International Council for the   C.M.1990/Assess:5
Exploration of the Sea

REPORT OF THE ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP

Copenhagen, 16-20 October 1989

*General Secretary
 ICES
 Palægade 2-4
 DK-1261   Copenhagen K
 DENMARK

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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 summer-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 93 000 t. All the herring were caught in the purse-fishery which started on 8th 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]

[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 1983-1986 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 south-western 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 summer-spawning 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 t in 1985. It is estimated that in 1989 the spawning stock was just less than 400,000 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, respectively, 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	F_{4+}	SSB at 1 July	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 $F_{0.1}$ = 0.22. During the period 1986 to 1988 the fishing mortality appears to have been somewhat higher.

2.7 Management 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 $F_{0.1}$ would lead to a catch of 76,000 t in 1989 and a spawning stock of 450,000 t in 1990. This is 20,000 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 $F_{0.1}$. Despite this the spawning stock would increase from 385,000 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 t in 1990. Assuming a catch of 90,000 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°N" by I. Røttingen.

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 t 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-group 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 0-group surveys in the Barents Sea (Toresen, 1985; Anon., 1989a) (Table 3.5).

3.3.3 Acoustic O-group estimates in the Barents Sea

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

Year class	Estimated number (billions)	Time of 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 O-group herring were detected in the Barents Sea. In November 1988, O-group herring were found in the area between 34^0 and 41^0 E and to the south of 71^0 30'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 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 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 underestimation 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 0-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 Karmøy.

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 Vesterålen 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-Vesterålen 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 $0°$ 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 Vesterålen-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 Regulation 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 0-group survey in the Barents Sea in August 1989 (Anon., 1989a), 0-group capelin were observed over the whole of the Barents Sea north to approximately 76°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 (billions)	Mean weight (g)	Biomass ('000 tonnes)
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 1970s 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 t. It is uncertain whether the stock/recruitment relations from the 1970s 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 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 1980s. 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 Regulation

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 (October-November) 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 Greenland-Jan 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 t. (The target spawning stock was 400,000 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 their 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 109×10^9 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 period. The TAC for the remainder of the season (December 1989-March 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 Mayen-Iceland 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 x 10^9 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 x 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 t 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.

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Table 2.1 Catch in numbers, millions and total catch in weight,
'000 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	0.047	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
Total	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	14.017
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
Total	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.

Rings	1970	1971	1972	1973	1974	1975	1976
1	85.0	88.0	96.0	90.0	80.0	110.0	103.0
2	169.0	165.0	177.0	199.0	189.0	179.0	189.0
3	216.0	237.0	278.0	257.0	262.0	241.0	243.0
4	263.0	273.0	332.0	278.0	297.0	291.0	281.0
5	312.0	301.0	358.0	337.0	340.0	319.0	305.0
6	329.0	324.0	379.0	381.0	332.0	339.0	335.0
7	338.0	346.0	410.0	380.0	379.0	365.0	351.0
8	357.0	368.0	419.0	397.0	356.0	364.0	355.0
9	378.0	390.0	470.0	385.0	407.0	407.0	395.0
10	396.0	409.0	500.0	450.0	410.0	389.0	363.0
11	408.0	412.0	500.0	450.0	410.0	430.0	396.0
12	425.0	420.0	500.0	450.0	423.0	416.0	396.0
13	430.0	442.0	500.0	450.0	423.0	416.0	396.0
14	450.0	450.0	500.0	450.0	423.0	416.0	396.0

Rings	1977	1978	1979	1980	1981	1982	1983
1	84.0	73.0	75.3	68.9	60.8	65.0	59.3
2	157.0	128.0	145.3	115.3	140.9	141.0	131.7
3	217.0	196.0	182.4	202.0	190.5	186.1	179.7
4	261.0	247.0	230.9	232.5	245.5	217.3	218.1
5	285.0	295.0	284.7	268.9	268.6	273.7	259.9
6	313.0	314.0	315.7	316.7	297.6	293.3	308.6
7	326.0	339.0	333.7	351.6	329.8	323.0	328.7
8	347.0	359.0	350.4	360.4	355.7	353.8	356.5
9	364.0	360.0	366.7	379.9	368.3	384.6	370.2
10	362.0	376.0	368.3	382.9	405.4	388.7	406.9
11	358.0	380.0	370.6	392.7	381.5	400.4	436.6
12	355.0	425.0	350.0	390.0	400.0	393.5	458.6
13	400.0	425.0	350.0	390.0	400.0	390.3	429.9
14	420.0	425.0	450.0	390.0	400.0	419.5	471.5

Rings	1984	1985	1986	1987	1988	1989[1]
1	49.3	53.2	60.0	60.0	75.1	75.1
2	131.4	146.0	139.7	167.5	157.1	157.1
3	188.6	219.0	200.4	200.3	221.1	221.1
4	216.8	265.8	251.6	239.8	238.6	238.6
5	244.9	285.3	282.2	277.7	271.0	271.0
6	276.9	314.6	297.9	303.7	298.0	298.0
7	314.6	334.6	320.1	325.3	318.9	318.9
8	321.7	365.0	334.4	338.8	333.6	333.6
9	350.7	388.2	372.7	355.8	354.0	354.0
10	333.8	400.5	379.6	377.6	351.5	351.5
11	361.9	453.0	393.9	400.2	371.4	371.4
12	446.3	468.9	407.8	403.6	390.4	390.4
13	417.4	432.8	404.8	424.1	408.5	408.5
14	392.3	446.7	438.9	429.6	436.6	436.6

[1] Estimated.

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

[1] Estimated.

Table 2.4   Stock abundance and catches by age groups (millions) and fishing mortality rates for the Icelandic summer spawners. F' 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 62^0 N.

Rings 1988	Acoustic survey estimate Nov - Dec 1988	Catch 1988	F'	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	98.2	.17	.309	.164
5	216.4	68.5	.27	.491	.260
6	52.8	22.7	.34	.618	.328
7	29.1	19.9	.5	1	.53
8	38.0	31.8	.58	1	.53
9	20.2	12.2	.45	1	.53
10	12.1	10.1	.58	1	.53
11	10.5	7.3	.5	1	.53
12	6.1	7.2	.73	1	.53
13	4.1	4.8	.73	1	.53
14	2.9	1.9	.48	1	.53

Table 2.5   VIRTUAL POPULATION ANALYSIS.

SUMMER SPAWNING HERRING AT ICELAND (FISHING AREA VA)

FISHING MORTALITY COEFFICIENT   UNIT: Year-1   NATURAL MORTALITY COEFFICIENT = .10

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
1	.064	.140	.002	.000	.000	.008	.001	.002	.013	.004	.012	.003
2	.907	.646	.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	.252	.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	1982-85
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	.646	.530	.816
14	.300	.200	.130	.160	.250	.250	.530	.197
15+	.300	.200	.130	.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 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	0.538	0.520	1.161	0.893	0.762	5.892
13	0.268	0.058	0.471	0.440	1.049	0.097	0.132
14	0.005	0.242	0.028	0.375	0.294	0.853	0.017
Spawning 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:	tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	600.0	.00	.10	.00	60.000	60.000
2	857.0	.15	.10	.05	135.700	135.700
3	229.7	.50	.10	.90	196.900	196.900
4	347.1	1.00	.10	1.00	240.500	240.500
5	524.0	1.00	.10	1.00	274.200	274.200
6	218.8	1.00	.10	1.00	304.100	304.100
7	55.5	1.00	.10	1.00	327.700	327.700
8	27.0	1.00	.10	1.00	348.500	348.500
9	43.1	1.00	.10	1.00	372.300	372.300
10	16.5	1.00	.10	1.00	384.400	384.400
11	13.7	1.00	.10	1.00	415.100	415.100
12	9.9	1.00	.10	1.00	427.900	427.900
13	9.8	1.00	.10	1.00	420.500	420.500
14	6.4	1.00	.10	1.00	439.600	439.600

present exploitation pattern
$\bar{F}_{0)}$

Table 2.8   Results.

12.58.16   20 OCTOBER 1989
ICELANDIC SUMMER SPAWNERS

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

| | | | | | | at 1 January | | at spawning time | |
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.0000	.000	.0	600.00	36000	.00	0	.00	0
2	.0390	31.204	4234.4	857.00	116294	42.85	5814	40.76	5531
3	.1300	26.676	5252.5	229.70	45227	206.73	40705	196.65	38719
4	.2600	75.788	18226.9	347.10	83477	347.10	83477	330.17	79406
5	.2600	114.413	31372.0	524.00	143680	524.00	143680	498.44	136673
6	.2600	47.774	14528.0	218.80	66537	218.80	66537	208.13	63292
7	.2600	12.118	3971.1	55.50	18187	55.50	18187	52.79	17300
8	.2600	5.895	2054.5	27.00	9409	27.00	9409	25.68	8950
9	.2600	9.411	3503.6	43.10	16046	43.10	16046	41.00	15263
10	.2600	3.603	1384.9	16.50	6342	16.50	6342	15.70	6033
11	.2600	2.991	1241.7	13.70	5686	13.70	5686	13.03	5409
12	.2600	2.162	925.0	9.90	4236	9.90	4236	9.42	4029
13	.2600	2.140	899.8	9.80	4120	9.80	4120	9.32	3919
14	.2600	1.397	614.3	6.40	2813	6.40	2813	6.09	2676
Total		335.571	88208.6	2958.50	558061	1521.38	407058	1447.18	387205

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

| | | | | | | at 1 January | | at spawning time | |
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.0000	.000	.0	400.00	24000	.00	0	.00	0
2	.0390	19.768	2682.5	542.90	73671	27.15	3683	25.82	3503
3	.1300	86.610	17053.6	745.79	146845	671.21	132160	638.47	125715
4	.2600	39.849	9583.7	182.50	43892	182.50	43892	173.60	41751
5	.2600	52.875	14498.4	242.16	66401	242.16	66401	230.35	63162
6	.2600	79.823	24274.2	365.58	111173	365.58	111173	347.75	105751
7	.2600	33.331	10922.5	152.65	50023	152.65	50023	145.21	47584
8	.2600	8.455	2946.4	38.72	13494	38.72	13494	36.83	12836
9	.2600	4.113	1531.3	18.84	7013	18.84	7013	17.92	6671
10	.2600	6.566	2523.8	30.07	11558	30.07	11558	28.60	10995
11	.2600	2.514	1043.4	11.51	4778	11.51	4778	10.95	4545
12	.2600	2.087	893.0	9.56	4089	9.56	4089	9.09	3890
13	.2600	1.508	634.2	6.91	2904	6.91	2904	6.57	2762
14	.2600	1.493	656.3	6.84	3005	6.84	3005	6.50	2859
Total		338.990	89243.0	2754.03	562852	1763.70	454180	1677.68	432029

24

Table 2.8 (cont'd)

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

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.0000	.000	.0	400.00	24000	.00	0	.00	0
2	.0390	13.178	1788.3	361.93	49114	18.10	2455	17.21	2335
3	.1300	54.867	10803.3	472.45	93025	425.20	83722	404.47	79639
4	.2600	129.381	31116.0	592.55	142508	592.55	142508	563.65	135558
5	.2600	27.802	7623.2	127.33	34913	127.33	34913	121.12	33210
6	.2600	36.890	11218.2	168.95	51378	168.95	51378	160.71	48872
7	.2600	55.691	18249.8	255.06	83582	255.06	83582	242.62	79506
8	.2600	23.254	8104.0	106.50	37115	106.50	37115	101.31	35305
9	.2600	5.899	2196.0	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	8.03	3436	7.64	3269
13	.2600	1.456	612.3	6.67	2804	6.67	2804	6.34	2667
14	.2600	1.052	462.5	4.82	2118	4.82	2118	4.58	2015
Total		358.673	95928.6	2565.43	547815	1774.35	467854	1687.81	445036

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

						at 1 January		at spawning time	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass	sp.stock size	sp.stock biomass
1	.0000	.000	.0	400.00	24000	.00	0	.00	0
2	.0390	13.178	1788.3	361.93	49114	18.10	2455	17.21	2335
3	.1300	36.578	7202.2	314.97	62016	283.47	55815	269.64	53092
4	.2600	81.962	19711.8	375.38	90278	375.38	90278	357.07	85875
5	.2600	90.266	24750.9	413.41	113356	413.41	113356	393.25	107828
6	.2600	19.397	5898.5	88.83	27014	88.83	27014	84.50	25697
7	.2600	25.737	8434.0	117.87	38627	117.87	38627	112.12	36743
8	.2600	38.854	13540.6	177.95	62014	177.95	62014	169.27	58990
9	.2600	16.224	6040.1	74.30	27663	74.30	27663	70.68	26314
10	.2600	4.115	1581.9	18.85	7244	18.85	7244	17.93	6891
11	.2600	2.002	831.0	9.17	3806	9.17	3806	8.72	3620
12	.2600	3.196	1367.5	14.64	6262	14.64	6262	13.92	5957
13	.2600	1.223	514.5	5.60	2356	5.60	2356	5.33	2241
14	.2600	1.016	446.6	4.65	2045	4.65	2045	4.43	1945
Total		333.748	92107.9	2377.56	515801	1602.22	438941	1524.08	417533

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

Year	A	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[3]
1986	71,122	55,507	156	–	126,785	225,256[3]
1987	62,910	49,798	181	–	112,899	127,306[3]
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 = by-catches of 0- and 1-group herring in the sprat fishery.
D = USSR-Norway by-catch in the capelin fishery (2-group).

[1] Includes also by-catches of adult herring in other fisheries.
[2] In 1972, there was also a directed herring 0-group fishery.
[3] 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	2,600	169,872
1986	225,256	-	225,256
1987	108,417	18,889	127,306
1988	144,266	20,225	164,491
1989	38,223[1]	15,123	53,346[1]

[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	800
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	-	-	870	11,216	8,165
7	694	278	196	5	13,086	419	-	326	15,838
8	1,486	178	-	2	-	10,766	620	-	441
9	198	-	-	-	-	-	5,027	-	8
10	-	-	-	-	-	-	-	2,534	-
11	494	-	-	-	-	-	-	-	2,688
12	593	-	-	-	-	-	-	-	-
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	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	4,591	7,892	21,191	5,388	15,500	17,594	501,393	23,904
5	8,596	4,507	9,521	61,543	16,500	14,500	18,672	588,457
6	2,200	6,258	6,181	18,202	130,000	15,500	3,502	8,600
7	4,512	1,960	6,823	12,638	59,000	105,500	7,058	4,686
8	8,280	5,075	1,293	15,608	55,000	75,000	28,000	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	8,550
11	114	37	143	6,478	31,000	19,469	4,500	3,100
12	964	37	40	-	50,000	66,000	7,834	3,645
13	-	37	143	-	-	80,000	6,500	2,512
14	-	-	862	-	-	-	7,000	1,538
15	-	-	-	1,652	-	-	453	611
16	-	-	-	-	2,638	2,469	-	-

[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 1975-1988 (number in millions).

Year	Area			Total
	$62^0 N - 65^0 N$	$65^0 N - 68^0 N$	North of $68^0 30'$	
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	4,543	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 0-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, 1976-1989.

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)U	.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	1344451	200248	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
TOTAL NO	1432037	1717950	1810360	1978145	2440454	2193128	1939787	1714543	1249188	9157512	7910592	
SPS NO	1261974	1201969	1343873	1485782	1506795	1601673	1738860	1547681	1985544	3020922	6633088	
TOT.BIOM	461983	551495	623369	627467	707734	739762	663807	580973	1849755	1380015	1535009	
SPS BIOM	426083	453564	517812	530059	532365	590070	621194	552059	491959	513114	1336072	

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	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
1	5314000.0	.05	.90	.00	.009	.006
2	90000.0	.08	.90	.00	.111	.100
3	60000.0	.14	.13	.10	.154	.154
4	380834.0	.14	.13	.30	.195	.175
5	144295.0	.19	.13	.90	.234	.209
6	5554204.0	.24	.13	1.00	.262	.252
7	30322.0	.24	.13	1.00	.291	.305
8	16522.0	.24	.13	1.00	.293	.325
9	19967.0	.24	.13	1.00	.341	.340
10	49739.0	.24	.13	1.00	.351	.359
11	30146.0	.24	.13	1.00	.394	.395
12+	40220.0	.24	.13	1.00	.361	.375

Table 3.12

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

NORWEGIAN SPRING-SPAWNING HERRING

Year 1989					Year 1990				Year 1991		
fac-tor	ref. F	stock biomass	sp.stock biomass	catch	fac-tor	ref. F	stock biomass	sp.stock biomass	catch	stock biomass	sp.stock biomass
.3	.06	1613	1514	100	.0	.00	1812	1539	0	1927	1476
					.1	.02			34	1891	1442
					.2	.04			67	1856	1409
					.3	.06			99	1821	1377
					.4	.08			130	1787	1346
					.5	.11			161	1754	1315
					.6	.13			192	1722	1285
					.7	.15			221	1690	1256
					.8	.17			250	1659	1227
					.9	.19			278	1629	1199
					1.0	.21			305	1600	1172

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-factor    .292 and reference F    .0619 *
*-----------------------------------------------------*
* Run depending on a TAC value                         *
***********************************************************
```

| | | | | | | at 1 January | |
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass
1	.0146	50785	457	5314000	31884	0	0
2	.0230	1354	150	90000	9000	0	0
3	.0411	2268	349	60000	9240	6000	924
4	.0420	14695	2865	380834	66645	114250	19993
5	.0554	7299	1708	144295	30157	129865	27141
6	.0685	345306	90470	5554204	1399659	5554204	1399659
7	.0685	1885	548	30322	9248	30322	9248
8	.0685	1027	300	16522	5369	16522	5369
9	.0685	1241	423	19967	6788	19967	6788
10	.0685	3092	1085	49739	17856	49739	17856
11	.0685	1874	738	30146	11907	30146	11907
12+	.0685	2500	902	40220	15082	40220	15082
Total		433330	100000	11730250	1612840	5991236	1513972

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

| | | | | | | at 1 January | |
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass
1	.0150	68793	619.1	7000000	42000	0	0
2	.0237	32939	3656.3	2129230	212923	0	0
3	.0423	1389	214.0	35757	5506	3575	550
4	.0432	2005	391.1	50562	8848	15168	2654
5	.0570	16670	3900.8	320653	67016	288588	60314
6	.0705	7657	2006.3	119873	30208	119873	30208
7	.0705	290919	84657.5	4554013	1388974	4554013	1388974
8	.0705	1588	465.3	24861	8080	24861	8080
9	.0705	865	295.1	13546	4605	13546	4605
10	.0705	1045	367.1	16371	5877	16371	5877
11	.0705	2605	1026.5	40782	16108	40782	16108
12+	.0705	3685	1330.5	57694	21635	57694	21635
Total		430165	98929.7	14363348	1811784	5134477	1539010

Table 3.13 (cont'd)

```
*******************************************************
* Year 1991. F-factor    .300 and reference F    .0637 *
*******************************************************
```

						at 1 January	
age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	sp.stock size	sp.stock biomass
1	.0150	68793	619.1	7000000	42000	0	0
2	.0237	43372	4814.4	2803616	280361	0	0
3	.0423	32849	5058.8	845405	130192	84540	13019
4	.0432	1193	232.8	30098	5267	9029	1580
5	.0570	2210	517.3	42521	8887	38269	7998
6	.0705	16990	4451.5	265964	67022	265964	67022
7	.0705	6266	1823.6	98095	29919	98095	29919
8	.0705	238065	69753.2	3726646	1211160	3726646	1211160
9	.0705	1299	443.2	20344	6917	20344	6917
10	.0705	708	248.6	11085	3979	11085	3979
11	.0705	855	337.2	13397	5291	13397	5291
12+	.0705	5147	1858.4	80585	30219	80585	30219
Total		417754	90158.0	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 number (10E-7)	Biomass tonnes (10E-3)	Biomass (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		39	45	1	84	19.2	47.5
17.0-17.4		32	9		41	11.6	28.3
17.5-17.9		12	18		29	9.0	16.7
18.0-18.4		5	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 '000 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	-	114.4	-	-	-	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	-	1,127.9
1980	392.0	-	367.4	118.7	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[1]	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 class	Estimates in August as 1-group	Calculated from estimates of 3- and 4-group spawners
1981	119	145
1982	155	147
1983	286	252
1984	31	100
1985	71	142
1986	101	111[1]
1987	147	−
1988	111	−

[1] 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 class	Mean weight autumn	Mean weight winter	Year class	Mean weight autumn	Mean weight 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		17.4	19.4

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

Estimate	Period	Mortality per month
I	1 November 1978 - 31 January 1979	0.045
II	1 November 1979 - 31 January 1980	0.026
III	1 November 1980 - 31 January 1981	0.030
IV	15 November 1981 - 31 January 1982	0.048
V	1 December 1981 - 31 January 1982	0.035
VI	1 November 1982 - 31 January 1983	0.028
VII	1 November 1983 - 31 January 1984	0.034
VIII	15 November 1984 - 31 January 1985	0.035
Mean		0.035
Standard deviation		0.008

FISH STOCK SUMMARY

STOCK: Herring – Va (Summer)
24-10-1989

Figure 2.1

Trends in yield and fishing mortality (F)

Trends in spawning stock biomass (SSB)
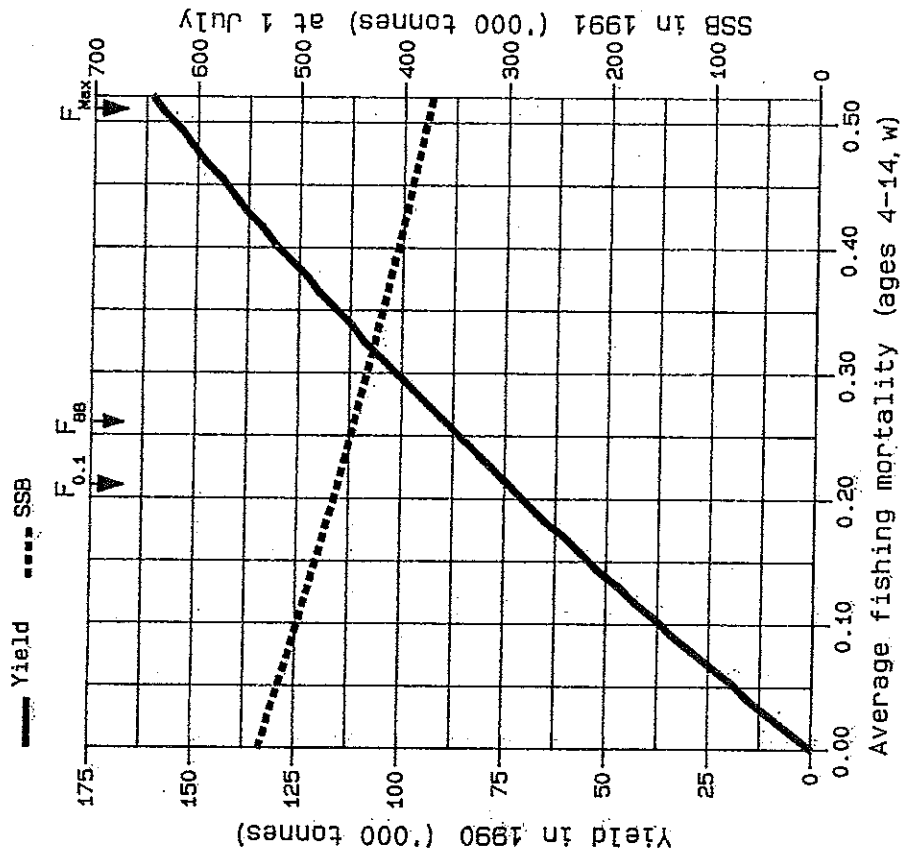and recruitment (R)

A

B

(cont'd)

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FISH STOCK SUMMARY

STOCK: Herring – Va (Summer)
24-10-1989

Figure 2.1 (cont'd)

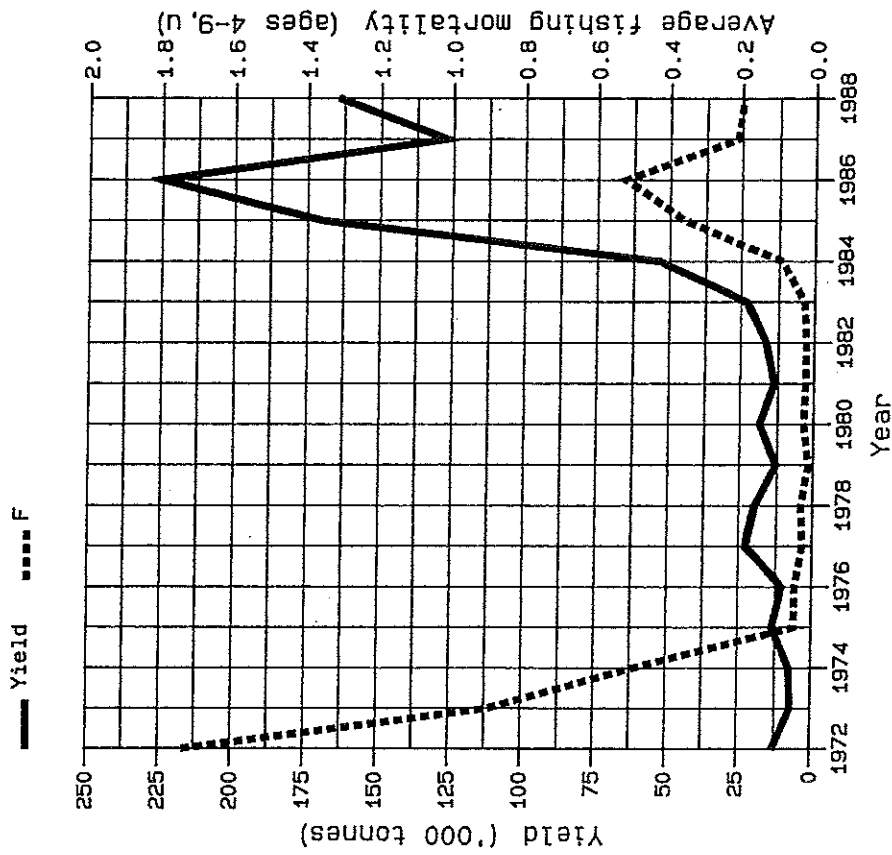Long-term yield and spawning stock biomass

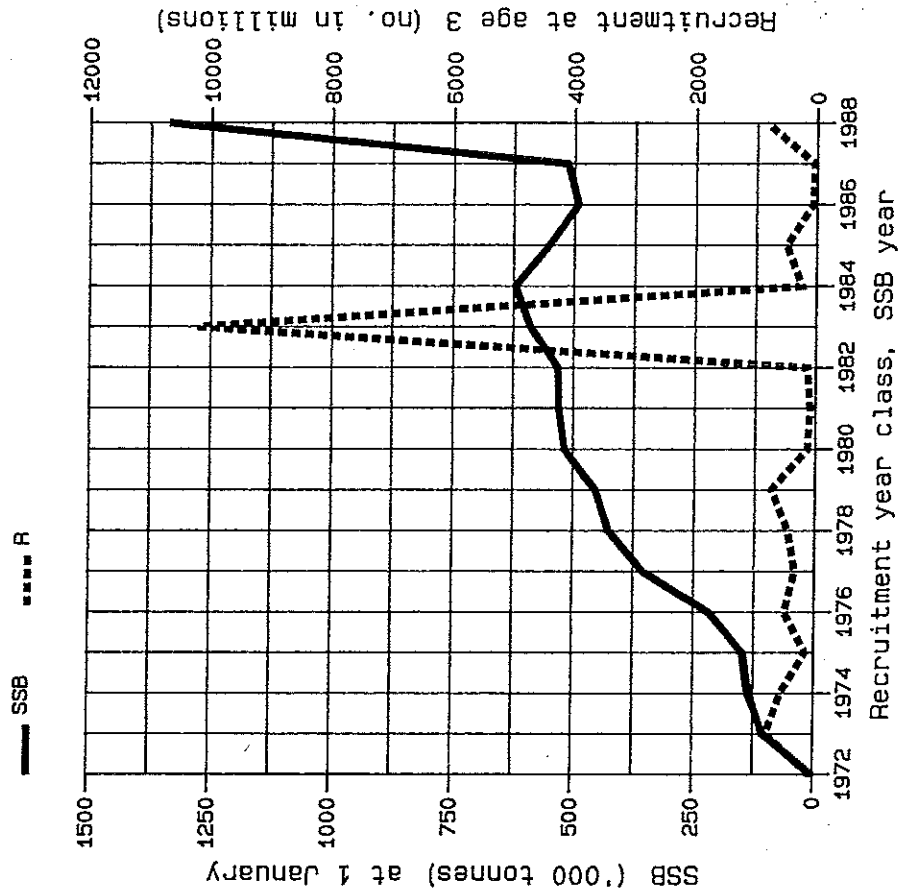Short-term yield and spawning stock biomass

Figure 3.1

FISH STOCK SUMMARY

STOCK: Norwegian Spring Spawning Herring
24-10-1989

Trends in yield and fishing mortality (F)

Trends in spawning stock biomass (SSB) and recruitment (R)

FISH STOCK SUMMARY

STOCK: Norwegian Spring Spawning Herring
24-10-1989

Figure 3.1 (cont'd)

Long-term yield and spawning stock biomass
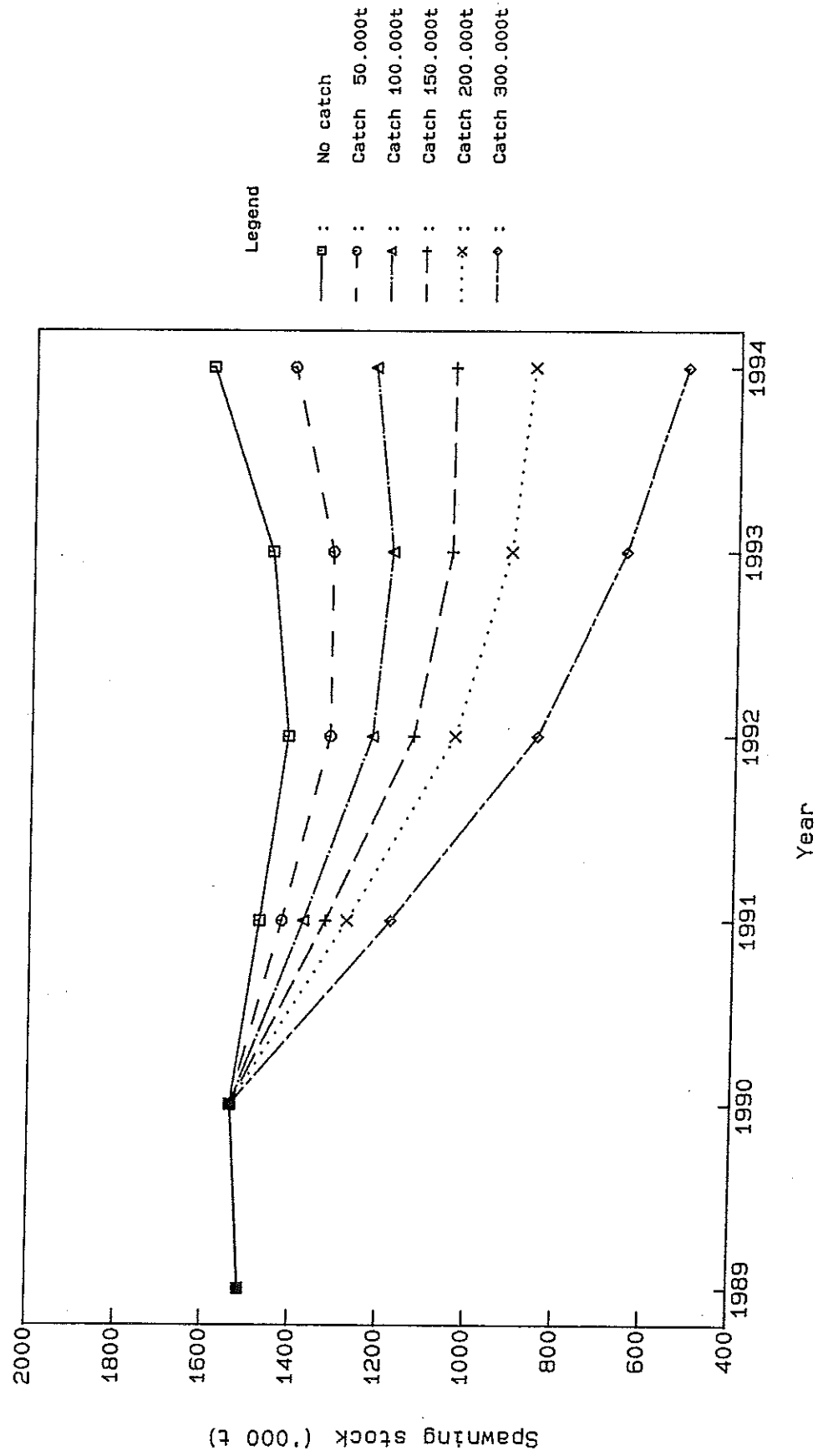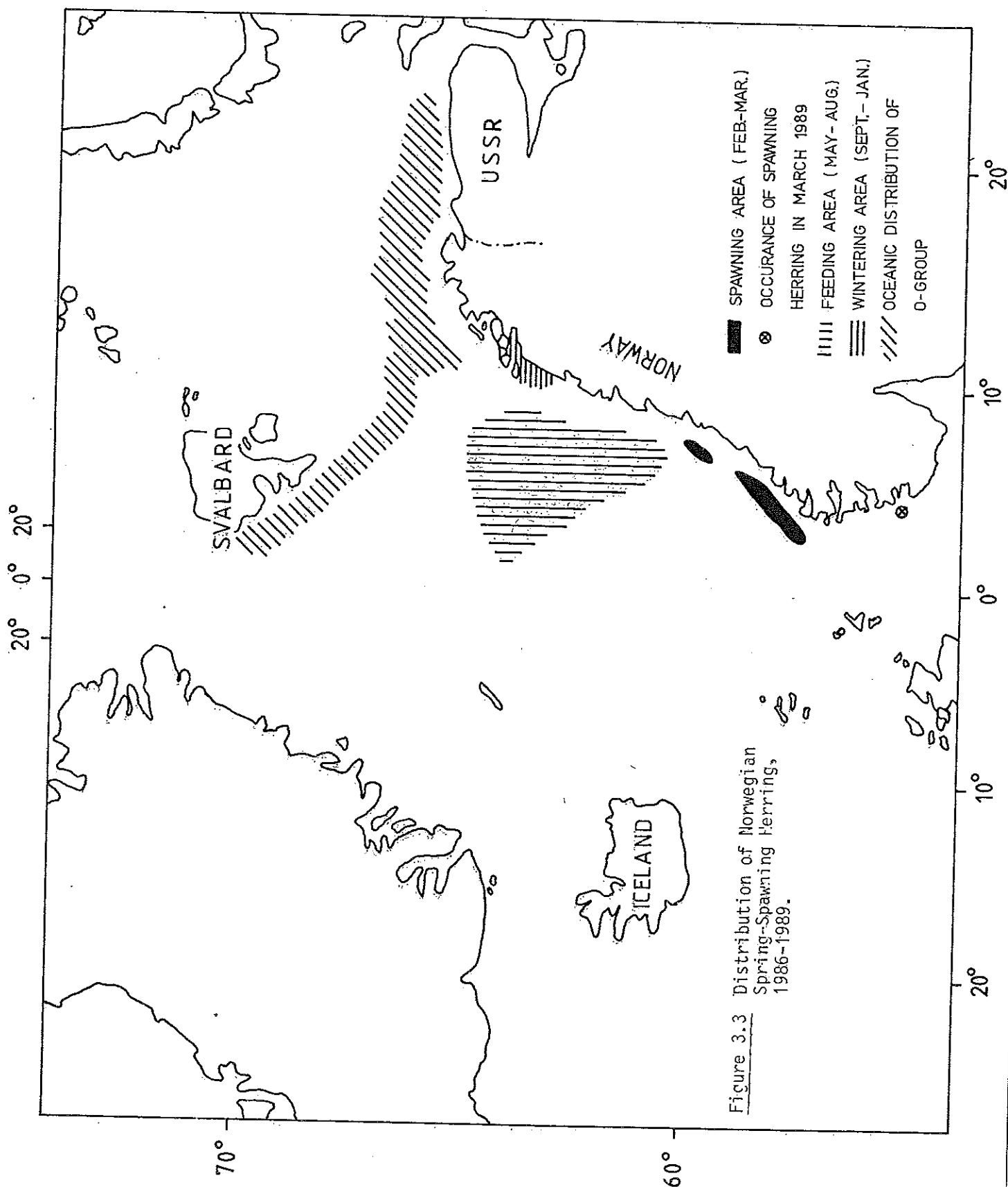
Short-term yield and spawning stock biomass

Average fishing mortality (ages 4-9, u)

C
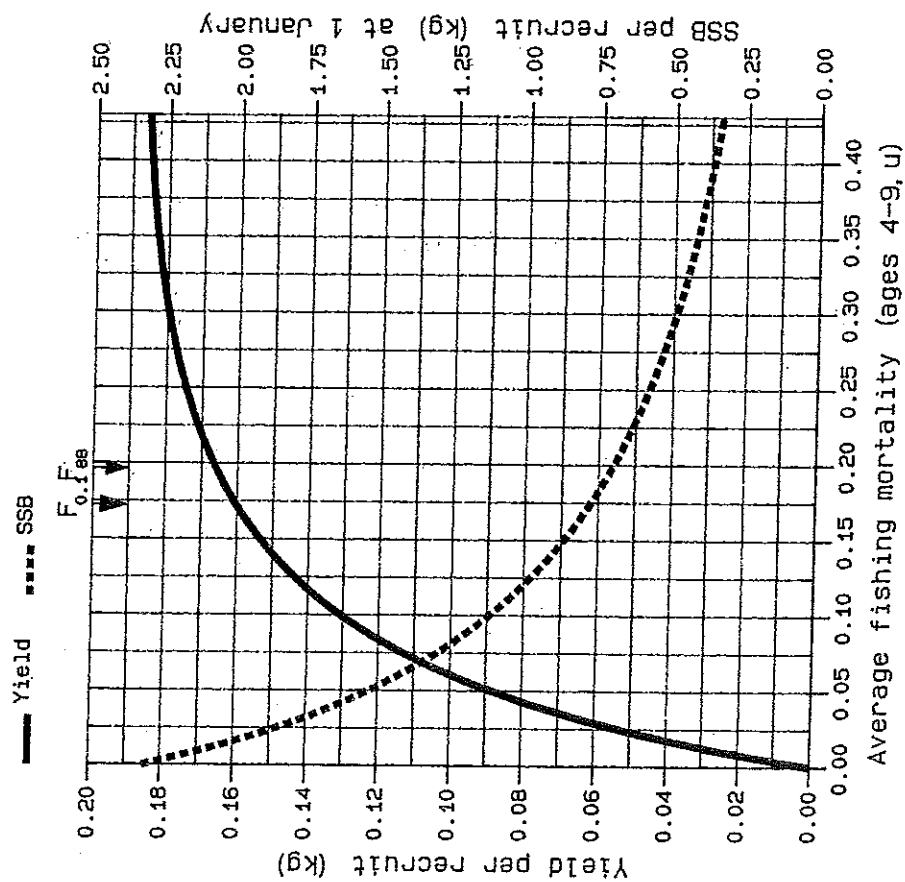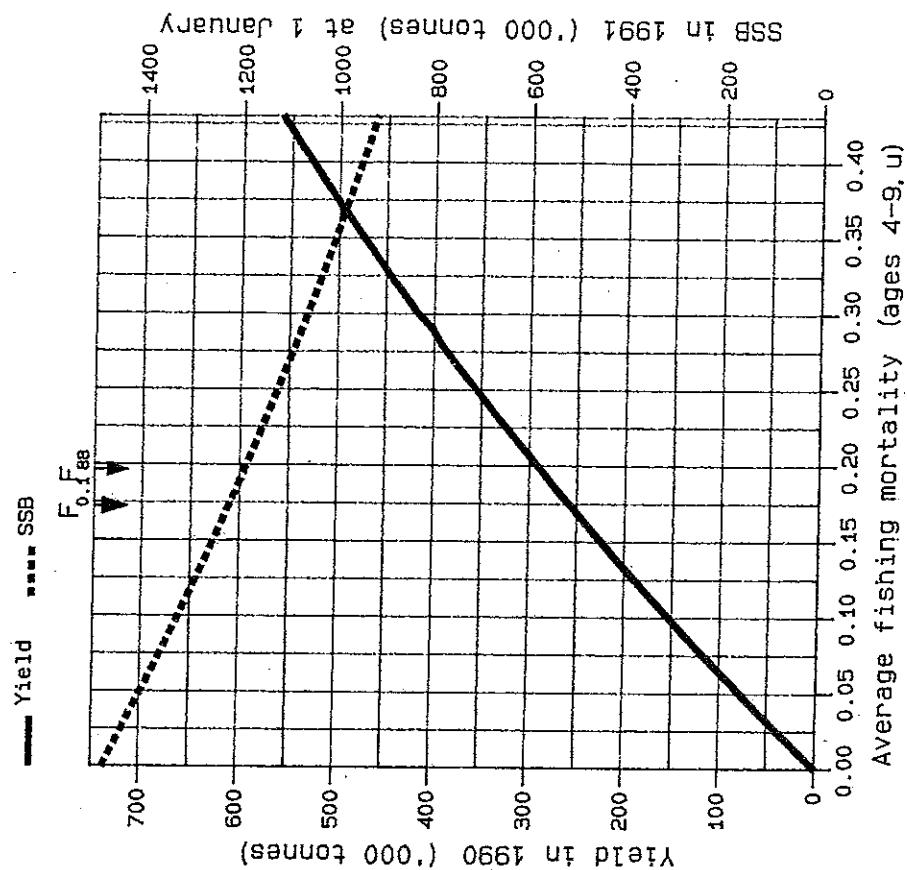
D

Figure 3.2

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

Legend

▫ :	——	No catch
○ :	—	Catch 50.000t
△ :	—·—	Catch 100.000t
+ :	— —	Catch 150.000t
× :	·····	Catch 200.000t
◇ :	—··—	Catch 300.000t

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Figure 3.3 Distribution of Norwegian
Spring-Spawning Herring,
1986–1989.

SPAWNING AREA (FEB-MAR.)

⊗ OCCURANCE OF SPAWNING
HERRING IN MARCH 1989

||||| FEEDING AREA (MAY- AUG.)

≡ WINTERING AREA (SEPT.- JAN.)

/// OCEANIC DISTRIBUTION OF
0-GROUP

USSR

NORWAY

SVALBARD

ICELAND

70°

60°

20°

10°

0°

10°

20°

20°

0°

20°
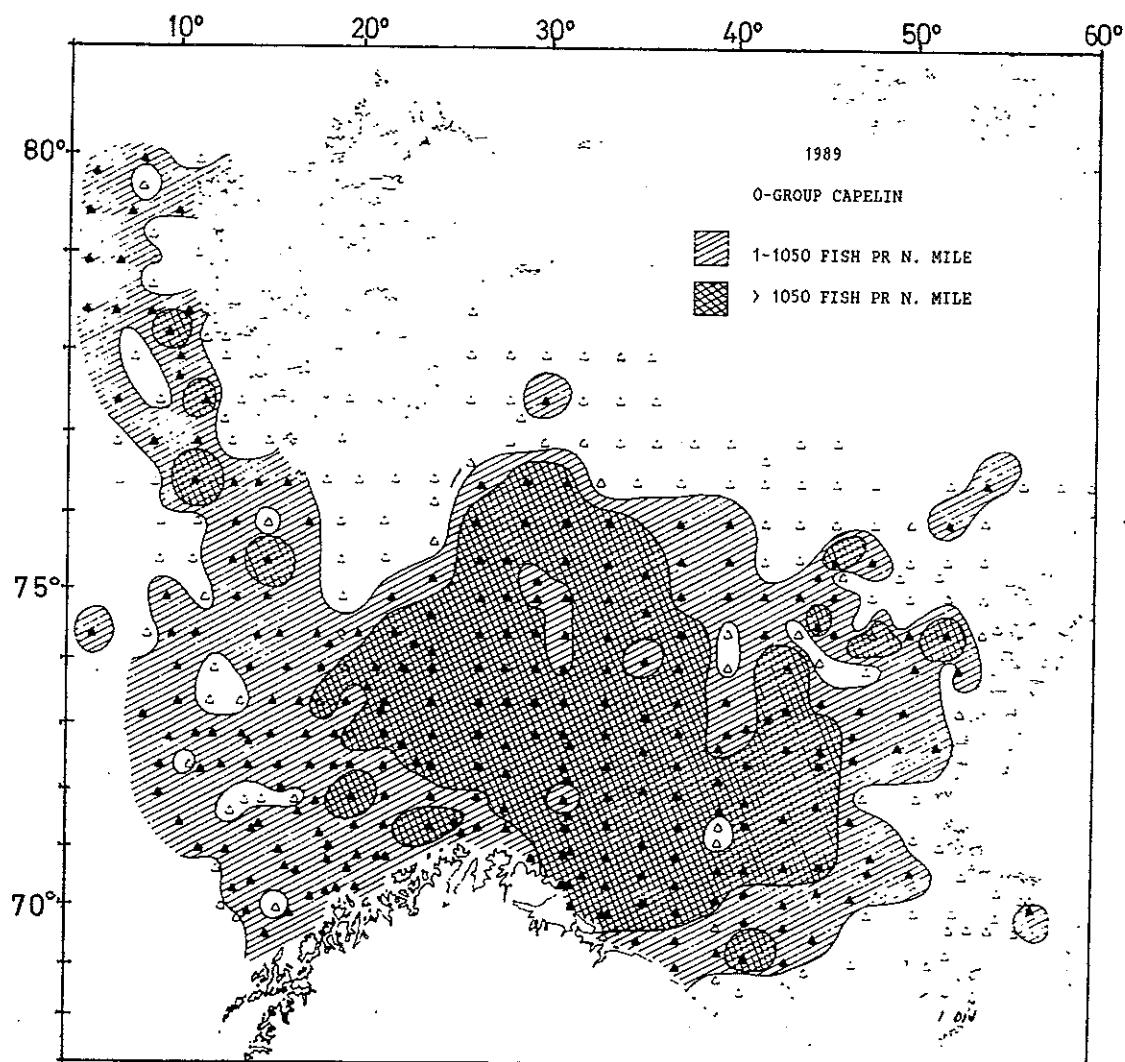
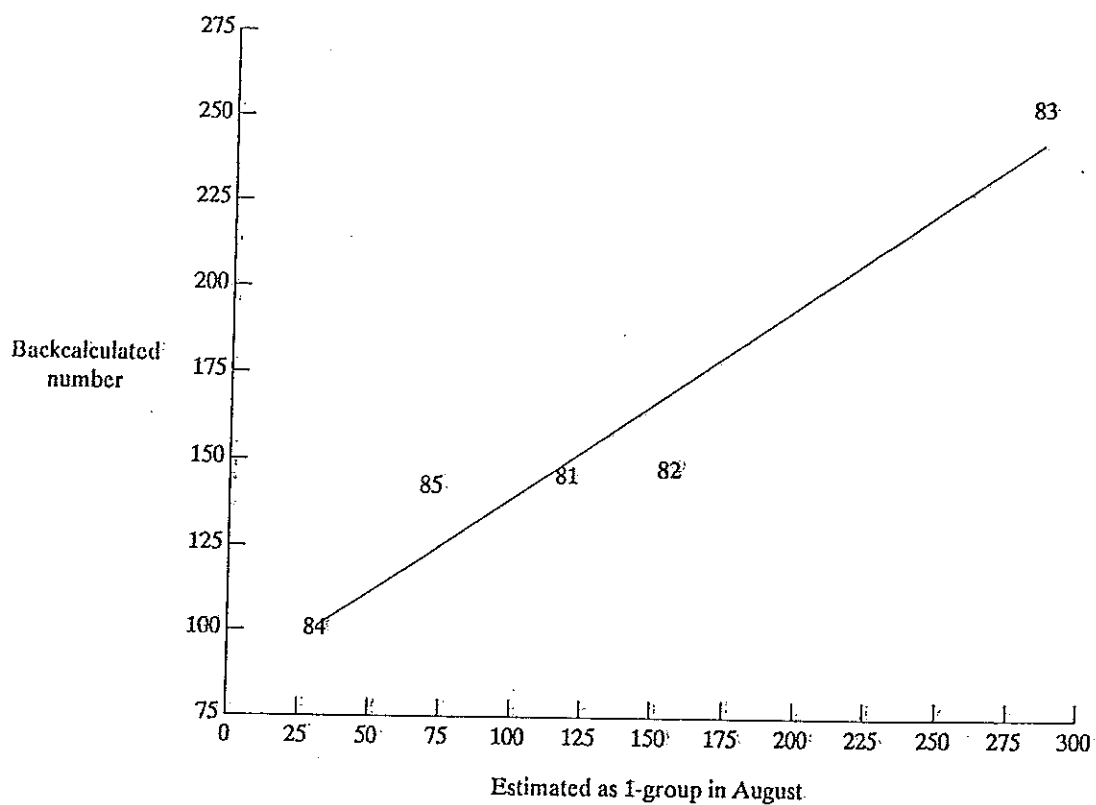Figure 4.1 0-group distribution Barents Sea Capelin, August 1989.
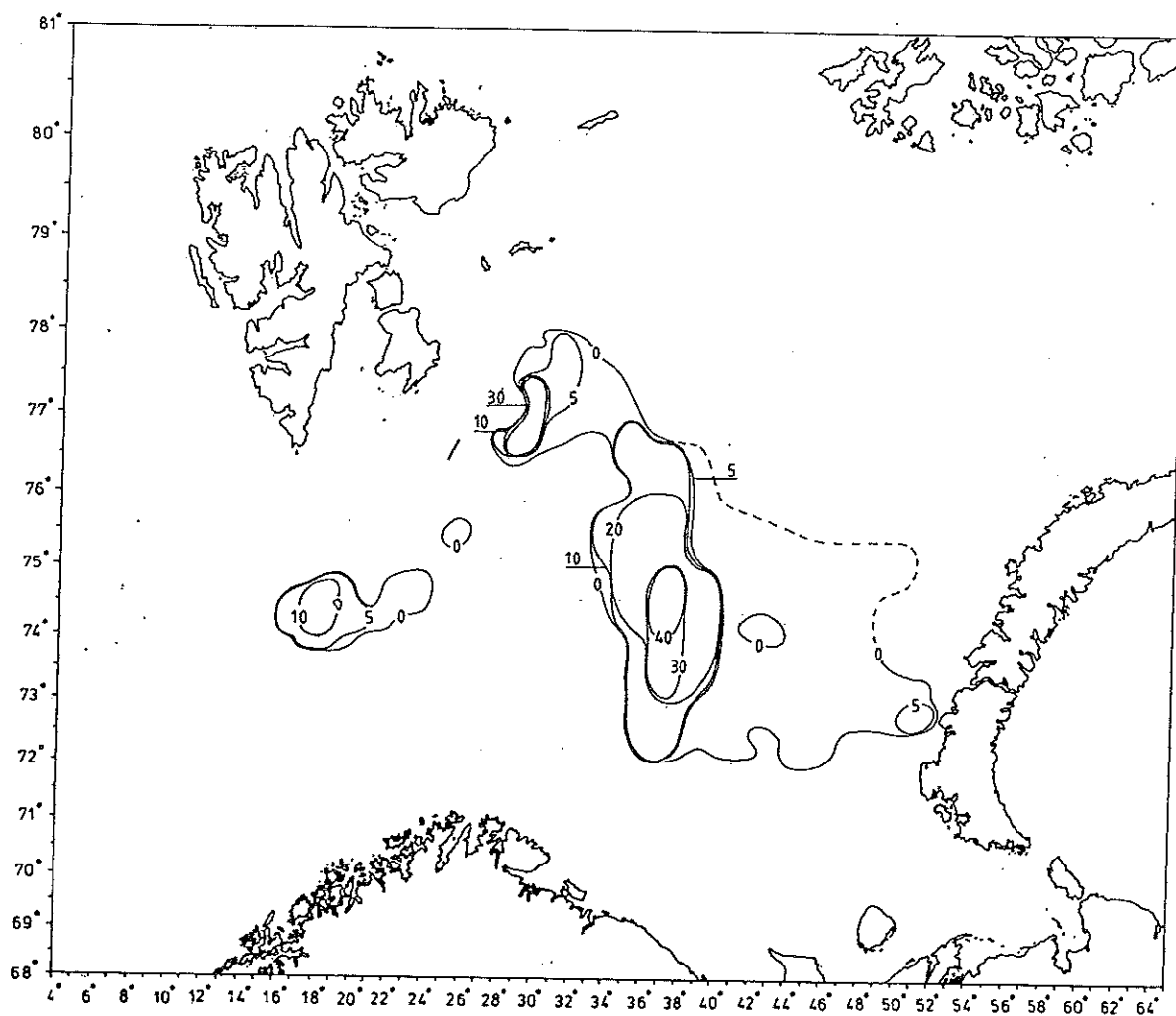
Figure 4.2 Estimated total density distribution of Barents Sea Capelin,
September 1989 (tonnes per square nautical mile).

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