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REPORT OF THE ATLANTO-SCANDIAN HERRING AND CAPELIN WORKING GROUP

Copenhagen, 8 - 12 April 1991

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1 INTRODUCTION AND PARTICIPATION

1.1 Terms of Reference

The Atlanto-Scandian Herring and Capelin Working Group (Chairman: Dr V.N. Schleinik, USSR) met at ICES Headquarters from 8-12 April 1991 (C.Res. 1990/ 2:5:12) to

a) assess the status of the Norwegian spring-spawning herring, Icelandic summer-soawning herring, and capelin stocks in Sub-areas I, II, V, and XIV and provide catch options within safe biological limits for the herring for 1992 and for the capelin for the summer-autumn 1991 and winter 1991/1992 seasons;

b) provide information on the present spatial and temporal distribution of Norwegian spring-spawning herring;

c) evaluate the expectation of rebuilding the spawning stock biomass of Norwegian spring-spawning herring to the target level of 2.5 million t.

1.2 Participants

H. Gjøsæter	Norway
J.A. Jacobsen	Faroe Islands
J. Møller Jensen (from 10 April)	Greenland
A. Krysov	USSR
I. Røttingen	Norway
V. Shleinik (Chairman)	USSR
G. Stefansson	Iceland
S. Sveinbjörnsson	Iceland

1.3 Nomenclature

The types and stocks of herring which have been included in the term "Atlanto-Scandian" seems to have varied. The term was introduced by Johansen (1919). He felt that the large spring herrings from "Iceland, the Northlands coasts of Norway and the southwest coast of Norway" stood very close to each other and deserved to be regarded as a unit. These herring were distinguished in comparison with all other herring by a very high average number of vertebra combined with a relatively small number of keeled scales. He proposed the name Atlanto-Scandian spring herring for this group.

Later biological research and tagging experiments (Fridriksson, 1935, 1944; Fridriksson and Aasen, 1952) have shown that this group consisted of two unit stocks, one unit stock spawning on the west coast of Norway (with occasionally minor spawning at Faroes (Jakobsson, 1970) and in the area north of Shetland) and the other unit stock spawning in the south and west coast of Iceland.

A third herring stock, the summer spawners, also appeared off Iceland, and this stock has often been included in the Atlanto-Scandian Herring Group in spite of the biological differences compared to the two spring spawning stocks.

During the last 30 years or so, herring workers (for example, Anon., 1963 and 1970) dealing with the northern herring stocks have used the name "Atlanto-Scandian herring" to include three unit stocks: Norwegian spring spawners (Norwegian spring herring is the traditional name of the herring spawning at the west coast of Norway); Icelandic spring spawners and Icelandic summer spawners). In spite of this, the term Atlanto-Scandian herring is frequently used as a

synonym for Norwegian spring spawners, which has sometimes given rise to misunderstanding (Jakobsson, 1980).

In view of this, the Working Group recommends that the term "Atlanto-Scandian" be limited to spring-spawning herring as described by Johansen (1919), but that the names of the unit stocks, which have now been accepted and are in common use, i.e., Norwegian spring spawners; Iceland spring spawners and Icelandic summer spawners, should be used instead of the term Atlanto-Scandian herring.

2 ICELANDIC SUMMER-SPAWNING HERRING

2.1 Working Papers Presented "Icelandic Summer-spawning Herring" by G. Stefansson

2.2 The Fishery

The catches of summer spawning herring from 1972-1990 are given in Table 2.1. The 1990 catches amounted to about 93,000 t, which includes an estimate of unavoidable dumping of 3,250 t. In 1990, the fishery was a purse-seine fishery which started in October and finished in December, except for a catch of some 2,300 t caught in January. The fishery in 1990 took place almost entirely off southeast Iceland with only minor catches taken in the east coast fiords. Of the total catch, some 39,000 t or 42% went for reduction. The text table below gives the catches and the TACs recommended during the last few years for this fishery:

Year	Catches	TACs	Recommended TACs[1]
1984	50.3	50.0	50.0
1985	49.1	50.0	50.0
1986	65.5	65.0	65.0
1987	73.0	72.9	70.0
1988	92.8	90.0	100.0
1989	101.0[2]	90.0	-
1990	92.8[2]	90.0	-

Weights in '000 t.
[1] Recommended by ACFM.
[2] Includes discard estimates (3,700 t in 1989 and 3,250 t in 1990).

2.3 Catch in Number and Weight at Age

The catches in number at age for the Icelandic summer spawners for the period 1972-1990 are given in Table 2.1. As usual, age is given in rings, where the age in years equals the number of rings plus one. In the first years after the fishery was reopened 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 3- to 10-ring herring. In 1989 and 1990, the 1983 year class dominated in the catch. It should be noted that the proportion of older herring (7 rings or more) is considerably lower in 1989-1990 (8-15%) than in 1986-1987 (27-43%). This is partly due to the strong 1983 year class becoming fully recruited and thus replacing older year classes, including the 1979 year class, in the catches.

The weights at age for each year are given in Table 2.2. The mean weight at age generally went down during the period from 1972 to about 1980, but has levelled

off somewhat since then (Figure 2.1). Maturity at age is given in Table 2.3.

2.4 Acoustic Surveys

The Icelandic summer-spawning herring stock has been monitored by acoustic surveys annually since 1973 (no satisfactory estimates are available for the stock size at the beginning of the years 1977, 1983 and 1987). These surveys have been carried out in November-December or January, usually after the fishery has been closed.

In November 1990 and in February 1991, measurements of two different age components of the stock were carried out. The survey in November 1990 was aimed at the 0- and 1-ringed herring off west and north Iceland. The February measurement was part of a capelin survey and aimed at the adult concentration at southeast Iceland. The 1988 year class (1-ringers, 1990) was recorded in both surveys. The locations of the two measurements were entirely different and records of juvenile herring off the west coast persisted into January, 1991. It is therefore assumed that the two measurements of the 1988 year class are measurements of two distinct components (514 million in the west and north and 605 million in the southeast), so the measurements have been added to obtain a total estimate and hence the 1988 year class has been estimated as 1,100 million individuals in 1991, backcalculated to some 1,200 million 1-ringers in 1990.

The results of the November survey are the basis for the present assessment of the 0-ringers in 1990, and the results of the February survey are used as input for the assessment of the 2+ ringers in 1990. The results are given in Table 2.4.

2.5 Stock Assessment

The results of the acoustic surveys together with the catch in numbers by age were used to calculate initial fishing mortalities for the 1990 season. Results are given in Table 2.4 as F'. In this analysis, 5 ringers and older have been grouped for estimating the fishing mortality on the oldest herring. If 6+ is used instead, the 5 ringers have virtually the same mortality as the 6+, and hence they are included in the plus group.

As in previous years, the estimation procedure of Halldórsson *et al*. (1986) was used to estimate the stock size in the final year, based on all available acoustic data for the older part of the stock (5+ ringers on 1 January each year). The procedure was modified by minimizing the sum of squares of log-transformed data, rather than untransformed data, since there is increased variability in later years coinciding with the increase in stock size. This has little effect on the final results (as indicated in the appendix to last year's report), but should make associated confidence intervals for the terminal fishing mortality more valid.

The fishing mortalities on the 1-4 ringers in 1990, based on the 1991 survey, have been used without modification, since they cannot be estimated from a procedure using only 5+ ringers as a criterion. This is in accordance with earlier procedure for 1-ringers (and 0-ringers), since those are considered covered by surveys and juvenile estimates have been used in previous years. The 2-4 ringers may not be fully covered by either survey, and hence they may not be as precisely estimated. However, these year classes are of little significance in the projections. The procedure used previously was to obtain a fishing pattern for 2-4 ringers based on the survey, and scale this pattern in the same fashion as the mortality on the 5+ ringers. This has very little effect on the results, since the survey estimate for the 5+ fishing mortality is 0.272, but the fitted terminal F is 0.265.

A series of VPAs was run using varying terminal Fs on ages 5+. For each terminal F a sum of squares (SSE(F)) of differences between the 5+ from the VPA and the acoustic surveys is computed. A plot of these SSE-values is shown in Figure 2.2.

From this series of VPAs it is clear that the best (giving the minimum value for SSE) one to one relation between the acoustic estimates and virtual population analysis was obtained with an input F of about 0.26. This is almost the same as the results from the latest survey results alone because that would give an input F for the 5-ringers and older herring of about 0.27. The confidence interval for the fitted terminal F is (0.19, 0.38). These are obtained as described in Halldórsson et al. (1986) and Stefánsson (1987), by using the tabled F-distribution to set bounds on the SSE and finding the terminal F values corresponding to these bounds (cf. Figure 2.2).

Using the catch data given in Table 2.1 and the fitted values of fishing mortalities given in the last column of Table 2.4, a final VPA was run using a natural mortality rate of 0.1 on all age groups. Fishing mortality at age and stock in numbers at age with spawning-stock biomass on 1st of July are given in Tables 2.5 and 2.6 and Figures 2.5.A and B. The resulting stock trend is plotted in Figure 2.3, and the correspondence with acoustic estimates is shown in Figure 2.4.

According to the current assessment, the spawning stock biomass will be 425,000 at 1 July, 1991, and will have decreased steadily by a total of some 16% from its peak value of 504,000 t in 1988. The estimate for 1 July 1989 is now 471,000 t, but it was 458,000 t in last year's report.

2.6 Catch and Stock Projections

Catches have been calculated over a range of Fs for 1991 onwards, using the final exploitation pattern given in Table 2.4. The 1991 stock in numbers data are as given in Table 2.6.

As in previous years, a regression of weight increase has been used to predict the weights at age for 2-8 ringers (using as input weights at age for 1-7 ringers the year before). Data for the regression included as starting years the period 1981-1989, except for the year 1985, which was considered an outlier and excluded from the regression. For 1-ringers and 8+ ringers, a simple average of mean weights at age for the period 1986-1989 was used for prediction.

Weights at age for 2-8 ringers in the catch are thus obtained by using the relation:

$$W_{i+1} - W_i = -0.2368\ W_i + 90.22\ (g)$$

where W_i and W_{i+1} are the mean weight of the same year class in year i and i+1, respectively.

Sexual maturity is predicted by the average over the years 1987-1990.

The fishing pattern used for short- and longer-term projections is the same as the one used for the final year in the VPA. In last year's assessment, an average selection pattern based on 1983-1986 was used.

This year's estimate of the 1990 selection pattern (F' in Table 2.4) is considerably different from that obtained from the average, although this year's estimate of the effect of the 88,000 t catch (4% decrease in SSB) is very similar to last year's estimate of the effect of a catch of 90,000 t (0.4% decrease in SSB) - in both cases an estimated negligible effect. In accordance with a

similar comment made in last year's report, it is thus seen that the short-term predictions are quite insensitive to such changes in the selection pattern. As a methodological point, it is, however, much more reasonable for the shorter term to work with a pattern which is expected to be close to the one which will be realized, rather than a long-term average.

In general, one would therefore expect to work with different selection patterns for the short- and long-term predictions. In the present case, however, the $F_{0.1}$ estimate is 0.23 (Figure 2.5C) using the current pattern estimate and 0.22 using the average pattern for 1984-1987, a trivial difference. It would, therefore, seem irrelevant which pattern is used, and the short-term pattern is used in both cases, since there are considerable problems involved in estimating an appropriate long-term pattern (particularly due to the effect of differing year class effects in the F-matrix).

It is not always clear from the context, what the value of $F_{0.1}$ refers to. In the case of a flat selection pattern, it is directly comparable to an average F (weighted or unweighted) over the same age range in the VPA. This is the value most easily interpreted and its use has been continued in this report. Thus, $F_{0.1}$ and F_{5+} values reported are comparable, as is the input of F of 0.265 in the VPA, but all of those values correspond to the F-factor in the yield and prognosis runs. For a full comparison, it should be noted that the terminal F=0.265 for 1990 corresponds to a stock-weighted F of 0.246 and $F_{0.1}$ of 0.231 corresponds to 0.204. This should ease the comparison with last year's report where it was also found that with a flat selection pattern on 4+, $F_{0.1}$ becomes 0.20.

In accordance with last year's observations by the Working Group that the level of recruitment has increased (Figures 2.6 and 2.7)), a predicted value of 600 million has been used. This corresponds to a yield at $F_{0.1}$ of 87,000 t.

Projections of spawning stock biomass and catches ('000 t) for a range of values of Fs using the input data shown in Table 2.7 are given in the text table below and in Figure 2.8.

1990		1991			1992			1993
Catch	F_{5+}	SSB at 1 July	F_{5+}	Catch	SSB at 1 July	F_{5+}	Catch	SSB at 1 July
93	0.26	425	0.24	80	503	0.21	80	560
			0.30	100	483	0.29	100	520
			0.37	120	464	0.38	120	480

Weights in '000 t.

Detailed output for the prediction, assuming catches of 80,000 t per year, is given in Table 2.8.

2.7 Management Considerations

Continued fishing at $F_{0.1}$ = 0.23 for the next two years corresponds to 79,000 t in 1991 and 86,000 t in 1992 giving an average catch of about 82,000 t in each year. The status quo TAC with F = 0.26 is higher than the $F_{0.1}$, giving a catch of 89,000 t in 1991 and 95,000 t in 1992, or an average catch of about 92,000 t in each year.

It must be noted that the older age groups have not been observed in the catches to the extent expected in recent years and catches have depended on rather few, strong, year classes. Some caution is therefore advised and the TAC should not

be set higher than that corresponding to a two-year average $F_{0.1}$ TAC for 1991 and 1992.

These figures refer to catches including discards, and discard estimates should be substracted to obtain the final TAC. Discards have been estimated as 3,000-4,000 t in the past two years and hence the $F_{0.1}$ catches correspond to a TAC of about 80,000 t in terms of landings each year.

The Working Group noted that management and prediction for this stock has been stable and that it should be sufficient for ICES to give advice every other year, rather than annually.

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 Working Papers

The following working papers were presented: "Soviet investigations and fishery of Atlanto-Scandian herring in the Norwegian Sea in the winter-spring period of 1991" by A.I. Krysov; "Regression analysis of ln recruitment at age 3 on ln spawning stock biomass and ln population fecundity of Atlanto-Scandian herring in 1950-1989" by A.I. Krysov; "Norwegian spring-spawning herring" by I. Røttingen; "Estimates of the wintering spawning stock of the Norwegian spring-spawning herring" by R. Toresen.

3.2 The Fisheries

The Norwegian fishery in 1990 started in the beginning of January in the wintering areas in the fjords in northern Norway. Approximately 11,000 t were caught in this area in January. From the beginning of February to mid-March the main fishing area was at the spawning grounds off Møre. The Soviet catch in this area in February to April amounted to 11,807 t. The Norwegian catch on the spawning area amounted to about 20,000 t. The Norwegian catches in late spring and summer were small, due to low quality and poor price of herring. In addition, the availability of the herring was low due to the fact that the main part of the stock was distributed in very scattered concentrations in the Norwegian Sea. In September the herring migrated into the wintering areas off northern Norway, and in late autumn approximately 19,000 t were caught in this area. In 1990, as has been the case since 1985, the 1983 year class dominated in the catches of Norwegian spring-spawning herring. However, as in 1989, there was a local coastal fishery (approximately 3,000 t were caught in 1990) in the autumn in the Møre area where immature and recruit spawners of the 1987 year class dominated in the catches. The 1987 year class was only represented to a minor extent (approximately 2%) in the wintering areas in northern Norway.

So far, the same main features have prevailed in the fishery in 1991. The Norwegian catch by 11 March 1991 was 18,000 t, the USSR catch was by 19 March, 11,000 t.

3.3 Catch Statistics

The total annual catches of Norwegian spring spawning herring during the period 1972-1991 in terms of weight and numbers are presented in Tables 3.1, 3.2 and 3.3. In 1988 and 1989, 10,000 t were added to the reported catches to account for an additional mortality in the fishery. New regulation measures (ban on daytime purse seining and allowance for one fishing vessel to catch the quota of others), and increasing awareness among fishermen and controlling authorities of the additional mortality may have reduced this problem. Therefore, the amount

which has been added to the reported catches in 1990 is reduced to 8,000 t. This amount has been converted to catch in numbers using Norwegian data on catch at age in the adult fisheries.

3.4 Recruitment

The nursery areas are located in the Norwegian fjords and coastal areas and, in some years, the southern part of the Barents Sea. Recruitment has, therefore, been assessed in two components, one coastal and one from the Barents Sea.

3.4.1 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. In 1987, the Working Group recommended the following relation between strength (TS) and length (L) to be used for acoustic abundance estimations of this stock: TS = 20.0 log L = 71.9. Prior to 1987, the same target strength as applied to capelin abundance estimates was also used for herring. In Table 3.4, estimates for the years 1975-1986 have been recalculated using the new target strength.

3.4.2 The 0-group index in the Barents Sea

Indices of 0-group Norwegian spring-spawning herring have been estimated for the period 1965-1990 based on data from the international 0-group surveys in the Barents Sea (Toresen, 1985; Anon., 1991) (Table 3.5).

3.4.3 Acoustic 0-group estimates in the Barents Sea

The acoustic estimates of 0-group herring in the Barents Sea for the last seven years are shown in the text table below (an acoustic survey will be carried out in the Barents Sea in May-June 1991 in order to record the abundance and distribution of the 1990 year class):

Year Class	Estimated number (billions)	Time of survey
1983	17.9	Nov 1983
1984	3.8	Nov 1984
1985	2.7	Nov 1985
1986	-	Sep 1986
1987	-	Sep 1987
1988	4.9	Nov 1988
1989	4.4	Jun 1990

3.4.4 Acoustic estimates of year classes 1988 and 1989 in 1990

Acoustic estimates (in million individuals) of year classes 1988 and 1989 are given in the text table below:

Year class:	1988	1989
Barents Sea, September 1990	221	4,748
Norwegian coast, November 1990	555	913[1]

[1] Of the 913 million individuals, 308 million were recorded south of Finnmark, i.e., outside the Barents Sea area.

Due to wintering immigration to the fjords some of the herring which were recorded in the Barents Sea in September may also be included in the Norwegian Coast estimate from November.

3.5 The Adult Stock

3.5.1 Acoustic estimates

A) Acoustic measurements were carried out from 1 February to 13 March 1991 covering the spawning grounds off Møre and further north. The stock estimate in number (million individuals, assuming TS = 20 log L -71.9) by year class is shown in the text table below:

Year class	Acoustic estimate in million individuals (at 1 March 1991)
1982+	102
1983	4,148
1984	122
1985	354
1986	12
1987	54
1988	59
59	
Total	4,895

The 1990 estimate applies to the areas to the north of Møre. However, for the first time in 20 years, the Norwegian spring spawning herring reappeared on the traditional spawning grounds off Karmøy (approximately 59^0 15'N) in 1989 (Røttingen, 1989) and again in 1990 and 1991. The amount of spawning herring at Karmøy in 1991 (in the period 4-8 March) is estimated to some 12,000 t, but this amount has not been added to the estimate off Møre (obtained between 13 February and 4 March) because the component which spawned at Karmøy in March may have passed through the spawning areas off Møre in the two last weeks of February, and thus been recorded in the survey off Møre. Recaptures of tagged herring at Karmøy in 1990 and 1991 show that the herring were tagged on the coast north of 62^0N and had similar length and age distri butions to the herring which spawned at Møre.

B) As part of methodological studies of herring in the wintering areas, acoustic measurements were carried out in January 1991 in Lofoten fjord, Northern Norway. In the wintering areas the herring occur in dense concentrations. The results from these investigations indicate a higher spawning stock than that obtained from the surveys on the spawning areas. This may be due to new

equipment (Simrad EK-500, BEI-integrator) which almost eliminated problems such as instrument saturation from strong reflected signals which was a feature of earlier equipment; the new equipment uses a new method to deal with the problem of the extinction of sound in dense herring concentrations (Toresen, 1991). However, more data points from this new investigation series are needed before they can be fully taken into account. The acoustic investigations in the wintering areas will be continued.

3.5.2 The state of the stock and VPA

The input data in the VPA are the following:

Total catch:	Table 3.1 (Column "Total catch as used by the WG")
Catch in number per year:	Table 3.3
Weight at age in the stock:	Table 3.6
Proportion of maturity:	Table 3.8
Natural mortality:	0.13 (Age 3 and older)

The terminal F of the older age groups (1983+) chosen was the one which minimized the squared residuals between VPA estimates of the stock, and those of the series of acoustic stock estimates obtained on the spawning areas of the year classes 1983+ in 1988 (the year when the 1983 year class recruited to the spawning stock), 1989, 1990 and 1991. The result is shown in Figure 3.1. The curve shows a minimum at approximately F = 0.054.

It should be noted, as discussed in last year's Working Group report and commented on by ACFM, that there is considerable uncertainty involved in determining the proportions of year classes other than the 1983 year class, due to the dominance of that year class, both in the catches and the acoustic survey. The consequence of this is that it is quite difficult to obtain reliable acoustic estimates (or fishing mortalities) for individual year classes other than the 1983 year class.

The results of the VPA are given in Tables 3.9 and 3.10 and Figure 3.2A and B.

3.6 Catch and Stock Prognosis

The following estimates of year-class strength (at 1 January 1991) have been used in the prognosis:

Year classes 1991-1996: A level of 6,500 million as 1-year-old have been chosen. This is an average for year classes 1988-1990 as 1-year-old.

Year class 1990: Estimates of the strength of the 1990 year class so far obtained (Tables 3.4 and 3.5) indicate that it is no more than half the strength of the 1989 year class. Since the 1989 year class was estimated to 9,135 million individuals as 1-year-olds, a year class strength of 5,000 million is applied in the prognosis for the 1990 year class as 1 year old.

Year class 1989: According to the prognosis made by the Working Group in 1990 the strength of the year class 1989 at 1 January 1991 is expected to be 3,717 million individuals (9,135 million reduced by an annual natural mortality of 0.9). In September 1990 an acoustic estimate of 4,748 million individuals was obtained for this year class in the Barents Sea off the coast of Finnmark. Further, 308 million individuals were recorded on the coast south of Finnmark later in autumn (Section 3.4.1). The total estimate from these surveys is 5,056 million (pr October 1990). Reduced by the estimated natural mortality for 3

months gives an estimate of 4,037 million individuals which is used in the prognosis (i.e., an increase of 320 million compared with the prognosis from last year's estimate.

Year class 1988: According to the prognosis made last year, the year class strength of this year class is expected to be 879 million. In the autumn of 1990, 221 million individuals of this year class were recorded in the Barents Sea, and 555 million on the coast, giving a total of 776 million which is used in this year's prognosis.

Year class 1987: The estimate of this year class is uncertain. As discussed earlier in this report, this year class has so far been distributed in the coastal areas of Møre (62^0-64^0N) and has not been mixed with the rest of the stock. It has been exploited during a fishery in the autumn (Section 3.2). The acoustic survey on the spawning area gave an estimate of 54 million individuals (Section 3.5.1). Last year's acoustic estimate of this year class was 187 million. This estimate, reduced to 149 million individuals by natural mortality and a catch of 15 million individuals (Table 3.3), has been used for the 1987 year class in this year's stock prognosis.

Year class 1986 and older: The results of the VPA are used in the prognosis.

The biomass prognosis (in weight) will of course strongly depend on the future growth pattern of the dominant 1983 year class. The individual growth of the herring in 1990 has been greater than expected. According to last year's prognosis, the average weight in catch in 1991 of the 1983 year class was expected to be 293 g. However, the observed weight in stock of this year class at 1 January 1991 was 336 g. In this year's prognosis an average of the last 5 years of the weight in catch and weight in stock have been used. This gives a weight in catch of the 1983 year class in 1991 of 350 g (Table 3.11).

3.7 Results of Prognosis

Table 3.12 and Figure 3.2D give the effects of different levels of fishing mortality in 1992 on catch, stock biomass, and spawning stock biomass. A long-term prediction for the next 5 years is illustrated in Figure 3.2.

3.8 Preferred Level of Spawning Stock and Expectations of Rebuilding of the Spawning Stock Biomass to the Preferred Level

The preferred minimum level of the spawning stock has been set at 2.5 million t, (Dragesund, Hamre and Ulltang 1980). The opinion of the Working Group is that there are no new data or information which can justify a change in the preferred minimum level.

Traditionally, the recruitment to this stock is variable. Very strong year classes in relation to parent spawning stock have appeared at certain times, i.e., 1950, 1959-1960, 1963, 1973 and 1983 (Hamre, 1988). The reasons why strong year classes appear at intervals of several years are not fully understood, but they may be sought in underlying biological and environmental conditions. There have not been any strong year classes since that of 1983, but at present the spawning stock is substantially higher than in 1983. If conditions in one of the next few years are as favourable as in 1983, there are reasons to expect a year class stronger than the 1983 year class. If this happens, the spawning stock could be rebuilt to a level above 2.5 million t in a matter of 4-5 years.

3.9 Management Considerations

The Norwegian spring-spawning herring is a depleted stock (Category 1) according to the criteria used by ACFM (Anon., 1989). The preferred level of the stock, 2.5 million t will not be reached in the very near future, even without fishing. The aim should be to keep the spawning stock as high as possible until a new strong year class appears. However, a fishery at a level of F = 0.05 in 1992, corresponding to a catch of about 80,000 t (including discards, etc.) will have very little effect on the future development of the stock.

3.10 Information on the Spatial and Temporal Distribution of Norwegian Spring-Spawning Herring

No new information has been obtained since the last Working Group meeting.

4 BARENTS SEA CAPELIN

4.1 Working Papers Presented

The following working papers were presented: "Optimal harvesting of the Barents Sea Capelin" by H. Gjøsæter; "USSR capelin research in spring 1991" by N.G. Ushakov; "Catch statistics from Norwegian Barents Sea capelin fishery, winter 1991" by B. Røttingen; "Postspawning mortality (survival) of the Barents Sea Capelin" by N.G. Ushakov; and "Do capelin survive spawning?" by H. Gjøsæter.

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. TACs have been set separately for the winter and the summer-autumn fisheries. 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. From May 1986 to December 1990 there was no fishing. For the winter season of 1991 a TAC of 850,000 t was set.

4.3 Catch Statistics

The international catch by country in the years 1965-1991 is given in Table 4.1. More detailed statistics for the winter season of 1991 are given in Table 4.2.

4.4 Stock Size Estimates

No new stock size estimates which can be used for management purposes have become available to the Working Group since its last meeting in November 1990. An updated stock size estimate will be available only after the September-October survey in 1991. All projections of the stock, therefore, had to be based on the survey in September-October 1990.

4.5 Catch and Stock Projections

4.5.1 Growth in 1991

In the report from the Working Group meeting of 15-19 October 1990 (Anon., 1991) it was stated: "How much of the 1989 year class matures in 1991-1992 depends mainly on the growth rate of this age-group, and this is impossible to predict. The Working Group has, therefore, not projected the stock a year ahead to assess

the state of the maturing stock in the autumn of 1991." As no new data are available, the Working Group is not in any better position to do such forecasting at the present meeting. The Working Group decided, however, to make some scenarios based on various growth options, and use them as a basis for the discussion on preliminary TAC options for the summer 1991 - winter 1992 season.

By examining the length increment from age 1 to age 2 and from age 2 to age 3 in the period 1980-1990, six different combinations of individual length age experienced in the past, were chosen for these age groups for the period 1 October 1990 to 1 October 1991. The part of the stock which had lengths below 14 cm last autumn was taken as a basis for the calculations. The resulting stock was reduced by a natural mortality of 0.02 per month. The observed length/weight relation from the autumn survey of 1990 was used to convert numbers to biomass. The strength of the 1990 year class is unknown, although it is seemingly much weaker than the 1989 year class (Anon., 1991). The 1990 year class will not affect the maturing stock in 1991-1992. It will, however, to a certain degree enter the part of the population that will be caught in a summer fishery in 1991. The Working Group decided to tentatively assume that the 1990 year class is equal in number and biomass to the 1988 year class. Some key quantities for the resulting stocks 1 October 1991 are shown in Table 4.3 and Figure 4.1.

All the growth scenarios in Table 4.3 can in principle be considered possible outcomes of the 1991 growth season. Between the lowest growth (A) and the highest (F), there is nearly a doubling of total stock size (one-year-olds and older). Even more striking is the difference in the maturing part of the stock which increases by a factor of 6.3 between (A) and (F), while the immature part shrinks by a factor of 2.3. These examples of the effects of different individual growth rates reveal some of the difficulties involved in projecting the stock one year ahead.

The question arises of which of the growth options is the most likely for the 1991 growth season. Scenario (A) corresponds to the lowest growth observed during the 1980s when the environmental conditions were seemingly much poorer for capelin growth than has been the case in recent years, and this scenario is probably not very likely. On the other hand, Scenario (F) (i.e., the same growth pattern that was observed last year) is almost inconceivable given that the resulting total stock would be almost twice the size of that last year, and the total demand for food would increase correspondingly. Since the growth conditions in the Barents Sea seem to be deteriorating rather than improving (based on forecast of Atlantic water, inflow and plankton production for 1991 made by the Institute of Marine Research, Bergen), Scenario (F) can probably be ruled out. Scenario (C) produces a total stock of the same size as the largest on record in 1975 and 1980, although the growth rate was much lower those years. Thinking in terms of carrying capacity, this would seem a reasonable guess. However, the production in the stock during one season may be a more important factor than the total stock size. In Table 4.4 the number of immature individuals (below 14 cm) and the biomass of the mature stock (above 14 cm) in the autumn stock for the years 1972 to 1990 are shown. Corresponding pairs of these values are plotted in a scatter diagram in Figure 4.2. It can be seen that apart from the cases when the number of immatures is very low, there is no correspondence between the strength of the immature stock one autumn and the mature stock the next autumn. The large mature stocks in 1977, 1980 and 1990 were all produced from immature stocks of medium or low abundance (by a high growth rate). The small mature stocks in 1974, 1983 and 1984 were produced from relatively strong immature components, but with a slow growth rate. A mature stock of more than 3 million tonnes has only been produced twice before, and in one of those years (1976) this can partly be explained by a high number of age groups with many individuals in the length groups just below 14 cm. It is reasonable to conclude that in periods of optimal growth conditions, the maximum growth potential is reached, even when the immature stock component is relatively poor in terms of numbers. When there is an abundant immature component,

the growth rate is correspondingly reduced. In both cases the resulting mature stock is about 2-3 million t. Therefore, scenario (B) may give the most likely stock development, resulting in a maturing stock of 2.4 million t in the autumn of 1991. Details of the modelled stock at 1 October 1991 based on this growth scenario are given in Table 4.5.

4.5.2 Division of the TAC into a summer and a winter fishery

4.5.2.1 Basic considerations

The Working Group discussed if a summer-autumn fishery for the Barents Sea capelin is recommendable at all. The following arguments against were put forward:

1) A summer fishery is always based on a much more uncertain stock prognosis than a winter fishery, because the TAC advice is based on a stock projection 1 1/2 years beyond the last available data. This is in most years a difficult task, and in periods of changes in natural mortality, growth and recruitment, it is almost impossible.

2) The analysis done by Hamre and Tjelmeland (1982) implies that the allocation of a part of the total TAC to a summer fishery would lower the output biomass from the stock. However, this analysis rests on the assumptions that only fish two-year-olds and older are caught in the summer fishery and that the fishing pattern generates an F-value for the two-year-olds at 50% of that of the older age groups (Hamre and Tjelmeland, 1982). If this fishery should, on the other hand, uniformly exploit the total stock above 11 cm, the catch would consist of a considerable amount of fish below 14 cm. This would mean that the above-mentioned effects on the output biomass would be less. On the other hand, such a fishery would have a negative effect on the immature part of the stock. This is in all cases a non-rational fishing strategy, and particularly so in a period when the probability of having reduced recruitment seems large. An even worse consequence is that undersized capelin (below 11 cm) may be killed in the fishing operations.

3) Most of the growth takes place in the period July to October. A fishery in August to September does not allow the capelin fully to utilize its growth potential.

4) The possibility of having a downward revision of the summer TAC resulting from a new stock analysis based on the survey in September is limited.

The conclusion drawn was that the Working Group will in general be reluctant to recommend any summer fishery to take place irrespective of the stock situation.

4.5.2.2 The situation in 1991

The Working Group then discussed if the situation for the capelin stock this year is such that a summer quota could be recommended. The following arguments against were put forward:

1) If a summer fishery in 1991 should uniformly exploit the total stock above 11 cm, the catch would (based on growth Scenario B, Table 4.5) consist of 74% (by number) and 61% (by weight) of fish below 14 cm. 4% of this amount would be 1-year-olds, 92% 2-year-olds, and 4% 3-year-olds (Table 4.5). Such a fishery would negatively affect that part of the stock that will constitute the spawners in 1993 and 1994.

2) We can now foresee a period of reduced recruitment to the stock, due to an increasing stock of young herring in the Barents Sea (Hamre, 1988). In such periods it is essential not to exploit the immature part of the stock.

3) We now have a stock which is heavily dependent on the 1989 year class, a year class which has only been assessed with acoustic methods at the 1-year-stage. The acoustic estimate of the 1-year-olds has always been considered less reliable than those of the older age groups. A fishery in the summer of 1991 would almost totally depend on this age group, together with the 1990 year class which we know very little about.

4) We are in a period of great fluctuation in growth- and mortality-rates leading to large uncertainties in stock prognoses. A fishery in the summer of 1991 would have to depend on prognoses based on one year old data. The range of possible outcomes of variable growth during 1991 (Table 4.3) illustrates this argument.

5) The relatively strong year classes in the Arcto-Norwegian cod stock in 1989 and 1990 will have an increased demand for food in the next few years. Considering the multispecies and ecological aspects of fishery management, a strategy for the capelin fishery that excessively reduces the amount of capelin available as food for cod should be avoided.

4.6 Management Considerations

4.6.1 TAC options for the winter 1992 season

Based on scenario (B), a TAC for the winter 1992 fishery was calculated, based on the assumption that 500,000 t of capelin should be allowed to spawn. A natural mortality of 0.02 per month for the autumn period and 0.15 per month in the period 1 January to 1 April was chosen, as this M produces an output biomass of 140,000 t (autumn period) + 800,000 t (winter period), which is somewhat larger than that considered by the Working Group in October 1990 (Anon., 1991) to be sufficient for the Arctic Cod stock's need for food (700-750,000 t). The necessary amount of food for the cod in the winter of 1992 cannot be assessed more precisely before the assessment of the cod stock is available in the autumn of 1991, and so the natural mortality estimate of 0.15 is, therefore, preliminary. Based on these assumptions a preliminary TAC for the winter season of 1992 of 1.2 million t was calculated. A final TAC for this season should be set after the results from the autumn survey 1991 are available.

4.6.2 TAC options for the summer-autumn period 1991

Based on the arguments put forward in Section 4.5.2, the Working Group decided not to recommend a summer fishery in 1991. If a TAC is set for this period, it should be kept as low as possible. A uniform fishing pattern on all length groups above 11 cm under growth scenario (B) (Table 4.5), implies that for each 100,000 t of catch this summer, the immature parts of the age groups will be reduced by about 10 billion individuals. From previous experience with summer fishing of capelin, the mortality imposed on the immature capelin by fishing may be even more substantial, if undersized capelin is mixed with the rest of the stock.

4.6.3 Spawning Survival

The question of whether the capelin all die after spawning was addressed by the Working Group in response to a question asked by the Norwegian-USSR Fishery

Commission. Previously, the Working Group has regarded the spawning mortality to be total for management purposes, although the participants have been aware of the possibility that small fractions of the females may survive spawning. It is generally agreed that the males die soon after spawning.

The Working Group is of the opinion that the question should be divided into two parts: (A) Does a certain proportion survive spawning, and (B) does a certain proportion spawn a second time?

The most important question from a managers point of view is the second one, since the management of the capelin stock is based on a minimum spawning stock size. If a part of the stock survives spawning, but does not manage to take part in the spawning next year, this survival will not affect the management of the capelin stock.

The first of these questions can be dealt with only by biological examination of the fish before and after spawning, looking for changes in the gonads that will discriminate between those fishes that have spawned from those who have not. Such a method can only answer the second question if some features are found that could distinguish first-time spawners from the others just prior to spawning.

The working paper by N.G. Ushakov presented some results of such investigations, but the Working Group found it difficult to interpret the results as the method used was not fully documented. Besides, these results were based on data sampled some years ago. New samples were taken during January-February 1991, which will be processed, and the results will be presented to the Working Group.

The second question can most easily be dealt with by analyzing the age and sex distribution of the mature stock.

Table 4.6 gives the age distribution in percentage from the autumn surveys of 1972 to 1990. The percentage of four-year-olds vary from 0 to 11% and for five-year-olds from 0 to 2%. Taking into account the fact that the majority of the spawners most years are 4 or 5 years old, it is reasonable to conclude that only a negligible proportion of spawners can survive spawning and live long enough to be caught in the autumn of the same year.

If all males die soon after spawning, a theory strongly supported by observations during and after spawning under natural conditions and in aquaria, and survival by females should show up as an increasing proportion of females for increasing age. Table 4.7 show the sex proportion for four and five years old fish in the Barents Sea. The mean sex proportion among the four years-olds is 49.3% females and 50.7% males, and among the five year-olds 47.4% and 52.6%. In only four out of 12 years are there more females than males among the four year-olds, and in neither of two years of observations is there a predominance of females in the oldest age group.

Based on this evidence the Working Group concluded that only negligible amounts of fish in the Barents Sea capelin stock will survive the first spawning and live long enough to take part in a second spawning.

5 CAPELIN IN THE ICELAND-GREENLAND-JAN MAYEN AREA

5.1 Working Papers Presented

The following working papers were presented: "Stock assesssment surveys of the spawning component of Icelandic capelin in the time period January-February 1991" by H. Vilhjalmsson; "Report on an acoustic survey of the Icelandic capelin stock in November 1990" by H. Vilhjalmsson; "A short summary of Icelandic

scouting and acoustic surveys of the 1991 Icelandic capelin spawning stock during the 1990/1991 fishing season and the main results" by S. Sveinbjørnsson; "Capelin in the Iceland-Greenland-Jan Mayen Area" by S. Sveinbjørnsson.

5.2 Catch Regulations

As this is a very short-lived species, the fishery depends to a very large extent upon the recruiting year class, the size of which is difficult to assess accurately until after recruitment to the fishable stock.

The fishery on the Iceland-Greenland-Jan Mayen stock of capelin has, therefore, been regulated by preliminary catch quotas set prior to each fishing season (July-March) based on the results of 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 acostic surveys of abundance of the maturing fishable stock carried out in autumn (October-November) and/or winter (January-February) in that season.

5.3 The Catch in the 1990/1991 Season

The total annual catches of capelin in the Iceland-East Greenland-Jan Mayen area by years and seasons are shown in Tables 5.1 and 5.2.

A preliminary TAC for the 1990/1991 season was set at 600,000 t. An acoustic estimate of the abundance of the 1990/1991 fishable stock of capelin in late November amounted to 370,000 t. Consequently the ongoing fishery was stopped in the first week of December 1990. At that time the total catch amounted to about 137,000 t. On the basis of another acoustic abundance estimate obtained in the second week of February 1991, a TAC of 312,000 t was set for the whole 1990/1991 season. The total catch amounted to about 315 000 t leaving a residual spawning stock biomass of about 330,000 t.

5.4 TAC for the 1991/1992 Fishery

In August 1990 an estimate of the abundance of 1-group capelin of the 1989 year class was obtained. The resulting estimate is the second lowest obtained since 1982 (see Table 5.3). Tables 5.4-5.6 present information on maturity, mean weight at age and natural mortality.

The abundance of 1-group capelin has been estimated annually in August since 1982. The resulting estimates have been compared to estimates of the same year classes, obtained by back calculating 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 natural mortality rate (M).

The relationship between the two sets of data has been used to set a preliminary TAC for the autumn period (Anon., 1991). A final TAC for each season has 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 the winter (January-February) in that season.

Calculations based on the results of the 1-group survey in August 1990 and on this relationship would give a TAC of 580,000 t for the 1991/1992 season spread evenly over the period. In the last two seasons the expected relationship between the number of 1-group capelin on the one hand and the back calculated

number of the 3- and 4-group spawners of the same year class on the other has not materialized (Figure 5.1). This has resulted in a much smaller maturing stock than expected. In the last 3 years (1988-1990) environmental conditions in the nursery and feeding areas of the capelin north of Iceland have been unfavourable and it seems that natural mortality, late in the first year of life and early in the second, may be much higher than expected under adverse environmental conditions.

Whatever the reason for the declining year classes in the last 2 years the Working Group recommends that a preliminary TAC for the August-November 1991 period should not be set and that a TAC should only be set after the completion of the autumn 1991 surveys of stock abundance, which are to take place in October and November. Since all indications point to a very small 1989 year class which will form the basis of the fishery, the Working Group recommends that the fishery should not be opened until after the new survey results are available.

6 COMMENTS ON ACFM PROPOSAL FOR RE-ARRANGEMENT OF ICES WORKING GROUPS

6.1 Optimal Timing of Assessment for the Species Included in Atlanto-Scandian Herring and Capelin Working Group

Of the four stocks assessed by this Working Group, two should be handled in spring (Icelandic capelin and Icelandic summer-spawning herring), one can possibly be handled during the spring, but should preferably be handled at an autumn meeting (Norwegian spring-spawning herring), and the last one (Barents Sea capelin) can only be handled during the autumn.

The Norwegian spring-spawning herring should preferably be assessed in the autumn because of the additional information obtained for 0-group abundance during the International 0-group Survey, and the acoustic measurements of young herring in the Barents Sea obtained during a Norwegian survey in May, and the Soviet-Norwegian survey on pelagic species in the Barents Sea in September-October.

The Barents Sea capelin stock should be assessed in the autumn, after the Barents Sea survey in September-October (which provides the only stock size information used for this species), after the 0-group survey in the Barents Sea (to get information on recruitment of herring, cod and capelin), and after the assessment has been done on the Arcto-Norwegian cod stock.

At present it is the feeling of the Working Group that the capelin in the Iceland-Greenland-Jan Mayen area can only be managed on a yearly basis depending on the results of acoustic surveys carried out in the autumn and winter of the fishing season. Thus, this stock does not fit well into any fixed-time assessment scheme, due to the need to set a TAC immediately upon completion of a successful survey.

6.2 Comments on ACFM Proposals on Re-Arrangment of ICES Working Groups

A. Norwegian spring-spawning herring be included in the Herring Assessment Working Group for the Area South of 62^{0}N.

Disadvantages: 1. The timing of meetings would not be optimal for Norwegian spring-spawning herring (see above).

2. This would split the Norwegian spring-spawning herring from the other key species in the Norwegian Sea and Barents Sea ecosystem, the Barents Sea capelin.

Advantages: 1. Cooperation with other people doing herring assessment work.

B. The Barents Sea capelin be included in the Arctic Fisheries Working Group.

Disadvantages: 1. The capelin assessment should not start before the assessment of the cod stock is finished. This would inevitably prolong the meeting.

2. The Arctic Fisheries Working Group would have to be moved until after the capelin survey is finished (approximately mid-October). This could be inconvenient for the ICES Secretariat/ACFM.

3. This would hamper the cooperation with other people doing capelin assessment work.

Advantages: 1. It seems to be a reasonable approach to form an area-based Working Group seen from a multispecies point of view. On the other hand, it can be argued that until methods for multispecies assessment are available, this may be a bit premature.

C. The Icelandic summer-spawning herring be included in the Herring Assessment Working Group for the Area South of 62^0N.

Disadvantages: 1. This would split this stock from the other member stocks in the Iceland/Greenland ecosystem.

Advantage: 1. Cooperation with other people doing herring assessment work.

D. The Icelandic capelin be included in the North-Western Working Group.

Disadvantages: 1. This would hamper the cooperation with other people doing assessment work for pelagic species.

Advantages: 1. This would promote multispecies assessment work.

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Table 2.1 Icelandic summer spawners. Catch in numbers, millions, and total catch in weight, '000 tonnes. Age in years is number of rings + 1.

Rings	1972	1973	1974	1975	1976	1977	1978
1	0.147	0.001	0.001	1.518	0.614	0.705	2.634
2	0.322	0.159	3.760	2.049	9.848	18.853	22.551
3	0.131	0.678	0.832	31.975	3.908	24.152	50.995
4	0.163	0.104	0.993	6.493	34.144	10.404	13.846
5	0.264	0.017	0.092	7.905	7.009	46.357	8.738
6	0.047	0.013	0.046	0.863	5.481	6.735	39.492
7	0.028	0.006	0.002	0.442	1.045	5.421	7.253
8	0.024	0.006	0.001	0.345	0.438	1.395	6.354
9	0.013	0.003	0.001	0.114	0.296	0.524	1.616
10	0.009	0.003	0.001	0.004	0.134	0.362	0.926
11	0.003	0.001	0.001	0.001	0.092	0.027	0.400
12	0.001	0.001	0.001	0.001	0.001	0.128	0.017
13	0.003	0.001	0.001	0.001	0.001	0.001	0.025
14	0.001	0.001	0.001	0.001	0.001	0.001	0.051
Total	0.310	0.255	1.274	13.280	17.168	28.924	37.333

Rings	1979	1980	1981	1982	1983	1984	1985
1	0.929	3.147	2.283	0.454	1.470	0.421	0.111
2	15.098	14.347	4.629	19.187	22.422	18.011	12.800
3	47.561	20.761	16.771	28.109	151.198	32.237	24.521
4	69.735	60.728	12.126	38.280	30.181	141.324	21.535
5	16.451	65.329	36.871	16.623	21.525	17.039	84.733
6	8.003	11.541	41.917	38.308	8.637	7.111	11.836
7	26.040	9.285	7.299	43.770	14.017	3.915	5.708
8	3.050	19.442	4.863	6.813	13.666	4.112	2.323
9	1.869	1.796	13.416	6.633	3.715	4.516	4.339
10	0.494	1.464	1.032	10.457	2.373	1.828	4.030
11	0.439	0.698	0.884	2.354	3.424	0.202	2.758
12	0.032	0.001	0.760	0.594	0.552	0.255	0.970
13	0.054	0.110	0.101	0.075	0.100	0.260	0.477
14	0.006	0.079	0.062	0.211	0.003	0.003	0.578
Total	45.072	53.269	39.544	56.528	58.665	50.293	49.092

Rings	1986	1987	1988	1989	1990
1	0.100	0.029	0.869	3.963	7.541
2	8.161	3.144	4.702	22.568	9.666
3	33.893	44.590	40.855	26.578	45.997
4	23.421	60.285	98.222	77.618	29.966
5	20.654	20.622	68.533	188.155	69.429
6	77.526	19.751	22.691	43.000	133.802
7	18.228	46.240	19.899	8.095	30.657
8	10.971	15.232	31.830	5.881	8.099
9	8.583	13.963	12.207	7.273	4.085
10	9.662	10.179	10.132	4.767	4.184
11	7.174	13.216	7.293	3.440	2.529
12	3.677	6.224	7.200	1.406	1.232
13	2.914	4.723	4.752	0.842	1.024
14	1.786	2.280	1.935	0.347	0.572
Total	65.413	75.439	91.760	100.733	92.600

Table 2.2 Icelandic summer spawners. Weight at age in grammes. Age in years is number of rings + 1.

Rings	1972	1973	1974	1975	1976	1977	1978
1	96.0	90.0	80.0	110.0	103.0	84.0	73.0
2	177.0	199.0	189.0	179.0	189.0	157.0	128.0
3	278.0	257.0	262.0	241.0	243.0	217.0	196.0
4	332.0	278.0	297.0	291.0	281.0	261.0	247.0
5	358.0	337.0	340.0	319.0	305.0	285.0	295.0
6	379.0	381.0	332.0	339.0	335.0	313.0	314.0
7	410.0	380.0	379.0	365.0	351.0	326.0	339.0
8	419.0	397.0	356.0	364.0	355.0	347.0	359.0
9	470.0	385.0	407.0	407.0	395.0	364.0	360.0
10	500.0	450.0	410.0	389.0	363.0	362.0	376.0
11	500.0	450.0	410.0	430.0	396.0	358.0	380.0
12	500.0	450.0	423.0	416.0	396.0	355.0	425.0
13	500.0	450.0	423.0	416.0	396.0	400.0	425.0
14	500.0	450.0	423.0	416.0	396.0	420.0	425.0

Rings	1979	1980	1981	1982	1983	1984	1985
1	75.3	68.9	60.8	65.0	59.3	49.3	53.2
2	145.3	115.3	140.9	141.0	131.7	131.4	146.0
3	182.4	202.0	190.5	186.1	179.7	188.6	219.0
4	230.9	232.5	245.5	217.3	218.1	216.8	265.8
5	284.7	268.9	268.6	273.7	259.9	244.9	285.3
6	315.7	316.7	297.6	293.3	308.6	276.9	314.6
7	333.7	351.6	329.8	323.0	328.7	314.6	334.6
8	350.4	360.4	355.7	353.8	356.5	321.7	365.0
9	366.7	379.9	368.3	384.6	370.2	350.7	388.2
10	368.3	382.9	405.4	388.7	406.9	333.8	400.5
11	370.6	392.7	381.5	400.4	436.6	361.9	453.0
12	350.0	390.0	400.0	393.5	458.6	446.3	468.9
13	350.0	390.0	400.0	390.3	429.9	417.4	432.8
14	450.0	390.0	400.0	419.5	471.5	392.3	446.7

Rings	1986	1987	1988	1989	1990	1991 [1]
1	60.0	60.0	75.1	62.8	75.3	64.5
2	139.7	167.5	157.1	130.5	119.4	147.7
3	200.4	200.3	221.1	206.4	198.5	181.3
4	251.6	239.8	238.6	245.9	243.9	241.7
5	282.2	277.7	271.0	261.0	272.9	276.4
6	297.9	303.7	298.0	290.5	285.6	298.5
7	320.1	325.3	318.9	331.3	309.0	308.2
8	334.4	338.8	333.6	337.7	328.7	326.0
9	372.7	355.8	354.0	352.4	350.9	358.7
10	379.6	377.6	351.5	368.6	369.0	369.3
11	393.9	400.2	371.4	388.6	386.8	388.5
12	407.8	403.6	390.4	380.1	421.5	395.5
13	404.8	424.1	408.5	434.1	408.0	417.9
14	438.9	429.6	436.6	409.2	436.5	428.6

[1] Predicted

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

Rings	1972	1973	1974	1975	1976	1977	1978
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.29	0.64	0.14	0.27	0.13	0.02	0.04
3	1.00	0.99	0.94	0.97	0.90	0.87	0.78
4	1.00	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	1979	1980	1981	1982	1983	1984	1985
1	0.00	0.00	0.00	0.02	0.00	0.00	0.00
2	0.07	0.05	0.03	0.05	0.00	0.01	0.00
3	0.65	0.92	0.65	0.85	0.64	0.82	0.90
4	0.98	1.00	0.99	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	1986	1987	1988	1989	1990	1991 [1]
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.03	0.01	0.05	0.06	0.00	0.03
3	0.89	0.87	0.90	0.93	0.78	0.87
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] predicted

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 1990 calculated from the acoustic surveys. F_p is the exploitation pattern in 1990, based on the surveys. F_{90} is the fitted fishing mortality, based on the fitting procedure for the 5+ and the 1991 acoustic estimates for the 1-4 ringers in 1990.

Rings in 1990	Yearclass	Acoustic estimate 1991	Catch 1990	F'	F_p	F_{90}
1	1988	1100.0	7.541	.006	0.024	.006
2	1987	304.6	9.666	.030	0.109	.030
3	1986	396.4	45.997	.105	0.385	.105
4	1985	174.5	29.966	.151	0.555	.151
5+	1984+	776.0	255.613	.272	1.000	.265

Table 2.5 Icelandic summer spawners. Fishing mortality at age (M=0.1)

Rings	1972	1973	1974	1975	1976	1977	1978
1	0.002	0.000	0.000	0.008	0.001	0.002	0.014
2	0.006	0.002	0.010	0.018	0.059	0.040	0.061
3	0.010	0.014	0.012	0.104	0.039	0.180	0.131
4	0.026	0.009	0.024	0.108	0.138	0.124	0.134
5	0.087	0.003	0.009	0.237	0.146	0.252	0.130
6	0.039	0.005	0.009	0.097	0.230	0.183	0.314
7	0.059	0.006	0.001	0.104	0.147	0.331	0.273
8	0.089	0.015	0.001	0.175	0.128	0.266	0.707
9	0.674	0.013	0.003	0.140	0.199	0.199	0.492
10	0.547	0.283	0.005	0.012	0.216	0.354	0.558
11	0.173	0.094	0.128	0.005	0.367	0.055	0.727
12	0.033	0.072	0.115	0.164	0.006	1.134	0.040
13	0.159	0.038	0.087	0.145	0.219	0.007	0.610
14	0.222	0.066	0.044	0.105	0.189	0.316	0.465
W.Av 4-14	0.050	0.007	0.019	0.149	0.147	0.217	0.240
U.Av 4-10	0.217	0.048	0.007	0.125	0.172	0.244	0.373

Rings	1979	1980	1981	1982	1983	1984	1985
1	0.004	0.012	0.003	0.002	0.006	0.001	0.000
2	0.091	0.067	0.020	0.025	0.107	0.089	0.026
3	0.159	0.156	0.094	0.146	0.249	0.198	0.150
4	0.237	0.279	0.116	0.284	0.207	0.345	0.177
5	0.208	0.324	0.244	0.205	0.228	0.155	0.319
6	0.152	0.197	0.316	0.380	0.140	0.098	0.138
7	0.313	0.236	0.165	0.559	0.207	0.079	0.096
8	0.158	0.361	0.168	0.205	0.300	0.078	0.055
9	0.408	0.118	0.402	0.321	0.147	0.137	0.099
10	0.242	0.572	0.083	0.554	0.163	0.090	0.156
11	0.498	0.557	0.723	0.246	0.313	0.017	0.172
12	0.100	0.002	2.178	1.527	0.075	0.031	0.094
13	0.156	0.507	0.201	1.935	1.118	0.041	0.067
14	0.253	0.319	0.530	0.716	0.308	0.071	0.110
W.Av 4-14	0.236	0.290	0.239	0.351	0.209	0.240	0.208
U.Av 4-10	0.245	0.098	0.213	0.358	0.199	0.140	0.149

Rings	1986	1987	1988	1989	1990	1984-1987
1	0.000	0.000	0.001	0.011	0.006	0.000
2	0.006	0.006	0.016	0.043	0.030	0.032
3	0.080	0.039	0.087	0.107	0.105	0.117
4	0.188	0.180	0.103	0.211	0.151	0.222
5	0.229	0.225	0.284	0.259	0.265	0.232
6	0.478	0.317	0.365	0.259	0.265	0.258
7	0.289	0.517	0.537	0.191	0.265	0.245
8	0.241	0.370	0.721	0.265	0.265	0.186
9	0.263	0.482	0.505	0.312	0.265	0.245
10	0.296	0.499	0.685	0.334	0.265	0.260
11	0.403	0.730	0.717	0.462	0.265	0.330
12	0.322	0.643	1.036	0.254	0.265	0.273
13	0.395	0.771	1.416	0.270	0.265	0.319
14	0.336	0.541	0.748	0.293	0.265	0.264
W.Av 4-14	0.317	0.313	0.220	0.248	0.246	
U.Av.4-10	0.283	0.370	0.457	0.262	0.248	

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

Rings	1972	1973	1974	1975	1976	1977	1978
1	91.215	419.741	133.995	200.951	556.039	440.662	204.145
2	55.390	82.395	379.796	121.243	180.385	502.541	398.057
3	13.575	49.813	74.403	340.079	107.757	153.859	436.798
4	6.594	12.159	44.428	66.532	277.339	93.788	116.288
5	3.345	5.811	10.903	39.256	54.032	218.519	74.981
6	1.297	2.776	5.242	9.778	28.019	42.234	153.739
7	0.511	1.129	2.500	4.699	8.028	20.151	31.821
8	0.296	0.436	1.016	2.260	3.832	6.271	13.093
9	0.028	0.245	0.389	0.918	1.717	3.052	4.351
10	0.022	0.013	0.219	0.351	0.723	1.273	2.264
11	0.020	0.012	0.009	0.197	0.314	0.527	0.809
12	0.032	0.015	0.010	0.007	0.177	0.196	0.451
13	0.021	0.028	0.013	0.008	0.005	0.160	0.057
14	0.005	0.017	0.025	0.011	0.006	0.004	0.143
SSB	10.362	28.820	46.226	117.668	130.428	134.354	177.329

Rings	1979	1980	1981	1982	1983	1984	1985
1	258.427	273.272	902.968	256.085	247.513	577.518	1494.871
2	182.214	232.951	244.275	814.869	231.283	222.561	522.159
3	338.746	150.529	197.149	216.629	719.084	187.973	184.269
4	346.796	261.347	116.490	162.454	169.319	507.188	139.484
5	92.071	247.618	178.868	93.886	110.682	124.559	324.932
6	59.546	67.694	162.104	126.860	69.173	79.721	96.525
7	101.656	46.280	50.296	106.926	78.478	54.387	65.379
8	21.912	67.287	33.064	38.580	55.325	57.705	45.492
9	5.841	16.930	42.453	25.300	28.441	37.099	48.306
10	2.407	3.514	13.613	25.699	16.603	22.207	29.279
11	1.172	1.709	1.794	11.337	13.356	12.769	18.357
12	0.354	0.645	0.886	0.788	8.025	8.838	11.362
13	0.392	0.289	0.582	0.091	0.155	6.736	7.754
14	0.028	0.303	0.158	0.431	0.012	0.046	5.848
SSB	200.554	216.459	191.084	201.207	230.320	246.742	271.134

Rings	1986	1987	1988	1989	1990	1991
1	633.008	342.219	621.028	387.928	1225.733	740.000
2	1352.510	572.674	309.625	561.103	347.244	1101.919
3	460.301	1216.042	515.188	275.690	486.256	305.011
4	143.447	384.293	1057.937	427.343	224.206	396.285
5	105.764	107.562	290.487	863.948	313.004	174.413
6	213.657	76.098	77.755	197.834	603.214	217.347
7	76.098	119.902	50.126	48.845	138.210	418.867
8	53.734	51.566	64.713	26.519	36.512	95.972
9	38.955	38.210	32.220	28.469	18.416	25.354
10	39.587	27.105	21.351	17.596	18.863	12.788
11	22.666	26.655	14.887	9.739	11.401	13.098
12	13.991	13.710	11.628	6.576	5.554	7.917
13	9.359	9.173	6.519	3.733	4.616	3.857
14	6.563	5.707	3.838	1.432	2.579	3.206
SSB	295.384	438.374	504.070	471.338	442.853	425.305

Table 2.7

List of input variables for the ICES prediction program.

Icelandic summer spawners.
The reference F is the mean F (weighted) for the age group range from 4 to 14

The number of recruits per year is as follows:

Year	Recruitment
1991	740.0
1992	600.0
1993	600.0
1994	600.0
1995	600.0
1996	600.0

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	740.0	.02	.10	.00	64.500	64.500
2	1101.9	.11	.10	.03	147.700	147.700
3	305.0	.40	.10	.87	181.300	181.300
4	396.3	.57	.10	1.00	241.700	241.700
5	174.4	1.00	.10	1.00	276.400	276.400
6	217.3	1.00	.10	1.00	298.500	298.500
7	418.9	1.00	.10	1.00	308.200	308.200
8	96.0	1.00	.10	1.00	326.000	326.000
9	25.4	1.00	.10	1.00	358.700	358.700
10	12.8	1.00	.10	1.00	369.300	369.300
11	13.1	1.00	.10	1.00	388.500	388.500
12	7.9	1.00	.10	1.00	395.500	395.500
13	3.9	1.00	.10	1.00	417.900	417.900
14+	3.2	1.00	.10	1.00	428.600	428.600

For data that can be entered by file or manually by screen the following table gives the method of input by age group. The identifiers in the table are to be interpreted as:

space: not defined or set by the program
M : manual input by screen
F : data read from a file

age	F at age	M at age	maturity ogive	weight in the catch	weight in the stock
1	M	F	F	F	F
2	M	F	F	F	F
3	M	F	F	F	F
4	M	F	F	F	F
5	M	F	F	F	F
6	M	F	F	F	F
7	M	F	F	F	F
8	M	F	F	F	F
9	M	F	F	F	F
10	M	F	F	F	F
11	M	F	F	F	F
12	M	F	F	F	F
13	M	F	F	F	F
14+	M	F	F	F	F

proportion of F before spawning: F
proportion of M before spawning: F

The data from the files were selected as follows:

M at age:	year 1990 from file NATMOR
Maturity ogive:	year 1991 from file MORPROP
Catch weight:	year 1991 from file WECA
Stock weight:	year 1991 from file WEST
Proportions of F and M:	from file MORPROP

Table 2.8 Icelandic summer spawners.

```
**********************************************************
* Year 1991. F-factor    .235 and reference F    .2059 *
*--------------------------------------------------------*
* Run depending on a TAC value                           *
**********************************************************
```

						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	.0047	3.305	213.2	740.00	47730	.00	0	.00	0
2	.0259	26.786	3956.3	1101.90	162750	33.06	4882	31.44	4644
3	.0941	26.080	4728.4	305.00	55296	265.35	48107	252.41	45761
4	.1341	47.368	11448.8	396.30	95785	396.30	95785	376.97	91114
5	.2352	34.851	9632.7	174.40	48204	174.40	48204	165.89	45853
6	.2352	43.423	12961.9	217.30	64864	217.30	64864	206.70	61700
7	.2352	83.709	25799.2	418.90	129105	418.90	129105	398.47	122808
8	.2352	19.184	6253.9	96.00	31296	96.00	31296	91.32	29769
9	.2352	5.076	1820.7	25.40	9110	25.40	9110	24.16	8666
10	.2352	2.558	944.6	12.80	4727	12.80	4727	12.18	4496
11	.2352	2.618	1017.0	13.10	5089	13.10	5089	12.46	4841
12	.2352	1.579	624.4	7.90	3124	7.90	3124	7.51	2972
13	.2352	.779	325.7	3.90	1629	3.90	1629	3.71	1550
14+	.2352	.639	274.1	3.20	1371	3.20	1371	3.04	1304
Total		297.955	80000.7	3516.10	660085	1667.61	447298	1586.28	425483

```
**********************************************************
* Year 1992. F-factor    .214 and reference F    .1870 *
*--------------------------------------------------------*
* Run depending on a TAC value                           *
**********************************************************
```

						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	.0043	2.434	157.0	600.00	38700	.00	0	.00	0
2	.0235	14.727	2175.2	666.44	98432	19.99	2952	19.02	2808
3	.0854	75.752	13733.9	971.58	176146	845.27	153247	804.05	145773
4	.1217	27.424	6628.4	251.20	60714	251.20	60714	238.95	57753
5	.2136	57.487	15889.3	313.60	86678	313.60	86678	298.30	82451
6	.2136	22.865	6825.1	124.73	37232	124.73	37232	118.65	35416
7	.2136	28.489	8780.4	155.41	47898	155.41	47898	147.83	45562
8	.2136	54.920	17904.0	299.60	97669	299.60	97669	284.99	92905
9	.2136	12.586	4514.6	68.66	24628	68.66	24628	65.31	23427
10	.2136	3.330	1229.8	18.17	6708	18.17	6708	17.28	6381
11	.2136	1.678	652.0	9.15	3556	9.15	3556	8.71	3383
12	.2136	1.717	679.3	9.37	3705	9.37	3705	8.91	3524
13	.2136	1.036	432.8	5.65	2361	5.65	2361	5.37	2246
14+	.2136	.931	399.0	5.08	2176	5.08	2176	4.83	2070
Total		305.376	80000.7	3498.63	686608	2125.88	529530	2022.20	503704

cont'd.

Table 2.8 cont'd.

```
*********************************************************
* Year 1993. F-factor    .196 and reference F    .1716 *
*-------------------------------------------------------*
* Run depending on a TAC value                          *
*********************************************************
```

						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	.0039	2.233	144.1	600.00	38700	.00	0	.00	0
2	.0216	10.972	1620.6	540.59	79844	16.22	2395	15.43	2278
3	.0784	42.286	7666.4	589.02	106788	512.45	92906	487.45	88375
4	.1117	81.251	19638.4	807.14	195086	807.14	195086	767.78	185571
5	.1960	34.135	9434.9	201.24	55623	201.24	55623	191.43	52910
6	.1960	38.876	11604.5	229.19	68413	229.19	68413	218.01	65077
7	.1960	15.463	4765.6	91.16	28095	91.16	28095	86.71	26725
8	.1960	19.266	6280.8	113.58	37028	113.58	37028	108.04	35222
9	.1960	37.140	13322.3	218.96	78541	218.96	78541	208.28	74710
10	.1960	8.512	3143.3	50.18	18531	50.18	18531	47.73	17627
11	.1960	2.252	874.9	13.28	5157	13.28	5157	12.63	4906
12	.1960	1.135	448.8	6.69	2646	6.69	2646	6.36	2517
13	.1960	1.161	485.4	6.85	2861	6.85	2861	6.51	2721
14+	.1960	1.330	570.0	7.84	3360	7.84	3360	7.46	3196
Total		296.013	80000.0	3475.72	720680	2274.78	590647	2163.84	561841

```
*********************************************************
* Year 1994. F-factor    .172 and reference F    .1502 *
*-------------------------------------------------------*
* Run depending on a TAC value                          *
*********************************************************
```

						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	.0034	1.955	126.1	600.00	38700	.00	0	.00	0
2	.0189	9.620	1420.9	540.78	79873	16.22	2396	15.43	2279
3	.0686	30.224	5479.7	478.71	86790	416.48	75508	396.17	71825
4	.0978	43.713	10565.5	492.78	119106	492.78	119106	468.75	113297
5	.1715	98.108	27116.9	653.15	180530	653.15	180530	621.29	171725
6	.1715	22.484	6711.5	149.69	44681	149.69	44681	142.39	42502
7	.1715	25.607	7892.1	170.48	52541	170.48	52541	162.16	49978
8	.1715	10.185	3320.3	67.81	22104	67.81	22104	64.50	21026
9	.1715	12.690	4552.0	84.49	30304	84.49	30304	80.37	28826
10	.1715	24.464	9034.5	162.87	60146	162.87	60146	154.92	57213
11	.1715	5.606	2178.1	37.32	14500	37.32	14500	35.50	13793
12	.1715	1.483	586.7	9.88	3905	9.88	3905	9.39	3715
13	.1715	.748	312.4	4.98	2079	4.98	2079	4.73	1978
14+	.1715	1.641	703.4	10.93	4682	10.93	4682	10.39	4454
Total		288.529	80000.0	3463.85	739948	2277.06	612488	2166.01	582617

cont'd.

Table 2.8 cont'd.

****
* Year 1995. F-factor .165 and reference F .1443 *
----
* Run depending on a TAC value *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0033	1.879	121.2	600.00	38700	.00	0	.00	0
2	.0181	9.252	1366.5	541.04	79912	16.23	2397	15.44	2280
3	.0659	29.170	5288.5	480.17	87055	417.75	75737	397.38	72044
4	.0939	34.538	8347.9	404.44	97752	404.44	97752	384.71	92984
5	.1648	58.552	16183.8	404.36	111765	404.36	111765	384.64	106314
6	.1648	72.088	21518.4	497.84	148605	497.84	148605	473.56	141358
7	.1648	16.521	5091.8	114.10	35164	114.10	35164	108.53	33449
8	.1648	18.816	6133.9	129.94	42360	129.94	42360	123.60	40294
9	.1648	7.484	2684.4	51.68	18538	51.68	18538	49.16	17634
10	.1648	9.325	3443.6	64.40	23781	64.40	23781	61.26	22621
11	.1648	17.976	6983.6	124.14	48228	124.14	48228	118.09	45876
12	.1648	4.120	1629.3	28.45	11251	28.45	11251	27.06	10703
13	.1648	1.090	455.5	7.53	3145	7.53	3145	7.16	2992
14+	.1648	1.755	752.2	12.12	5194	12.12	5194	11.53	4941
Total		282.566	80000.8	3460.21	751456	2272.97	623924	2162.12	593495

****
* Year 1996. F-factor .163 and reference F .1426 *
----
* Run depending on a TAC value *
****

age	absolute F	catch in numbers	catch in weight	stock size	stock biomass	at 1 January: sp.stock size	at 1 January: sp.stock biomass	at spawning time: sp.stock size	at spawning time: sp.stock biomass
1	.0033	1.857	119.8	600.00	38700	.00	0	.00	0
2	.0179	9.144	1350.6	541.12	79922	16.23	2397	15.44	2280
3	.0651	28.869	5233.9	480.76	87161	418.26	75830	397.86	72132
4	.0928	34.341	8300.3	406.76	98313	406.76	98313	386.92	93518
5	.1629	47.708	13186.6	333.13	92078	333.13	92078	316.89	87587
6	.1629	44.436	13264.1	310.28	92619	310.28	92619	295.15	88102
7	.1629	54.709	16861.3	382.02	117737	382.02	117737	363.38	111995
8	.1629	12.538	4087.4	87.55	28541	87.55	28541	83.28	27149
9	.1629	14.279	5122.1	99.71	35765	99.71	35765	94.85	34021
10	.1629	5.680	2097.5	39.66	14645	39.66	14645	37.72	13931
11	.1629	7.077	2749.3	49.41	19197	49.41	19197	47.00	18261
12	.1629	13.642	5395.4	95.26	37674	95.26	37674	90.61	35837
13	.1629	3.126	1306.5	21.83	9122	21.83	9122	20.77	8678
14+	.1629	2.159	925.4	15.08	6461	15.08	6461	14.34	6146
Total		279.565	80000.0	3462.55	757943	2275.18	630386	2164.22	599642

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

Year	A	B[1]	C	D	Total	Total catch as used by the Working Group
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	-	8,557	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[4]	55,507	156	-	126,785	225,256[3]
1987	62,910	49,798	181	-	112,899	127,306[3]
1988	78,592	46,582	127	-	125,301	135,301
1989	52,003	41,770	57	-	93,830	103,830
1990	48,633	29,770	8	-	78,411	86,411
1991[5]	28,605	-	-	-	-	-

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 caused by fishing operations in addition to unreported catches.
[4] Includes 26,000 t of immature herring (1983 year class) fished by USSR in the Barents Sea.
[5] Preliminary catch per 11 March 1991.

Table 3.2 Total catch of Norwegian spring-spawning herring (t) 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	199,256	26,000	225,256
1987	108,417	18,889	127,306
1988	115,076	20,225	135,301
1989	88,707	15,123	103,830
1990	74,605	11,807	86,411
1991[1]	17,605[1]	11,000	-

[1] Preliminary up to 11 March.

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	1975	1976	1977	1978	1979	1980	1981	1982
0	30,600	20,100	43,000	20,100	32,600	6,900	8,300	22,600
1	3,600	2,400	6,200	2,400	3,800	800	1,100	1,100
2	1,800	1,200	3,100	1,200	1,900	400	11,900	200
3	3,268	23,248	22,103	3,019	6,352	6,407	4,166	13,817
4	132	5,436	23,595	12,164	1,866	5,814	4,591	7,892
5	910	-	336	20,315	6,865	2,278	8,596	4,507
6	30,667	-	-	870	11,216	8,165	2,200	6,258
7	5	13,086	419	-	326	15,838	4,512	1,960
8	2	-	10,766	620	-	441	8,280	5,075
9	-	-	-	5,027	-	8	345	6,047
10	-	-	-	-	2,534	-	103	121
11	-	-	-	-	-	2,688	114	37
12	-	-	-	-	-	-	964	37
13	-	-	-	-	-	-	-	121
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-

Age	1983	1984	1985	1986	1987	1988	1989	1990
0	127,000	33,857	28,571	13,805	13,846	15,488	7,120	1,020
1	4,679	1,700	13,149	1,381	6,327	2,787	1,927	401
2	1,675	2,489	207,224[1]	3,091	35,770	9,112	25,203	15,542
3	3,183	4,483	21,500	539,785[2]	19,776	62,923	2,890	18,633
4	21,191	5,388	15,500	17,594	501,393	25,059	3,623	2,658
5	9,521	61,543	16,500	14,500	18,672	550,367	5,650	11,875
6	6,181	18,202	130,000	15,500	3,502	9,452	324,290	10,854
7	6,823	12,638	59,000	105,500	7,058	3,679	3,469	226,280
8	1,293	15,608	55,000	75,000	28,000	5,964	800	1,289
9	4,598	7,215	63,000	42,000	12,000	14,583	679	1,519
10	7,329	16,338	10,000	77,000	9,500	8,872	3,297	2,036
11	143	6,478	31,000	19,469	4,500	2,818	1,375	2,415
12	40	-	50,000	66,000	7,834	3,356	679	646
13	143	-	-	80,000	6,500	2,682	321	179
14	862	-	-	-	7,000	1,565	258	585
15	-	1,652	-	-	453	542	-	166
16	-	-	2,638	2,469	-	-	-	314

[1] 197,244 are from the oceanic component.
[2] 481,481 are from the oceanic component.

Table 3.4 Norwegian spring-spawners. Acoustic abundance (TS= 20 log L - 71.9) of 0-group herring in Norwegian coastal waters in 1975-1990 (numbers in millions).

Year	Area			Total
	62°N-65°N	65°N-68°N	North of 68°30'	
1975	164	346	28	538
1976	208	1,305	375	1,888
1977	35	153	19	207
1978	151	256	196	603
1979	455	1,130	144	1,729
1980	6	2	109	117
1981	132	1	1	134
1982	32	286	1,151	1,469
1983	162	2,276	4,432	6,866
1984	2	234	465	701
1985	221	177	104	502
1986	5	72	127	204
1987	327	26	57	410
1988	14	552	708	1,274
1989	575	263	2,052	2,890
1990	75	146	788	1,009

Table 3.5 Abundance indices for 0-group herring in the Barents Sea, 1973-1990 (Anon., 1990).

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	1990	0.31

Table 3.6 Average weight (gm) in stock (1 January), Norwegian spring spawners, 1979-1991.

Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	178	175	170	170	155	140	148	54	90	96	154	219	147
4	232	283	224	204	249	204	234	206	143	143	175	198	210
5	359	347	336	303	304	295	265	265	241	200	209	258	244
6	385	402	378	355	368	338	312	289	279	250	252	288	300
7	420	421	387	383	404	376	346	339	299	300	305	309	324
8	444	465	408	395	424	395	370	368	316	333	367	428	336
9	505	465	397	413	437	407	395	391	342	343	377	370	343
10	520	520	520	453	436	413	397	382	343	352	359	403	382
11	551	534	543	468	493	422	425	388	362	400	395	387	366
12	500	500	512	512	480	459	434	383	370	358	375	386	432
13	500	500	512	500	470	449	443	403	378	360	406	401	410
14	500	500	512	500	500	427	452	403	381	385	436	480	420
15	500	500	512	500	500	437	463	450	388	400	417	480	421
16	500	500	512	500	500	437	480	470	390	400	417	480	430

Table 3.7 Average weight (gm) in catch, Norwegian spring spawners, 1978-1990.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	232	283	224	204	249	204	233	226	54	121	149	189	235
4	359	347	336	303	304	250	281	292	244	169	186	265	244
5	385	402	378	355	368	317	348	311	288	248	234	261	272
6	420	421	387	383	404	356	371	357	306	287	291	283	311
7	444	465	408	395	424	386	408	380	345	306	320	307	314
8	505	465	397	413	437	401	428	402	367	321	367	310	384
9	520	520	520	453	436	410	442	419	390	342	368	392	415
10	551	534	543	468	493	418	434	432	394	346	382	423	421
11	500	500	512	512	480	441	456	440	393	362	372	365	433
12	500	500	512	500	470	455	469	458	392	371	383	415	430
13	500	500	512	500	500	438	460	460	409	379	398	421	440
14	500	500	512	500	500	432	460	465	434	380	440	439	442
15	500	500	512	500	500	432	445	470	450	390	440	442	440
16	500	500	512	500	500	432	445	470	454	400	440	442	440

Table 3.8 VIRTUAL POPULATION ANALYSIS

Herring, Norwegian spring spawners

PROPORTIONS OF MATURITY

UNIT:

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	.620	.060	.100	.000	.500	.500	.500	.500	.730	.130	.100	.250
4	.890	.130	.250	.100	.900	.900	1.000	.900	.890	.900	.620	.500
5	.950	.310	.600	.250	1.000	1.000	1.000	1.000	1.000	1.000	.950	.970
6	1.000	.170	.900	.600	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	.900	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	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	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	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	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	1.000

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	.300	.100	.100	.100	.100	.100	.100	.100	.100	.400
4	.500	.480	.500	.500	.500	.200	.300	.300	.300	.800
5	.900	.700	.690	.900	.900	.900	.900	.900	.900	.900
6	1.000	1.000	.710	.950	1.000	1.000	1.000	1.000	1.000	.900
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	.900
8	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
10	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
12+	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

Herring, Norwegian spring spawners

FISHING MORTALITY COEFFICIENT UNIT: Year-1 NATURAL MORTALITY COEFFICIENT = .13

	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	2.073	.559	.298	.075	.081	.001	.083	.032	.044	.023	.014	.021
4	.278	1.540	.149	1.369	.066	.010	.001	.180	.038	.028	.016	.040
5	.786	.320	.331	1.015	.988	.078	.043	.000	.014	.038	.019	.023
6	.618	.714	.298	2.101	1.807	1.408	.123	.000	.000	.042	.025	.026
7	.361	1.138	.510	1.403	2.445	1.415	.072	.066	.027	.000	.019	.041
8	.325	1.211	1.725	4.209	2.203	.045	.037	.017	.066	.046	.000	.029
9	.206	.692	3.018	2.463	.054	.054	.054	.022	.020	.037	.000	.000
10	.411	.228	.470	.065	.065	.065	.065	.065	.026	.023	.022	.000
11	.400	.600	.080	.080	.080	.080	.080	.080	.080	.030	.027	.027
12+	.400	.600	.080	.080	.080	.080	.080	.080	.080	.030	.027	.027
(4- 9)W	.282	1.031	.444	1.657	.079	.076	.089	.058	.039	.033	.020	.034
(4-9)u	.429	936	1.005	2.094	1.260	.502	.055	.047	.027	.032	.013	.027

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	.010	.020	.018	.039	.177	.058	.056	.192	.049	.110
4	.018	.023	.035	.036	.171	.199	.066	.087	.014	.054
5	.025	.020	.032	.128	.139	.221	.309	.088	.024	.054
6	.026	.022	.032	.074	.392	.173	.071	.234	.064	.054
7	.017	.027	.027	.080	.332	.580	.103	.091	.117	.054
8	.026	.022	.021	.075	.526	.836	.274	.111	.024	.054
9	.027	.022	.023	.145	.442	.914	.274	.207	.015	.054
10	.002	.011	.031	.098	.198	1.455	.489	.308	.061	.054
11	.013	.001	.015	.032	.252	1.080	.250	.240	.066	.054
12+	.013	.001	.015	.032	.252	1.080	.250	.240	.066	.054
(4- 9)W	.022	.022	.031	.094	.357	.515	.072	.091	.060	.054
(4-9)u	.023	.023	.029	.090	.233	.487	.183	.136	.043	.054

Table 3.10 VIRTUAL POPULATION ANALYSIS

Herring, Norwegian spring spawners

STOCK SIZE IN NUMBERS UNIT: thousands

BIOMASS TOTALS UNIT: tonnes

ALL VALUES ARE GIVEN FOR 1 JANUARY

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	518565	32745	112253	43488	798338	551803	142160	499805	324276	429301	755401	186032
4	4900	422251	26519	98475	35129	679254	463847	122004	432929	278747	373066	650378
5	5928	1094	347196	23061	86347	25766	574364	395915	105384	365351	240469	320200
6	2951	1886	358	281944	19398	75820	22311	485332	341224	90404	312766	206935
7	967	317	272	77	218895	17032	66576	18777	415667	291984	77324	268780
8	1552	209	24	58	63	179965	14564	58459	16182	350171	252165	66063
9	225	20	20	20	49	54	147953	12208	51332	13797	299733	216674
10	17	17	17	17	17	42	47	125211	10719	45067	11792	257533
11	6846	14	14	14	14	14	36	40	107575	9411	39476	10241
12+	16478	2522	69	69	69	69	180	200	200	79912	82154	74983
TOTAL NO	558430	461076	486742	447222	1158317	1529820	1432037	1717950	1805489	1954146	2444346	2257818
SPS NO	29731	402478	427963	425478	755636	1306115	1261974	1201969	1342656	1477727	1498350	1605928
TOT.BIOM	36571	117307	145006	149641	291828	400710	461983	551495	622517	623156	707307	748881
SPS BIOM	9303	103587	134778	145705	217506	354391	426083	453564	517599	528574	530297	589698

	1984	1985	1986	1987	1988	1989	1990	1991
3	124495	141068	10171276	384315	383610	64451	134157	0
4	160374	105122	103777	8426210	318959	278046	53889	100385
5	551259	135780	77820	74686	6929842	256633	240759	44833
6	272253	426003	103800	54788	48155	5570188	220059	200296
7	175923	222033	252851	76660	44832	33457	4587700	183075
8	229627	142653	139915	124316	60713	35925	26134	3816671
9	56799	187031	74051	53252	83019	47733	30797	21742
10	185956	43130	105518	26075	35556	59274	41279	25621
11	219278	148004	31081	21636	14048	22942	48963	34341
12+	56055	251326	237022	104757	40607	21023	38319	72613
TOTAL NO	2032019	1802150	11297110	9346698	7959340	6389672	5422056	
SPS NO	1771048	1609050	2052160	094996	6697838	6111370	4825932	
TOT.BIOM	679820	602027	930554	1408775	1555267	1595516	165009	
SPS BIOM	626912	567340	417065	532382	1354773	1547159	1482026	

Table 3.11

List of input variables for the ICES prediction program.

Norwegian Spring-Spawning Herring
The reference F is the F of age group 8

The number of recruits per year is as follows:

Year	Recruitment
1991	16000.0
1992	16000.0
1993	16000.0
1994	16000.0
1995	16000.0
1996	16000.0

Data are printed in the following units:

Number of fish:	millions
Weight by age group in the catch:	kilogram
Weight by age group in the stock:	kilogram
Stock biomass:	thousand tonnes
Catch weight:	thousand tonnes

age	stock size	fishing pattern	natural mortality	maturity ogive	weight in the catch	weight in the stock
0	16000.0	.01	.90	.00	.009	.004
1	5000.0	.01	.90	.00	.073	.012
2	4037.0	.02	.90	.10	.117	.052
3	776.0	.02	.13	.30	.150	.142
4	149.0	.02	.13	.90	.222	.172
5	45.0	.05	.13	1.00	.261	.230
6	200.0	.05	.13	1.00	.284	.279
7	183.0	.05	.13	1.00	.318	.310
8	3817.0	.05	.13	1.00	.350	.357
9	21.0	.05	.13	1.00	.381	.355
10	25.0	.05	.13	1.00	.393	.369
11	40.0	.05	.13	1.00	.385	.375
12+	72.0	.05	.13	1.00	.398	.387

Table 3.12

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

Norwegian Spring-Spawning Herring

Year 1991					Year 1992					Year 1993	
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
1.0	.05	2014	1623	82	.0	.00	1916	1511	0	1990	1622
					.2	.01			16	1976	1608
					.4	.02			32	1962	1595
					.6	.03			48	1947	1581
					.8	.04			64	1933	1568
					1.0	.05			79	1919	1555
					1.2	.06			95	1905	1542
					1.4	.07			110	1891	1529
					1.6	.08			125	1878	1516
					1.8	.09			140	1864	1503
					2.0	.10			155	1851	1490

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 F of age group 8

Table 4.1 International catch of Barents Sea Capelin ('000 t) in the years 1965 to 1991 as used by the Working Group.

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	1301	13	-	1314
1971	1371	21	-	1392
1972	1556	37	-	1593
1973	1291	45	-	1336
1974	987	162	-	1149
1975	943	431	43	1417
1976	1949	596	-	2545
1977	2116	822	2	2940
1978	1122	747	25	1894
1979	1109	669	5	1783
1980	999	641	9	1649
1981	1238	721	28	1987
1982	1158	596	5	1759
1983	1493	846	36	2375
1984	811	628	42	1481
1985	453	398	17	868
1986	72	51	-	123
1987	-	-	-	-
1988	-	-	-	-
1989	-	-	-	-
1990	-	-	-	-
1991[1]	505	154	20	679

[1] Preliminary up to April 1, 1991.

Table 4.2a Catch in numbers (millions) of Barents Sea Capelin in winter 1991 divided by months and age groups. Preliminary figures, only Norwegian and Soviet catches are included.

	Age						
Month	1	2	3	4	5	6	7	Total
Jan	8	352	5479	983	86	4	-	6913
Feb	-	88	8190	2662	269	59	-	11268
Mar	-	18	9739	3839	1033	267	98	14994
Sum	8	458	23408	7484	1388	329	98	33174
%	+	1.4	70.6	22.6	4.2	1.0	0.2	

Table 4.2b Catch in weight ('000 tonnes) of Barents Sea Capelin in winter 1991 divided by months and age groups. Preliminary figures, only Norwegian catches and Soviet catches are included.

	Age						
Month	1	2	3	4	5	6	7	Total
Jan	+	1.8	96.8	21.9	2.3	0.1	-	122.9
Feb	-	0.9	167.2	67.2	7.3	2.2	-	244.9
Mar	-	0.2	169.1	84.6	25.4	7.9	3.1	290.5
Sum	+	2.9	433.1	173.8	35.1	10.2	3.1	658.2
%	+	0.4	65.9	26.4	5.3	1.5	0.5	

Table 4.3 Key quantities of simulated stocks by 1. October 1991 under different growth scenarios.

Scenario no.	Length increment		B1	B2	B3	Btot	Bimm	Bmat	Comments
	1-2	2-3							
A	2.5	1.0	0.6	4.6	0.6	5.8	4.4	1.4	Lowest obs.
B	3.0	1.5	0.6	5.4	0.7	6.6	4.3	2.4	
C	3.5	2.0	0.6	6.2	0.8	7.7	3.9	3.6	Mean obs.
D	4.0	2.5	0.6	7.1	0.9	8.6	3.3	5.2	As 1981 year class
E	4.5	3.0	0.6	8.1	1.0	9.7	2.4	7.3	As 1987 year class
F	5.0	3.0	0.6	9.2	1.0	10.8	1.9	8.9	As year 1990

B1= Biomass of 1-year-olds (1990 year class)
B2= Biomass of 2-year-olds (1989 year class)
B3= Biomass of 3-year-olds (1988 year class)
Btot= Total stock biomass
Bimm= Biomass of immatures (i.e. fish below 14 cm length)
Bmat= Biomass of matures (i.e. fish above 14 cm length)

The observations mentioned in comments pertains to the period 1980-1990 All biomass values are given in million t. Length increments in cm.

Table 4.4 Number of fish with lengths below 14 cm, 'N IMM' (billions) and biomass of those with length above 14 cm 'B MAT' ('000 t) in the years 1972 to 1990.

Year	N IMM	B MAT
1972	350	2.1
1973	950	1.4
1974	1010	0.9
1975	790	3.0
1976	540	3.3
1977	580	2.8
1978	490	2.0
1979	410	1.2
1980	450	3.9
1981	590	1.5
1982	760	2.1
1983	680	1.3
1984	330	1.1
1985	80	0.3
1986	10	0.06
1987	38	0.02
1988	37	0.3
1989	180	0.2
1990	760	2.6

Table 4.5 Modelled stock at 1 October 1991 according to growth scenario B and the other conditions mentioned in the text.

Age		1		2		3		Sum		
Year class		1990		1989		1988				
length		N	B	N	B	N	B	N	B	W
8.0-	8.4	17.1	37					17.1	37	2.0
8.5-	8.9	27.4	68					27.4	68	2.3
9.0-	9.4	39.8	112					39.8	112	2.7
9.5-	9.9	33.5	108					33.5	108	3.2
10.0-	10.4	25.0	95	2.8	11			27.8	106	3.8
10.5-	10.9	16.2	70	9.3	41			25.5	111	4.4
11.0-	11.4	7.5	38	40.2	205			47.7	243	5.1
11.5-	11.9	5.1	31	71.5	436			76.6	467	6.1
12.0-	12.4	3.2	24	80.4	595	0.1	1	83.7	620	7.4
12.5-	12.9	1.7	15	80.6	692	2.3	20	84.6	727	8.6
13.0-	13.4	0.9	9	79.5	804	5.1	52	85.5	865	10.1
13.5-	13.9	0.1	2	63.8	733	8.2	95	72.1	830	11.5
14.0-	14.4	0.1	1	53.7	703	7.6	100	61.4	804	13.1
14.5-	14.9	0.1	1	33.7	505	12.5	187	46.2	693	15.0
15.0-	15.4	+	+	19.3	331	13.6	232	32.9	563	17.1
15.5-	15.9			9.2	181			9.2	181	19.7
16.0-	16.4			2.4	54			2.4	54	22.2
16.5-	16.9			2.7	67			2.7	67	24.5
N < 11 cm		159.0		12.1		0.0		171.1		
B < 11 cm			490		52		0		542	
N 11-14 cm		18.5		416.0		15.7		450.2		
B 11-14 cm			119		3465		168		3753	
N > 14 cm		0.2		121.0		33.7		154.8		
B > 14 cm			2		1841		519		2362	
N tot		177.7		549.1		49.4		776.1		
B tot			611		5358		687		6656	

Where:

N = Number of individuals (billions)
B = Biomass ('000 t)
W = Mean weight (g)

Table 4.6 Age distribution (%) of Barents Sea capelin at the annual autumn surveys 1972-1990.

Year	Age				
	1	2	3	4	5
1972	31.0	28.9	34.6	4.7	0.4
1973	57.0	37.1	4.1	1.8	+
1974	30.3	52.7	16.7	0.3	+
1975	21.0	37.8	31.9	9.2	0.1
1976	31.3	33.1	23.0	10.8	1.7
1977	52.4	25.2	14.1	5.8	1.0
1978	18.3	61.8	16.6	2.4	0.1
1979	3.1	69.7	23.5	1.0	+
1980	41.4	30.0	23.5	5.0	+
1981	62.1	28.8	7.1	2.0	+
1982	56.9	35.6	7.2	0.2	0.0
1983	68.4	26.5	5.1	+	0.0
1984	38.2	48.3	12.6	0.8	0.0
1985	33.8	45.4	19.9	0.9	0.0
1986	53.7	24.4	20.8	1.1	0.0
1987	95.4	4.3	0.3	+	0.0
1988	40.8	58.7	0.5	0.0	0.0
1989	89.8	9.4	0.7	+	0.0
1990	78.3	19.8	1.9	+	0.0

Table 4.7 Sex proportions among four- and five-year-olds in the Barents Sea capelin stock (autumn survey). Years where less than 20 individuals from these age groups were excluded.

Year class	Age			
	4		5	
	% f	% m	% f	% m
1969	47.5	52.5	-	-
1971	45.9	54.1	49.1	50.9
1972	53.9	46.1	44.9	55.1
1973	50.1	49.9	-	-
1974	39.7	60.3	-	-
1975	42.3	57.7	-	-
1976	49.2	50.8	-	-
1977	49.3	50.7	-	-
1978	52.2	47.8	-	-
1980	23.2	76.8	-	-
1981	50.5	49.5	-	-
1982	29.5	70.5	-	-
Av. (w)	49.3	50.7	47.4	52.6

Table 5.1 The total annual and seasonal catch of CAPELIN in the Iceland-Greenland-Jan Mayen area since 1964 (in '000 tonnes).

Year	Winter Season			Summer and Autumn Season				Total
	Iceland	Norway	Faroes	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	-	-	-	460.7
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	329.0	-	-	367.4	118.7	24.2	17.3	919.6
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	1,268.2
1986	341.8	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	56.6	-	311.4	11.5	48.5	-	1,028.6
1989	609.1	56.0	-	53.9	52.7	14.4	-	786.1
1990	612.0	62.3	12.3	84.8[1]	22.0[1]	5.6[1]	-	799.0[1]
1991	202.6[1]	-	-	-	-	-	-	-

[1] The figures for the autumn season 1990 and winter season 1991 are preliminary.

Table 5.2 Seasonal catch (July-April) of Capelin in the Iceland-Greenland-Jan Mayen area ('000 t).

Season	Iceland	Norway	Faroes	EEC	Total
1975-1976	341.8	-	-	-	341.8
1976-1977	663.6	-	24.3	-	687.9
1977-1978	728.1	-	36.2	-	764.3
1978-1979	1,091.2	154.1	21.6	-	1,194.9
1979-1980	834.1	124.0	22.0	-	980.1
1980-1981	523.4	118.7	24.2	17.3	683.6
1981-1982	497.8	91.4	16.2	20.8	626.2
1982-1983	-	-	-	-	-
1983-1984	573.0	-	-	-	573.0
1984-1985	773.7	104.6	10.2	8.5	897.0
1985-1986	986.6	243.0	65.9	16.0	1,311.5
1986-1987	1,053.1	209.6	65.4	5.3	1,333.4
1987-1988	911.9	138.7	65.2	-	1,115.8
1988-1989	920.5	67.5	48.5	-	1,036.5
1989-1990	665.9	115.0	26.7	-	807.6
1990-1991[1]	287.4	22.0	5.6	-	315.0

[1] Preliminary up to 20 March.

Table 5.3 Abundance by number (in billions) 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	146.4
1982	155	122.5
1983	286	251.6
1984	31	101.7
1985	71	147.5
1986	101	150.2
1987	147	115.2
1988	111	50.5[1]
1989	36	-

[1] The 1988 year class is not fully recruited to the surveys of the adult stock and consequently underestimated.

Table 5.4 The percentage of 4-group Capelin in the spawning stock in the years 1981-1991. (The high contribution in 1987 is due to the very strong 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
1990	27
1991	19
Mean	22

Table 5.5 Mean weight (g) of mature 2-3- and 3-4-years-old capelin in autumn and winter in the seasons 1980/1981 - 1990/1991.

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
10	1989/1990	1986	23.8	24.7	1987	13.4	17.7
11	1990/1991	1987	25.5	27.9	1988	17.5	20.1
Mean			24.6	26.3		17.0	19.3

Table 5.6 Natural mortality rates of Icelandic capelin as calculated 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

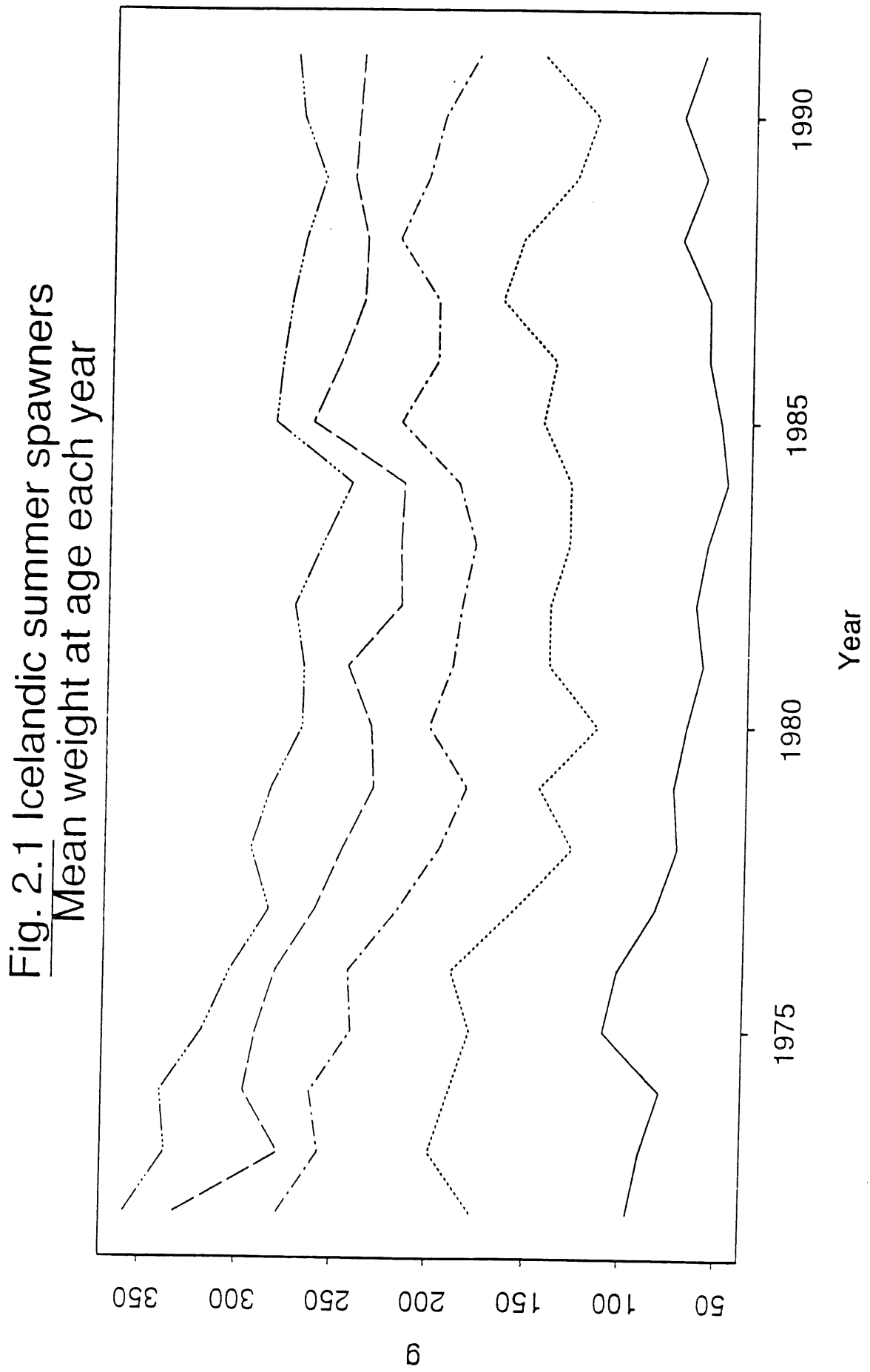


Fig. 2.1 Icelandic summer spawners
Mean weight at age each year

Fig. 2.2 Icelandic summer spawners.
SSE for fit of VPA to acoustics

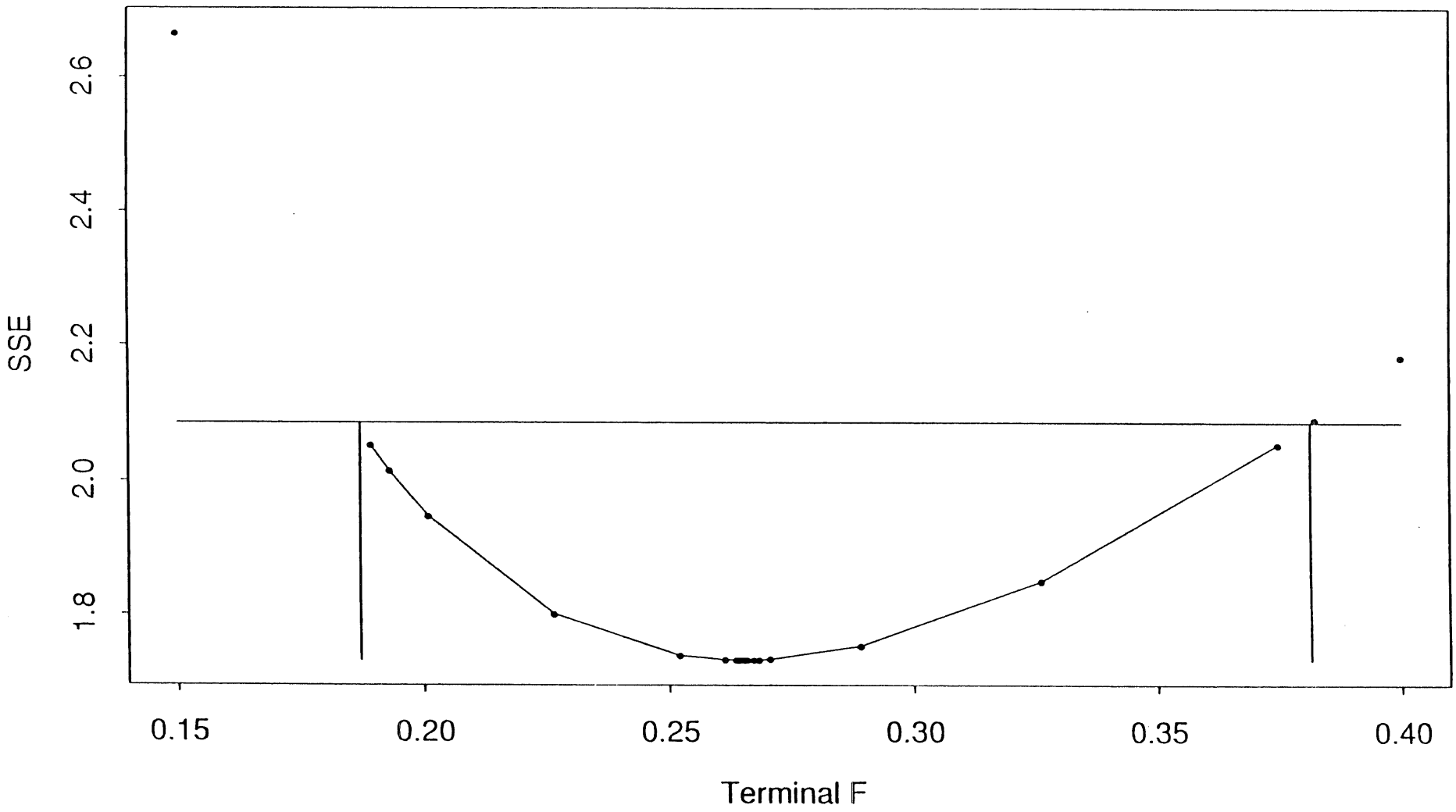


Fig. 2.3 Icelandic summer spawners.
Trends in acoustics and VPA stock numbers

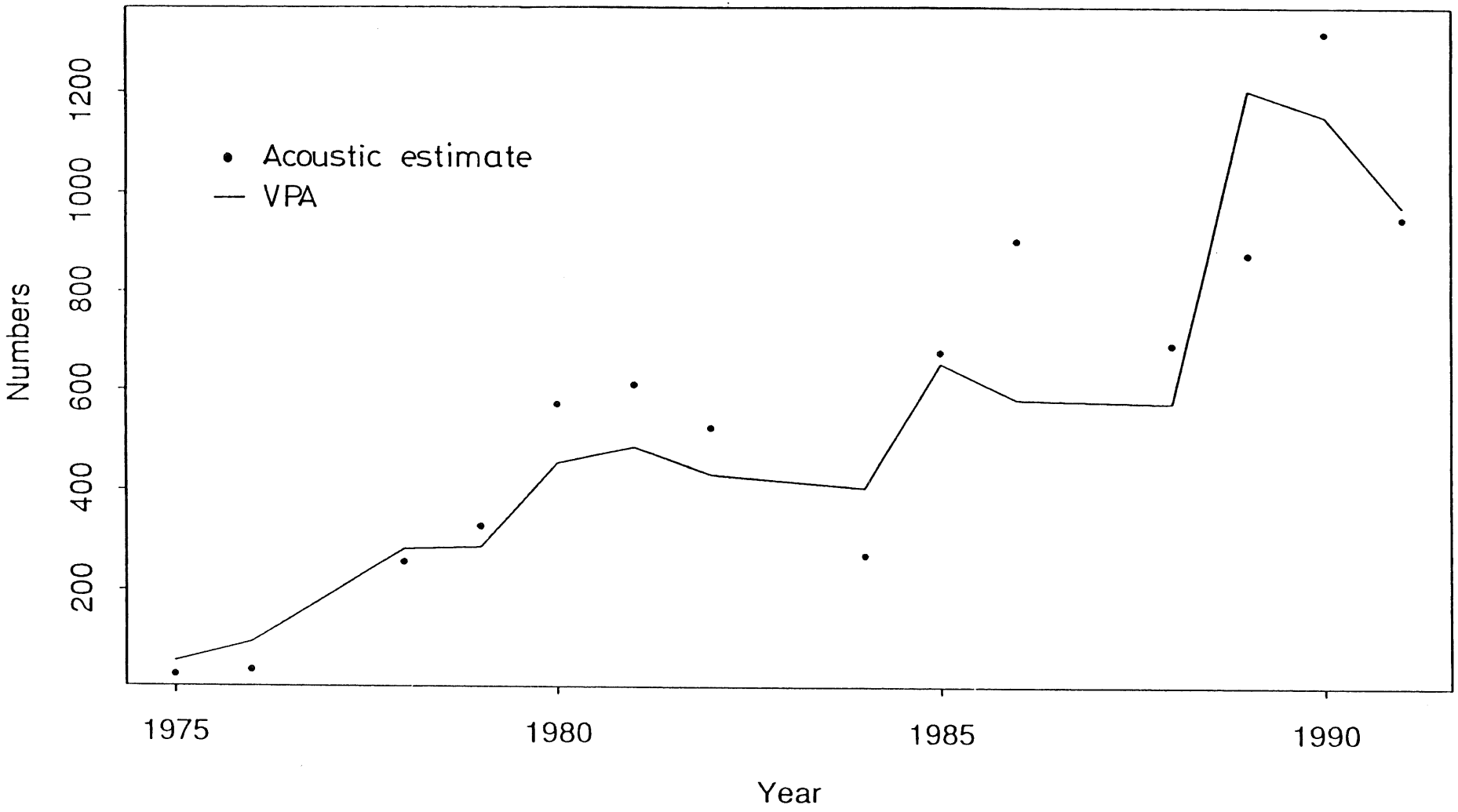


Fig. 2.4 Icelandic summer spawners.
Acoustic estimates vs VPA stock numbers

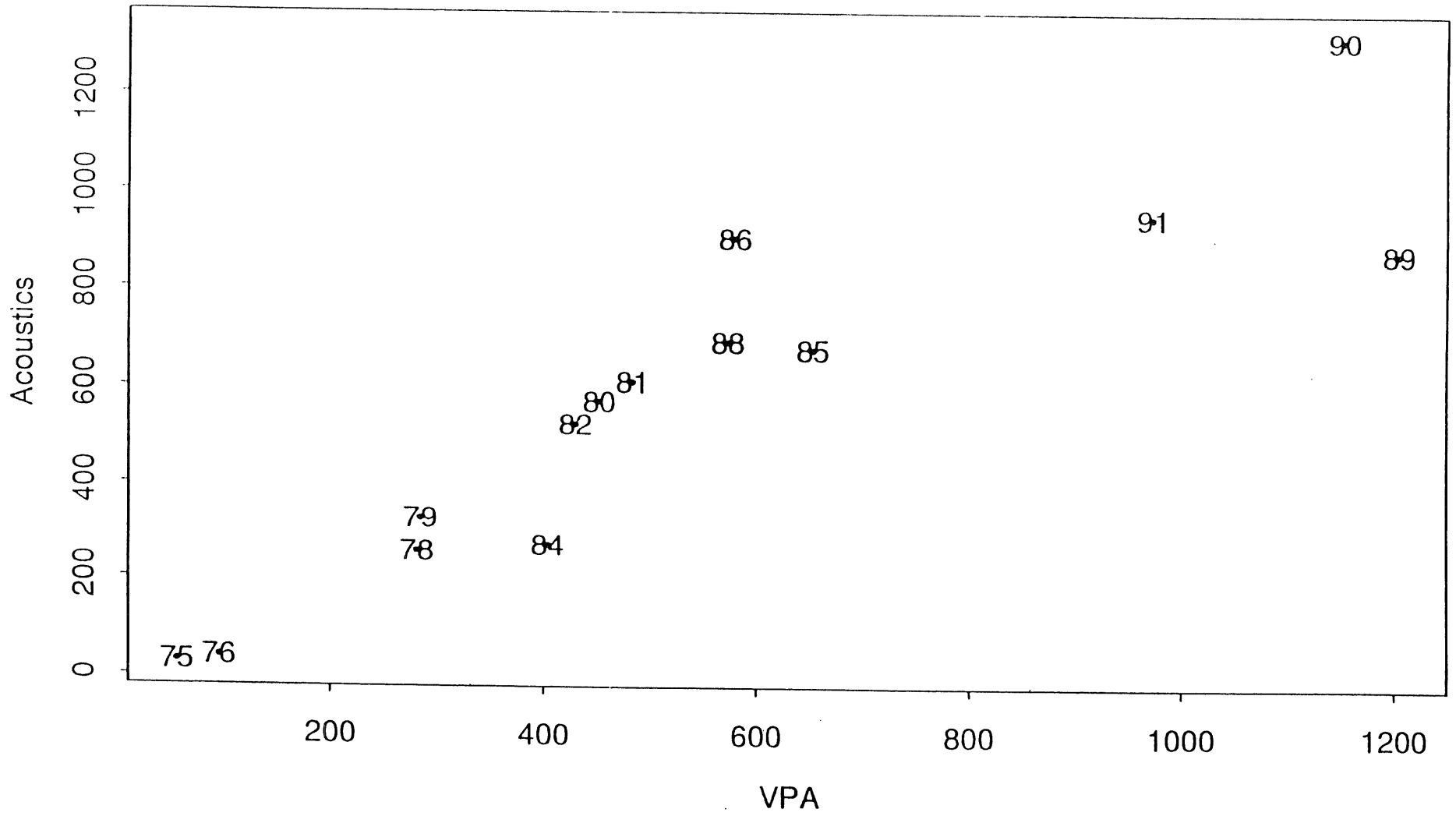
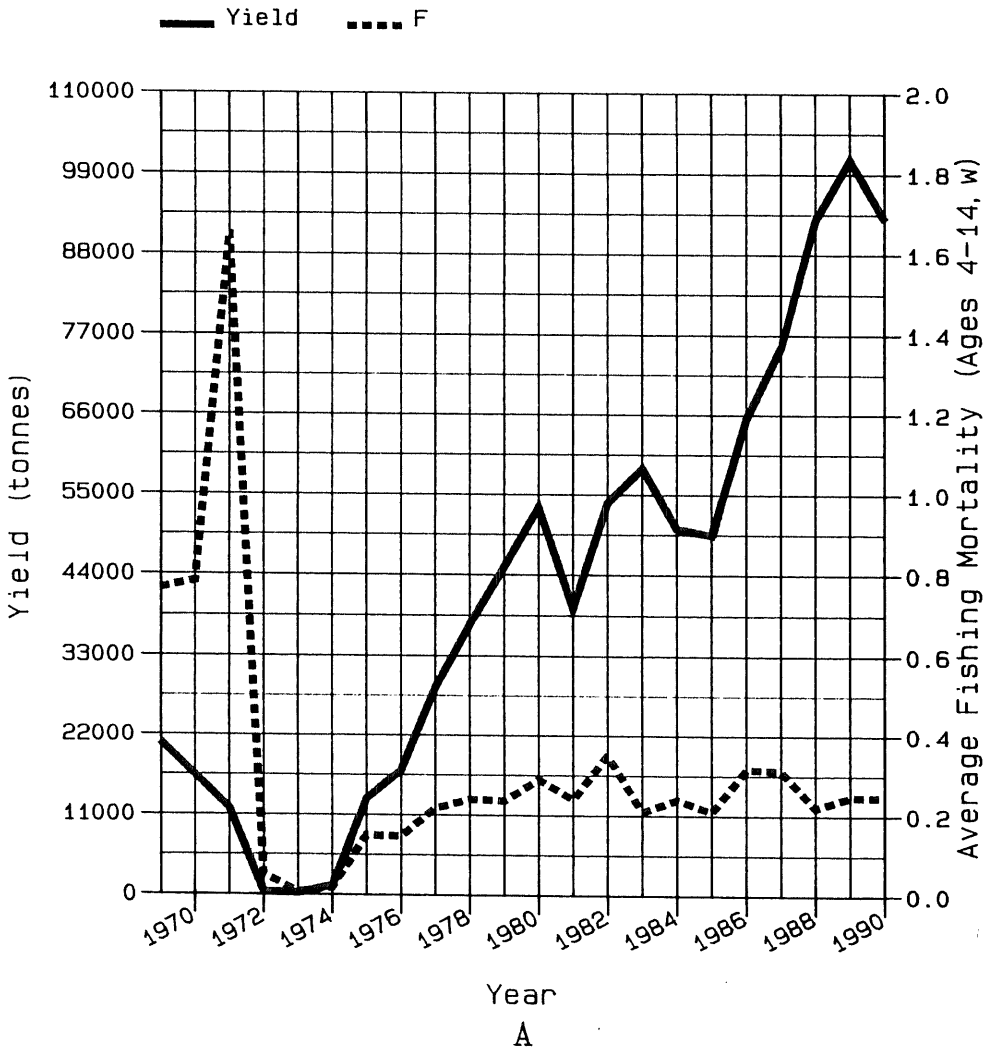


Figure 2.5

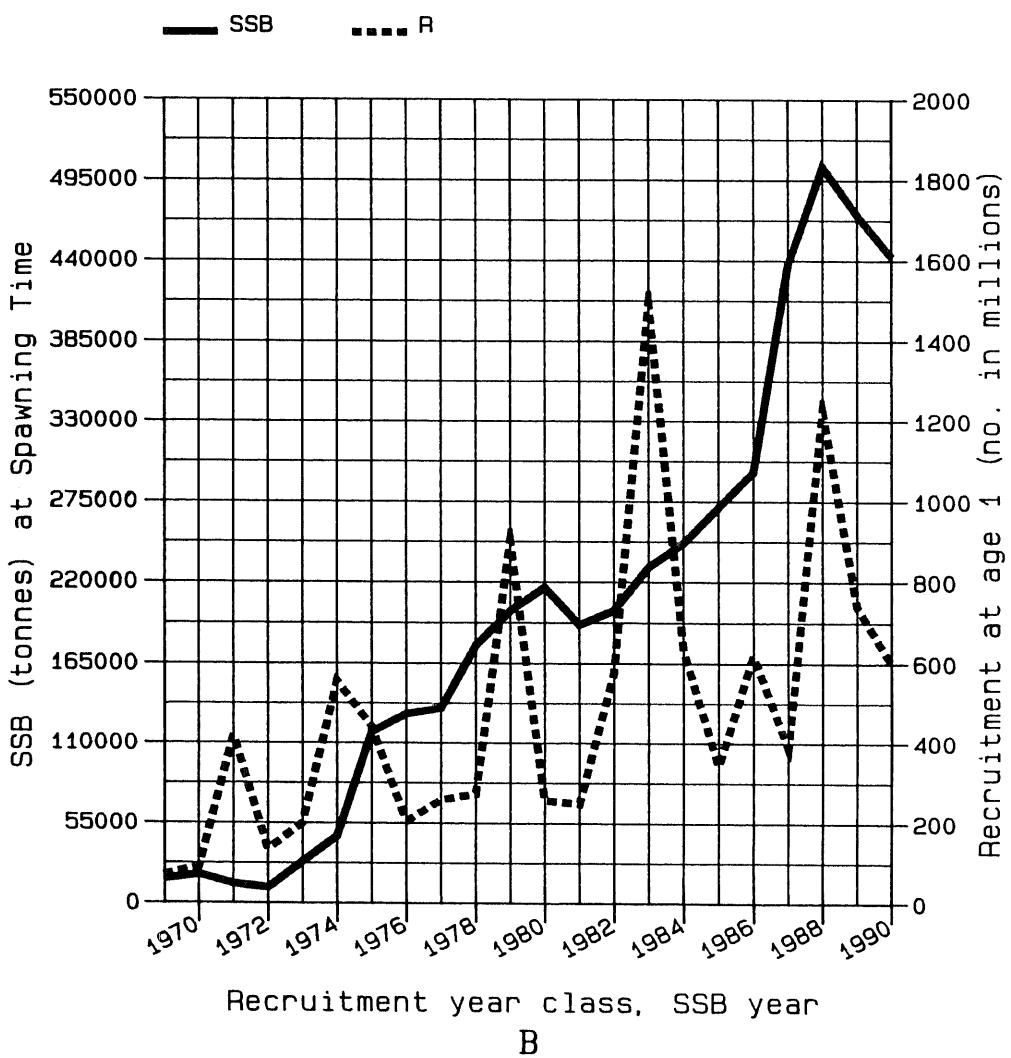
FISH STOCK SUMMARY
Summer spawning Herring at Iceland
16-04-1991

Trends in yield and fishing mortality (F)



A

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



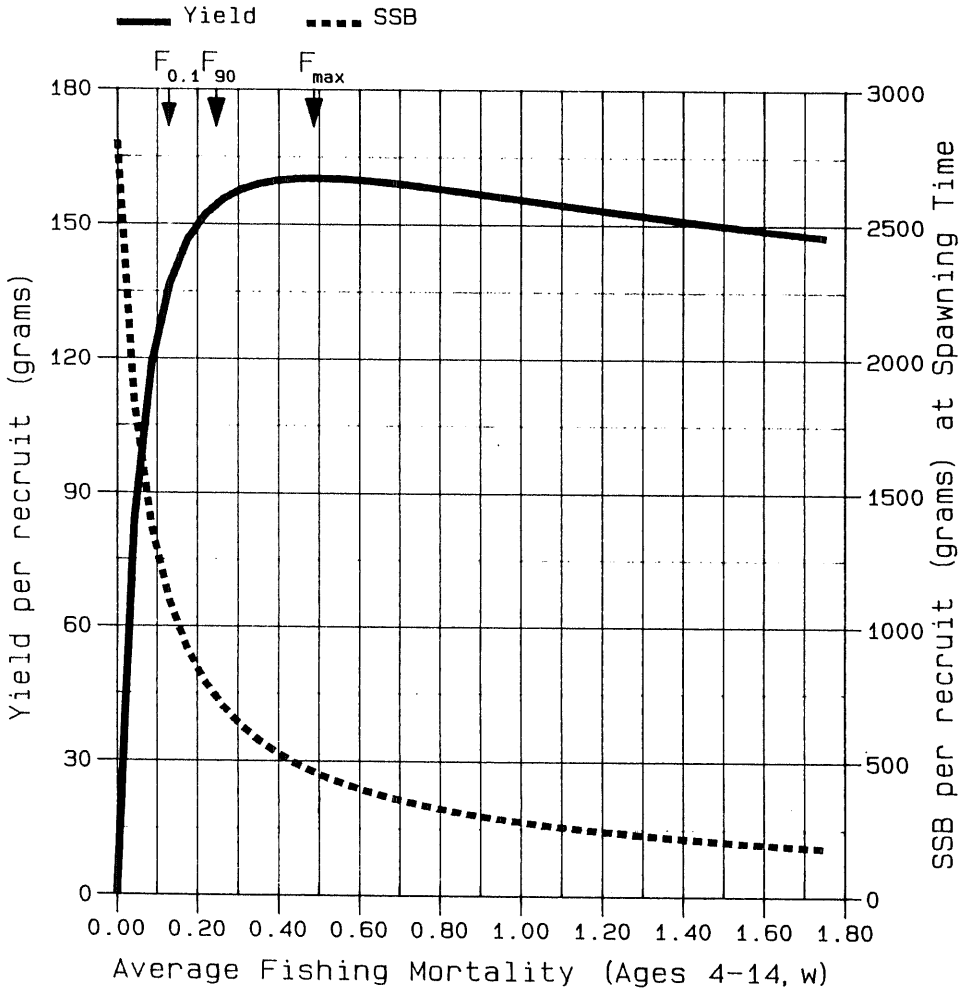
B

cont'd.

Figure 2.5 cont'd.

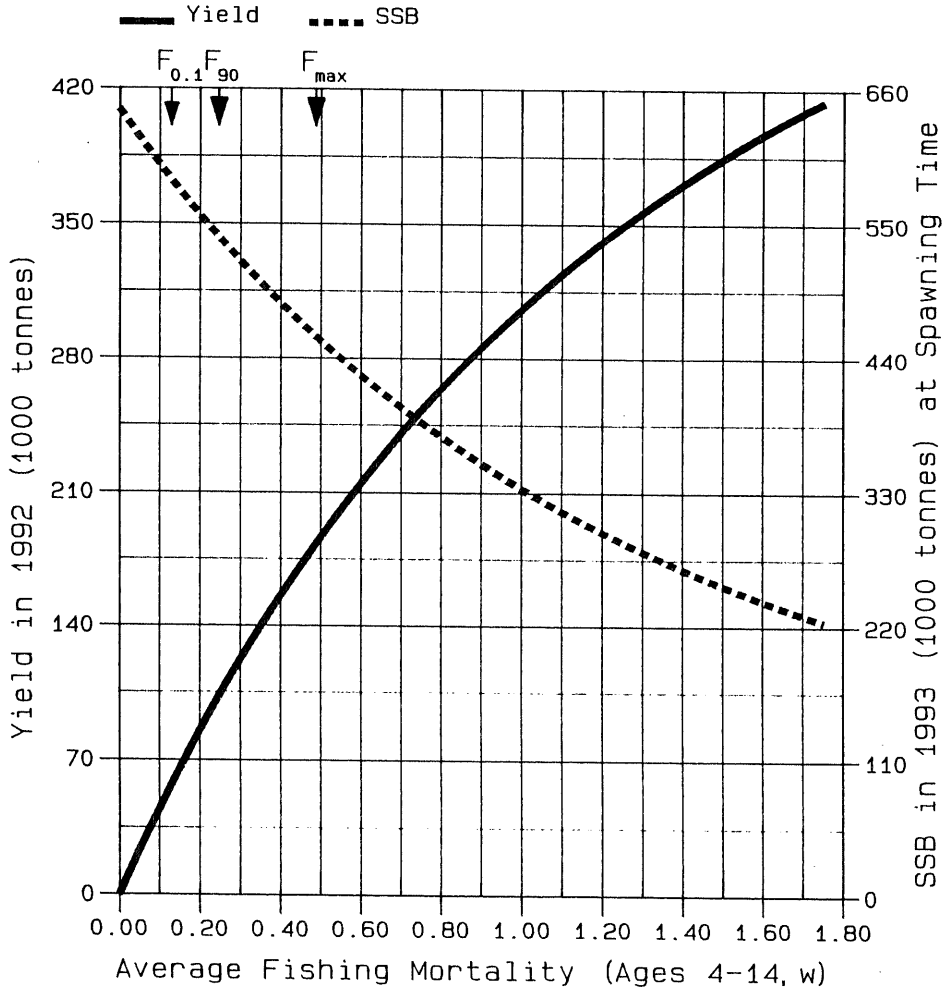
FISH STOCK SUMMARY
Icelandic summer spawners
16-04-1991

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

Figure 2.6 Icelandic summer spawners
Recruitment trend - actual and smoothed

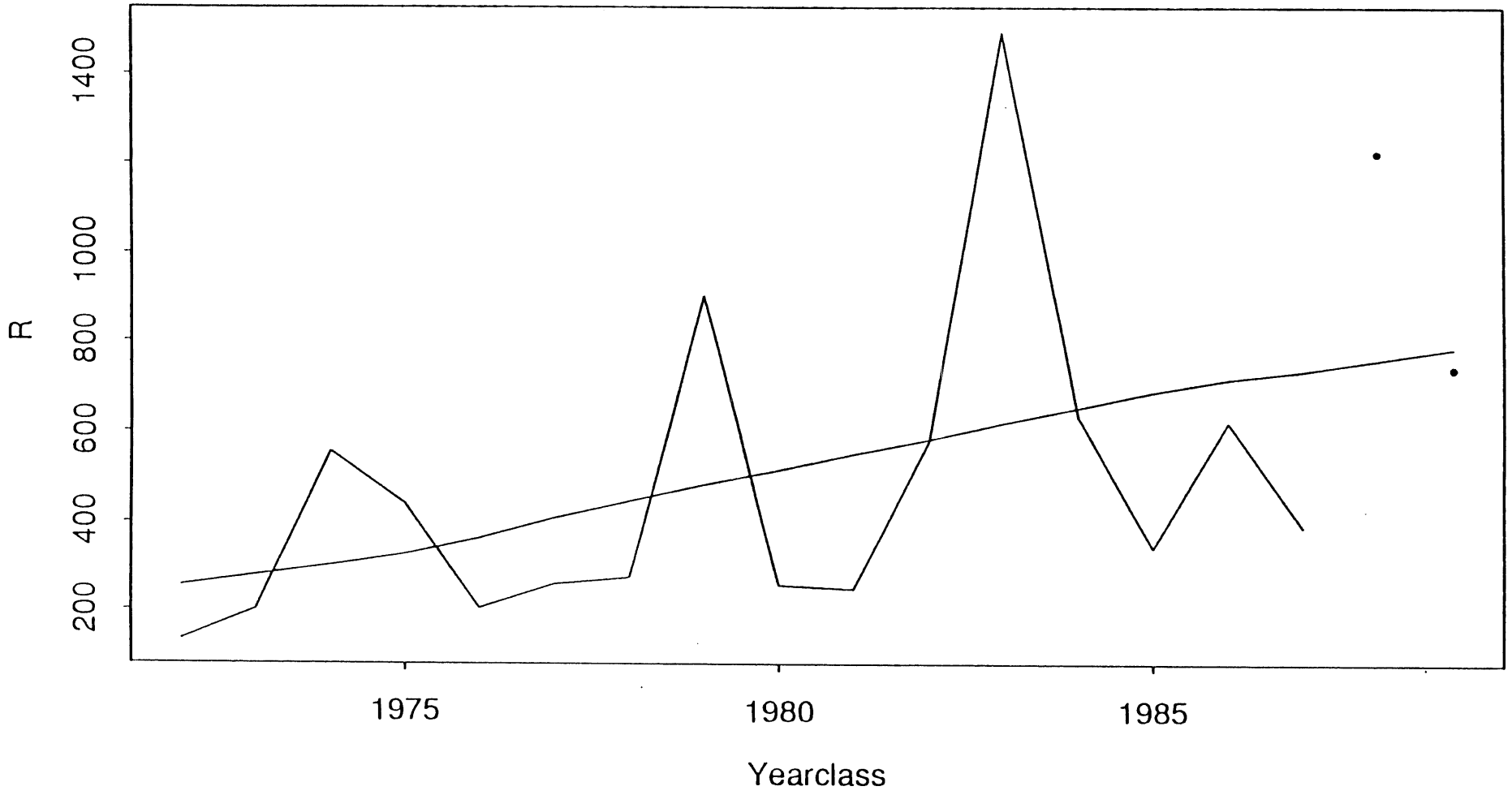


Fig. 2.7 Icelandic summer spawners.
Recruitment vs SSB, with smoothed curve

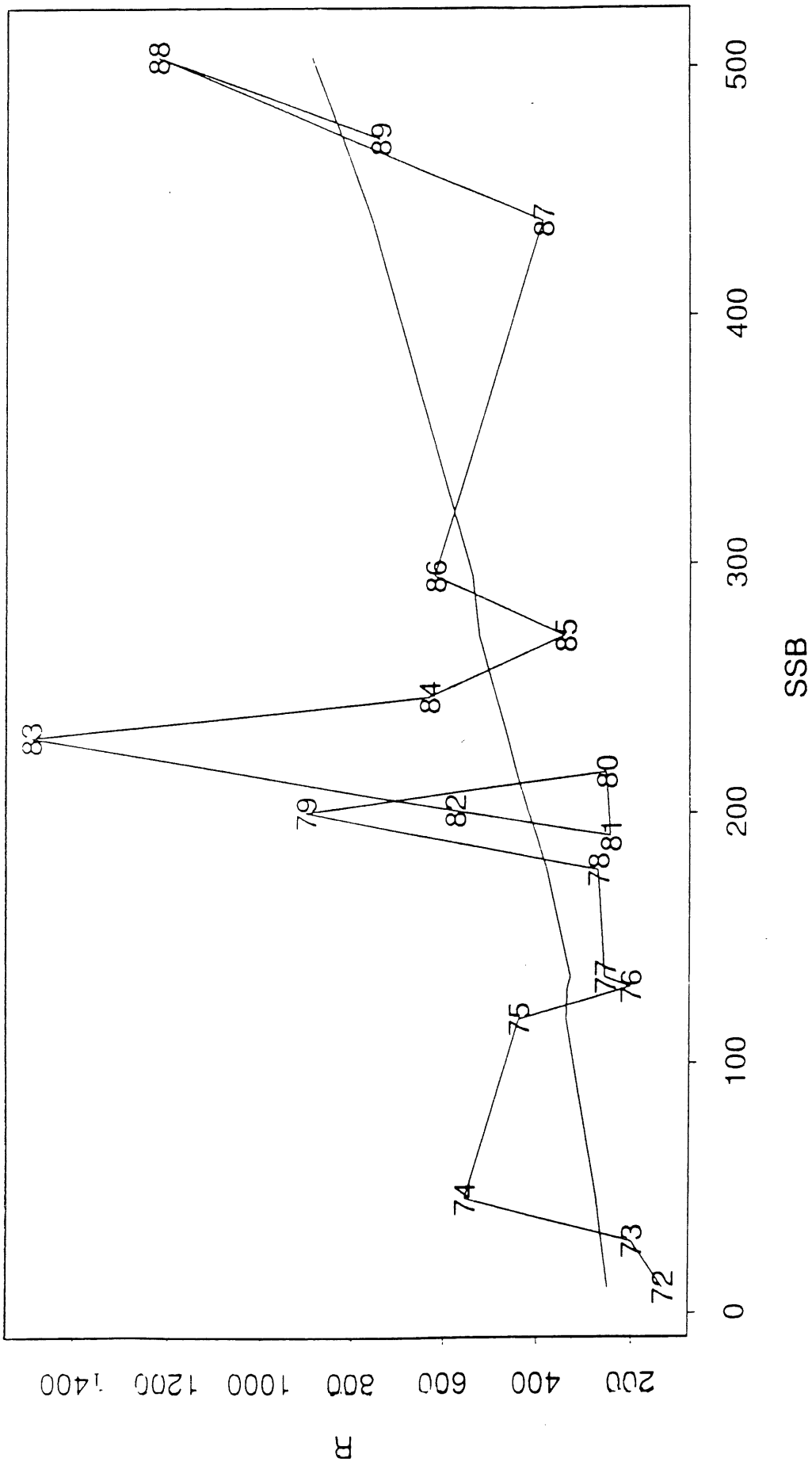


Figure 2.8

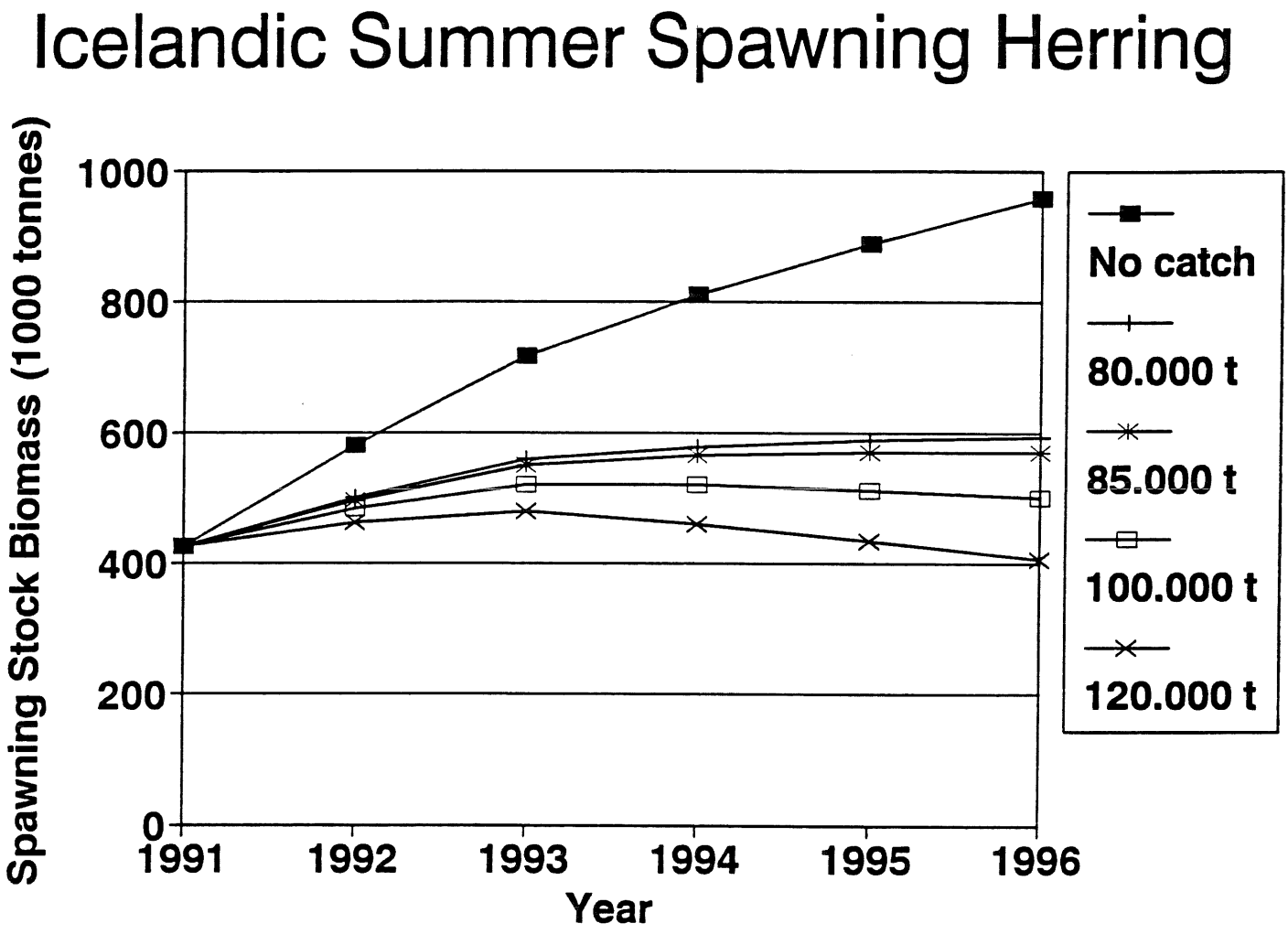

Icelandic Summer Spawning Herring
Spawning Stock Biomass (1000 tonnes)
1000
800
600
400
200
0
1991
1992
1993
1994
1995
1996
Year
No catch
80.000 t
85.000 t
100.000 t
120.000 t

Figure 3.1 Sum of squared residuals against F (year classes 1983+).

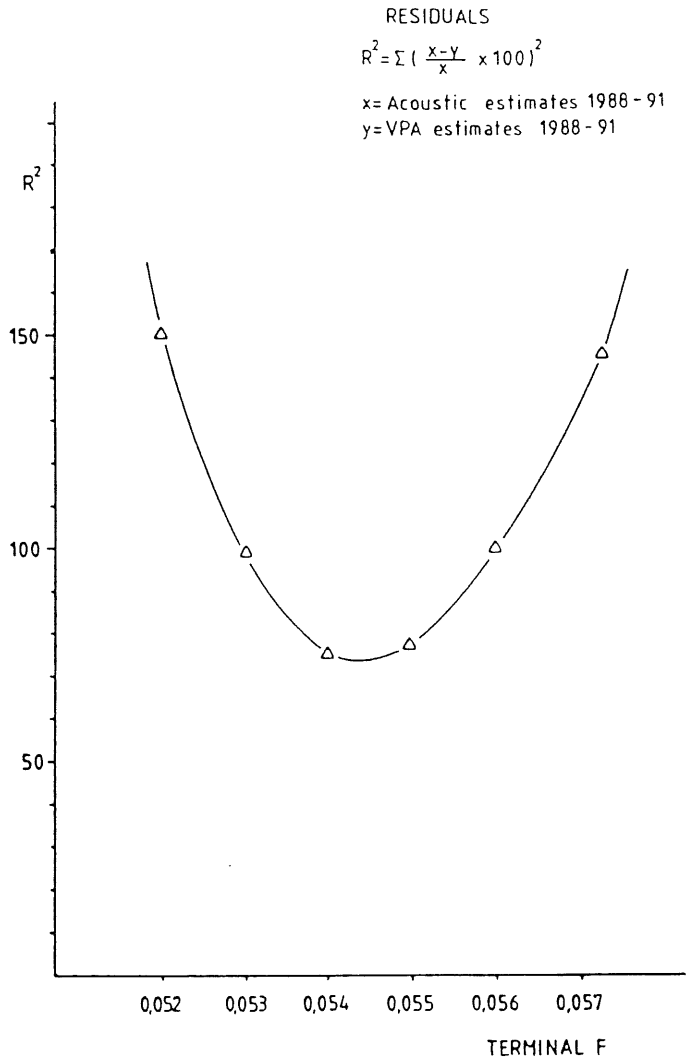
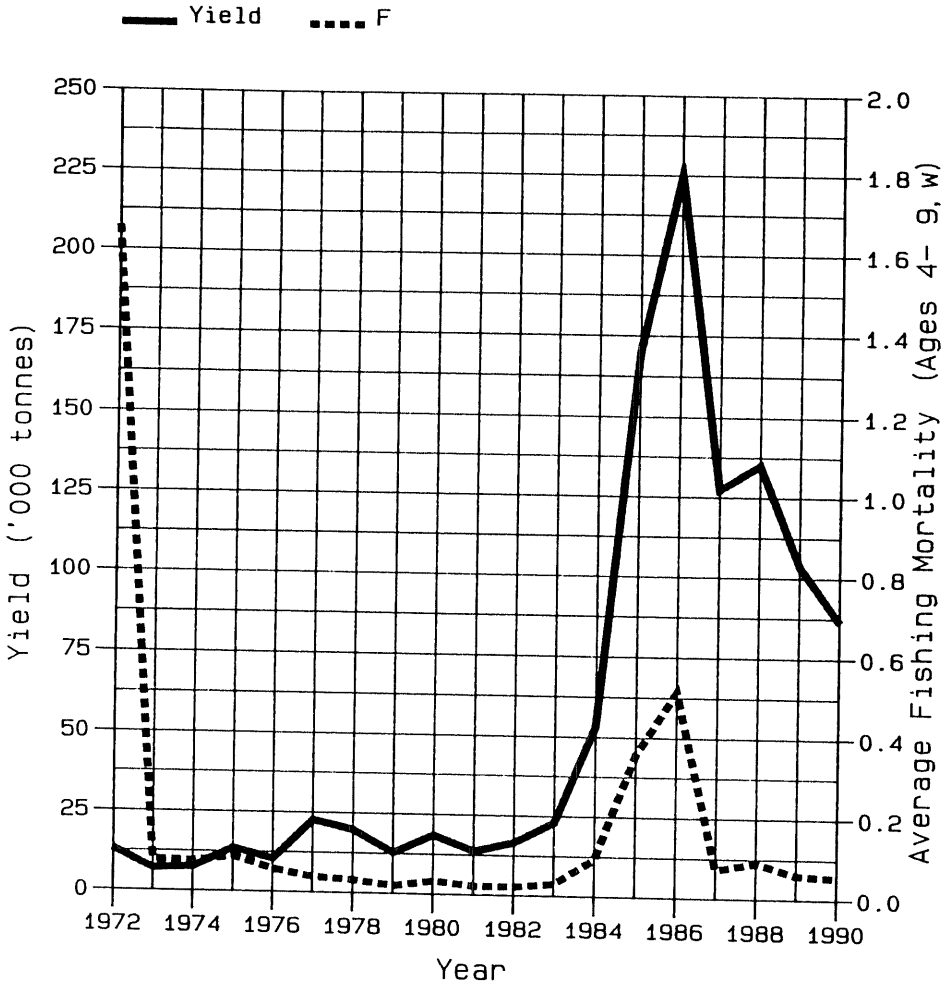


Figure 3.2

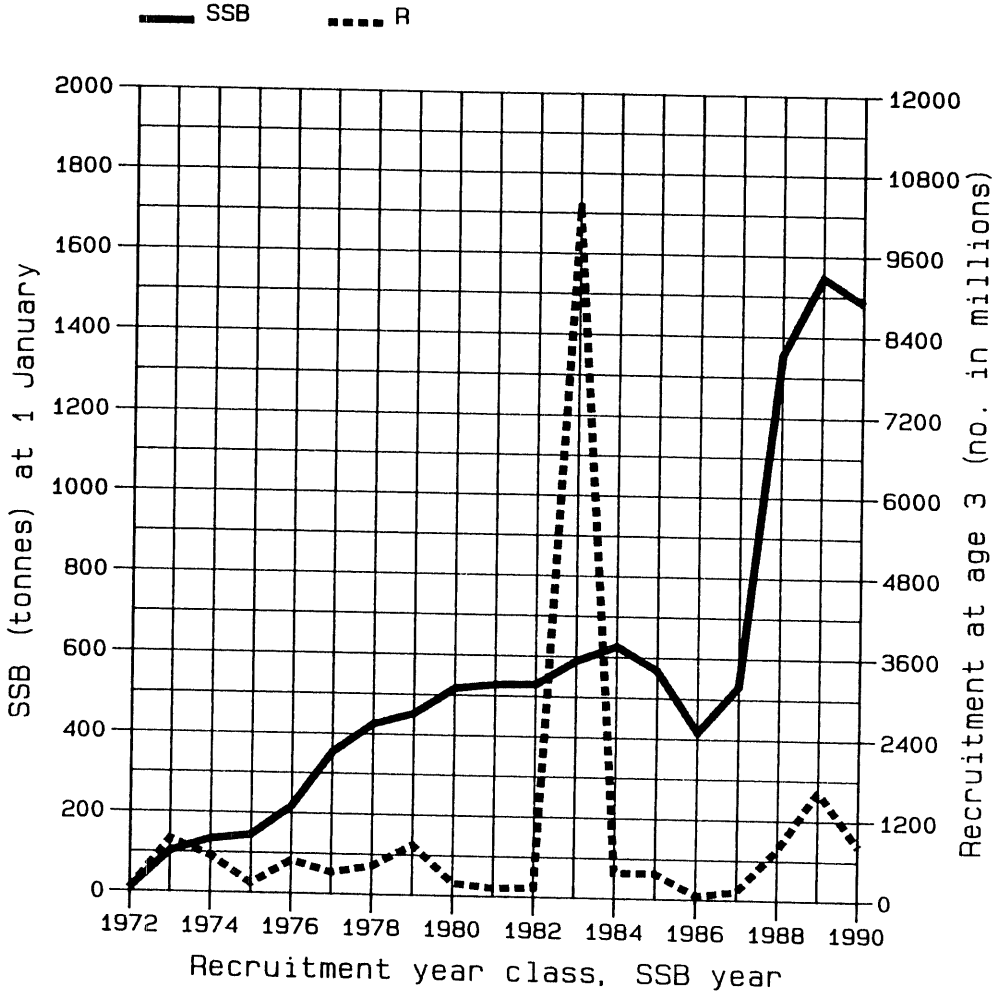
FISH STOCK SUMMARY
Norwegian Spring-Spawning Herring
17-04-1991

Trends in yield and fishing mortality (F)



A

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



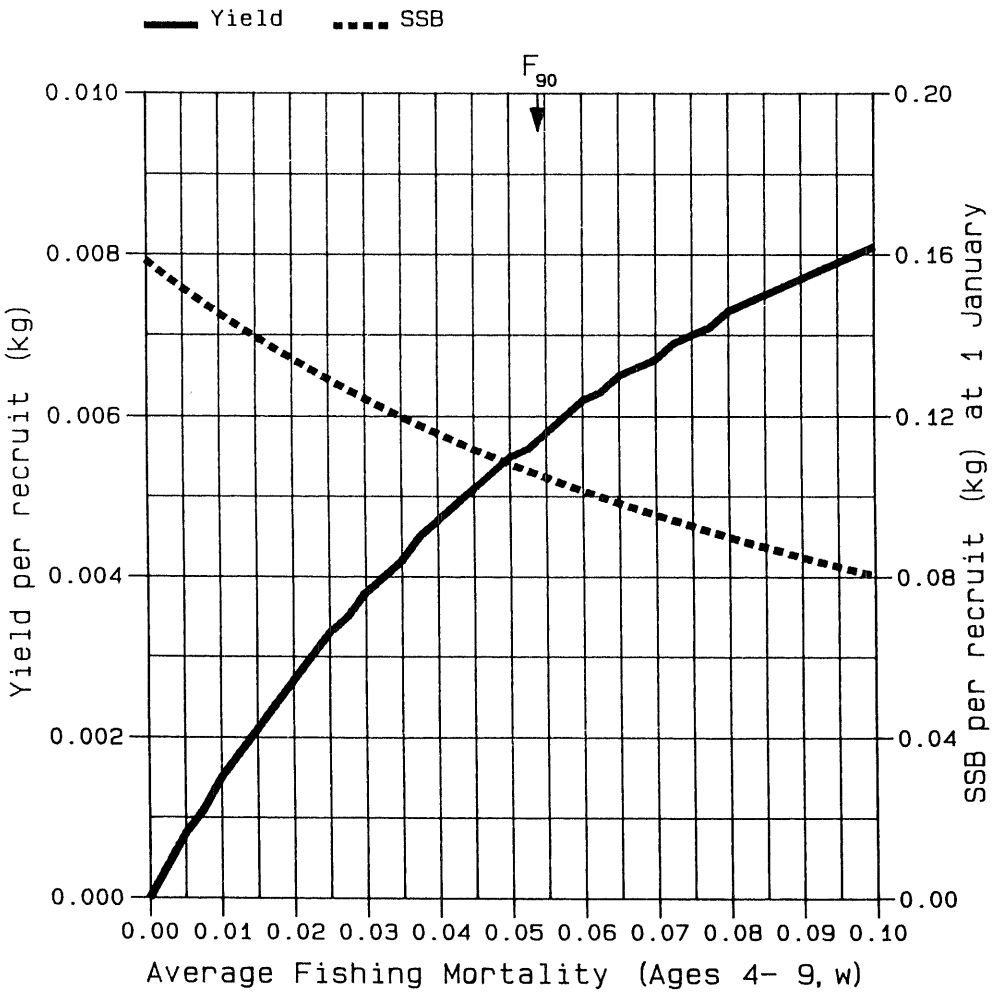
B

cont'd.

Figure 3.2 cont'd.

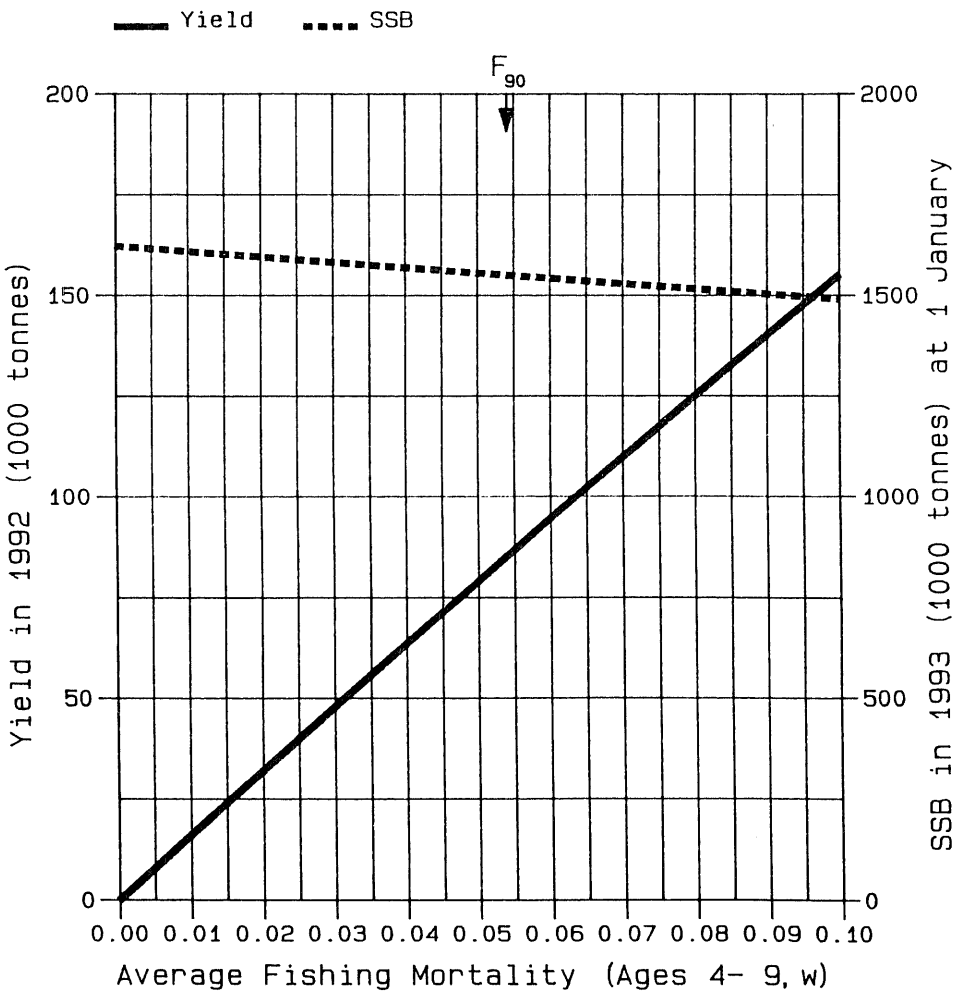
FISH STOCK SUMMARY
Norwegian Spring-Spawning Herring
17-04-1991

Long-term yield and spawning stock biomass



C

Short-term yield and spawning stock biomass



D

Figure 3.3

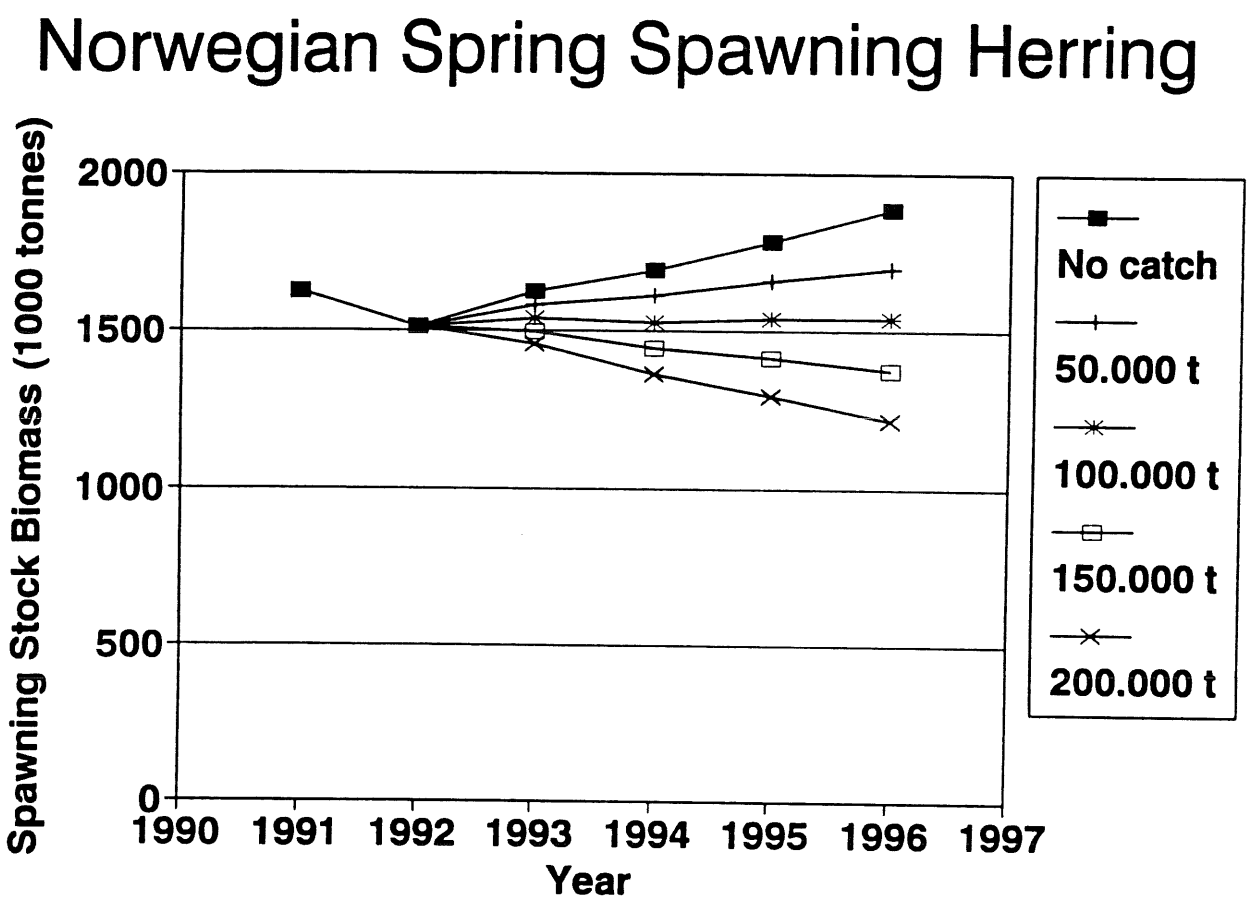
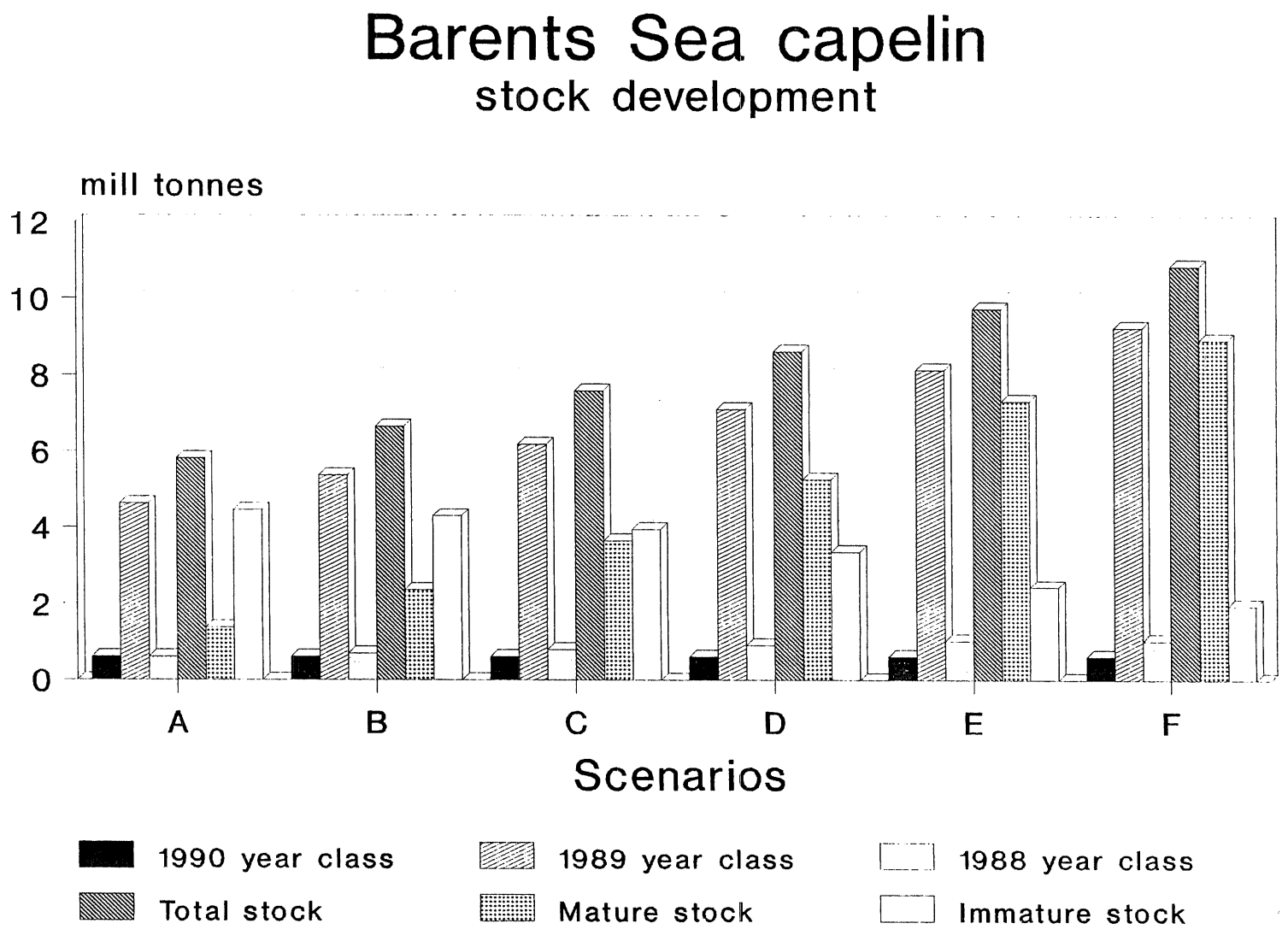

Norwegian Spring Spawning Herring
Spawning Stock Biomass (1000 tonnes)
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
Year
No catch
50.000 t
100.000 t
150.000 t
200.000 t

Figure 4.1 Barents Sea capelin stock development based on the stock measurements in September 1990 and the growth scenarios described in the text. The bars represent stock biomass on October 1. 1991.



Scenario description: refer to text

Figure 4.2 Barents Sea capelin. Biomass of mature stock component in September versus number of individuals in the immature stock component in September the previous year. The year labels refer to initial years.

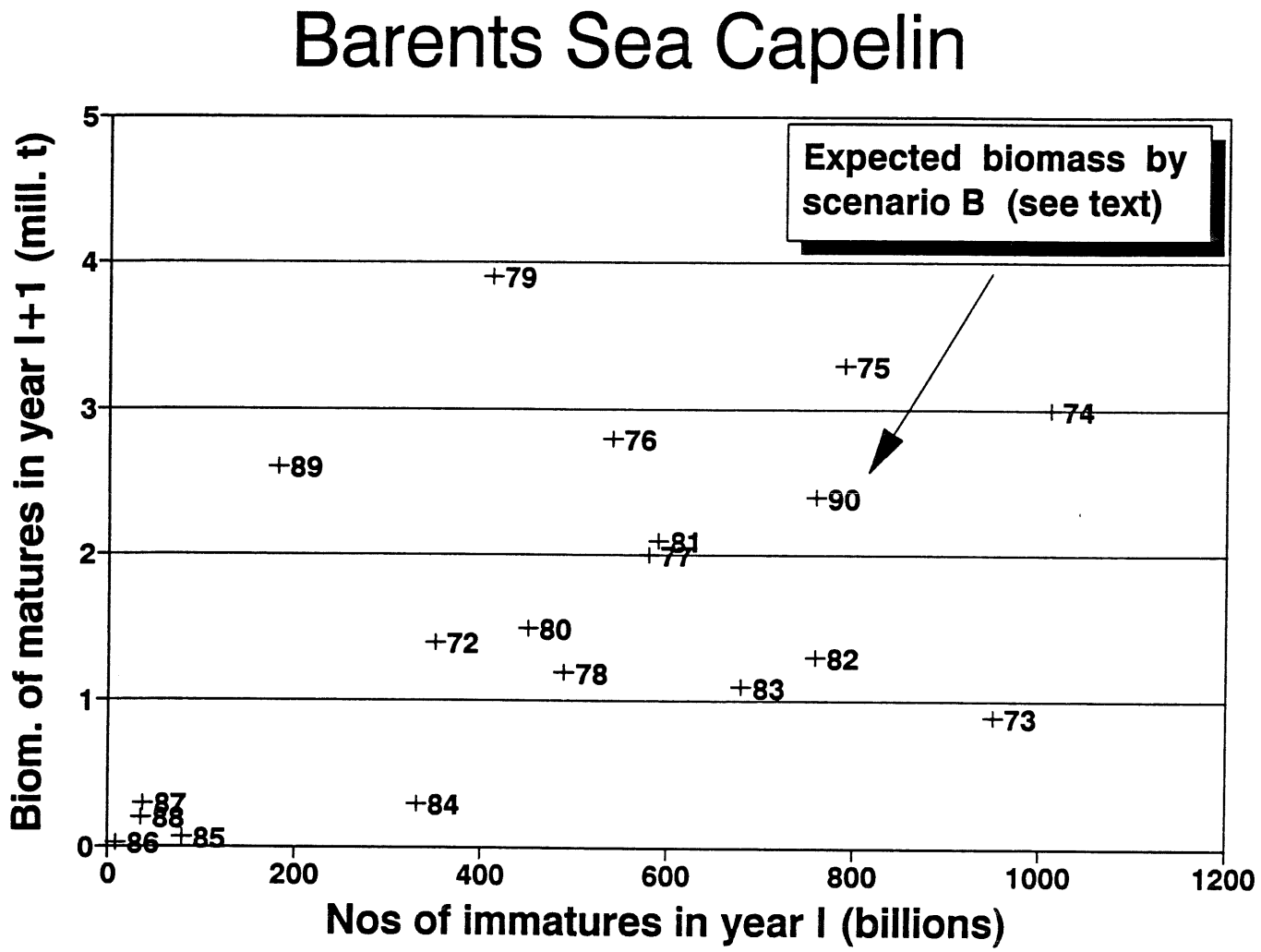


Figure 5.1 The relation between two different estimates of the abundance of the 1981-1988 year classes of capelin. Numbers are in 10^{-9}.