Advisory Committee on Fishery Management

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REPORT OF THE NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

Institute of Marine Research, Bergen,
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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer
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1. INTRODUCTION

1.1 Terms of reference

The Atlanto-Scandian Herring, Capelin and Blue Whiting Assessment Working Group will be renamed the Northern Pelagic and Blue Whiting Fisheries Working Group (Chairman: Mr I. Røttingen, Norway) and will meet in Bergen, Norway from 23-29 April 1996 to

a) assess the status of and provide catch options for 1997 for the Norwegian spring-spawning herring stock and catch options for the 1996-1997 season for the Icelandic summer-spawning herring stock;

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

c) assess the status of capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 1996 and winter 1997 season;

d) assess the status of and provide catch options for capelin in Sub-areas I and II (excluding Division IIa west of 5°W) for the summer/autumn 1996 and winter 1997 seasons;

e) consider further possibilities for the incorporation of biological interactions into the assessments of capelin, herring and cod stocks;

f) assess the status of and provide catch options for 1997 and 1998 for the blue whiting stock;

g) update the information on the spatial and temporal distribution of the stock and fisheries on blue whiting;

h) provide estimates of the minimum biologically acceptable level of spawning stock biomass (MBAL) for as many stocks as possible, with an explanation of the basis on which the estimates are obtained;

j) prepare medium-term forecasts under different management scenarios, taking into account uncertainties in data and assessments and possible stock-recruitment relationships, and indicate the associated probability of the stocks falling or remaining below MBAL within a stated time period.

In addition, the following relevant paragraphs of the NEAFC request for advice from ICES was passed on to the present working group by the chairman of ACFM:

k) evaluate the scientific basis and data employed for the estimation of the temporal and quantitative distribution by areas of Norwegian spring-spawning herring contained in the "Report of the Scientific Working Group on zonal attachment of Norwegian spring-spawning herring (Reykjavik 13-19 September 1995);

l) Indicate possible new developments in the seasonal and area distribution of the total Norwegian spring spawning stock.

The following should be added to item j) above:

For Norwegian spring-spawning herring the management scenarios should include constant fishing mortality rates of 0.05, 0.10, 0.15 and 0.20 and constant TACs of 0.5, 1.0, 1.5 and 2.0 million tonnes;

The following should be added to item f) above:

Evaluate the development of catches, total stock biomass and spawning stock biomass in the short and medium term.

1.2 Participants

S. Belikov	Russia
B. Bogstad	Norway
J. Carscadden	Canada
A. Dommasnes	Norway
H. Gjøsæter	Norway
J. Hamre	Norway
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M. Meixide	Spain
T. Monstad	Norway
K. Patterson	UK (Scotland)
I. Røttingen (Chairman)	Norway
D. W. Skagen	Norway
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2. ICELANDIC SUMMER SPAWNING HERRING

2.1 The fishery

The catches of summer spawning herring from 1975-1995 are given in Table 2.1.1. These include an estimate of 890 t. of discards for the 1995/1996 season. The fishery took place off the south-east coast and 53% of the catches were used for reduction while 47% were used for human consumption. The major part of the catches was taken by purse seiners. Until 1990 the herring fishery took place during the last three months of each calendar year, but in 1990-1995 the autumn fishery continued in January and early February the following year. Therefore all references to the years 1990-1995 refer to the season starting in October of that year.

Year	*Landings '000 t.*	*Catches '000 t.*	*Recommended TACs' '000 t.*
1984	50.3	50.3	50.0
1985	49.1	49.1	50.0
1986	65.5	65.5	65.0
1987	73.0	73.0	70.0
1988	92.8	92.8	100.0
1989	97.3	101.0	90.0
1990/1991	101.6	105.1	90.0
1991/1992	98.5	109.5	79.0
1992/1993	106.7	108.5	86.0
1993/1994	101.5	102.7	90.0
1994/1995	132.0	134.0	120.0
1995/1996	125.0	125.9	110.0

2.2 Catch in numbers, weight at age and maturity

The catches in number at age for the Icelandic summer spawners for the period 1975-1995 are given in Table 2.1.1. As usual the age is given in rings were the age in years equals the number of rings +1. 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 strong 1979 year class. In 1987 and 1988 the fishery was on the other hand based on a number of year classes ranging from 3-10 ringed herring.

In the period 1989-1991 the 1983 year class predominated in the catch. The 1988 year class was also well represented in the 1991 catches and predominated during the 1992 season. In 1993 the age distribution was dominated by the strong 1989 year class although the 1988 year class was also well represented. In 1994/1995 the catches were distributed on 4 year classes, 1988-1991. The catch in numbers of 2-ringers has never been higher and yielded some 25 % of the total numbers. In 1995/96 the catches were distributed on 4 year classes, from 1988-1991.

The weight at age for each year is given in Table 2.2.1 and the proportion mature at age is given in Table 2.2.2. The most striking feature of these parameters in this stock is that despite an inter-annual variation, the weights at age as well as other biological parameters of this herring stock have remained relatively stable over a wide range of stock size and fluctuations in environmental conditions in Icelandic waters.

2.3 Acoustic surveys

The Icelandic summer spawning herring stock has been monitored by acoustic surveys annually since 1973. These surveys have been carried out in November-December or January, usually after the fishery has been closed. During a survey, which took place in November - December 1995, an estimate of the adult stock was obtained and of 1 year old herring in the fjords west and north of Iceland. The adult stock was mainly located in one area of the south-east coast of Iceland and a small proportion was found to be south-west of Iceland. No estimate of the 1992 and 1993 year classes was obtained, but the 1994 year class was found to be above average abundance. The results of the survey have been used as a basis for the present assessment for the 4-ringers and older (Table 2.3.1). As in last year's report, the TS value of TS = 20 log L-72 dB was used to calculate the stock estimates.

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain a 1-1 relationship between acoustic and VPA estimates of stock size. This was done by fitting regression lines between these estimate and testing for slope=1 and intercept=0. Although this provides an adequate model, it was further found that a modification of the target strength gave a better fit between the two data sets. The resulting target strength is the one used in this report.

2.4 Stock Assessment

As in previous years the estimation procedure from 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 minimises the sum of squares of log-transformed rather than untransformed data since there is increased variability in later years coinciding with the increase in stock size.

The results are given in Table 2.4.1 as F'. In this analysis 5-ringers and older have been grouped for estimating the fishing mortality on the oldest herring, whereas the fishing mortality for the younger age groups is calculated for each year class. For F on the oldest age group an average of F for 6-13 ringers was used.

A series of VPAs were run using varying terminal F's on 5+ ringers. For each terminal F a sum of squares (SSE(F)) of differences between the 5+ from the VPA and acoustic estimates is computed. A plot of these values is shown in Figure 2.4.1. From this series of VPAs it is clear that the best (giving the minimum value of SSE) one to one relation between the acoustic estimates and virtual population analysis is obtained with an input F of about 0.27. The confidence intervals (0.18, 0.41) for the fitted terminal F values are obtained as described by 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 (Figure 2.4.1).

Using the catch data given in Table 2.1.1 and the fitted values of fishing mortalities given in Table 2.4.1, a final VPA was run using a natural mortality rate of 0.1 on all age groups and proportion M before spawning as 0.5. Fishing mortality at age and stock in numbers at age with spawning stock biomass on 1 July are given in Tables 2.4.2 and 2.4.3, respectively, and the standard plots are shown in Figure 2.4.2. The resulting stock trend from VPA is plotted along the acoustic estimate in Figure 2.4.3 and the correspondence with acoustic estimates is shown in Figure 2.4.4. In the absence of any abundance estimates of the 1992 and 1993 year classes the average strength the of the year classes was used (approximately 600 million as 1-ringers).

According to the current assessment the spawning stock biomass was about 521,000 t in July 1995 as compared to the projected spawning stock from last year's assessment of 587,000 t. This difference is mostly due to overestimation of the 1991 year class in last year's report and partly due to higher catches than expected.

2.5 Catch and Stock Projections

The input data for the projections are given in Table 2.5.1.Although the variations in mean weight at age are relatively small with regard to the extreme variations in environmental conditions and changes in stock size observed during the past decades, it was found in earlier work by this group (Anon 1993A) that a simple model of the inter-annual variation explains a statistically significant portion of the variance in the weight at age.

As in previous years a regression of weight increase has been used to predict the weight at age for 2-8 ringers (using as input weight at age for 1-7 ringers the year before).

Data for the regression included, as starting years, the period 1986-1995. For 1 ringers and 9+ ringers, a simple average of mean weights at age for the period 1986-1995 was used for the prediction. Weights at age for 2-8 ringers in the catch are thus obtained by using the relation:

$$W_{y+1} - W_y = -0.2184 \cdot W_y + 87.011 \text{ (g)}$$

Where W_y and W_{y+1} are the mean weight of the same year class in the year y and y+1, respectively.

During the 1996/97 fishing season the age distribution will be dominated by the 1988 - 1991 year classes. With the recruitment of the strong 1991 year class the exploitation pattern changed in the 1995/96 season as the fishery concentrated on the 1991-1988 year classes. The exploitation pattern used for the stock and catch predictions takes this into account. This is somewhat different from the average exploitation pattern based on the fishery during 1987-1991 as shown in Table 2.4.1.

As in previous assessment and in agreement with the increased level of recruitment during the 1980s and early 1990s, an assumed value of 600 million of 1-ringers in 1994 and 1995 has been used.

Output of the prediction assuming catches corresponding to a fishing mortality rate of $F_{0.1}$ = 0.225 are given in Table 2.5.2, and projections of spawning stock biomass and catches ('000 t) for a range of values of F are given in Table 2.5.3.

Yield per recruit calculations are shown in Figure 2.5.1 using the long term average values given in Table 2.5.4. The selection pattern is based on data from 1977-93, while the proportion mature and weight at age data are based on data from 1977-95.

2.6 Management Considerations

During the last 20 years the Icelandic summer spawning herring stock has been managed at levels corresponding fairly closely to fishing at $F_{0.1}$. Fishing at the fishing mortality rate of $F_{0.1}$= 0.225 during the 1996/97 season would result in a catch of about 100,000 tonnes (Table 2.5.2). The spawning stock biomass in 1997 would be similar to that in 1996 about 485,000 tonnes. Fishing at higher fishing mortality rates than $F_{0.1}$ would give a correspondingly higher short-term yield but would reduce the stock sharply when the effect of the strong year classes presently in the stock has dwindled.

The working group points out that managing this stock at an exploitation at or near $F_{0.1}$ has been successful in the past.

2.7 Medium-term prediction

In 1995 the working group carried out a medium term prediction for the Icelandic summer spawning herring, based on a fixed F strategy ($F_{0.1}$). As the input parameters for the medium term projections have not changed substantially since the last Working Group meeting in October, no runs were made this year. The results from last year's report are shown in Figure 2.7.1. It is seen that there is very low probability of the harvesting strategy reducing the stock to a low level. There is some probability within the model used of the stock increasing to very high levels. This is due to the handling of uncertainty in the parameters of the recruitment from Ricker curve and is a consequence of the fact that the present state of the stock is at the known historical upper bound.

2.8 Comments on the assessment

The XSA method was also used for this stock. The resulting VPA summary tables from the usual method and XSA are given in Tables 2.8.1-2. The average F for age 5-15 is estimated to be 0.31 and the SSB in July 1995 from XSA is 460 thousand tonnes, compared to 521 thousand tonnes from section 2.4. Retrospective plots of the SSB for both methods are shown in Figure 2.8.1. The results from the method described in section 2.4 give better agreement between runs made in different years. Therefore the method used in earlier assessments has been retained.

3. NORWEGIAN SPRING SPAWNING HERRING

3.1 The Fisheries

3.1.1 1995

The following catch quotas were set autonomously for 1995: For the fisheries of Norway and Russia: 650,000 tonnes, of which 550,000 tonnes were allocated to Norway and 100,000 tonnes to Russia. By the Faroes and Iceland: 250,000 tonnes, of which 170,000 tonnes were allocated to Iceland and 80,000 tonnes to the Faroes.

The landings in 1995 amounted to 902,226 tonnes, which is slightly below the figure of 914,000 tonnes used by the Working Group last year.

The Faroes

The Faroese fishery started in the beginning of May. The first catches were taken in the area north of the Faroes, but later in May the fishery shifted to the north and north-east to the northern border of the Faroese EEZ. The total catch of herring in Faroese waters was about 50,000 t. In addition some Faroese catches were taken in international waters in the Norwegian Sea. Landings of Faroese catches in 1995 amounted to about 57,000 tonnes.

Iceland

The Icelandic fishery started in late April, and by the end of May the Icelandic catch was about 142,000 tonnes, of which about ½ were taken within the Faroese EEZ and the rest in international waters. In June some 32,000 tonnes were caught, mostly in international waters, but also within the Icelandic EEZ. The Icelandic catch amounted to about 173,000 tonnes.

Norway

The Norwegian fishery on Norwegian spring spawning herring is carried out throughout the year, and the main developments are linked to the migration pattern of the herring. The fishery started in the beginning of January in the wintering areas of Northern Norway. About 194,500 tonnes were taken in this area by the end of February. 65,400 tonnes were taken during the spawning migration and on the main spawning areas in the period January throughout February. A catch of 900 tonnes was taken at Karmøy, a minor spawning area. In the latter part of March and in April about 67,900 tonnes were taken of spent herring at the start of the feeding migration. In the Norwegian Sea, during late spring and summer, there was a total catch of 11,900 tonnes, where approximately 4,900 tonnes and 2,400 tonnes were caught by Norwegian vessels in international waters and in the Jan Mayen EEZ, respectively, and the remainder in the Norwegian EEZ. During summer and autumn there was a coastal fishery where 10,200 tonnes were taken. Finally 179,000 tonnes were caught during autumn in Vestfjorden, the wintering area. The total Norwegian catch was about 529,800 tonnes. Approximately 75% of the Norwegian catch is used for human consumption, the rest is utilised for reduction purposes.

Russia

The Russian catch in the spawning area in February to April amounted to 92,000 tonnes. In addition 8,000 tonnes of herring was taken in the Lofoten area in September. The total Russian catch was 100,000 tonnes.

Other Nations

The fishery in international waters by Denmark, Greenland, the Netherlands, UK (Scotland) and Germany caught about 41,900 tonnes.

3.1.2 1996

For 1996 quotas were again set separately by Norway/Russia (Norway: 725,000 tonnes, Russia 200,000 tonnes) and Iceland/The Faroes (Iceland 250,000 tonnes, The Faroes 100,000 tonnes). This year the countries of EU also set a quota of 150,000 tonnes for their fishery in international waters and EU waters north of 62°N. The Working Group assumes that all the quotas will be taken, giving an expected catch in 1996 of approximately 1,400,000 tonnes. By 1. April the Norwegian catch was approximately 380,000 tonnes and the Russian catch approximately 80,000 tonnes.

3.2 Catch Statistics

The total annual catches of Norwegian spring spawning herring for the period 1972-95 (1995 preliminary) are presented in Tables 3.2.1 (by fishery) and 3.2.2 (by country). Catch in number per age group and nation is given in Table 3.2.3. The amount of samples used for converting landings to number by age group is listed in chapter 9.

The Working Group noted that in this type of fishery an additional mortality caused by fishing operations probably exists. In general, it was not possible to assess the magnitude of these extra removals from the stock, and taking into account the large catches taken in recent years, the relative importance of such additional mortality is probably low. Therefore no extra amount to account for these factors have been added in 1994 and 1995. In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches (Table 3.2.1).

For 1995 age compositions and weight at age were provided for the full range of age groups by Norway, Iceland and Russia. The Faroes provided such data up to age 13+, while the Netherlands provided such data up to age 10+. These plus groups were split in the same way as in the Icelandic catch. For the catch by Denmark, UK (Scotland), and Greenland the Icelandic data on age composition and weight at age were used to calculate the number caught at age and weight at age, while for the German catch, the Dutch data were used. The mean weight at age in the catch was calculated as a weighted average of the weight at age in the catch for all the countries.

The method used to calculate catch in number in the Norwegian fishery is described in a working document by Slotte and Røttingen. Each herring landing utilised for human consumption is registered with the following: catch size in kilograms (kg), catch position in terms of area and location and date of delivery for production. In addition the majority of the catches that are used for consume are divided into 5 size groups as follows:

Group	Weight (g)
1	> 333
2	200-333
3	125-200
4	83-125
5	< 83

The percentage of the total catch in kg is calculated for each size group, by taking out subsamples of the catch during the production process. These percentages are registered by the sales organisation. The per cent age composition within each size group can found from sampling, and the total catch in number calculated.

3.3 The adult stock

3.3.1 Acoustic survey on the spawning stock

In 1996 this survey also included areas of both spawning and spawning migration. Fig 3.3.1 shows the distribution of the herring in the period 17.2 - 10.3 1996.

The acoustic abundance estimate was converted to biomass using TS=20 log L - 71.9 (Foote, 1987). The number per year class is presented in Table 3.3.1.

3.3.2 Acoustic survey in the wintering areas

The wintering area was acoustically surveyed in December 1995 and in January 1996 (Working document by Foote and Røttingen), but the results from the December survey was not available to the WG. The time series for the December surveys up to 1994 was used in the VPA tuning, and is given in table 3.3.3. The estimates obtained in January 1996 are given in Table 3.3.2. Both estimates are corrected for acoustic extinction and applying a target strength/length relationship of TS=20 log L-71.9 (Foote, 1987).

3.3.3 Use of tagging experiments in stock assessment

The Working Group decided to include information from the tagging experiments directly in the stock assessment model, in order to evaluate the use of tagging information for estimating natural and fishing mortality rates. The following assumptions were made:

1. Starting in year t, (where t denotes the number of years that fish in a given cohort have been in the sea with tags) a number of fish X_t are tagged. These then undergo a mortality $1-S_t$ immediately after tagging and throughout the rest of the year, so that the number of tagged fish in the sea at 31 December in year t is X_tS_t.

2. In subsequent years, tagged fish are subjected to natural mortality M and to fishing mortality F at the same rate as untagged fish.

3. A random sample of size m_y is drawn from the catch C_y in each year and examined for tags. A 100 % efficiency of the screening process is assumed.

4. Random mixing of tagged fish X in the overall stock N is assumed.

Following these simplifying assumptions, the dynamics of the tagged fish in the stock could be modelled as:

$$X_{t+1} = X_t \ \exp(-M_t - F_t)$$

and consequently the predicted catches of tagged fish (K) in each year follow the usual catch equation,

$$K_t = X_t \frac{F_t}{(F_t + M_t)} (1 - \exp(-M_t - F_t))$$

and if a sample of size m is screened for recoveries with 100% efficiency, the expected number of tag recoveries is:

$$\hat{T} = m_t \frac{K_t}{C_t}$$

and these can be compared to the observed values of tag returns (T) from the experiments. The probability distribution of errors in T is not known. Errors about T are likely to arise from systematic model errors (non-random mixing, increased mortality rates, imperfect screening of samples, etc.) as well as from stochastic sampling errors. Various assumptions could arguably be made about the probability distribution of such errors (e.g. log-normal, normal, Poisson, binomial) and it was not immediately clear what was the most appropriate treatment, and hence the most appropriate objective function. The Working Group investigated two approaches, based on either a least-squares approach weighted by the size of the screened catch, or by using an approximation to a binomial distribution. In the former case, the term to be minimised was simply:

$$\sum_{i,t} m_t (T_{i,t} - \hat{T}_{i,t})^2$$

where the summation over i indicates a summation for tagging experiments, an 'experiment' being the release of tagged fish in a given year, and all the recaptures therefrom thereafter.

Alternatively, an approach following Haist *et al.* (1993) was considered. From the binomial distribution, a sample of size m drawn at random from a mixed population having a proportion $\hat{P}$ of tagged fish would yield an estimate P of $\hat{P}$ with variance

$$Var(P) = \hat{P}(1 - \hat{P}) / m$$

Following Haist *et al.*, the variance is considered dependent on an additional term τ^2, which includes such effects as stratification of sampling, non-random mixing, variable screening efficiency, etc. A constant (0.01) is introduced to make the model more robust by placing a minimum bound on the variance estimate. The variance estimate becomes:

$$Var(P) = \frac{\hat{P}(1 - \hat{P}) + 0.01}{m\tau^2}$$

and writing

$$\xi = \frac{\hat{P}(1 - \hat{P}) + 0.01}{m}$$

the log-likelihood function to be maximised is, for all experiments i and all recaptures from each experiment t,

$$-\frac{1}{2} \sum_{i,t} \left(\ln(2\pi) + \ln(\tau^2) + \ln(\xi_{i,t}) \frac{(P_{i,t} - \hat{P}_{i,t})^2}{\tau^2 \xi_{i,t}} \right)$$

In this case it was necessary to recalculate τ^2 iteratively, as

$$\hat{\tau}^2 = \frac{1}{n} \sum_{i,t} \left(\frac{(P_{i,t} - \hat{P}_{i,t})^2}{\xi_{i,t}} \right)$$

where n is the number of observations of P.

3.3.4 Estimates of mortality rates from tagging data

The Norwegian tagging experiment on herring, which was initiated in 1975, has been continued, and recoveries from commercial catches have been screened for tags using tag detector installed at sea food processing factories. These data were considered suitable for use in the assessment. Recoveries have also been reported from other Norwegian factories, mainly fish meal plants, which use herring entrails from the herring filleting industry in the production. These tags originate from an unknown catch, and have not been used in the assessment. From the catch of herring in the Norwegian Sea last summer, Iceland has reported 630 herring tags retained on magnets in Icelandic fish meal plants. A magnet efficiency test carried out at one of the plants gave a screening efficiency of 47.5 %. The herring used in the test experiment was, however, in very poor condition, which may have caused error in the efficiency estimate. The Icelandic sample was therefore not used in the assessment.

The length of the fish at the time of tagging is used to calculate the age. The yearly number of fish released and number screened, and the number of recaptures by tagging year and recapture year is given in Table 3.3.4, for fish belonging to the 1986 and earlier year classes. These data were used to attempt to estimate natural mortality and stock size for the 1983 cohort alone, because the adjacent year classes are considered to be poor. Recaptures in the tagging year and the year after the tagging were excluded from the analysis, and the recaptures in 1995 of the fish tagged in 1993 were also excluded.

Both of the methods described in Section 3.3.3 were used. Estimation of stock abundance in 1996 and of natural mortality was attempted, and the sensitivity of the model fit to assumed values of S was tested. The feasibility of estimating the additional mortality caused by the *Ichtyophonus* was also investigated. Such investigations were somewhat hampered by the inability of the Working Group to estimate the precision of the parameter estimates obtained on fitting the models, and hence are of a tentative nature only.

After a number of exploratory model fits the following was concluded:

- Estimating the *Ichtyophonus*- induced mortality is unlikely to be feasible to any useful degree of accuracy.

- The model could be used to estimate natural mortality or total mortality, but the estimate of abundance (and hence of fishing mortality) was strongly dependent on the assumed value of S. Estimates of M were very robust to the value assumed for this parameter.

- Fitting either the log-likelihood function or the least-squares fit yielded similar estimates of mortality.

Figure 3.3.2 shows the actual vs. expected number of recaptures for all combinations of tagging year and recapture year used in the analysis, using the log-likelihood approach outlined in Section 3.3.3 and assuming a constant natural mortality. M is then estimated to 0.16. In this estimation, S was set to 0.6.

The Working Group concluded that this was a promising approach, but that further work was required to:

- Combine the tagging model with the acoustic survey information in a consistent way,
- Develop a robust method, possibly based on bootstrapping, for estimating the uncertainty in the parameter estimates.

3.4 Recruitment

3.4.1 Stock estimates of immature herring

The nursery area of the Norwegian spring spawning herring are Norwegian fjord and coastal areas and the southern part of the Barents Sea. Since 1988, when the 1983 year class spawned for the first time, the latter area has increased in importance as a nursery area for the herring. Since the last Working Group meeting, new information is available only for the 0-group herring in the fjords and coastal areas of Norway (Table 3.4.1)

3.4.2 Assessment of immature and recruiting year classes

The results from the acoustic young herring surveys are shown in Table 3.4.2. During 1995, most of the strong year classes are 1991 and 1992 have migrated out of the Barents Sea. The migration from the nursery results in recordings of stationary and migrating herring over wide areas. As described in last year's report, The Working Group regarded a combination of the estimates from surveys in the feeding areas in the south-eastern and north-eastern as the most reliable for these year classes for use in the prognoses. These estimates correspond to 16.4 billion for the 1991 year class and 20.7 billion for the 1992 year class at 1 January 1996. There are no further total estimates of these year classes, and the working group decided to maintain these estimates.

The estimates of the 1993 and 1994 year classes given in Table 3.4.2 are used as basis for the prognoses. The 0-group index from the Barents Sea in autumn 1995 was the lowest since 1987 (Table 3.4.3) and the abundance recorded in the Norwegian fjord and coastal 0-group survey in Norway was the lowest estimate (29 million) since the survey started in 1975 (Table 3.4.1). A Russian survey in December 1995 in the Barents Sea (working document by A. Krysov) estimated the abundance of the 1995 year class to 14 million. These results indicate that the 1995 is a very weak year class. The sum of the abundance in the Norwegian fjords and the Barents Sea is 43 million individuals, and this number is used in the prognoses. The estimates of the 1993-1995 year classes have been projected forward to age 3 applying a natural mortality at ages 1 and 2 of 1.56 and 0.54 respectively (Barros, 1995).

3.5 VPA and Catch and Stock Prognosis

3.5.1 Tuning the VPA

Data from the acoustic surveys in the wintering areas in December and January and on the spawning grounds in February-March were available for tuning the VPA. Based on the analysis of the tagging data given in Section 3.3.4, it was decided not to include stock estimates from tagging. It was decided to use these acoustic estimates only for age 5 and older fish, because younger age groups are not completely covered by these surveys. The survey data, catch data and natural mortalities used are given in Table 3.5.1.

An attempt was made to estimate the natural mortality (see section 3.3.4), including that induced by the *Ichtyophonus* disease, using tagging data. The overall natural mortality was set at 0.16 for the 1983 year class, but a separate mortality for the years when the disease was prominent could not be obtained. The Working Group decided to retain the natural mortalities used previously (0.13 and 0.23) which are compatible with the estimate from the tagging data, pending further work on the estimation of these values.

The same method as last year was used. Mathematically, it can be expressed as follows:

y: year index
s:survey index
N_y: Stock number in year y
$A_{y,s}$: Survey index in year y from survey s
n_s: Number of observations for s

The method minimises $\sum_{y,s}\left(\ln N_y - \ln\left(A_{y,s}q_s\right)\right)^2$

where $q_s = \exp\left(\sum_y \frac{\ln \frac{N_y}{A_{y,s}}}{n_s}\right)$ can be regarded as a catchability. The results of this minimisation, applied to the 1983, 1988, 1989 and 1990 year classes, is shown in Table 3.5.1. Figure 3.5.1-3.5.4 show, for each year class, the VPA compared to the survey data adjusted by the estimated catchabilities. The figures illustrate that there is a lot of noise in the survey data. The estimates for the 1983 and 1990 year classes are somewhat higher than the estimates for these year classes obtained by the Working Group last year, while the estimates for the 1988 and 1989 year classes change very little. There is a strong positive correlation among the estimates for the various year classes. The CV for the terminal N estimates is approximately 50 %.

We also attempted to estimate the natural mortality from the tuning data by allowing M to vary in addition to the four terminal Ns. When M was assumed to be constant during the period, a point estimate of 0.08 was obtained. The Working Group did not obtain any estimate of the variance of this estimate of M.

3.5.2 VPA input and output

The input data to the VPA are given in Tables 3.5.2-3.5.6. The terminal Fs for the different year classes in the last year were found by tuning the catch at age data given in Table 3.5.2 to the stock numbers at age calculated from the tuning (1983,1988,1989 and 1990 year classes, Section 3.5.1) and from estimates of the 1991 and 1992 year classes, Section 3.4.2. The terminal Fs for the weak 1982 and 1984-1987 year classes were assumed to be equal to the terminal F for the 1983 year class. This year the VPA was run for age groups 3-14+. The terminal Fs at oldest age were the same as last year, although last years' VPA was run on age groups 3-13+.

Historic estimates of stock size have been revised substantially since the assessment presented by the previous Working Group meeting, due to a slightly different age range used for the VPA. The change in age range was necessary to avoid incorporating the 1983 cohort in the plus-group, but the change in the historic estimates illustrates that the VPA estimates of abundance are very unstable when fishing mortality is lower than natural mortality. This is the case for many years in this stock.

Following the advice given by ACFM at its November 1995 meeting, it was decided to use F_{5-12} weighted by the population number (hereafter denoted as $F_{5-12,w}$) as the reference F for this stock. The results of the VPA are given in Tables 3.5.7-3.5.11.

3.5.3 Input data for the catch and stock prognosis

These data are given in Table 3.5.12. For the year classes 1982-1992 the VPA stock numbers at 1 January 1996 have been used (Table 3.5.8). The abundance of the 1993-1995 year classes is calculated as described in Section 3.4.3.

The weight at age in the stock for 1996 is calculated from biological samples in December 1995 and January 1996. As stock size is expected to increase towards the level from the 1950s and 1960s in the coming years, a slower growth may be anticipated, something which is also indicated by the data for weight at age in the stock and in the catch in the last two years. The weights at age in the catch data from the 1950s are not comparable to the present values due to a different structure in the fisheries (a larger proportion was then taken as spent herring). The Working Group therefore chose the 1960s as a reference point for weight at age in the stock and catch at higher stock sizes, set the weight at age in the stock and in the catch in 1997 and later years equal to the 1960-1969 average. The change in the weight at age in the catch is made gradual by setting the 1996 values equal to the average of the 1995 and 1997 values. The maturity at age for 1996 was the same as used at the last Working Group meeting, this is based on data from July-August 1995. For the years 1997 and later the average maturity at age in the period 1960-1968 was used.

For the prognosis the same flat-topped exploitation pattern as last year was chosen, assuming full recruitment to the fishery at age 5. A natural mortality of M=0.13 was applied for all age groups.

3.5.4 Results of the prognosis

The expected catch in 1996 (1,400,000 t) indicates that the fishing mortality ($F_{5-12,w}$) will increase from 0.17 in 1995 to 0.18 in 1996. The effects of different levels of F on the catch in 1997 and on the stock and SSB in 1998 are presented in Table 3.5.13.

The assessment shows that the spawning stock biomass will increase from 5.4 million tonnes in 1996 to 7.2 million tonnes in 1997. In 1998, the spawning stock biomass will increase further for all levels of fishing mortality in 1997 given in Table 3.5.13. The total stock biomass (3+) will increase from 10.1 million t in 1996 to 11.2 million tonnes in 1997, but will decrease again in 1998.

3.6 Risk analysis

3.6.1 Harvesting strategies

For the past decades, the methods used for setting annual TACs for herring in the north-east Atlantic has been based on low-F-strategies. For some herring stocks, an $F_{0.1}$-strategy has been used, but this strategy is found to correspond to a collapse of the Norwegian spring spawners in deterministic simulations. It is also clear that using a fixed-F strategy for the Norwegian spring spawners will yield extremely high catches when a large year class enters the fishery and there may be considerable gain in an alternative fixed-catch (Q-based) strategy.

Thus, from a historical, theoretical and practical viewpoint, there is some virtue in considering both F-based and Q-based harvesting strategies. These can also be considered special cases of a more general strategy, based on F until the catches reach an upper limit, Q. The Q-based strategy follows by increasing F in the combined strategy and the F-based strategy follows from increasing Q in the combined strategy. Thus, the combined strategy can be used as a common base for comparing Q- and F-based strategies in a continuum.

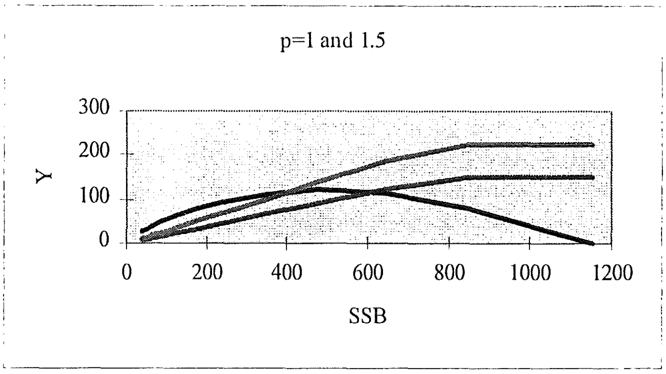
Recent TAC allocations for Norwegian spring spawning herring correspond to a much more precarious present harvesting regime, however. This can be modelled in the following fashion. Management body A (country or group of countries) decides that Y is an appropriate catch level and decides to allocate the proportion p_A of this level to the corresponding industries. Management bodies B and C, however, decide to allocate the proportions p_B and p_C of Y to their industries. Notably, the sum of the proportions, p, is considerably greater than 1. In an initial year, when this is applied, the result will simply be that the allocated catches will amount to pY in total, rather than Y. In the combined strategy setting, this can easily be modelled by replacing Q with pQ and F with F' where F' gives a relative catch increase of p from that obtained from F. Thus, this allocation scheme is merely a variation on the combined strategy as long as the allocation debate remains in the present stalemate.

The proposed model of the "current" harvesting strategy can therefore be summarised as follows:

The annual TAC, is set as pY, where Y is based on fishing with fixed fishing mortality F, although in no year may Y exceed Q. In short,

TAC=p *min*(Y(F),Q)

where Y(F)=catch corresponding to fishing with fixed fishing mortality F. The figure below depicts an arbitrary example of this model for p=1 and 1.5, where the dark curve represents equilibrium catch.



3.6.2 Risk analysis

A risk analysis was performed with 500 iterations. The time range for the runs was 1 January 1997 to 1 January 2006.

3.6.2.1 Input data

The same data as for the short-term prognosis was used (Table 3.5.12). However, the stock at 1 January 1996 was projected to 1 January 1997 assuming that a total catch of 1.4 million tonnes will be taken in 1996. Thus, the initial stock is dependent on the M-value used.

3.6.2.2 Modelling of uncertainty

Stock data

In order to include the uncertainty of M in the analysis, and since changing M also leads to different initial stock numbers, a VPA run was made with all M's increased by 0.02, in addition to the standard VPA. These results give the derivative of the initial stock numbers as functions of M. During simulations, a value for M was drawn at random, and initial stock numbers computed assuming a linear relation between them and M. A single multiplicative error, with a CV of 0.5, was applied to these numbers.

Maturity ogive

A normal distribution with expectation 0.39 and a standard deviation of 0.1 was assumed for the proportion mature of 5 year old fish. The drawn value was kept through each simulation run.

Natural mortality

A standard deviation of 0.05 was assumed. The drawn value was kept throughout each simulation run.

Recruitment

Five different recruitment assumptions were considered:

A Beverton-Holt recruitment function was fitted to the data assuming a log-normal error. Two different cases were applied: Retaining all data (recruitment model 2) and deleting the exceptionally large year classes 1950, 1959 and 1983 year classes (recruitment model 1). The rationale behind the latter approach is that the time series shows that there always has been a period of up to 10 years between years of good recruitment. 1992 was a year of good recruitment, so it is unlikely that another year of good recruitment will occur within the time series used for the simulations.

The historical half values in a Beverton-Holt model were calculated assuming a maximum recruitment of 1.5 times the maximum observed recruitment and were drawn with equal probability during the simulations (recruitment model 4). In this case the effect of autocorrelation in recruitment was taken into account by drawing half values from the same number of years after a good year class (1950, 1959, 1983) as the time from the year in question to 1992 (recruitment model 3).
A Ricker model (recruitment model 5) was also used, where the parameters are drawn each year taking into account the parameter estimation errors and covariance.

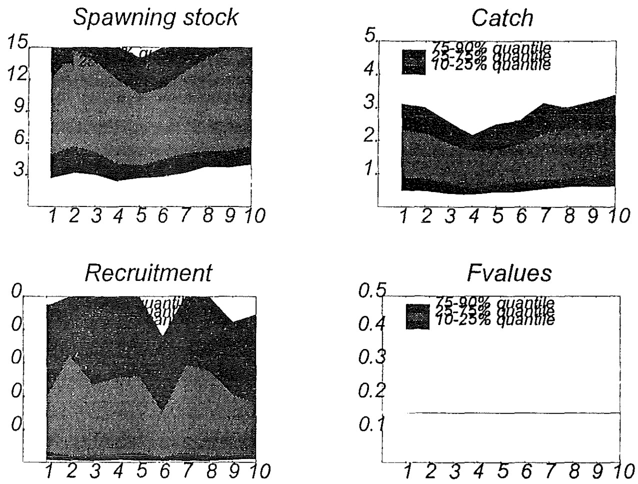
All recruitment refers to 3 year old fish. The recruitments and the spawning stocks were calculated assuming a linear relationship for both recruitment and spawning stocks with M was assumed. During simulations the appropriate half values (recruitment model 3 and recruitment model 4) were used. In case of recruitment models 1 and 2 a linear relationship with M for the recruitments based on the two different M-values was assumed.

It was felt that the consideration from previous years that the large 1991 and 1992 year classes may adversely affect recruitment in the nearest years may not longer be valid since these year classes now migrate into the Norwegian Sea after spawning. Thus there is no overlap with the drifting larvae. Therefore recruitment model 2 was chosen as the reference model.

3.6.2.3 Results

The figure below shows simulation results for recruitment model 2 and an F-value of 0.15.

WGRiskF0.15R2



It is seen that the stock is, in a stochastic sense, more or less stable throughout the period.

The text table below shows the simulation results for recruitment model 2:

	Prob (SSB2006 < 2.5)	Median SSB2006	Median Mean Catch
F = 0.05	0.00	12.54	0.56
F = 0.1	0.02	10.72	1.02
F = 0.15	0.03	8.41	1.28
F = 0.2	0.14	6.00	1.34
MaxCatch = 0.5	0.06	12.40	0.50
MaxCatch = 1.0	0.25	7.40	1.00
MaxCatch = 2.0	0.56	1.18	2.00
F = 0.10, catch < 1.0	0.02	11.35	0.92
F = 0.10, catch < 1.5	0.02	10.72	1.02
F = 0.20, catch < 1.0	0.02	9.48	1.00
F = 0.20, catch < 1.5	**0.11**	**6.71**	**1.16**

It is seen that for mean yearly catches above 1.0 million tonnes the danger of the stock not increasing from the present level increases.

The text table below show comparisons between models. In these runs, a combined strategy is used where a constant F-value equal 0.2 is applied provided the yield is below 1.5 million tonnes. The choice of recruitment model had a profound effect on the terminal spawning stock biomass of the simulation. In particular, the Ricker model (model 5) gives the highest probability of a low stock size.

	Prob (SSB2006 < 2.5)	Median SSB2006	Median Mean Catch
Model 1	0.16	4.72	1.05
Model 2	**0.11**	**6.71**	**1.16**
Model 3	0.40	2.96	1.03
Model 4	0.17	7.19	1.20
Model 5	0.80	1.96	0.85

The text table below shows simulation results for the M-values estimated from the tagging and the acoustic data respectively. The runs are made for a constant F of 0.15.

	Prob (SSB2006 < 2.5)	Median SSB2006/ SSB1996 ratio	Median Mean Catch
M = 0.08	0.00	xxx	1.99
M = 0.16	0.07	xxx	1.00

3.6.3 Analysis of overfishing

An alternative and much simpler model for risk analysis was derived for comparison with the more extensive one presented above and for the specific task of comparing some management alternatives, including a model of the current harvesting "strategy" for the stock.

Simulation model

A fairly simple simulation model is used, where estimation error is inserted into the estimated stock size each year (including the initial stock size) and process error is inserted into recruitment.

A target fishing mortality, F_{target}, will of course never be attained exactly. In particular, an F-based yield prediction for year y+1 will be derived from a stock estimate corresponding to an estimated fishing mortality F_y' rather than a true value. Assume that the estimate is perturbed from the true fishing mortality, F_y by a single estimation error. Let ε_y denote multiplicative log-normal estimation errors of the overall fishing mortality in year y so that $F_y' = F_y \varepsilon_y$. The TAC is then computed by taking the stock estimate corresponding to F_y' and applying F_{target}.

For low values of fishing mortality, all these operations are essentially multiplicative. Thus, the above is almost equivalent to computing the TAC based on the true stock size *etc.* and then applying the multiplicative error afterwards: Let B_y denote the biomass, so the desired TAC is approximately $Y= F_y B_y$ but the estimated is $Y= F_y' B_y$. Hence, in the simulations, estimation error in the F-based TAC will be incorporated simply through a multiplicative error in the TAC computed from the rule. The true (inflicted) fishing mortality can then readily be computed as the one giving the TAC from the true population.

Stochastic simulation results

For recruitment, the simpler model is based on fitting a Ricker curve to the logged stock and recruitment data, as in recruitment model 5 above. This provides an estimate of the CV (about 200%) of recruitment and the log-scale coefficients in the Ricker model (resulting in α=0.9486 and K=6448). The fit also provides an estimate of the standard error of the log-scale estimates as well as the correlations between them.

For simulation purposes, log-scale parameters can be generated from a multivariate Gaussian distribution with these standard errors and correlations, yielding a simulated stock-recruitment relationship for each simulated time trajectory. For each simulated year, recruitment is picked from a log-normal distribution around this relationship.

The selection pattern, maturity ogive, weight at age in catch and stock as well as proportion of M and F before spawning were all assumed to be fixed throughout the simulations, all based on the averages used in other predictions.

Simulation results were tabulated for several different values of p and Q. Rather than consider a full range of fishing mortality values, it should be noted that the long-term sustainability of fishing mortalities over 0.10 is somewhat doubtful but the fishing mortality in 1996 is estimated above this level. Hence the approach taken is to simulate with F=0.10 and to account for higher catches in the future by considering p-values larger than 1.

Results are given in tables 3.6.1-2. Each of the two tables provides an upper block of expected values from the simulations and a lower block of corresponding standard errors. Results are given in subtable for different quantities: The probability of the stock being below 2.5 million tonnes in 2006, the average catch during the 10-year period 1997-2006, the SSB and the catch at the end of the period. Values of p and Q_{max} index each subtable, where p=1, 1.25 and 1.5 and Q_{max} =1.0 or 1.5 million tonnes.

The tables clearly illustrate the trade-off between stock sizes and short-term yields.

3.7 Management considerations

Although the stock assessment indicates an increasing stock size with good recruitment and a low fishing mortality, the assessment is imprecise and the stock has a known vulnerability to collapse at high levels of exploitation. Therefore, although prospects for this fishery appear good in the short-term, the adoption of a cautious harvesting strategy is likely to improve the medium and long-term benefits to be obtained from this fishery.

The spawning stock is expected to increase in the near future due to the recruitment of the strong 1991 and 1992 year-classes. However, the year-classes 1993 to 1995 appear to be weak. The estimate of the spawning stock size in 1996 is assessed as being between approximately 3 and 15 million tonnes with 90 % confidence. The wide confidence limits reflect the sensitivity of the stock size estimates to assumed values of natural mortalities and to variability in the data used to fit the assessment model. Unfortunately, the precision of the current estimate of M could not be assessed. On account of this uncertainty, the choice of a harvesting strategy for 1997 and onwards should not be made on the basis of the short-term predictions (Table 3.5.13). Rather, the choice should be made on the basis of the desired medium-term development.

The stochastic medium-term projections suggest that the current estimates of stock size are highly imprecise. These projections and associated analyses of risk are highly dependent on assumed values for coefficients of variation. Perceptions of risk are highly dependent on the prior choice of recruitment model, and there is not, at present, any objective way of choosing among those tested. Furthermore, different approaches to the treatment of the problem appear to imply different appropriate strategies for medium-term exploitation of the stock. The reasons for this were not known and could not be evaluated by the Working Group in the time available. For these reasons, the Working Group does not present advice based on stochastic medium-term projections.

Completion of the work on medium-term projections is a prerequisite for providing appropriate advice on the exploitation of this stock, and the Working Group has therefore nominated a sub-group to identify an appropriate and robust medium-term projection procedure. Advice on exploitation strategies based on such a procedure will be presented in a separate working document to ACFM.

3.8 Information on the Spatial and Temporal Distribution of Norwegian spring spawning herring

The emigration of the major part of the large year classes 1991 and 1992 from the nursery areas in the Barents Sea to the Norwegian Sea in 1995 is was an important factor in relation to development in the spatial and temporal distribution of the stock of Norwegian spring spawning herring.

3.8.1 Recorded distribution in 1996

3.8.1.1 Winter 1996

Adult herring: Before the spawning migration at the beginning of January, the entire spawning stock was located in the same wintering areas as in previous years, in Ofotfjorden and Tysfjorden in northern Norway. The spawning areas were the coastal banks of the Norwegian coast from approximately 59°N to 70°N, and spawning began in mid-February. Compared to 1995 there seems to be a small increase in spawning in the southernmost part of the spawning area, and a certain decrease in the northern part.

Immature herring: The main distribution area of immature herring in winter 1996 has changed compared to the distribution area of immature herring in winter 1995. Last year the main concentrations of immature herring (1992 year class) were located in the Barents Sea. This year class left the nursery areas in the Barents Sea during 1995) (only a minor proportion of the year class is still distributed in the Barents Sea). The main part of the year class was by winter 1996 still immature and wintered in the Vestfjorden area.

There were some recordings of immature herring in the Barents Sea in December 1995, consisting mainly of the 1993 year class. (Fig3.8.1). The biomass estimate of immature herring in the Barents Sea in December 1995 was approximately 160 thousand tonnes.

3.8.1.2 Spring 1996

Adult herring: After spawning the herring started their feeding migration. According to survey results the area between 67°N and 68°N seems to be an important migration channel from the spawning areas to the feeding areas in the Norwegian Sea. Figs 3.8.2 and 3.8.3 shows distributions of herring in March and in April 1996 in the Norwegian Sea.

Further migrations of adult herring in the Norwegian Sea will be monitored by joint international surveys. So far in 1996, the distribution and migration of adult herring seems to be comparable to the corresponding time period in 1995. Fig 3.8.4 gives a general picture of the feeding migration in 1995, and Fig 3.8.5 indicates the migration in 1996.

Immature herring: The main part of the immature herring which wintered in 1995/96 in the Vestfjorden, seems to have left that area by mid-March, migrating westwards to the coastal banks and the Norwegian Sea. The distribution and abundance of immatures in the Barents Sea will be mapped during joint Russian-Norwegian surveys in May-June.

Herring larvae: Fig 3.8.6 gives the distribution of herring larvae in April 1996.

3.9 *Ichtyophonus hoferi* disease in the Norwegian spring spawning herring stock

Norwegian data from the wintering and spawning areas indicate that virtually no disease was present in the stock (Working Document by D. Skagen). Russian data from the spawning areas may show higher percentages, but the exact data were not available to the Working Group. There is however, no evidence indicating increases in the disease prevalence, and hence no need to apply an increased natural mortality for 1996.

4. BARENTS SEA CAPELIN

4.1 Regulation of the Barents Sea Capelin Fishery

Since 1979 the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between USSR/Russia and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. The fishery was closed from 1 May to 15 August until 1984. During the period 1984 to 1986, the fishery was closed from 1 May to 1 September. From the autumn of 1986 to the winter of 1991, no fishery took place. The fishery was re-opened in the winter season 1991, on a recovered stock. From the autumn 1993 the fishery was again closed. A minimum landing size of 11 cm has been in force for several years.

4.2 Catch Statistics

The international catch by country and season in the years 1965-1995 is given in Table 4.2.1. Following the recommendation from ACFM, there was no fishing for Barents Sea capelin during 1995 nor 1996.

4.3 Stock Size Estimates

4.3.1 Acoustic stock size estimates in 1996

Since the last meeting of the Northern Pelagic and Blue Whiting Fisheries Working Group (hereafter called NWG) in October 1995, no surveys designed to estimate the abundance of this stock have been conducted. During various Norwegian and Russian demersal fish surveys in January to March 1996, covering most of the ice free part of the Barents Sea, the distribution of capelin was mapped by trawl and acoustics. No abundance estimates were made, mainly due to the very dispersed nature of the capelin distribution and inadequate sampling of capelin. Capelin was detected in thin scattering layers dispersed over the surveyed area, and mature and spawning capelin were located in coastal areas of western Finnmark in late February - early March. The general impression from the distribution of s_A-values is that the state of the stock, as assessed from the capelin survey last autumn, is still valid.

4.3.2 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1986-1995 is given in Tables 4.3.1-4.3.10. The methods and assumptions used for constructing the tables were explained in Appendix A to Anon. (1995a). In that report, the complete time series back to 1973 also can be found. It should be noted that several of the assumptions and parameter values used in constructing these tables are provisional and future research may alter some of the tables considerably. For instance, natural mortalities for immature capelin will be calculated using new estimates of the length at maturity and natural mortalities for mature capelin will be calculated taking the predation by cod into account. However, the tables should be adequate to give a crude overview of the development of the Barents Sea capelin stock.

Estimates of stock in number by age group and total biomass for the period are shown in Table 4.3.1. Catch in number by age group and total biomass is shown for the spring season and the autumn season in Tables 4.3.2 and 4.3.3. Fishing mortality coefficients by age group for the autumn season and natural mortality coefficients by age group for immature capelin are shown in Tables 4.3.4 and 4.3.5. Stock size at 1 January in numbers by age group and total biomass and the mean weight by age group at 1 January are shown in Tables 4.3.6 and 4.3.7. Proportion of mature stock by age group at 1 January and spawning stock biomass at 1 April are shown in Tables 4.3.8 and 4.3.9. Table 4.3.10 gives an aggregated summary.

4.4 Management Considerations

In the present situation, where the spawning stock size is lower than any target level, and where the year classes 1995, 1994 and 1993 are poor (the size of the 1996 year class is as yet unknown), there is no reason to change the previous management advice based on the assessment done during the 1995 NWG meeting.

4.5 The change in timing of the meeting

The change in timing of the meetings of NWG from late autumn to spring, results in some obvious problems for assessing and giving advice on TAC for this stock. The assessment of the stock is primarily based on the acoustic survey conducted annually in September-October. The main fishing season is from January to March. Consequently, this stock must be assessed during the autumn ACFM meeting (late October - early November) and the TAC set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. If NWG does not meet in October, one option is to leave the assessment of Barents Sea Capelin to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk. The scientists conducting this survey (who are mostly members of the NWG) always meet after the survey to prepare a joint report. That group could do the assessment during that meeting, using methods approved by the NWG, and submit a separate report to ACFM, which could be reviewed at the next meeting of the NWG. If this working group decides to recommend fishing during an autumn fishery season, a preliminary

TAC could be advised during the subgroup meeting in October, and this recommendation could be assessed during the spring NWG meeting in light of any new information on the stock. This advice could then be dealt with at the ACFM meeting in May.

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

5.1 The fishery

5.1.1 Regulation of the fishery

The fishery depends for the most part upon maturing capelin, *i.e.* that part of each year class which spawns at age 3 as well as those fish of age 4, which did not spawn earlier. The abundance of the immature components is difficult to assess before their recruitment to the adult stock at ages 2 and 3. This is especially true of age 3 immatures.

The fishery of the Iceland-East Greenland-Jan Mayen capelin has, therefore, been regulated by precautionary catch quotas set prior to each fishing season (July-March) based on the results of surveys of the abundance of immature 1 and 2 year olds. Final catch quotas for each season have then been set in accordance with the results of acoustic surveys of abundance of the maturing fishable stock, carried out in autumn (October-November) and/or winter (January/February) in that season. A summary of the results of this procedure is given in Table 5.1.1.

Over the years, fishing has not been permitted during April-June and the season opened in July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. In addition, areas with high abundance of juvenile 1- and 2-group capelin (in the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

5.1.2 The Fishery in the 1995/1996 Season

In accordance with a previously determined procedure, ACFM recommended that a precautionary TAC should not exceed 2/3 of the total TAC predicted for the season, *i.e.* 800,000 t. This advice was accepted by all parties concerned.

The season opened on 1 July with the Icelandic fishing fleet taking good catches, especially near the shelf edge north of the Vestfirðir peninsula. However, it soon became apparent that the catch consisted of slow growing age 2 capelin, especially in the westernmost part of the fishing area. That part of the area was temporarily closed to the fishery around mid-July.

In the second week of July a Norwegian fishery was begun in deep waters to the ENE of Langanes with catches consisting mainly of large capelin of the 1993 and 1992 year classes. However, it seems that there was not much capelin in this area and the fishery soon shifted to near the shelf edge north of Melrakkaslétta (around 16°W).

In the summer of 1995, Icelandic, Norwegian and Greenlandic vessels caught about 82,000, 28,000 and 1,000 tonnes, respectively. All of the catch was taken in July. Extensive sampling of the catch around mid-July by Icelandic fishery inspectors revealed that a large part by number of the catch in the north Icelandic area consisted of immature capelin <13.5 cm. The area within the Icelandic EEZ, south of 68°10'N to the west of 18°W, and south of 67°40'N to the east of 18°W was, therefore, closed to the fishery from 20 July 1995. At the time there was much ice in the Denmark Strait, as well as off the coast of Greenland farther to the north, and no fishable capelin concentrations could be found outside of the closed area.

When the fishing ban was lifted on 9 August, the Icelandic fishing fleet searched for capelin in the previously closed area as well as in most of the usual summer distribution area of the fishable stock. No commercial concentrations were located.

The situation remained the same throughout August and September. An Icelandic capelin fishery began again in October north of the Vestfirðir peninsula, but the fishable stock remained scattered and for the most part mixed with immatures during the rest of the year.

The total catch during the summer/autumn season amounted to 205,700 tonnes.

The capelin remained in scattered concentrations east of Iceland for the most part of January 1996. The monthly catch amounted to only 40,000 tonnes, with a considerable part taken during an experimental pelagic trawl fishery.

A large scale fishery began in the first days of February in shallow waters off the eastern southcoast. Catch rates remained high throughout the month and a record catch of just over 420,000 tonnes was taken. A spell of bad weather disrupted fishing in the first week of March. The catch during the rest of the month amounted to 260,000 tonnes.

Thus, in spite of the scattered condition of the fishable stock in January and the weather constraints during March, a record catch of just under 725,000 tonnes was taken during the 1996 winter season.

5.2 Catch Statistics

The total annual catch of capelin in the Iceland-East Greenland-Jan Mayen area since 1964 is given by weight, season and fleet in Table 5.2.1.

The total catch in numbers during the summer/autumn 1978-1995 and winter 1979-1996 seasons is given by age and years in Tables 5.2.2 and 5.2.3 respectively.

The distribution of the catch during the summer-autumn 1995 and winter 1996 seasons is given by size groups at age in Tables 5.2.4 and 5.2.5.

5.3 Surveys of stock abundance

5.3.1 0-group surveys

The distribution and abundance of 0-group capelin in the Iceland-Greenland-Jan Mayen area has been recorded during surveys carried out in August since 1970. The resulting abundance indices, divided according to areas, are given in Table 5.3.1.

An acoustic estimate of the abundance of age 1 capelin has also been obtained during the August surveys. Their abundance by number, mean length and weight are given for the period 1982 - 1994 in Table 5.3.2.

5.3.2 Stock abundance in autumn 1995

An acoustic survey was carried out in the period 30 October - 14 November 1995. The distribution of the stock was unusually wide and continuous, reaching from 29°W, west of the NW-peninsula of Iceland, across the outer part of the northern shelf to 10°30'W off the northern east coast. The largest and most dense capelin concentrations were recorded near the shelf edge off the western north coast and north-east of Iceland.

Because of ice, the westernmost part of the channel between Iceland and Greenland as well as the Greenland shelf could not be reached. Although only scattered capelin were recorded in the vicinity of the ice border, the presence of capelin in ice covered areas can not be ruled out. Weather conditions were good and the capelin almost always recorded in scattering layers. However, in most areas the recordings consisted of a mixture of mature and immature fish, the ratio of which it was often difficult to determine.

According to the autumn 1995 survey the immature stock component amounted to 163.0 and 46.3 billion fish, belonging to age groups 1 and 2 respectively. The estimated fishable/spawning stock abundance was 95.7 billion fish in mid-November 1995. The observed mean weight in the fishable stock was 14.3 g and the fishable/spawning stock biomass, therefore, about 1,365,000 tonnes. Details of this stock estimate are given in Table 5.3.3.

5.4 Historical Stock Abundance

The historic estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys. The "best" in each case is defined as that estimate on which the final decision on TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (Anon 1991a) the abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 August (before the fishing season) and 1 January in the following year for the 1978/79 - 1995/96 seasons. The results are given in Tables 5.4.1 and 5.4.2 (1 August and 1 January, respectively). Table 5.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979-1996.

The observed annual mean weight by age was used to calculate the stock biomass on 1 January. With the exception of juvenile capelin which are surveyed in summer, the historic average growth pattern was used to estimate stock biomass of the maturing components on 1 August, from mean weights observed in the autumn of the same year or in January of the following year. The remaining spawning stock biomass is calculated from mean weights in January of the same year. Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is slightly underestimated.

5.5 Stock Prognoses

5.5.1 Methods

The precautionary TAC should be set at such a level as to open the fishery before the October/November survey, yet keep it closed when it is likely that fishing will reduce the residual spawning stock below 400,000 tonnes. Thus the prognosis procedure needs to predict the fishable stock in the beginning of the season in order to predict the effects of fishing. To account for the highly variable year class strength and maturing ratio, the procedure needs to predict separately the two major components of the mature stock (age groups 2 and 3). These predictions need to be done in spring.

Available data include acoustic survey estimates of the different age groups in August, October and January. However, the August survey results, used for a number of years in order to predict age 2 recruits, have proven unreliable. This has become apparent by comparing these predictions to later assessments of the same stock components. On the other hand, it has been found that autumn (October/November) acoustic estimates of the abundance of age groups 1 and 2 are more reliable predictors of fishable stock abundance about 8 months prior to the fishery (Tab. 5.5.1).

A prediction model was developed (Anon 1993a) based on a linear relationship between the historic back-calculated abundance of maturing capelin of age group 2 (N_{2mat}) and the autumn acoustic estimates of the same year classes. This relationship was then used to predict the new autumn 1-group abundance estimate (N_1) at the beginning of the fishing season some 8 months later.

The maturing part of the 3-group in summer corresponds to the surviving part of the year class which did not mature and spawn in the year before. Unfortunately, the surveys of the immature capelin of age 2 (N_{2imm}) in the year before have usually been gross underestimates and have, therefore, not been used. Similarly, the January survey of this year class only estimates the part which will spawn and thus is no indication of what will appear in summer of next year.

In general terms, however, maturity at age 2 is inversely related to year class size (N_{2tot}), *i.e.* the maturing ratio is a function of year class abundance. Therefore, the total abundance of age group 2 in autumn should be an indication of what will appear as 3-group in the following season. Since 1993, a regression relating the back-calculated total abundance of year classes at age 2 to their abundance at age 3 year (N_{2tot} and N_{3tot}, respectively) has been used for predicting the abundance of age 3 capelin.

The data sets comprising all comparisons of numbers by age and maturity, relevant to this prediction model, are given in Table 5.5.1. The mean weight of maturing 2- and 3-group capelin in autumn 1981-1995 (year classes 1978-1993) is given in Table 5.5.2. The above regressions were updated as new data became available. A comparison of the predicted TAC and the advised TAC updated with data from the autumn survey is given in Table 5.5.3.

5.5.2 Stock Prognosis and Assessment for the 1995/1996 Season

Calculations of expected TAC for the 1995/1996 season, based on the method described in section 5.5.1, were used for predicting the abundance by number of maturing capelin of ages 2 and 3 on 1 August 1995. This gave an estimate of 92.5 and 14.9 billion mature fish, belonging to the 1993 and 1992 year classes respectively.

The fishable stock biomass, obtained by multiplying the estimated stock in number by the average mean weight of maturing capelin in autumn, was then projected forward to spawning time in March 1996 with the assumption of a monthly mortality rate of M = 0.035 and a constraint of a remaining spawning stock of 400,000 t. This gave a predicted TAC of 1,200,000 t if spread evenly over the time August 1995 - March 1996 (Table 5.5.3).

With a monthly natural mortality rate of 0.035, the constraint of a remaining spawning stock of 400,000 tonnes and an estimated weight increase of 2.6 g, the autumn 1995 abundance estimate indicated a TAC of 1,010,000 tonnes in the period mid-November 1995-March 1996, assuming catches were evenly spread over time. Counting the catch taken during 1 July- mid-November 1995, this corresponded to a total TAC of about 1,150,000 tonnes for all of the 1995/96 season.

However, sampling of the winter fishery on mature capelin indicated that the 1992 year class contributed more strongly to the fishable/spawning stock than was predicted from the autumn 1995 estimate. Indeed, it appears from the catch at age data that, including natural mortality, 8.9 billion fish of the 1992 year class were removed by the fishery, *i.e.* 1.9 billion more than the number recorded during the autumn 1995 assessment survey. Furthermore, the weight at age of maturing capelin, observed in autumn 1995, was abnormally low, especially in the case of the 1993 year class.

A comparison between available winter survey estimates of adult stock structure and corresponding data extracted from samples of the commercial catch, shows that the year class ratio in samples of the catch during the winter fishery is a reflection of the age composition of the adult stock at large ($y = 1.067x + 0.546$; $R^2 = 0.962$). From the 1996 winter catch, some 80 samples of 100 fish each were collected, spread over the period January-March. During almost all of the period the year class ratio remained stable at about 2, 77 and 21 %, for age groups 2, 3 and 4 respectively. Furthermore, the increase in both length and weight at age was much larger than usual, especially in the case of age group 3.

It is therefore quite clear, that the autumn 1995 survey must have missed a part of the maturing stock, most likely consisting fish belonging to both age groups 3 and 4. The result of an attempt to reconcile these differences is given in Table 5.5.4. Two basic assumptions were made:

1) that the proportion of age group 3 be raised to about 0.21, and
2) that the age distribution of the missing part was in the ratio 0.4/0.6 of age groups 3 and 4 by number, this being near the lowest contribution of 2 year olds observed in nature for this stock.

The calculation procedure was as follows;

for the 1993 year class;

$$N_3 = h * (pc * n_2 - (1 - pc) * n_3) / (h - pc)$$

for the 1992 year class;

$N_2 = 0.4 * n_3 / 0.6$

where h denotes the ratio of 3-group fish among the missing component (=0.6), pc denotes the final proportion of age group 3 in the stock estimate (=0.21), and n_2 and n_3 are the observed abundance of age groups 2 and 3 by number.
The numbers of 13.8 and 9.2 billion fish thus calculated, of age 3 and 2 respectively, were then divided on length groups according to the length distribution of the catch samples. Correcting for growth during November-February (average growth = 0.5 cm), the resulting numbers at length were then added to the autumn 1995 estimate. Finally, the length/weight relationship, observed during the autumn 1995 survey (Table 5.3.3), was used to recalculate the adult stock biomass. According to this procedure the estimated biomass of adult capelin in mid-November 1995 was about 1,635,000 tonnes (Table 5.5.4).

Counting the catch already taken (140,000 tonnes), the corrected autumn 1995 abundance estimate corresponds to a TAC of about 1,450,000 tonnes for all of the 1995/96 season, or 1,300,000 tonnes from mid-November 1995 until the end of the winter fishery in March 1996. During that time a catch of about 790,000 tonnes was taken, thus leaving about 900,000 tonnes to spawn in March-April 1996.

5.5.3 Stock Abundance and TAC in the 1996/1997 Season

Although the models, described in section 5.5.1, have with one exception, proven adequate for the purpose of keeping the precautionary TAC within safe limits, it has gradually become clear that the relationship between year class size and maturing ratio is far too variable to use for predictive purposes. Furthermore, autumn estimates of age group 1 capelin abundance indicate that recruitment in the last few years has been at a significantly higher level than at any time during the first part of the period. This is contrary to observation, as can be seen by comparing the 1-group estimates with back-calculations of year class abundance from acoustic estimates of mature capelin, catches and natural mortality rates (Table 5.5.1). The most probable explanation of this feature of the data seems to be that the design of recent autumn surveys has been changed to provide a detailed coverage of the distribution of all age groups from age 1 and older in contrast to earlier surveys which were specifically aimed at the mature stock.

Using the 1993 model for predicting the number of maturing capelin of age 2 from the autumn 1995 acoustic assessment of the 1994 year class would yield an estimate of 122.4 billion maturing 2-group fish on 1 August 1996. This is about 30% higher than the highest recruitment of mature 2-group capelin in the 1979-1995 series.

In view of the features of the data set just described and the probable lower maturation rate for large year classes, a curvilinear relationship might be expected to provide a better estimate of recruitment for large year classes. However, the data series are as yet inadequate for determining the exact shape of such a curve. Therefore, the Working Group recommends the continued use of the relationship established in 1993, but with an upper limit near the highest recruitment actually observed in the known past.

As yet, there seems to be no plausible way to predict the abundance of maturing capelin of age 3 one year ahead in time, using a comparable method. However, it is quite obvious from the autumn 1995 acoustic estimate that there will be a fairly large contribution by the 1993 year class to the fishable/spawning stock of 1996/97. The Working Group agreed that, in cases such as at present, the most reasonable procedure is a projection of the autumn 1995 acoustic estimate of the age 2 immature component by number to 1 August 1996.

The main component of the fishable stock in the 1996/1997 season will be the maturing part of the 1994 year class and that part of the 1993 year class which had not spawned in the spring of 1996.

The autumn 1995 survey gave an estimate of 163.0 billion immature capelin belonging to the 1994 year class as well as a total of 46.3 billion immature capelin of the 1993 year class (Table 5.5.4). Using the 1993 prediction model (section 3), this corresponds to 122.4 billion maturing capelin belonging to the 1994 year class on 1 August 1996. However, the observed largest numbers of maturing 2-group recruits are 86.9 and 95.7 billion fish, belonging to the 1991 and 1993 year classes respectively. In view of concerns expressed above the Working Group agreed to set the predictive figure at 90 billion.

A projection of the estimated abundance of immature capelin of the 1993 year class (Table 5.5.4) yields 35.0 billion maturing capelin of the 1993 year class at 1 August 1996, assuming a monthly natural mortality rate of 0.035.

The fishable stock biomass, obtained by multiplying the predicted stock in number by the average mean weight of maturing capelin in autumn (Table 5.5.2), was then projected forward to spawning time in March 1997 with the assumption of a monthly mortality rate of M = 0.035 and the constraint of a remaining spawning stock of 400,000 tonnes. This gave a predicted TAC of 1,635,000 tonnes if spread evenly over the time August 1996 - March 1997 (Table 5.5.3).

Using the same approach as in previous years, *i.e.* that the precautionary TAC be set at approximately 2/3 of the predicted total for the season, the Working Group recommends that a preliminary TAC for the 1996/97 capelin fishery be set at 1,100,000 tonnes. Decisions on the final TAC for the 1996/97 season should, as in earlier years, be based on the results of surveys carried out in October-November 1996 and/or January 1997.

5.5.4 Stock Abundance and TAC in the 1997/98 Season

The main components of the fishable stock in the 1997/98 season will be the 1995 and 1994 year classes. As yet the only available information on the abundance of the 1995 year class is the 0-group index, obtained in August 1995 (Table 5.3.1). However, information on the 1994 year class includes an 0-group index (Table 5.3.1) and an acoustic abundance estimate during surveys in August and October/November 1995 (Table 5.3.2).

The 0-group index for the 1995 year class ranks among the lowest indices recorded in the past. In contrast, the 1994 0-group index is among the highest on record and both the summer and autumn estimates of age 1 capelin abundance indicate that the 1994 year class is abundant.

The above information may be said to point to a situation similar to that of 1986/87, when the remainder of the large 1983 year class more than made up for the lower than average recruitment to the fishable stock by the following 1984 year class. However, experience has shown that 0-group indices and 1-group abundance are poor predictors of stock abundance one and a half to two years ahead in time.

Information necessary for predicting year class abundance in the 1997/1998 season, using the methods described in section 5.5.1, will not become available until after both the autumn 1996 and winter 1997 surveys have been completed. Therefore, even a preliminary advice on a precautionary TAC for the 1997/1998 season, must be postponed until such data become available.

5.6 Special comments

As in previous years, the Working Group recommends that measures be taken to prevent the fishing on concentrations of juvenile capelin which have only in part used their natural growth potential.

An overview of stock developments during 1978 - 1995 is given in Table 5.6.1.

6. BLUE WHITING

6.1 Stock identity and stock separation

This topic has been dealt with in previous Working Group reports, and in 1995 it was stated that several populations of blue whiting could appear in the spawning area. There are, however, no indications of genetic substructure among the blue whiting from west of the British Isles to Gibraltar and since 1994 the two stocks, i.e. the northern one and the southern one have been treated as one for the assessment purpose (Anon., 1996). It is however, necessary to continue the study of this species population structure, and an EU-project of genetic analysis is continuing (J. Mork, pers. comm.).

6.2 Fisheries in 1995.

Estimates of the total landings of blue whiting in 1995 from various fisheries by countries are given in Tables 6.2.2-5 and summarised in Table 6.2.1. The total landings from all blue whiting fisheries in 1995 were 578,683 tonnes, which is 21 % more than in 1994.

The majority of blue whiting catches have been taken in the spawning area. The landings in 1995 from the directed fishery increased by 11 % from 1994, while the landings from the mixed industrial fishery increased almost 4 times resulting in a catch of more than 104.000 tonnes. The strong 1995 yearclass was the basis for this fishery, where in the North Sea the Norwegian fleet alone caught 78.565 tonnes in the 2nd half of the year, of which 65 % in numbers were one year old (Fig. 6.2.1).

Landings from the southern fisheries (Spain and Portugal) were 27,664 t in 1995 which is 6 % less than in 1994. (Tables 6.2.1 and 6.2.5).

The amount of discards in this area was expected to be high. A sampling program on discards was carried out in 1994, financed by the EU , in which observers on board sampled both retained catch and discards. Discards were estimated to be 62 % in weight in the single bottom trawlers and 22 % in the bottom pair trawlers. The observed discarding rates were applied to the age composition of landings from the southern fisheries in 1995 (Meixide and Pérez, 1996) and the results are shown in text table below.

$N \times 10^{-3}$

CATCH SOUTHERN FISHERY			
Age	Landings	Discards	Catch
0	2912	115609	118521
1	96049	1154156	1250205
2	122956	86608	209564
3	55114	17790	72904
4	38153	9961	48114
5	44105	7333	51438
6	19737	2234	21972
7	6430	619	7049
8	3744	241	3985
9	791	61	852
10	492	31	523
11	333	46	379
12	89	10	100

6.3 Biological characteristics

6.3.1 Length composition of catches

Data on length compositions of the 1995 commercial catches of the blue whiting stock by ICES division and quarter were presented by Norway, Russia, Faroes, The Netherlands, Denmark, Spain and Portugal (Tables 6.3.1-6.3.8). The lengths of the catches varied over the seasons and areas.

The length compositions of the catches in the Russian directed fishery ranged from 16-44 cm. The Norwegian directed fishery was based on blue whiting with length from 23-41 cm and the mixed fishery from 12-35 cm. The length compositions from the Faroes vessels in the directed fishery ranged from 22-41 cm. The Netherlands directed fishery was based on fish from 13-41 cm and the Danish fishery on blue whiting with lengths from 13-39 cm. Spain and Portugal caught blue whiting in the length range of 14-40 cm.

6.3.2 Age composition of catches

For the directed fishery in the northern area in 1995, age compositions were provided by Norway, Russia and Faroes, which together accounted for about 88 % of the catches. Norwegian age-length keys were used to allocate the landings by other countries into catch in numbers by age groups.

For the mixed industrial fisheries age compositions were provided only by Norway, representing 75 % of the landings.

Spanish age-length keys were used to derive catch-at-age data for Portuguese and Spanish landings in the Southern area (Table 6.3.9).

The catch at age data for the years 1991 - 1994 have been revised in respect to various differences in the mean weights due to some calculation errors. The age compositions have changed in accordance with this. The separate tables for catch at numbers at age for the directed fishery and for the mixed industrial fishery respectively, are omitted in present report. The revised combined age composition for the directed fishery in the spawning area as well as in the Norwegian Sea and the mixed industrial fishery, together with the age composition for the landings in the southern area, are given in Table 6.3.10, and assumed to be the total age composition for the landings of the blue whiting stock. Details of the sampling to allocate numbers of age are given in Section 9.

6.3.3 Weight at Age

Data on mean weight at age for 1995 were available from Norway, Russia, Faroes and Spain. Landings of other countries were assumed to have the same mean weight at age when fished in the same area and period as the sampled catches. The revisions of the mean weights of 1991-1994 are accounted for in Table 6.3.11, which shows the weight-at-age from 1981-1995 as used in the VPA run. The weight in the stock is assumed to be the same as in the catch.

6.3.4 Maturity at Age

The same maturity at age was used in the VPA run for all years. It is shown in the text table below:

Age	
0	.00
1	.11
2	.40
3	.82
4	.86
5	.91
6	.94
7	1.00
8	1.00
9	1.00
10+	1.00

These values have previously been used for the years 1981-1991, and although other values had been used for 1992-1994, it was decided to use the maturity ogive above for the whole period, on account of the uncertainties due to sampling.

6.4 Stock estimates

6.4.1 Acoustic

6.4.1.1 Surveys in the spawning season

1995. During 22 March-24 April the fifth joint Norwegian-Russian survey in the shelf edge area to the west of the British Isles was conducted to describe and estimate the abundance of the blue whiting stock size in the spawning area (Monstad et al. 1995). A ship-to-ship calibration resulted in a 1:1 relationship between the vessel's acoustic instruments. The combined result of the acoustic assessment was a spawning stock biomass of 6.1 mill. tonnes and 0.8 mill. tonnes of immature blue whiting representing 45.5 x 10^9 and 21.9 x 10^9 individuals respectively. One year olds dominated by numbers especially in the Faroes/Shetland area. This 1994 yearclass made up almost 30 % of the stock estimate. The 1992 yearclass was the most numerous one in the adult portion.

1996. From 24 March-19 April Norway and Russia carried out the sixth joint survey on the blue whiting spawning stock west of the British Isles, with research vessels from IMR, Bergen and from PINRO, Murmansk (Monstad, 1996; Shamrai and Belikov, 1996). The Norwegian survey was also part of the SEFOS-project

(EU, FAIR) and hence a number of plankton stations were included to study blue whiting eggs and larvae.

Both vessels operated echo sounders of 38 khz (Simrad EK-500) connected to echo integrator systems, but due to poor weather conditions and time limitation, an intercalibration of the acoustic instruments was not performed. However, both vessels had precalibrated the acoustic instruments using a standard copper sphere method (Foote, 1981).

The Russian vessel started from the north and the Norwegian vessel from the south in the edge area south of Ireland (Figures 6.4.1 and 6.4.2). The Norwegian vessel recorded the highest concentrations of blue whiting in the northern area of the Porcupine bank, and along the shelf edge off St. Kilda west of the Hebrides (Figure 6.4.3). The Russian vessel found the densest concentrations between the latitudes 56°30'-57°30'N (Figure 6.4.4). Due to a time difference of approximately 7 days between the coverages of the area by the two vessels, it was decided not to combine the data for a common estimate. The results are given in the text table below:

	N x 10^9		mill. t		w	l	Area size
	mature	total	mature	total	(g)	(cm)	sq.n.mile
J.Hjort	36.2	52.2	4.5	5.1	94.9	25.5	33,687
F. Nansen	47.9	57.3	5.8	7.1	123.1	27.9	16,081

The time difference between the coverages during the spawning season resulted in different biological data due to changes in the proportions of fish at the various maturity stages and the corresponding weights. The concentrations had shifted their locations more to the north between the two observation times, or had partly migrated to areas outside the surveyed ones. Another reason for not combining the results is the difference in the assessment.

The total distribution of length and age of blue whiting are shown in Figures 6.4.5 and 6.4.6. According to the Norwegian samples the 1995 yearclass dominated in numbers and contributed with more than 30 %. The data from the Russian samples show that the 1992, 1993 and 1994 yearclasses were predominant.

During 2 surveys by R.V."G.O. Sars" in March-April 1996, concentrations of young blue whiting, mainly the 1995 yearclass, were recorded in the Norwegian Sea, approximately from the Norwegian shelf edge and westwards to the polar front area at 0^0C (Figures 6.4.7 and 6.4.8). In March the highest concentrations were found along the Svinøy-section where 1 year old blue whiting with a peak length of 15 cm were found (Melle, 1996). In early April it was present up to position 67°30'N 01°30'W, but the densest concentrations were encountered at 300-400m depth in the northern part of the EU zone, and off the continental shelf off Møre(Misund, 1996).

An acoustic survey was carried out in the Bay of Biscay in March- April 1996. The eastern and northern parts of the area were covered twice to verify the southwards migration, observed in 1994. Results were not available at the beginning of the meeting.

6.4.1.2 Surveys in the feeding season

1995

As reported in last years report (Anon.,1996) blue whiting was recorded during the international survey in the Norwegian Sea by

Russia, Norway and Faroes over a rather wide area in June/July and July/August. From the Faroes area the distribution in May/June stretched northwards to 71°N between the Norwegian coast and 5°W, while in July/August it was observed northwards to 74°N and westwards to 7°W. The recordings were mostly very scattered, but some higher concentrations were found in both periods between 62° and 68°N from the Norwegian coast to 1°E.

Norway, with R.V. "Johan Hjort" assessed the biomass to 1.8 mill tonnes during 7/-2/8 while Russia with R.V. "Prof. Marty" assessed it to 2.5 mill. tonnes during 6/6-12/7.

The 1994 yearclass dominated and contributed with 45 % in numbers to the stock estimate.

6.4.1.3 Surveys in the winter season

1995

The Icelandic R.V. "Bj. Sæmundsson" made an abundance acoustic assessment on the blue whiting in the area along the entire shelf edge from SW to SE of Iceland in the middle of November. The abundance estimate amounted to 679 thousand tonnes representing 9.3 x 10^{-9} fish. The length varied from 15-41 cm (Sveinbjornsson, 1996).

6.4.1.4 Discussion

In the text table below the total biomass estimates (in mill. tonnes) in the spawning area since 1983 are given. The corresponding spawning stock size are given in brackets.

Year	Russia	Norway	Faroes	Russia + Norway combined
1983	3.6 (3.6)	4.7 (4.4)	-	-
1984	3.4 (2.7)	2.8 (2.1)	2.4 (2.2)	-
1985	2.8 (2.7)	-	6.4 (1.7)	-
1986	6.4 (5.6)	2.6 (2.0)	-	-
1987	5.4 (5.1)	4.3 (4.1)	-	-
1988	3.7 (3.1)	7.1 (6.8)	-	-
1989	6.3 (5.7)	7.0 (6.1)	-	-
1990	5.4 (5.1)	6.3 (5.7)	-	-
1991	4.6 (4.2)	5.1 (4.8)	-	4.7 (4.4)
1992	3.6 (3.3)	4.3 (4.2)	-	4.6 (4.3)*
1993	3.8 (3.7)	5.2 (5.0)	-	5.1 (4.9)
1994	-	4.1 (4.1)	-	-
1995	6.8 (6.0)	6.7 (6.1)	-	6.9 (6.1)
1996	7.1 (5.8)	5.1 (4.5)	-	-
Mean	4.8 (4.4)	5.0 (4.6)		5.3 (4.9)

* with calibration factor: 1.38

The variability between survey estimates in the early years of the period listed above has been discussed in previous Blue Whiting Working Groups. As also mentioned in previous reports differences in estimates may be caused by differences in acoustic equipment, weather conditions during the surveys, size of the area surveyed and timing of the survey with respect to spawning progression.

From 1988/89 to 1992 there has been a downward trend in the spawning stock estimates, but in 1993 the stock increased due to the recruitment of the strong 1989 year class to the spawning stock. The 1994 estimate of 4.1 mill. tonnes is considered an underestimate due to extremely bad weather conditions. The conditions in 1995, however, were very favourable and hence a best possible coverage of the spawning stock within the survey period was obtained. The 1994 yearclass dominated in the concentrations, and was especially abundant in the south and in the north. During the surveys in the Norwegian Sea during the summer of 1995 the abundant 1994 yearclass dominated in the samples, and contributed with more than 45 % in numbers.

As mentioned above the difference between the two estimates of the spawning stock in spring 1996, may be due to a difference in timing of the surveys. The size of the spawning stock, however, was found to be at a rather stable and average level, between 4.5 and 5.8 mill. tonnes. Also this year additional good recordings of one year old blue whiting in the spawning area were obtained, especially in the northern and the southern areas. This verified the strength of the 1995 yearclass which as 0-group was reported to be abundant. It formed a significant portion of the successful fishery in the Norwegian industrial mixed fisheries in the North Sea during the autumn of 1995 (Fig. 6.2.1).

The international surveys in the Norwegian Sea in March-April of 1996, also confirmed the very high abundance of the 1995 yearclass.

6.4.2 Bottom trawl surveys in the Southern area

Bottom trawl surveys have been conducted off both the Galician (NW Spain) and Portuguese coast since 1980 and 1979 respectively, following a stratified random sampling design and covering depths down to 500 m. Since 1983, the area covered in the Spanish survey was extended to completely cover the Spanish waters in Division VIIIc. Stratified mean catch and standard error in Spanish and Portuguese surveys are shown in Table 6.4.1 and Table 6.4.2.(updated in Silva and Pestana, 1996).

6.4.3 Catch per unit effort

Data on CPUE from the fisheries in the northern area were submitted by Norway. Those data, which were from the 1995 directed fishery in the spawning area , were combined by vessel tonnage class, area and month. The data were added to the time series of overall aggregated CPUE values across areas in the Norwegian blue whiting fisheries, and presented in Fig.6.4.9. An increase from 1991 to 1993, appears then a slight decrease up to 1995.

Data on CPUE of 1995 from two bottom trawl fleets were submitted by Spain (Galician single and pair trawl) and shown in Fig. 6.4.10. While the CPUE varied throughout the 1980s for both fleets, it has been more stable in the 1990s.

6.4.4 Virtual Population Analysis

6.4.4.1 Tuning the VPA to survey results

Altogether 6 tuning series were used by the Working Group to tune the VPA, the same used in 1995. Two series from the spawning area west of British Isles (Norwegian acoustic and Russian acoustic surveys), one series from the acoustic surveys in the Norwegian Sea, two from Spain (bottom trawl survey and CPUE from pair trawlers) and one from a Portuguese survey (bottom trawl). The inclusion of fleets with estimates of recruits improved the tuning in the past, and especially the inclusion of the acoustic survey in the Norwegian Sea. Tuning input data are shown in Table 6.4. 3.

Earlier tests (Anon.1994) had failed to indicate that improvement in retrospective performance could be achieved by departure from default options suggested in the Lowestoft XSA implementation. Alternative tuning methods (YC method), and weighted XSA (where the tuning fleets were manually weighted according to the catch proportions in the area were the surveys were conducted) were also done in the past (Anon 1996). All methods gave similar results, showing conflicting trends in some years with the acoustic surveys, especially if these are considered absolute measures of stock size. However, some errors in the data have been identified and corrected, which is expected to lessen the discrepancy between data series. Catch and mean weight at age data were revised this year, for the period 1991-1995. Data from earlier years and the tuning data need to be revised also. For these reasons only a default XSA calculation is presented. Tuning diagnostics are shown in Table 6.4.4 . and VPA results in Tables 6.4.5-6.4.7. Figure 6.4.11 shows the retrospective analysis of this assessment.

The available indices of abundance for this stock appear to be very variable, and it is not clear that the indices genuinely measure the strength of the cohorts in the fishery. If the surveys are dominated by stochastic fluctuations, the effect of this in the assessment will be to yield an estimate of stock size which is approximately at historic mean levels. It does not appear to be any systematic trend in stock size in the assessment, and this, coupled with the apparently variable tuning data, suggests that some form of 'shrunk' analysis is appropriate. In retrospective testing, the analysis appears to perform with reasonable consistency, suggesting that the stock forecasts may perform reasonably well. However, the apparently high survey variability suggests that the stock assessment may have a low capability to detect changes in stock size or exploitation rates .

6.5 Short term prediction

Input data for the prediction are given in Table 6.5.1. The initial stock size at the beginning of 1996 for ages 2 to 10+ was taken from the VPA results. The recruitment at age 0 in 1996-1998 was set to 12.3 billions, which is the average from 1981-1996. Stock numbers at age 1 in 1996 were estimated assuming the recruitment at age 0 in 1995 to be equal to the average of the 1982, 1983, and 1984 strong yearclasses. Mean weights at age, maturity ogive and natural mortality were the same used in the VPA. The fishing pattern was considered to be the average of the period 1993-1995.

Usually the basis for prediction has been a TAC constrained based on a projection of the preliminary catch in the first half of the year the prediction starts, i.e. 1996. Unfortunately, this procedure was not possible this year, due to the early date for the Working Group meeting. The catch in 1996 was assumed to be 600 thousand tonnes, slightly higher than in 1995, as can be expected taking into account the incoming 1995 yearclass, that is considered to be strong (see sections 6.2 and 6.4.1.4).

The results of the prediction are shown in Table 6.5.2. The estimated reference fishing mortality in 1996 was 0.45, slightly higher than in 1995. Continuing at this fishing level gives an SSB of 1.6 million tonnes in 1996, 1.8 million tonnes in 1997 and 2.1 million tonnes in 1997.

A suggestion of the MBAL for this stock, taken as the lowest SSB on record (1.6 million tonnes) is commented in section 10.

6.6 Medium-term Projections

6.6.1 Estimation of Uncertainty

Uncertainty in the assessment was evaluated by fitting a separable model (Deriso, 1985, Gudmundsson, 1986) to the observations of catch at age and to the indices of abundance. The estimate of the parameter variance-covariance matrix at the solution was used as the estimate of uncertainty in the fitted populations and mortality rates.

The separable model was fitted with the ICA programmes (Patterson and Melvin, in press). A series of initial model fits was made in order to evaluate the consistency of the different indices of abundance. The model was fitted to observations from ages 0 to 10+, and in all cases with the following choices:

Selection on age 9 = Selection on age 4
Separable model fitted from 1990 to 1995, earlier years treated as conventional VPA.
All indices of abundance assumed to bear linear relationships to stock size.

All observations given equal weight in the fit and assumed made with lognormal observation error.
No attempt was made to include a stock-recruit model in the fit.

Results of the initial runs are summarised in Figure 6.6.1, which shows the fishing mortality at reference age (4) estimated by fitting each of the tuning indices separately, with estimates of the standard deviations of these parameters. These estimates vary from approximately 0.2 to 0.55, but most of the indices lie in the range 0.2 to 0.4. This suggests that most of the indices are in general consistent and indicate a rather low fishing mortality. However, the Spanish Bottom trawl survey indicates a substantially higher fishing mortality (0.55) than the other surveys, with a wider confidence interval. In addition, the estimated coefficient of variation for this survey was of the order of 1.0 for most ages, suggesting that this survey is a poor predictor of stock size. For these reasons, this survey was considered to be less reliable than and poorly consistent with the other surveys.

No systematic deviations from separability were apparent, although the fishing mortality on the recruiting year-class appeared to be highly variable.

A 'combined' fit was calculated in which all the surveys except the Spanish Bottom Trawl index were included with equal weight. Results are given in Table 6.6.1. The results obtained by fitting this model are similar to those obtained by using the XSA procedure.

The model estimated an extremely high, but very uncertain recruitments in 1995. As this was based on few observations and was well outside the historic range of recruitment, the estimate of the abundance of this year-class was replaced with the mean of the three highest recruitments that have been observed previously. The corresponding estimate of the variance was left unchanged. The procedure used is arbitrary, but based on the belief (supported by evidence from the fishery and survey observations) that the year-class is a very strong one, although its abundance cannot be estimated precisely.

6.6.2 Medium-term projections

Medium-term projections were calculated by the procedure described in Anon. (1996). In summary Monte-Carlo pseudo data-sets for the starting populations were drawn from a multivariate normal distribution having as its mean the parameters (Stock abundance, fishing mortality, selection at age, on a logarithmic scale) estimated as above, and with error structure according to the variance-covariance matrix estimates.

Historic stock and recruitment information do not show any apparent dependence of recruitment on stock size (Figure 6.6.2), although there is arguably a trend of diminishing recruitment, the causes for which are not immediately apparent. In consequence, no attempt was made to model such a dependency. Future recruitments were drawn from a distribution determined by the geometric mean of all historic recruitments in the data set, with the addition of an error drawn at random with replacement from the historic distribution of recruitments about the mean.

A single scenario was simulated, for fishing mortality in future years equal to the estimated fishing mortality in 1995. For reference purposes, stock sizes in the projections are compared with the lowest historical estimate of stock size, 1.6 million t.

Figures 6.6.3 and 6.4.4 show the projected development of the stock under a regime of constant fishing mortality. This suggests that the incoming strong 1995 recruitment will result in an increase in stock size over the next three to four years, but that the stock would decline slowly in size thereafter. However, the stock is estimated to have a rather low probability (<10 %) of falling below the 1.6 million tonne level once the 1995 year class is fully recruited. Despite concerns about highly variable survey data, the projections suggest that stock size in 1996 is reasonably well estimated, with 95 % confidence limits between 1.4 and 2.3 million tonnes. Such an estimate of uncertainty is, of course, dependent on the assumption that the surveys genuinely measure the stock abundance with log-normal error with no systematic deviations. In this case, that assumption has not yet been evaluated.

6.7 Spatial, temporal and zonal distribution

The available knowledge from various sources on the distribution and the main fishing areas of blue whiting in the northern area have been summarised and presented in previous Working Group Reports (Anon., 1985, 1991 and 1995). During the two acoustic surveys west of the British Isles in spring 1996, blue whiting eggs were extremely numerous in the sampling area to the north of Porcupine bank (S.V. Belikov, pers.comm.) and larvae from this area to west of St. Kilda (Monstad, 1996).

This indicates that the 1996 yearclass may be a strong one.

During 1995 and 1996 most of the blue whiting concentrations were recorded within the EU-zone, i.e. in British and Irish waters. Most of the recordings during the feeding season of 1995 in the Norwegian Sea were observed in the Norwegian Faroes zones. The WG concludes and underlines every year, that the percentage distribution of concentrations obtained within various zones, strongly depends upon the geographical size and location of the survey area.

Total international catch of blue whiting in 1978-1995 divided into areas within and beyond national fisheries jurisdiction of NEAFC are presented in Table 6.7, as provided by the WG members. Due to increased Norwegian catches in the mixed industrial fisheries in 1995, the percentages in this area have been doubled. Catches of nations not giving zonal informations about the fisheries, have been subjectively allocated to the probable appropriate zones.

6.8 Otolith reading Workshop in 1995

For this workshop otolith samples from the summer period were selected as suggested in last years otolith Workshop report (Anon., 1994), especially for determination of the last rings. This years results show a great step towards better agreement in age reading than earlier workshops, as shown in the text table below.

Reader 1		97.6	91.1	84.4	93.5
Reader 2	97.6		91.1	85.7	96.2
Reader 3	91.1	91.1		86.5	90.1
Reader 4	84.4	85.7	86.5		85.4
Reader 5	93.5	96.2	90.1	85.4	

The age compositions obtained from the summer samples in the Norwegian Sea show that the strong 1989 yearclass can be followed in the period 1993-1995. Following strong year classes is considered a proper method available to validate blue whiting age readings.

Bias Plots (Figure 6.8) and Wilcoxson's Rank Test were used to analyse bias between readers (Meixide, 1996). The results show that the disagreement between readers is not the big problem that it was in the past, as bias was observed in only in 4 of the 15 comparison.

Results from Wilcoxson's Rank Test are shown in text table below:

	Reader1	Reader 2	Reader 3	Reader 4	Reader 5	Modal Age
Reader 1		-	-	*	*	-
Reader 2	-		-	**	-	-
Reader 3	-	-		-	**	-
Reader 4	*	**	-		**	*
Reader 5	*	-	**	**		**
Age	-	-	-	*	**	

- : Absence of bias
* : Possibility of bias
** : Certainty of bias

7. ECOLOGICAL CONSIDERATIONS

Ecological considerations were discussed in detail in the Working Group report from 1995 (Anon. 1996a). There is new information only on hydrography.

1995 was a relatively warm year in the Barents Sea with temperatures around 0.3 - 0.5 °C above the normal in the western and central parts of the Barents Sea. The highest increase in temperatures was observed in the eastern part, with around 0.7 - 1.0 °C above the normal (Anon. 1996b). It has been shown that the recruitment of herring is positively influenced by high temperatures (Sætersdal and Loeng, 1987).

For the first time in several years there is now little 1 - 3 years old herring in the Barents Sea. This means that predation on capelin larvae by young herring will be low (Huse and Toresen, 1995), and the possibility for a good capelin year class in the Barents Sea increases.

In contrast to the relatively high temperatures in the eastern and north-eastern parts of the Norwegian Sea in 1995, the ocean climate north-east of Iceland was cold. The warm Atlantic water was pushed back, and the area experienced the strongest influence of Arctic water since routine observations started north of Iceland in 1952. The low temperatures, and the increased easterly propagation of the East Icelandic Current, limited the westward migration of Norwegian spring spawning herring in 1995 (Anon. 1996a).

During the last months of 1995, however, the flow of Atlantic water to the shelf area north and east of Iceland increased considerably. A survey of these waters during February 1996 showed a continued improvement of the hydrographic regime. Thus, the temperature in the shelf area north and east of Iceland was about 1.5 - 2.0 °C higher than in February 1995 and the East Icelandic Current was much weaker.

8. RECOMMENDATIONS

The new timing chosen for the meetings of WGNPBW is not satisfactory for the Blue Whiting assessment. The Russian and Norwegian formally joint survey on the spawning grounds lasts until late April. This year the members who joined this survey arrived 1 and 2 days late for the WGNPBW meeting and had not been able to prepare the data adequately. In addition there had been too little time for comparing the Russian and the Norwegian data thoroughly and combining them. Therefore the working group recommends to move the meetings of WGNPBW to the beginning of May.

The terms of reference for the working group was very extensive this year. Some items (for instance the evaluation of the scientific basis and data employed for the estimation of the temporal and quantitative distribution by areas of Norwegian spring spawning herring in the "Reykjavik" report), were added after the original time schedule for the working group meeting had been decided on. The adding of items in the terms of reference resulted in a reduced time available for discussions, appraising of new models and methodology and quality control of the remaining terms.The working group recommends that extra time should be considered allocated to the Working group meeting if additional terms of reference are added after a time schedule is set.

9. SAMPLING SUMMARY

9.1 Icelandic summer spawning herring

Investigation	No of samples	Length measurements	Aged individuals
Fishery(1995 -1996)	61	6032	3265
Acoustic wintering area	1200	1200	1200

9.2 Norwegian spring spawning herring

Investigation	No of samples	Length measurements	Aged individuals
Norwegian fishery (1995)	79	7613	7613
Norwegian acoustic wintering area 1995	31	3321	2600
Norwegian acoustic spawning area 1995	39	3006	2517
Faroe Fishery (1995)	6		311
Icelandic fishery (1995)	21	2052	1957
Icelandic acoustic feeding area (1995)	8	799	762
Russian fishery (1995)	11	9278	1100
Russian acoustic spawning area 1995	16	42745	1310
Russian acoustic feeding area 1995	6	796	272
Russian acoustic wintering area 1995	4	5104	302
Netherlands fishery (1995)	10		250
Norwegian acoustic wintering area 1996	38	3660	1974
Norwegian acoustic spawning area 1996	58	3872	2467

Catches in the spawning time adequately sampled spawning stock. Very difficult to obtain satisfactory knowledge of age distribution of wintering and feeding population due to present wide distribution of stock and extreme dynamic recruitment situation. Russian sampling from spawning area were taken in same time and from same area with fishery .

9.3 Barents Sea Capelin

Investigation	No of samples	Length measurements	Aged individuals
Acoustic survey 1995	95	4619	2710
Norwegian bottom trawl survey January 1996	322	9439	614
Russian acoustic survey December 1995	12	5437	780

No fishing have been taking place , and therefore no samples from catches.

9.4 Capelin in the Iceland-East Greenland-Jan Mayen area

Investigation	No of samples	Length measurements	Aged individuals
Fishery 1995	38	13800	3800
Survey 1995	129	11457	11457
Fishery 1996	68	6800	6800
Survey 1996	12	1200	1200

9.5 Blue Whiting

Investigation	No of samples	Length measurements	Aged individuals
Fishery 1995	173	15197	640
Survey British Isles	49	17155	3047
Survey Norwegian Sea	67	4503	2136
Southern fishery	403	3896	930
Southern surveys	122	13414	1452
South of Iceland	10	1000	-

10. MBAL

The definition of MBAL as the level below which the data indicate that the probability of poor recruitment increases as the spawning stock decreases (ACFM 1991) leads to different approaches for the different stocks that are treated by this WG. This is mainly because of differences in recruitment dynamics, but also because some of the stocks have been through a collapse, while others have not.

Icelandic Summer Spawning Herring

The WG considers the definition of MBAL for this stock to be of limited value, since the stock has been harvested at or near $F_{0.1}$ and has been increasing during the last 25 years. Furthermore, the stock is in a healthy state and well above any 'alarm level'. Therefore, it is hardly relevant to use any model or calculations to establish an MBAL for this stock for the time being. However, it is clear that during the last 10 years, the average recruitment has been at a higher level than in the 1970's when the stock had just begun to recover after the collapse in the late 1960's.

The WG also discussed a possible target level for the SSB, which could represent an optimal level. The group noted that the stock biomass by now is larger than at any time in the known past. Even by assuming a continuation of the present harvesting strategy, it is difficult to predict the future development of the stock. The main reasons are variations in environmental conditions and possible changes in the position of the stock in the ecosystem, with respect to predation and competition.

Capelin

The MBAL concept has a slightly different meaning for semelparous fish like capelin compared to e.g. herring. The capelin stocks have been managed according to a target spawning stock level believed large enough to provide sufficient recruitment for stock replacement. Since the capelin die after spawning, this target spawning stock size becomes equal to the MBAL. For the capelin in the Iceland-Greenland-Jan Mayen area this spawning stock target level has been 400 000 tonnes, and 500 000 tonnes for the Barents Sea capelin stock.

For the Barents Sea stock, an MBAL based on inspection of a stock-recruitment relationship is difficult, due to lack of direct measurements of the spawning stock size. The total stock size in autumn is monitored by acoustic methods, but due to fish behaviour such measurements on the spawning stock in spring is impossible. Consequently, the SSB is modelled based on the stock size in autumn, a maturity ogive, and modelled natural mortality between the survey time and the spawning time. The natural mortality is very much dependent on the amount of young cod praying on the pre-spawning and spawning capelin, and is therefore quite variable.

The SSB in the stock-recruitment relationship is therefore, uncertain.

Blue whiting

For this stock, the recruitment is quite variable, while the experienced range of SSB's is rather narrow. Within this range there is no clear relation between recruitment an SSB, and it is considered likely that the fluctuations in recruitment are driven by other factors, like climatic variations and variations in currents. Therefore, the WG considers the lowest SSB on record (1.6 mill. tonnes) as an appropriate value for MBAL.

Norwegian Spring Spawning Herring

For many years, a SSB of 2.5 million tonnes was used as a target for the management of the NSSH. This was not intended as an MBAL in the present sense, but rather as the level to be reached before normal fishery should be opened after the stock collapse. The background for this number was the observation that no strong year classes had been generated by SSB's below that level. (Dragesund & al, 1980). Since then, the stock has recovered, largely due to the 1983 year class. However, it still holds true that the probability of getting a good year class is much lower below this level of SSB than above it. Thus, $R > 2*10^9$ individuals at age 3 has occurred in three out of 20 years at SSB below 2.5 mill. tonnes and in 12 out of 20 years above this SSB-level.

For this stock, a wide range of recruitments and SSB's are represented in the time series, including a long-lasting stock collapse, which provides background for a more extensive evaluation. The definition of MBAL cited above requires a definition of poor recruitment, and is still open to interpretation in cases where the recruitment appears to depend on the SSB even at large levels of SSB.

A possible interpretation of poor recruitment is the level typical of a stock collapse. In the case of NSSH, the recruitment is poor in many of the years, irrespective of the SSB, but in those years where the recruitment is good, its level appears to depend on the SSB. By inspection of the stock-recruit plot (Figure 10.1), a suitable level for separating poor and good year classes appears to be about 2-4 $*10^9$ individuals (as 3 year old). Figure 10.2 shows the cumulated frequency of good year classes as function of the SSB. For $2*10^9$ this frequency rises gradually from 2-3 million tonnes SSB onwards and for 4 $*10^9$ individuals, they rise sharply between 5 and 6 million tonnes SSB, suggesting that the 2.5 million tonnes level is not inappropriate.

The other interpretation of MBAL is a level of SSB below which the exploitation of the production potential of the stock is clearly suboptimal. The current practise of giving options without specific recommendations as long as the stock is above MBAL, is more in accordance with this interpretation.

Even when applying this last interpretation of the MBAL, the use of a certain fixed minimum level of SSB as guideline for the management is considered to be unsatisfactory for these stocks, because of the recruitment dynamics. For NSSH, the success of recruitment is periodic, with a dominating period of 10-12 years Moreover, more than 1-2 strong year classes in succession are very unlikely, because the larvae are preyed upon by the juveniles staying in the same area. There will be information from surveys about the incoming year classes several years before they enter the fishery.

Any management should take this into consideration, which implies that the main guideline for management advise should be the prospects for the stock several years ahead, e.g. based on medium term predictions which take the strength of incoming year classes into account.

In addition, there appears to be a correlation between the strength of the strong year classes and the parent SSB. Therefore, it is not likely that any level of SSB can be found for this stock above which the recruitment is more or less independent of the SSB. Accordingly, an MBAL at the level of SSB at which good year classes become unlikely is not a good guideline for the management.

The most rational approach under such conditions is to simulate management regimes, and look for levels of SSB that can serve as warning signals which should induce modifications to the management. It is questionable if such a value should be referred to as MBAL.

A simulation program was developed for this meeting (Tjelmeland 1996, WD xx), which allows stock simulations of the NSSH with stochastic recruitments over long time periods, assuming several kinds of management rules. The first 30 years of each trajectory is removed, so what is modelled is the general effects after the specific influence of the initial values has subsided. Two categories of models for drawing stochastic recruitments are available, one drawing the parameter b in the Beverton - Holt model $R = a * SSB/(b + SSB)$, and the other drawing the exponent β in the power model $R = \alpha * SSB^{\beta}$. The background for the latter model is described in a separate WD (Skagen 1996, WD yy). In both cases the oscillatory properties of the recruitment can be simulated, and for the Beverton-Holt type approach, also the effect of cannibalism, i.e. the recruitment is reduced according to the abundance of 3-4 year old herring. The management rules include options where it is assumed that the manager can run a prediction for up to 10 years before a decision on next years fishery is taken.

A set of simulations with constant F indicate that the average yearly yield has its maximum at F near 0.13, which coincides with the value used for the natural mortality. Both recruitment models show this, but at somewhat different levels of average yield.

Another set of runs assumed F constant over periods of 10 years, with adjustments every 10th year guided by a target SSB, to the level of F at which the 30-percentile of the SSB predicted 10 years ahead was at the target level. These simulations indicate an increase in total catch with increasing target SSB over the whole range of target SSB's from 2 to 10 million tonnes, which is in accordance with the dependence of the recruitment on the SSB over the whole of this range. Although it seems clear that the optimum level is well above 2.5 million tonnes, it is not possible at the present stage to determine it more precisely. At this level, the simulations are sensitive to the choice of recruitment model, and factors like density dependent growth are not accounted for.

Although the level of 2.5 million tonnes is still valid as a target in a rebuilding phase, and as a limit below which there is an imminent danger of a stock collapse, this level is not considered by this WG to be suitable as a guide to management when the stock is in a good shape. Rather, an optimal regime will probably be one where the fishing mortality is adjusted according to medium term predictions, aiming at keeping the SSB at a quite high level in most of the time range, i.e. in principle along the line suggested in the second set of simulations above.

11. EVALUATION OF THE REYKJAVIK REPORT

11.1 Background

The Working Group considered the following request from ACFM to:

evaluate the scientific basis and data employed for the estimation of the temporal and quantitative distribution by areas of Norwegian spring-spawning herring contained in the "Report of the Scientific Working Group on Zonal Attachment of Norwegian Spring-Spawning herring (13-19 September 1995).

The report will henceforth be referred to as the 'Reykjavik Report' and its authors as the 'Reykjavik Group'. This group was established by the Governments of the Faroe Islands, Iceland, Norway and Russia in July 1995 with terms of reference beginning as follows:

"A Working Group of marine scientists and statisticians from the Faroe Islands, Iceland, Norway and Russia is established with the objective of evaluating the zonal attachment of Norwegian Spring Spawning Herring to the Exclusive EEZs of the parties and to the international waters between the EEZs of the coastal states concerned. Each country may be represented by maximum three persons in the Working Group (...)".

The report was commissioned at short notice; it is clearly to the credit of the scientists concerned that despite the limited availability of historic data and the time constraints (about two months to prepare information covering a 50-year time span) it proved possible to develop the model, provide the input data and calculate the zonal attachments as requested in the terms of reference. In retrospect and with wider participation a full description of data and of methods would have been possible had these been requested in the terms of reference and had the meeting been extended. Should such prove to be required a further meeting would probably be necessary.

The Working Group considered that it was not possible to provide a full evaluation of the Reykjavik Report in detail in the time available. Because a detailed description of data and of methods was not included in the Reykjavik report, a full evaluation of the report would entail a lengthy process of recovery of original data and consultation with the experts involved, and this could not be undertaken during the meeting on account of other obligations. However, the following observations could be made.

11.2 The Model

No model has been implemented for the 1973 year-class because there are no data indicating that it was outside the Norwegian EEZ.

The model is a single-cohort model which is fitted separately for the 1950, 1959 and 1983 year-classes of the stock. The model is a deterministic structural model, which is desegregated into 9 areas, four quarters and 16 ages.

It requires the following inputs to be provided by age and by quarter:

Natural Mortality
Fishing Mortality
Weight at age in the stock
Spatial distribution of the year-class by zone.

In total the model requires 124 estimates of mortality, 558 estimates of the proportions of fish by number and by area and 62 estimates of weights at age to be specified for each of the three year-classes, although many of the proportions can be assumed to be zero or constant across years.

The model requires a large number of input parameters to be specified, but it is not altogether clear from the report how such parameters have been derived from data, and in what cases they have been assigned values on the basis of judgement and experience. For this reason a full evaluation of the report was not feasible. However some comments have been made below on the methods used to estimate the parameters.

The model used is similar to one used in 1983 (Anon., 1983) to evaluate the zonal attachment of capelin in the Iceland-Greenland-Jan Mayen area.

11.2.1 Mortality Rates

Natural and fishing mortalities are assumed constant across quarters. Values of natural mortality on the adult fish used were 0.16 for the 1950 year-class, 0.16 for the 1959 year-class and for the 1983 year-class values of 0.13 were used for ages 3 to 7 and a value of 0.23 was used for ages older than 7 years. For younger fish, a natural mortality of 0.57 was used for all year-classes.

The report states that 'Fishing Mortality was obtained from the ICES data files' and by 'running the Lowestoft VPA program'. The basis for these calculations is the stock assessment calculated by the Working Group (Anon. 1995a) and were not evaluated.

As the model is structured, changes in either fishing mortality or in natural mortality would result in different distributions of "biomass*zones". Using a copy of the original spreadsheet model, the Working Group tested this by including a factor in the cells containing fishing mortality, so that the values used in the original model easily could be decreased or increased proportionally. The result is shown in Table 11.2.1 for factors of 0.3, 0.7, 1.0, 1.5 and 3.0. The changes in percentage distribution in zones are most pronounced for the Icelandic and the Russian zones for the 1950- and 1959-yearclasses, with the percentage in the Icelandic zone increasing with low fishing mortalities and the percentage in the Russian zone increasing with high fishing mortalities. For the 1983 year class perhaps the most important change is that the percentage in the international zone in the Norwegian Sea increases with low fishing mortalities. As long as the change in fishing mortality is moderate, the actual effect in percentages is small. However, distribution at age is not likely to be completely independent by fishing mortality. The percentage distributions on zones used in the Reykjavik report are the ones that were "observed" when fishing mortalities were as used in the original model. It may not be appropriate to use the same distributions with other fishing mortalities. The distribution of the stock by area is likely to depend on overall stock abundance and the model is implemented to apply specifically to dominant year classes. Hence for low stock abundance changes in spatial distribution in response to changes in exploitation rate may be different to those calculated by the model.

11.2.2 Weight at age in the stock

Mean weights have been obtained from research vessel catches and commercial catches. In some cases information from several countries' sampling has been pooled, but these details are not described in the report and could not be evaluated.

In some cases fish appear to decrease in weight along the same cohort. This could be due to a real reduction in weight during winter when the herring do not feed. For older herring, there is also a large reduction in weight during the spawning season due to the "loss" of spawning products.

11.2.3 Spatial Distribution of the Year-Class by Zone

The spatial distributions of the year-classes by zones have been interpreted in an essentially qualitative way from distribution maps. These identify the main areas of distribution of the stock (as presence or absence of strong marks in acoustic surveys).

Better information is available from surveys after 1986. For this period there exists detailed distribution maps from surveys. Some of them have been reported to the ICES statutory meeting (1983-1988), as reports from the Atlanto-Scandian Herring and Capelin Working Group, and some are shown in the Reykjavik Report as examples. The areas of distribution within each zone were measured with a planimeter by a qualified technical assistant.

Where more than one distribution chart was available for a quarter, interpretation of the data and estimation of critical proportions was done by an "expert team" within the Reykjavik group.

When no distribution chart was available for a quarter, the distribution had to be interpolated from the quarters before and after. The process is described on page 3 of the Reykjavik report, but the detailed distribution charts are not given and the basis for the zonal allocation of fish by number is not shown.

For the periods 1945-1962 and 1963-1971 detailed distribution charts were not available. Spatial allocations were made in a qualitative way on the basis of charts showing overall migrations patterns provided by the 1969 report of the Atlanto-Scandian Herring Working Group (Anon. 1970). These maps were interpreted by the team mentioned above. The team also extracted distribution data for immature herring in the same way. However, these charts had been drawn to illustrate typical migration patterns, and not with a view to quantifying fish distribution by economic zone.

Although the Reykjavik report did not provide the detailed input data used, members of the Working Group who had participated in the preparation of that report felt that the process could in principle be repeated by anyone who has the original distribution charts and another team with the same level of expertise.

Questions of uncertainty in input data had not been assessed in the Reykjavik report. Acoustic surveys in other areas have been shown to have a relatively low accuracy in estimating stock size, so estimates of the proportions of stocks in different zones are likely to be subject to similar uncertainty. This is particularly the case for earlier surveys which were made at a time when acoustic survey methods were newly developed.

In some cases, assignations of the fish stock to zones have been made on the basis of judgement and experience relying on interpretation of charts from the Atlanto-Scandian Herring WG in 1969. The interpretation of those charts in terms of zonal distribution was necessarily less precise than for the most recent period where a large number of detailed acoustic surveys are available. However the precision of the assignation of proportions could not be evaluated.

11.3 Conclusion

The model appears to be an appropriate and effective tool for translating a qualitative historic understanding of the stock migrations into quantitative estimates of biomass distributions. Its use was appropriate to the terms of reference of the Reykjavik meeting. However, because of the lack of documentation of the data sources used by the Reykjavik Group as inputs to the model the Working Group was unable to evaluate the robustness and precision of the data and of the model outputs.

12. REFERENCES AND WORKING DOCUMENTS

12.1 References

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Table 2.1.1 Icelandic summer spawners. Catch in numbers(millions) and total catch in weight, ′000 tonnes. Age in years is number of rings +1

Rings/year	1975	1976	1977	1978	1979	1980	1981
1	1.518	0.614	0.705	2.634	0.929	3.147	2.283
2	2.049	9.848	18.853	22.551	15.098	14.347	4.629
3	31.975	3.908	24.152	50.995	47.561	20.761	16.771
4	6.493	34.144	10.404	13.846	69.735	60.728	12.126
5	7.905	7.009	46.357	8.738	16.451	65.329	36.871
6	0.863	5.481	6.735	39.492	8.003	11.541	41.917
7	0.442	1.045	5.421	7.253	26.040	9.285	7.299
8	0.345	0.438	1.395	6.354	3.050	19.442	4.863
9	0.114	0.296	0.524	1.616	1.869	1.796	13.416
10	0.004	0.134	0.362	0.926	0.494	1.464	1.032
11	0.001	0.092	0.027	0.400	0.439	0.698	0.884
12	0.001	0.001	0.128	0.017	0.032	0.001	0.760
13	0.001	0.001	0.001	0.025	0.054	0.110	0.101
14	0.001	0.001	0.001	0.051	0.006	0.079	0.062
Catch in wt	13.280	17.168	28.924	37.333	45.072	53.269	39.544

Rings/year	1982	1983	1984	1985	1986	1987	1988
1	0.454	1.470	0.421	0.111	0.100	0.029	0.869
2	19.187	22.422	18.011	12.800	8.161	3.144	4.702
3	28.109	151.198	32.237	24.521	33.893	44.590	40.855
4	38.280	30.181	141.324	21.535	23.421	60.285	98.222
5	16.623	21.525	17.039	84.733	20.654	20.622	68.533
6	38.308	8.637	7.111	11.836	77.526	19.751	22.691
7	43.770	14.017	3.915	5.708	18.228	46.240	19.899
8	6.813	13.666	4.112	2.323	10.971	15.232	31.830
9	6.633	3.715	4.516	4.339	8.583	13.963	12.207
10	10.457	2.373	1.828	4.030	9.662	10.179	10.132
11	2.354	3.424	0.202	2.758	7.174	13.216	7.293
12	0.594	0.552	0.255	0.970	3.677	6.224	7.200
13	0.075	0.100	0.260	0.477	2.914	4.723	4.752
14	0.211	0.003	0.003	0.578	1.786	2.280	1.935
Catch in wt	56.528	58.665	50.293	49.092	65.413	75.439	91.76

Rings/year	1989	1990	1991	1992	1993	1994	1995
1	3.963	11.061	35.872	11.820	0.870	6.225	7.411
2	22.568	14.413	92.766	78.547	35.581	110.079	26.221
3	26.578	57.293	51.052	129.508	170.207	99.377	159.170
4	77.618	34.509	87.614	43.109	87.415	150.310	86.940
5	188.155	78.187	33.439	55.215	25.161	90.824	105.542
6	43.000	152.955	54.845	41.283	28.819	23.926	74.326
7	8.095	32.417	109.428	35.663	18.317	20.809	20.076
8	5.881	8.754	9.252	44.072	24.282	19.164	13.797
9	7.273	4.453	3.796	9.101	14.327	17.973	8.873
10	4.767	4.307	2.634	2.224	3.641	16.222	9.140
11	3.440	2.529	1.826	0.573	0.879	2.955	7.079
12	1.406	1.232	0.516	0.300	0.300	1.433	2.376
13	0.842	1.024	0.262	0.200	0.200	0.345	0.927
14	0.347	0.613	0.298	0.100	0.100	0.345	0.124
Catch in wt	100.733	105.593	109.499	106.825	102.802	134.003	125.851

Table 2.2.1 Icelandic summer spawners. Weight at age in grammes. Age in years is number of rings +1.

Rings/year	1975	1976	1977	1978	1979	1980	1981
1	110	103	84	73	75	69	61
2	179	189	157	128	145	115	141
3	241	243	217	196	182	202	190
4	291	281	261	247	231	232	246
5	319	305	285	295	285	269	269
6	339	335	313	314	316	317	298
7	365	351	326	339	334	352	330
8	364	355	347	359	350	360	356
9	407	395	364	360	367	380	368
10	389	363	362	376	368	383	405
11	430	396	358	380	371	393	382
12	416	396	355	425	350	390	400
13	416	396	400	425	350	390	400
14	416	396	420	425	450	390	400

Rings/year	1982	1983	1984	1985	1986	1987	1988
1	65	59	49	53	60	60	75
2	141	132	131	146	140	168	157
3	186	180	189	219	200	200	221
4	217	218	217	266	252	240	239
5	274	260	245	285	282	278	271
6	293	309	277	315	298	304	298
7	323	329	315	335	320	325	319
8	354	356	322	365	334	339	334
9	385	370	351	388	373	356	354
10	389	407	334	400	380	378	352
11	400	437	362	453	394	400	371
12	394	459	446	469	408	404	390
13	390	430	417	433	405	424	408
14	420	472	392	447	439	430	437

Rings/year	1989	1990	1991	1992	1993	1994	1995	1996*
1	63	75	74	63	74	67	69	69
2	130	119	139	144	150	135	129	141
3	206	198	188	190	212	204	178	188
4	246	244	228	232	245	249	236	226
5	261	273	267	276	288	269	276	272
6	290	286	292	317	330	302	292	303
7	331	309	303	334	358	336	314	315
8	338	329	325	346	373	368	349	333
9	352	351	343	364	387	379	374	369
10	369	369	348	392	401	398	381	384
11	389	387	369	444	425	387	400	405
12	380	422	388	399	387	421	409	401
13	434	408	404	419	414	402	438	415
14	409	436	396	428	420	390	469	420

* Predicted

Table 2.2.2 Icelandic summer spawners. Proportion mature at age. Age in years is number of rings + 1. Based on samples taken in September - Jamuary by purse seine.

Rings/year	1975	1976	1977	1978	1979	1980	1981
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.27	0.13	0.02	0.04	0.07	0.05	0.03
3	0.97	0.90	0.87	0.78	0.65	0.92	0.65
4	1.00	1.00	1.00	1.00	0.98	1.00	0.99
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/year	1982	1983	1984	1985	1986	1987	1988
1	0.02	0.00	0.00	0.00	0.00	0.00	0.00
2	0.05	0.00	0.01	0.00	0.03	0.01	0.05
3	0.85	0.64	0.82	0.90	0.89	0.87	0.90
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/year	1989	1990	1991	1992	1993	1994	1995	1996*
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.06	0.00	0.01	0.02	0.05	0.05	0.16	0.11
3	0.93	0.78	0.72	0.93	1.00	1.00	0.98	0.99
4	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00
5	1.00	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	1.00
7	1.00	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	1.00
9	1.00	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	1.00
11	1.00	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	1.00
13	1.00	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	1.00

* Predicted (mean of 1993-1995).

Table 2.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-1996.

Rings	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
1	-	-	-	-	-	-	-	625	3	-	-	-	201	-	392	285	5	478	410	1418	-	-	845
2	154	5	136	-	212	158	19	361	17	-	171	28	652	-	126	725	178	805	745	254	332	-	-
3	-	137	20	-	424	334	177	462	75	-	310	67	208	-	352	181	593	227	850	858	533	-	-
4	-	19	133	-	46	215	360	85	159	-	724	56	110	-	836	249	177	304	353	687	860	-	515
5	-	21	17	-	19	49	253	170	42	-	80	360	86	-	287	381	302	137	273	160	443	-	316
6	-	2	10	-	139	20	51	182	123	-	39	65	425	-	53	171	538	176	94	99	55	-	361
7	-	2	3	-	18	111	41	33	162	-	15	32	67	-	37	42	185	387	81	87	69	-	166
8	-	-	3	-	18	30	93	29	24	-	27	16	41	-	76	23	-	40	210	44	43	-	110
9	-	-	-	-	10	30	10	58	8	-	26	17	17	-	25	30	-	10	32	92	86	-	52
10	-	-	-	-	-	20	-	10	46	-	10	18	27	-	21	16	-	2	11	39	55	-	29
11	-	-	-	-	-	-	-	-	10	-	5	9	26	-	14	10	18	-	-	-	2	-	16
12	-	-	-	-	-	-	-	-	-	-	12	7	16	-	17	9	-	-	17	-	-	-	27
13	-	-	-	-	-	-	-	-	-	-	-	4	6	-	8	5	-	-	-	-	-	-	19
14	-	-	-	-	-	-	-	-	-	-	-	5	6	-	6	3	-	-	-	-	-	-	8
15	-	-	-	-	-	-	-	-	-	-	-	5	1	-	3	2	-	-	-	-	-	-	2
5+	-	25	33	-	204	260	448	482	415	-	214	538	718	-	547	692	1043	752	718	521	753	-	1105

Table 2.4.1 Stock abundance and catches by age groups (millions) and fishing mortality rate for the Icelandic summer spawners. F´is the F calculated from the acoustic surveys Estimates for the 1-4 ringers in 1995. F_{p95} is the explotation pattern in 1995 (used in the prognosis) Fpav is the average explotation pattern for 1987-1991.

Rings in 1995	Year class	Acoustic estimate Nov-Des 95	Catch 1995/96	F´	F95	Fp95	Fpav
1	1993	600	7.411	0.012	0.013	0.048	0.021
2	1992	543	26.221	0.045	0.053	0.196	0.087
3	1991	515	159.17	0.258	0.271	1.000	0.229
4	1990	316	86.94	0.232	0.271	1.000	0.418
5+	1989-	1105	242.26	0.252	0.271	1.000	1.000

Table 2.4.2 Icelandic summer spawners. Fishing mortality at age (M=0.1). Age in years is number of rings + 1.

Rings/year	1976	1977	1978	1979	1980	1981	1982
1	0.001	0.002	0.014	0.004	0.013	0.003	0.002
2	0.060	0.040	0.062	0.095	0.070	0.022	0.026
3	0.040	0.183	0.131	0.161	0.165	0.098	0.159
4	0.139	0.126	0.136	0.238	0.284	0.123	0.301
5	0.149	0.253	0.133	0.212	0.326	0.249	0.221
6	0.230	0.187	0.316	0.156	0.202	0.319	0.391
7	0.147	0.331	0.281	0.316	0.243	0.170	0.567
8	0.128	0.266	0.708	0.164	0.367	0.174	0.213
9	0.200	0.199	0.492	0.409	0.123	0.412	0.337
10	0.218	0.354	0.561	0.242	0.573	0.087	0.577
11	0.368	0.056	0.729	0.502	0.558	0.725	0.260
12	0.006	1.137	0.041	0.100	0.002	2.183	1.542
13	0.220	0.007	0.614	0.157	0.510	0.203	1.966
14	0.189	0.317	0.468	0.256	0.322	0.534	0.731
W.Av 4-14	0.148	0.220	0.244	0.239	0.294	0.246	0.367
Ave 4-14	0.181	0.294	0.407	0.250	0.319	0.471	0.646
Ave 4-9	0.166	0.227	0.344	0.249	0.258	0.241	0.338

Rings/year	1983	1984	1985	1986	1987	1988	1989
1	0.007	0.001	0.000	0.000	0.000	0.002	0.011
2	0.116	0.097	0.032	0.008	0.006	0.015	0.051
3	0.257	0.217	0.166	0.099	0.048	0.085	0.097
4	0.229	0.360	0.198	0.212	0.228	0.128	0.207
5	0.246	0.175	0.339	0.263	0.261	0.388	0.340
6	0.153	0.107	0.159	0.523	0.383	0.449	0.398
7	0.215	0.087	0.106	0.346	0.603	0.729	0.253
8	0.306	0.081	0.061	0.271	0.481	0.989	0.433
9	0.154	0.141	0.104	0.297	0.574	0.788	0.558
10	0.173	0.095	0.161	0.313	0.603	0.967	0.729
11	0.332	0.018	0.182	0.420	0.807	1.057	0.946
12	0.080	0.033	0.101	0.347	0.693	1.365	0.514
13	1.158	0.044	0.072	0.432	0.881	1.810	0.477
14	0.321	0.076	0.118	0.369	0.628	1.019	0.539
W.Av 4-14	0.224	0.255	0.227	0.356	0.382	0.291	0.311
Ave 4-14	0.306	0.111	0.145	0.345	0.558	0.881	0.490
Ave 4-9	0.217	0.159	0.161	0.319	0.422	0.579	0.365

Rings/year	1990	1991	1992	1993	1994	1995	1988-1991
1	0.011	0.030	0.018	0.001	0.011	0.013	0.013
2	0.044	0.105	0.078	0.062	0.138	0.053	0.054
3	0.160	0.195	0.187	0.215	0.219	0.271	0.134
4	0.158	0.347	0.224	0.166	0.267	0.271	0.210
5	0.296	0.202	0.341	0.177	0.233	0.271	0.306
6	0.452	0.310	0.363	0.267	0.228	0.271	0.402
7	0.522	0.601	0.303	0.242	0.280	0.271	0.526
8	0.421	0.244	0.457	0.309	0.380	0.271	0.522
9	0.602	0.290	0.357	0.234	0.352	0.271	0.559
10	0.671	0.774	0.245	0.211	0.400	0.271	0.785
11	0.990	0.595	0.331	0.130	0.237	0.271	0.897
12	0.977	0.482	0.161	0.258	0.286	0.271	0.835
13	0.775	0.495	0.309	0.137	0.467	0.271	0.889
14	0.676	0.474	0.316	0.224	0.329	0.271	0.677
W.Av 4-14	0.356	0.372	0.324	0.201	0.267	0.271	0.376
Ave 4-14	0.595	0.438	0.310	0.214	0.314	0.271	0.601
Ave 4-9	0.409	0.332	0.341	0.233	0.290	0.271	0.421

Table 2.4.3 Icelandic summer spawners. VPA stock size in numbers(millions) and SSB in '000 tonnes. Age in years is number of rings +1.

Rings/year	1976	1977	1978	1979	1980	1981	1982
1	553.914	435.878	195.297	247.787	253.515	878.862	237.896
2	178.097	500.618	393.728	174.208	223.324	226.398	793.057
3	105.961	151.790	435.058	334.829	143.286	188.438	200.452
4	275.979	92.162	114.416	345.222	257.804	109.937	154.572
5	53.035	217.288	73.510	90.377	246.195	175.664	87.957
6	28.013	41.332	152.625	58.215	66.162	160.817	123.962
7	8.027	20.145	31.004	100.649	45.076	48.911	105.763
8	3.821	6.270	13.088	21.174	66.377	31.976	37.326
9	1.715	3.041	4.350	5.836	16.263	41.630	24.316
10	0.719	1.271	2.254	2.406	3.510	13.009	24.956
11	0.313	0.523	0.807	1.163	1.708	1.790	10.791
12	0.177	0.196	0.448	0.352	0.637	0.885	0.784
13	0.005	0.159	0.057	0.389	0.288	0.575	0.090
14	0.006	0.004	0.143	0.028	0.301	0.157	0.425
SSB	129.339	132.96	175.6	198.266	212.554	185.959	192.996

Rings/year	1983	1984	1985	1986	1987	1988	1989
1	227.613	477.410	1225.836	643.799	374.854	523.214	389.873
2	214.826	204.555	431.578	1109.077	582.438	339.154	472.598
3	699.348	173.084	167.977	378.340	995.775	524.023	302.409
4	154.685	489.339	126.016	128.709	310.136	858.634	435.337
5	103.556	111.323	308.798	93.581	94.231	223.410	683.631
6	63.810	73.276	84.551	199.072	65.080	65.698	137.196
7	75.859	49.536	59.548	65.266	106.732	40.167	37.951
8	54.275	55.336	41.102	48.458	41.773	52.828	17.537
9	27.307	36.149	46.163	34.983	33.439	23.372	17.779
10	15.712	21.181	28.420	37.648	23.513	17.043	9.616
11	12.685	11.964	17.429	21.889	24.902	11.645	5.864
12	7.530	8.231	10.633	13.152	13.008	10.049	3.662
13	0.152	6.289	7.206	8.700	8.414	5.886	2.322
14	0.011	0.043	5.444	6.067	5.111	3.155	0.872
SSB	219.375	232.535	251.091	261.415	366.635	426.524	399.917

Rings/year	1990	1991	1992	1993	1994	1995	1996
1	1093.050	1255.912	699.997	988.307	600.000	600.000	845.000
2	349.004	978.517	1102.297	622.147	893.430	536.981	535.866
3	406.175	302.093	797.270	922.763	529.128	703.863	460.945
4	248.380	313.119	224.882	598.451	673.401	384.456	485.877
5	320.234	191.975	200.255	162.568	458.499	466.715	265.390
6	440.176	215.600	141.964	128.847	123.209	328.676	322.174
7	83.389	253.397	143.068	89.320	89.244	88.778	226.885
8	26.659	44.763	125.751	95.629	63.438	61.011	61.283
9	10.297	15.827	31.724	72.038	63.500	39.237	42.116
10	9.204	5.104	10.720	20.078	51.586	40.418	27.085
11	4.196	4.256	2.129	7.590	14.711	31.304	27.900
12	2.060	1.411	2.123	1.383	6.033	10.507	21.609
13	1.982	0.702	0.788	1.636	0.967	4.099	7.253
14	1.303	0.826	0.387	0.524	1.290	0.548	2.830
SSB	363.353	313.384	385.756	517.320	522.016	520.995	

Table 2.5.1 Icelandic summer spawning herring. Short term prediction. Input data.

Rings	N_{1996}	Selp	pmat	w*	M
1	845	0.043	0.00	69	0.1
2	535.6	0.257	0.06	141	0.1
3	460.9	0.676	0.93	188	0.1
4	484.5	1.000	1.00	226	0.1
5	264.6	1.000	1.00	272	0.1
6	321.3	1.000	1.00	303	0.1
7	226.2	1.000	1.00	315	0.1
8	61.1	1.000	1.00	333	0.1
9	42.0	1.000	1.00	369	0.1
10	27.0	1.000	1.00	384	0.1
11	27.8	1.000	1.00	405	0.1
12	21.5	1.000	1.00	401	0.1
13	7.2	1.000	1.00	415	0.1
14	2.8	1.000	1.00	420	0.1

Fmort95	0.225
Ffin	0.271
Ffactor	1
Fmort	0.271

Rings	N_{1996}	N_{1997}	N_{1998}	N_{1999}	N_{2000}
1	845	600	600	600	600
2	536	757	537	537	537
3	461	457	639	453	453
4	484	358	345	481	341
5	265	350	247	238	332
6	321	191	242	171	164
7	226	232	132	167	118
8	61	163	160	91	115
9	42	44	113	111	63
10	27	30	30	78	76
11	28	20	21	21	54
12	22	20	13	14	15
13	7	16	14	9	10
14	3	5	11	10	6

Average for rings 1 and 9+: regression for rings 2-8

Table 2.5.2 Icelandic summer spawning herring. 'Single option prediction results.

Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock biomass	Sp. stock biomass
1996	0.83	0.225	384	97	641	480
1997	0.83	0.225	452	115	648	475
1998	0.83	0.225	444	113	628	482
1999	0.83	0.225	428	110	603	460
2000	0.83	0.225	406	105	582	440
					1. January	Sp. time
			Millions	Thousand tonnes	Thousand tonnes	Thousand tonnes

Table 2.5.3 Icelandic summer spawners. Prediction with management option table.

Year: 1995					Year: 1996					Year: 1997	
F Factor	Reference F	Stock biomass	Sp. stock biomass	Catch in weight	F Factor	Reference F	Stock biomass	Sp. stock biomass	Catch in weight	Stock biomass	Sp. stock biomass
1.00	0.271	649	520	126	0.00	0.000	641	480	0	752	573
					0.07	0.020		480	9	742	563
					0.15	0.040		480	19	732	554
					0.22	0.060		480	28	722	545
					0.30	0.080		480	37	713	536
					0.37	0.100		480	46	703	527
					0.44	0.120		480	54	694	518
					0.52	0.140		480	63	685	510
					0.59	0.160		480	71	676	502
					0.66	0.180		480	79	667	493
					0.70	0.190		480	83	663	489
					0.74	0.200		480	87	659	485
					0.77	0.210		480	91	655	481
					0.81	0.220		480	95	650	477
					0.85	0.230		480	99	646	474
					0.92	0.250		480	107	638	466
					1.00	0.270		480	114	630	458
					1.07	0.290		480	122	622	451
					1.14	0.310		480	129	614	444
					1.22	0.330		480	136	607	437
					1.29	0.350		480	143	599	430
					1.37	0.370		480	150	592	423
					1.44	0.390		480	157	585	416
					1.51	0.410		480	163	578	409
					1.59	0.430		480	170	571	403
					1.66	0.450		480	176	564	396
					1.73	0.470		480	182	557	390

Table 2.5.4 Input data for long-term prediction

Rings	Selection pattern	Proportion mature	Weight at age	Natural mortality
1	0.021	0.000	66.8	0.1
2	0.160	0.028	139.4	0.1
3	0.439	0.829	197.9	0.1
4	0.636	0.998	239.2	0.1
5	1.000	1.000	274.0	0.1
6	1.000	1.000	303.1	0.1
7	1.000	1.000	327.9	0.1
8	1.000	1.000	347.6	0.1
9	1.000	1.000	366.6	0.1
10	1.000	1.000	378.4	0.1
11	1.000	1.000	394.8	0.1
12	1.000	1.000	405.0	0.1
13	1.000	1.000	410.1	0.1
14	1.000	1.000	424.7	0.1

Table 2.8.1 Icelandic summer spawning herring. Summary table from classical ADAPT - type assesment (based on cohort analysis).

Year	Recruits Age 1	Total Biomass	SSB	Landings	Yield/SSB	$F_{w\,4\text{-}14}$	$F_{w\,4\text{-}9}$
1947	52	132	111	42.2	0.380	0.533	0.54
1948	67	101	92	53.8	0.586	2.582	1.96
1949	78	56	46	4.9	0.108	0.131	0.13
1950	198	71	50	8.7	0.173	0.233	0.23
1951	117	82	53	13.7	0.259	0.306	0.31
1952	325	101	68	11.6	0.170	0.243	0.24
1953	198	124	76	12.4	0.163	0.224	0.22
1954	168	145	113	11.5	0.101	0.166	0.17
1955	192	165	135	23.7	0.176	0.220	0.22
1956	471	187	138	18.5	0.134	0.177	0.17
1957	795	248	148	25.4	0.172	0.197	0.19
1958	371	317	194	33.9	0.174	0.261	0.26
1959	558	369	279	35.8	0.128	0.179	0.15
1960	717	361	261	45.7	0.175	0.051	0.05
1961	534	395	303	83.3	0.275	0.303	0.31
1962	529	414	328	129.4	0.395	0.423	0.42
1963	471	353	283	155.9	0.551	0.790	0.80
1964	591	262	200	97.9	0.489	0.745	0.73
1965	512	267	166	149.7	0.902	1.240	1.24
1966	100	155	89	60.8	0.685	0.904	0.89
1967	39	107	95	76.3	0.802	1.422	1.42
1968	179	47	29	19.0	0.655	0.920	0.92
1969	46	43	18	21.1	1.203	0.766	0.75
1970	34	30	21	15.8	0.758	0.787	0.77
1971	71	23	14	11.0	0.802	1.697	1.70
1972	89	26	11	0.3	0.029	0.052	0.05
1973	419	74	30	0.3	0.008	0.007	0.01
1974	130	121	48	1.3	0.027	0.019	0.02
1975	198	162	123	13.3	0.108	0.152	0.15
1976	555	225	136	17.2	0.127	0.148	0.15
1977	437	257	139	28.9	0.208	0.221	0.22
1978	196	266	184	37.3	0.203	0.246	0.24
1979	249	273	208	45.1	0.217	0.240	0.24
1980	255	268	223	53.3	0.239	0.295	0.29
1981	882	293	195	39.5	0.203	0.247	0.25
1982	239	330	202	56.5	0.279	0.369	0.36
1983	228	318	231	58.7	0.254	0.225	0.22
1984	479	301	245	50.3	0.205	0.256	0.27
1985	1230	397	264	49.1	0.186	0.227	0.23
1986	645	473	275	65.4	0.237	0.356	0.35
1987	375	532	386	75.4	0.195	0.384	0.34
1988	524	552	450	91.8	0.204	0.293	0.26
1989	390	508	422	100.7	0.239	0.311	0.30
1990	1093	525	383	105.6	0.276	0.356	0.35
1991	1256	573	330	109.5	0.332	0.373	0.37
1992	700	616	406	106.8	0.263	0.325	0.33
1993	987	706	544	102.9	0.189	0.202	0.20
1994	600	704	548	134.0	0.244	0.268	0.26
1995	600	649	547	125.8	0.230	0.271	0.27

Table 2.8.2. Icelandic summer spawners. Summary of XSA tuning
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Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 1	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-11
1976	562144	226811	129084	17168	0.133	0.1938
1977	435756	260011	133892	28924	0.216	0.2183
1978	195704	268554	177738	37333	0.21	0.3818
1979	248458	276325	200744	45072	0.2245	0.3039
1980	253993	270558	215176	53269	0.2476	0.2967
1981	879927	295368	188341	39544	0.21	0.2389
1982	238557	332761	195277	56528	0.2895	0.3394
1983	223488	319881	221598	58665	0.2647	0.2288
1984	469341	301440	234273	50293	0.2147	0.1396
1985	1199009	396188	253837	49092	0.1934	0.1597
1986	603055	466562	261763	65413	0.2499	0.3014
1987	343431	517538	362519	75439	0.2081	0.4498
1988	496121	529660	413955	91760	0.2217	0.6344
1989	349912	481026	380575	100733	0.2647	0.4596
1990	989631	486349	340262	105593	0.3103	0.517
1991	1153518	520780	284860	109499	0.3844	0.4562
1992	772414	557576	339551	106825	0.3146	0.3656
1993	939842	640532	448708	102802	0.2291	0.2705
1994	537504	635538	465228	134003	0.288	0.381
1995	548625	576594	460534	125851	0.2733	0.3803
Arith. Mean	572022	418003	285396	72690	0.2474	0.3358
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.2.1 Catches of Norwegian spring-spawning herring (tonnes) 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	-	8,577	18,577
1981	844	7,814	78	-	8,736	13,736
1982	983	10,447	225	-	11,655	16,655
1983	3,857	13,290	907	-	18,054	23,054
1984	18,730	29,463	339	-	48,532	53,532
1985	29,363	37,187	197	4,300	71,047	169,872
1986	71,122[3]	55,507	156	-	126,785	225,256
1987	62,910	49,798	181	-	112,899	127,306
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	48,353	31,280	50	-	79,683	84,683
1992	43,688	55,737	23	-	99,448	104,448
1993	117,195	110,212	50	-	227,457	232,457
1994	288,581	190,643	4	-	479,228	479,228
1995	320,731	581,495	0	-	902,226	902,226

A = catches of adult herring in winter
B = mixed herring fishery in remaining part of the year
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 26,000 t of immature herring (1983 year-class) fished by USSR in the Barents Sea

Table 3.2.2 Total catch of Norwegian spring-spawning herring (tonnes) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Netherlands	Greenland	UK (Scotland)	Germany	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	74,604	11,807	-	-	-	-	-	-	-	86,411
1991	73,683	11,000	-	-	-	-	-	-	-	84,683
1992	91,111	13,337	-	-	-	-	-	-	-	104,448
1993	199,771	32,645	-	-	-	-	-	-	-	232,457
1994	380,771	74,400	-	2,911	21,146	-	-	-	-	479,228
1995[1]	529,838	100,000	30,131[1]	57,084	173,418	7,969	3,000	230	556	902,226

[1] Preliminary

Table 3.2.3 Norwegian Spring Spawning Herring. Catches in 1995 (millions) divided on age group and country

	Age	Norway	Russia	Iceland	Faroes	Netherlands	Denmark	UK(Scot)	Germany	Greenland	Total
	0	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
	1	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
	2	0,000	1,111	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,111
	3	39,500	8,409	2,341	6,664	0,035	0,407	0,003	0,002	0,040	57,402
	4	295,030	15,292	11,259	21,265	0,992	1,956	0,015	0,069	0,195	346,073
	5	360,540	119,417	61,054	64,315	2,718	10,608	0,081	0,190	1,056	619,979
	6	320,470	85,517	132,803	65,889	4,605	23,074	0,176	0,321	2,297	635,153
	7	125,340	27,120	51,373	14,488	1,836	8,926	0,068	0,128	0,889	230,168
	8	3,630	1,427	6,804	1,744	0,486	1,182	0,009	0,034	0,118	15,434
	9	3,560	2,948	5,813	1,235	1,008	1,010	0,008	0,070	0,101	15,753
	10	26,380	5,041	27,037	4,685	1,032	4,698	0,036	0,072	0,468	69,448
	11	11,880	3,439	48,622	8,028	1,856	8,448	0,064	0,129	0,841	83,308
	12	544,730	85,865	203,023	27,701	7,750	35,275	0,269	0,541	3,512	908,666
	13	0,000	0,000	2,884	0,491	0,110	0,501	0,004	0,008	0,050	4,047
	14	0,000	0,000	0,180	0,031	0,007	0,031	0,000	0,000	0,003	0,253
	15	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
	16+	0,000	0,000	0,316	0,054	0,012	0,055	0,000	0,001	0,005	0,443
Sum		1731,060	355,586	553,509	216,589	22,447	96,171	0,734	1,566	9,575	2987,238
Weight (t)		529,838	100,000	173,418	57,084	7,969	30,131	230	556	3,000	902,226
Av. weight (g)		306	281	313	264	355	313	313	355	313	302

Table 3.3.1 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys on the spawning stock in February-March. Numbers in millions.

Year Age	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
2		101	183	44			16		407
3	255	5	187	59			128	1792	231
4	146	373	0	54			676	7621	7638
5	6805	103	345	12			1375	3807	11243
6	202	5402	112	354			476	2151	2586
7		182	4489	122			63	322	957
8			146	4148			13	20	471
9				102			140	1	0
10							35	124	0
11							1820	63	165
12								2573	0
13+									2024
Total	7408	6166	5462	4895	-	-	4742	18474	25756

In 1992 and 1993 there was no estimate due to poor weather conditions.

Table 3.3.2 Norwegian Spring Spawning herring. Estimates obtained on the acoustic in the wintering areas in December. Numbers in millions.

Year Age	**1992**	**1993**	**1994**	**1995**
1		72		
2	36	1518	16	
3	1247	2389	3708	
4	1317	3287	4124	
5	173	1267	2593	
6	16	13	1096	
7	208	13	34	
8	139	158	25	
9	3742	26	196	
10	69	4435	29	
11			3239	
12				
13+				
Total	6947	13178	15209	

No acoustic estimate has been calculated for December 1995

Table 3.3.3 Norwegian Spring Spawning herring. Estimates obtained on the acoustic in the wintering areas in January. Numbers in millions.

Year Age	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
2	90			73		
3	220	410	61	642	47	315
4	70	820	1905	3431	3781	10442
5	20	260	2048	4847	4013	13557
6	180	60	256	1503	2445	4312
7	150	510	27	102	1215	1271
8	5500	120	269	29	42	290
9	440	4690	182	161	24	22
10		30	5691	131	267	25
11			128	3679	29	200
12					4326	58
13+						1146
Total	6670	6900	10567	14598	16189	31638

Table 3.4.1 **Norwegian** spring-spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975-1994 (numbers in millions).

Year	Area				Total
	South of 62°N	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
1991		80	299	2,428	2,807
1992		73	1,993	621	2,891
1993	290	109	140	288	827
1994	157	452	323	6,168	7,101
1995	0	27	2	0	29

Table 3.4.2 Norwegian spring spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Age												
1	21.4						4.4	24.3	32.6	102.7	6.6	0.5
2		19.9						5.2	14.0	25.8	59.2	7.7
3			3.0						5.7	1.5	18.0	8.0
4											1.7	1.1

Table 3.4.3 Norwegian spring spawning herring. Abundance indicies for 0-group herring in the Barents Sea, 1973 - 1995.

Year	Log index	Year	Log index
1973	0.05	1984	0.34
1974	0.01	1985	0.23
1975	0.00	1986	0.00
1976	0.00	1987	0.00
1977	0.01	1988	0.30
1978	0.02	1989	0.58
1979	0.09	1990	0.31
1980	0.00	1991	1.19
1981	0.00	1992	1.05
1982	0.00	1993	0.75
1983	1.77	1994	0.28
		1995	0.16

Table 3.5.1 Norwegian spring spawning herring. Tuning data.

	Catches and stock			1983 yearcl		Year	Surveys			
	C-no	N	F	M	Z		AcDec	AcJan	AcSpawn	WG 95
88	0.550	22.126	0.027	0.13	0.16	88			6.81	17.90
89	0.324	18.913	0.018	0.13	0.15	89			5.40	15.20
90	0.226	16.304	0.015	0.13	0.14	90			4.49	13.04
91	0.219	14.104	0.018	0.23	0.25	91			4.15	11.24
92	0.226	11.011	0.023	0.23	0.25	92		4.69		8.74
93	0.410	8.548	0.055	0.23	0.29	93	3.77	5.70		6.74
94	0.570	6.426	0.105	0.23	0.33	94	4.44	3.68	1.82	4.99
95	0.908	4.598	0.237	0.13	0.37	95	3.24	4.33	2.55	3.46
96		3.186				96		1.15	2.02	
	Catches and stock			1988 yearcl						
	C-no	**N**	**F**	**M**	**Z**					
91	0.008	2.804	0.003	0.13	0.13	91				2.45
92	0.033	2.455	0.014	0.13	0.14	92				2.14
93	0.087	2.125	0.045	0.13	0.17	93	1.32	2.05		1.85
94	0.162	1.784	0.102	0.13	0.23	94	1.27	1.50	0.476	1.54
95	0.230	1.415	0.191	0.13	0.32	95	1.10	1.22	0.28	1.20
96		1.027				96		0.29	0.471	
	Catches and stock			1989 yearcl						
	C-no	**N**	**F**	**M**	**Z**					
92	0.013	6.772	0.002	0.13	0.13	92				6.04
93	0.107	5.935	0.019	0.13	0.15	93				5.29
94	0.425	5.111	0.093	0.13	0.22	94	3.29	4.85	1.375	4.55
95	0.635	4.090	0.181	0.13	0.31	95	2.59	2.45	1.902	3.60
96		2.996				96		1.27	0.957	
	Catches and stock			1990 yearcl						
	C-no	**N**	**F**	**M**	**Z**					
93	0.028	8.514	0.004	0.13	0.13	93				6.65
94	0.189	7.450	0.027	0.13	0.16	94				5.81
95	0.620	6.365	0.110	0.13	0.24	95	4.12	4.01	3.272	4.93
96		5.008				96		4.31	2.586	
						q	0.65	0.63	0.36	1
						SSE	0.20	2.05	1.51	
						3.76				

Table 3.5.2

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	276200,	1636600,	39300,	740100,	266300,	93000,
4,	184800,	383800,	60500,	46600,	1435500,	276400,
5,	185500,	172400,	602300,	100900,	142900,	2045100,
6,	547000,	164400,	136300,	355600,	236000,	114300,
7,	628600,	515600,	204500,	81900,	490300,	189600,
8,	79500,	602000,	380200,	110900,	128100,	274700,
9,	88600,	77100,	377900,	314100,	199800,	85300,
10,	109500,	82700,	79200,	394900,	440400,	193400,
11,	86900,	103100,	85700,	61700,	460700,	295600,
12,	194500,	107600,	107700,	91200,	88400,	203200,
13,	368300,	253500,	106800,	94100,	100600,	58700,
+gp,	410700,	700500,	750900,	829200,	936200,	665200,
TOTALNUM,	3160100,	4799300,	2931300,	3221200,	4925200,	4494500,
TONSLAND,	933000,	1278400,	1254800,	1090600,	1644500,	1359800,
SOPCOF %,	115,	104,	150,	125,	124,	112,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	116500,	23300,	17500,	15100,	121700,	31200,	1843800,	760400,	114600,	89900,
4,	251600,	373300,	17900,	26800,	18200,	8100,	8000,	835800,	399000,	256200,
5,	314200,	153800,	110900,	25900,	28100,	4100,	3100,	5300,	2045800,	571100,
6,	2555100,	228500,	89300,	146600,	24400,	15000,	7200,	1800,	13700,	2199700,
7,	110000,	1985300,	194400,	114800,	96200,	19400,	20200,	3600,	1500,	19500,
8,	203900,	72000,	973500,	240700,	73300,	61600,	11900,	18300,	3000,	14900,
9,	264200,	127300,	70700,	1103800,	203900,	49200,	59100,	9300,	24900,	7400,
10,	130700,	182500,	123000,	88600,	1163000,	136100,	52600,	107700,	29300,	19100,
11,	198300,	88400,	200900,	124300,	85200,	728100,	117000,	92500,	95600,	40000,
12,	272800,	121200,	98700,	198000,	129700,	49700,	813500,	174100,	82400,	100500,
13,	163300,	149300,	77400,	88500,	153500,	45000,	44200,	923700,	153000,	107800,
+gp,	628100,	413000,	326500,	313300,	225600,	123100,	207000,	264900,	1109600,	1021800,
TOTALNUM,	5208700,	3917900,	2300700,	2486400,	2322800,	1270600,	3187600,	3197400,	4072400,	4447900,
TONSLAND,	1659400,	1319500,	986600,	1111100,	1101800,	830100,	848600,	984500,	1281800,	1547700,
SOPCOF %,	109,	113,	128,	128,	130,	166,	128,	124,	109,	116,

Table 3.5.2 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	2048700,	1392300,	99100,	188200,	6300,	1820,	35376,	2389,	100,	3268,
4,	26900,	3254000,	1880500,	800,	18600,	1020,	3476,	25200,	241,	132,
5,	466600,	26600,	1387400,	8800,	600,	1240,	3583,	651,	24505,	910,
6,	1306000,	421300,	14200,	4700,	3300,	360,	2481,	1506,	257,	30667,
7,	2884500,	1132000,	94000,	700,	3300,	1110,	694,	278,	196,	5,
8,	37900,	1720800,	134100,	11700,	1000,	1130,	1486,	178,	1,	2,
9,	14300,	8900,	345100,	33600,	13400,	360,	198,	1,	1,	1,
10,	17400,	5700,	2000,	36000,	26200,	4410,	1,	1,	1,	1,
11,	26200,	3500,	1100,	300,	28100,	6910,	494,	1,	1,	1,
12,	11000,	8500,	800,	200,	300,	5450,	593,	1,	1,	1,
13,	69100,	8900,	2500,	200,	100,	1,	593,	1,	1,	1,
+gp,	628800,	121900,	19600,	2600,	2200,	142,	3,	180,	3,	3,
TOTALNUM,	7537400,	8104400,	3980400,	287800,	103400,	23953,	48978,	30387,	25308,	34992,
TONSLAND,	1955000,	1677200,	712200,	67800,	62300,	21100,	13161,	7017,	7619,	13713,
SOPCOF %,	106,	110,	107,	150,	225,	258,	189,	108,	121,	107,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	23248,	22103,	3019,	6352,	6407,	4166,	13817,	3183,	4483,	21500,
4,	5436,	23595,	12164,	1866,	5814,	4591,	7892,	21191,	5388,	15500,
5,	1,	336,	20315,	6865,	2278,	8596,	4507,	9521,	61543,	16500,
6,	1,	1,	870,	11216,	8165,	2200,	6258,	6181,	18202,	130000,
7,	13086,	419,	1,	326,	15838,	4512,	1960,	6823,	12638,	59000,
8,	1,	10766,	620,	1,	441,	8280,	5075,	1293,	15608,	55000,
9,	1,	1,	5027,	1,	8,	345,	6047,	4598,	7215,	63000,
10,	1,	1,	1,	2534,	1,	103,	121,	7329,	16338,	10000,
11,	1,	1,	1,	1,	2688,	114,	37,	143,	6478,	31000,
12,	1,	1,	1,	1,	1,	964,	37,	40,	1,	50000,
13,	1,	1,	1,	1,	1,	1,	121,	143,	1,	1,
+gp,	3,	3,	3,	3,	3,	3,	3,	864,	1654,	2640,
TOTALNUM,	41781,	57228,	42023,	29167,	41645,	33875,	45875,	61309,	149549,	454141,
TONSLAND,	10436,	22706,	19824,	12864,	18577,	13736,	16655,	23054,	53532,	169872,
SOPCOF %,	105,	108,	104,	109,	101,	118,	102,	110,	101,	103,

Table 1 Catch numbers at age Numbers*10**-3

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	539785,	19776,	62923,	2890,	18633,	8438,	12586,	28408,	58530,	57448,
4,	17594,	501393,	25059,	3623,	2658,	2780,	33100,	106866,	188652,	346191,
5,	14500,	18672,	550367,	5650,	11875,	1410,	4980,	87269,	425414,	620086,
6,	15500,	3502,	9452,	324290,	10854,	14698,	1193,	8625,	161767,	635115,
7,	105000,	7058,	3679,	3469,	226280,	8867,	11981,	3648,	14601,	229776,
8,	75000,	28000,	5964,	800,	1289,	218851,	5748,	29603,	7655,	15442,
9,	42000,	12000,	14583,	679,	1519,	2499,	225677,	18631,	33623,	15756,
10,	77000,	9500,	8872,	3297,	2036,	461,	2483,	410110,	31875,	69456,
11,	19469,	4500,	2818,	1375,	2415,	87,	639,	1,	569883,	82548,
12,	66000,	7834,	3356,	679,	646,	690,	247,	1,	2825,	908426,
13,	80000,	6500,	2682,	321,	179,	103,	1236,	1,	459,	4046,
+gp,	2471,	7454,	2108,	260,	1065,	797,	3,	3,	2163,	699,
TOTALNUM,	1054319,	626189,	691863,	347333,	279449,	259681,	299873,	693166,	1497447,	2984989,
TONSLAND,	225256,	127306,	135301,	103830,	86411,	84683,	104448,	232457,	479228,	902226,
SOPCOF %,	100,	103,	101,	105,	102,	101,	100,	100,	100,	100,

Table 3.5.3

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 2 Catch weights at age (kg)

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	.1100,	.1300,	.1150,	.1200,	.1170,	.1190,
4,	.1880,	.2220,	.1970,	.2050,	.2010,	.2040,
5,	.2110,	.2490,	.2210,	.2300,	.2250,	.2290,
6,	.2340,	.2760,	.2450,	.2550,	.2500,	.2540,
7,	.2530,	.2980,	.2650,	.2750,	.2690,	.2740,
8,	.2660,	.3140,	.2790,	.2900,	.2840,	.2890,
9,	.2800,	.3300,	.2930,	.3050,	.2990,	.3040,
10,	.2940,	.3460,	.3080,	.3200,	.3130,	.3180,
11,	.3030,	.3570,	.3170,	.3300,	.3230,	.3280,
12,	.3120,	.3680,	.3270,	.3400,	.3330,	.3380,
13,	.3200,	.3770,	.3350,	.3470,	.3410,	.3460,
+gp,	.3320,	.3877,	.3463,	.3612,	.3546,	.3606,
SOPCOFAC,	1.1509,	1.0423,	1.5000,	1.2498,	1.2447,	1.1244,

Table 2 Catch weights at age (kg)

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	.1260,	.1270,	.1330,	.1350,	.1190,	.0870,	.0850,	.0980,	.1390,	.0890,
4,	.2150,	.2160,	.2270,	.2310,	.1880,	.1590,	.1480,	.1710,	.2190,	.2170,
5,	.2410,	.2430,	.2550,	.2590,	.2770,	.2760,	.2880,	.2750,	.2390,	.2340,
6,	.2680,	.2690,	.2830,	.2870,	.3370,	.3220,	.3330,	.2680,	.2980,	.2620,
7,	.2890,	.2900,	.3050,	.3100,	.3180,	.3720,	.3600,	.3230,	.2950,	.3310,
8,	.3040,	.3060,	.3210,	.3270,	.3630,	.3630,	.3520,	.3290,	.3390,	.3600,
9,	.3200,	.3220,	.3380,	.3440,	.3790,	.3930,	.3500,	.3360,	.3500,	.3670,
10,	.3360,	.3380,	.3550,	.3600,	.3600,	.4070,	.3740,	.3410,	.3580,	.3860,
11,	.3460,	.3480,	.3660,	.3720,	.4200,	.3970,	.3840,	.3580,	.3510,	.3950,
12,	.3570,	.3590,	.3770,	.3830,	.4110,	.4220,	.3740,	.3850,	.3670,	.3930,
13,	.3650,	.3670,	.3860,	.3920,	.4390,	.4470,	.3940,	.3530,	.3750,	.4040,
+gp,	.3809,	.3801,	.3999,	.4062,	.4477,	.4587,	.4099,	.3845,	.3905,	.4266,
SOPCOFAC,	1.0943,	1.1288,	1.2805,	1.2816,	1.3046,	1.6573,	1.2771,	1.2392,	1.0941,	1.1635,

Table 3.5.3 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 2 Catch weights at age (kg)

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	.0630,	.0660,	.0750,	.0720,	.1050,	.1770,	.1030,	.1610,	.1680,	.2410,
4,	.2460,	.0930,	.1080,	.1050,	.1710,	.2160,	.1540,	.2130,	.2220,	.3180,
5,	.2600,	.3050,	.1580,	.1520,	.2560,	.2500,	.2150,	.2390,	.2490,	.3580,
6,	.2650,	.3050,	.3750,	.2960,	.2160,	.2770,	.2580,	.2550,	.2650,	.3810,
7,	.3010,	.3100,	.3830,	.3760,	.2770,	.3050,	.2950,	.2770,	.2880,	.4130,
8,	.4100,	.3330,	.3640,	.3290,	.2980,	.3330,	.3220,	.2870,	.2990,	.4290,
9,	.4250,	.3590,	.3820,	.3290,	.3040,	.3530,	.3410,	.3240,	.3370,	.4840,
10,	.4560,	.4130,	.4410,	.3410,	.3050,	.3660,	.3540,	.3380,	.3520,	.5060,
11,	.4600,	.4460,	.4100,	.3630,	.3090,	.3770,	.3650,	.2570,	.2670,	.3840,
12,	.4670,	.4010,	.4420,	.3850,	.3570,	.3880,	.3760,	.2570,	.3240,	.4660,
13,	.4460,	.4080,	.5170,	.3770,	.3480,	.3990,	.3870,	.2570,	.3240,	.4660,
+gp,	.4709,	.4317,	.4854,	.4298,	.3739,	.4405,	.4220,	.2570,	.3240,	.4660,
SOPCOFAC,	1.0596,	1.1021,	1.0723,	1.5005,	2.2546,	2.5761,	1.8870,	1.0849,	1.2095,	1.0675,

Table 2 Catch weights at age (kg)

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	.1890,	.3160,	.2740,	.2930,	.2660,	.1960,	.2560,	.2170,	.2180,	.2140,
4,	.2500,	.3500,	.4240,	.3590,	.3990,	.2910,	.3120,	.2650,	.2620,	.2770,
5,	.2800,	.3980,	.4540,	.4160,	.4490,	.3410,	.3780,	.3370,	.3250,	.2950,
6,	.2980,	.4390,	.4950,	.4360,	.4600,	.3680,	.4150,	.3780,	.3460,	.3380,
7,	.3230,	.4950,	.5240,	.4820,	.4850,	.3800,	.4350,	.4100,	.3810,	.3600,
8,	.3360,	.5110,	.5960,	.4820,	.4720,	.3970,	.4490,	.4260,	.4000,	.3810,
9,	.3790,	.5580,	.6130,	.5390,	.6180,	.4360,	.4480,	.4350,	.4130,	.3970,
10,	.3960,	.5830,	.6500,	.5530,	.6450,	.4500,	.5060,	.4440,	.4050,	.4090,
11,	.3000,	.5370,	.5900,	.5180,	.6080,	.4920,	.4930,	.4680,	.4260,	.4170,
12,	.3640,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,
13,	.3640,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,
+gp,	.3640,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,
SOPCOFAC,	1.0453,	1.0766,	1.0382,	1.0865,	1.0132,	1.1828,	1.0218,	1.0976,	1.0141,	1.0306,

Table 2 Catch weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	.0550,	.1240,	.1240,	.1880,	.2300,	.2080,	.1910,	.1530,	.1940,	.1530,
4,	.2490,	.1730,	.1540,	.2640,	.2390,	.2500,	.2330,	.2430,	.2390,	.1920,
5,	.2940,	.2530,	.1940,	.2600,	.2660,	.2880,	.3040,	.2820,	.2800,	.2340,
6,	.3120,	.2320,	.2410,	.2820,	.3050,	.3120,	.3370,	.3200,	.3170,	.2830,
7,	.3520,	.3120,	.2650,	.3060,	.3080,	.3160,	.3650,	.3300,	.3280,	.3280,
8,	.3740,	.3280,	.3040,	.3090,	.3760,	.3300,	.3610,	.3650,	.3560,	.3490,
9,	.3980,	.3490,	.3050,	.3910,	.4070,	.3440,	.3710,	.3730,	.3720,	.3560,
10,	.4020,	.3530,	.3170,	.4220,	.4120,	.3720,	.4030,	.3790,	.3900,	.3740,
11,	.4010,	.3700,	.3080,	.3640,	.4240,	.3540,	.3650,	.3800,	.3790,	.3660,
12,	.4100,	.3850,	.3340,	.4290,	.4280,	.3980,	.3940,	.3850,	.3990,	.3930,
13,	.4100,	.3850,	.3340,	.4290,	.4280,	.3980,	.4040,	.3900,	.4030,	.3870,
+gp,	.4100,	.3850,	.3340,	.4290,	.4280,	.3980,	.4080,	.4000,	.4069,	.4000,
SOPCOFAC,	1.0032,	1.0291,	1.0071,	1.0549,	1.0183,	1.0062,	1.0039,	1.0016,	1.0037,	1.0008,

Table 3.5.4

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 3 Stock weights at age (kg)

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.2040,	.2040,	.2040,	.2040,	.2040,	.1950,
5,	.2300,	.2300,	.2300,	.2300,	.2300,	.2130,
6,	.2550,	.2550,	.2550,	.2550,	.2550,	.2600,
7,	.2750,	.2750,	.2750,	.2750,	.2750,	.2750,
8,	.2900,	.2900,	.2900,	.2900,	.2900,	.2900,
9,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,
10,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,
11,	.3250,	.3250,	.3250,	.3250,	.3250,	.3250,
12,	.3300,	.3300,	.3300,	.3300,	.3300,	.3300,
13,	.3400,	.3400,	.3400,	.3400,	.3400,	.3400,
+gp,	.3610,	.3549,	.3590,	.3618,	.3618,	.3620,

Table 3 Stock weights at age (kg)

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.2050,	.1360,	.2040,	.2040,	.2040,	.2320,	.2190,	.1850,	.1940,	.1860,
5,	.2300,	.2280,	.2420,	.2520,	.2700,	.2500,	.2910,	.2530,	.2130,	.1990,
6,	.2490,	.2550,	.2920,	.2600,	.2910,	.2920,	.3000,	.2940,	.2640,	.2360,
7,	.2750,	.2620,	.2950,	.2900,	.2930,	.3020,	.3160,	.3120,	.3170,	.2600,
8,	.2900,	.2900,	.2930,	.3000,	.3210,	.3040,	.3240,	.3290,	.3630,	.3630,
9,	.3050,	.3050,	.3050,	.3050,	.3180,	.3230,	.3260,	.3270,	.3530,	.3500,
10,	.3150,	.3150,	.3150,	.3150,	.3200,	.3220,	.3350,	.3340,	.3490,	.3700,
11,	.3250,	.3250,	.3300,	.3250,	.3440,	.3210,	.3380,	.3410,	.3540,	.3600,
12,	.3300,	.3300,	.3400,	.3300,	.3490,	.3440,	.3340,	.3490,	.3570,	.3780,
13,	.3400,	.3400,	.3450,	.3400,	.3700,	.3570,	.3470,	.3410,	.3590,	.3870,
+gp,	.3626,	.3584,	.3611,	.3549,	.3787,	.3655,	.3569,	.3699,	.3762,	.3935,

Table 3.5.4 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 3 Stock weights at age (kg)

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1500,	.1700,	.1700,	.1810,
4,	.1850,	.1800,	.1150,	.1150,	.2090,	.1900,	.1500,	.2590,	.2590,	.2590,
5,	.2190,	.2280,	.2060,	.1450,	.2720,	.2250,	.1400,	.3420,	.3420,	.3420,
6,	.2220,	.2690,	.2660,	.2700,	.2300,	.2500,	.2100,	.3840,	.3840,	.3840,
7,	.2490,	.2700,	.2750,	.3000,	.2950,	.2750,	.2400,	.4090,	.4090,	.4090,
8,	.3060,	.2940,	.2740,	.3060,	.3170,	.2900,	.2700,	.4040,	.4440,	.4440,
9,	.3540,	.3240,	.2850,	.3080,	.3230,	.3100,	.3000,	.4610,	.4610,	.4610,
10,	.3770,	.4200,	.3500,	.3180,	.3250,	.3250,	.3250,	.5200,	.5200,	.5200,
11,	.3910,	.4300,	.3250,	.3400,	.3290,	.3350,	.3350,	.5340,	.5430,	.5430,
12,	.3790,	.3660,	.3630,	.3680,	.3800,	.3450,	.3450,	.5000,	.4820,	.4820,
13,	.3780,	.3680,	.4080,	.3600,	.3700,	.3550,	.3550,	.5000,	.4820,	.4820,
+gp,	.3805,	.4167,	.3793,	.3967,	.3900,	.3865,	.3817,	.5000,	.4820,	.4820,

Table 3 Stock weights at age (kg)

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	.1810,	.1810,	.1800,	.1780,	.1750,	.1700,	.1700,	.1550,	.1400,	.1480,
4,	.2590,	.2590,	.2940,	.2320,	.2830,	.2240,	.2040,	.2490,	.2040,	.2340,
5,	.3420,	.3430,	.3260,	.3590,	.3470,	.3360,	.3030,	.3040,	.2950,	.2650,
6,	.3840,	.3840,	.3710,	.3850,	.4020,	.3780,	.3550,	.3680,	.3380,	.3120,
7,	.4090,	.4090,	.4090,	.4200,	.4210,	.3870,	.3830,	.4040,	.3760,	.3460,
8,	.4440,	.4440,	.4610,	.4440,	.4650,	.4080,	.3950,	.4240,	.3950,	.3700,
9,	.4610,	.4610,	.4760,	.5050,	.4650,	.3970,	.4130,	.4370,	.4070,	.3950,
10,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,	.4530,	.4360,	.4130,	.3970,
11,	.5430,	.5430,	.5430,	.5510,	.5340,	.5430,	.4680,	.4930,	.4220,	.4280,
12,	.4820,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,
13,	.4820,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,
+gp,	.4820,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,

Table 3 Stock weights at age (kg)

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	.0540,	.0900,	.0980,	.1540,	.2190,	.1470,	.1280,	.0810,	.0750,	.0660,
4,	.2060,	.1430,	.1350,	.1750,	.1980,	.2100,	.2240,	.2010,	.1510,	.1380,
5,	.2650,	.2410,	.1970,	.2090,	.2580,	.2440,	.2960,	.2650,	.2540,	.2300,
6,	.2890,	.2790,	.2770,	.2520,	.2880,	.3000,	.3270,	.3230,	.3180,	.2960,
7,	.3390,	.2990,	.3150,	.3050,	.3090,	.3240,	.3550,	.3540,	.3710,	.3460,
8,	.3680,	.3160,	.3390,	.3670,	.4280,	.3360,	.3450,	.3580,	.3470,	.3880,
9,	.3910,	.3420,	.3430,	.3770,	.3700,	.3430,	.3670,	.3810,	.4120,	.3630,
10,	.3820,	.3430,	.3590,	.3590,	.4030,	.3820,	.3410,	.3690,	.3820,	.4090,
11,	.3880,	.3620,	.3650,	.3950,	.3870,	.3660,	.3610,	.3960,	.4070,	.4140,
12,	.3950,	.3760,	.3760,	.3960,	.4400,	.4250,	.4300,	.3930,	.4100,	.4220,
13,	.3950,	.3760,	.3760,	.3960,	.4400,	.4250,	.4700,	.3740,	.4100,	.4100,
+gp,	.3950,	.3760,	.3760,	.3960,	.4400,	.4250,	.4633,	.4010,	.4100,	.4333,

Table 3.5.5

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 4 Natural Mortality (M) at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
4,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
5,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
6,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
7,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
8,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
9,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
10,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
11,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
12,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
13,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
+gp,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,

Table 4 Natural Mortality (M) at age

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
4,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
5,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
6,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
7,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
8,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
9,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
10,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
11,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
12,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
13,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,
+gp,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,	.1600,

Table 3.5.5 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 4 Natural Mortality (M) at age

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
4,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
5,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
6,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
7,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
8,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
9,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
10,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
11,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
12,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
13,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,
+gp,	.1600,	.1600,	.1600,	.1600,	.1600,	.1300,	.1300,	.1300,	.1300,	.1300,

Table 4 Natural Mortality (M) at age

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
4,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
5,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
6,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
7,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
8,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
9,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
10,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
11,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
12,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
13,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
+gp,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,

Table 4 Natural Mortality (M) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,	.1300,
4,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.1300,	.1300,	.1300,	.1300,
5,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.1300,	.1300,	.1300,
6,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.1300,	.1300,
7,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
8,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
9,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
10,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
11,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
12,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
13,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,
+gp,	.1300,	.1300,	.1300,	.1300,	.1300,	.2300,	.2300,	.2300,	.2300,	.1300,

Table 3.5.6

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 5 Proportion mature at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0800,
4,	.1000,	.1000,	.1000,	.1000,	.1000,	.2200,
5,	.3000,	.3000,	.3000,	.3000,	.3000,	.3700,
6,	.6000,	.6000,	.6000,	.6000,	.6000,	.8500,
7,	.9000,	.9000,	.9000,	.9000,	.9000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	.0800,	.0000,	.0800,	.0800,	.0800,	.0400,	.0000,	.0400,	.0200,	.0000,
4,	.2200,	.0000,	.2200,	.2200,	.2200,	.3500,	.1100,	.0300,	.0600,	.3400,
5,	.3700,	.5000,	.3700,	.3700,	.3700,	.6800,	.6700,	.3200,	.2800,	.3500,
6,	.8500,	.6000,	.8500,	.8500,	.8500,	.9400,	1.0000,	.9000,	.3200,	.7600,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.5.6 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Table 5 Proportion mature at age

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	.0100,	.0000,	.0000,	.6200,	.0600,	.1000,	.0000,	.5000,	.5000,	.5000,
4,	.1500,	.0100,	.0000,	.8900,	.1300,	.2500,	.1000,	.9000,	.9000,	1.0000,
5,	1.0000,	.2300,	.0100,	.9500,	.3100,	.6000,	.2500,	1.0000,	1.0000,	1.0000,
6,	.9600,	1.0000,	.7600,	1.0000,	.1700,	.9000,	.6000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	.5000,	.7300,	.1300,	.1000,	.2500,	.3000,	.1000,	.1000,	.1000,	.1000,
4,	.9000,	.8900,	.9000,	.6200,	.5000,	.5000,	.4800,	.5000,	.5000,	.5000,
5,	1.0000,	1.0000,	1.0000,	.9500,	.9700,	.9000,	.7000,	.6900,	.9000,	.9000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.7100,	.9500,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	.1000,	.1000,	.1000,	.1000,	.4000,	.1000,	.1000,	.0100,	.0100,	.0000,
4,	.2000,	.3000,	.3000,	.3000,	.8000,	.7000,	.2000,	.3000,	.3000,	.0100,
5,	.9000,	.9000,	.9000,	.9000,	.9000,	1.0000,	.8000,	.8000,	.8000,	.8000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.5.7

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	.0298,	.3099,	.0152,	.0174,	.0394,	.0310,
4,	.0569,	.0506,	.0159,	.0215,	.0408,	.0502,
5,	.0569,	.0662,	.1005,	.0320,	.0814,	.0722,
6,	.0824,	.0628,	.0656,	.0761,	.0933,	.0829,
7,	.1245,	.0998,	.0994,	.0490,	.1368,	.0967,
8,	.0661,	.1613,	.0952,	.0689,	.0967,	.1014,
9,	.0541,	.0809,	.1381,	.1018,	.1631,	.0827,
10,	.0915,	.0628,	.1071,	.2002,	.1938,	.2245,
11,	.0867,	.1119,	.0821,	.1091,	.3608,	.1845,
12,	.0344,	.1411,	.1567,	.1129,	.2151,	.2551,
13,	.1100,	.0550,	.1940,	.1910,	.1680,	.2070,
+gp,	.1100,	.0550,	.1940,	.1910,	.1680,	.2070,
FBAR 5-12,	.0746,	.0984,	.1056,	.0938,	.1676,	.1375,
FWEI 5-12,	.0753,	.1016,	.1023,	.0873,	.1549,	.0887,

Table 8 Fishing mortality (F) at age

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	.0406,	.0437,	.0388,	.1006,	.7289,	.1519,	.0992,	.1204,	.0598,	.6640,
4,	.1053,	.1692,	.0411,	.0738,	.1620,	.0883,	.0507,	.0571,	.0821,	.1760,
5,	.0711,	.0830,	.0665,	.0739,	.0989,	.0477,	.0424,	.0413,	.1845,	.1549,
6,	.1162,	.0649,	.0608,	.1128,	.0886,	.0674,	.1060,	.0299,	.1366,	.2948,
7,	.1027,	.1192,	.0693,	.0993,	.0964,	.0904,	.1167,	.0679,	.0302,	.2796,
8,	.1370,	.0868,	.0757,	.1101,	.0815,	.0792,	.0705,	.1410,	.0712,	.4387,
9,	.1282,	.1139,	.1103,	.1104,	.1230,	.0692,	.0973,	.0694,	.2762,	.2396,
10,	.1682,	.1176,	.1470,	.1879,	.1558,	.1081,	.0942,	.2460,	.3075,	.3370,
11,	.3600,	.1571,	.1756,	.2078,	.2653,	.1323,	.1224,	.2276,	.3428,	.8503,
12,	.2475,	.3721,	.2518,	.2508,	.3318,	.2333,	.2049,	.2574,	.3104,	.6972,
13,	.3200,	.1990,	.4120,	.3580,	.3000,	.1750,	.3200,	.3600,	.3600,	.8100,
+gp,	.3200,	.1990,	.4120,	.3580,	.3000,	.1750,	.3200,	.3600,	.3600,	.8100,
FBAR 5-12,	.1664,	.1393,	.1196,	.1441,	.1552,	.1034,	.1068,	.1351,	.2074,	.4115,
FWEI 5-12,	.1219,	.1126,	.0859,	.1219,	.1478,	.1187,	.1662,	.2064,	.1918,	.2617,

Table 3.5.7 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	.3105,	.5004,	3.2157,	2.0397,	.5513,	.2964,	.1698,	.1301,	.1198,	.2635,
4,	.4036,	1.1137,	4.5519,	.2668,	1.5156,	.1491,	1.3557,	.1627,	.0161,	.2122,
5,	.5268,	.8526,	4.7028,	.7636,	.3134,	.3261,	1.0141,	.9587,	.2175,	.0724,
6,	.5927,	1.3006,	1.7927,	.6007,	.7026,	.2952,	1.9943,	1.7989,	1.2755,	.4240,
7,	.7433,	1.6706,	1.2051,	.3493,	1.1207,	.5073,	1.3685,	1.6732,	1.3879,	.0596,
8,	1.2962,	1.4494,	.9297,	.4228,	1.1821,	1.6940,	3.8737,	1.9061,	.0182,	.0361,
9,	.9571,	1.3150,	1.4577,	.6031,	1.2050,	2.6819,	2.1425,	.0381,	.0381,	.0211,
10,	1.3341,	1.3726,	1.2694,	.5247,	1.3863,	2.1544,	.0452,	.0452,	.0452,	.0452,
11,	1.0201,	1.0852,	1.1065,	.6055,	.9893,	2.4039,	3.3190,	.0541,	.0541,	.0541,
12,	.5694,	1.1218,	.7508,	.5706,	3.0096,	.4811,	3.6833,	.0653,	.0653,	.0653,
13,	1.6300,	1.2800,	1.2500,	.4000,	.6000,	.0800,	.0800,	.0800,	.0800,	.0800,
+gp,	1.6300,	1.2800,	1.2500,	.4000,	.6000,	.0800,	.0800,	.0800,	.0800,	.0800,
FBAR 5-12,	.8800,	1.2710,	1.6518,	.5550,	1.2386,	1.3180,	2.1801,	.8174,	.3877,	.0972,
FBARP,	.6782,	1.4924,	3.4057,	.5544,	1.1302,	1.1331,	1.8598,	1.4960,	.2227,	.3780,

Table 8 Fishing mortality (F) at age

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	.0300,	.0426,	.0166,	.0145,	.0233,	.0118,	.0186,	.0385,	.0341,	.1035,
4,	.8382,	.0359,	.0276,	.0118,	.0153,	.0194,	.0258,	.0334,	.0786,	.1465,
5,	.0020,	.0977,	.0365,	.0182,	.0167,	.0264,	.0222,	.0366,	.1189,	.3347,
6,	.0001,	.0023,	.3593,	.0236,	.0252,	.0187,	.0224,	.0357,	.0847,	.3608,
7,	.2970,	.0459,	.0027,	.2043,	.0392,	.0162,	.0193,	.0285,	.0883,	.3932,
8,	.0141,	.3911,	.0824,	.0030,	.4283,	.0241,	.0211,	.0148,	.0783,	.6071,
9,	.0211,	.0163,	.2941,	.0002,	.0282,	.6449,	.0205,	.0222,	.0993,	.4668,
10,	.0246,	.0246,	.0189,	.2187,	.0002,	.5388,	.4503,	.0290,	.0954,	.1798,
11,	.0541,	.0288,	.0288,	.0220,	.3494,	.0236,	.3463,	1.4184,	.0301,	.2432,
12,	.0653,	.0653,	.0339,	.0339,	.0256,	.1876,	.0089,	.7083,	.0256,	.3114,
13,	.0800,	.0800,	.0800,	.0400,	.0400,	.0300,	.0300,	.0400,	.0300,	.0300,
+gp,	.0800,	.0800,	.0800,	.0400,	.0400,	.0300,	.0300,	.0400,	.0300,	.0300,
FBAR 5-12,	.0598,	.0840,	.1071,	.0655,	.1141,	.1850,	.1139,	.2867,	.0776,	.3621,
FBARP,	.2429,	.2945,	.0471,	.0243,	.0340,	.0235,	.0214,	.0296,	.0904,	.3717,

Table 8 Fishing mortality (F) at age

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	.0195,	.0104,	.0422,	.0103,	.0666,	.0032,	.0020,	.0036,	.0029,	.0026,
4,	.1072,	.0211,	.0152,	.0028,	.0109,	.0124,	.0146,	.0194,	.0275,	.0197,
5,	.1839,	.1470,	.0270,	.0039,	.0106,	.0070,	.0284,	.0450,	.0930,	.1100,
6,	.5522,	.0572,	.0958,	.0185,	.0087,	.0160,	.0075,	.0649,	.1022,	.1810,
7,	.5091,	.4821,	.0730,	.0429,	.0150,	.0085,	.0166,	.0294,	.1539,	.1910,
8,	1.1768,	.2259,	.9004,	.0190,	.0187,	.0176,	.0070,	.0535,	.0821,	.2370,
9,	1.2774,	.5304,	.1630,	.2116,	.0422,	.0448,	.0233,	.0292,	.0818,	.2370,
10,	1.7028,	1.1017,	.8839,	.0467,	1.5783,	.0158,	.0590,	.0554,	.0658,	.2370,
11,	.5708,	.3608,	1.1348,	.2907,	.0407,	.2218,	.0281,	.0000,	.1048,	.2370,
12,	1.0835,	.4358,	.4599,	.8692,	.1993,	.0143,	1.9678,	.0001,	.1159,	.2370,
13,	1.0800,	.2500,	.2400,	.0660,	.5400,	.0430,	.0330,	.0330,	.0330,	.2370,
+gp,	1.0800,	.2500,	.2400,	.0660,	.5400,	.0430,	.0330,	.0330,	.0330,	.2370,
FBAR 5-12,	.8821,	.4176,	.4672,	.1878,	.2392,	.0432,	.2672,	.0347,	.0999,	.2084,
FBARP,	.8393,	.2514,	.0295,	.0178,	.0147,	.0168,	.0218,	.0516,	.0983,	.1736,

Table 3.5.8

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	1016136,	661928,	282349,	4633524,	745596,	329292,
4,	361323,	840435,	413762,	236978,	3880198,	610812,
5,	362582,	290872,	680804,	347007,	197644,	3174187,
6,	747648,	291880,	231981,	524677,	286400,	155258,
7,	579963,	586718,	233576,	185123,	414343,	222318,
8,	134424,	436343,	452486,	180208,	150204,	307950,
9,	181960,	107224,	316434,	350568,	143346,	116198,
10,	135333,	146892,	84269,	234864,	269810,	103767,
11,	113053,	105238,	117554,	64516,	163820,	189411,
12,	622146,	88334,	80185,	92278,	49296,	97318,
13,	382050,	512231,	65369,	58418,	70237,	33879,
+gp,	426033,	1415460,	459605,	514775,	653640,	383920,
TOTAL,	5062653,	5483555,	3418374,	7422939,	7024532,	5724310,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	316469,	58934,	49688,	17052,	25202,	23909,	2110400,	724467,	213471,	19874,
4,	272032,	258940,	48073,	40728,	13140,	10361,	17503,	1628566,	547344,	171348,
5,	495029,	208642,	186309,	39315,	32237,	9522,	8083,	14178,	1310759,	429663,
6,	2516460,	392890,	163626,	148544,	31116,	24883,	7737,	6602,	11593,	928768,
7,	121774,	1909136,	313746,	131205,	113083,	24268,	19822,	5930,	5460,	8618,
8,	171986,	93639,	1444078,	249447,	101234,	87503,	18893,	15031,	4721,	4514,
9,	237121,	127789,	73162,	1140883,	190402,	79514,	68891,	15004,	11125,	3747,
10,	91161,	177740,	97174,	55835,	870561,	143478,	63224,	53262,	11928,	7192,
11,	70644,	65657,	134657,	71486,	39430,	634821,	109732,	49032,	35488,	7474,
12,	134214,	42000,	47814,	96265,	49486,	25771,	473937,	82736,	33278,	21466,
13,	64255,	89296,	24669,	31674,	63834,	30261,	17392,	329051,	54503,	20791,
+gp,	247143,	247015,	104061,	112128,	93817,	82782,	81450,	94366,	395274,	197069,
TOTAL,	4738286,	3671677,	2687057,	2134562,	1623541,	1177074,	2997063,	3018224,	2634945,	1820524,

Table 3.5.8 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	827168,	380178,	10771,	22826,	1597,	754,	24115,	2085,	94,	1500,
4,	8718,	516726,	196425,	368,	2530,	784,	492,	17869,	1608,	73,
5,	122444,	4962,	144578,	1765,	240,	474,	593,	111,	13335,	1389,
6,	313580,	61612,	1802,	1117,	701,	150,	300,	189,	38,	9420,
7,	589396,	147724,	14299,	256,	522,	296,	98,	36,	27,	9,
8,	5552,	238851,	23683,	3651,	154,	145,	156,	22,	6,	6,
9,	2481,	1294,	47774,	7965,	2039,	40,	23,	3,	3,	5,
10,	2513,	812,	296,	9476,	3714,	521,	2,	2,	2,	2,
11,	4375,	564,	175,	71,	4779,	791,	53,	2,	2,	2,
12,	2721,	1344,	162,	49,	33,	1514,	63,	2,	2,	2,
13,	9109,	1312,	373,	65,	24,	1,	822,	1,	1,	1,
+gp,	82892,	17972,	2925,	849,	523,	197,	4,	249,	4,	4,
TOTAL,	1970948,	1373351,	443265,	48460,	16855,	5667,	26723,	20572,	15122,	12415,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	83733,	56521,	19569,	47059,	29630,	37996,	79890,	8986,	14273,	23284,
4,	1012,	71350,	47562,	16901,	40728,	25418,	32974,	68857,	7593,	12113,
5,	52,	384,	60443,	40625,	14666,	35218,	21890,	28216,	58480,	6163,
6,	1135,	46,	306,	51173,	35030,	12665,	30120,	18799,	23885,	45595,
7,	5413,	996,	40,	188,	43885,	29996,	10915,	25863,	15929,	19270,
8,	8,	3532,	836,	35,	134,	37053,	25917,	9401,	22071,	12805,
9,	5,	7,	2097,	676,	31,	77,	31761,	22282,	8134,	17920,
10,	4,	4,	6,	1373,	593,	26,	35,	27323,	19135,	6467,
11,	2,	4,	4,	5,	968,	521,	13,	20,	23306,	15274,
12,	2,	2,	3,	3,	4,	600,	447,	8,	4,	19859,
13,	1,	1,	1,	3,	3,	4,	436,	389,	4,	4,
+gp,	4,	4,	4,	8,	8,	11,	11,	2349,	5966,	9523,
TOTAL,	91372,	132851,	130872,	158049,	165681,	179584,	234409,	212493,	198780,	188278,

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE											
3,	2977369,	203809,	162283,	29952,	30823,	278996,	676117,	848270,	2161053,	2396084,	0,
4,	18435,	2563879,	177112,	136611,	26030,	25322,	244195,	592517,	742202,	1892130,	2098611,
5,	9188,	14542,	2204390,	153175,	119618,	22608,	19872,	211328,	510281,	634064,	1629060,
6,	3872,	6712,	11024,	1884143,	133973,	103924,	17838,	15346,	177398,	408280,	498772,
7,	27911,	1957,	5566,	8796,	1624097,	116625,	81264,	14066,	11427,	140641,	299152,
8,	11420,	14730,	1061,	4544,	7399,	1404926,	91874,	63502,	10852,	7784,	102024,
9,	6127,	3091,	10319,	379,	3915,	6376,	1096803,	72486,	47824,	7942,	5393,
10,	9866,	1500,	1597,	7698,	269,	3295,	4844,	851384,	55936,	35012,	5503,
11,	4744,	1578,	438,	579,	6451,	49,	2577,	3628,	640017,	41612,	24257,
12,	10517,	2354,	966,	124,	380,	5438,	31,	1991,	2883,	457931,	28829,
13,	12771,	3125,	1337,	536,	45,	274,	4260,	3,	1582,	2040,	317259,
+gp,	394,	3584,	1051,	434,	271,	2118,	10,	10,	7454,	352,	1657,
TOTAL,	3092614,	2820861,	2577144,	2226969,	1953270,	1969952,	2239686,	2674532,	4368909,	6023873,	5010518,

Table 3.5.9

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	101614,	66193,	28235,	463352,	74560,	32929,
4,	73710,	171449,	84407,	48344,	791560,	119108,
5,	83394,	66900,	156585,	79812,	45458,	676102,
6,	190650,	74429,	59155,	133793,	73032,	40367,
7,	159490,	161347,	64233,	50909,	113944,	61138,
8,	38983,	126539,	131221,	52260,	43559,	89305,
9,	55498,	32703,	96512,	106923,	43721,	35441,
10,	42630,	46271,	26545,	73982,	84990,	32687,
11,	36742,	34202,	38205,	20968,	53241,	61558,
12,	205308,	29150,	26461,	30452,	16268,	32115,
13,	129897,	174158,	22226,	19862,	23881,	11519,
+gp,	153792,	502292,	165002,	186265,	236456,	138975,
TOTALBIO,	1271707,	1485636,	898787,	1266922,	1600669,	1331243,

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	31647,	5893,	4969,	1705,	2520,	2391,	211040,	72447,	21347,	1987,
4,	55767,	35216,	9807,	8309,	2681,	2404,	3833,	301285,	106185,	31871,
5,	113857,	47570,	45087,	9907,	8704,	2381,	2352,	3587,	279192,	85503,
6,	626598,	100187,	47779,	38622,	9055,	7266,	2321,	1941,	3061,	219189,
7,	33488,	500194,	92555,	38050,	33133,	7329,	6264,	1850,	1731,	2241,
8,	49876,	27155,	423115,	74834,	32496,	26601,	6121,	4945,	1714,	1639,
9,	72322,	38976,	22315,	347969,	60548,	25683,	22459,	4906,	3927,	1311,
10,	28716,	55988,	30610,	17588,	278579,	46200,	21180,	17790,	4163,	2661,
11,	22959,	21338,	44437,	23233,	13564,	203778,	37089,	16720,	12563,	2691,
12,	44290,	13860,	16257,	31767,	17271,	8865,	158295,	28875,	11880,	8114,
13,	21847,	30361,	8511,	10769,	23619,	10803,	6035,	112206,	19567,	8046,
+gp,	89606,	88526,	37578,	39798,	35529,	30260,	29073,	34905,	148714,	77538,
TOTALBIO,	1190972,	965264,	783018,	642551,	517698,	373960,	506062,	601457,	614043,	442791,

Table 3.5.9 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	82717,	38018,	1077,	2283,	160,	75,	3617,	354,	16,	272,
4,	1613,	93011,	22589,	42,	529,	149,	74,	4628,	416,	19,
5,	26815,	1131,	29783,	256,	65,	107,	83,	38,	4561,	475,
6,	69615,	16574,	479,	302,	161,	37,	63,	73,	14,	3617,
7,	146760,	39886,	3932,	77,	154,	81,	23,	15,	11,	4,
8,	1699,	70222,	6489,	1117,	49,	42,	42,	9,	3,	3,
9,	878,	419,	13616,	2453,	658,	12,	7,	1,	1,	2,
10,	947,	341,	104,	3013,	1207,	169,	1,	1,	1,	1,
11,	1711,	242,	57,	24,	1572,	265,	18,	1,	1,	1,
12,	1031,	492,	59,	18,	13,	522,	22,	1,	1,	1,
13,	3443,	483,	152,	24,	9,	0,	292,	1,	1,	1,
+gp,	31539,	7489,	1110,	337,	204,	76,	2,	125,	2,	2,
TOTALBIO,	368767,	268308,	79447,	9946,	4781,	1537,	4244,	5247,	5028,	4398,

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	15156,	10230,	3522,	8377,	5185,	6459,	13581,	1393,	1998,	3446,
4,	262,	18480,	13983,	3921,	11526,	5694,	6727,	17145,	1549,	2835,
5,	18,	132,	19704,	14585,	5089,	11833,	6633,	8578,	17251,	1633,
6,	436,	18,	114,	19702,	14082,	4787,	10693,	6918,	8073,	14226,
7,	2214,	407,	16,	79,	18476,	11608,	4180,	10449,	5989,	6668,
8,	3,	1568,	385,	16,	62,	15118,	10237,	3986,	8718,	4738,
9,	2,	3,	998,	341,	14,	31,	13117,	9737,	3310,	7079,
10,	2,	2,	3,	714,	308,	14,	16,	11913,	7903,	2568,
11,	1,	2,	2,	3,	517,	283,	6,	10,	9835,	6537,
12,	1,	1,	2,	2,	2,	307,	226,	4,	2,	8499,
13,	1,	1,	1,	1,	1,	2,	221,	192,	2,	2,
+gp,	2,	2,	2,	4,	4,	6,	5,	1163,	2607,	4076,
TOTALBIO,	18098,	30846,	38733,	47743,	55268,	56141,	65643,	71488,	67238,	62305,

Table 12 Stock biomass at age (start of year) Tonnes*10**-1

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	160778,	18343,	15904,	4613,	6750,	41012,	86543,	68710,	162079,	158142,
4,	3798,	366635,	23910,	23907,	5154,	5318,	54700,	119096,	112072,	261114,
5,	2435,	3505,	434265,	32014,	30861,	5516,	5882,	56002,	129611,	145835,
6,	1119,	1873,	3054,	474804,	38584,	31177,	5833,	4957,	56413,	120851,
7,	9462,	585,	1753,	2683,	501846,	37786,	28849,	4980,	4239,	48662,
8,	4202,	4655,	360,	1668,	3167,	472055,	31696,	22734,	3766,	3020,
9,	2396,	1057,	3539,	143,	1448,	2187,	402527,	27617,	19704,	2883,
10,	3769,	514,	573,	2763,	108,	1259,	1652,	314161,	21368,	14320,
11,	1841,	571,	160,	229,	2496,	18,	930,	1437,	260487,	17227,
12,	4154,	885,	363,	49,	167,	2311,	13,	782,	1182,	193247,
13,	5045,	1175,	503,	212,	20,	116,	2002,	1,	649,	836,
+gp,	156,	1348,	395,	172,	119,	900,	5,	4,	3056,	153,
TOTALBIO,	199154,	401145,	484779,	543255,	590722,	599657,	620632,	620480,	774625,	966289,

Table 3.5.10

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,
AGE						
3,	0,	0,	0,	0,	0,	2584,
4,	7213,	16788,	8294,	4747,	77582,	25659,
5,	24481,	19621,	45768,	23488,	13312,	244416,
6,	111651,	43673,	34701,	78403,	42723,	33489,
7,	139514,	141489,	56330,	44870,	99551,	59588,
8,	38112,	122538,	127915,	51078,	42455,	87001,
9,	54322,	31925,	93678,	104160,	42330,	34591,
10,	41571,	45251,	25845,	71364,	82036,	31454,
11,	35847,	33285,	37291,	20411,	50540,	59474,
12,	201356,	28286,	25636,	29632,	15669,	30809,
13,	126437,	170454,	21453,	19177,	23110,	11104,
+gp,	149695,	491608,	159263,	179840,	228826,	133967,
TOTSPBIO,	930198,	1144918,	636173,	627171,	718135,	754135,

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR,	1956,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,
AGE										
3,	2481,	0,	390,	133,	184,	93,	0,	2818,	418,	0,
4,	11947,	0,	2115,	1786,	571,	821,	413,	8844,	6219,	10478,
5,	41165,	23214,	16308,	3581,	3138,	1586,	1544,	1125,	75526,	28998,
6,	518099,	58775,	39725,	31945,	7508,	6676,	2260,	1714,	951,	159178,
7,	32619,	486422,	90457,	37075,	32294,	7148,	6093,	1808,	1698,	2144,
8,	48416,	26493,	413260,	72840,	31721,	25972,	5982,	4799,	1675,	1543,
9,	70267,	37923,	21719,	338686,	58859,	25101,	21888,	4795,	3759,	1260,
10,	27788,	54455,	29684,	16987,	269920,	44978,	20649,	17082,	3973,	2532,
11,	21796,	20672,	42970,	22394,	12999,	197908,	36057,	16084,	11947,	2432,
12,	42522,	13142,	15601,	30489,	16442,	8523,	152623,	27694,	11334,	7447,
13,	20823,	29290,	8038,	10225,	22557,	10447,	5752,	106521,	18575,	7302,
+gp,	85407,	85404,	35489,	37789,	33932,	29263,	27710,	33136,	141179,	70370,
TOTSPBIO,	923331,	835791,	715756,	603929,	490124,	358516,	280971,	226421,	277254,	293686,

Table 3.5.10 (cont)

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995

At 2/05/1996 10:44

Traditional vpa using screen input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,
AGE										
3,	789,	0,	0,	1136,	9,	7,	0,	173,	8,	131,
4,	229,	819,	0,	36,	58,	36,	6,	4045,	369,	18,
5,	25035,	235,	183,	222,	19,	61,	19,	34,	4405,	466,
6,	61984,	14321,	300,	280,	25,	32,	31,	60,	13,	3422,
7,	134084,	33213,	3431,	73,	136,	76,	18,	12,	10,	4,
8,	1469,	59783,	5819,	1054,	43,	35,	28,	7,	3,	3,
9,	785,	362,	11582,	2273,	574,	9,	6,	1,	1,	2,
10,	816,	292,	90,	2814,	1034,	135,	1,	1,	1,	1,
11,	1520,	214,	50,	22,	1401,	206,	13,	1,	1,	1,
12,	959,	433,	54,	17,	9,	491,	15,	1,	1,	1,
13,	2879,	418,	132,	22,	8,	0,	286,	1,	1,	1,
+gp,	26370,	6485,	964,	318,	189,	74,	2,	122,	2,	2,
TOTSPBIO,	256920,	116577,	22604,	8267,	3506,	1164,	423,	4459,	4814,	4051,

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,
AGE										
3,	7458,	7340,	451,	826,	1277,	1911,	1338,	137,	197,	337,
4,	214,	16176,	12388,	2397,	5680,	2805,	3179,	8434,	758,	1379,
5,	18,	129,	19379,	13652,	4865,	10485,	4573,	5821,	15145,	1403,
6,	430,	17,	108,	19401,	13865,	4717,	10531,	4831,	7507,	13544,
7,	2121,	400,	16,	76,	18166,	11440,	4118,	10284,	5860,	6328,
8,	3,	1489,	377,	15,	59,	14886,	10084,	3929,	8538,	4401,
9,	2,	3,	957,	337,	14,	28,	12921,	9590,	3235,	6668,
10,	2,	2,	3,	689,	304,	13,	15,	11725,	7727,	2489,
11,	1,	2,	2,	3,	493,	278,	6,	8,	9679,	6298,
12,	1,	1,	2,	2,	2,	297,	223,	4,	2,	8132,
13,	1,	1,	1,	1,	1,	2,	217,	189,	2,	2,
+gp,	2,	2,	2,	4,	4,	5,	5,	1143,	2566,	4011,
TOTSPBIO,	10253,	25562,	33686,	37403,	44730,	46867,	47211,	56095,	61215,	54992,

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1

YEAR,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,
AGE										
3,	15839,	1809,	1563,	455,	2648,	4047,	8541,	678,	1599,	0,
4,	742,	108341,	7070,	7077,	4065,	3633,	10783,	35199,	33096,	2572,
5,	2124,	3068,	384751,	28429,	27387,	5387,	4586,	44024,	101402,	113901,
6,	1045,	1838,	2985,	467804,	34248,	30420,	5696,	4813,	55118,	117150,
7,	8876,	550,	1718,	2637,	445161,	36896,	28146,	4852,	4080,	47125,
8,	3688,	4492,	325,	1643,	3120,	460511,	30954,	22098,	3650,	2911,
9,	2081,	990,	3437,	138,	1424,	2128,	392459,	26910,	19099,	2779,
10,	3138,	455,	518,	2715,	91,	1228,	1605,	305322,	20745,	13804,
11,	1716,	544,	141,	219,	2454,	17,	907,	1404,	251911,	16607,
12,	3680,	836,	342,	44,	162,	2255,	11,	765,	1142,	186283,
13,	4470,	1131,	484,	208,	19,	113,	1950,	1,	632,	806,
+gp,	138,	1297,	381,	168,	111,	876,	5,	4,	2977,	147,
TOTSPBIO,	47536,	125352,	403715,	511538,	520890,	547512,	485641,	446071,	495450,	504086,

Table 3.5.11

Run title : Herring Spring-Spawn file 0: VPA for the years 1950-1995 ,

At 2/05/1996 10:44

Table 16 Summary (without SOP correction)

Traditional vpa using screen input for terminal F

	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-12,	FWEI5-12,
1950,	10161361,	12717074,	9301980,	933000,	.1003,	.0746,	.0753,
1951,	6619283,	14856356,	11449182,	1278400,	.1117,	.0984,	.1016,
1952,	2823487,	8987874,	6361726,	1254800,	.1972,	.1056,	.1023,
1953,	46335240,	12669215,	6271712,	1090600,	.1739,	.0938,	.0873,
1954,	7455963,	16006693,	7181346,	1644500,	.2290,	.1676,	.1549,
1955,	3292924,	13312432,	7541355,	1359800,	.1803,	.1375,	.0887,
1956,	3164693,	11909724,	9233314,	1659400,	.1797,	.1664,	.1219,
1957,	589342,	9652640,	8357909,	1319500,	.1579,	.1393,	.1126,
1958,	496878,	7830179,	7157555,	986600,	.1378,	.1196,	.0859,
1959,	170516,	6425511,	6039292,	1111100,	.1840,	.1441,	.1219,
1960,	252019,	5176980,	4901235,	1101800,	.2248,	.1552,	.1478,
1961,	239093,	3739599,	3585156,	830100,	.2315,	.1034,	.1187,
1962,	21103996,	5060620,	2809710,	848600,	.3020,	.1068,	.1662,
1963,	7244674,	6014567,	2264207,	984500,	.4348,	.1351,	.2064,
1964,	2134705,	6140428,	2772540,	1281800,	.4623,	.2074,	.1918,
1965,	198742,	4427911,	2936860,	1547700,	.5270,	.4115,	.2617,
1966,	8271676,	3687673,	2569195,	1955000,	.7609,	.8800,	.6782,
1967,	3801775,	2683082,	1165765,	1677200,	1.4387,	1.2710,	1.4924,
1968,	107714,	794469,	226042,	712200,	3.1507,	1.6518,	3.4057,
1969,	228262,	99459,	82671,	67800,	.8201,	.5550,	.5544,
1970,	15970,	47808,	35061,	62300,	1.7769,	1.2386,	1.1302,
1971,	7542,	15374,	11643,	21100,	1.8122,	1.3180,	1.1331,
1972,	241153,	42435,	4229,	13161,	3.1118,	2.1801,	1.8598,
1973,	20853,	52466,	44585,	7017,	.1574,	.8174,	1.4960,
1974,	943,	50284,	48137,	7619,	.1583,	.3877,	.2227,
1975,	15004,	43977,	40513,	13713,	.3385,	.0972,	.3780,
1976,	837334,	180981,	102533,	10436,	.1018,	.0598,	.2429,
1977,	565212,	308458,	255624,	22706,	.0888,	.0840,	.2945,
1978,	195692,	387332,	336861,	19824,	.0588,	.1071,	.0471,
1979,	470591,	477429,	374026,	12864,	.0344,	.0655,	.0243,
1980,	296299,	552680,	447299,	18577,	.0415,	.1141,	.0340,
1981,	379963,	561409,	468670,	13736,	.0293,	.1850,	.0235,
1982,	798897,	656427,	472107,	16655,	.0353,	.1139,	.0214,
1983,	89861,	714876,	560950,	23054,	.0411,	.2867,	.0296,
1984,	142729,	672383,	612150,	53532,	.0874,	.0776,	.0904,
1985,	232843,	623051,	549922,	169872,	.3089,	.3621,	.3717,
1986,	29773684,	1991536,	475358,	225256,	.4739,	.8821,	.8393,
1987,	2038086,	4011454,	1253517,	127306,	.1016,	.4176,	.2514,
1988,	1622832,	4847788,	4037154,	135301,	.0335,	.4672,	.0295,
1989,	299520,	5432552,	5115381,	103830,	.0203,	.1878,	.0178,
1990,	308227,	5907221,	5208901,	86411,	.0166,	.2392,	.0147,
1991,	2789965,	5996568,	5475119,	84683,	.0155,	.0432,	.0168,
1992,	6761171,	6206321,	4856413,	104448,	.0215,	.2672,	.0218,
1993,	8482695,	6204801,	4460709,	232457,	.0521,	.0347,	.0516,
1994,	21610530,	7746252,	4954501,	479228,	.0967,	.0999,	.0983,
1995,	23960842,	9662890,	5040857,	902226,	.1790,	.2084,	.1736,
Arith. Mean ,	4927190,	4686679,	3205456,	578515,	.4173,	.3710,	.2667,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 3.5.12 Input data to the prediction

Weight in catch (g)			Weight in stock (g)		Maturity ogive	
Age	1996	1997-	1996	1997-	1996	1997-
3	0.121	0.089	0.076	0.100	0	0.02
4	0.179	0.165	0.118	0.182	0.01	0.14
5	0.240	0.246	0.188	0.227	0.45	0.39
6	0.295	0.306	0.261	0.270	1	0.83
7	0.334	0.337	0.316	0.289	1	1
8	0.347	0.344	0.346	0.318	1	1
9	0.362	0.367	0.374	0.327	1	1
10	0.381	0.388	0.390	0.350	1	1
11	0.386	0.398	0.390	0.354	1	1
12	0.399	0.405	0.384	0.359	1	1
13	0.396	0.405	0.398	0.361	1	1
14+	0.403	0.405	0.398	0.361	1	1

Age	Stock size in 1996 (thousands)	Fpattern all years	Recruitment age 3 (thousands)	
3	5600000	0.0042	1997	5600000
4	20986110	0.0419	1998	5000
5	16290600	0.1736	Proportion of F and M before	
6	4987720	0.1736	spawning equal to 0.1 in all years	
7	2991520	0.1736		
8	1020240	0.1736		
9	53930	0.1736		
10	55030	0.1736		
11	242570	0.1736		
12	288290	0.1736		
13	3172590	0.1736		
14+	16570	0.1736		

Table 3.5.13 Management option table - Norwegian Spring-Spawning Herring.

Year	1996				1997					1998	
F factor	Ref F	Stock B	SSB	Catch	F factor	Ref F	Stock B	SSB	Catch	Stock B	SSB
1.0141	0.1761	10080935	5353251	1400000	0.0000	0.0000	11247841	7306887	0	11125222	9576104
					0.1000	0.0174		7294378	187652	10948747	9400198
					0.2000	0.0347		7281890	372186	10775255	9227590
					0.3000	0.0521		7269425	553654	10604696	9058218
					0.4000	0.0694		7256981	732107	10437018	8892021
					0.5000	0.0868		7244558	907599	10272172	8728939
					0.6000	0.1042		7232157	1080178	10110110	8568913
					0.7000	0.1215		7219777	1249894	9950784	8411885
					0.8000	0.1389		7207419	1416795	9794148	8257800
					0.9000	0.1562		7195082	1580930	9640154	8106601
					1.0000	0.1736		7182766	1742345	9488759	7958234
					1.1000	0.1910		7170472	1901086	9339917	7812645
					1.2000	0.2083		7158199	2057198	9193584	7669783
					1.3000	0.2257		7145947	2210727	9049719	7529596
					1.4000	0.2430		7133716	2361716	8908277	7392034
					1.5000	0.2604		7121507	2510208	8769219	7374164

Table 3.6.1. Medium-term simulation results 1 (simple model): Expected values and standard errors for different values of Qmax and overallocation. F=0.1, future selection pattern and weights as in '95 long-term pred. Recruitment variation only enters through annual variability around fixed Ricker curve.

	Q_{max}	1000	1500	1000	1500	1000	1500	1000	1500
	p	Prob		Yave		SSB06		Y06	
Average	1.00	0.24	0.29	586	627	3520	3327	439	427
	1.25	0.46	0.49	687	727	2946	2764	470	448
	1.50	0.61	0.68	773	812	2463	2295	479	451
St. d.	1.00	0.43	0.45	139	183	1619	1421	251	262
	1.25	0.50	0.50	171	216	1468	1267	295	287
	1.50	0.49	0.47	200	246	1322	1131	324	302

Prob =Probability of SSB being below 2.5 million tonnes in 2006.
Yave =Average yield, 1997-2006.
SSB06 =SSB in 2006.
Y06 =Yield in 2006.

Table 3.6.2. Medium-term simulation results 2 (simple model): Expected values and standard errors for different values of Qmax and overallocation. F=0.1, future selection pattern and weights as in '95 long-term pred. Recruitment variation enters through annual variability and uncertain Ricker curve.

	Q_{max}	1000	1500	1000	1500	1000	1500	1000	1500
	p	Prob		Yave		SSB06		Y06	
Average	1.00	0.29	0.33	590	633	3642	3422	450	437
	1.25	0.45	0.50	693	735	3041	2839	479	459
	1.50	0.60	0.66	780	820	2534	2354	487	464
St. d.	1.00	0.45	0.47	150	191	1751	1570	258	275
	1.25	0.50	0.50	184	224	1560	1392	297	309
	1.50	0.49	0.47	213	253	1383	1235	322	333

Prob =Probability of SSB being below 2.5 million tonnes in 2006.
Yave =Average yield, 1997-2006.
SSB06 =SSB in 2006.
Y06 =Yield in 2006.

Table 4.2.1 Barents Sea CAPELIN. International catch ('000 t) as used by the Working Group.

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	13	360	1592
1973	1078	34	0	1111	213	12	225	1336
1974	749	63	0	812	237	99	336	1149
1975	559	301	43	903	407	131	538	1440
1976	1252	228	0	1480	739	368	1107	2587
1977	1441	317	2	1760	722	504	1227	2987
1978	784	429	25	1237	360	318	678	1915
1979	539	342	5	886	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	429	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	373	36	1161	758	439	1197	2358
1984	330	257	42	629	481	368	849	1478
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	159	20	707	31	195	226	933
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0				

Table 4.3.1 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. August.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	11.1	48.8	20.9	181.4	700.1	405.0	395.2	3.1	27.0	8.3
2	5.0	2.2	30.1	18.9	177.5	596.1	223.9	73.1	4.7	9.4
3	4.3	0.1	0.3	1.5	16.6	34.1	147.6	23.7	5.9	1.8
4	0.2	0.0	0.0	0.0	0.2	1.3	1.5	3.3	0.2	0.4
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	20.6	51.2	51.2	201.8	894.4	1036.5	768.2	103.1	37.9	19.9
Biomass	106	73	188	478	2931	4623	3654	704	164	129

Table 4.3.2 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the spring season.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.4	0.3	0.5	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	24.1	23.8	4.8	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	8.3	17.2	26.9	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	2.8	2.1	1.4	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.0	35.6	43.5	33.6	0.0	0.0	0.0
Landings	0	0	0	0	707	891	586	0	0	0

Table 4.3.3 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.0	0.0	0.0	0.0	0.0	2.2	0.9	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	9.3	5.8	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	3.1	7.9	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.9	0.8	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.0	0.0	15.5	15.3	0.0	0.0	0.0
Landings	0	0	0	0	0	226	232	0	0	0

Table 4.3.4 Barents Sea CAPELIN. Fishing mortality coefficients by age group and weighted average for age groups 2-4 in the autumn fishing season.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.10	0.06	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	0.00	1.19	0.85	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00
Avr (2-4)	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00

Table 4.3.5 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (M_{imm}), used for the whole year, and for mature fish (per season) (M_{mat}) used January to March, by age group and average for age groups 1-5.

	1986		1987		1988		1989		1990	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000
2	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000
3	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000
4	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000
5	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000
Avr	0.195	0.585	0.134	0.402	0.022	0.066	0.010	0.030	0.000	0.000

Table 4.3.5 (Continued)

	1991		1992		1993		1994		1995	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224
2	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224
3	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224
4	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224
5	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224
Avr	0.016	0.048	0.058	0.174	0.157	0.471	0.157	0.471	0.075	0.224

Table 4.3.6 Barents Sea CAPELIN. Estimated stock size in numbers (unit: 10^9) by age group and total, and biomass ('000 t) of total stock, by 1. January.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	43.3	124.7	24.4	194.5	700.6	453.0	593.1	9.2	81.2	13.9
2	26.0	4.2	25.0	18.7	172.5	699.8	371.8	294.9	1.4	12.3
3	32.8	1.9	1.1	26.9	18.0	177.4	541.4	162.6	33.3	2.1
4	12.1	1.6	0.1	0.2	1.4	16.6	28.5	103.7	10.8	2.7
5	0.2	0.1	0.0	0.0	0.0	0.1	0.4	0.5	1.5	0.1
Sum	114.4	132.5	50.6	240.4	892.6	1346.9	1535.0	570.9	128.2	31.2
Biomass	669	174	108	706	1997	7090	8134	4645	690	174

Table 4.3.7 Barents Sea CAPELIN. Mean weight (g) by age group and weighted average for the whole stock by 1. January.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	1.70	0.83	1.39	1.37	1.52	1.49	1.42	1.38	1.76	2.66
2	4.70	4.67	2.29	3.83	3.76	4.19	4.09	3.91	3.78	4.84
3	9.07	12.81	13.48	13.52	13.65	16.85	9.52	9.47	9.94	12.32
4	14.26	15.74	15.71	18.92	25.09	29.82	21.21	18.55	16.63	18.15
5	17.22	17.60	36.66	22.00	25.14	21.56	33.06	32.45	20.58	20.24
Avr	5.85	1.32	2.13	2.94	2.24	5.26	5.30	8.14	5.38	5.58

Table 4.3.8 Barents Sea CAPELIN. Estimated proportion of maturing stock by 1. January.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04
3	0.46	0.65	0.41	0.48	0.65	0.15	0.12	0.11	0.43	0.58
4	0.85	0.82	0.72	1.00	1.00	0.89	0.74	0.71	0.87	0.93
5	1.00	1.00	1.00	0.77	1.00	0.96	1.00	0.92	0.88	1.00
Avr	0.02	0.02	0.05	0.01	0.10	0.07	0.17	0.10	0.11	0.40

Table 4.3.9 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0	0	0	0	0	0	0	0	0	0
2	0	0	0	1	17	0	0	0	1	2
3	11	12	195	156	1600	939	132	37	13	48
4	19	1	3	30	177	134	532	105	41	19
5	1	0	0	0	0	0	0	22	2	5
Sum	31	13	198	187	1794	1072	663	165	57	74

Table 4.3.10 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish (unit:10^9) and stock biomass ('000 t) given at 1. August, spawning stock ('000 t) at time of spawning (1. April next year). Landings ('000 t) are the sum of the total landings in the season starting in the autumn of the year indicated and those in the following spring season.

Year	Recruit-ment	Total stock biomass	Landings	Spawning stock biomass
1973	1175	4480	1037	389
1974	762	5576	1239	95
1975	510	6639	2018	1147
1976	447	5740	2867	919
1977	789	4598	2464	475
1978	857	4406	1565	579
1979	553	4375	1697	21
1980	592	5607	2087	1654
1981	487	3348	1579	505
1982	574	2686	2088	25
1983	613	3019	1826	150
1984	174	2310	1439	102
1985	43	746	401	13
1986	11	106	0	31
1987	49	73	0	13
1988	21	188	0	198
1989	181	478	0	187
1990	700	2931	707	1794
1991	405	4623	1117	1072
1992	395	3654	817	663
1993	3	704	0	165
1994	27	164	0	57
1995	8	129	0	74

Table 5.1.1 Capelin in the Iceland-Greenland -Jan Mayen area. Preliminary TACs for the summer/autumn fishery, recommended TACs for the whole season, landings and remaining spawning stock in the 1984/85-1995/96 seasons.

Season	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96
Prelim. TAC	300	700	1100	500	900	900	600	0	500	900	950	800
Rec. TAC	920	1280	1290	1115	1065	-	250	740	900	1250	850	1390
Landings	897	1311	1333	1116	1036	808	314	677	788	1179	842	930
Spawn. stock	460	460	420	400	445	115	330	475	460	460	420	830

Table 5.2.1 Capelin in the Iceland-Greenland -Jan Mayen area. The international capelin catch 1964 - 1996 (thousand tonnes)

	Winter season				Summer- and autumn season					Total
Year	Iceland	Norway	Faroes	Total	Iceland	Norway	Faroes	Others	Total	
1964	8.6	-	-	8.6	-	-	-	-	-	8.6
1965	49.7	-	-	49.7	-	-	-	-	-	49.7
1966	124.5	-	-	124.5	-	-	-	-	-	124.5
1967	97.2	-	-	97.2	-	-	-	-	-	97.2
1968	78.1	-	-	78.1	-	-	-	-	-	78.1
1969	170.6	-	-	170.6	-	-	-	-	-	170.6
1970	190.8	-	-	190.8	-	-	-	-	-	190.8
1971	182.9	-	-	182.9	-	-	-	-	-	182.9
1972	276.5	-	-	276.5		-	-	-	-	276.5
1973	440.9	-	-	440.9	-	-	-	-	-	440.9
1974	461.9	-	-	461.9	-	-	-	-	-	461.9
1975	457.1	-	-	457.1	3.1	-	-	-	3.1	460.2
1976	338.7	-	-	338.7	114.4	-	-	-	114.4	453.1
1977	549.2	-	24.3	573.5	259.7	-	-	-	259.7	833.2
1978	468.4	-	36.2	504.6	497.5	154.1	3.4	-	655.0	1,159.6
1979	521.7	-	18.2	539.9	442.0	124.0	22.0	-	588.0	1,127.9
1980	392.1	-	-	392.1	367.4	118.7	24.2	17.3	527.6	919.7
1981	156.0	-	-	156.0	484.6	91.4	16.2	20.8	613.0	769.0
1982	13.2	-	-	13.2	-	-	-	-	-	13.2
1983	-	-	-	-	133.4	-	-	-	133.4	133.4
1984	439.6	-	-	439.6	425.2	104.6	10.2	8.5	548.5	988.1
1985	348.5	-	-	348.5	644.8	193.0	65.9	16.0	919.7	1,268.2
1986	341.8	50.0	-	391.8	552.5	149.7	65.4	5.3	772.9	1,164.7
1987	500.6	59.9	-	560.5	311.3	82.1	65.2	-	458.6	1,019.1
1988	600.6	56.6	-	657.2	311.4	11.5	48.5	-	371.4	1,028.6
1989	609.1	56.0	-	665.1	53.9	52.7	14.4	-	121.0	786,1
1990	612.0	62.5	12.3	686,8	83.7	21.9	5.6	-	111.2	798.0
1991	202.4	-	-	202.4	56.0	-	-	-	56.0	258.4
1992	573.5	47.6	-	621.1	213.4	65.3	18.9	*0.5	298.1	919.2
1993	489.1	-	*0.5	489.6	450.0	127.5	23.9	*10.2	611.6	1,101.2
1994	550.3	15.0	*1.8	567.1	210.7	99.0	12.3	*2.1	324.1	891.2
1995	539.4	-	*0.4	539.8	175.5	28.0	-	*2.2	205.7	745.5
1996	707.9	-	**15.7	723.6						

* Greenlandic vessel

** Faroes and Greenland

Table 5.2.2 Capelin in the Iceland-Greenland -Jan Mayen area. The total international catch of capelin in the Iceland-Greenland-Jan Mayen area by age groups in numbers (billions) and the total catch by numbers and weight (thous. tonnes) the autum season (August-December) 1978 - 1995

	Year								
Age	1978	1979	1980	1981	1982	1983	1984	1985	1986
1	-	0.6	4.9	0.6	-	0.6	0.5	0.8	+
2	21.4	29.4	17.2	27.9	-	7.2	9.8	25.6	10.0
3	12.2	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3
4	-	-	-	+	-	-	0.1	0.2	0.5
Total number	33.6	36.1	27.5	30.5	-	8.6	18.2	42.0	33.8
Total weight	655.0	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9

	Year								
Age	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	+	0.3	1.7	0.8	0.3	1.7	0.2	0.6	1.5
2	27.7	13.6	6.0	5.9	2.7	14.0	24.9	15.0	9.7
3	6.7	5.4	1.5	1.0	0.4	2.1	5.4	2.8	1.1
4	+	+	+	+	+	+	0.2	+	+
Total number	34.4	19.3	9.2	7.7	3.4	17.8	30.7	18.4	12.3
Total weight	458.6	371.4	121.0	111.2	56.0	298.1	611.6	324.1	205.7

Table 5.2.3 Capelin in the Iceland-Greenland -Jan Mayen area. The total international catch of capelin in the Iceland-Greenland-Jan Mayen area by age groups in numbers (billions) and the total catch by numbers and weight (thous. tonnes) the winter season (January-March) 1979 - 1996.

	Year								
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987
2	1.0	1.3	1.7	-	-	2.1	0.4	0.1	+
3	20.8	17.6	7.1	0.8	-	18.1	9.1	9.8	6.9
4	4.8	3.5	1.9	0.1	-	3.4	5.4	6.9	15.5
5	0.1	-	-	-	-	-	-	0.2	-
Total number	26.7	22.4	10.7	0.9	-	23.6	14.5	17.0	22.4
Total weight	539.9	392.1	156.0	13.2	-	439.6	348.5	391.8	560.5

	Year								
Age	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	+	0.1	1.4	0.5	2.7	0.2	0.6	1.3	0.6
3	23.4	22.9	24.8	7.4	29.4	20.1	22.7	17.6	27.4
4	7.2	7.8	9.6	1.5	2.8	2.5	3.9	5.9	7.7
5	0.3	+	0.1	+	+	+	+	+	+
Total number	30.9	30.8	35.9	9.4	34.9	22.8	27.2	24.8	35.7
Total weight	657.2	665.1	686.8	202.4	621.1	489.6	567.1	539.8	723.6

Table 5.2.4 Capelin in the Iceland-Greenland -Jan Mayen area. The total international catch in numbers (millions) of capelin in the Iceland-east Greenland-Jan Mayen area in the summer/autumn season of 1995 by age and length, and the catch in weight ('000 t) by age groups.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
07 - 08	67	-	-		67	0.6
08 - 09	267	-	-		267	2.2
09 - 10	170	-	-		170	1.4
10 - 11	80	4	-		84	0.7
11 - 12	102	30	-	-	132	1.1
12 - 13	401	463	-	-	864	7.1
13 - 14	264	1316	12	-	1592	13.1
14 - 15	75	2055	100	-	2230	18.1
15 - 16	20	2829	284	-	3133	25.7
16 - 17	10	2124	380	-	2514	20.6
17 - 18	5	755	224	-	984	8.1
18 - 19	-	75	56	-	136	1.1
19 - 20	-	1	-	-	1	+
Total	1461	9660	1057	-	12178	
%	12.0	79.3	8.7	-		100.0
Weight ('000 t)	13.8	169.1	22.4	-	205.3	

Table 5.2.5 Capelin in the Iceland-Greenland -Jan Mayen area. The total international catch in numbers (millions) of capelin in the Iceland-east Greenland-Jan Mayen area in the winter season of 1996 by age and length, and the catch in weight ('000 t) by age groups.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Precentage
10 - 11	38	-	-	-	38	0.1
11 - 12	43	5	-	-	48	0.1
12 - 13	48	151	5	-	204	0.6
13 - 14	77	1159	16	-	1252	3.5
14 - 15	250	4413	144	-	4807	13.5
15 - 16	106	6408	1066	-	7580	21.2
16 - 17	5	7635	2015	14	9670	27.1
17 - 18	-	5787	2580	14	8381	23.5
18 - 19	-	1734	1695	14	3443	9.6
19 - 20	-	160	139	14	263	0.7
20 - 21	-	-	6	-	6	+
Total	567	27403	7666	57	35692	
%	1.5	77.0	21.5	+		100.0
Weight ('000 t)	6.3	534.6	183.2	1.4	725.4	

Table 5.3.1 Capelin in the Iceland-Greenland -Jan Mayen area. Abundance indices of 0-group capelin 1970-1995 and their division by areas.

Area	Year												
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
NW-Irminger Sea	1	+	+	14	26	3	2	+	4	3	10	+	+
W-Iceland	8	7	37	39	44	37	5	2	19	18	13	8	3
N-Iceland	2	12	52	46	57	46	10	29	25	19	6	5	18
East Iceland	-	+	17	7	3	15	+	1	1	-	+	1	1
Total	11	19	89	116	134	89	32	31	49	41	29	13	22

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NW-Irminger Sea	+	+	1	+	1	3	-	+	8	3	2	3	+
W-Iceland	3	2	8	16	6	22	16	7	2	11	21	9	6
N-Iceland	18	17	19	17	6	26	7	12	43	20	13	69	10
East Iceland	1	9	3	4	1	1	-	2	1	+	15	10	8
Total	22	28	31	37	14	52	23	21	54	35	51	94	24

Table 5.3.2 Capelin in the Iceland-Greenland -Jan Mayen area. Estimated numbers, mean length and weight of age 1 capelin in during the August surveys of 1982-1995.

	Year													
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Number (10^9)	119	155	286	31	71	101	147	111	36	50	87	33	85	189
Mean length (cn)	10.0	10.4	9.7	10.2	9.5	9.1	8.8	10.1	10.4	10.7	9.7	9.4	9.0	9.8
Mean weight (g)	3.4	4.2	3.6	3.8	3.3	3.0	2.6	3.4	4.0	5.1	3.4	3.0	2.8	3.4

Table 5.3.3 Capelin in the Iceland-Greenland -Jan Mayen area. Acoustic assessment of total capelin abundance of age groups 1-3, 30/10- 14/11 1995.

	Age/Year class							
Length (cm)	1 1994	2 1993	3 1992	4+ 1988	Number mature (10^9)	Total number (10^9)	Weight (10^3t)	Mean weight (g)
7.5 - 7.9	0.1	-	-	-	-	0.1	0.1	1.1
8.0 - 8.4	1.8	-	-	-	-	1.7	3.5	2.0
8.5 - 8.9	10.7	-	-	-	-	10.7	20.5	1.9
9.0 - 9.4	29.4	-	-	-	-	29.3	65.5	2.2
9.5 - 9.9	33.4	-	-	-	-	33.4	100.3	3.0
10.0 - 10.4	28.6	-	-	-	-	28.6	92.1	3.2
10.5 - 10.9	18.0	-	-	-	-	18.0	71.1	3.9
11.0 - 11.4	16.7	0.9	-	-	-	17.6	83.3	4.7
11.5 - 11.9	10.1	4.0	-	-	-	14.1	77.3	5.5
12.0 - 12.4	8.6	10.1	+	-	-	18.8	124.5	6.6
12.5 - 12.9	3.4	15.1	+	-	-	18.5	143.5	7.8
13.0 - 13.4	2.2	16.1	+	-	18.4	18.4	166.2	9.0
13.5 - 13.9	1.1	15.8	0.1	-	17.0	17.0	174.7	10.3
14.0 - 14.4	0.4	12.8	0.2	-	13.5	13.5	160.4	11.9
14.5 - 14.9	0.2	10.6	0.6	-	11.4	11.4	155.3	13.7
15.0 - 15.4	0.2	8.2	0.7	-	9.1	9.1	143.0	15.7
15.5 - 15.9	0.1	7.2	1.1	-	8.3	8.3	149.8	18.0
16.0 - 16.4	+	6.8	1.5	-	8.2	8.2	167.0	20.3
16.5 - 16.9	-	3.3	0.9	-	4.3	4.3	97.0	22.8
17.0 - 17.4	-	2.3	1.1	-	3.3	3.3	84.9	25.5
17.5 - 17.9	-	0.9	0.4	-	1.3	1.3	36.5	28.4
18.0 - 18.4	-	0.4	0.4	-	0.7	0.7	22.6	32.4
18.5 - 18.9	-	0.1	0.1	-	0.1	0.1	4.1	32.2
19.0 - 19.4	-	0.1	+	-	0.1	0.1	4.0	38.4
19.5 - 19.9	-	-	+	-	+	+	0.4	47.0
Number (10^9)	165.0	114.7	7.0	-	95.7	286.7	-	-
Weight (10^3t)	608.1	1394.6	145.0	-	1366.1	2147.7	-	-
Mean length (cm)	10.3	14.1	16.2	-	14.7	12.0	-	-
Mean weight (g)	3.7	12.2	20.8	-	14.3	7.5	-	-

Table 5.4.1 Capelin in the Iceland-Greenland -Jan Mayen area. The calculated number (billions) of capelin on 1 August 1978 - 1995 by age and maturity groups. The total number (billions) and weight (thous. tonnes) of the immature and maturing (fishable) stock components are also given.

	Year								
Age/maturity	1978	1979	1980	1981	1982	1983	1984	1985	1986
1 juvenile	163.9	60.3	65.9	49.1	147.3	125.1	252.1	99.1	157.1
2 immature	15.3	16.4	4.2	3.7	15.0	42.5	40.9	100.0	29.4
2 mature	81.9	91.3	35.4	39.7	17.1	53.7	40.7	64.6	35.6
3 mature	29.1	10.1	10.8	2.8	2.3	9.8	27.9	27.0	65.8
4 mature	0.4	0.3	+	+	+	0.1	0.4	0.4	0.7
Number immat.	179.2	76.7	70.1	52.8	162.3	167.6	293.0	199.1	176.5
Number mature	111.4	101.7	46.2	42.5	19.4	63.6	69.0	92.0	102.1
Weight immat	790	337	298	228	650	882	1343	1358	812
Weight mature	2147	1482	932	743	307	985	1270	1417	2116

	Year								
Age/maturity	1987	1988	1989	1990	1991	1992	1993	1994	1995
1 juvenile	143.5	80.8	64.2	117.8	132.9	148.4	144.5	*223.1	*184.2
2 immature	37.2	24.0	10.3	10.1	9.7	16.6	20.1	35.2	*52.3
2 mature	65.4	70.3	42.8	31.9	67.7	70.7	77.4	59.7	94.3
3 mature	20.1	24.5	15.8	6.8	6.7	6.4	10.9	13.2	24.0
4 mature	0.1	0.4	+	+	+	+	0.2	-	+
Number immat.	180.7	104.8	74.5	127.9	142.6	165.0	164.6	*258.3	*236.5
Number mature	85.6	95.2	58.6	38.7	74.4	77.1	88.5	72.9	118.3
Weight immat	832	469	307	562	764	707	678	*955	*1011
Weight mature	1540	1528	1072	680	1146	1237	1490	1101	1775

* Preliminary
** Predicted

Table 5.4.2 Capelin in the Iceland-Greenland -Jan Mayen area. The calculated number (billions) of capelin on 1 January 1979 - 1996 by age and maturity groups. The total number (billions) and weight (thous. tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

	Year								
Age/maturity	1979	1980	1981	1982	1983	1984	1985	1986	1987
2 juvenile	137.6	50.6	55.3	41.2	123.7	105.0	211.6	83.2	131.9
3 immature	12.8	13.8	3.5	3.0	12.6	35.7	34.3	83.9	25.6
3 mature	51.8	53.4	16.3	8.0	14.3	39.8	25.2	34.5	22.1
4 mature	14.8	3.6	4.9	0.5	2.0	7.6	15.6	10.5	37.0
5 mature	0.3	0.2	+	+	+	0.1	0.3	0.2	0.2
Number immat.	150.9	64.4	58.8	44.2	136.3	140.7	245.9	167.1	157.5
Number mature	65.6	57.2	21.2	8.5	16.3	47.5	41.1	45.2	59.1
Weight immat.	1028	502	527	292	685	984	1467	1414	1003.0
Weight mature	1358	980	471	171	315	966	913	1059	1355
Number sp.st.	29.0	17.5	7.7	6.8	13.5	21.6	20.7	19.6	18.3
Weight sp. st	600	300	170	140	260	440	460	460	420

	Year								
Age/maturity	1988	1989	1990	1991	1992	1993	1994	1995	1996
2 juvenile	120.5	67.8	53.9	98.9	111.6	124.6	121.3	*143.7	*154.6
3 immature	31.2	20.1	8.6	8.6	8.1	13.9	16.9	*29.5	*43.8
3 mature	34.1	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5
4 mature	11.7	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1
5 mature	+	0.3	+	+	+	+	+	+	+
Number immat.	151.3	87.9	62.5	107.5	119.7	138.5	121.7	*179,2	*198.4
Number mature	45.8	64.8	43.3	26.8	60.1	50.0	55.1	43.8	92.7
Weight immat.	1083	434	291	501	487	622	573	*696	900
Weight mature	993	1298	904	544	1106	1017	1063	914	1757
Number sp.st.	18.5	22.0	5.5	16.3	25.8	23.6	24.8	19.2	43.8
Weight sp. st.	400	440	115	330	475	499	460	420	830

* Preliminary/Predicted

Table 5.5.1 Capelin in the Iceland-Greenland -Jan Mayen area. The data used in the comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for calculations of preliminary TACs.

Year class	Age 1 Acoustics N_1	Age 2 Back-calc. Mature N_{2mat}	Age 2 Acoustics Immature N_{2imm}	Age 2 Back-calc. Total N_{2tot}	Age 3 Back-calc. Mature N_{3tot}
1980	23.7	17.1	1.7	32.1	9.8
1981	68.0	53.7	8.2	96.2	27.9
1982	44.1	40.7	4.6	81.6	27.0
1983	73.8	64.6	12.6	164.6	65.8
1984	33.8	35.6	1.4	65.0	20.1
1985	58.6	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.3	15.8
1987	43.9	42.8	1.8	53.1	6.8
1988	29.2	31.9	1.3	42.0	6.7
1989	*39.2	67.7	5.2	77.4	6.4
1990	60.0	70.7	2.3	87.3	10.9
1991	104.6	86.9	10.8	107.0	13.2
1992	100.4	59.8	6.9	95.0	24.0
1993	119.0	94.3	46.3	**146.6	
1994	163.0				

* Invalid due to ice conditions.
** Preliminary

Table 5.5.2 Capelin in the Iceland-Greenland -Jan Mayen area. Mean weight (g) in autumn of mature capelin of the 1978-1993 year classes

	Years							
	1981	1982	1983	1984	1985	1986	1987	1988
Age 2	19.2	16.5	16.1	15.8	15.5	18.1	17.9	15.5
Age 3	24.0	24.1	22.5	25.7	23.8	24.1	25.8	23.4
	1989	1990	1991	1992	1993	1994	1995	1996
Age 2	18.0	18.1	16.3	16.5	16.2	16.0	15.3	
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	

Table 5.5.3 Capelin in the Iceland-Greenland -Jan Mayen area. Predictions of fishable stock abundance and TACs for the 1982/83 - 1995/96 seasons. The last column gives contemporary advice on TACs for comparison.

Age 2 and age 3 = Numbers in age groups at the beginning of season.
Fish.st. = calculated weight of maturing capelin in thous. tonnes (ref. 1 August).
TAC calc = predicted TAC and TAC adv = advised TAC.

Mean weight of maturing 2 and 3 group capelin in October/November 1981-1991 is 17.0 and 24.3 g respectively. Numbers are billions; weights in thous. tonnes.

Season	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Year classes	80-79	81-80	82-81	83-82	84-83	85-84	86-85	87-86
Age 2	26.6	63.0	43.4	67.8	34.9	55.5	64.8	43.2
Age 3	4.1	0.0	26.3	20.2	55.0	13.7	29.0	25.5
Fishable stock	549	1065	1373	1637	1926	1268	1800	1350
Calculated TAC	17	465	733	963	1215	642	1105	713
Advised TAC	0	573	897	1311	1333	1115	1036	550

Season	90/91	91/92	92/93	93/94	94/95	95/96	96/97
Year classes	88-87	89-88	90-89	91-90	92-91	93-92	94-93
Age 2	31.1	39.4	56.4	93.1	89.6	92.5	90.0
Age 3	8.2	3.7	18.3	22.6	27.0	14.9	35.0
Fishable stock	724	755	1398	2123	2170	1916	2352
Calculated TAC	170	197	755	1385	1427	1200	1635
Advised TAC	265	740	*900	1250	850	1390	

* In January 1993 80,000 t were added to the 820,000 t recommended after the October 1992 survey due to an unexpectedly large increase in mean weights.

Table 5.5.4 Capelin in the Iceland-Greenland -Jan Mayen area. Corrected assessment of capelin abundance, 30/10-14/11 1995.

	Age/Year class							
Length (cm)	1 1994	2 1993	3 1992	4+ 1988	Number mature (10^9)	Total number (10^9)	Weight (10^3t)	Mean weight (g)
7.5 - 7.9	0.1	-	-	-	-	0.1	0.1	1.1
8.0 - 8.4	1.8	-	-	-	-	1.7	3.5	2.0
8.5 - 8.9	10.7	-	-	-	-	10.7	20.5	1.9
9.0 - 9.4	29.4	-	-	-	-	29.3	65.5	2.2
9.5 - 9.9	33.4	-	-	-	-	33.4	100.3	3.0
10.0 - 10.4	28.6	-	-	-	-	28.6	92.1	3.2
10.5 - 10.9	18.0	-	-	-	-	18.0	71.1	3.9
11.0 - 11.4	16.7	0.9	-	-	-	17.6	83.3	4.7
11.5 - 11.9	10.1	4.0	-	-	-	14.1	77.3	5.5
12.0 - 12.4	8.6	10.1	+	-	-	18.8	124.5	6.6
12.5 - 12.9	3.4	15.1	+	-	-	18.5	143.5	7.8
13.0 - 13.4	2.2	16.1	+	-	-	18.4	166.2	9.0
13.5 - 13.9	1.1	16.8	0.3	-	18.2	18.2	187,5	10.3
14.0 - 14.4	0.4	13.9	0.7	-	15.0	15.0	178.5	11.9
14.5 - 14.9	0.2	11.9	2.0	-	14.1	14.1	193.2	13.7
15.0 - 15.4	0.2	9.7	2.4	-	12.3	12.3	193.1	15.7
15.5 - 15.9	0.1	8.7	3.0	-	11.8	11.8	212.4	18.0
16.0 - 16.4	+	8.0	3.9	-	11.9	11.9	241.6	20.3
16.5 - 16.9	-	4.3	3.3	-	7.6	7.6	173.3	22.8
17.0 - 17.4	-	2.7	3.2	-	5.9	5.9	150.5	25.5
17.5 - 17.9	-	1.1	1.3	-	2.4	2.4	68.2	28.4
18.0 - 18.4	-	0.4	0.6	-	1.0	1.0	32.4	32.4
18.5 - 18.9	-	0.1	0.1	-	0.2	0.2	6.4	32.2
19.0 - 19.4	-	0.1	+	-	0.1	0.1	4.0	38.4
19.5 - 19.9	-	-	+	-	+	+	0.4	47.0
Number (10^9)	165.0	123.9	20.7	-	100.2	309.6	-	-
Weight (10^3t)	608.1	1544.8	423.4	-	1634.8	2579.6	-	-
Mean length (cm)	10.3	14.1	16.2	-	15.3	12.1	-	-
Mean weight (g)	3.7	12.5	20.4	-	16.3	8.3	-	-

Table 5.6.1 Capelin in the Iceland-Greenland- Jan Mayen area. Recruitment of 1 year old fish (unit 109) and stock biomass ('000 t) given at 1 August, spawning stock ('000 t) at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated ending in March of the following year.

Year	Recruit-ment	Total stock biomass	Landings	Spawning stock biomass
1978	164	2937	1195	600
1979	60	1819	980	300
1980	66	1230	684	170
1981	49	971	626	140
1982	147	957	0	260
1983	125	1867	573	440
1984	252	1613	897	460
1985	99	2775	1312	460
1986	157	2928	1333	420
1987	144	2372	1116	400
1988	81	1996	1037	440
1989	64	1379	808	115
1990	118	1242	314	330
1991	1323	1910	677	475
1992	148	1944	788	499
1993	1445	2168	1179	460
1994	223	2056	864	420
1995	184	2786	929	830

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the main fisheries, 1986-1995, as estimated by the Working Group.

Area	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Norwegian Sea fishery ('Subareas I+II and Divisions Va,XIVa-b)	160 061	123 042	55 829	42 615	2 106	78 703	62 312	43 240	22 674	23 733
Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	534 263[1)]	445 881[1)]	421 636	473 165[3)]	463 495	218 946	317 237	347 101	378 704	423 282[3)]
Industrial mixed fishery (Divisions IVa-c, Vb and IIIa)	99 580	62 689	45 143	75 958	63 192	39 872	65 974	58 082	28 563	104 004
Subtotal northern fishery	793 904[2)]	631 612[2)]	522 608	591 738	528 793	337 521	445 523	448 423	429 941	551 019
Southern fishery (Subareas VII+IX, Divisions VIId,e,g-k)	33 082	32 819	30 838	33 695	32 817	32 003	28 722	32 256	29 473	27 664
Total	826 986	664 431	553 446	625 433	561 610	369 524	474 245	480 679	459 414	578 683

1) Including directed fishery also in Divisions VIIg-k, Iva and Subarea XII
2) Excluding directed fishery also in Division VIIg-k
3) Including Icelandic industrial fishery in Division Va

Table 6.2.2 Landings (tonnes) of BLUE WHITING from the directed fisheries in the Norwegian Sea (Subareas 1 and II, Divisions Va, XIVa and XIVb) 1986-1995, as estimated by the Working Group.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Faroes	-	9 290	-	1 047	-	-	-	-	-	-
German Dem. Rep.	3 541	1 010	3	1 341	-	-	-	-	-	-
Germany Fed. Rep.	106	-	-	-	-	-	-	-	2[4)]	3[4)]
Greenland	10	-	-	-	-	-	-	-	-	-
Iceland	-	-	-	4 977[3)]	-	-	-	-	-	369[3)]
Netherlands	-	-	-	-	-	-	-	-	-	72
Norway	-	-	-	-	566	100	912	240	-	-
Poland	-	56	10	-	-	-	-	-	-	-
USSR/Russia[1)]	156 404	112 686	55 816	35 250	1 540	78 603	61 400	43 000	22 250[2)]	23 289
Latvia	-	-	-	-	-	-	-	-	422	-
Total	160 061	123 042	55 829	42 615	2 106	78 703	62 312	43 240	22 674	23 733

[1)] From 1992
[2)] Includes Vb
[3)] Icelandic mixed fishery in Va
[4)] Germany

Table 6.2.3 Landings (tonnes) of BLUE WHITING from directed fisheries in the spawning area (Division Vb, VIa, b, VIIb, c, VIIg-k and Sub-area XII), as estimated by the Working Group.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	11 364	2 655	797	25	-	-	3 167	-	770	-
Faroes	80 564	70 625	79 339	70 711	43 405	10 208[1)]	12 731	14 984	22 548	26 009
France	-	-	-	2 190	-	-	-	1 195	-	720
German Dem. Rep.	2 750	3 584	4 663	3 225	230	-	-	-	-	-
Germany Fed, Rep.	-	266	600	848	1 469	349[3)]	1 307[3)]	91[3)]	-	6 310[3)]
Ireland	16 440	3 300	245	-	-	-	-	-	3	-
Netherland	8 888	5 627	800	2 078	7 280	17 359	11 034	18 436	21 076	26 703
Norway	283 162	191 012	208 416	258 386	281 036[1)]	114 866[1)]	148 733[1)]	198 916	226 235	261 272
UK (Eng.& Wales)	10	5	3	1 557	13	-	356	2	1 418	4 622[4)]
UK (Scotland)	3 472	3 310	5 068	6 463	5 993	3 541	6 493	2 030	3 047	
USSR/Russia 2)	127 613	165 497	121 705	127 682	124 069	72 623	115 600	96 000	94 531	83 931
Japan	-	-	-	-	-	-	918	1 742	2 574	-
Estonia	-	-	-	-	-	-	6 156	1 033	4 342	13 715
Latvia	-	-	-	-	-	-	10 742	10 626	2 160	-
Lithauen	-	-	-	-	-	-	-	2 046	-	-
Total	534 263	445 881	421 636	473 165	463 495	218 946	317 237	347 101	378 704	423 282

[1)] Including directed fishery also in Division IVa
[2)] From 1992
[3)] Germany
[4)] UK

Table 6.2.4 Landings (tonnes) of BLUE WHITING from the mixed industrial fisheries and caught as by-catch in ordinary fisheries in Divisions IIIa, IVa.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Denmark	57 315	28 541	18 144	26 605	27 052	15 538	31 189	41 053	19 686	12 439
Faroes	5 678	7 051	492	3 325	5 281	355	705	1 522	1 794	-
German Dem. Rep.[1)]	-	53	-	-	-	-	-	-	-	-
Germany Fed, Rep.[1)]	-	62	280	3	-	-	25[3)]	9[3)]	-	-
Netherland	1 114	-	-	-	20	-	2	46	-	-
Norway	26 941	24 969	24 898	42 956	29 336[2)]	22 644	31 977	12 333	3 408	78 565
Sweden	8 532	2 013	1 229	3 062	1 503	1 000	2 058	2 867[4)]	3 675	13 000
UK (Eng.& Wales) 1)	-	-	-	7	-	-	17	-	-	-
UK (Scotland)	-	-	100	-	-	335	1	252	-	-
Total	99 580	62 689	45 143	75 958	63 192	39 872	65 974	58 082	28 563	104 004

[1)] Including directed fishery also in Division IVa
[2)] Including mixed industrial fishery in the Norwegian Sea
[3)] Germany
[4)] Unprecise estimates reported catch of 34 265 t in 1993; the mean of 1992 and 1994, i.e. 2 867 t, is used in the VPA-RUN

Table 6.2.5 Landings (tonnes) of BLUE WHITING from the Southern areas
(Subareas VIII and IX and Divisions VIIg-k and VIId, e) 1985-1994 as estimated by the Working Group.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Netherlands	-	-	-	-	450	10	-	-	-	-
Norway	-	4	-	-	-	-	-	-	-	-
Portugal	8 116	9 148	5 979	3 557	2 864	2 813	4 928	1 236	1 350	2 285
Spain	24 965	23 644	24 847	30 108	29 490	29 180	23 794	31 020	28 118	25 379
UK (Eng.& Wales)	1	23	12	29	13	-	-	-	5	-
France	-	-	-	1	-	-	-	-	-	-
Total	33 082	32 819	30 838	33 695	32 817	32 003	28 722	32 256	29 473	27 664

Table 6.3.1. Length distribution, commercial samples, Norway 1995. Directed Fishery

Area	VIIbc	VIIg-k	VIIbc	VIb
Quarter	1	1	1	1
No. samples	12	1	15	1
23	3		1	
24	7		2	2
25	13		16	1
26	24	3	15	
27	37	4	35	
28	91	4	72	1
29	111	13	161	11
30	167	24	235	21
31	163	20	237	14
32	180	16	187	16
33	166	6	104	9
34	132	9	90	3
35	72	10	72	3
36	53	4	50	1
37	37	3	33	2
38	21	2	9	
39	7	1	6	
40	6	1	1	
41	2		1	
Total	1292	120	1327	84

Table 6.3.2. Length distribution, commercial samples, Norway 1995. Directed Fishery

Area	VIIbc	VIa	IVa	Vb
Quarter	2	2	2	2
No. samples	3	15	3	2
22		2		
23		2	1	
24	1	3	4	
25		16	6	
26	5	20	7	2
27	20	39	13	5
28	32	91	19	13
29	45	170	23	30
30	75	265	29	52
31	55	235	34	38
32	49	187	34	34
33	32	135	18	17
34	19	111	13	20
35	17	92	12	17
36	7	49	6	9
37	4	32	4	2
38	3	21	4	1
39		3		
41		2		
Total	364	1475	227	240

Table 6.3.3. Length distribution, commercial samples, Norway 1995. Mixed industrial fishery

Area	IVa	IVa	IVa	IVa
Quarter	1	2	3	4
No. samples	1	15	48	46
12			8	6
13			215	211
14			938	737
15			2214	1666
16			921	895
17		10	393	236
18		9	83	53
19		50	26	21
20		90	2	
21		105		
22		106		2
23		48		7
24		22		2
25	1	39		6
26	1	43		6
27		38		8
28		14		8
29	1	7		4
30		3		12
31		1		10
32				1
33				8
34		1		7
35				1
Total	3	586	4800	3907

Table 6.3.4. Length distributions. Blue Whiting. Russia. 1995

Area	VIIbc	VIIg-k	VIIbc	Vb1	VIa	IIa	IVa
Quarter	1	1	2	2	2	2	2
16		3					
17	1	9	2		1		1
18	1	24	5				2
19	2	15	13		1		1
20	2	9	11		1		3
21	1	5	5		1	3	1
22		1		1	6	2	3
23	1	2		1	2	6	1
24		1	1		6	6	3
25	1	11	1	1	28		16
26	1	14	1	2	31	3	16
27	2	23	2	2	34	9	21
28	6	26	2	4	25	2	11
29	8	35	4	1	30	1	4
30	10	25	7	3	31	1	1
31	8	25	7	12	40	1	1
32	15	17	2	4	37	6	3
33	7	12	6	9	41	1	1
34	10	7	3	6	31	4	3
35	6	8	6	3	14	1	2
36	6	4	8	1	9	2	2
37	5	5	3		11	1	
38	5	2	7		5		
39	1	3	1		8		3
40	1	1	2		5	1	
41					1		1
42							
43		1	1				
44					1		
Total	100	288	100	50	400	50	100

Table 6.3.5 Length distribution, commercial samples, Faroes 1995. Directed fishery.

Area	VIIb,c,g-k	VIa	IVa	IVa
Quarter	2-3	2	2	3-4
22		1	2	1
23		1	2	1
24	11	5	6	1
25	26	14	17	3
26	14	11	20	9
27	18	16	20	4
28	42	33	43	10
29	61	55	75	20
30	73	80	111	31
31	76	75	110	35
32	43	76	111	35
33	36	49	81	32
34	22	19	40	21
35	16	26	37	11
36	8	15	28	13
37	4	4	8	4
38	6	8	10	2
39	2	1	3	2
40		1	2	1
41		1	1	
Total	458	491	727	236

Table 6.3.6. Length distribution, commercial samples, Netherlands. 1995

Area	VIIc	VIIc	VIa	Vb1	IIa
Quarter	1	2	2	2	4
No. samples	1	1	6	2	1
13					21
14					65
15					50
16					36
17					23
18			1		7
19			1		3
20			1	1	
21			1		
22			5	2	
23			2	3	
24			18	4	
25		4	35	7	
26		2	33	9	
27	1	5	39	8	
28	6	11	71	10	
29	14	14	105	19	
30	16	32	122	48	
31	23	22	97	43	
32	17	16	102	39	
33	15	31	65	32	
34	8	8	52	26	
35	9	3	32	21	
36	4	5	32	14	
37	3		25	10	
38	1		15	2	
39	1		10	1	
40	1		3	2	
41			5	4	
42			1		
Total	119	153	873	305	205

Table 6.3.7. Length distribution, commercial samples, Denmark 1995.

Area	IVab	IVab	IVab	IIIa	IIIa
Quarter	1	3	4	3	4
No. samples	4	1	5	1	9
13	1		2		1
14			5		17
15	1		28		74
16	3		29		102
17			25		149
18			11		115
19	2		3		2
20	2		2	1	
21	2		1	3	
22	1		1	4	
23	2	2	2	4	
24	2	1	1	4	
25	1	1	4	1	
26	2	1		6	
27		1		3	
28				4	
29		1			
30		1		4	
31				2	
32		2			
33	1		1	2	1
34					3
35					5
36					1
37			1		3
38					3
39					1
Total	20	10	116	38	477

Table 6.3.8. Length composition (1000) of commercial blue whiting catches of Portugal and Spain 1995.

A

PORTUGAL					
	Quarter				
Length	1	2	3	4	Total
10					0
11					0
12					0
13					0
14					0
15	123				123
16	1356	180	21		1557
17	1925	1130	673	1085	4813
18	3328	3681	2009	1751	10769
19	4202	2873	2593	2382	12050
20	3314	1293	1526	1953	8086
21	673	712	42	1587	3014
22	4	88	6	598	696
23	22		6	212	240
24	219		16	97	332
25	550		17	65	632
26	922		7	65	994
27	957		13	44	1014
28	667		9	40	716
29	589		5	28	622
30	362		2	16	380
31	239			15	254
32	155			10	165
33	94			4	98
34	5			2	7
35					0
36					0
37					0
38					0
39					0
40					0
TOTAL	19706	9957	6945	9954	46562
Landings (t)	1190	364	261	470	2285
N samples	14	5	10	13	42
Fish sampled	1134	387	737	1002	3260

B

SPAIN					
	Quarter				
Length	1	2	3	4	Total
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	67	0	99	38	204
15	706	10	327	184	1227
16	3589	190	367	73	4219
17	6453	822	907	337	8520
18	10883	6296	3835	2108	23122
19	7567	14422	12190	9503	43682
20	3293	17257	20167	14752	55469
21	2363	11075	14695	15228	43362
22	6514	10191	10563	11062	38330
23	8742	11640	6050	5303	31734
24	10120	14397	5465	4978	34960
25	7256	9545	4045	3127	23973
26	5186	5228	3416	2460	16289
27	3417	2241	1464	724	7847
28	3011	1338	1018	487	5853
29	1470	494	471	319	2754
30	845	355	189	95	1485
31	340	224	91	148	803
32	38	48	35	65	185
33	10	17	36	84	147
34	8	8	19	12	48
35	3	5	12	13	34
36	7	6	25	22	60
37	0	2	1	1	4
38	0	1	23	1	24
39	2	1	1	0	4
40	0	0	6	0	6
TOTAL	81891	105811	85516	71126	344344
Landings (t)	6387	8031	5967	4994	25379
N samples	89	99	92	81	361
Fish sampled	8839	9583	9025	8199	35646

C

	SPAIN			PORTUGAL	
	Bottom	Pair	Long	Bottom	
Length	trawl	trawl	line	trawl	TOTAL
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	116	88	0	0	204
15	780	446	1	123	1350
16	3438	770	11	1557	5776
17	5605	2900	14	4813	13333
18	10166	12951	5	10769	33891
19	13004	30665	14	12050	55732
20	12024	43437	8	8086	63555
21	9058	34294	10	3014	46376
22	8371	29943	16	696	39026
23	6020	25675	39	240	31974
24	5207	29689	64	332	35292
25	3523	20365	85	632	24605
26	2737	13488	63	994	17283
27	1378	6396	73	1014	8861
28	1333	4458	62	716	6569
29	512	2200	42	622	3376
30	313	1124	47	380	1865
31	235	536	32	254	1057
32	57	105	24	165	350
33	19	108	20	98	245
34	6	29	13	7	55
35	13	13	9	0	34
36	22	32	6	0	60
37	0	1	2	0	4
38	0	23	1	0	24
39	0	1	4	0	4
40	0	6	0	0	6
TOTAL	83937	259742	665	46562	390906
Landings (t)	5462	19827	91	2285	27665
N samples	214	122	25	42	403
Fish sampled	18850	14988	1808	3260	38906

Table 6.3.9. Blue Whiting. Catch in numbers (millions) by age group in the Southern area (Div. VIIIc and IXa) 1986-1994.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	32	105	30	41	74	70	19	25	13	3
1	93	383	147	200	198	181	139	41	12	96
2	218	111	233	175	182	182	205	146	56	123
3	168	62	114	93	57	70	95	181	149	55
4	68	28	32	61	25	39	43	62	72	38
5	15	13	10	27	24	17	12	12	27	44
6	6	3	9	15	11	8	6	7	9	20
7	1	1	3	6	2	3	2	2	5	6
8+	1	1	0	3	2	3	1	1	4	5
Total	602	707	578	621	575	573	522	477	347	391
Tonnes	33082	32819	30838	33695	32817	32003	28722	32256	29468	27664

Table 6.3.10. Blue Whiting. Catch in numbers at age 1981-1995.

Year Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	48	3512	437	584	1174	84	341	46	1949	83	161	19	198	42	3307
1	258	148	2283	2291	1305	650	838	425	865	1611	267	408	263	307	296
2	348	274	567	2331	2044	816	578	721	718	703	1024	654	305	108	354
3	681	326	270	455	1933	1862	728	614	1340	672	514	1642	621	368	422
4	334	548	286	260	303	1717	1897	683	791	753	302	569	1571	389	465
5	548	264	299	285	188	393	726	1303	837	520	363	217	411	1222	616
6	559	276	304	445	321	187	137	618	708	577	258	154	191	281	800
7	466	266	287	262	257	201	105	84	139	299	159	110	107	174	254
8	634	272	286	193	174	198	123	53	50	78	49	80	65	90	160
9	578	284	225	154	93	174	103	33	25	27	5	32	38	79	60
gp+	1460	673	334	255	259	398	195	50	38	95	10	12	17	31	42

Table 6.3.11. Blue Whiting. Mean weights at age 1981-1995.

Year Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.038	0.018	0.020	0.026	0.016	0.030	0.023	0.031	0.014	0.034	0.036	0.024	0.028	0.033	0.022
1	0.052	0.045	0.046	0.035	0.038	0.040	0.048	0.053	0.059	0.045	0.055	0.057	0.066	0.061	0.064
2	0.065	0.072	0.074	0.078	0.074	0.073	0.086	0.076	0.079	0.070	0.091	0.083	0.082	0.087	0.091
3	0.103	0.111	0.118	0.089	0.097	0.108	0.106	0.097	0.103	0.106	0.107	0.119	0.109	0.108	0.118
4	0.125	0.143	0.140	0.132	0.114	0.130	0.124	0.128	0.126	0.123	0.136	0.140	0.137	0.137	0.143
5	0.141	0.156	0.153	0.153	0.157	0.165	0.147	0.142	0.148	0.147	0.174	0.167	0.163	0.164	0.154
6	0.155	0.177	0.176	0.161	0.177	0.199	0.177	0.157	0.158	0.168	0.190	0.193	0.177	0.189	0.167
7	0.170	0.195	0.195	0.175	0.199	0.209	0.208	0.179	0.171	0.175	0.206	0.226	0.200	0.207	0.203
8	0.178	0.200	0.200	0.189	0.208	0.243	0.221	0.199	0.203	0.214	0.230	0.235	0.217	0.217	0.206
9	0.187	0.204	0.204	0.186	0.218	0.246	0.222	0.222	0.224	0.217	0.232	0.284	0.225	0.247	0.236
gp+	0.213	0.231	0.228	0.206	0.237	0.257	0.254	0.260	0.253	0.256	0.266	0.294	0.281	0.254	0.256

Table 6.4.1 Stratified mean catch (Kg/haul and Number/haul) and standard error of BLUE WHITING in bottom trawl surveys in Spanish waters. All surveys in September.

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.6	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.1	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66

Numb/ haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	267	181.71	3669	1578.86	1377	262.98	2644	963.20
1986	368	237.56	2486	1006.67	752	238.87	1763	616.40
1987	-	-	-	-	-	-	-	-
1988	83	71.74	6112	1847.36	7276	6339.88	5694	2086.00
1989	629	537.29	3197	876.75	566	213.11	2412	599.00
1990	220	115.48	2219	426.46	578	185.43	1722	276.00
1991	2922	1645.73	5563	1184.69	1789	847.33	4214	780.88
1992	124	50.81	1412	233.99	845	199.12	1069	146.87
1993	14	8.61	257	69.61	894	427.77	401	124.53
1994	346	234.12	2002	456.50	997	245.91	1487	689.00
1995	1291	864.97	2004	341.48	485	137.81	1493	240.37

Table 6.4.2. Stratified mean catch rates (Kg/hour) and standard error in Portuguese bottom trawl surveys.

Year	Month	20-100 m y	20-100 m sy	100-200 m y	100-200 m sy	200-500 m y	200-500 m sy	500-750 m y	500-750 m sy	20-500 m y	20-500 m sy	20-750 m y	20-750 m sy
1979	June	0.2	0.2	32.8	22.7	86.3	34.6	-	-	31.2	11.5	-	-
	October/November	5.1	4.9	17.2	7.6	102.9	47.9	-	-	27.8	9.3	-	-
1980	March	0.0	0.0	178.0	173.0	4.7	0.7	-	-	71.7	68.5	-	-
	May/June	0.9	2.7	4.0	1.5	45.4	18.2	-	-	10.7	3.5	-	-
	October	3.6	2.7	9.9	4.4	586.7	305.9	-	-	117.3	58.3	-	-
1981	March	0.0	0.0	23.5	17.4	185.5	112.7	-	-	42.2	22.2	-	-
	June	0.0	0.0	4.2	1.6	177.5	24.5	-	-	33.8	4.4	-	-
1982	April/May	0.0	0.0	3.2	2.6	136.4	39.3	-	-	26.0	7.2	-	-
	September	0.6	0.5	85.1	42.3	271.4	122.6	-	-	85.7	28.7	-	-
1983	March	0.7	0.6	14.0	9.5	259.2	96.1	-	-	54.3	18.3	-	-
	June	0.0	0.0	22.6	8.4	177.2	46.9	-	-	42.2	9.3	-	-
1985	June	0.1	0.1	194.4	145.9	404.8	161.5	-	-	159.0	67.9	-	-
	October	3.7	3.3	132.9	83.5	340.6	39.3	-	-	119.8	35.1	-	-
1986	June	4.1	1.1	59.2	18.5	196.3	30.9	-	-	64.8	9.8	-	-
	October	2.4	1.2	357.0	144.4	650.2	111.0	-	-	276.2	63.2	-	-
1987	October	3.2	0.0	297.4	63.6	746.7	226.5	-	-	263.0	50.0	-	-
1988	October	4.2	1.8	164.5	46.9	457.0	106.1	-	-	154.7	27.6	-	-
1989	July	0.0	0.0	41.9	20.5	322.6	142.7	79.3	35.8	-	-	77.7	24.4
	October	6.6	4.1	69.5	26.4	306.4	83.7	24.2	1.7	-	-	79.1	16.3
1990	July	2.1	1.8	153.1	103.3	241.5	41.5	49.7	4.9	-	-	86.3	34.5
	October	11.0	5.3	90.2	28.1	761.5	233.9	42.1	9.7	-	-	152.5	35.3
1991	July	0.9	0.7	140.3	39.6	267.7	38.3	64.1	17.9	-	-	98.4	14.6
	October	8.1	4.7	82.5	18.3	258.7	53.2	120.9	26.5	-	-	90.7	11.4
1992	February	7.3	7.3	42.8	34.5	249.2	21.0	73.3	3.1			67.7	12.0
	July	1.4	1.2	29.0	18.0	215.5	42.5	26.8	4.5	-	-	46.8	8.6
	October	0.7	0.5	22.1	7.0	208.3	43.6	79.8	2.9	-	-	54.2	6.8
1993	February	0.0	0.0	18.6	14.1	104.5	30.6	36.2	0.2	-	-	42.3	9.5
	July	0.0	0.0	3.0	2.6	150.7	28.2	55.3	5.2	-	-	34.3	4.3
	November	0.0	0.0	90.3	0.3	188.6	42.8	5.8	0.7	-	-	85.8	9.2
1994	October	0.0	0.0	373.8	29.7	282.5	32.0	48.7	7.0	-	-	173.8	10.9
1995	July	0.0	0.0	17.8	13.9	130.4	19.6	51.9	3.0	-	-	35.6	6.4
	October	18.5	15.4	103.1	20.9	328.2	90.5	31.4	11.6	-	-	93.9	15.8

Table 6.4.3. Tuning input data used in the Extended Survivors Analysis (XSA).

BLUE WHITING
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Norway Spawning Area/Acoustic

81	95									
1	1	0.17	0.25							
2	11									
1	2368	7511	3219	3626	4551	4625	3626	2590	1776	1332
0	0	0	0	0	0	0	0	0	0	0
1	297	2108	2723	6511	3735	3650	3153	2279	1182	631
1	11130	1514	1616	1719	1858	1128	567	440	348	80
0	0	0	0	0	0	0	0	0	0	0
1	954	7183	7340	1159	383	251	373	151	174	73
1	4042	8050	22357	4697	282	417	385	159	27	111
1	6960	8799	12271	20285	7323	723	617	326	398	126
1	6745	22270	8973	10504	7803	933	293	177	46	148
1	14169	12670	11228	5587	6556	3273	516	183	108	81
1	11147	6340	8497	7407	4558	2019	545	96	16	33
1	1232	26123	4719	1574	1386	810	616	257	19	0
1	4489	3321	26771	2643	1270	557	426	108	22	12
1	1603	2950	4476	11354	1742	1687	908	770	207	0
1	8538	9874	7906	6861	9467	1795	1083	482	149	48

USSR Spawning Area/Acoustic

82	95								
1	1	0.17	0.25						
3	11								
1	540	2750	1340	1380	1570	2350	1730	1290	650
1	2330	2930	9390	3880	1970	1370	780	660	100
1	2900	800	1100	4200	2200	1200	1700	1200	500
1	13220	930	580	1780	860	610	580	540	110
1	18750	23180	2540	610	620	750	640	710	720
1	4480	19170	5860	1070	500	810	860	670	560
1	3710	4550	8610	4130	1270	480	250	260	330
1	11910	7120	6670	6970	4580	2750	1880	810	410
1	9740	12140	5740	2580	1470	220	80	10	10
1	10300	5350	5130	2630	1770	870	300	220	0
1	20010	6700	1350	440	390	170	0	0	0
1	4728	12337	5304	2249	1316	621	386	150	0
0	0	0	0	0	0	0	0	0	0
1	12657	10028	8942	2651	1093	408	131	14	14

CPUE Spanish Pair Trawlers

83	95					
1	1	0	1			
1	6					
1	7196	16392	9311	7476	6326	1718
1	13710	27286	14845	4836	1765	1750
1	14573	23823	14126	6256	1232	217
1	3721	14131	14745	7113	1278	505
1	25328	13153	6664	2938	1029	166
1	7778	21473	18436	6391	1300	781
1	15272	18486	17160	8374	3760	1003
1	21444	19407	5194	1803	1357	451
1	15924	15370	4989	2329	1045	440
1	10007	24235	9671	4316	1194	462
1	4036	13991	22493	7979	1354	658
1	543	6066	15917	7474	2990	1055
1	9090	14409	6833	4551	1990	623

Spanish Survey (Bottom trawl)

85	95							
1	1	0.67	0.75					
0	7							
1	1748.4	508.3	266.4	104	11.4	3.5	1	0.5
1	1572.8	26.7	67.5	63.2	28.7	2	2.6	0.2
0	0	0	0	0	0	0	0	0
1	4979.6	368.7	344.9	37.3	7.2	3	5	0.3
1	1923.3	163	51.2	28.6	3.8	2.8	0.7	0.2
1	1525	74.9	46.1	10.7	10.4	2.4	0.1	0.5
1	4003.2	95.2	49.6	24.5	17.9	5.1	1.5	0.8
1	299.8	428.2	233.3	77	20.4	6.9	2.3	0.9
1	115.7	107.5	150.8	19.4	5.5	1.6	0.2	0.2
1	1415.4	30.9	4.8	16	13.5	5.1	0.9	0.3
1	1309	58.5	93.1	17.3	10.2	4.4	0.6	0.2

Norwegian Sea acoustic

81	95											
1	1	0.6	0.75									
0	11											
1	0.001	182	728	4542	3874	2678	2834	2964	2756	2064	1300	1092
1	3680	184	460	1242	4715	3611	3128	2323	1679	874	414	253
1	8280	22356	396	468	756	1404	576	468	432	324	216	108
1	1862	30380	13916	833	392	539	539	343	49	49	49	49
1	2256	5969	23876	12502	658	423	188	235	141	376	141	47
1	5040	2324	2380	7224	6944	1876	952	336	308	140	196	56
1	3192	8204	4032	5180	5572	1204	224	168	56	84	28	28
1	8760	4992	2880	2640	3480	912	120	96	24	48	0.001	0.001
1	20430	1172	1125	812	379	410	212	22	32	0.001	8	1
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	792	1134	6939	766	247	172	90	11	18	1	3
1	0.001	830	125	1070	6392	1222	489	248	58	88	71	0.001
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	6974	2811	1999	1209	1622	775	173	61	1	15	0.001

Portuguese survey (Bottom trawl)

85	95					
1	1	0.75	0.83			
0	5					
1	719	1467	306	129	18	6
0	0	0	0	0	0	0
1	4757	1190	366	110	26	19
1	4018	158	218	27	3	4
1	835	690	318	143	45	41
1	1935	519	270	262	271	87
1	1445	144	154	169	124	55
1	109	164	120	200	147	59
1	43	134	431	127	59	23
1	2677	1595	12	34	59	31
1	2405	200	342	79	57	42

Table 6.4.4. Blue Whiting. XSA diagnostics.

Lowestoft VPA Version 3.1
26/04/1996 20:55
Extended Survivors Analysis
BLUE WHITING 1996 WG
CPUE data from file C:\VPA_L\DATA\BW-TUN.DAT
Catch data for 15 years. 1981 to 1995. Ages 0 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Norway Spawning Area/Acoustic	1981	1995	2	9	0.17	0.25
USSR Spawning Area/Acoustic	1982	1995	3	9	0.17	0.25
CPUE Spanish Pair Trawlers	1983	1995	1	6	0	1
Spanish Survey (Bottom trawl)	1985	1995	0	7	0.67	0.75
Norwegian Sea acoustic	1981	1995	0	9	0.6	0.75
Portuguese survey (Bottom trawl)	1985	1995	0	5	0.75	0.83

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 5 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .500

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00015

Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 29	0.0825	0.0412	0.0725	0.1972	0.2473	0.3701	0.6123	0.5769	0.6035	0.4911
Iteration 30	0.0825	0.0412	0.0725	0.1972	0.2473	0.3701	0.6123	0.5769	0.6034	0.4911

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.01	0.05	0.01	0.10	0.01	0.03	0.00	0.03	0.01	0.08
1	0.09	0.11	0.08	0.13	0.11	0.04	0.08	0.07	0.05	0.04
2	0.13	0.11	0.14	0.18	0.15	0.09	0.12	0.08	0.04	0.07
3	0.24	0.16	0.17	0.40	0.25	0.15	0.21	0.17	0.13	0.20
4	0.56	0.42	0.23	0.35	0.41	0.17	0.25	0.32	0.15	0.25
5	0.57	0.48	0.57	0.48	0.40	0.35	0.18	0.29	0.45	0.37
6	0.45	0.39	1.04	0.70	0.73	0.36	0.25	0.23	0.34	0.61
7	0.58	0.49	0.45	0.71	0.75	0.45	0.25	0.27	0.34	0.58
8	0.56	0.87	0.49	0.53	1.21	0.25	0.42	0.23	0.39	0.60
9	0.71	0.65	0.60	0.45	0.61	0.21	0.26	0.37	0.49	0.49

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1986	1.06E+07	7.97E+06	7.44E+06	9.59E+06	4.45E+06	1.00E+06	5.74E+05	5.08E+05	5.11E+05	3.77E+05
1987	8.30E+06	8.62E+06	5.94E+06	5.35E+06	6.17E+06	2.09E+06	4.66E+05	3.00E+05	2.34E+05	2.39E+05
1988	9.67E+06	6.48E+06	6.30E+06	4.34E+06	3.72E+06	3.33E+06	1.05E+06	2.58E+05	1.51E+05	8.04E+04
1989	2.33E+07	7.88E+06	4.92E+06	4.51E+06	3.00E+06	2.43E+06	1.55E+06	3.04E+05	1.35E+05	7.57E+04
1990	9.72E+06	1.73E+07	5.67E+06	3.38E+06	2.48E+06	1.74E+06	1.23E+06	6.28E+05	1.23E+05	6.53E+04
1991	7.20E+06	7.88E+06	1.27E+07	4.00E+06	2.16E+06	1.35E+06	9.52E+05	4.87E+05	2.44E+05	3.01E+04
1992	5.30E+06	5.75E+06	6.21E+06	9.47E+06	2.81E+06	1.50E+06	7.73E+05	5.46E+05	2.55E+05	1.55E+05
1993	8.98E+06	4.32E+06	4.34E+06	4.50E+06	6.27E+06	1.79E+06	1.03E+06	4.94E+05	3.48E+05	1.36E+05
1994	9.94E+06	7.17E+06	3.30E+06	3.27E+06	3.12E+06	3.71E+06	1.09E+06	6.69E+05	3.08E+05	2.26E+05
1995	4.62E+07	8.10E+06	5.59E+06	2.60E+06	2.35E+06	2.20E+06	1.93E+06	6.40E+05	3.90E+05	1.70E+05

Estimated population abundance at 1st Jan 1996

0.00E+00	3.48E+07	6.37E+06	4.26E+06	1.75E+06	1.50E+06	1.24E+06	8.57E+05	2.94E+05	1.75E+05

Taper weighted geometric mean of the VPA populations:

1.18E+07	8.12E+06	6.02E+06	4.36E+06	3.02E+06	1.91E+06	1.09E+06	5.66E+05	3.23E+05	1.78E+05

Standard error of the weighted Log(VPA populations) :

0.6178	0.4532	0.4585	0.4612	0.4343	0.4048	0.425	0.5237	0.7509	1.0874

Log catchability residuals.

Fleet : Norway Spawning Area

Age	1981	1982	1983	1984	1985
0	No data for this fleet at this age				
1	No data for this fleet at this age				
2	-0.16	99.99	-2.1	0.34	99.99
3	-0.12	99.99	-0.5	-1	99.99
4	-0.98	99.99	-0.74	-0.82	99.99
5	-0.59	99.99	0.07	-0.83	99.99
6	-0.31	99.99	-0.1	-0.73	99.99
7	-0.29	99.99	0.37	-0.85	99.99
8	-0.62	99.99	0.23	-0.91	99.99
9	-0.99	99.99	-0.16	-1.19	99.99

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	-1.68	-0.01	0.48	0.7	1.3	0.24	-1.24	0.4	-0.36	0.79
3	-0.82	-0.14	0.16	1.1	0.79	-0.09	0.48	-0.85	-0.66	0.79
4	-0.39	0.37	0.23	0.26	0.59	0.39	-0.44	0.51	-0.62	0.26
5	-0.75	-0.1	0.92	0.56	0.24	0.77	-0.92	-0.56	0.21	0.21
6	-1.27	-1.38	1.2	0.81	0.87	0.69	-0.32	-0.7	-0.42	0.76
7	-1.54	-0.52	0.17	0.32	0.85	0.56	-0.51	-0.78	0.04	0.2
8	-1.15	-0.28	0.56	-0.07	0.73	-0.1	0.02	-0.7	0.21	0.19
9	-1.72	-1.23	0.57	-0.01	0.2	0.25	-0.39	-1.11	0.37	0.19

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-7.2153	-6.284	-5.8559	-5.858	-5.911	-5.911	-5.911	-5.911
S.E(Log q)	0.9699	0.7184	0.5236	0.6294	0.8815	0.6861	0.5622	0.8216

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.8	0.312	8.93	0.21	13	0.81	-7.22
3	1.01	-0.014	6.21	0.28	13	0.76	-6.28
4	0.71	1.004	8.47	0.59	13	0.37	-5.86
5	0.54	1.697	9.8	0.62	13	0.31	-5.86
6	0.47	2.042	10.17	0.63	13	0.36	-5.91
7	1.07	-0.146	5.5	0.32	13	0.76	-6.03
8	1.76	-1.872	0.99	0.41	13	0.87	-6
9	1.62	-1.833	2.64	0.5	13	1.09	-6.23

Fleet : USSR Spawning Area/A

Age	1981	1982	1983	1984	1985
0	No data for this fleet at this age				
1	No data for this fleet at this age				
2	No data for this fleet at this age				
3	99.99	-2.24	-0.37	-0.32	0.07
4	99.99	-0.99	-0.48	-1.33	-1.29
5	99.99	-1.38	0.59	-1.12	-1.25
6	99.99	-0.85	0.13	0.28	-0.07
7	99.99	-0.72	-0.05	0.01	-0.74
8	99.99	-0.35	-0.41	0.03	-0.76
9	99.99	-0.69	-1.04	0.36	-0.06

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	0.16	-0.7	-0.68	0.5	0.55	0.42	0.24	-0.47	99.99	1.07
4	0.94	0.4	-0.58	0.11	0.85	0.12	0.1	-0.08	99.99	0.68
5	0.19	0.28	0.21	0.25	0.42	0.56	-0.92	0.29	99.99	0.62
6	-0.61	0.15	0.82	0.89	0.13	0.33	-1.27	0.07	99.99	-0.32
7	-0.44	-0.15	0.93	2.1	0.25	0.62	-1.05	0.28	99.99	-0.11
8	-0.26	0.66	0.5	2.36	0.07	0.56	-1.08	-0.13	99.99	-0.59
9	-0.08	0.65	0.5	2.55	-0.43	1.58	99.99	0.36	99.99	-0.92

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-6.3083	-6.041	-6.0087	-6.1037	-6.1037	-6.1037	-6.1037
S.E(Log q)	0.7281	0.7235	0.703	0.6345	0.8718	0.9289	1.1391

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	0.98	0.038	6.48	0.31	13	0.76	-6.31
4	0.63	1.156	9.3	0.54	13	0.45	-6.04
5	0.58	1.143	9.5	0.47	13	0.4	-6.01
6	0.73	0.755	8.22	0.48	13	0.47	-6.1
7	******	-2.012	******	0	13	305.05	-5.96
8	3.44	-1.87	-10.12	0.07	13	2.82	-6.01
9	2.18	-1.821	-1.62	0.24	12	2.09	-5.76

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Fleet : CPUE Spanish Pair Tr

Age	1981	1982	1983	1984	1985
0	No data for this fleet at this age				
1	99.99	99.99	-0.79	-0.28	0.41
2	99.99	99.99	0.61	-0.05	-0.39
3	99.99	99.99	0.6	0.92	-0.23
4	99.99	99.99	0.7	0.73	0.88
5	99.99	99.99	1.04	0.21	0.37
6	99.99	99.99	0.5	0.62	-0.94
7	No data for this fleet at this age				
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	No data for this fleet at this age									
1	-0.74	1.16	0.21	0.74	0.29	0.73	0.59	-0.06	-2.64	0.13
2	-0.3	-0.16	0.28	0.4	0.29	-0.77	0.41	0.2	-0.38	-0.03
3	-0.47	-0.71	0.52	0.51	-0.46	-0.72	-0.89	0.68	0.63	0.05
4	0.1	-1.17	0.02	0.57	-0.75	-0.47	-0.08	-0.23	0.32	0.16
5	0.45	-0.54	-0.74	0.6	-0.11	-0.14	-0.2	-0.19	-0.06	0.02
6	0.44	-0.49	0.52	0.24	-0.32	-0.25	-0.04	0.02	0.48	-0.49
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log q	-5.8029	-5.7994	-6.1856	-6.755	-7.1673
S.E(Log q)	0.4006	0.6406	0.5845	0.4411	0.4676

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	1.03	-0.035	6.56	0.15	13	1.08	-6.8

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.87	-1.786	-2.72	0.32	13	0.68	-5.8
3	4.36	-2.058	-26.08	0.04	13	2.43	-5.8
4	3.19	-1.856	-12.91	0.07	13	1.67	-6.19
5	1.44	-0.9	3.36	0.32	13	0.64	-6.75
6	0.88	0.364	7.98	0.5	13	0.43	-7.17

Fleet : Spanish Survey (Bott

Age	1981	1982	1983	1984	1985
0	99.99	99.99	99.99	99.99	1.13
1	99.99	99.99	99.99	99.99	-3.98
2	99.99	99.99	99.99	99.99	0.48
3	99.99	99.99	99.99	99.99	0.88
4	99.99	99.99	99.99	99.99	0.67
5	99.99	99.99	99.99	99.99	0.66
6	99.99	99.99	99.99	99.99	0.21
7	99.99	99.99	99.99	99.99	-0.46
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	0.69	99.99	3.7	0.58	0.7	3.48	-2.82	-5.72	0.48	-1.11
1	3.38	99.99	-2.61	-0.96	0.13	0.47	-2.85	0.73	3.22	1.59
2	-0.29	99.99	1.51	-0.13	-0.39	-1.16	1.12	1.01	-2.19	0.27
3	0.08	99.99	0.29	0.15	-0.65	-0.06	0.27	-0.4	-0.3	0.06
4	0.77	99.99	-0.67	-1	0.24	0.75	0.67	-1.39	0.08	0.16
5	0.22	99.99	-0.58	-0.39	-0.27	0.71	0.78	-0.78	-0.24	0.08
6	1.69	99.99	2.16	-0.43	-2.13	0.57	1.13	-1.61	-0.09	-0.87
7	-0.66	99.99	0.33	-0.05	0.17	0.68	0.54	-0.84	-0.69	-0.89
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7
Mean Log q	-11.0814	-11.6958	-12.1864	-12.7974	-13.5391	-13.5391
S.E(Log q)	1.154	0.4066	0.7892	0.5636	1.3897	0.6391

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	2.53	-0.909	-2.14	0.05	10	3.08	-8.99
1	-2.37	-1.395	27.56	0.02	10	2.58	-10.93

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.76	0.316	12.16	0.2	10	0.93	-11.08
3	0.68	1.672	12.89	0.79	10	0.25	-11.7
4	-3.13	-2.223	23.45	0.04	10	2.03	-12.19
5	4.7	-2.165	6.71	0.05	10	2.2	-12.8
6	-0.74	-1.843	14.15	0.14	10	0.9	-13.54
7	2.8	-1.093	14.75	0.05	10	1.69	-13.72

Fleet : Norwegian Sea acoust

Age	1981	1982	1983	1984	1985
0	-7.15	3.86	4.45	3.84	4.24
1	-0.23	-0.45	-0.06	-0.1	-0.05
2	-0.49	-0.55	-0.91	1.48	1.81
3	0.53	-0.3	-0.86	-0.41	1.22
4	0.68	0.87	-0.54	-0.71	-0.3
5	0.73	1.02	0.11	-0.38	-0.1
6	1.02	1.55	-0.19	-0.12	-0.62
7	1.05	1.25	0.16	-0.23	-0.38
8	0.92	0.89	0.08	-1.48	-0.58
9	0.58	0.21	-0.31	-1.55	1.17

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	4.87	4.76	5.42	5.28	99.99	99.99	-7.1	-7.61	99.99	-9.22
1	-0.11	0.26	0.36	-0.33	99.99	99.99	-0.17	0.13	99.99	0.25
2	0.1	0.84	0.46	-0.2	99.99	99.99	-0.46	-2.34	99.99	0.52
3	0.37	0.57	0.11	-0.95	99.99	99.99	0.32	-0.83	99.99	0.36
4	1.23	0.58	0.49	-1.43	99.99	99.99	-0.73	0.64	99.99	-0.09
5	1.5	0.27	-0.42	-0.97	99.99	99.99	-1.19	0.31	99.99	0.43
6	1.53	0.25	-0.75	-0.8	99.99	99.99	-0.62	0.13	99.99	0.22
7	0.69	0.47	0.03	-1.43	99.99	99.99	-0.91	0.21	99.99	-0.2
8	0.59	-0.13	-0.79	-0.37	99.99	99.99	-2.14	-0.92	99.99	-0.73
9	0.21	0.11	0.61	-10.21	99.99	99.99	-1.26	0.53	99.99	-4.09

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-7.928	-7.2628	-7.1782	-7.2628	-7.4919	-7.4919	-7.4919	-7.4919
S.E(Log q)	1.1803	0.6905	0.8305	0.8108	0.788	0.7523	1.0699	3.8912

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	0.82	0.049	13.94	0.01	12	7	-13.41
1	0.35	3.058	12.99	0.77	12	0.27	-7.71

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.32	2.897	13.14	0.73	12	0.27	-7.93
3	0.62	1.373	10.37	0.65	12	0.4	-7.26
4	0.49	2.022	11.16	0.7	12	0.34	-7.18
5	1.88	-0.599	0.96	0.06	12	1.59	-7.26
6	1.25	-0.325	5.91	0.2	12	1.04	-7.49
7	0.7	0.977	9.29	0.61	12	0.52	-7.58
8	0.67	1.315	9.65	0.7	12	0.56	-8.07
9	0.41	1.192	11.01	0.37	12	1.4	-9.03
1							

Fleet : Portuguese survey (B

Age	1981	1982	1983	1984	1985
0	99.99	99.99	99.99	99.99	-0.27
1	99.99	99.99	99.99	99.99	0.78
2	99.99	99.99	99.99	99.99	-0.28
3	99.99	99.99	99.99	99.99	-0.23
4	99.99	99.99	99.99	99.99	-0.39
5	99.99	99.99	99.99	99.99	-0.87
6	No data for this fleet at this age				
7	No data for this fleet at this age				
8	No data for this fleet at this age				
9	No data for this fleet at this age				

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
0	99.99	2.38	1.96	-0.85	1.02	0.96	-2.09	-3.79	1.41	-0.18
1	99.99	0.8	-0.49	0.48	-0.54	-0.78	-0.34	-0.21	1.17	-0.55
2	99.99	0.71	0.15	0.8	0.48	-0.93	-0.45	1.16	-2.18	0.67
3	99.99	-0.18	-1.36	0.45	1.22	0.54	-0.11	0.15	-0.88	0.24
4	99.99	-1.26	-3.06	-0.04	1.99	1.16	1.13	-0.53	0.03	0.36
5	99.99	-0.37	-2.33	0.25	1.27	1.03	0.85	-0.17	-0.48	0.28
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5
Mean Log q	-10.1533	-10.3306	-10.6324	-10.699
S.E(Log q)	1.0409	0.7358	1.4136	1.0513

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.29	-0.257	7.14	0.1	10	2.08	-9.18
1	0.77	0.331	11.14	0.22	10	0.75	-9.71

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.1	-0.105	9.58	0.12	10	1.23	-10.15
3	1.45	-0.447	8.09	0.12	10	1.12	-10.33
4	-1.58	-1.519	21.75	0.05	10	2.07	-10.63
5	-4.82	-1.407	32.84	0.01	10	4.79	-10.7
1							

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1995

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	0	0	0	0	0	0
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	1	0	0	0	0	0	0
Spanish Survey (Bott	11477853	3.247	0	0	1	0.01	0
Norwegian Sea acoust	3447	7.991	0	0	1	0.002	0
Portuguese survey (B	28984174	2.237	0	0	1	0.02	0
P shrinkage mean	8115447	0.45				0.532	0.314
F shrinkage mean	218691664	0.5				0.437	0.014

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
34804856	0.33	0.95	5	2.874	0.082

Age 1 Catchability dependent on age and year class strength

Year class = 1994

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	0	0	0	0	0	0
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	7262987	1.124	0	0	1	0.034	0.036
Spanish Survey (Bott	19570009	2.116	0.547	0.26	2	0.01	0.014
Norwegian Sea acoust	8138264	0.3	0	0	1	0.483	0.032
Portuguese survey (B	4590907	0.76	0.625	0.82	2	0.075	0.057
P shrinkage mean	6016957	0.46				0.216	0.044
F shrinkage mean	3722063	0.5				0.181	0.07

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6366357	0.21	0.16	8	0.737	0.041

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	9362860	1.014	0	0	1	0.064	0.034
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	3396602	0.401	0.696	1.73	2	0.407	0.09
Spanish Survey (Bott	5309576	1.081	1.357	1.26	3	0.056	0.059
Norwegian Sea acoust	5967326	1.231	1.193	0.97	2	0.043	0.052
Portuguese survey (B	8420240	0.659	0.822	1.25	3	0.147	0.037
F shrinkage mean	3152596	0.5				0.283	0.097

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4259531	0.26	0.28	12	1.069	0.072

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	2591140	0.604	0.55	0.91	2	0.068	0.137
USSR Spawning Area/A	5078076	0.762	0	0	1	0.043	0.072
CPUE Spanish Pair Tr	1376426	0.339	0.137	0.4	3	0.212	0.245
Spanish Survey (Bott	1437583	0.397	0.433	1.09	4	0.158	0.235
Norwegian Sea acoust	2054307	0.278	0.185	0.67	3	0.298	0.17
Portuguese survey (B	1065061	0.494	0.56	1.13	4	0.098	0.306
F shrinkage mean	1897460	0.5				0.122	0.183

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1749461	0.16	0.14	18	0.899	0.197

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1540676	0.407	0.299	0.73	3	0.132	0.242
USSR Spawning Area/A	2960033	0.757	0	0	1	0.04	0.133
CPUE Spanish Pair Tr	2024972	0.298	0.112	0.38	4	0.228	0.189
Spanish Survey (Bott	1362980	0.36	0.293	0.81	5	0.16	0.269
Norwegian Sea acoust	1147217	0.279	0.342	1.23	3	0.232	0.313
Portuguese survey (B	1291036	0.467	0.385	0.82	5	0.089	0.282
F shrinkage mean	1405878	0.5				0.119	0.262

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1501123	0.15	0.11	22	0.756	0.247

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	796643	0.349	0.28	0.8	4	0.159	0.53
USSR Spawning Area/A	1489759	0.536	0.537	1	2	0.07	0.318
CPUE Spanish Pair Tr	1673976	0.254	0.121	0.47	5	0.287	0.287
Spanish Survey (Bott	1149233	0.311	0.166	0.53	6	0.194	0.395
Norwegian Sea acoust	983879	0.515	0.423	0.82	3	0.071	0.449
Portuguese survey (B	1129740	0.438	0.204	0.46	6	0.089	0.401
F shrinkage mean	1388928	0.5				0.13	0.337

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1244673	0.14	0.09	27	0.63	0.37

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1989

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1358205	0.346	0.104	0.3	5	0.137	0.427
USSR Spawning Area/A	722466	0.458	0.147	0.32	3	0.098	0.694
CPUE Spanish Pair Tr	568789	0.244	0.131	0.54	6	0.301	0.821
Spanish Survey (Bott	648986	0.318	0.238	0.75	7	0.139	0.749
Norwegian Sea acoust	1210909	0.514	0.148	0.29	4	0.073	0.469
Portuguese survey (B	542856	0.446	0.119	0.27	6	0.056	0.847
F shrinkage mean	1555734	0.5				0.196	0.382

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
857257	0.15	0.1	32	0.641	0.612

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1988

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	253397	0.321	0.196	0.61	6	0.155	0.645
USSR Spawning Area/A	337424	0.428	0.117	0.27	4	0.086	0.519
CPUE Spanish Pair Tr	325910	0.236	0.171	0.72	6	0.229	0.533
Spanish Survey (Bott	191529	0.304	0.206	0.68	8	0.168	0.788
Norwegian Sea acoust	230194	0.306	0.149	0.49	5	0.139	0.692
Portuguese survey (B	459506	0.449	0.197	0.44	6	0.046	0.405
F shrinkage mean	446854	0.5				0.176	0.415

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
294265	0.14	0.08	36	0.585	0.577

Table 6.4.4. Blue Whiting. XSA diagnostics. (cont.)

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1987

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	180208	0.29	0.203	0.7	7	0.204	0.589
USSR Spawning Area/A	139955	0.368	0.246	0.67	5	0.111	0.71
CPUE Spanish Pair Tr	161705	0.236	0.128	0.54	6	0.198	0.639
Spanish Survey (Bott	140619	0.295	0.308	1.04	7	0.14	0.707
Norwegian Sea acoust	160754	0.309	0.267	0.86	6	0.121	0.642
Portuguese survey (B	374286	0.459	0.3	0.65	6	0.041	0.327
F shrinkage mean	219579	0.5				0.185	0.506

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
174558	0.14	0.09	38	0.631	0.603

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1986

Fleet		Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	97532	0.306	0.186	0.61	8	0.236	0.441
USSR Spawning Area/A	63000	0.392	0.372	0.95	6	0.121	0.619
CPUE Spanish Pair Tr	80283	0.257	0.148	0.58	6	0.161	0.514
Spanish Survey (Bott	87037	0.329	0.297	0.9	7	0.114	0.483
Norwegian Sea acoust	74074	0.348	0.309	0.89	7	0.098	0.547
Portuguese survey (B	197218	0.507	0.258	0.51	5	0.026	0.242
F shrinkage mean	86347	0.5				0.245	0.486

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
85156	0.16	0.09	40	0.55	0.491

Table 6.4.5. Blue Whiting. F-at-age 1981-95

Run title : BLUE WHITING 1996 WG

At 26/04/1996 11:01

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1981	1982	1983	1984	1985
AGE					
0	0.01	0.17	0.02	0.05	0.13
1	0.08	0.04	0.16	0.14	0.15
2	0.10	0.12	0.19	0.25	0.18
3	0.17	0.13	0.16	0.23	0.33
4	0.12	0.20	0.16	0.23	0.24
5	0.27	0.13	0.16	0.23	0.26
6	0.28	0.21	0.23	0.37	0.45
7	0.23	0.21	0.36	0.31	0.38
8	0.29	0.20	0.36	0.44	0.35
9	0.26	0.21	0.26	0.34	0.40
+gp	0.26	0.21	0.26	0.34	0.40
FBAR 3-7	0.21	0.18	0.21	0.28	0.33

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	FBAR 93-95
AGE											
0	0.01	0.05	0.01	0.10	0.01	0.03	0.00	0.02	0.00	0.08	0.04
1	0.09	0.11	0.08	0.13	0.11	0.04	0.08	0.07	0.05	0.04	0.05
2	0.13	0.11	0.14	0.18	0.15	0.09	0.12	0.08	0.04	0.07	0.06
3	0.24	0.16	0.17	0.40	0.25	0.15	0.21	0.17	0.13	0.20	0.17
4	0.56	0.42	0.23	0.35	0.41	0.17	0.25	0.32	0.15	0.25	0.24
5	0.57	0.48	0.57	0.48	0.40	0.35	0.18	0.29	0.45	0.37	0.37
6	0.45	0.39	1.04	0.70	0.73	0.36	0.25	0.23	0.33	0.61	0.39
7	0.57	0.49	0.45	0.70	0.75	0.45	0.25	0.27	0.34	0.58	0.40
8	0.56	0.87	0.49	0.53	1.21	0.25	0.42	0.23	0.39	0.60	0.41
9	0.71	0.65	0.60	0.45	0.61	0.21	0.26	0.37	0.49	0.49	0.45
+gp	0.71	0.65	0.60	0.45	0.61	0.21	0.26	0.37	0.49	0.49	
FBAR 3-7	0.48	0.39	0.49	0.53	0.51	0.30	0.23	0.26	0.28	0.40	

Table 6.6.1. (cont.)

PARAMETERS OF THE DISTRIBUTION OF ln CATCHES AT AGE

Separable model fitted from 1990 to 1995

Variance	:	.2006
Skewness test statistic	:	.5322
Kurtosis test statistic	:	.0143
Partial chi-square	:	.5373
Probability of chi-square	:	1.0000
Degrees of freedom	:	31

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR ln AGED INDEX 1

Linear catchability relationship assumed.

Age	:	2	3	4	5	6	7	8	9	10
Variance	:	.9637	.5450	.3189	.3902	.7233	.4813	.3805	.6915	1.1659
Skewness test stat.	:	-1.2905	.6825	-.6083	.1852	.2494	-.8097	-.3717	-.8310	-.1663
Kurtosis test stat.	:	-.1639	-.7354	-.9324	-.9594	-.8535	-.4533	-.5659	-.7380	-.6701
Partial chi-square	:	1.4320	.7659	.4328	.5585	1.1585	.8167	.7058	1.4059	2.9326
Prob. of chi-square	:	.9999	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9999	.9960
Number of data	:	13	13	13	13	13	13	13	13	13
Degrees of freedom	:	12	12	12	12	12	12	12	12	12
Weight in analysis	:	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111

DISTRIBUTION STATISTICS FOR ln AGED INDEX 2

Linear catchability relationship assumed.

Age	:	3	4	5	6	7	8	9	10
Variance	:	.7780	.5839	.6134	.4486	.7125	.7842	1.0315	1.3238
Skewness test stat.	:	-1.0343	-.3088	-1.1677	-.5786	1.7581	1.5300	1.9180	-1.3178
Kurtosis test stat.	:	1.0009	-.8002	-.7183	-.2771	1.0286	1.1445	1.0214	.0158
Partial chi-square	:	1.1205	.8334	.9026	.7069	1.2898	1.5514	2.1108	3.0523
Prob. of chi-square	:	1.0000	1.0000	1.0000	1.0000	.9999	.9998	.9981	.9900
Number of data	:	13	13	13	13	13	13	12	12
Degrees of freedom	:	12	12	12	12	12	12	11	11
Weight in analysis	:	.1250	.1250	.1250	.1250	.1250	.1250	.1250	.1250

DISTRIBUTION STATISTICS FOR ln AGED INDEX 3

Linear catchability relationship assumed.

Age	:	1	2	3	4	5	6
Variance	:	.8987	.1471	.4342	.3799	.2277	.2874
Skewness test stat.	:	-2.2059	-.7344	-.3448	-.6480	.5059	-.7205
Kurtosis test stat.	:	1.3214	-.1271	-1.1497	-.5810	-.6444	-.7711
Partial chi-square	:	1.2106	.1778	.5578	.5369	.3587	.5357
Prob. of chi-square	:	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
Number of data	:	13	13	13	13	13	13
Degrees of freedom	:	12	12	12	12	12	12
Weight in analysis	:	.1667	.1667	.1667	.1667	.1667	.1667

Table 6.6.1. (cont.)

DISTRIBUTION STATISTICS FOR ln AGED INDEX 4

Linear catchability relationship assumed.

Age	0	1	2	3	4	5	6	7	8
Variance	.4826	1.7200	1.3239	.5020	.6549	.5590	.7615	.6579	.9492
Skewness test stat.	.1811	-.5563	-.6010	.0495	-.4221	.0467	1.0733	.0783	-.4188
Kurtosis test stat.	-.7354	-.8104	.1060	-.7708	-.5867	-.4623	-.6370	-.6051	-.1313
Partial chi-square	.3942	2.4539	1.9192	.7221	.9615	.9159	1.3841	1.3068	2.0495
Prob. of chi-square	.9997	.9962	.9988	1.0000	1.0000	1.0000	.9997	.9998	.9983
Number of data	8	12	12	12	12	12	12	12	12
Degrees of freedom	7	11	11	11	11	11	11	11	11
Weight in analysis	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111

DISTRIBUTION STATISTICS FOR ln AGED INDEX 5

Linear catchability relationship assumed.

Age	0	1	2	3	4	5
Variance	2.5145	.7779	.7729	.6108	1.9398	1.1415
Skewness test stat.	-.5044	.5107	-1.0693	-.5803	-.8738	-.9407
Kurtosis test stat.	-.6997	-.8337	-.2151	-.3217	.1083	-.0797
Partial chi-square	3.3228	1.1568	1.4504	1.2258	4.4830	3.0711
Prob. of chi-square	.9501	.9990	.9975	.9987	.8769	.9614
Number of data	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9
Weight in analysis	.1667	.1667	.1667	.1667	.1667	.1667

Table 6.6.1. (cont.)

```
Total weighted SSQ is :        48.359193101924330

Unweighted Residuals About the Model fit
----------------------------------------
                      Start SSQ      End SSQ   df        Variance     IV Wt
Separable model:         5.8544       6.2214  31          .2007  4.98280
   Aged index  1    118.2478039   67.9235731 108          .6289   .31910
   Aged index  2    122.2648854   72.9563320  94          .7761   .25858
   Aged index  3     30.7934761   28.5001450  72          .3958   .50700
   Aged index  4     82.6927326   81.7908911  95          .8610   .23310
   Aged index  5     74.1738896   69.8164171  54         1.2929   .15523

Partition of the weighted residuals
-----------------------------------

 Catch at Age Matrix :     .6221E+01 for    60 observations.


Aged Index           1
Age:                2          3          4          5          6          7          8          9         10
 Wted SSQ: .1285E+01 .7266E+00 .4252E+00 .5203E+00 .9643E+00 .6418E+00 .5073E+00 .9220E+00 .1555E+01
 No data:         13         13         13         13         13         13         13         13         13
Aged Index           2
Age:                3          4          5          6          7          8          9         10
 Wted SSQ: .1167E+01 .8758E+00 .9201E+00 .6730E+00 .1069E+01 .1176E+01 .1418E+01 .1820E+01
 No data:         13         13         13         13         13         13         12         12
Aged Index           3
Age:                1          2          3          4          5          6
 Wted SSQ: .1797E+01 .2941E+00 .8685E+00 .7597E+00 .4554E+00 .5748E+00
 No data:         13         13         13         13         13         13
Aged Index           4
Age:                0          1          2          3          4          5          6          7          8
 Wted SSQ: .3753E+00 .2102E+01 .1618E+01 .6136E+00 .8005E+00 .6832E+00 .9308E+00 .8041E+00 .1160E+01
 No data:          8         12         12         12         12         12         12         12         12
Aged Index           5
Age:                0          1          2          3          4          5
 Wted SSQ: .3772E+01 .1167E+01 .1159E+01 .9161E+00 .2910E+01 .1712E+01
 No data:         10         10         10         10         10         10
```

Table 6.7. Total catches of BLUE WHITING in 1978-1995 divided into areas within and beyond areas of national fisheries jurisdiction of NEAFC contracting parties, as estimated by the Working Group members.

Year	International	Jan Mayen	Norway	Iceland	Greenland	Faores	EU	Total (t)
1978	136,504	-	67,391	26.444	6.580	195,361	136,421	568,701
	(24 %)		(12 %)	(5 %)	(1 %)	(34 %)	(24 %)	
1979	614,734	-	75,545	15,117	204	224,202	191,564	1,121,365
	(55 %)		(7 %)	(1 %)	(0 %)	(20 %)	(17 %)	
1980	567,693	-	152,095	4,562	8,757	164,342	160,361	1,057,810
	(54 %)		(14 %)	(0 %)	(1 %)	(16 %)	(15 %)	
1981	168,681	123,000	215,004	7,751	-	174,801	203,223	892,460
	(19 %)	(14 %)	(24 %)	(1 %)		(20 %)	(23 %)	
1982	22,993	-	130,435	5,797	-	125,072	279,474	563,771
	(4 %)		(23 %)	(1 %)		(22 %)	(50 %)	
1983	15,203	-	109,675	7,000	-	91,804	325,816	549,498
	(3 %)		(20 %)	(1 %)		(17 %)	(59 %)	
1984	18,407	-	150,603	105	-	124,905	313,591	607,611
	(3 %)		(25 %)	(0 %)		(21 %)	(52 %)	
1985	38,978	-	114,785	-	-	196,003	335,162	684,928
	(6 %)		(17 %)			(29 %)	(49 %)	
1986	20,665	-	187,768	-	116	171,074	408,338	787,961
	(3 %)		(24 %)		(0 %)	(22 %)	(52 %)	
1987	103,535	-	109,201	-	-	135,980	267,045	615,761
	(17 %)		(18 %)			(22 %)	(43 %)	
1988	65,172	-	38,449	-	-	157,368	265,182	526,171
	(12 %)		(7 %)			(30 %)	(50 %)	
1989	137,093	-	68,817	4,977	-	101,177	318,033	630,097
	(22 %)		(11 %)	(1 %)		(16 %)	(50 %)	
1990	88, 509	-	39,160	-	-	115,308	318,710	561,687
	(16 %)		(7 %)			(21 %)	(57 %)	
1991	51,950	-	72,309	-	-	99,268	197,522	421,049
	(12 %)		(17 %)			(24 %)	(47 %)	
1992	47,786	-	66,333	-	-	135,294	253,754	503,167
	(9 %)		(13 %)			(27 %)	(50 %)	
1993	69,213	-	47,917	-	-	112,773	249,094	478,997
	(14 %)		(10 %)			(24 %)	(52 %)	
1994	68,926	-	36,933	-	-	133,678	218,303	457,840
	(15 %)		(8 %)			(29 %)	(48 %)	
1995	82,784	-	98,034	369	-	107,483	290,010	578,680
	(14,0 %)		(17,0 %)	(0 %)		(19,0 %)	(50,0 %)	

Table 11.2.1

Results from runs of the "biomass*time" model for the year-classes 1950, 1959 and 1983 of the Norwegian spring spawning herring when a factor is applied to the fishing mortality (F relative to the Reykjavik report).

F relative to Reykj. report	Year-class	Faroes	Iceland	Norway	Jan Mayen	Russia	Intern. Bar. Sea	Intern. Norw. Sea	Spits-bergen	EU	Total
0.3	1950	9.8	30.2	21.4	12.0	17.7	0.5	7.6	0.1	0.8	100
0.7	1950	9.2	28.6	21.8	11.4	20.4	0.5	7.2	0.1	0.7	100
1.0	1950	8.8	27.5	22.0	11.0	22.3	0.6	6.9	0.1	0.7	100
1.5	1950	8.3	25.8	22.5	10.4	25.3	0.7	6.4	0.1	0.6	100
3.0	1950	6.7	21.2	23.6	8.6	33.0	0.9	5.2	0.1	0.5	100
0.3	1959	8.5	28.3	33.4	3.3	7.6	-	8.7	9.5	0.7	100
0.7	1959	7.6	27.5	35.7	3.1	9.8	-	6.7	9.1	0.6	100
1.0	1959	7.1	26.6	36.7	3.0	11.2	-	5.9	9.1	0.5	100
1.5	1959	6.4	24.9	37.7	2.8	13.2	-	5.1	9.5	0.5	100
3.0	1959	4.8	19.9	38.5	2.4	19.3	-	3.8	10.9	0.4	100
0.3	1983	1.8	0.2	85.5	1.6	5.0	0.1	4.8	0.9	-	100
0.7	1983	1.5	0.2	86.7	1.2	5.7	0.1	3.7	0.9	-	100
1.0	1983	1.3	0.1	87.3	1.0	6.2	0.1	3.1	0.9	-	100
1.5	1983	1.1	0.1	87.9	0.7	6.8	0.2	2.4	0.8	-	100
3.0	1983	0.8	0.1	87.8	0.4	8.6	0.2	1.5	0.7	-	100

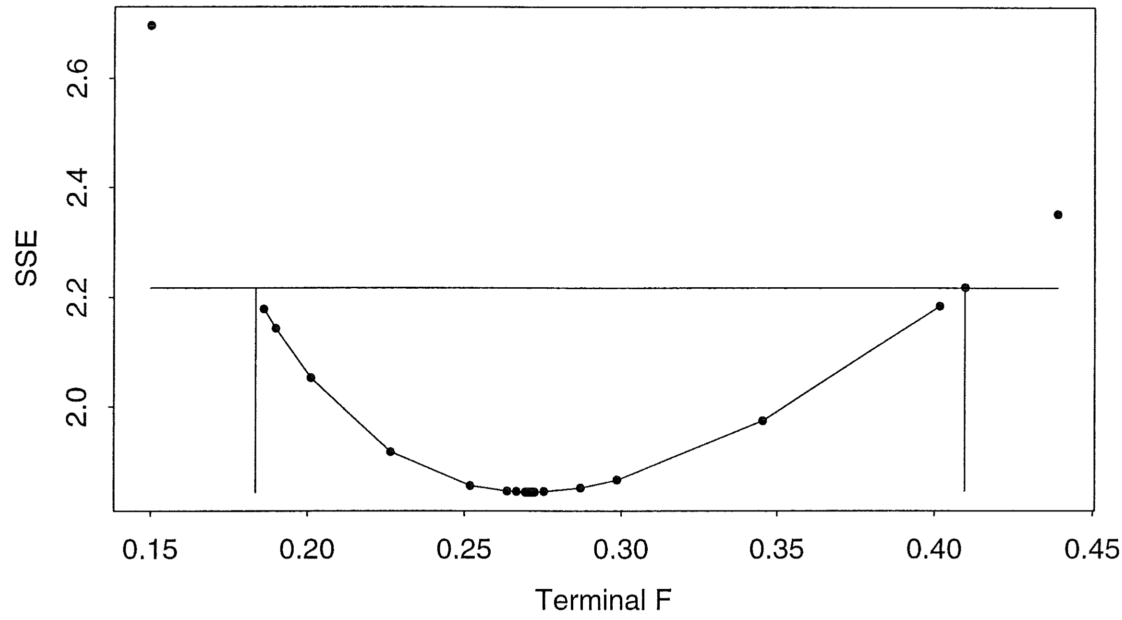
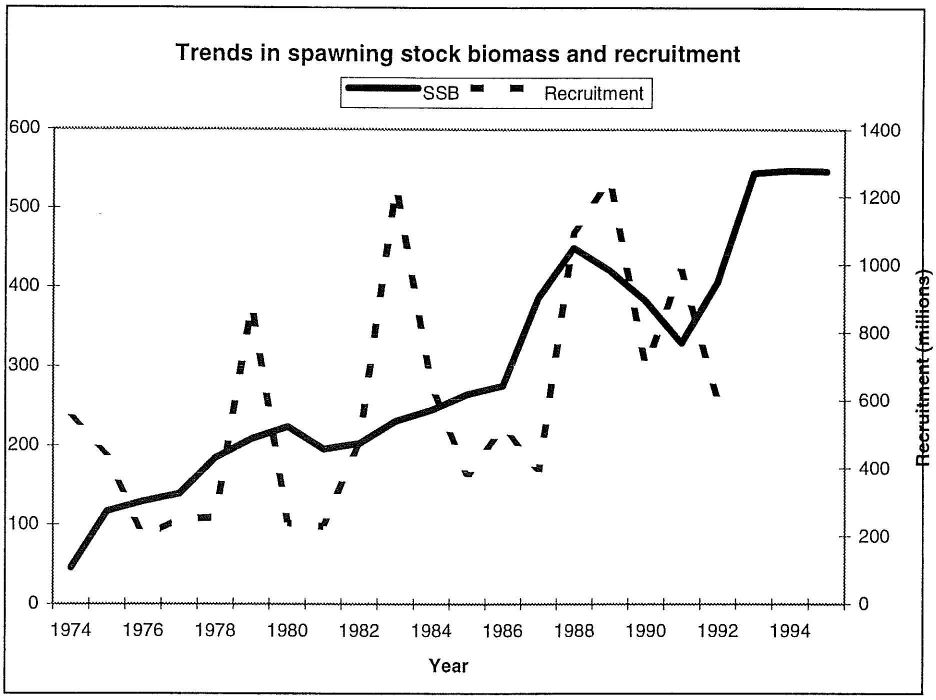


Figure 2.4.1. Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.



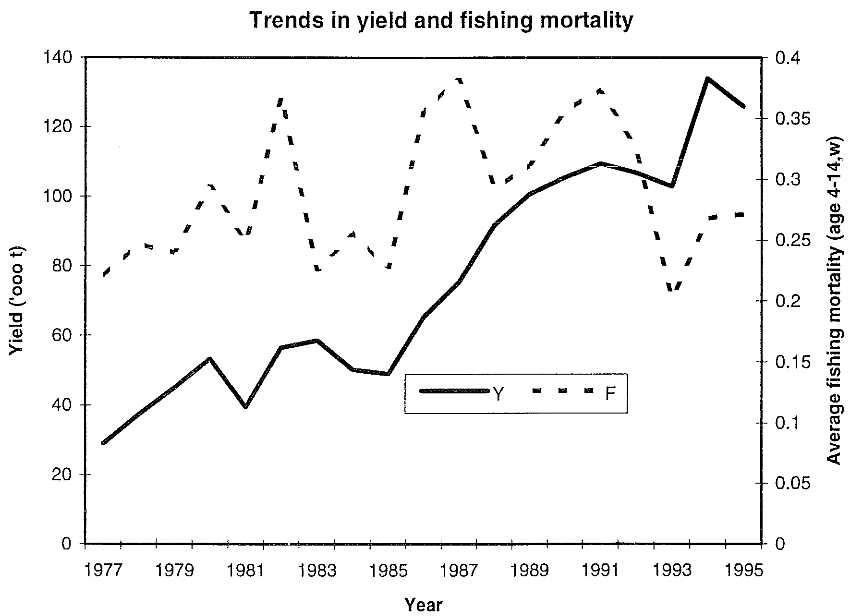


Figure 2.4.2 Icelandic summer spawning herring. Fish stock summary.

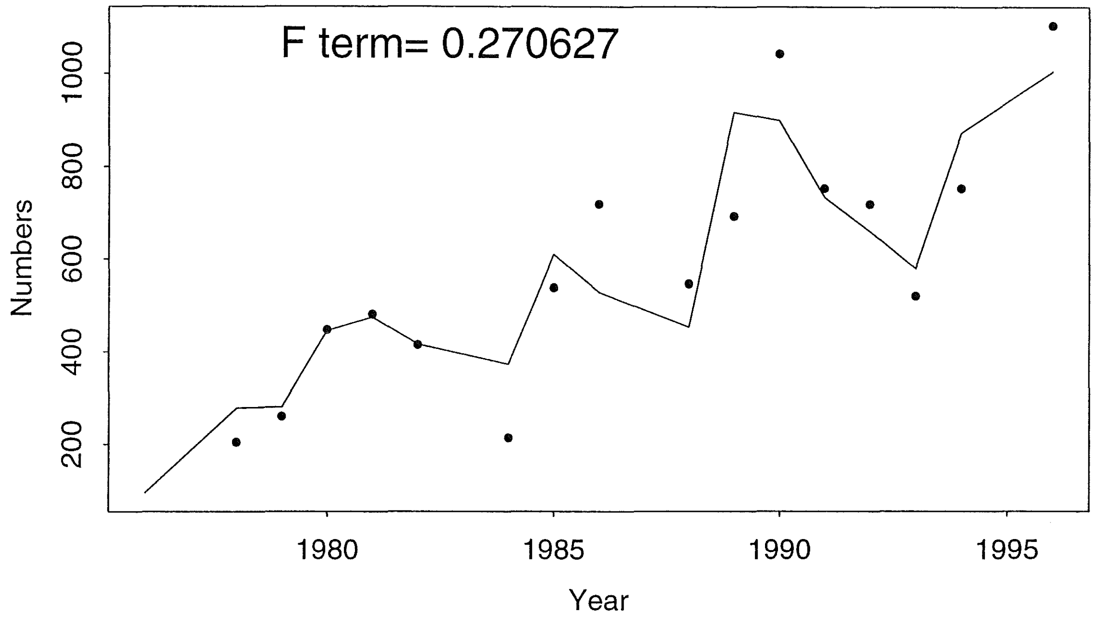


Figure 2.4.3. Icelandic summer spawners. Trends in acoustics and VPA stock numbers.

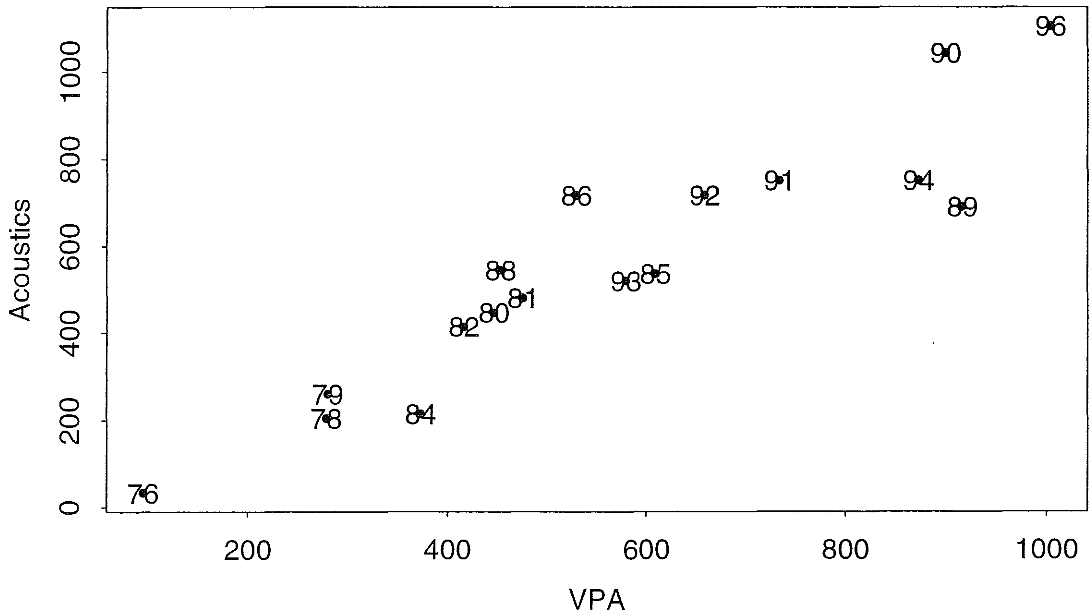


Figure 2.4.4. Icelandic summer spawners. Acoustic estimates vs VPA stock numbers.

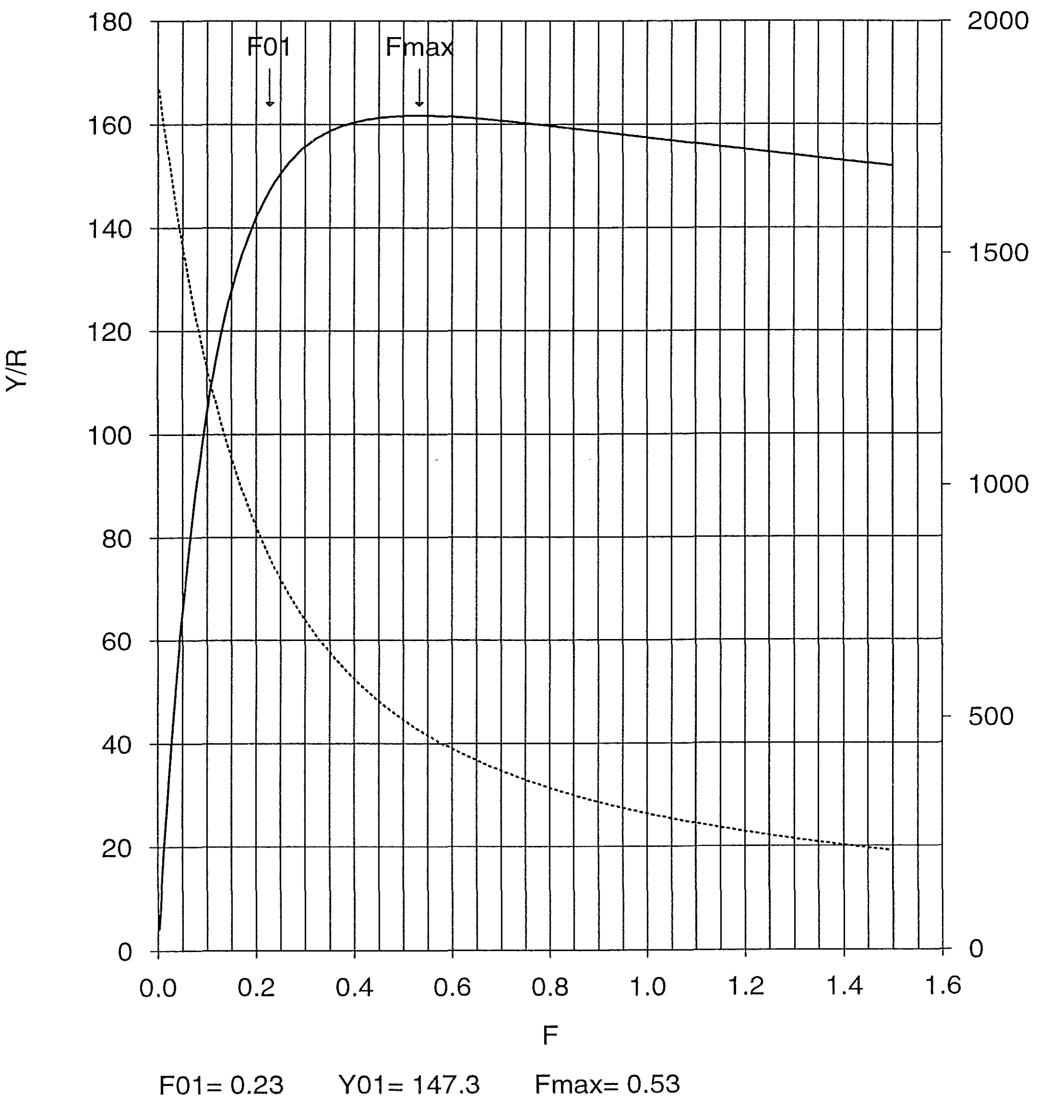


Figure 2.5.1. Icelandic summer spawners. Yield per recruit and spawning stock per recruit.

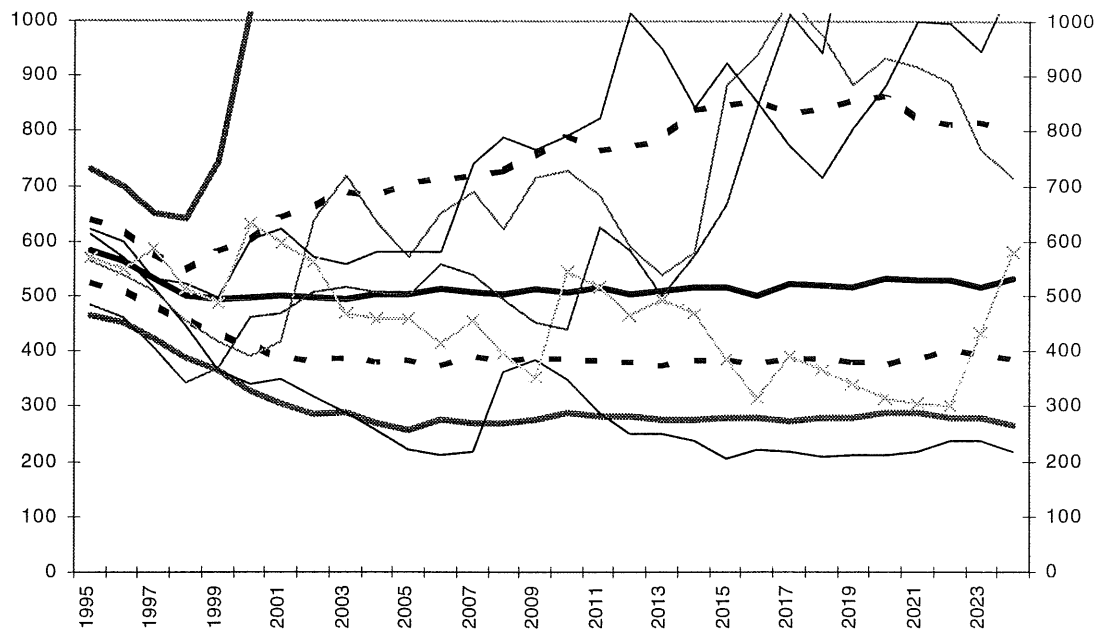
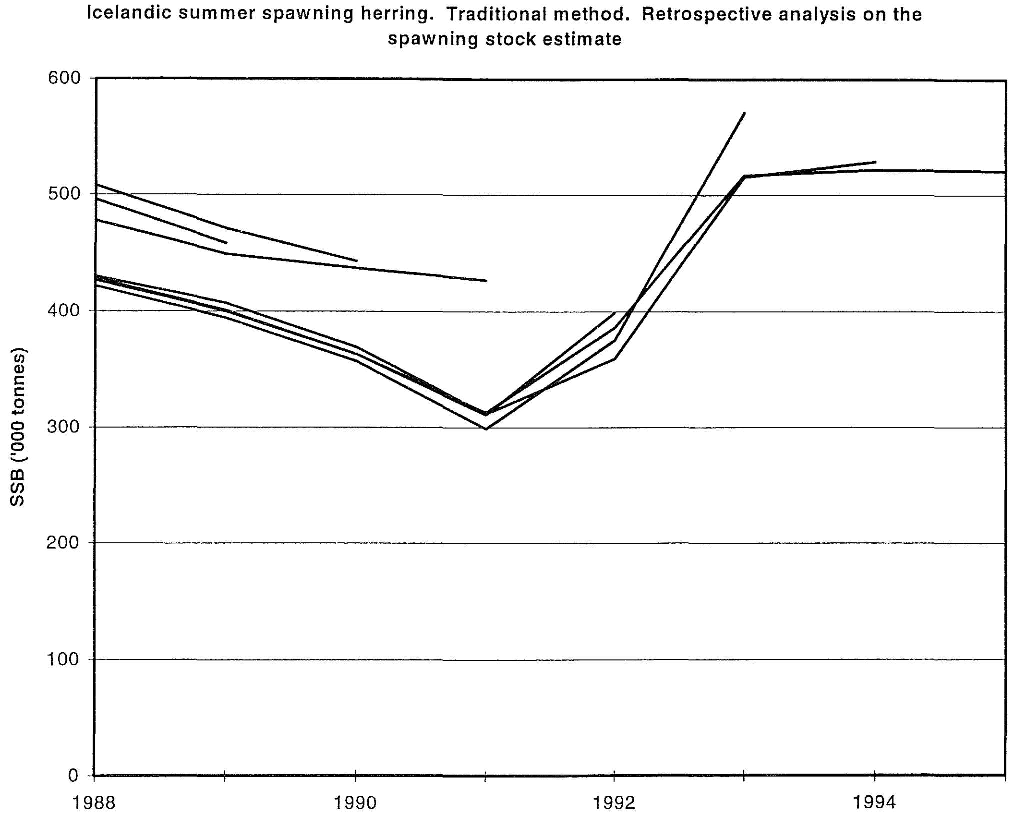


Figure 2.7.1 Icelandic summer spawning herring. Results from medim-term prodjection (from last years WG). Thin lines denote sample trajectories. Thick lines denote 5%, 25%, 75% and 95% percentiles.



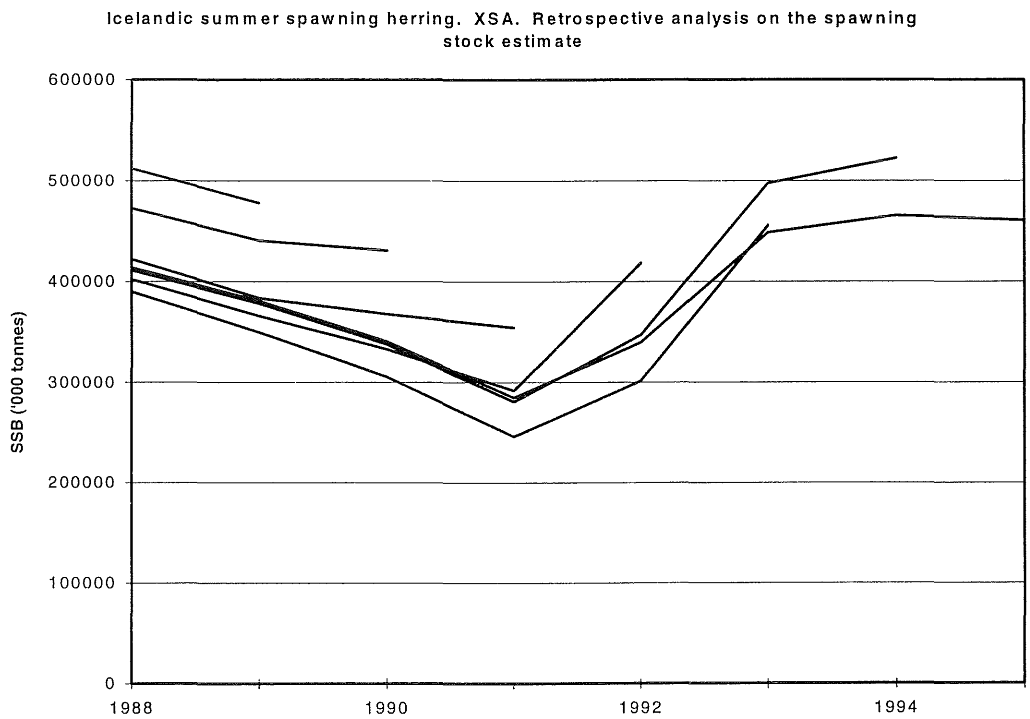


Figure 2.8.1. Icelandic summer spawners. Retrospective plots off the SSB using different tuning methods.

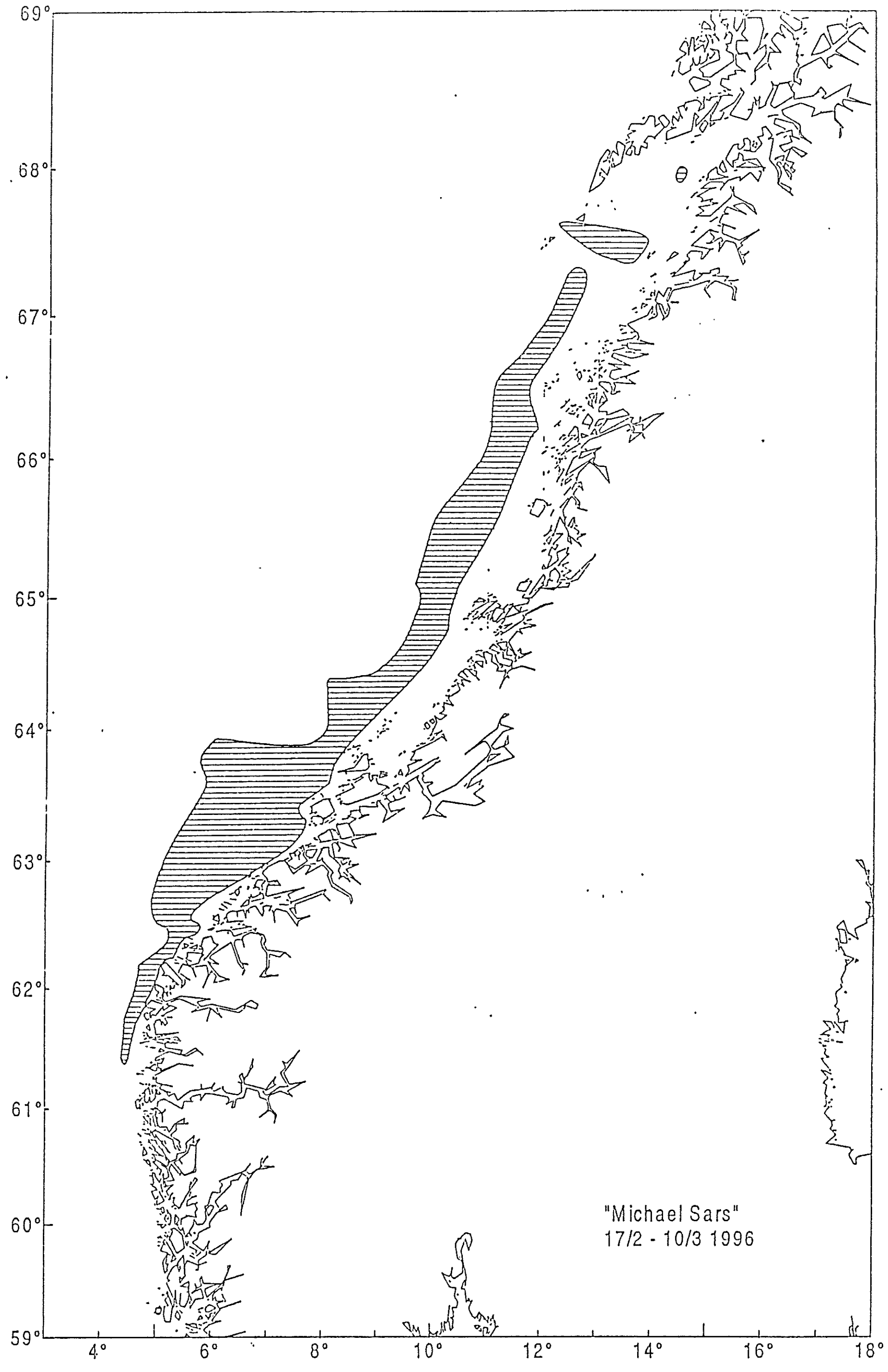


Fig 3.3.1 Norwegian spring spawning herring. Distribution of herring, 17.2 -10.3 1996

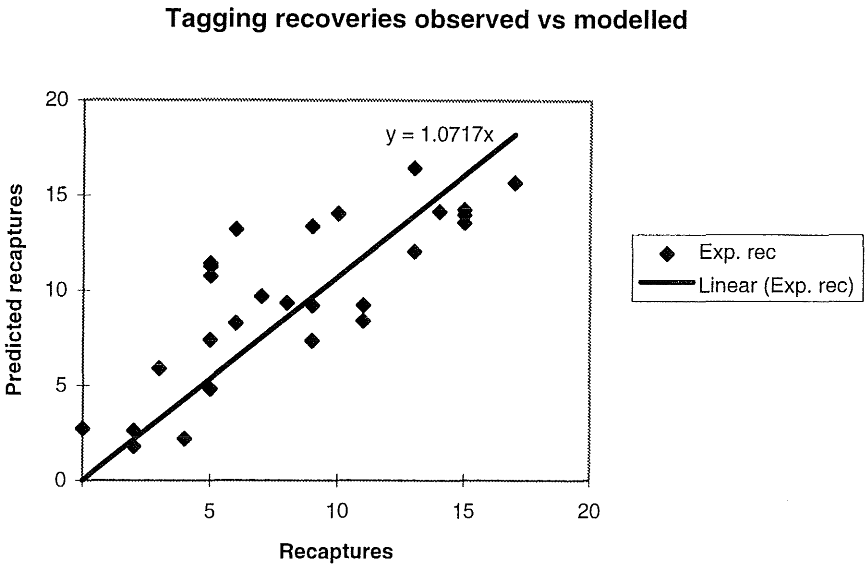


Figure 3.3.2. Norwegian Spring Spawning Herring. Actual versus expected number of recaptures.

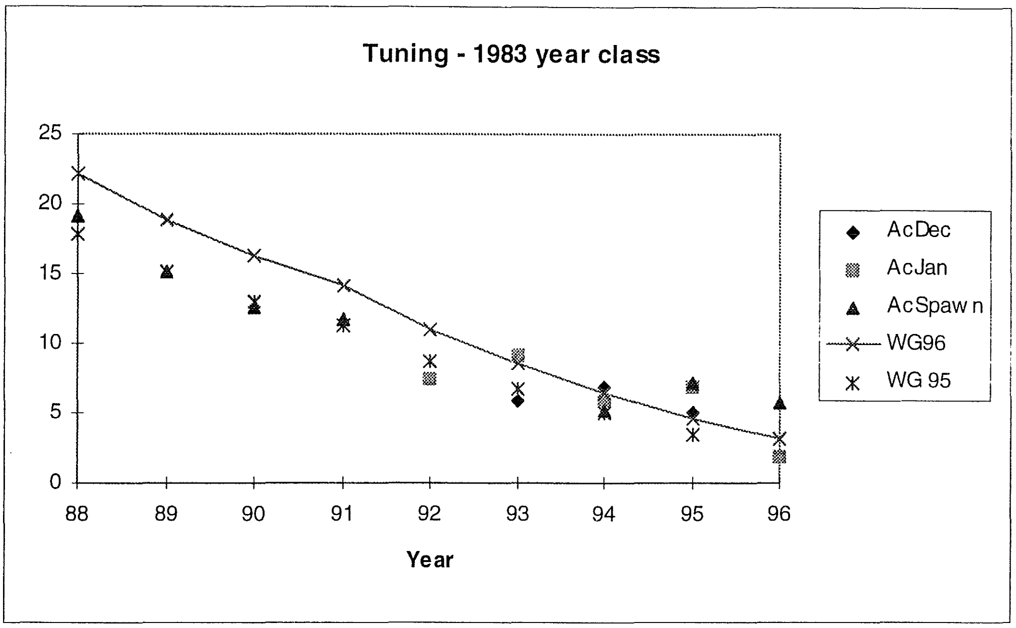


Figure 3.5.1. Norwegian Spring Spawning Herring. The VPA compared to survey data adjusted by estimated catchabilities. 1983 year class.

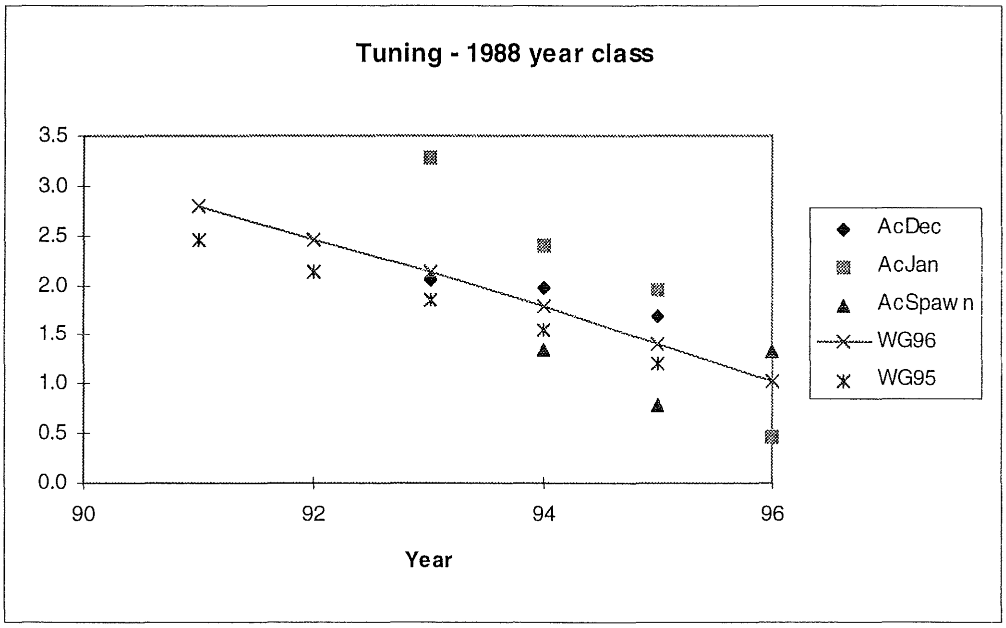


Figure 3.5.2. Norwegian Spring Spawning Herring. The VPA compared to survey data adjusted by estimated catchabilities. 1988 year class.

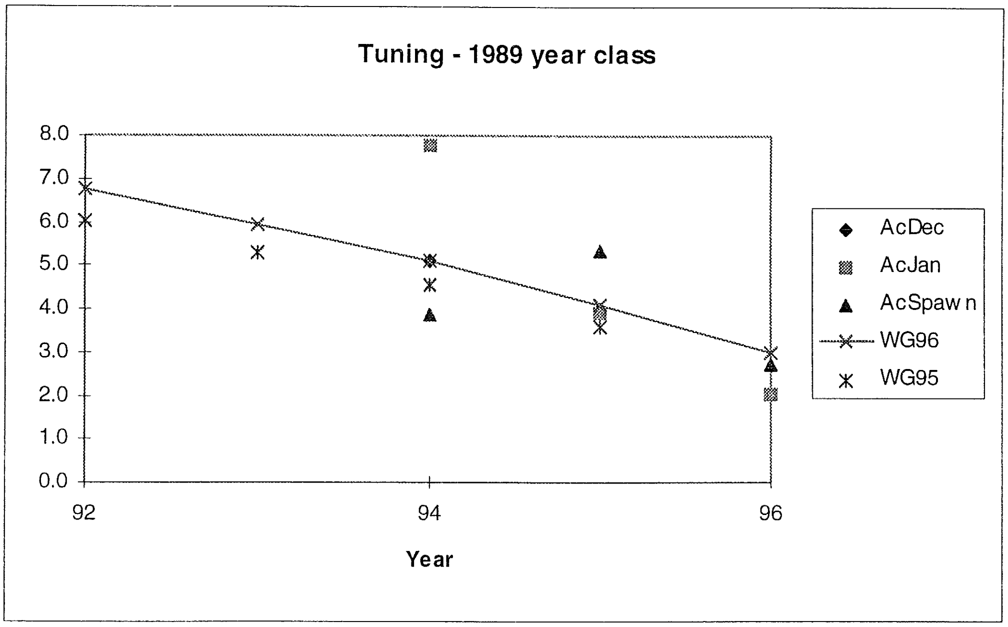


Figure 3.5.3. Norwegian Spring Spawning Herring. The VPA compared to survey data adjusted by estimated catchabilities. 1989 year class.

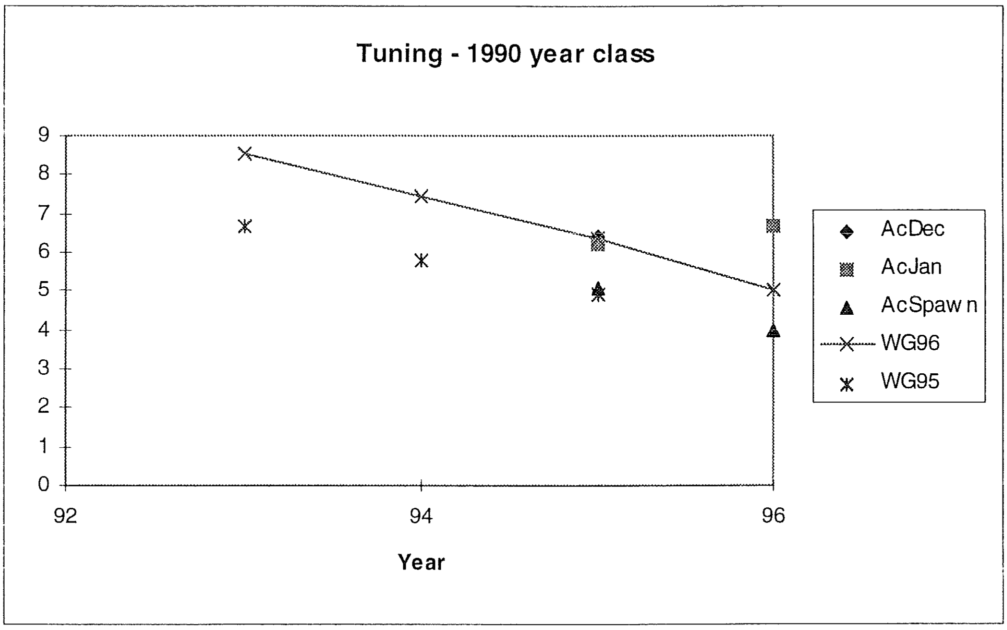


Figure 3.5.4. Norwegian Spring Spawning Herring. The VPA compared to survey data adjusted by estimated catchabilities. 1990 year class.

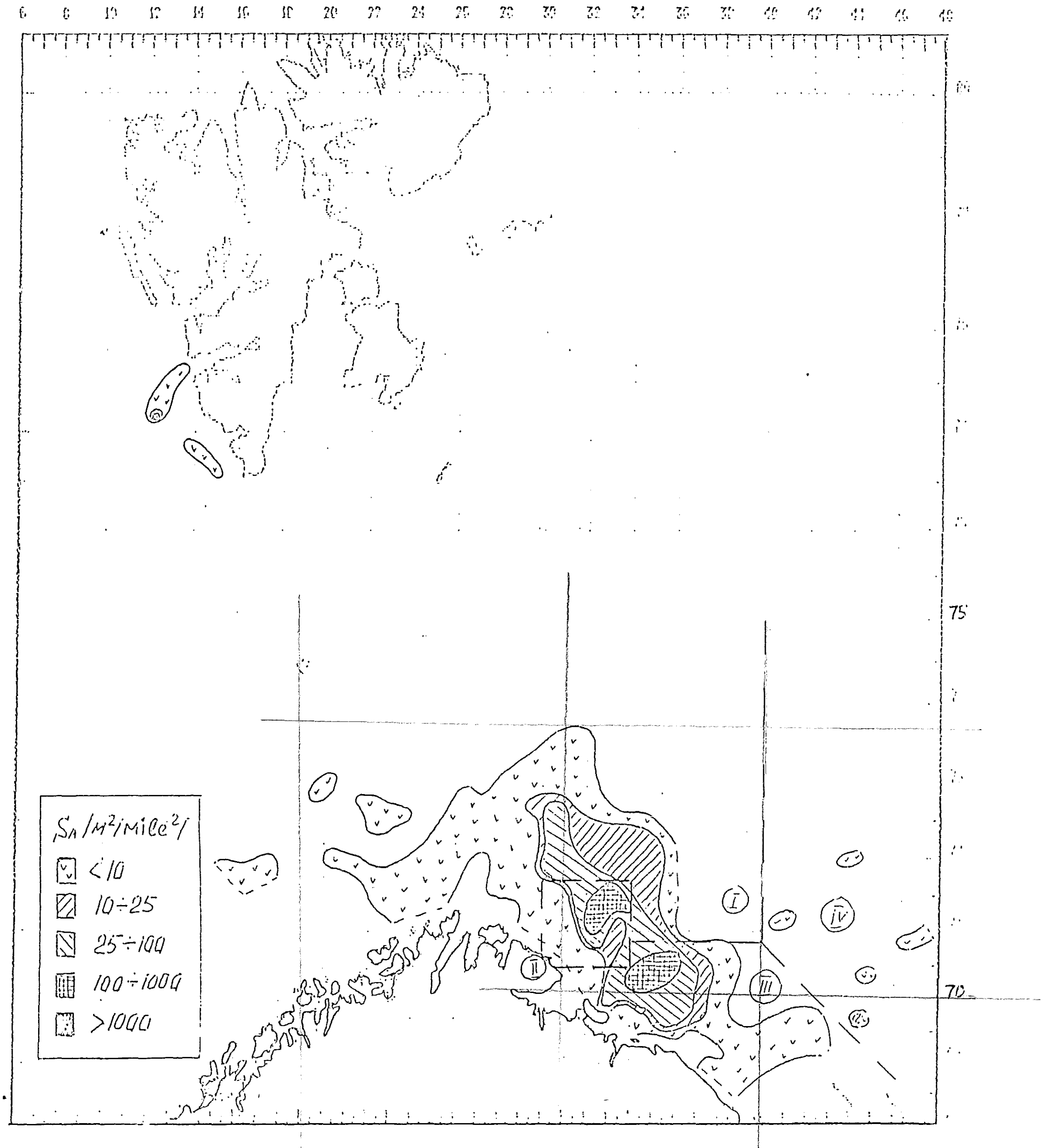


Fig 3.8.1 Distribution of immature herring in the Barents Sea, December 1995. Relative densities (integrator values) are indicated.

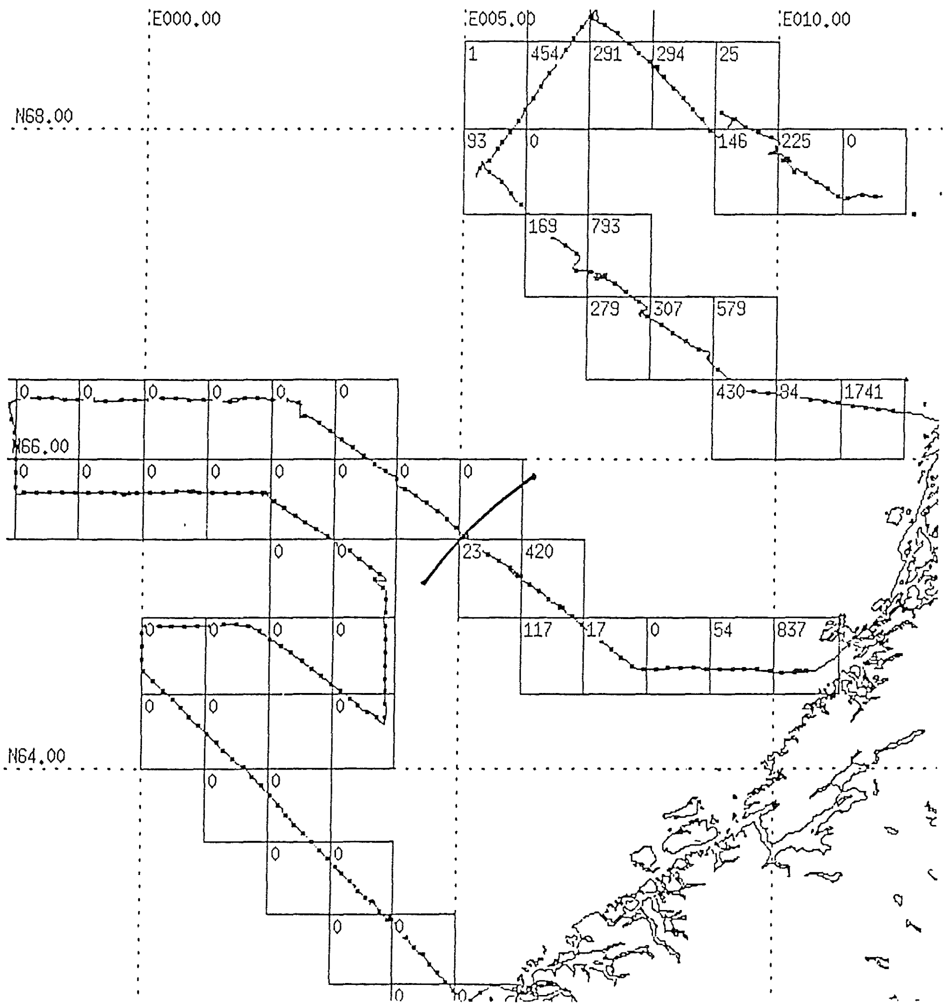


Fig 3.8.2 Distribution of herring in the Norwegian Sea as illustrated by mean integrator values allocated to herring in squares of 30' latitude and 1° longitude. Period 23.03 - 31.03 1996 .

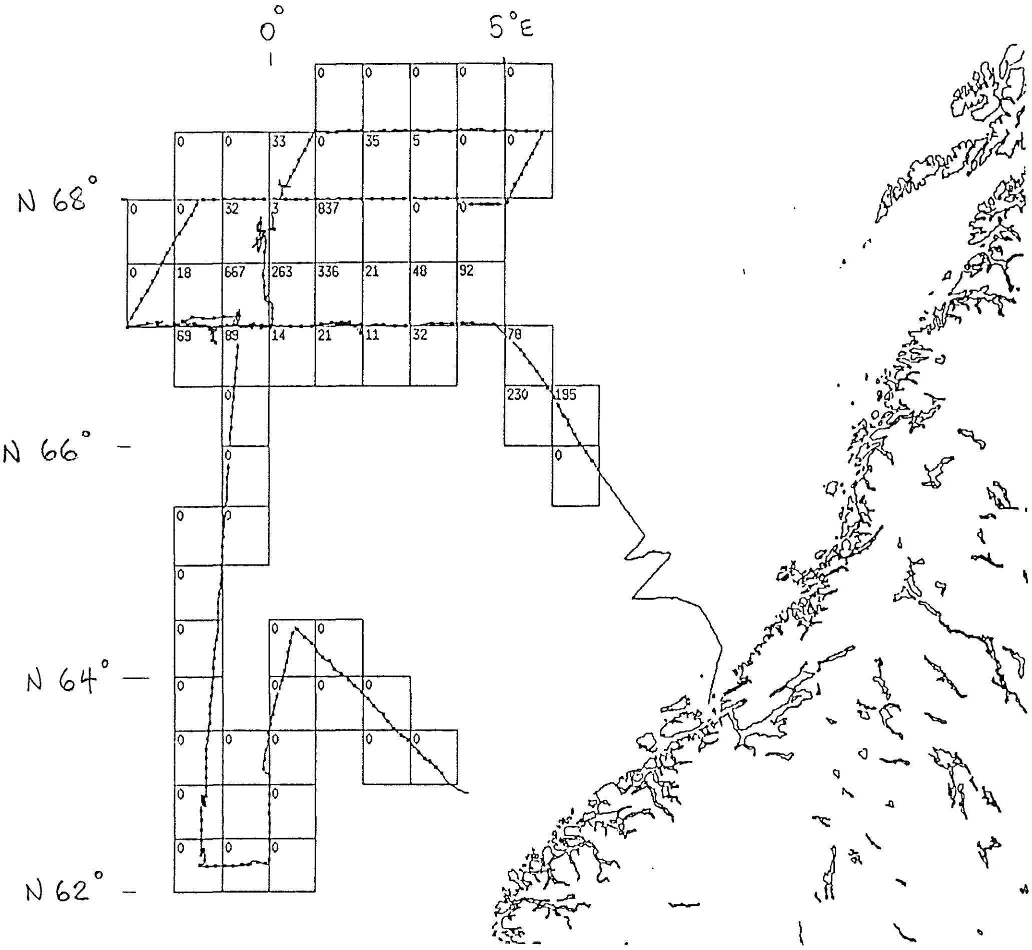


Fig 3.8.3 Distribution of herring in the Norwegian Sea as illustrated by mean integrator values allocated to herring in squares of 30' latitude and 1° longitude. Period 03.04 - 18.04 - 1996.

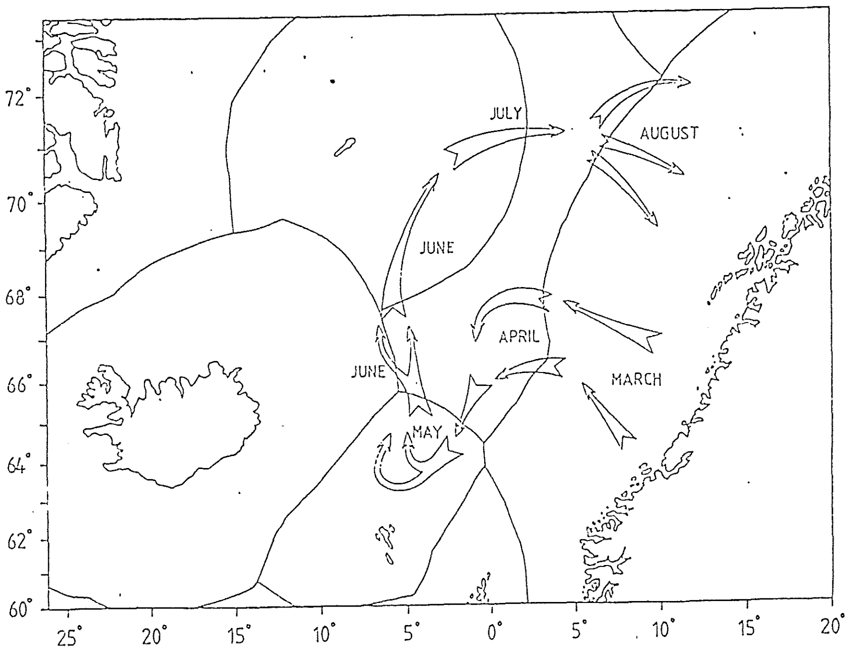


Fig 3.8.4 Adult Norwegian spring spawning herring. General migration pattern in spring/summer 1995.

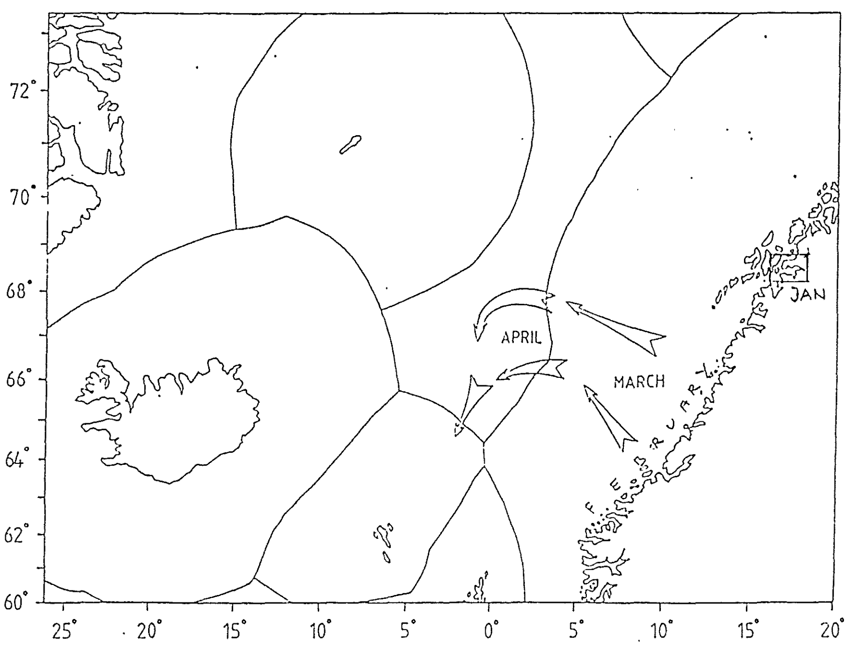


Fig 3.8.5 Adult Norwegian spring spawning herring. General migration pattern January to April 1996.

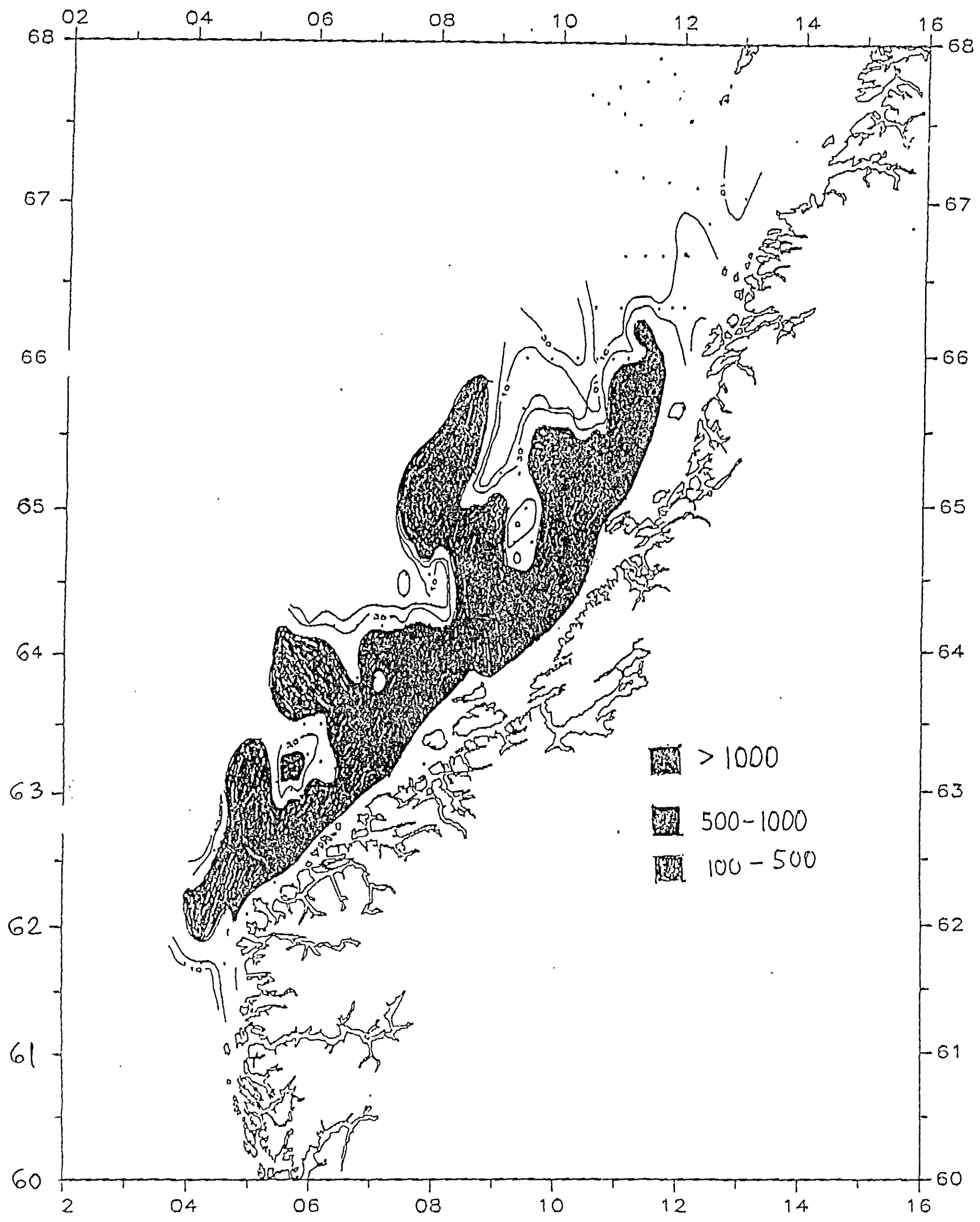


Fig 3.8.6 Norwegian spring spawning herring. Distribution of larvae , April 1996

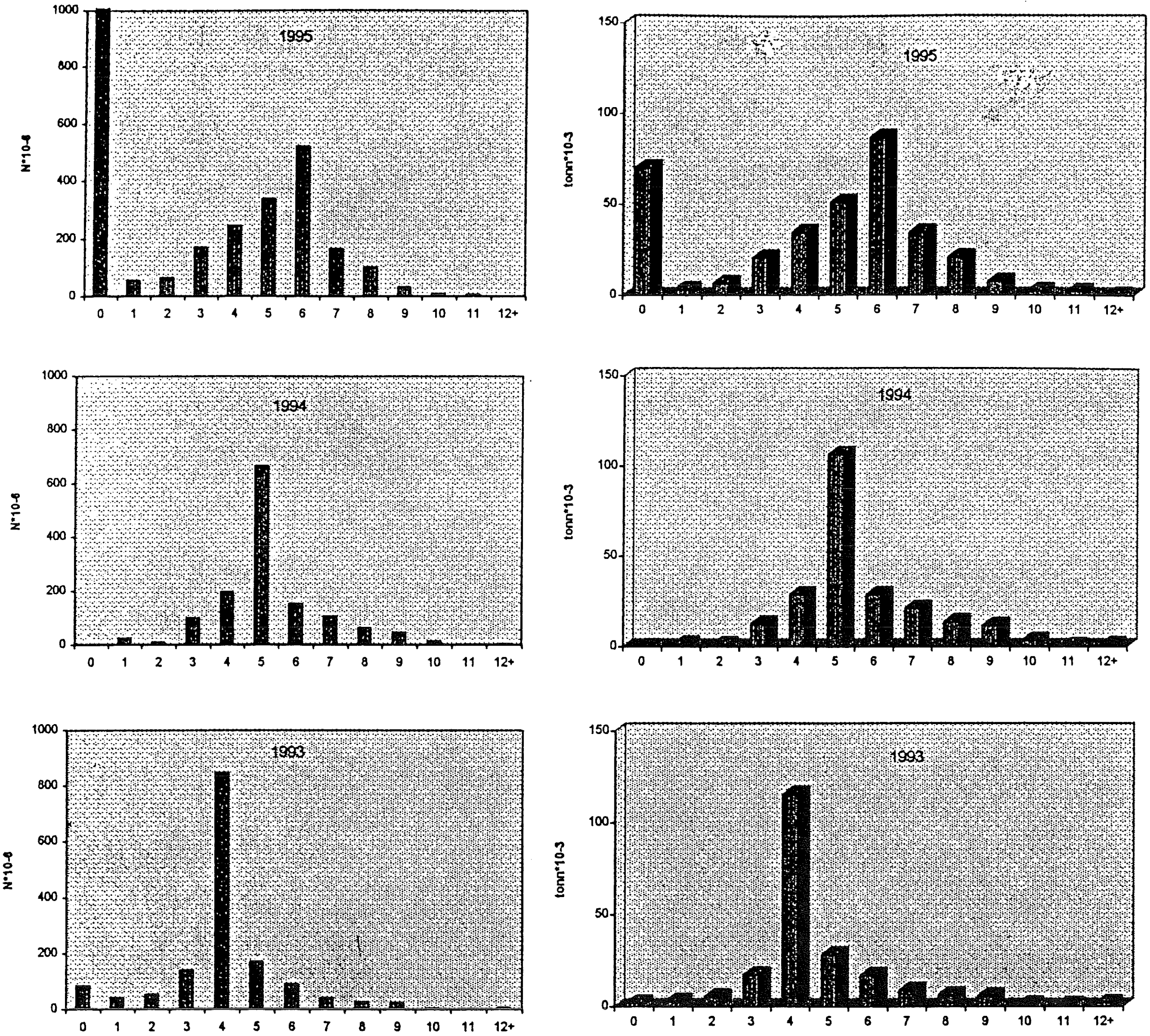


Fig. 6.2.1. Total Norwegian landings of blue whiting, by age, 1993-1995, showing the significant catches of 0-group fish in 1995.

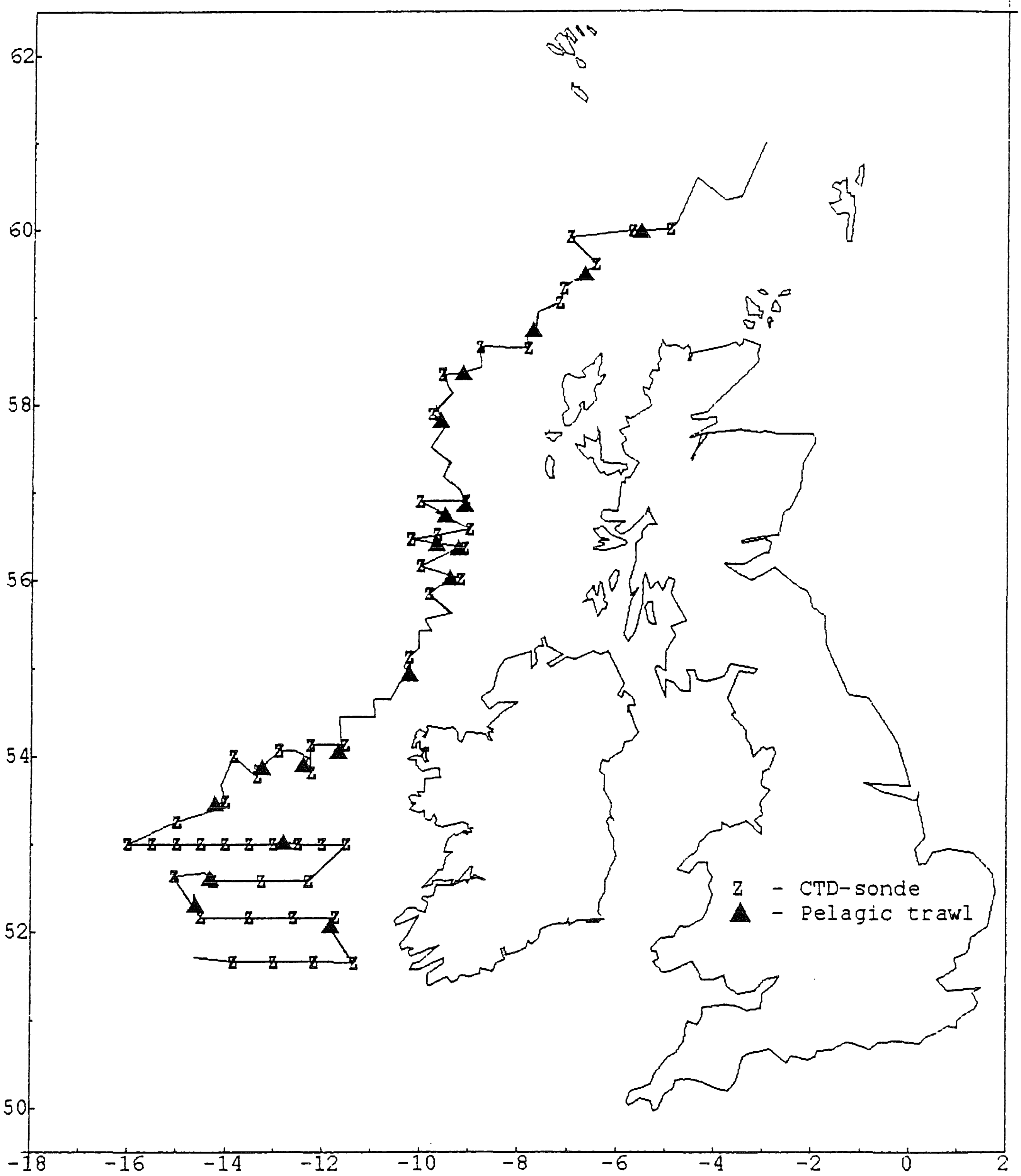


Fig. 6.4.1. Cruise tracks and stations of R/V "Fridtjof Nansen", Russia, April 1996.

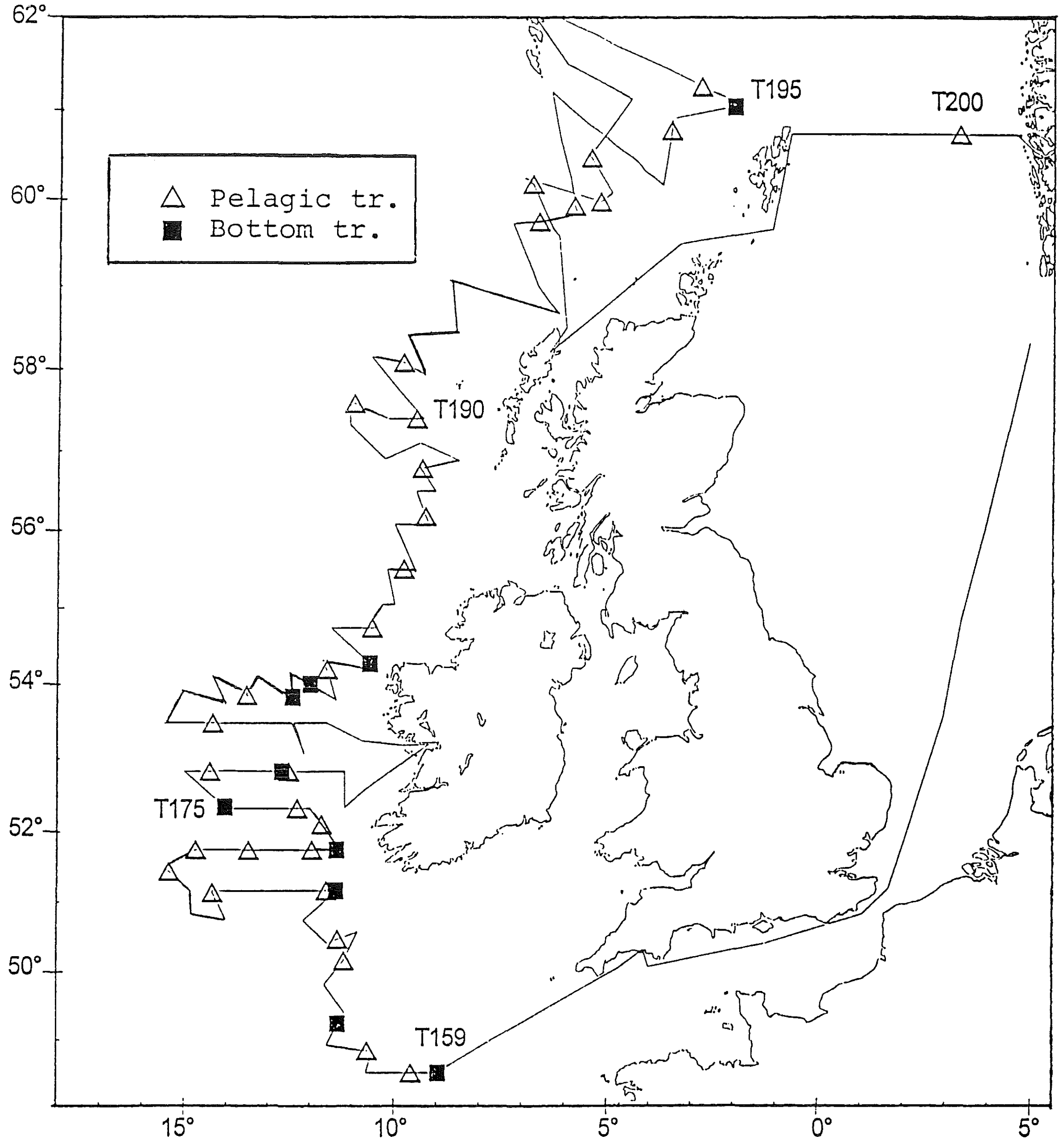


Fig. 6.4.2. Cruise tracks and trawl stations of R/V "Johan Hjort" 20 March-22 April 1996.

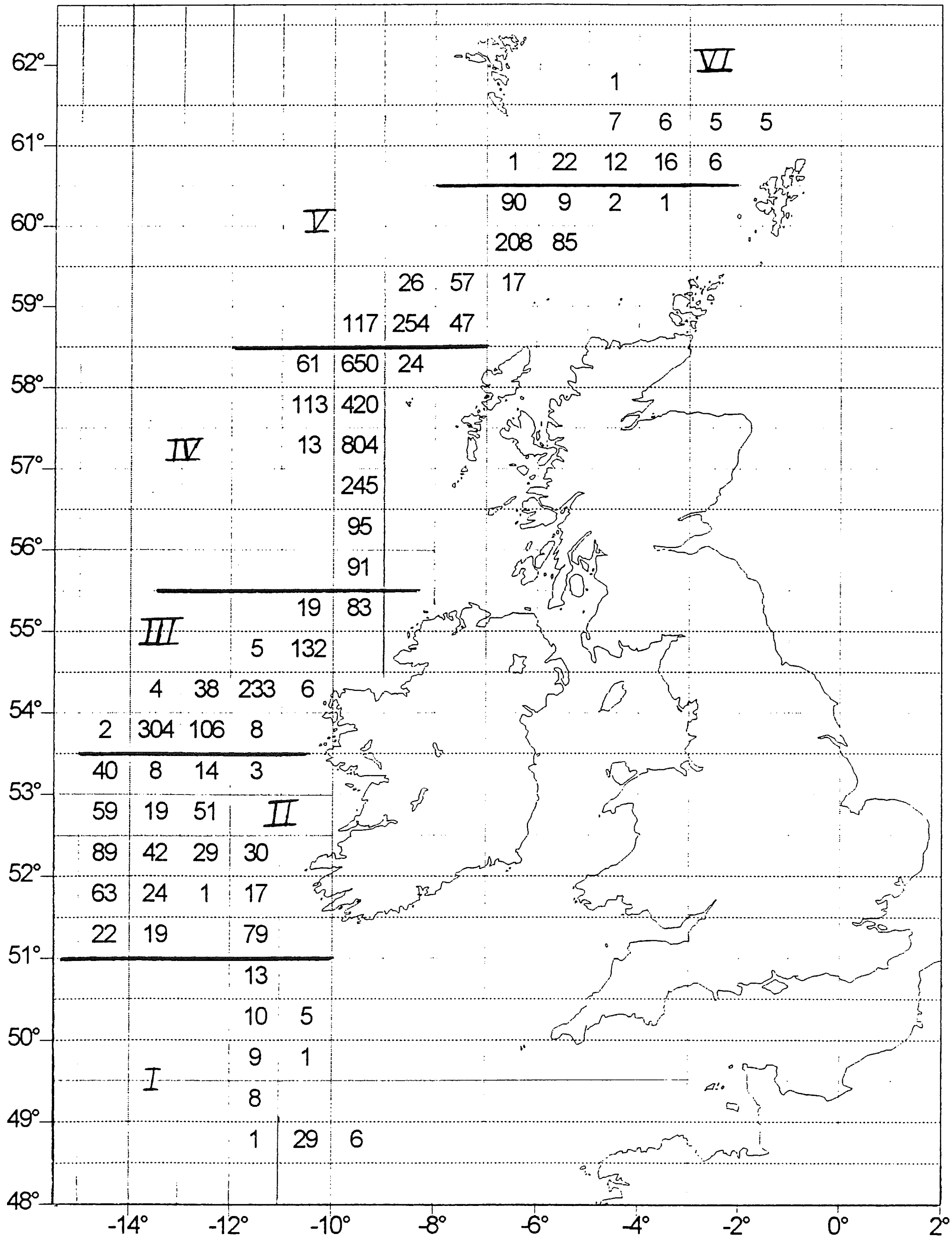


Fig. 6.4.3. Blue Whiting biomass in 1000 tonnes,
R/V "Johan Hjort", March-April 1996.

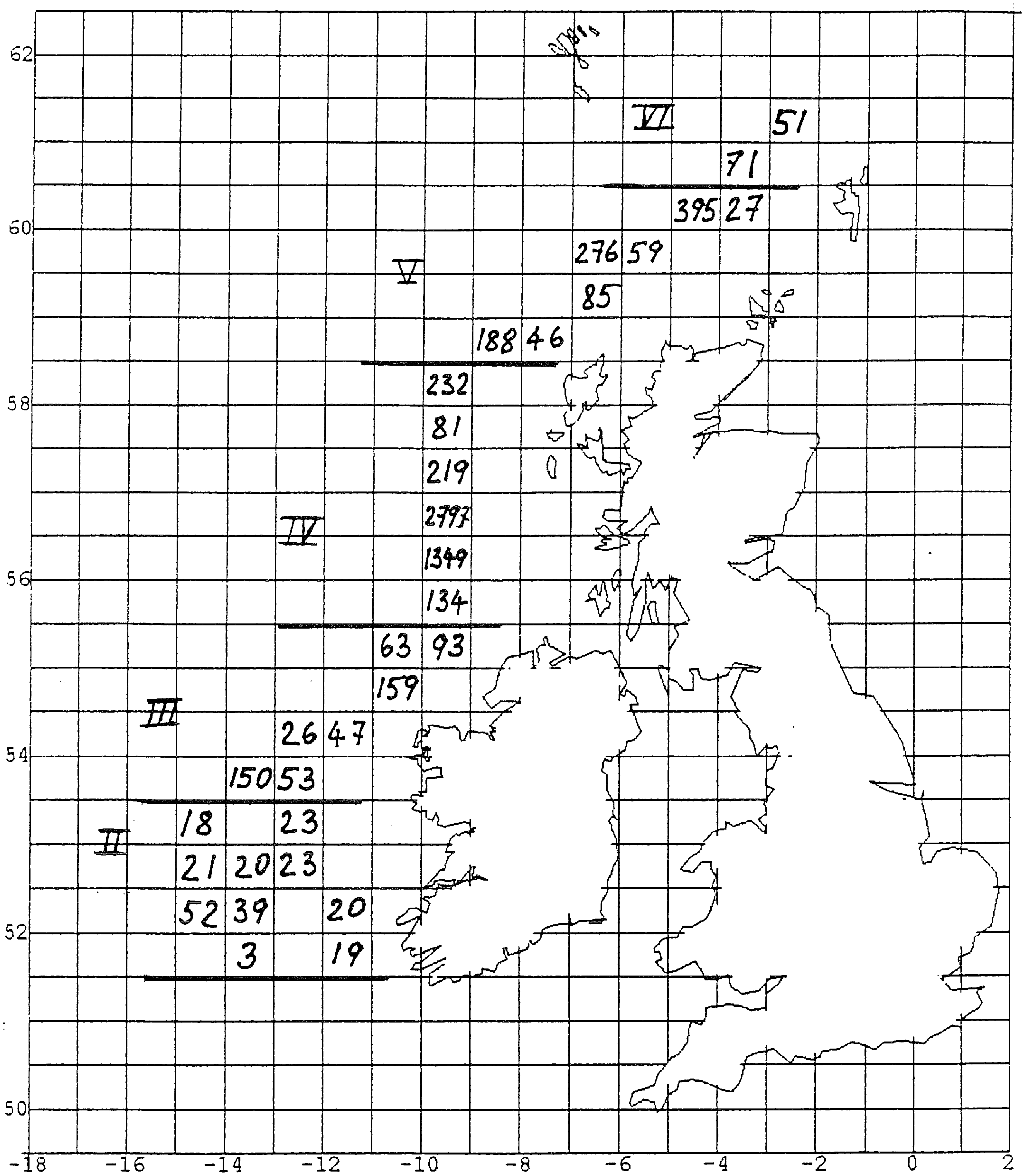


Fig. 6.4.4. Blue Whiting biomass (1000 tonnes) obtained by Russia, April 1996. Markings of subareas II-VI used in the assessment.

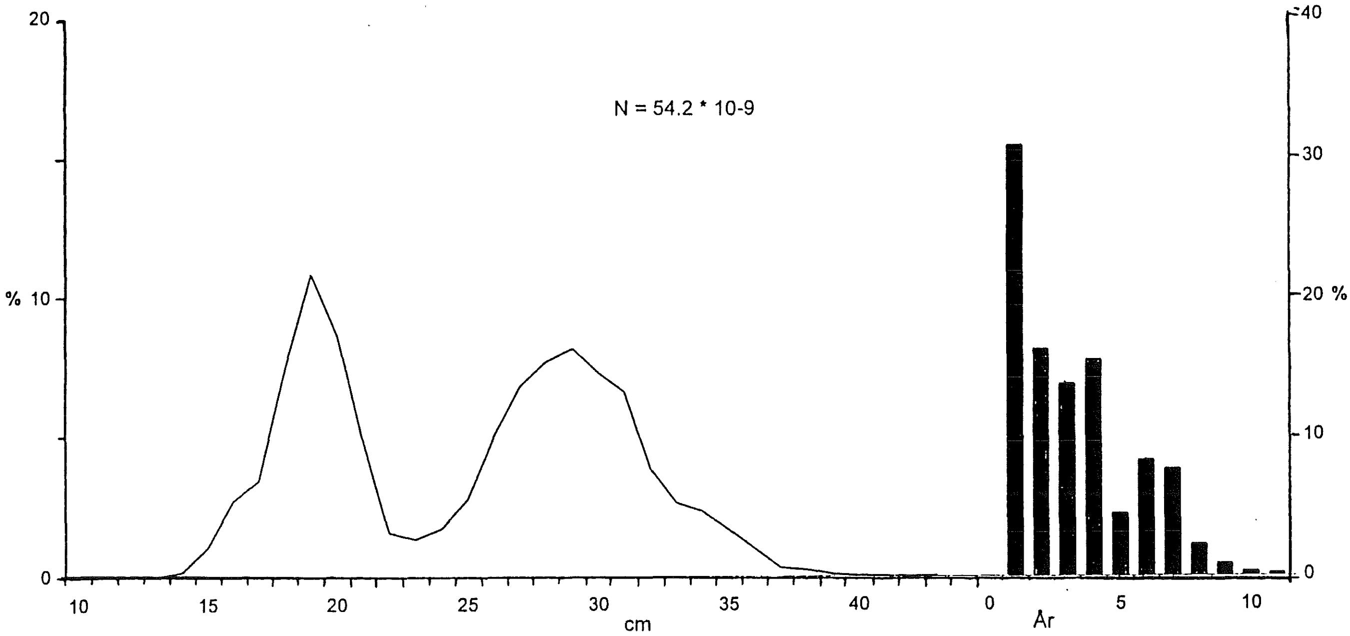


Fig. 6.4.5. Total length and age distribution (N&) of blue whiting in the area west of the British Isles, spring 1996, weighted by abundance. R/V "Johan Hjort", Norway.

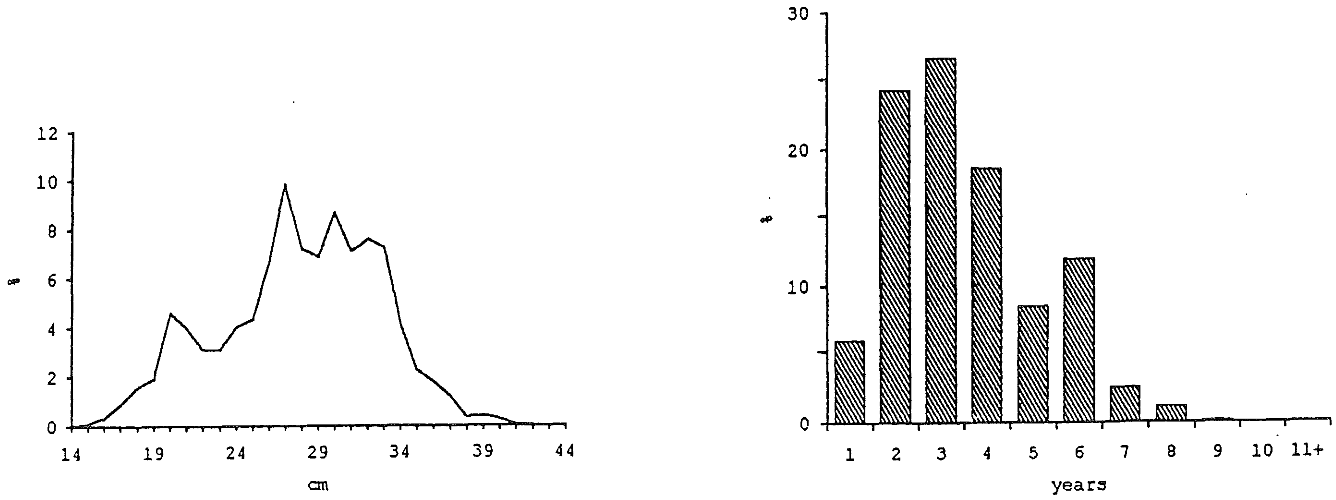


Fig. 6.4.6. Total length and age distribution of blue whiting west of the British Isles, April 1996. R/V "Fridtjof Nansen", Russia.

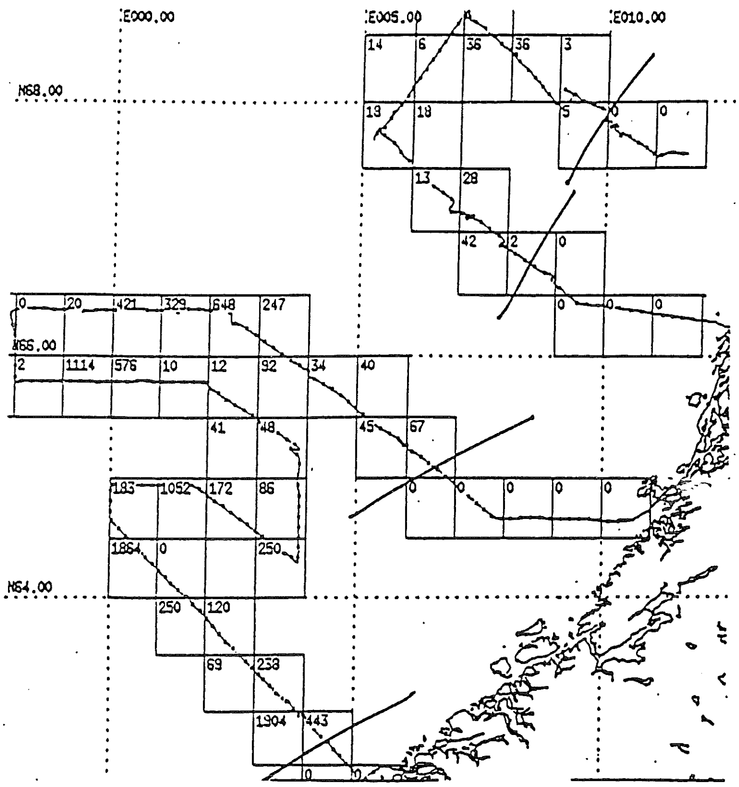


Fig. 6.4.7. Cruise tracks with S_a-values for blue whiting, drawn by the BEI system.March 1996, R/V "G.O. Sars".

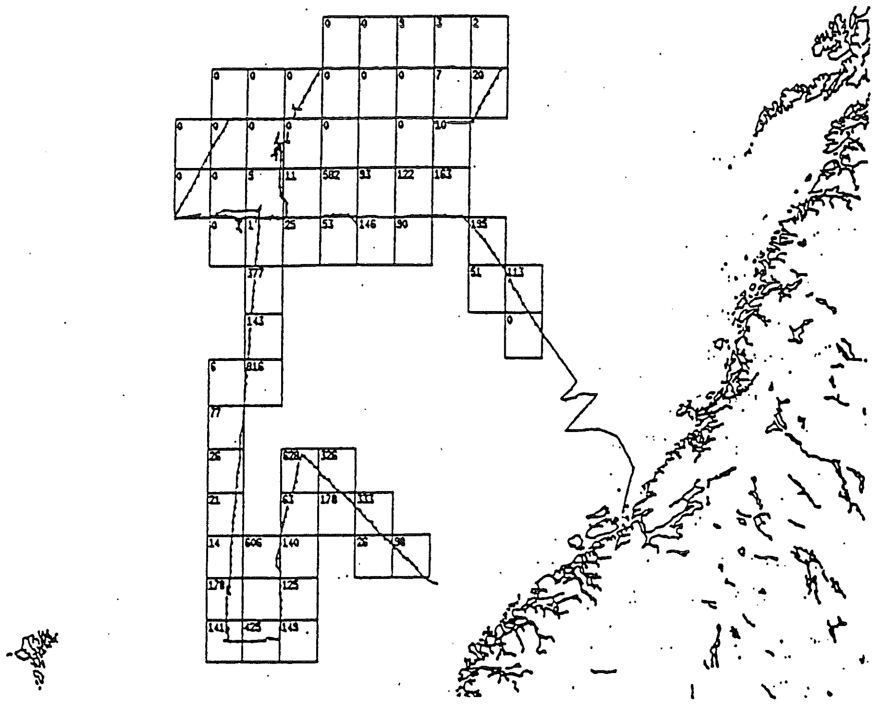


Fig. 6.4.8. Horizontal distribution of S_a-values allocated to blue whiting as drawn by the BEI map procedure in squares of 30' lat. and 1^o longitude. April 1996. "G.O. Sars".

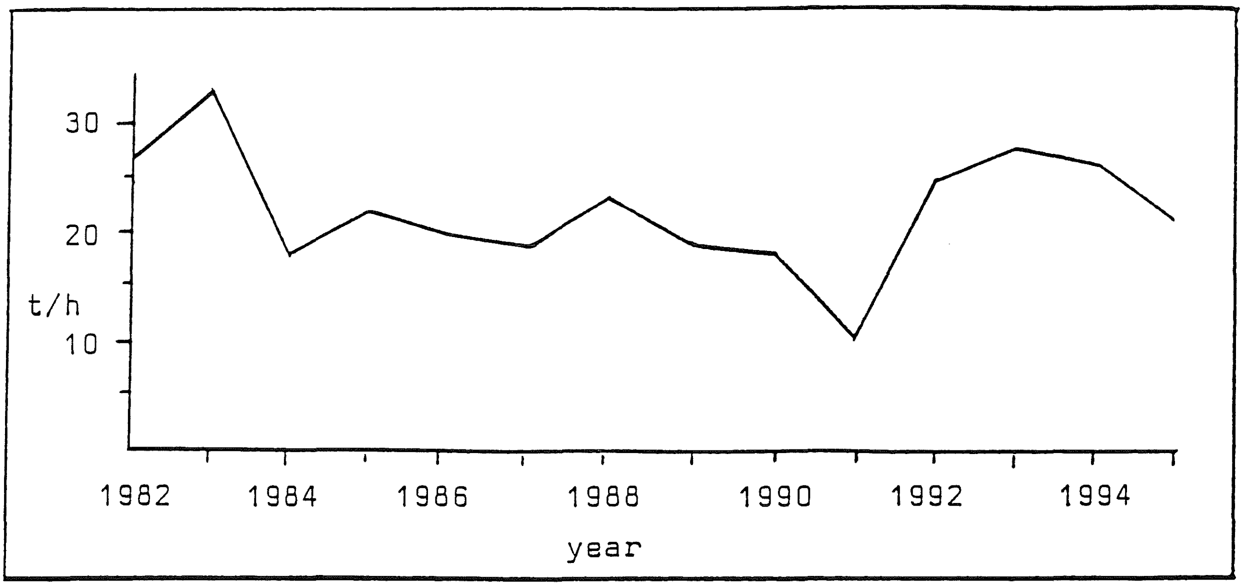


Fig. 6.4.9. Blue Whiting. Overall aggregated CPUE from the Norwegian directed fishery 1982-1995 (tonnes/hour).

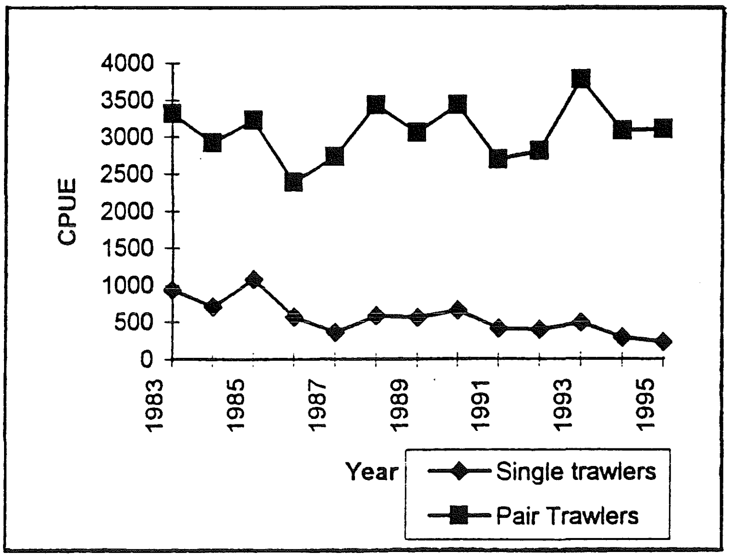


Fig. 6.4.10. Blue whiting CPUE from Galician single and pair trawlers in the southern fishery (Divisions VIIIc and IXa).

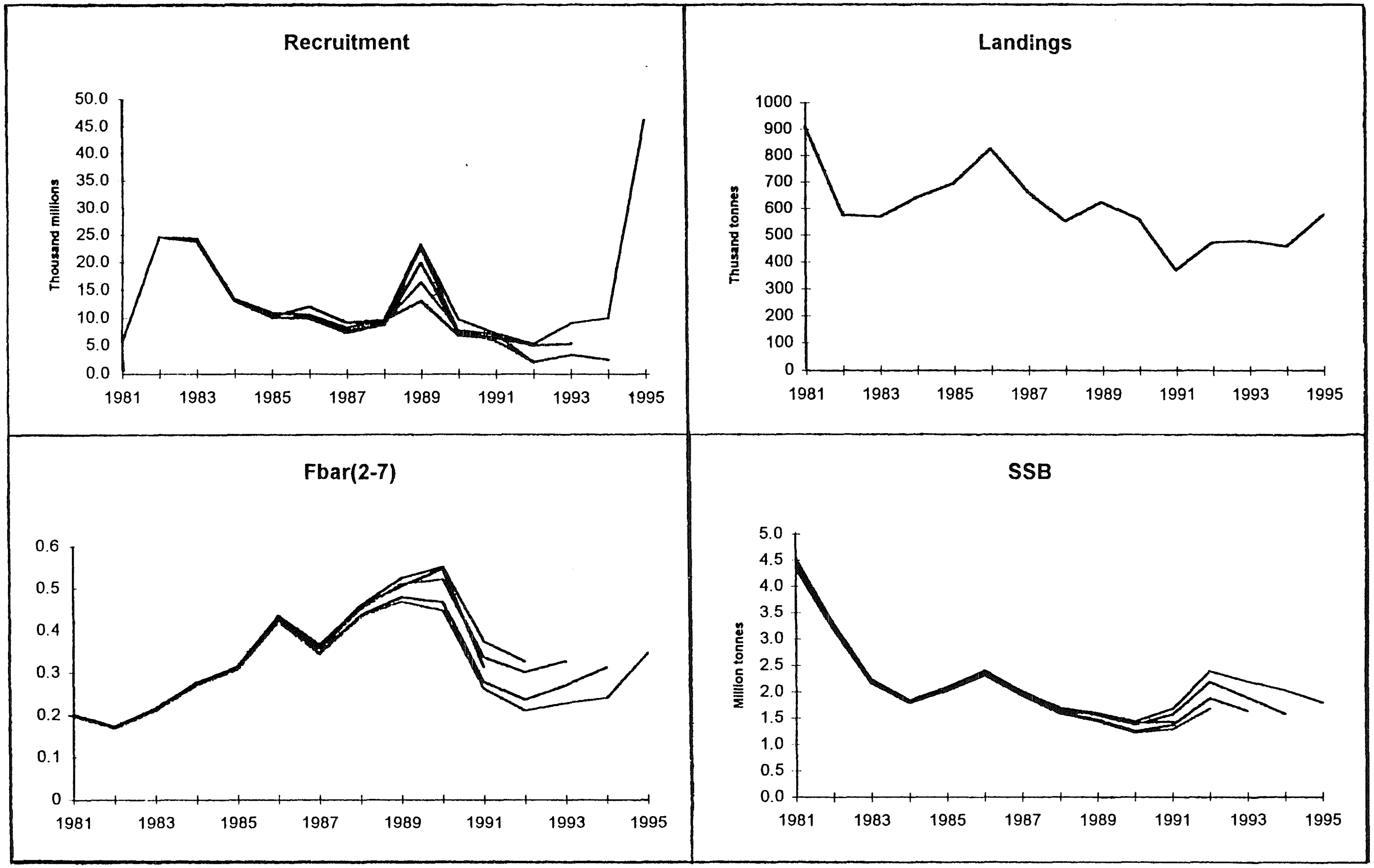


Fig. 6.4.11. Blue Whiting. Results of retrospective analysis, with terminal Fs derived from Extended Survivors Analysis (XSA).

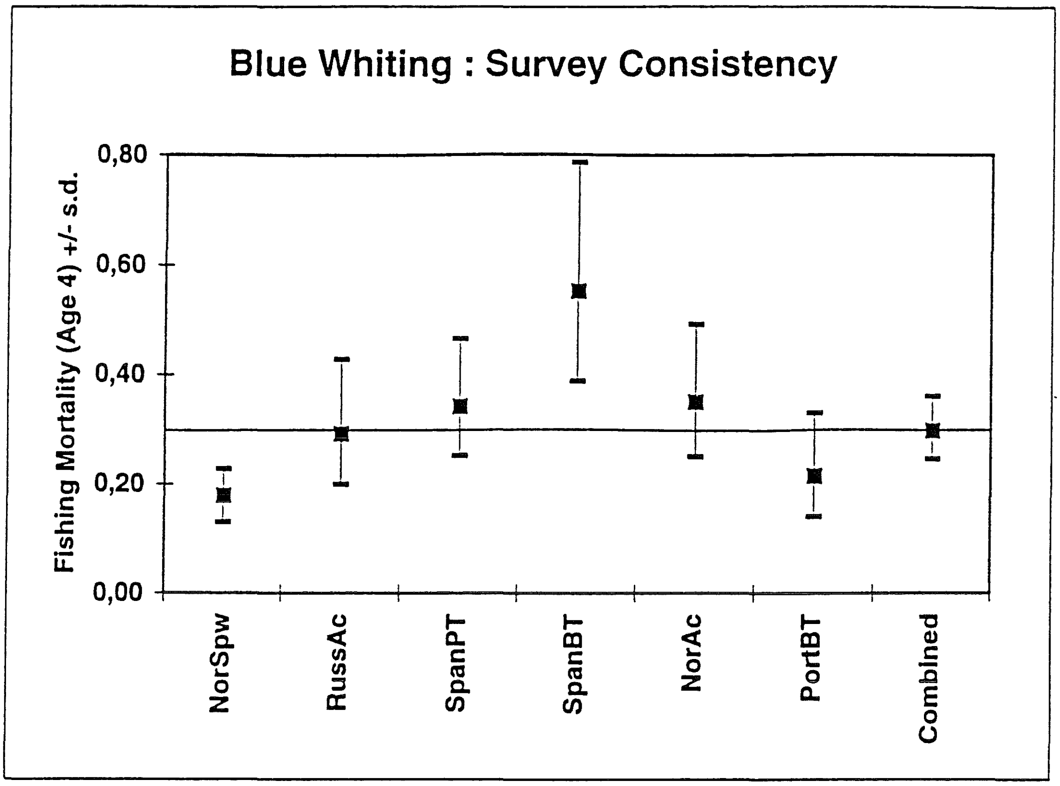


Fig. 6.6.1. Blue Whiting. Estimates of fishing mortality at age 4 (+/- standard deviation) obtained by fitting separable models to catch at age information and to information from each of five indices of abundance in turn. **NorSpw**, Norwegian acoustic surveys in the spawning area. **RussAc**, Russian Acoustic surveys in the spawning area. **SpanPT**, Commercial catch per unit effort by Spanish pair trawlers. **SpanBT**, Spanish bottom trawl surveys. **NorAc**, Acoustic surveys in the Norwegian Sea. **PorBT**, Portuguese bottom trawl surveys. **Combined**, all surveys except for Spanish bottom trawl surveys.

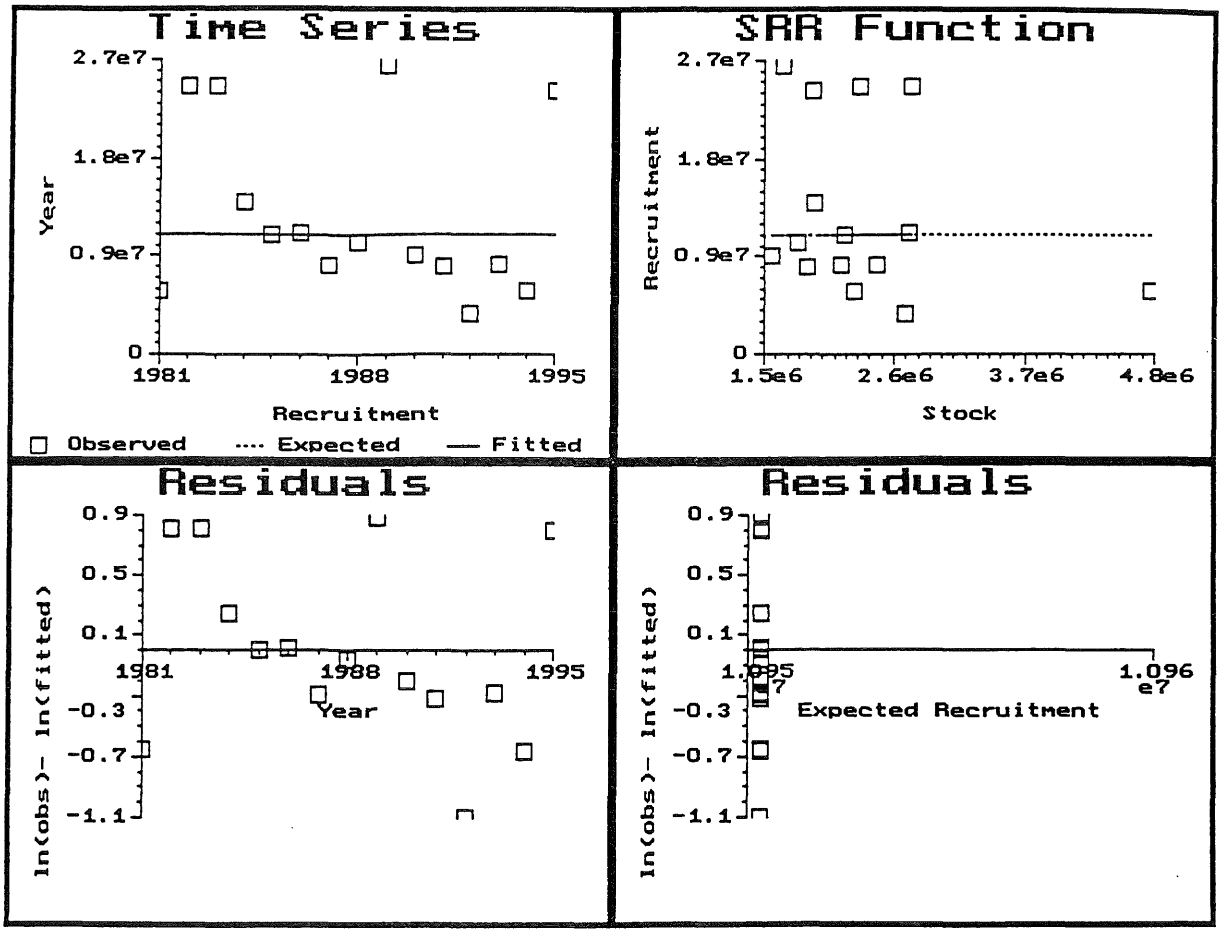


Fig 6.6.2. Blue Whiting. Stock and recruitment scatterplots. Top left, recruitment by year. Top right, recruiment plotted against stock size. The 'function' plotted is the historic geometric mean used for the medium-term projections. Bottom left, plot of log-transformed residuals about the mean by year. Bottom right, plot of residuals against expected value: in this case only a mean is used and there is no spread of expected values.

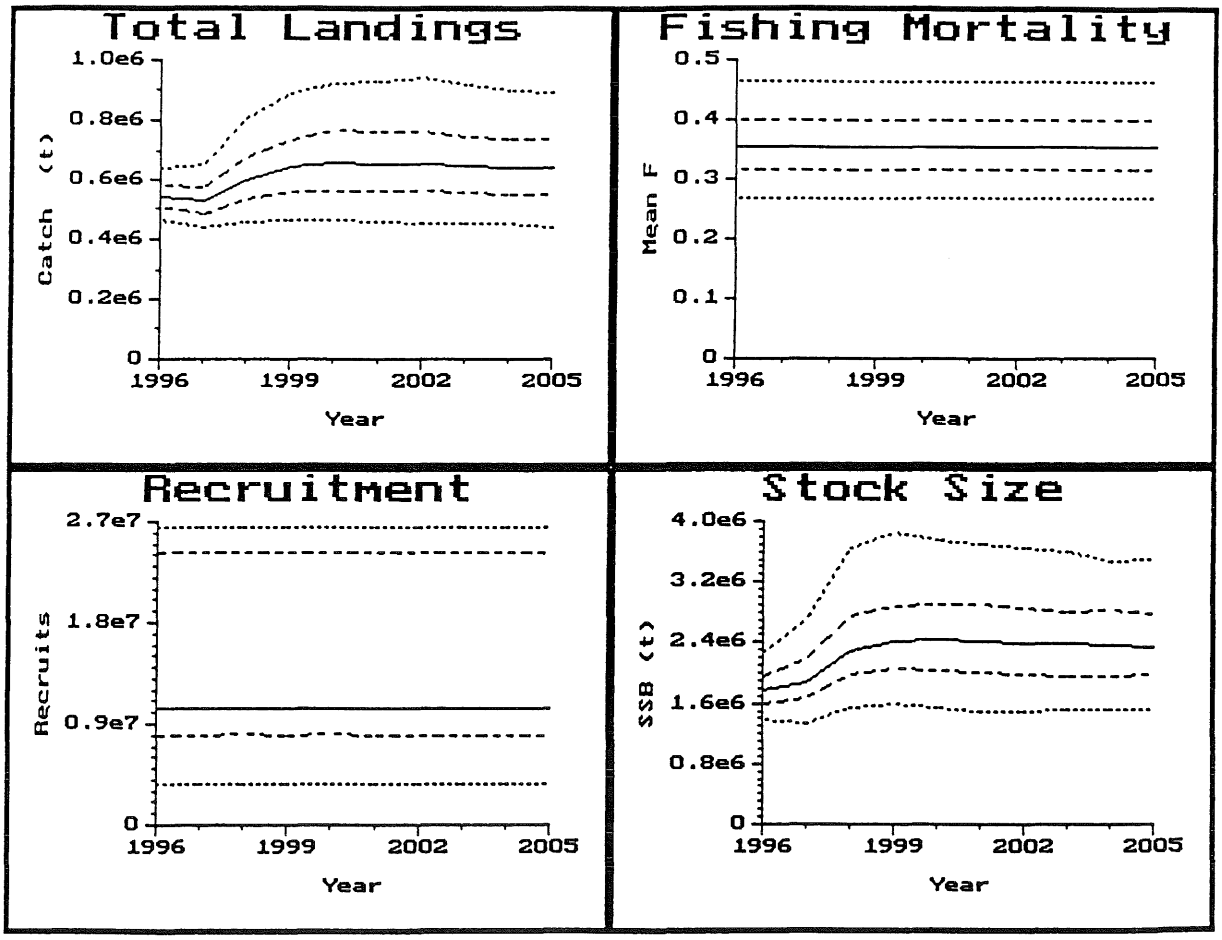


Fig. 6.6.3 Blue whiting. Results of medium term projections, as percentiles of 1000 Monte-Carlo simulations. Full lines, 50th percentiles. Dashed lines 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. Top left, yield from the fishery as estimated landings. Top right, fishing mortality, as an arithmetic mean F on ages 3 to 7. Bottom left, recruitment in numbers of fish at age 0. Bottom right, spawning stock size on 1. January.

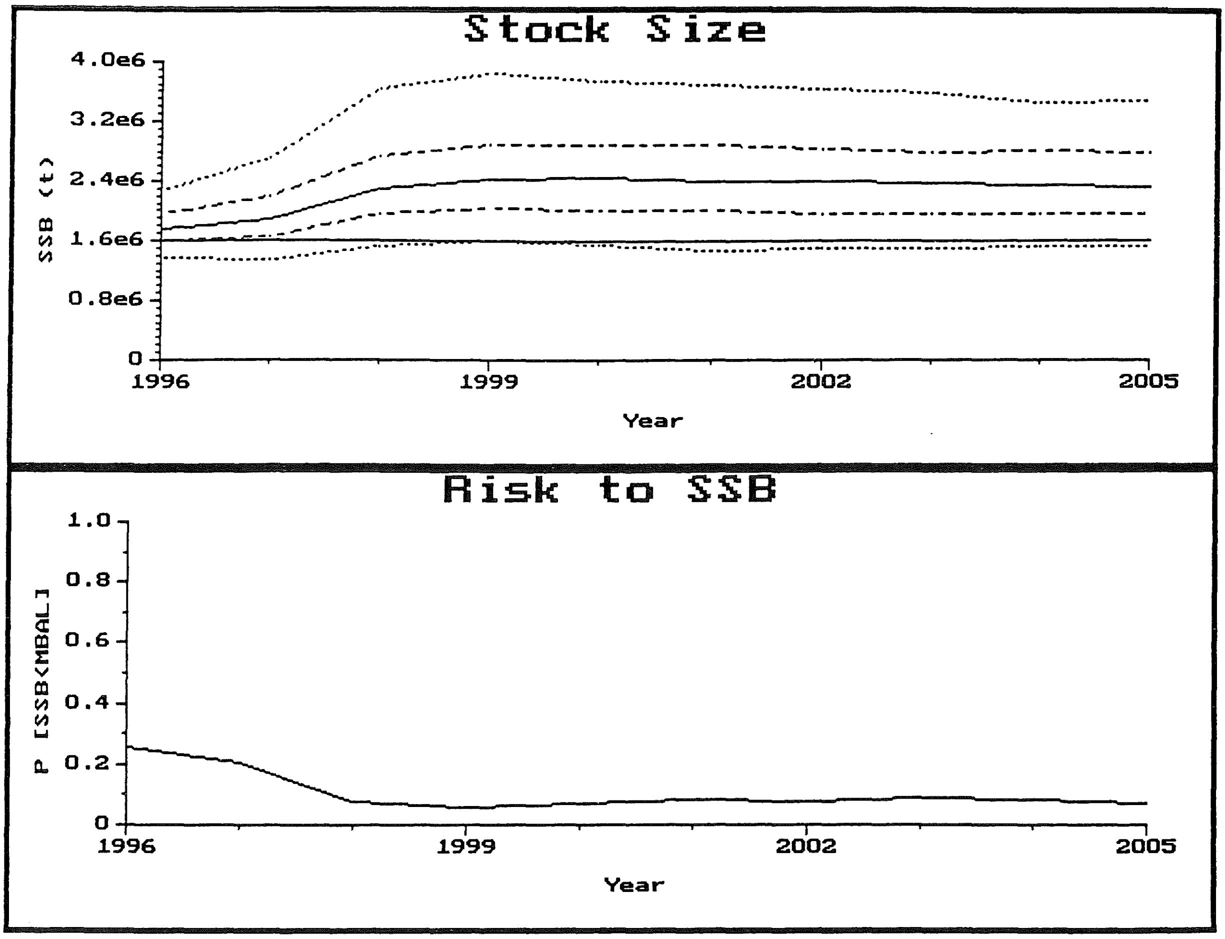


Fig. 6.6.4. Blue Whiting. Results of medium-term projections. Upper panel. estimated trajectory of stock size, compared with a reference level of 1.6 million tonnes. Full lines, 50th percentiles. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. Lower panel, estimated probability that the stock may fall below 1.6 million tonnes (labelled ' MBAL') in each year of the simulations.

BLUE WHITING SAMPLES 1-6

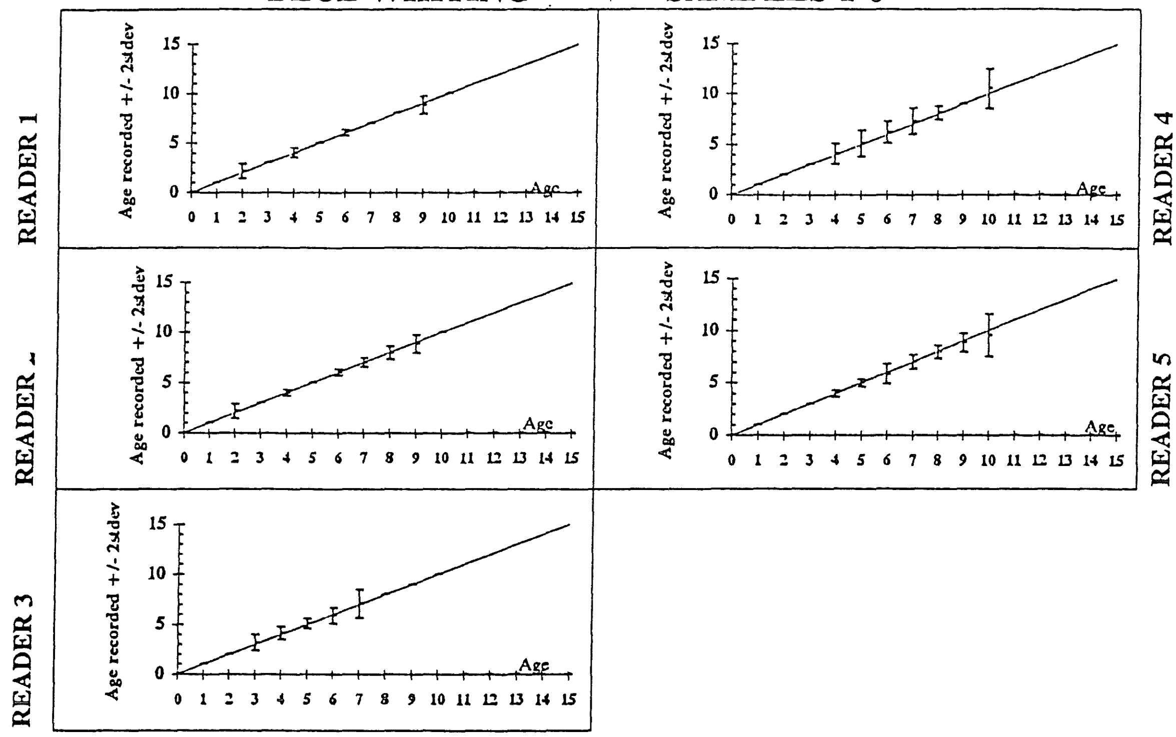


Figure 6.8a In above age bias plots average age +/- 2stdev of each age reader is plotted against actual age.

Modal age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Age recorded	-	1,00	2,06	3,03	4,02	5,02	5,97	7,05	7,98	8,88	10,00	-	-	-	-	-
2*stdev	-	0,00	0,47	0,36	0,62	0,63	0,80	0,94	0,49	0,66	1,30	-	-	-	-	-
CV	-	0,00	11,45	5,97	7,66	6,30	6,68	6,66	3,09	3,73	6,49	-	-	-	-	-

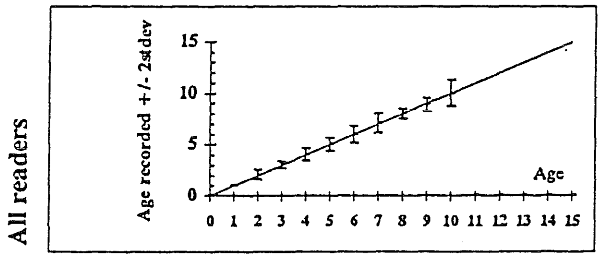


Figure 6.8b In above age bias plot average age +/- 2stdev of all age readers is plotted against actual age.

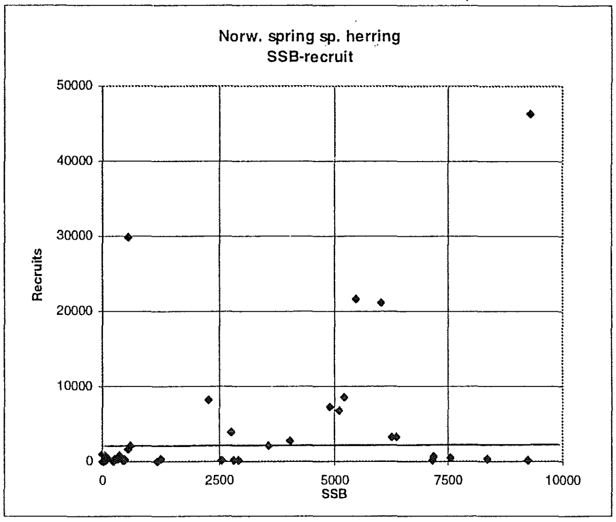


Figure 10.1 Stock-recruit plot of Norwegian Spring Spawning Herring.

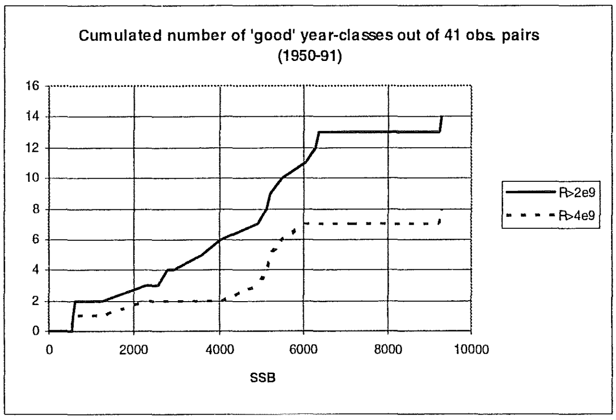


Figure 10.2 Cumulated frequency of good year classes as function of the SSB.