Advisory Committee on
Fishery Management

ICES CM 1997/Assess:14

REPORT OF THE

NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

ICES Headquarters
29 April–7 May 1997

This report is not to be quoted without prior consultation with the General Secretary. The document is a report of an expert group under the auspices of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council.

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

Table of Contents

Section	Page

1 INTRODUCTION

1.1 Terms of Reference

The **Northern Pelagic and Blue Whiting Fisheries Working Group** [WGNPBW] (Chairman: Mr I. Røttingen, Norway) will meet at ICES Headquarters from 29 April to 7 May 1997 to:

a) assess the status of and provide catch options for 1998 for the Norwegian spring-spawning herring stock, and catch options for the 1997–1998 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 1997 and winter 1998 seasons;

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 1997 and winter 1998 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 1998 and 1999 for the blue whiting stock;

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

h) propose a definition of safe biological limits using target reference points based, where appropriate, on biomass, fishing mortality, maturity, growth, age structure, exploitation pattern, geographical distribution and other relevant parameters; based on the above parameters, propose limit reference points to be avoided with high probability;

i) prepare medium-term forecasts of yield and SSB, taking into account uncertainties in data and assessment and assuming a stock-recruitment relationship, to indicate the probability of attaining target reference points and avoiding limit reference points;

j) provide information on quantities of discards by gear type and area for commercially-exploited stocks of fish and fisheries considered by this group [OSPAR 1997/5.3] and report to WGECO.

The above terms of reference are set up to provide ACFM with the information required to respond to the requests for advice from NEAFC, the EC and OSPAR.

The following items were added on receipt of a request from NEAFC dated 22 January 1997:

k) indicate new developments in the seasonal and area distribution of the total Norwegian spring-spawning herring stock;

l) assess for Norwegian spring-spawning herring the development of catches and the probability that the spawning stock biomass will fall in the medium-term below the MBAL level of 2.5 million tonnes under the harvesting strategy of a catch ceiling of 1.5 million tonnes and a maximum fishing mortality of 0.15;

m) assess for blue whiting the probability that the spawning stock can sustain a harvesting strategy of a constant value of 650 thousand tonnes.

Following an additional meeting in March 1997, NEAFC also requested ICES (letter dated 30 April 1997) to:

n) provide short- and medium-term levels of catches and spawning stock biomass, taking into account the stock specific recruitment pattern and the risk of reduced recruitment at low stock sizes and using the longest possible time series of recruitment. In particular, for the medium-term analysis, ICES is requested to provide 1–10 years stochastic projections of the spawning stock at levels of F of 0.1, 0.15 and 0.2 subject to catch ceilings of 1.0, 1.5 and 2.0 million tonnes. The percentiles given of the distribution of 5, 10, 20, 30, 50, 80 and 90 per cent;

o) provide appropriate reference points for fishing mortality and spawning stock biomass. In addition to nominal absolute values, biomass reference points may also be based on a reference year in order to demonstrate problems of changes in scale;

p) provide appropriate management regimes (i.e. "harvest control laws") including reference points at which immediate remedial action should be taken and appropriate time scale for actions, which might be used in future management of the stock and which takes into account sustainable exploitation rates and appropriate biomass thresholds.

1.2 Participants

Sergei Belikov	Russia
Bjarte Bogstad	Norway
Jim Carscadden	Canada
Petter Fossum	Norway
Harald Gjøsæter	Norway
Kjellrun Hiis Hauge	Norway
Sigurdur Tor Jonsson	Iceland
Per Kanneworff	Denmark (Greenland)
Alexander Krysov	Russia
Manuel Meixide	Spain
Terje Monstad	Norway
Kenneth Patterson	UK (Scotland)
Ingolf Røttingen (Chairman)	Norway
Gunnar Stefánsson	Iceland (part-time)
Sigurd Tjelmeland	Norway
Hjalmar Vilhjalmsson	Iceland

2 ICELANDIC SUMMER-SPAWNING HERRING

2.1 The Fishery

The catches of summer-spawning herring from 1977–1996 are given in Table 2.1.1. No estimate of discards was made for the 1996/97 season. The fishery took place off the east coast of Iceland, considerably farther to the north than in previous seasons. The proportion used for reduction has continued to decrease from the 1992/93 maximum of 74% to 23% last season. The remainder of the catch was either salted or frozen for human consumption. While most of the catch was taken by purse seiners, some 8.7% were taken with pelagic trawl. Until 1990 the herring fishery took place during the last three months of each calendar year, but after that the autumn fishery has continued in January and early February of the following year. Therefore, all references to the years 1990–1996 refer to the season starting in October of that year. Landings, catches and recommended TACs since 1984 are given in thousands of tonnes in the text table below.

Year	Landings	Catches	Recommended TACs
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
1996/1997*	95.9	95.9	100.0

* Preliminary

2.2 Catch in Numbers, Weight at Age and Maturity

The catches in numbers at age for the Icelandic summer-spawners for the period 1977–1996 are given in Table 2.1.1. As usual the age is given in rings where 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. On the other hand, the fishery in 1987 and 1988 was 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 1994/95 the catches were distributed on 4 year classes, i.e. those of 1988–1991. The catch in numbers of 2-ringers has never been higher and yielded some 25% of the total numbers in the 1994/95 season.

In the 1995/96 and 1996/97 seasons, the catches were again mainly distributed on the 4 year classes from 1988–1991. In the 1996/97 season the total catch numbered some 384 million herring, while in the two previous seasons the numbers caught exceeded 500 million. The reason for this reduction is the lower total catch in tonnes, consisting of larger herring and a smaller proportion of age groups 2 and 3 than in the preceding seasons.

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 inter-annual variations, the weights at age as well as other biological parameters have remained relatively stable over a wide range of stock size and fluctuations in environmental conditions of 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 October–December or January, usually after the fishery had been closed. During surveys, which took place in October–December 1996, an estimate was obtained of the adult stock in open waters and of 1 year old herring in the fjords of the west and north coast of Iceland. The adult stock was mainly located in an area off the east coast of Iceland, but a small proportion was found southwest of Iceland. The abundance of the 1992 and 1993 year classes was low and the 1993 year class was first registered acoustically last autumn. The abundance of the 1994 year class was found to be above average, and it is followed by another year class of some promise.

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain a one-to-one relationship between acoustic and VPA estimates of stock size. This was done by fitting regression lines between these estimates 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 was used in this report, a value of TS = 20 log L-72 dB was used to calculate the stock estimates. The results of the autumn 1996 acoustic surveys have been used as a basis for the present assessment of 4-ringed and older herring (Table 2.3.1).

2.4 Stock Assessment

Like 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 concurrent with increasing stock size.

The results are given in Table 2.4.1 as F_{ac}. In this analysis, 5-ringers and older fish 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 was run using varying terminal F's on 5+ ringers. For each terminal F a sum of squares (SSE(F)) of differences between the 5+ group from the VPA and from the acoustic estimates was 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 0.203. The confidence intervals (0.16, 0.26) 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 limits on the SSE and finding the terminal F values corresponding to these limits (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 for all age groups and the proportion of M before spawning as 0.5. Fishing mortality at age for 1977–1996 and stock in numbers at age and spawning stock biomass on 1 July 1977–1997 are given in Tables 2.4.2 and 2.4.3 respectively. In addition, another VPA was run, extending backwards to 1947. The standard stock summary, based on the longer VPA, is given in Table 2.4.4 and the standard plots of the time series of spawning stock biomass and recruitment and trends in yield and fishing mortality are shown in Figure 2.4.2. The resulting stock trend from VPA is plotted together with the acoustic estimates in Figure 2.4.3 and the relationship between the two estimates is shown in Figure 2.4.4. In the absence of reliable abundance estimates for the 1993 year class, the size of this year class was set at 400 million as 1-ringers. This number is close to the lower quartile of the recruitment observed since 1980.

According to the present assessment the spawning stock biomass was about 510,000 tonnes on 1 July 1996 as compared to the projected spawning stock from last year's assessment of 480,000 tonnes.

2.5 Catch and Stock Projections

The input data for the projections are given in Table 2.5.1. Although the variations of mean weight at age are relatively small with regard to the extreme variations of environmental conditions and changes in stock size observed during the past decades, an earlier working group found that a simple model of the interannual variation explains a statistically significant portion of the variance in weight at age (ICES 1993/Assess:6).

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

Data for the regression included, as starting years, the period 1987–1996. For 1-ringers and 9+ ringers, a simple average of mean weights at age for the period 1986–1996 was used for the prediction. Weights at age for 2–8 ringers in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.2161 \cdot W_y + 85.453 \text{ (g)}$$

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

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 (thousand tonnes) for a range of values of F are given in Table 2.5.3.

Due to the low abundance estimates of the year classes from 1992 and 1993, i.e. age groups 3 and 4, the catch during the 1997/98 fishing season will consist mainly of herring belonging to the 1989–1991 year classes. In addition, there will still be some contribution by the 1988 year class. It is estimated that approximately 70% of the catch will consist of 6 years and older herring.

Like in previous assessments and in agreement with the increased level of recruitment during the 1980s and early 1990s, a value of 600 million 1-ringers has been assumed for 1997. For 1-ringers in 1996 a value of 845 millions was used.

Yield per recruit and spawning stock per recruit, and short-term yield and spawning stock biomass are shown in Figure 2.5.1, using the long-term average values given in Table 2.5.4.

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 $F_{0.1}$. Exploiting the stock at a fishing mortality rate of $F_{0.1}$= 0.22 during the 1997/98 season would result in a catch of about 100,000 tonnes (Table 2.5.3). The spawning stock biomass in 1998 would be similar to that in 1997, i.e. about 480,000 tonnes. Harvesting 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 been further reduced.

The Working Group points out that managing this stock at an exploitation rate at or near $F_{0.1}$ has been successful in the past. The stock is in a healthy state and well above any "alarm level". Thus, for the time being, further precautionary measures seem not to be needed in the management of this stock.

2.7 Stock and Recruitment

Part of the analysis by Jakobsson *et al.* (1993) was repeated for the time series of spawning stock biomass and recruitment in the period 1947–1994 from this assessment. The Beverton-Holt, Ricker, Cushing and Schnute models for the SSB-R relationship were fitted to the data by minimising the residual sum of squares from each log-transformed relationship. A summary of the basic results is given in Table 2.7.1 and the resulting graphs on Figure 2.7.1, along with the lines used to identify the parameters F_{high}, F_{med} and F_{low}. The relationship between the SSE from the model fits is unchanged from Jakobsson *et al.* (1993), who found that the data fit best to the Cushing model and used it for further analysis.

2.8 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 April 1996, no runs were made this year. There was 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 recruitment from the Ricker curve and is a consequence of the fact that the present state of the stock is at the highest known historical level.

2.9 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery	30	3214	2295
Acoustic, wintering area	15	3363	1500

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 The Fisheries

3.1.1 1996

The Faroes, Iceland, Norway and Russia agreed at a meeting in Oslo in May 1996 to limit their catches to a total catch of 1.1 million tonnes in 1996. EU set a quota of 150,000 tonnes for their fishery.

The landings in 1996 amounted to 1,217,224 tonnes.

EU

The EU fishing fleet operated in international waters in April–June. The EU catch amounted to 181,028 tonnes.

The Faroes

The Faroese fishery started in the latter half of April. The fishery in spring took place in the Faroese EEZ, in international waters, and in the Jan Mayen EEZ. This fishery terminated in the middle of June. In autumn the Faroese fishery took place in the Norwegian EEZ where 12,500 tonnes were caught. The Faroese catch amounted to 52,788 tonnes.

Iceland

The Icelandic fishery started 9 May on the border area between the Icelandic and Faroese EEZ and the international waters on the Norwegian Sea. Some of the Icelandic catches were taken in the Jan Mayen EEZ. The Icelandic fishery was terminated around mid-July. The Icelandic catch amounted to 164,957 tonnes.

Norway

The Norwegian fishery on Norwegian spring spawning herring is carried out throughout the year, and the main activity is linked to the migration pattern of the herring. The fishery started in the beginning of January in the wintering areas of northern Norway. About 158,500 tonnes were taken in this area by the end of February. 158,000 tonnes were taken during the spawning migration and on the main spawning areas in the period January throughout February. In the latter part of March and in April about 70,000 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 18,000 tonnes. Finally 298,000 tonnes were caught during autumn in Vestfjorden, the wintering area. The total Norwegian catch was 699,161 tonnes. Approximately 85% of the Norwegian catch was used for human consumption, the rest was utilised for reduction purposes.

Russia

The Russian catch in the spawning area in February to April amounted to 79,000 tonnes. In addition 40,000 tonnes of herring were taken in the Vesterålen area in autumn. The total Russian catch was 119,290 tonnes.

3.1.2 1997

At a meeting in Oslo in December 1996, the main participants in the fishery for Norwegian spring-spawning herring reached an agreement to limit their total catch in 1997 to 1.5 million tonnes and on the allocation of this TAC.

By 1 April the Norwegian catch was approximately 325,000 tonnes and the Russian catch approximately 87,000 tonnes.

3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring for the period 1972–1996 (1996 preliminary) are presented in Tables 3.2.1 (by fishery) and 3.2.2 (by country). Catch in number and mean weights per age group by nation are given in Tables 3.2.3 and 3.2.4. The amount of samples used for converting landings to number by age group is listed in Section 3.1.3.

The Working Group noted that in this international 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, 1995 and 1996. 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 1996 age compositions and weight at age were provided for all age groups by Norway and Russia. The Icelandic catches were split using Norwegian age compositions and weight at age from the Norwegian fishery taking place in the same area and time. The Netherlands provided such data up to age 9+. This + group was split in the same way as in the Norwegian, Russian and Icelandic catch combined. The catch at age and weight at age in the catch taken by Denmark, the Faroes and UK was calculated by combining length distributions provided by these countries with Norwegian age-length keys. For the catch by Ireland, Sweden and Germany, 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. Minor changes in the 1995 catch data have been accounted for.

The method used to calculate catch in number in the Norwegian fishery is described in a working document by A. Slotte. 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 consumption 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 be found from sampling, and the total catch in number calculated.

3.3 Surveys

3.3.1 Spawning areas

A survey was carried out under very bad weather conditions, and as described in the Working Document by A. Slotte and A. Dommasnes it was not possible to obtain an estimate on the spawning areas in 1997 (Table 3.3.1).

3.3.2 Wintering areas

The wintering area was surveyed acoustically in December 1996 (Working Document by K. Foote *et al.*) and in January 1997. The results from December 1996 are given in Table 3.3.2, but due to bad weather it was not possible to obtain an estimate in January 1997 (Table 3.3.3). In addition, results from the December 1995 acoustic survey were available (Table 3.3.2). These results were not available during the Working Group meeting last year.

3.3.3 Feeding areas

The feeding areas in the Norwegian Sea were mapped in a multinational acoustic survey in May 1996 (Working Document by Jakupsstovu *et al.*). The results showed that a survey in the feeding area will probably give relevant information on stock size and structure (Table 3.3.4). The survey will be repeated in May 1997 (ICES CM 1997/H:3) and it will be decided at the 1998 WGNPBW meeting if this survey should be incorporated into the tuning series.

3.3.4 Nursery areas

The nursery areas 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.

The results from the acoustic survey in the Barents Sea in May/June 1996 are given in Table 3.3.5. This survey had previously been a joint Norwegian/Russian cruise but this year the two nations conducted the survey separately. The results from the 0-group survey in fjord and coastal areas in November 1996 are given in Table 3.3.6. Furthermore, the abundance indices for herring from the joint Norwegian/Russian 0-group trawl survey in August/September 1996 are given in Table 3.3.7.

3.3.5 Herring larval survey

The distribution area of herring larvae was covered by a cruise with R/V " Michael Sars" during the period 5–21 April 1997 (Figure 3.3.1) High numbers of herring larvae (>1000m^{-2}) were recorded outside the Lofoten area, at Haltenbanken, outside Møre, outside Bremanger and Sognefjorden and outside Jæren. The herring larval indices for the period 1981–1997 are shown in Table 3.3.8. The number of larvae found in 1997 is the highest since the collapse of the herring stock and more than twice the previous recorded maximum in 1996.

The spawning areas of the NSSH have had a tendency to spread out in northern and southern direction the last years. This was easily seen in 1997 with high numbers of larvae both at the Røstbank and the Siragrunn. However, the numbers of larvae in the central areas have also increased, and the highest density of larvae was found at the Haltenbank with more than 20,000 larvae in one haul of approx. 60 m^3 (0.3 larvae l^{-1}), a concentration not usually found in nature.

Low densities of microzooplankton were recorded on the cruise, however many of the larvae were feeding and algae and copepod eggs were found in their guts.

3.4 Tagging Experiments

The Norwegian tagging experiment on herring, which was initiated in 1975, has been continued, and recaptures from commercial catches have been screened for tags using tag detectors installed at sea food processing factories. In 1996, 48.7 million herring were screened for tags, and 98 tagged herring were recaptured. Recaptures have also been reported from other Norwegian factories, mainly 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 1995 catches, Iceland reported 630 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. A total of 402 tags were recovered at 5 Icelandic reduction factories from total landings of about 92,000 tonnes in 1996. Attempts to obtain measures of efficiency of the magnets used at those factories were unsuccessful. It was decided not to use the data from the Icelandic recaptures in the assessment.

In the 1996 assessment, the length of the fish when tagged was used to separate the recaptures of the 1983 year class from recaptures of tagged herring of younger age groups. This procedure was acceptable as long as the recruiting year classes were small compared to the 1983 year class. In recent years, new strong year classes have been recruited, and a more reliable method of ageing the recaptures and calculating the corresponding number of released fish is suggested. The recaptures of tagged herring were aged individually by scale reading, and the grouping by age for each batch of release was available. The corresponding number of tagged herring by age in the batch was calculated from an age determined random sample of the catch from which the tagging was executed.

The number of releases in 1987–1996 and corresponding recaptures in the years 1989–1996 for the year classes 1983 and older are given in Table 3.4.1. In order to avoid error due to non-random mixing of the tagged fish, the recaptures in the year of tagging and in the year after tagging have been excluded. In addition 4 batches of tagged herring in 1987 and 1988 are excluded because they may have contained herring belonging to local stocks.

Similar data of screened catch and recaptures of tagged herring of younger year classes (1986–1989 and 1990 separately) are shown in Table 3.4.2.

The use of these data in the assessment is described in Section 3.5.2.3.

3.5 Stock Assessment and VPA

3.5.1 Models for stock assessment

A brief review was carried out of options and choices made for stock assessment and modelling, with the intention of developing a more formal assessment model structure that brings together the previously separate spreadsheet-tuning and VPA-running exercise. The Working Group reviewed choices made for the previous assessment of this stock, and attempted to define an appropriate model based on conventional assumptions and several Working Documents. The more important changes were then implemented step by step and the Working Group considered whether to accept or to reject each of the proposed alterations. In this case, the time series of survey information was too short to perform a retrospective analyses. Due to time constraints at the meeting, attention was focused on developing a model for the year classes that had recruited to the fishery, and recruitment forecasting was treated as a separate issue for the present. The following Section describes this process of *a priori* model definition and subsequent testing and review.

The Working Group considered that the preferred assessment model would ideally include all possible survey information in a single framework with a single fitting procedure based on least-squares or a maximum-likelihood approach, *i.e.* a maximum-likelihood 'ADAPT' formulation, with the addition of a model component describing tagging experiment releases, survival and recapture.

3.5.2 Input data

3.5.2.1 Year and age range

Age-structured information on catches, and biological information from 1950 to 1996 were available for use and were to be included. Historical information from 1936 onwards is being re-evaluated at the IMR, Bergen and it is expected eventually to include these years in the time series.

Previously, the age-range 3 to 14+ was used for the purposes of calculating age-structured assessments. Two problems were noted: (1) excluding younger ages meant excluding the significant exploitation of juvenile fish in the 1950s until the early 1970s, which may have implications for the estimation of stock-recruit relationships, and (2) the persistence of the 1983 cohort in the catches resulted in the Working Group having to increment the oldest age in the assessment year by year in recent years.

To overcome these problems it was decided that the full age-range of available information should be used, and the analysis should be run for ages 0 to 15 with a 16+ group.

3.5.2.2 Missing values

There is a large number of observations with missing values in the catch-at-age matrix, due to periods of very low abundance of some cohorts. In previous assessments, missing observations had been replaced with arbitrary values of 1000 fish, which (when assuming a reasonable terminal population) results in an arbitrary, and often excessively high fishing mortality being estimated at the oldest age with catch observation in the cohort. In some years when the stock was depleted the problem is severe as there are very few observations at older ages. It was not known how sensitive the perception of stock size was to this arbitrary treatment of terminal fishing mortalities.

One proposed solution was to replace the missing observations with values predicted by fitting a log-transformed separable model (Shepherd and Nicholson, 1991).

3.5.2.3 Natural mortality

Values of natural mortality assumed by the Working Group previously (ICES 1996/ASSESS: 14) for ages 3 and older were 0.16 for the years 1950 to 1970 and 0.13 for the years 1971 and subsequently. In the previous assessment of this stock it was assumed (on the basis of observations of many diseased and dying fish in catches) that the fish of the 1987 cohorts and older had suffered a higher natural mortality in the years 1991 to 1994. An additional disease-induced natural mortality of 0.1 was assumed. However, interim studies (Patterson, WD 1997; Tjelmeland WD 1997) directed at estimating disease-induced mortality have failed to provide compelling evidence for values above zero. Attempts to estimate natural mortality from tagging information (Hamre, WD 1997; Patterson, WD 1997a; Tjelmeland, WD 1997) were highly consistent with values in the range 0.13 to 0.16, but the Working Group did not consider that this parameter could be estimated with sufficient precision to justify a discrimination between levels of 0.13 and 0.16. Consequently it was decided to predicate the assessment model estimates on an arbitrarily-chosen M=0.15 for ages 3 and older, and no attempt was made to include additional disease-induced mortality in the maximum-likelihood assessment model. However, uncertainty in possible levels of this additional mortality was retained when estimating uncertainty in stock size.

Values of natural mortality for juvenile fish (ages 0-2) used by the Working Group in 1996 were 0.9 for all years in the historic VPA, but for forecasting purposes values of 1.56 for age 1 and 0.54 for age 2 were used for the 1993–1995 year classes. These values were based on an unpublished Ph.D. Thesis by de Barros (1995); this work was not available for evaluation by the Working Group, and hence it was decided to retain the assumption of M=0.9 for ages 0 to 2 in all years. This value is consistent with the mean of de Barros' estimates.

3.5.2.4 Calculation of fishing mortality at the last true age

For VPA calculations the fishing mortality at the last true age was chosen to be calculated as the population-weighted mean fishing mortality from ages 8 to 13, on the basis that historical selection patterns have been approximately flat over this age-range.

3.5.2.5 The plus-group

It was decided to calculate historic populations in the plus-group independently of the VPA populations based on the catch equation, the fishing mortality on the last true age and the estimated catch at age in the plus-group in conventional fashion.

3.5.2.6 Calculation of reference F

Following the advice given by ACFM at its November 1995 meeting, it was decided to use $F_{5\text{-}13}$ weighted by the population number (hereafter denoted as $F_{5\text{-}13,w}$) as the reference F for this stock.

3.5.2.7 Proportion of F and M before spawning

As in last year's assessment, the proportion of F and M before spawning was set to 0.1.

3.5.3 Choice of survey data and tagging data to use in the assessment

It was decided to use the following acoustic survey information, on the basis that survey efficiency was assumed constant over the years and age-ranges as below:

Surveys on the spawning stock in February-March, ages 5 to 13 and years 1988 to 1996. (1992, 1993 and 1997 missing due to bad weather conditions).
Surveys on the wintering area in December, ages 4 to 13 and years 1992 to 1996.
Surveys on the wintering area in January, ages 5 to 13 and years 1991 to 1996 (1997 missing).
Surveys on juvenile fish in the Barents Sea, age 1, years 1984 to 1996.
Surveys on juvenile fish in the Barents Sea, age 2, years 1984 to 1996.

It was argued that all available information from the surveys (including the very weak cohorts) should be included in the assessment, rather than just the information from the abundant cohorts that was used for the previous stock assessment.

It was decided to include information on tag marking mortality and subsequent recaptures of fish of the 1983 cohort in the assessment model. Data on recaptures of the 1986 and younger year classes were not used because few observations were available (Table 3.4.2).

The larval survey was not used in the assessment because there seems to be no evidence of a relation between those survey indices and the year class strength.

3.5.4 Treatment of acoustic surveys and tagging data in the assessment model

3.5.4.1 Survey structural relationships

As in the previous assessment of this stock, a simple age-independent proportionality relationship was assumed for the estimates of stock abundance $U_{a,y,i}$ from the ith survey in year y at age a on the adult stock. Denoting the constant of proportionality for the ith survey as Q_i the structural relationship to the VPA population abundance N, natural mortality M and fishing mortality F is:

$$U_{a,y,i} = Q_i N_{a,y} \exp\left(\left(-F_{a,y} - M_{a,y}\right) t_i\right)$$

Where t_i represents the timing of each survey relative to 1 January in years. Values of t_i are 3/12 for the February-March survey, 11/12 for the December survey and 0 for the January survey (stock assumed surveyed on 1 January).

The juvenile survey in the Barents Sea was treated similarly except that a separate Q for ages 1 and 2 was estimated. For this survey, t_i=5/12.

3.5.4.2 Choice of survey error model

Prior to 1996 the Working Group assumed a normal distribution of errors for acoustic survey residuals. Subsequently, a lognormal error distribution was chosen. Making this change resulted in a change in the perception in the size of the 1983 year class in the beginning of 1995 from 1.8 to 3.5 billion individuals. However, simple scatter plots suggest that distributional assumptions of both normal and lognormal error distributions may be violated. In the case of the normal error model, the variance of residuals appears to increase with expected values, whilst in the case of the lognormal error model the variance appears to decrease with expected value (Figure 3.5.1). In order to overcome this problem a gamma error distribution (being intermediate between normal and lognormal in the relationship of variance and expected value) was deemed a plausible alternative choice.

3.5.4.3 Tagging

A known number of tagged fish $K_{j,a,y}$ were released into the sea in each of j experiments and then assumed to suffer an initial tagging mortality S. The number of tagged fish in the sea T is estimated by:

$$T_{j,a,y} = K_{j,a,y} S$$

and in subsequent years as:

$$T_{j,a+1,y+1} = T_{j,a,y} \exp\left(-F_{a,y} - M_{a,y}\right)$$

Recaptures of tagged fish ($G_{j,a,y}$) are then modelled as rare Poisson events whose expectation ($H_{j,a,y}$) is given by the catch equation and the number of tagged fish in the sea. Expected recaptures of tagged fish of age a in year y given that m_y fish are screened out of a catch of $C_{a,y}$ untagged individuals is approximately:

$$H_{j,a,y} = \left(\frac{m_y}{\sum_a C_{a,y}}\right) T_{j,a,y} \frac{F_{a,y}}{F_{a,y} + M_{a,y}} \left(1 - \exp\left(-F_{a,y} - M_{a,y}\right)\right)$$

3.5.4.4 Likelihood function

Given the above structural relationships, the log-likelihood function for the above model (assuming gamma errors) was:

$$\sum_{j,a,y} G_{j,a,y} \ln\left(H_{j,a,y}\right) - H_{j,a,y} - \ln\left(G_{j,a,y}!\right) +$$

$$\sum_{i,a,y} -U_{i,a,y} / \beta_{i,a,y} + \left(\alpha_{i,a,y} - 1\right) \ln\left(U_{i,a,y} / \beta_{i,a,y}\right) - \ln\left(\beta_{i,a,y} \Gamma\left(\alpha_{i,a,y}\right)\right)$$

where the scale parameter estimate is:

$$\beta_{i,a,y} = \sigma^2 / \left(Q_i N_{a,y} \exp\left(\left(-F_{a,y} - M_{a,y}\right) t_i\right)\right)$$

and shape parameter estimate is:

$$\alpha_{i,a,y} = \left(Q_i N_{a,y} \exp\left(\left(-F_{a,y} - M_{a,y}\right) t_i\right)\right)^2 / \sigma^2$$

with the gamma function:

$$\Gamma(\alpha) = \int_0^\infty \exp(-u)\, u^{\alpha-1}\, du$$

A simple moment-based variance estimation procedure was used, although alternatives were suggested.

$$\sigma^2 = \frac{1}{n} \sum_{i,a,y} \left[U_{i,a,y} - Q_i N_{a,y} \ \exp((-F_{a,y} - M_{a,y}) t_i)\right]^2$$

3.5.5 Parameters

Two possible parameterisations were initially considered, and are referred to here as the 'short' and the 'long' parameterisations. In the 'long' parameterisation, year classes are estimated separately using survey data independently by year class. This is similar to the previous stock assessment procedure, but a simpler alternative was proposed (the 'short' parameterisation) in which a flat exploitation pattern from ages 6 to 13 (in 1996) was assumed, with the exploitation at age 5 estimated separately. Younger year classes could then be treated as recruitments in a separate calculation. The 'short' parameterisation is similar to that used for the Icelandic summer spawning Herring. In the 'long' parameterisation, a maximum in the log-likelihood function was located by searching on the following parameters:

Population abundance N at each of ages 3-9 and age 14 at 1 January 1997,
Catchabilities Q_i for each of the three surveys on the adult stock,
Catchabilities Q_i for ages 1 and 2 in the juvenile survey in the Barents Sea,
Tagging survival S (from the time of tagging to the end of the tagging year).

Population abundance at age 2 in 1997 was estimated conditionally on the fitted catchability, as:

$$N_{2,1997} = U_{BarentsSea,1,1996} / Q_{BarentsSea,1} \exp\left(-M_{1,1996} \frac{7}{12}\right)$$

Population abundances at ages 10–13 in 1997 were estimated by assuming that the estimated fishing mortality exerted on fish ages 13 years in 1996 was also exerted on ages 9 to 12. This is similar to the assumption made in the previous assessment of this stock.

In the 'short' formulation the parameters estimated are:

> Population abundance N at age 14 at 1 January 1997,
> Population abundance N at age 6 at 1 January 1997,
> Catchabilities Q_i for each of the three surveys on the adult stock,
> Tagging survival S.

and a constraint is imposed such that $F_{6\text{-}12,\,1996} = F_{13,\,1996}$.

3.5.6 Model fitting and testing

A starting point for the model exploration exercise was defined, being a model structure and data set similar to that used by Anon (ICES 1996/Assess:14). Specifically:

> Catch at age data 1950–1996, ages 0 to 16+
> Tagging data as used by Anon (ICES 1996/Assess:14)
> Surveys: 1983, 1988, 1989 and 1990 cohorts only
> year -range 1988–1996 (February-March), 1992 and 1993 missing
> 1992–1994 (December)
> 1991–1996 (January)
> Age-range for F on last age: 8 to 13
> Errors: lognormal
> M =0.15 on ages 3–16
> 'long' parameterisation
> tagging likelihood function included

The 1991 January survey, which was erroneously omitted last year, has been included, and M on ages 3 and older has been changed from 0.13 (with M=0.23 on the year classes 1987 and older in 1991–1994 due to *Ichtyophonus*).

Results obtained from this fitting procedure are labelled as 'Run 1' in Table 3.5.1. The following incremental changes to this model were then considered:

Run 2: Revised and extended tag release and recapture data for the 1983 year class presented by Hamre (WD, 1997) were used. The change in the estimate of spawning stock size estimates in 1996 was small, from 5.28 million t to 5.20 million t, and it was decided to adopt this change as it was consistent with previous information.

Run 3: The December acoustic surveys for the years 1995 and 1996 were included, except that the high observation at age 4 in 1996 was excluded. This resulted in a change in the spawning stock size estimate from 5.20 Million t to 3.69 Million t, concomitant with the estimate from that survey of a reduced stock size for the 1983 and 1988–1990 cohorts. The Working Group decided to adopt this change as being a valid addition of new information.

Run 4: The high outlying value of stock abundance at age 4 in 1996 from the December surveys was included. This resulted in a revision in spawning stock size from 3.69 to 6.56 million t. The Working Group did not wish to allow the assessment model estimates to be so highly dependent on a single observation from a partially recruited year class, and preferred instead to exclude this datum. This could be justified on account of a large increase in variance (493 to 3800).

Run 5: Information on juvenile surveys in the Barents Sea was included. These were found to have an extremely high variance, which made it appropriate to estimate a separate variance term for these surveys and to replace the year class estimate with a weighted mean of the historic recruitments (50% weight) and the survey-forecast recruitments (25% for each of age 1 and age 2) . As a further constraint and to be consistent with the assumption used in previous years that the acoustic survey of these fish could be used as an absolute estimator of year class strength, the constraints $0.5<Q_{\text{Barents Sea},\,1}<1.5$ and $0.5<Q_{\text{Barents Sea},\,2}<1.5$ were also imposed on the model.

Even with these additional constraints, the new information resulted in a change in the perception of spawning stock size from 3.69 to 2.32 million tonnes. Again, the Working Group decided not to allow the assessment of recruited year classes to be so strongly influenced by the highly-variable recruitment index and preferred to exclude the Barents Sea surveys from the assessment model.

Run 6: The model structure as in Run 3 was used with a catch at age data set in which the missing observations (previously set to 1000 fish) were replaced with Shepherd and Nicholson (1991) model predictions. The effect on spawning stock size estimates was small, changing from 3.69 to 3.68 million tonnes, although outlying values of fishing mortality in the catch-at-age matrix were removed. The Working Group considered that the improvement was mostly presentational in nature and did not warrant the additional computational burden that future Working Groups would incur if this procedure were to be adopted.

Run 7: The error structure was changed from lognormal to Gamma. This resulted in an increase in spawning stock size from 3.69 million t to 4.40 million t in 1996. This is consistent with the findings by Patterson (WD 1997) that making this change results in an increased stock size but improved consistency of the distribution of residuals with that predicted by the error model. The estimated selection pattern is shown in Figure 3.5.2.

Run 8: Consideration was given to including the very high survey observations made on the 1991 year class in January 1996 and in the February-March survey in 1996. This resulted in a change in perception of overall stock abundance from 4.40 Million t to 12.08 Million t. The large increase in variance suggests the inclusion of these values is inappropriate.

Run 9: The Working Group considered the exploitation pattern calculated using the 'long' parameterisation of the model (Run 7) to be highly fluctuating and questionable and explored the consequences of making a simplifying assumption of uniform exploitation at ages 6 and above in 1996 (Figure 3.5.2). Making this change resulted in a change in spawning stock estimate from 4.40 million t to 6.99 million t. The variance increases from 496 to 805, the number of fitted parameters decreases from 9 to 6.

Run 10: The Working Group considered including information from all year classes in the acoustic surveys on the adult stock. This was previously considered implausible as many year classes are of such low abundance they can only be very poorly estimated, and hence only contribute noise and outliers to the analysis. Including this information with Run 9 results in a change in perception of spawning stock size from 6.99 million t to 2.53 million t, but the variance estimate increases from 805 to 3461 and this fit also is unappealing on that ground.

Run 11: A flat exploitation pattern on ages 8 to 13 (in 1996) is assumed, the exploitation at age 5 is estimated separately and the exploitation pattern is assumed to be linear between ages 5 and 8 (Figure 3.5.2). Compared to run 7, this run gave a change in the spawning stock estimate from 4.40 to 5.48 million tonnes, which is very close to the value of 5.35 million t obtained in last year's assessment. The variance increased from 496 (Run 7) to 703, and the number of parameters estimated decreased from 9 to 7.

Clearly, the assessment procedure is highly sensitive to details of model structure and to the inclusion or exclusion of outlying data points. This is probably largely because fishing mortality is quite low, hence the VPA calculations are relatively uninformative. As a result, plausible solutions can be obtained in the range 2.3 to 12.1 million t.

3.5.7 Stock assessment of the 1991 and older year classes

For reference purposes a necessarily arbitrary choice was made of the most appropriate model. Due to the short time series of survey information, model testing by retrospective analysis is not appropriate in this case. Although other runs give better fit to the data, the Working Group finds the simple selection pattern of Run 11 more appropriate to use in a management context. In addition, the selection pattern is consistent with prior knowledge of fishery operations, and Run 11 gives good consistency with previous assessments. The age structure in the population estimates from the May 1996 survey in the Norwegian Sea (Table 3.3.4) also appears consistent with the results of Run 11.

Detailed input data are given in Tables 3.5.2–3.5.3. Diagnostic plots are given as Figures 3.5.3–3.5.4. The model was fitted using a FORTRAN implementation written for this purpose. For presentational purposes, terminal fishing mortalities so estimated were used to initiate the conventional VPA (see Section 3.5.9).

3.5.8 Assessment of the 1992 and younger year classes

In previous assessments, the size of the recruiting year classes has been determined by using the most recent acoustic estimates of these year classes as absolute estimates, and predicting the size of those year classes at age 3 using the natural mortalities given by de Barros (1995), i.e. 1.56 at age 1 and 0.54 at age 2. In some cases, acoustic estimates from several surveys were added together.

This year it was decided to use the RCT3 program for predicting the abundance of the year classes which were not determined by the assessment model given above, i.e. the 1992–1996 year classes.

The following survey estimates were considered for use in the RCT3 program:

Acoustic survey of the spawning stock in February-March, age 4 (Table 3.3.1)
Acoustic survey in the wintering areas in December, age 3 (Table 3.3.2)
Acoustic survey in the wintering areas in January, age 4 (Table 3.3.3)
Acoustic survey in the Barents Sea in May-June, ages 1 and 2 (Table 3.3.5)
(For 1996, the average of the Norwegian and Russian estimate was used)
International 0-group survey in the Barents Sea 1973–1996 (Table 3.3.7)

The default settings in the RCT3 program were used. The input data are given in Table 3.5.4 and the results of the analysis are given in Table 3.5.5. The year class strength of the 1992–1996 year classes at age 3 (billions) is given in the text table below, together with the estimates of those year classes made by last year's Working Group.

Year class	1997 WG	1996 WG
1992	29.473	23.961
1993	13.706	5.600
1994	0.688	0.845
1995	0.667	0.005
1996	3.103	-

It was also attempted to include the acoustic survey of 0-group in Norwegian coastal waters in November-December (Table 3.3.6) in the RCT3 analysis, this increased the size of the 1996 year class at age 3 from 3.103 to 10.689 billion individuals. As the acoustic survey of 0-group in Norwegian coastal waters covers only a small proportion of the 0-group fish in the case of good year classes, and some of the fish found in the 0-group survey in the Barents Sea was found very close to the coastal areas where most of the fish in the survey in coastal waters was found, it was decided to exclude the acoustic survey of 0-group in Norwegian coastal waters in November-December from the RCT3 analysis.

3.5.9 The final VPA

The catch at age, weight at age in the stock and catch and maturity ogive for the period 1950–1996 is given in Tables 3.5.6–3.5.9. The final VPA was run using the values of F in the last year taken from the assessment method presented above for the 1991 and older year classes. The fishing mortalities for the 1992–1994 year classes were adjusted so that the abundance at age 3 of those year classes are the same as those predicted by RCT3. The fishing mortalities and stock numbers are given in Tables 3.5.10–3.5.11, while the stock biomass at age and spawning stock biomass at age are given in Tables 3.5.12–3.5.13. A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment is given in Tables 3.5.14 and 3.5.15, for recruitment at age 0 and 3 respectively, and Figures 3.5.5A and 3.5.5B. Plots of recruitment at age 0 and age 3 vs. spawning stock biomass are given in Figure 3.5.6.

3.5.10 Yield-per-recruit analysis

The yield per recruit analysis using the fishing pattern and stock parameters from 1997 from the management option table gave estimates of $F_{0.1}$=0.22 and F_{max}=0.98. Yield per recruit vs. F is plotted in Figure 3.5.5 c.

3.6 Short-Term Prediction

3.6.1 Input data to the short-term prediction

These data are given in Table 3.6.1. The number at age at January 1, 1997, was taken from the final VPA for the year classes 1994 and older. For the 1995 and 1996 year classes, values corresponding to the RCT3 estimate of year class strength at age 3 were used. The weight at age and the maturity ogive in the stock in 1997 was set equal to the weight at age and maturity ogive for the corresponding age groups obtained from biological samples taken during the December 1996 survey. The 1997 values of those parameters were also used for later years. The weight at age in the catch and the fishing pattern in 1997 and later years were set equal to the 1996 values. The natural mortality was set to the same values as used in the assessment, i.e. 0.15 on ages 3 and older. The reason for those *status quo* choices is that the total stock size is expected to be relatively stable in the near future.

3.6.2 Results of the short-term prediction

The expected catch in 1997 (1,500,000 t) indicates that the fishing mortality ($F_{5\text{-}13,u}$) will decrease from 0.21 in 1996 to 0.20 in 1997. The effects of different levels of $F_{5\text{-}13,u}$ on the catch in 1998 and on the stock and SSB in 1999 are presented in Table 3.6.2.

The assessment shows that the spawning stock biomass increased from 5.5 million tonnes in 1996 to 9.1 million tonnes in 1997, and will increase further to 9.6 million tonnes in 1998. From 1998 to 1999, the spawning stock biomass will decrease for fishing mortalities above 0.06 in 1998. The total (3+) stock biomass will remain stable around 10 million tonnes in the period 1997–1999, but with a decreasing trend. With a *status quo* TAC in 1998, the $F_{5\text{-}13,u}$ will decrease from 0.20 in 1997 to 0.18 in 1998, but will remain above 0.15.

The total stock biomass is close to the values from last year's assessment, while the spawning stock estimates in 1997 and 1998 have been increased due to earlier maturation than expected last year. The fishing mortality in 1997 is calculated to 0.20, compared to 0.15 in last year's assessment. The change from last year is mostly due to lower weights at age in the catch than in last year's assessment.

3.7 Assessment of Uncertainty

3.7.1 Method and assumptions

A Bayesian approach to the estimation of uncertainty in some key parameters of management interest was used. This has allowed the Working Group to incorporate opinions held about the stock which are based on biological observations but which are difficult to quantify. It has now been possible to incorporate some such qualitative observations into the assessment procedure in a formal fashion, although a quantification of a large part of the uncertainty, due to choice of survey data and selection pattern model, remains intractable. The methodology used is described briefly below.

Conventional Bayesian analysis relies on an evaluation of the posterior probability $\mathbf{P(\Theta|X)}$ of a certain set of assumptions Θ, given prior belief $\mathbf{P(\Theta)}$ about those assumptions, a set of new information $\mathbf{X}$ and a likelihood function allowing the evaluation of $\mathbf{P(X|\Theta)}$. The conditional probability can be expressed as:

$$\mathbf{P(\Theta|X) = P(X|\Theta)\ P(\Theta) / \int P(X|\Theta)\ P(\Theta)\ d\Theta}$$

Conventionally the Θ is a vector of input parameters to a model $\mathbf{M}$, which is assumed to be correct and upon which the likelihood function is predicated. It is also possible to treat the entire model structure $\mathbf{M}$ as an additional unknown, and to integrate both over uncertainty in model parameters and over uncertainty in the model structure (in this case each Θ has a meaning which is specific to each $\mathbf{M}$). The evaluation of posterior probabilities proceeds analogously:

$$\mathbf{P(\Theta,M|X) = P(X|\Theta,M)\ P(\Theta|M)\ P(M) / \int P(X|\Theta,M)\ P(\Theta,M)\ P(M)\ d\Theta\ dM}$$

This approach allows the evaluation of a posterior probability distribution for any quantity of management interest (e.g. catch forecast, outcome of a harvest control regime, etc.) that can be calculated from any Θ and $\mathbf{M}$.

Such a distribution can be constructed for any reasonable range of alternative model components in **M**, so long as for each model component a likelihood term **P(X|Θ,M)** can be calculated.

In the present case, this has allowed the Working Group to make a calculation of uncertainty that includes uncertainty in the choice of appropriate error model and in the choice of appropriate stock-recruitment function. Gamma, lognormal and normal errors were admitted as alternative error models for the acoustic surveys with equal prior probability. With this approach it is not necessary to make a subjective choice of appropriate stock recruitment-function, as alternatives thought to be plausible can be admitted. In this case, the Working Group admitted three recruitment models as acceptable structural models with equal prior probability, being Beverton-Holt models (either for all cohorts, or excluding the extremely abundant 1950, 1959 and 1983 year classes), and a Ricker model with all cohorts included. However, the year classes 1991 and later were excluded from the calculation of the stock-recruitment function.

In summary, uncertainty was admitted on the following parameters as below:

Cohort abundance at age 14 in 1997:	**Uniform prior chosen to be unrestrictive**
Cohort abundance at age 6 in 1997	**Uniform prior chosen to be unrestrictive**
Catchabilities Q for each acoustic survey	**Prior Probability proportional to 1/Q, range chosen to be unrestrictive**
Additional mortality due to *Ichthyophonus*	**Uniform prior 0 to 0.1 consistent with (year classes 1987 and older, during 1991-1994) previous assessment**
Relative natural mortality on juvenile fish at ages 0-2	**Uniform prior in range 1-5; see Section 3.5.2.3**
Acoustic survey variance σ^2	**Prior probability proportional to 1/ σ^2 (see Jeffreys, 1961), range chosen to be unrestrictive**
Initial survival of tagged fish St	**Uniform prior in range 0.2-1.0, consistent with survival of tagged fish held in capture**
Error Models for Surveys	**Equal prior probability assigned to normal, lognormal and gamma models**
Recruitment Models	**Equal prior probability assigned to Beverton-Holt model (all year classes to 1991), Beverton-Holt model excluding 1959, 1950 and 1983 year classes, and Ricker model (all year classes)**

Some additional choices made were:

Selection Pattern Model	**As 'Run 11'**
Input data	**As 'Run 11'**

A Markov Chain Monte Carlo approach was used (Gilks *et al.* 1996) to generate multivariate samples from posterior probability distributions. A hybrid adaptive rejection sampling algorithm similar to that described by Gilks (1996) was used, except that Gilks' secant upper envelope function was replaced with a series of rectangular approximations. Although computationally less efficient, this algorithm was robust to structural bound-constraints (such as the upper bound of 100% tagging survival that the assessment model requires). Choice of burn-in period and the interval between which samples were assumed to be uncorrelated was set 1000 iterations and 60 iterations respectively, following previous calculations of minimum values of 600 and 76 respectively using the GIBBSIT algorithm of Raftery and Lewis (1996) on a similar assessment model (Patterson, WD 1997). Due to processing time constraints at the meeting a choice of a rather low thinning value of 60 was made, as a more stable posterior distribution could be calculated at some risk of increasing correlation in the sampled parameters. It was not possible to re-estimate serial correlations in the sampled parameters at the Working Group meeting.

Although it was considered desirable to develop a fully internally-consistent model of stock dynamics and forecasting, this goal was not entirely attained due to the perceived need to use the 'RCT3' recruitment prediction procedure for year classes 1992 to 1996 separately from the assessment procedure. The solution used was to fix the recruiting year classes (ages 1 to 5 in 1997) in the stochastic calculations to the same abundance (relative to the abundance at age 6) that they have in the deterministic calculation.

Recruitments of the 1996 and later year classes were predicted using the drawn stock-recruitment model and parameters, and calculating a non-parametric bootstrap. For consistency, a historic VPA calculation was made for each draw from the posterior to re-estimate the residuals conditional on the values of stock-recruit relationship parameters and of natural mortality in each draw.

The choice of selection model and the arbitrary deletion of data perceived as outliers in the Bayesian analysis has been adopted to be consistent with the choices made in the maximum-likelihood assessment. It would arguably have been preferable to base choices in the maximum-likelihood modelling approach on posterior perceptions from the Bayesian assessment rather than the converse, but that more correct approach was not possible due to time constraints and the much greater computational demands of the Bayesian calculations. The calculations of uncertainty made here are therefore underestimates.

3.7.2 Uncertainty in stock assessment expressed as posterior distributions

Posterior distributions calculated by the method described above for the parameters estimated directly in the assessment procedure (cohort abundances, natural mortality rates, etc.), for the 'nuisance' parameters (catchability, survey variance) and for estimates of stock size and fishing mortality are given in Figures 3.7.1 and 3.7.2. These indicate likely stock abundances in the range 4 to 8 billions at age 6 in 1997 compared with the maximum-likelihood estimate of 10.4 billions. At age 14, the maximum-likelihood estimate was 2.9 billion compared with a perception from the posterior distribution in the range 0.5 to 2 billion fish. The perception of natural mortality, which was admitted uncertain in the range 0.1 to 0.25, indicates that lower values are more likely and the probability reaches a maximum on the bound M=0.1. Similarly, estimates of the ratio of juvenile to adult mortality show little tendency to depart from unity, and lower values of Ichthyophonus-induced mortality (less than 0.04) also appear more likely.

The posterior estimate of appropriate error model differs from the choice made in the conventional procedure, and indicates a normal error distribution may have been a more appropriate choice in this case.

The distribution of spawning biomass estimates for 1997 (assuming F in 1997=F in 1996) spans a range from 2 to 6 million tonnes (calculated with the 1996 maturity ogive and weights at age).

The maximum-likelihood estimate was shown to be highly sensitive to the exclusion of values perceived as outliers. It is not known to what extent the Bayesian analysis is sensitive to such choices. As this uncertainty was not included in the modelling framework the analysis can be considered only approximately Bayesian.

3.8 Medium-Term Projections

Two different approaches to medium-term projections were applied. First, a simple model implemented on an Excel spreadsheet was run, similarly to the approach used at last year's meeting of this Working Group. Second, distributions from the Bayesian approach (Section 3.7) were used for projective runs.

3.8.1 Simple spreadsheet forecasts

Medium-term projection of stock and catch were carried out using a simple spreadsheet model. Here, the same assumptions were used as in the short-term prediction (Table 3.6.1), with the exception of maturity at age, which was set at 0.1 on age 4, 0.45 on age 5, 0 below and 1 above.

At last year's meeting there was considerable uncertainty as to the most appropriate model to use for recruitment, and a special working group was assigned to the task. Based on the work of this group and other material (WDs by G. Hagen, K. Patterson, D. Skagen, and S. Tjelmeland) the Working Group concluded that for the time being the Beverton-Holt model with logarithmic errors was to be preferred.

Future recruitment was generated from a Beverton-Holt model with a CV (or log-scale standard error) of 1.9. The model was parameterised from VPA data with age 3 as the youngest age, and scaled to age 0 using a total mortality of 2.7. The obtained parameters were 23.9 for the slope at the origin and 1.05 for the spawning stock that yields a slope half of this.

Uncertainty in current stock size was assumed to be adequately reflected by a standard error of 0.3 on log scale for ages 4 and older in 1997, taken from the Bayesian posterior. This value was used also during the simulations to account for future assessment errors. Uncertainty in younger ages was interpolated linearly from 1.8 at age -1 down to 0.3 at age 4.

The abundance of 4-year old fish and older fish were assumed to be fully correlated and independent of younger ages. It was found that this particular assumption made little difference as compared to an assumption of full independence across all ages from age 4 and older.

The projections started at January 1 1997 and the allocated catch for 1997 was implemented using an F of 0.19. The F by age applied during the simulations is the F-value in the catch control law multiplied with the exploitation pattern given in Table 3.6.1 and divided by the average over ages 5–10 of these numbers.

The average yield as a function of harvest control parameters is given in Table 3.8.1. It is seen that when either the catch ceiling or the fishing mortality is low, then that respective parameter becomes binding. Once F is at or over 0.15 and the ceiling is at or over 1 million tonnes, increases in either parameter lead to increasing catches.

Table 3.8.1 Medium-term simulation output. Average catch, 1998-2003, for different parameters in catch control law.

	Ybar(98-03)		F level in control law			
		0.05	0.1	0.15	0.2	0.25
	0.5	0.41	0.50	0.50	0.50	0.50
Maximum catch	1	0.45	0.76	0.90	0.96	0.98
	1.5	0.45	0.80	1.05	1.20	1.29
	2	0.45	0.81	1.08	1.28	1.41
	2.5	0.45	0.81	1.09	1.30	1.46

Table 3.8.2 provides a description of how the probability of a low spawning stock by 2003 varies with varying parameters in the catch control law. It is seen that for low values of the parameters there is very low probability of the stock reaching low levels. Conversely, at F>0.15 and Q_{max}>1.5 million tonnes the probability increases quickly.

Table 3.8.2 Medium-term simulation output. Probability of spawning stock biomass dropping below 2.5 million tonnes by 2003, for different parameters in catch control law.

	P[SSB<2.5 by 2003]		F level in control law			
		0.05	0.1	0.15	0.2	0.25
	0.5	0.00	0.00	0.00	0.00	0.00
Maximum catch	1	0.00	0.00	0.02	0.04	0.06
	1.5	0.00	0.00	0.02	0.16	0.34
	2	0.00	0.00	0.02	0.21	0.50
	2.5	0.00	0.00	0.02	0.24	0.60

Similar results for catches in the 10-year period 1998-2007 and SSB through the end of the period are given in Tables 3.8.3 and 3.8.4, respectively.

Table 3.8.3 Medium-term simulation output. Average catch, 1998-2008, for different parameters in catch control law.

		F level in control law				
	Ybar(98-08)	0.05	0.1	0.15	0.2	0.25
	0.5	0.37	0.47	0.49	0.50	0.50
Maximum catch	1	0.40	0.64	0.76	0.82	0.86
	1.5	0.41	0.67	0.84	0.94	1.01
	2	0.41	0.68	0.86	0.98	1.06
	2.5	0.41	0.69	0.87	1.00	1.09

In this case it is seen that there is relatively high probability of the stock declining to low levels, even with a very low fishing mortality. On the other hand, it must be borne in mind that these results are based on a very simple model and it is not clear how the inclusion of more complexity will affect these longer-term results.

Table 3.8.4 Medium-term simulation output. Probability of spawning stock biomass dropping below 2.5 million tonnes by 2008, for different parameters in catch control law.

		F level in control law				
	P[SSB<2.5 by 2008]	0.05	0.1	0.15	0.2	0.25
	0.5	0.03	0.14	0.18	0.20	0.22
Maximum catch	1	0.03	0.26	0.50	0.61	0.68
	1.5	0.03	0.28	0.52	0.72	0.79
	2	0.03	0.29	0.55	0.75	0.87
	2.5	0.03	0.29	0.55	0.75	0.87

If the primary objective is to obtain good catches while maintaining the spawning stock at above 2.5 million tonnes during the next 5 years or so, then the fishing mortality and catch ceiling should not exceed 0.15 and 1.5 million tonnes, respectively.

3.8.2 Bayesian medium-term projections

Admitting uncertainty in natural mortality requires a redefinition of the measure of exploitation of the stock, as fishing mortality rates are highly dependent on natural mortality. Although other parameterisations could be considered, a simple solution is to redefine exploitation rate as E=F/Z. Hence, for comparison with the conventional assessment (M assumed fixed =0.15) a calculation based on exploitation rate has been made.

The view of the state of the stock from taken from the Bayes posterior distributions is rather different from that calculated in the conventional assessment. The exploitation rate, as defined above, is considerably higher, and in the range approximately 3 to 4.5. The comparable value from the maximum-likelihood approach is 1.53. Concomitant with that difference, perceptions of stock development from this analysis show a faster decline in stock size at present exploitation rates. A medium-term projection calculated for an assumption of constant exploitation rate is given in Figure 3.8.1, and the associated estimates of risk (as probability that the spawning stock will fall below 2.5 million tonnes) in Figure 3.8.2. A calculation of the consequences of applying a harvest control law of F=M (equivalent to F =0.15 in the ML assessment) is given in Figure 3.8.3.

Inconsistencies between Bayesian and maximum-likelihood perceptions of stock dynamics have been noted before, especially in cases where information is relatively scarce (e.g. Walters and Ludwig, 1993). Arguments have been made that in such cases the Bayesian approach is more appropriate and provides a more realistic (and appropriately cautious) perception of stock dynamics.

3.9 Catch Control Laws

The simulated harvesting strategies have only included two parameters. These reflect the desire to maintain good and sustainable harvests while avoiding excessive variations in stock or yield due to either stock variations or assessment uncertainty. Due to the high level of uncertainty in the assessment, it is important that the harvest control law for this stock should rely also on a low level of fishing mortality in addition to a comparison with reference stock size.

Although the use of a formal catch control law is a major step on the way towards sustainable harvesting, this particular catch control law lacks a formal reflection of the need to maintain the spawning stock biomass above 2.5 million tonnes, below which reduced recruitment has been observed historically (Figure 3.5.6). The Working Group notes that it would be possible to formally take this need into account by adding more parameters to the catch control law. In particular, if the spawning stock biomass decreases towards 2.5 million tonnes in the future, then there will likely be a need for management action in order to try to prevent a further decline. If this action fails to prevent further decline and the spawning stock biomass drops below 2.5 million tonnes, then appropriate management action would be to decrease the fishing mortality (if not a moratorium), which corresponds to a rebuilding strategy.

This procedure as a whole may be reflected in a catch control law by decreasing the fishing mortality as function of the spawning stock biomass linearly from $F = F_{target}$ when $SSB = SSB_{pa}$ to $F= 0$ at $SSB = SSB_{limit}$, as outlined by the study group on the precautionary approach to fisheries management (ICES CM 1997/Assess:7). At spawning stock biomasses above SSB_{pa}, the previously described catch control law of a constant fishing mortality bounded by a catch ceiling apply. The fishing mortality and yield as a function of SSB applying this catch control law to a stock with constant recruitment using the stock parameters used in the short-term prediction is given in Figure 3.9.1.

3.10 Management Considerations

The immatures and adults of this stock form a central part of the ecosystem in the Barents and Norwegian Seas, respectively (Section 7). The herring has an important role as a transformer of the production of zooplankton biomass and energy to a form which is available to organisms at a higher level of the food chain. A large stock of herring will utilise larger quantities of plankton (and over larger areas) and be able to support larger fish stocks in the higher food chain levels, than a small stock will do.

The stock assessment indicates a large spawning stock in 1997. However, the assessment is imprecise, the assessment procedure is sensitive to details of model structure and to the inclusion or exclusion of outlying data points. Possible estimates of the spawning stock from varying runs can be obtained in the range 2.3 to 12.1 million t. The view of the state of stock taken from the Bayesian posterior distribution is more pessimistic than that calculated from the conventional assessment, they show a lower stock and indicate a faster decline in stock size. The Bayesian approach is more consistent in the treatment of uncertainty and in the correlation of parameters than the conventional approach.

The stock has a very dynamic recruitment pattern, and the spawning stock is expected to decrease in the coming years due to poor recruitment, especially from the year classes 1994 and 1995.

An adoption of a cautious harvesting strategy is likely to improve the medium and long-term benefits to be obtained from this fishery. The stock of Norwegian spring spawning herring is exploited by the world's most efficient purse seine and pelagic trawler fleets. The stock has a known vulnerability to collapse at high levels of exploitation. In the mid-1960s the condition of this stock changed very rapidly, from record catches in 1966–1967 to a depleted stock in late 1969.

According to the UN agreement on "Straddling fish stocks and highly migratory fish stocks" it is of paramount importance that the Management Agencies of this type of stocks agree in advance to a plan for remedial action in case of a development of spawning stock size to low levels. Possible elements of such plans for Norwegian spring spawning herring are indicated in Section 3.9.

3.11 Discards (OSPAR Request)

The herring and capelin fisheries dealt with by WGNPBW are single stock purse seine and pelagic trawl fisheries. Mixing of species rarely occur in the catches. Some additional mortality may occur in some fisheries (Section 3.2). An estimate of discards of blue whiting in the southern fisheries (Spain and Portugal) is given in last year's Working Group report (ICES 1996/Assess:14).

3.12 Information on New Developments in the Seasonal and Area Distribution of the Total Norwegian Spring-Spawning Stock

A planning group meeting was held in Bergen in February 1997 (ICES CM 1997/H:3) to plan and co-ordinate surveys under the auspices of ICES, on Norwegian spring-spawning herring in spring and summer 1997. An evaluation meeting for these surveys will be held in Reykjavik on 20–22 August 1997 (Chairman: Hjalmar Vilhjalmsson, Iceland).

All new information on the distribution and migration, based on surveys and fisheries, of the Norwegian spring-spawning herring will be included in the report from the meeting. The report will be presented to the ICES Annual Science Conference in 1997, and will be made available to the ACFM November 1997 meeting.

3.13 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals	Catch composition (Section 3.2)
Norway, fishery	68	6800	6705	1077
Norway, acoustic	225	22443	14607	-
Russia, fishery and acoustic 1996	24	14000	1728	-
Russia, fishery 1997	5	9228	640	-
Iceland, fishery	13	1011	1011	-
Iceland, acoustic	40	7823	3250	-
Faroes, fishery	16	1344	1344	-
Netherlands, fishery	12	1234	300	-
Denmark, fishery	5	450	443	-
UK, fishery	8	832	590*	-
Germany, fishery	0	0	0	-
Sweden, fishery	1	48	48	-
Ireland, fishery	3	348	188	-

* Not used

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 (now 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 1965–1996 is given in Table 4.2.1. Following the recommendation from ACFM, there was no fishing for Barents Sea capelin during 1996.

4.3 Stock Size Estimates

4.3.1 Larval and 0-group estimates

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 4.3.1. These larval abundance estimates do not show a high correlation with year class strength at age one, but are probably reflecting the amount of larvae produced in each year (Gundersen & Gjøsæter, in press). An exception is the year 1986, when no larvae were found, probably because the spawning took place so late that the eggs hatched after the survey were carried out. Also in later years some spawning is known to have taken place during the summer, and offspring from this spawning is not reflected in the larval abundance estimates in Table 4.3.1. The estimate at 2.4 thousand billion in 1996 shows that a sufficiently high number of larvae has been produced to give rise to a year class of intermediate strength. During the international 0-group surveys in August an area based index for the amount of 0-group capelin is calculated (Table 4.3.1). Gundersen & Gjøsæter (in press) found these indices to be well correlated ($r^2 = 0.75$) with the 1-group acoustic estimates obtained at the annual acoustic capelin surveys in autumn. Based on the regression they presented, the 0-group index obtained in 1996 of 291 should correspond to a year class strength of 153 billion one-year-olds in autumn 1997.

4.3.2 Acoustic stock size estimates in 1996

The 1996 acoustic survey was carried out jointly by two Russian and two Norwegian vessels in the period 12 September to 2 October. The results from the survey are given in Table 4.3.2, and are compared to previous years results in Table 4.3.3. The stock size was estimated at 500,000 tonnes, and was dominated by the 1995 year class (one-year-olds) which constituted about 85% by numbers and 47% by weight. The older age groups are not very numerous, but the individual growth in weight was the highest on record. About half of the stock biomass consists of maturing fish, and the stock is, therefore, well below the limit reference point of 500,000 tonnes.

4.3.3 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1986–1996 is given in Tables 4.3.4–4.3.13. The methods and assumptions used for constructing the tables were explained in Appendix A to ICES (1995/Assess:9). In that report, the complete time series back to 1973 also can be found. However, this year, some of the methods and assumptions used are slightly changed, and these changes are described in the working document "Updated tables for the historic development of Barents Sea Capelin based on the spreadsheet model "Capstock" by H. Gjøsæter to the present Working Group meeting. These changes for the most part have only small effects on the calculated quantities. 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, M-values for immature capelin will be calculated using new estimates of the length at maturity and M-values for mature capelin will be calculated taking the predation by cod into account. However, for giving a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

Estimates of stock in number by age group and total biomass for the period are shown in Table 4.3.4. Catch in number by age group and total landings are shown for the spring season and the autumn season in Tables 4.3.5 and 4.3.6. Fishing mortality coefficients by age group for the autumn season and natural mortality coefficients by age group for immature and mature capelin are shown in Tables 4.3.7 and 4.3.8. 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 4.3.9 and 4.3.10. Proportion of mature stock by age group at 1 January and spawning stock biomass at 1 April are shown in Tables 4.3.11 and 4.3.12. Table 4.3.13 gives an aggregated summary.

4.3.4 Stock-recruitment relationship

Based on the estimated spawning stock size and recruitment (at age one) included in the stock summary table (Table 4.3.13) a stock-recruitment plot was constructed including data from the years 1973 to 1995 (Figure 4.3.1). The SSB at 1 April is forecasted from the acoustic estimate of capelin larger than 14.0 cm length in the previous autumn (1 October), subtracting catches of capelin larger than 14 cm from 1 October to 31 December and the total catches 1 January to 1 April, and reducing with estimated natural mortality coefficients for each age group over the period 1 October to 1 April. The Ms are estimated from the reduction in number in age group i 1 October in year j to age group $i+1$ at 1 October in year $j+1$(ref. Table 4.3.8). The number of recruits are the estimated number of one-year-olds at 1 August. These numbers are back-calculated from the acoustic estimate of this age group at 1 October, adding catches (if any) in the period 1 August to 1 October. Before 1980, the one-group was seriously underestimated during the acoustic survey, due to incomplete coverage of the areas where this age group is normally found. In these years, the number of recruits (one-year-olds at 1 August) were back-calculated from the acoustic estimate of the two-year olds, compensating for catches and natural mortality in the 14 months from 1 August year i to 1 October year $i+1$. The estimated SSBs and Rs are, therefore, affected by the uncertainty in the acoustic estimates of the various age groups, the uncertainty in the number of individuals removed by natural mortality, and the uncertainty in the number of individuals caught. Of these sources of error, the last one is probably insignificant compared to the other two.

A Beverton-Holt model $R = \frac{S \cdot R_{\max}}{S + S_{1/2}}$ and a Ricker model $R = \alpha S e^{-\beta S}$ was fitted to the data. The parameters of the Beverton-Holt model were: R_{max}= 804 (billions) and $S_{½}$= 98.7, while the parameters of the Ricker model were: α=5.2 and β=0.0018. Which model to choose is open for discussion, but the traditional interpretation of the Ricker curve; that a too large spawning stock hampers recruitment because of cannibalism is not feasible for capelin, since the spawning stock is removed by natural mortality irrespective of size before such a mechanism could affect the recruitment. The Beverton-Holt model, where the recruitment rises towards an asymptote for increasing spawning stock size seems more appropriate on theoretical grounds, and seems to fit the present data quite well (Figure 4.3.1).

See Section 7.1.3 for a discussion of the implications of the presence of herring in the Barents Sea for the recruitment of capelin. It is concluded there that a realistic model for the recruitment of capelin has to take account of the presence of herring. When one year old and older herring is present in significant amount in the Barents Sea in June (more than 2–3 hundred thousand tonnes), the capelin recruitment will probably fail completely. The only exception is when there is an insignificant overlap of capelin larvae and herring, e.g. because the herring is concentrated in a small area compared to the capelin larvae.

4.4 Sampling

No fishing took place on the Barents Sea capelin in 1996, and consequently no samples from commercial vessels have been obtained. The sampling from scientific surveys is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Acoustic survey 1996 (Norway)	90	4967	2013
Acoustic survey 1996 (Russia)	16	3389	753
Norwegian bottom trawl survey winter 1997	162	4619	889
Russian investigations winter 1997	4	400	400

4.5 Management Considerations

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season is from January to March, advice for this stock must be given during the autumn ACFM meeting and the TAC set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. As previously decided by the Northern Pelagic and Blue Whiting Fisheries Working Group, the assessment of Barents Sea capelin is left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who will report directly to ACFM before its autumn 1997 meeting.

Previously, a harvesting strategy of aiming at a spawning stock size of at least 500,000 tonnes was used for the Barents Sea capelin. The Working Group is of the opinion that this strategy should be considered, to have a firm basis for a TAC advice when the stock rebuilds, probably in the near future. Work will be initiated at the IMR, Bergen, to revise the models previously used, and to establish harvesting control rules based on the precautionary approach. This work will be followed up by correspondence by the Working Group, with aim to have procedures approved by the Working Group before the capelin survey and assessment meeting in September-October.

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

5.1 The Fishery

5.1.1 Regulation of the fishery

The fishery depends mostly upon maturing capelin, i.e. that part of each year class which spawns at age 3 as well as those fish at age 4, which did not reach maturity to spawn at age 3. 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 the 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). Predictions of TACs have been computed based on data from surveys of the abundance of immature 1 and 2 year old capelin, carried out in the autumn of the year before. The process includes historical relationships between such data and the backcalculated abundance of the same year classes, an average growth rate and natural mortality and the provision of a remaining spawning stock of 400,000 t. Final catch quotas for each season have then been set in accordance with the results of acoustic surveys of the maturing, fishable stock abundance, carried out in autumn (October-November) and/or winter (January/February) in that fishing season. A more detailed description of the method is given in Section 5.5.1. A summary of the results of this catch regulation 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 1996/1997 season

In accordance with a previously determined procedure, ACFM recommended a precautionary TAC of 1,100,000 t which would not exceed 2/3 of the total TAC predicted for the season, i.e. 1,600,000 t. This advice was accepted by all parties concerned.

The season opened on 1 July with Icelandic, Norwegian and Faroese vessels taking good catches in the deep water area near the boundary between the EEZ of Iceland, Greenland and Jan Mayen. Catch rates remained high during July and the first half of August but declined after that. In this period most of the catch was taken in the area between 68°N and 70°N between about 14°W and the Greenland shelf.

After about mid-August catch rates declined and remained comparatively low throughout September. On returning to the shelf area north and northeast of Iceland from the summer feeding grounds farther north, the maturing capelin mixed with the immature part of the stock. Furthermore, the adults soon scattered and only occasionally aggregated in fishable concentrations during October-December.

The total catch in the 1996 summer and autumn season amounted to almost 775,000 t, of which about 80% were taken in July and August. There were no problems due to undersized immatures in the 1996 summer fishery in the northern cold water area. However, the situation was reversed in late autumn and winter when parts of the shelf area north of Iceland had to be temporarily closed to the fishery in order to protect the immature stock.

The capelin remained in scattered concentrations east of Iceland for the most part of January 1997. The monthly catch amounted to about 60,000 t, almost half of which were taken by a few boats operating with pelagic trawls.

An intense fishery began in the first days of February in shallow waters off the eastern south coast of Iceland. In spite of stormy periods, catch rates remained high throughout the month and a record catch of just over 460,000 t was taken by the Icelandic fleet. Bad weather also disrupted fishing in March, the Icelandic catch during this last month of the season amounting to 255,000 t.

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 775,000 t was taken by Icelandic vessels during the 1997 winter season. In addition, some 22,000 t were taken by vessels from the Faroes and Greenland, mainly in February and March.

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 1978–1996 and winter 1979–1997 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 1996 and winter 1997 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 0-group surveys. Their abundance by number, mean length and weight are given for the period 1982–1996 in Table 5.3.2.

5.3.2 Stock abundance in autumn 1996

An acoustic survey was carried out in the period 27 October–12 November 1996 (Working Document by Hjalmar Vilhjalmsson). The distribution of the stock was wide and continuous, reaching from 27°W, northwest of the NW-peninsula of Iceland, across the outer part of the northern shelf to 10°30'W off the northern and central east coast. The largest and most dense capelin concentrations were recorded near the shelf edge off the western and central north coast and northeast of Iceland.

In practical terms, the October/November 1996 survey was not constrained by drift ice and weather conditions were unusually good. There was little interference by aeration or sea swell in any part of the survey area and necessary adjustments for reductions of echo intensity for these reasons were minimal. 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. Furthermore, the coverage of the shelf area east of Iceland was probably inadequate with respect to the immature part of the stock.

According to the autumn 1996 survey the immature stock component amounted to 111.2 and 16.9 * 10^9 fish, belonging to age groups 1 and 2 respectively. The estimated fishable/spawning stock abundance was 86.4 * 10^9 fish in mid-November 1996. The observed mean weight in the fishable stock was 16.6 g and the fishable/spawning stock biomass, therefore, about 1,435,000 t.

Details of this stock estimate are given in Table 5.3.3.

5.4 Historical Stock Abundance

The historical 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 being 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 (ICES 1991/Assess:17) 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 of the following year for the 1978/79–1996/97 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 1979–1997.

The observed annual mean weight at age was used to calculate the stock biomass on 1 January. With the exception of juvenile capelin, which are surveyed in summer, the historical 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 by number, 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.

The maturing part of age group 2 in summer (N_{2mat}) is a part of the survivors of the 1-group of the previous autumn (N_1), which is measured in October. A prediction model was developed (ICES 1993/Assess:6), based on a linear relationship between the historic back-calculated abundance of maturing capelin at age group 2 (N_{2mat}) and the autumn acoustic estimates of the same year classes at age 1 (N_1). This relationship was then used to predict the adult 2-group abundance 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, therefore, have 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 1981–1996 (year classes 1978–1994) is given in Table 5.5.2. The above regressions have been updated as new data became available. A comparison of the predicted TAC updated with data from the autumn surveys is given in Table 5.5.3.

5.5.2 Stock prognosis and TAC in the 1996/1997 season

The 1993 model for predicting the number of maturing capelin of age 2 from the autumn 1995 acoustic assessment of the 1994 year class gave 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 this and the probable lower maturation rate for large year classes, a curved 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 recommended the continued use of the relationship established in 1993, but with an upper limit near the highest recruitment actually observed. 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. Therefore, the Working Group agreed to set the predictive figure at 90 billion individuals.

The unusually high abundance of immature 2-group capelin (1993 year class), recorded during the autumn 1995 acoustic survey would, when added to the maturing part of that year class, also have resulted in a predicted abundance of maturing 3-group capelin far outside the range previously observed. However, since it was 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 such cases the most reasonable procedure would be a projection of the autumn acoustic estimate of the age 2 immature component by number to 1 August of the following year. A projection of the estimated abundance of immature capelin of the 1993 year class (Table 5.5.3) yielded 35.0 billion maturing capelin of the 1993 year class when projected to 1 August 1996, assuming a monthly M = 0.035.

The fishable stock biomass, obtained by multiplying the stock in number thus predicted by the average mean weight of maturing capelin in autumn, 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 recommended that a preliminary TAC for the 1996/97 capelin fishery be set at 1,100,000 t.

According to the autumn 1996 survey the estimated fishable/spawning stock was 86.5 * 10^9 fish in mid-November 1996. At that time the observed mean weight in the fishable stock was 16.6 g and the stock biomass therefore about 1,435,000 t. With the usual prerequisite of a monthly natural mortality rate of 0.035, a remaining spawning stock of 400,000 t and an estimated weight increase of 2.6 g the above abundance estimate indicated a TAC of 1,010,000 t in the period mid-November 1996–March 1997 if the catch were spread evenly over the period. Counting the catch taken in July-October 1996, this corresponded to a total TAC of some 1,700,000 t for all of the 1996/97 season. However, due to the uncertainty of the estimate, described in section 5.3.2, and the large catch still to be taken it was decided to set the TAC at 1,600,000 t, i.e. at the level originally predicted.

5.5.3 Stock prognosis and assessment for the 1997/1998 season

Calculations of expected TAC for the 1997/1998 season, based on the method described in Section 5.5.1 and data from Table 5.5.1, were used for predicting the abundance by number of maturing capelin of ages 2 and 3 on 1 August 1997. An updated linear regression of the measured abundance of 1-group capelin (N_1) on the backcalculated abundance of mature 2-group fish (N_{2mat}) gives y = 0.58x +19.1; $R^2 = 0.81$, $p < 0.05$. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives y = 0.34x - 9.4; $R^2 = 0.63$, $p < 0.05$. The values used to predict the abundance of the 1995 and 1994 year classes are given in Table 5.5.1. This gave an estimate of 83.8 and 30.9 billion mature fish, belonging to the 1995 and 1994 year classes respectively.

Since 1989 there has been a general downward trend in weight at age of adult capelin, apparently inversely related to adult stock abundance in number (Figure 5.5.1). Plotting these pairs of data as simple linear regressions results in $R^2 = 0.72$ and 0.83 for age groups 2 and 3 respectively. Applying the appropriate regression equations, y = -0.027x + 18.8 for the younger component and y = -0.059x + 28.4 for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1997 combined, *i.e.* 114.7 * 10^9 fish, resulted in estimated mean weights of 15.7 and 21.6 g for age groups 2 and 3 respectively.

Using the predicted mean weight of maturing capelin in autumn instead of the average mean weight, results in a predicted TAC of 1,265,000 t if spread evenly over the period July 1997–March 1998. This corresponds to a precautionary TAC of about 850,000 t. As in previous years, decisions on the final TAC for the 1997/98 season should be based on surveys carried out in October/November 1997 and/or January/February 1998.

5.5.4 Management of capelin in the Iceland-Greenland-Jan Mayen area

The fishable stock consists of only 2 age groups (2 and 3 year olds, spawning at ages 3 and 4). The fishing season usually begins in July and ends in March of the following year when the remainder of the fishable stock spawns and dies. The fishable stock (= spawning stock) is thus renewed annually and its exploitation must of necessity be cautious. Due to the short life span and high spawning mortality, stock abundance can only be assessed by acoustics.

Since 1992, the key elements in the management of capelin in the Iceland-Greenland-Jan Mayen area have been as follows:

Acoustic survey estimates of juvenile capelin abundance have been used to predict fishable stock abundance by number in the following year (fishing season). Historical average mean weight at age, growth rates and natural mortality have been used for calculations and projections of spawning and fishable stock biomass.

Based on the data described above, a prediction of TAC is made in spring of the year in which the season begins, allowing for 400,000 t remaining to spawn at the end of the season. For precautionary purposes, a preliminary TAC, corresponding to approximately 2/3 of the predicted total TAC for the season, has then been allocated to the period July–December. With regard to a precautionary approach, the working group stresses the importance of setting a preliminary TAC for the first half of the season.

The preliminary TAC is near the lower 95% confidence limit of the TAC prediction for the whole season (July–March). The final decisions on TACs for each fishing season have been based on the results of acoustic stock abundance surveys in late autumn or in January of the following year during that season.

The procedure just described has worked well in the past for "normal" ranges of stock abundance. However, it is clear that an extra care should be taken when dealing with stock abundance below or above the norm, corresponding to TACs <500,000 or >1,500,000 tonnes.

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 1978–1996 is given in Table 5.6.1.

5.7 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 1996	111	13043	3636
Survey 1996	127	11450	11419
Fishery 1997	46	4550	4523
Survey 1997	24	2400	2385

6 BLUE WHITING

6.1 Stock Identity and Stock Separation

This topic has been dealt with in previous Working Group reports, and in 1994 the two stocks, i.e. the northern one and the southern one, have been treated as one for the assessment purpose (ICES 1996/Assess:14). In 1995 it was stated that several populations of blue whiting could appear in the spawning area, but preliminary analysis did not show any genetic substructure among the blue whiting from west of the British Isles to Gibraltar. The study has continued in an EU-project and further analysis indicated two main components in the spawning area. The location of a separation line has, however, not been defined, but the genetic analysis on samples from the spawning area will be intensified in the coming years (J. Mork, pers. comm.).

In a paper by Skogen *et al.* (in press) the existence of a possible separation line between a northern and a southern stock is tested by use of a Lagrangian water transport model in connection with a hydrodynamic circulation model. The hypothesis is that the separation could be explained from drift patterns of the larvae in such a way that the northern stock larvae tend to drift northwards and the southern ones southwards. After running the models for 20 years (1976–1995) with the particles assumed to be blue whiting larvae, the result of the modelled drift found a separation line north of the Porcupine Bank. However, the line shows a large interannual variability indicating a mix between the two stocks.

6.2 Fisheries in 1996

Estimates of the total landings of blue whiting in 1996 from various fisheries by countries are given in Tables 6.2.2–5 and are summarised in Table 6.2.1. The total landings from all blue whiting fisheries in 1996 were 637,825 tonnes, which is 10% more than in 1995.

The majority of the blue whiting catches was taken in the spawning area and consisted of about 470,000 tonnes. The landings in 1996 from the directed fisheries increased by 9% from 1995 and the landings from the mixed industrial fishery, which took place mainly in the Norwegian Trench, increased by 13%. Landings in this area increased by a factor of 4 times between 1994 and 1996. The strong 1995 and 1996 year classes were the basis for this fishery, making up 33 and 53% in numbers respectively of the landings in 1996.

Landings from the southern fisheries (Spain and Portugal) were 25,099 tonnes which was 10% less than in 1995.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on length compositions of the 1996 commercial catches of the blue whiting stock by ICES divisions and quarters were presented by Norway, Russia, Spain, Portugal, The Netherlands and Denmark (Tables 6.3.1–6.3.6). The lengths of the blue whiting varied over season and areas.

The majority of the fishes from the directed fishery had the length range from 27–33 cm. Nevertheless the Russian catches consisted mostly of fish with length from 16–22 cm (due to wintering fishery in the area south-east of Faroes). The modal length of the fish from the mixed industrial fishery was 19 cm.

Spain and Portugal caught blue whiting with modal length at 21 cm.

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 1996, age compositions were provided by Norway and Russia, which together accounted for 88% of the catches. Appropriate Russian age compositions of catches were used for the catches of Estonia, and Norwegian age compositions used to allocate the landings of all the other countries into catch in numbers by age groups. For Denmark and The Netherlands the age-length keys were used on their own length distributions. the age composition in the directed fishery is given in Table 6.3.7.

Age compositions for the mixed industrial fisheries in 1996 were provided by only Norway, which represented 48% of the catches, and its age compositions were used for allocation of the other nations catches. The by-catch of blue whiting in the Faroes fisheries of Norway pout, was estimated by use of corresponding Norwegian by-catch data (Table 6.3.8).

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 combined age composition for the directed fishery in the spawning area and in the Norwegian Sea , as well as the total by-catch of blue whiting in the mixed industrial fisheries, and for the landings in the southern area, were assumed to give the overall age composition of the total landings from the blue whiting stock. The number at age group as used in the VPA run are given in Table 6.3.10.

6.3.3 Weight at age

Data on mean weight at age were available from Russia, Norway and Spain. Landings from other countries were assumed to have the same mean weight at age as the sampled catches. Table 6.3.11 shows the mean weight-at-age for the total catch from 1981–1996 as used in the VPA run. The weight in the stock was assumed to be the same as in the catch.

6.3.4 Maturity at age

As was the case in the last year, the same maturity at age, given in Table 6.5.1 for input data for prediction, was used in the VPA run for all years. The values are obtained by combining the maturity ogive from the southern and from the northern areas, weighted by catch in numbers at age (ICES 1995/Assess:7).

6.4 Stock Estimates

6.4.1 Acoustic

6.4.1.1 Surveys in the spawning season

1996

The results of the sixth joint Norwegian-Russian acoustic surveys carried out in March/April in the spawning area west of the British Isles, were presented in last years report as well as the results of two Norwegian surveys in the Norwegian Sea in March and April 1996 (ICES 1996/Assess:14).

In addition Spain carried out an acoustic survey in the Bay of Biscay in March/April (Carrera and Meixide 1997). The R.V. "Cornide de Saavedra" made two coverages along the shelf edge off northern Spain and south-western of France (Divisions VIIa,b,c), from 21–29 March and 7–13 April respectively, to study the movement of blue whiting in the Bay of Biscay.

The recordings were made by use of a 38 kHz echo sounder. The population structure found in 1996 was different from 1994, and the 1 and 2 year olds represented up to 95% of the recorded population. The decrease in number of fish from the first to the second coverage was also accompanied with a change in the population structure. The decrease of 2 year olds off France and 1 year olds off Spain from the first to the second coverage without an increase in other surveyed areas, suggests that a postspawning migration is unlikely. It seems that the southwards postspawning migration from the Porcupine Bank area is undertaken by only a few young specimens (mainly 2 and 3 groups) and is moderate compared to the observed northwards postspawning migration (Monstad *et al.* 1996).

1997

Neither Norway nor Russia carried out their traditional acoustic spring surveys in the spawning area west of the British Isles. These have taken place in most years since the beginning of the 1970s, and as formally joint surveys since 1990.

In the Bay of Biscay Spain carried out an acoustic survey in April 1997, but no results were available at the meeting.

6.4.1.2 Surveys in the feeding season

Within the Norwegian Sea programme "Mare Cognitum" and during the international surveys for herring investigation in the Norwegian Sea, blue whiting was recorded by several vessels during summer 1996. The recorded concentrations, however, were rather scattered for most of the surveys, and within limited areas.

From the recordings of the Norwegian survey by R.V. "G.O. Sars" from 19 July–15 August, an acoustic assessment of the blue whiting concentrations was made (Monstad 1997). The area from the Norwegian coast westwards to 3°W between 62° and 72°N was surveyed (Figure 6.4.1) using the BEI system (Bergen Echo Integrator) connected to a 38 kzH echo sounder.

Scattered recordings of blue whiting were made throughout the area surveyed, and the distribution and relative abundance are given in Figure 6.4.2. The concentrations were highest in the continental shelf area, although the distribution occurred into the Norwegian Sea.

The biomass was estimated at 1.7 mill tonnes, the same as estimated during summer in 1993 and in 1995 within approximately the same area. However, the abundance was much higher this year at 27.9 x 10^9 compared to 15.6 x 10^9 last year. This was due to the high number of one year olds (1995 year class), and thus confirmed earlier observations that this is a very rich year class.

Age and length distributions are shown in Figures 6.4.3 and 6.4.4 for different sub-area and for the total respectively, clearly demonstrating the young fish being near the Norwegian coast and the bigger and older ones more over deep water areas. The 1995 year class contribution with 84% in numbers.

During the Russian survey with R.V. "Fridtjof Nansen" from 12 June–11 July, (Figure 6.4.5) the blue whiting recordings were also acoustically assessed (Krysov and Ushakov 1997), using a 38 kHz echo sounder connected to a Sigran G integrator. Blue whiting was found distributed over most of the area surveyed area, with the main concentrations to the south of 65°N and eastwards from 6°W (Figure 6.4.6). The recordings were mainly as scattered layers in various depths from 150–300m. The 1 year old (1995 year class) dominated in most of the trawl station catches of blue whiting. Older and larger fish was found only in the north-western part of the surveyed area, where 6 and 7 year olds prevailed. The total biomass was estimated at 5.6 mill. tonnes or 48.8 x 10^9 individuals.

6.4.1.3 Discussion

The biomass estimates of blue whiting in the spawning area since 1983 are given in Table 6.4.1 with the corresponding spawning stock sizes in brackets.

As mentioned in previous reports the differences in the estimates may be caused by differences in acoustic equipment, weather conditions during the surveys, size of the area surveyed and timing of the surveys with respect to spawning progression and hence the congregation of various parts the stock.

In the spawning area the rich 1989 year class was abundant, even as 1 year olds, and contributed significantly to the catches. Up to 1996 the blue whiting fishery was based on this year class to a great extent. In 1996 the rich 1995 year class (ICES 1996/Assess:14) was found to be abundant in the area to the west of the British Isles, especially in the northern and the southern part. This year class recruited significantly as 0-group to the catches in the mixed industrial fishery, and in spring 1997 also recruited to the fishery in the spawning area. Because the spawning area was not surveyed in 1997, information on this year class at age 2 is available only from the fishery.

The biomass estimate per rectangle is shown in Figure 6.4.7, combined for the Spanish (0.4 mill. tonnes) and the Norwegian surveys (5.1 mill tonnes) in spring 1996. It demonstrates the blue whiting distribution along the shelf edge area from The Faroes to the northern coast of Spain. The gap in the recordings in the mid area is due to lack of cruise tracks.

As reported to the Working Group last year the 1995 year class was abundant in the Norwegian Sea in March and April 1996. During the summer surveys it was found to dominate in the recorded concentrations, again confirming its high abundance. The Russian acoustic estimate of 5.6 mill tonnes was obtained during an earlier period than the Norwegian estimate of 1.7 mill. tonnes, and also represents a larger distribution area with the highest concentrations found in the eastern part of Faroes waters. However, this is the first time since the early 1980s that blue whiting concentrations have been recorded at the same level in the feeding area during summer as in the spawning area during spring (ICES 1987/Assess:4).

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. The area covered in the Portuguese survey was also extended in 1989 down to 750 m. depth. Stratified mean catch and standard error in Spanish and Portuguese surveys are shown in Table 6.4.2 and 6.4.3.

6.4.3 Catch per unit effort

No CPUE data from the fisheries in the northern area in 1996 were submitted to the Working Group. Figure 6.4.9 in last year's report (ICES 1996/Assess:14) shows the time series of overall aggregated CPUE values across areas in the Norwegian directed blue whiting fishery in the spawning area since 1982, indicating an increase from 1991 to 1993 and then decreasing to 1995.

Data on CPUE of 1996 from two bottom trawl fleets were submitted by Spain (Galician single and pair trawl) and shown in Figure 6.4.8. The CPUE values have been stable in the 1990s.

6.4.4 Virtual population analysis

6.4.4.1 Tuning the VPA to survey results

In total the 6 tuning series used by the Working Group to tune the VPA, the same as used in 1995, were 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 the Portuguese survey (bottom trawl). Earlier tests (ICES 1995/Assess:7) had indicated that variations on XSA options did not improve the results. 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 (ICES 1996/Assess:9). All methods gave similar results, showing conflicting trends in some years with the acoustic surveys. Although the inclusion of fleets that covered areas where the juveniles are distributed improved the tuning in the past, and especially the inclusion of the acoustic survey in the Norwegian Sea, this year ages with very high Log catchability residuals were excluded from the analysis. This was the case for ages 0 and for 9 and older in the Norwegian Sea acoustic survey, ages 0 and 1 in the Spanish and Portuguese bottom trawl surveys and in the Spanish Pair trawling fleet. The available tuning data are shown in Table 6.4.4, with the input values framed.

A standard XSA is presented with the tuning diagnostics shown in Table 6.4.5, and the VPA results are given in Tables 6.4.6–6.4.8. The SSB for 1996 came out with 2.2 mill. tonnes compared to 1.6 mill. tonnes from the prediction last year. The rich 1995 year class came out with 25.6 x 10^9 as 0 group, which is at the same level as the three other rich year classes; 1982, 1983 and 1989.

The Log catchability residuals plots are presented in Figure 6.4.9 a–f, by fleet and by age group. Figure 6.4.10 shows the retrospective analysis of this assessment. In retrospective testing, the analysis appears to perform with reasonable consistency, suggesting that the stock forecast may perform reasonably well. However, as it was noted in last year's report, the apparently high survey variability suggests that the stock assessment may have a low capability to detect changes in stock size or exploitation rates.

6.4.4.2 ICA analysis

An ICA-run (Patterson and Melvin 1996) was made (Table 6.4.9) on the input data described in Section 6.4.4.1. The following choices were made during the run:

- Selection on age 10+ equal to selection on age 5;
- All indices of abundance assumed to bear linear relationships to stock size;
- The 0-group in the catch-at-age data was weighted by 0.1, the 1-year-olds by 0.5, age 2 and older by 1.0;
- The index series were evenly weighted;
- No attempt was made to fit a stock-recruitment relationship.

While the rich 1995 year class in the XSA run was estimated at the same level as the rich 1982, 1983 and 1989 year classes (about 25 billions), the 1989 year class in the ICA run was almost double the size of these earlier year classes (about 42 billions). The estimated size of the two latest year classes varies considerably between the two runs. It should be noted that since the 1996 year class is only estimated from the catch-at-age data, and the 1995 year class from catch-at-age and from one index series, these estimates are quite uncertain. The coefficient of variation (CV) of the 1996 year class was 130% while that of the 1995 year class was 50%.

The spawning stock in 1996 was estimated at 1.6 million tonnes in the ICA-run, compared to 2.2 million tonnes in the XSA-run. The spawning stock estimates show a decreasing trend from 1992 in both runs. Since the Spawning stock estimate is considerably higher in the XSA-run, the estimated average fishing mortality for age three to seven is higher (.46) in the ICA-run compared to the XSA-run (0.31).

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 1997 for ages 1 to 10+ was taken from the VPA results. The recruitment at age 0 in 1997–1999 was set to 14.2 billions, which is the average from 1981–1995. Maturity ogive and natural mortality were the same used in the VPA. Mean weights at age were estimated as the average of the values used in the VPA for the period 1987–1996. The fishing pattern was considered to be the average of the period 1994–1996, rescaled to the level of reference F in 1996.

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. Unfortunately, this procedure was not possible this year, due to the early timing of the Working Group meeting. The Norwegian directed fishery up to April this year was notably less compared to same period in 1996. This is due to the fleet being occupied in the herring fishery and to the new system with separate vessel quotas. Norway will probably also take lower catches in the Faroes zone this year. So far this year the Russian fleet has not caught blue whiting in the international zones west of Ireland, as it used to do. On the other hand the rich year classes of 1994–1996 could result in higher total catches as well as promote higher fishing effort from other countries. Due to these considerations the expected catch in 1997 was assumed to be 600,000 tonnes. This is about 6% lesser than the total catch in 1996, and corresponds approximately to the *status quo* fishing level in 1996 (F-factor 0.96).

The results of the prediction are shown in Table 6.5.2. The estimated reference fishing mortality in 1997 was 0.31, at the same level than in 1996. Continuing at this fishing level gives an SSB of 2.4 million tonnes in 1997, 2.7 million tonnes in 1998 and 2.8 million tonnes in 1999.

A suggestion of the MBAL for this stock, taken as the lowest SSB on record (1.5 million tonnes) is discussed in Section 6.8.

6.6 Medium-Term Projections

Last year's ICA medium-term projection was run, but due to technical problems this could not be done this year. Instead, a deterministic medium-term projection was run (5 years starting in 1997) and with the same input data as in the short-term prediction (Section 6.5) and with a constraint of an annual catch of 650,000 tonnes, as requested by NEAFC. The results are shown in Figure 6.6.1. Both the total stock, the spawning stock and the fishing mortality is seen to be quite stable during the period.

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 (ICES 1985/H:6; 1991/Assess:2; 1995/Assess:7; 1996/Assess:14). 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 (Belikov, pers.comm.) and larvae from this area to the west of St. Kilda (Monstad, 1996). This indicated that the 1996 year class could be a strong one.

During 1995 and 1996 the landings from the mixed industrial fisheries increased significantly, and in 1996 were 4 times larger than in 1994. The total catch in 1996 by numbers and tonnes is shown in Figure 6.7.1. It clearly demonstrates the dominance of the 1995 year class in numbers, while the 1989 year class still dominates the catches in biomass.

In 1996 recordings of blue whiting were at the same level of abundance in the Norwegian Sea during summer (Faroes, Norwegian and international zones) as in the spawning area west of the British Isles during spring (EU zone).

The total international catch of blue whiting from 1978–1996 divided into areas within and beyond national fisheries jurisdiction of NEAFC are presented in Table 6.7.1, as provided by the Working Group members. Due to the increased catches in the mixed industrial fisheries of 1995 and 1996 in the area of the Norwegian Trench, the percentage in this area has increased significantly for the period. Catches of nations not giving zonal information about the fisheries, have been subjectively allocated to the probable appropriate zones.

Assembling of historical (1979–1995) blue whiting data from 7 countries' trawl catches in the area from Gibraltar to The Faroes has been done within the EU AIR Sefos-project (Monstad *et al.* 1996b). Length data from France, Spain, The Netherlands, Portugal, Scotland, Norway and Germany were mapped by age groups, using Norwegian keys for the northern area and Spanish keys for the southern area. Most of the data came from bottom trawl stations and hence represent the on-shelf part of the stock, i.e. mainly younger age groups, while the data from west of the British Isles during spring are from pelagic trawl stations and represent the oceanic part of the stock which are both young and older age groups. In Figures 6.7.2–6.7.4 the 1995 results are presented as an example, showing the appearance of blue whiting along the shelf edge from South-Portugal to the Norwegian Sea and in the North Sea.

The number of stations is highest in the south, and hence blue whiting seem to be more frequent there. However, when blue whiting are caught in the north, especially in the 1st half of each year, the numbers are in most cases significantly higher than in the south.

The migratory behaviour causes the appearance of blue whiting in the northern area, i.e. west of the British Isles, during spring when the mature part congregates there to spawn. In the 2nd half of each year the stock has returned to the feeding grounds, either northwards or southwards, and the majority of the larvae and later the 0-groups have likewise drifted northwards or southwards.

The area from the Channel to Gibraltar is a nursery area containing the majority of the southwards drifting larvae. The northwards drifting larvae occupy areas where the survey frequency is much lower, i.e. mainly in Faroese waters, in the Norwegian Trench and further north along the Norwegian coast, and hence the catch frequency of blue whiting is much lower than in the south.

It is not possible to get a complete picture of the distribution from the trawl station results alone, as the number of stations and their distribution are mostly in discordance with the blue whiting's abundance and availability. The maps merely show the geographical distribution of blue whiting within the shelf edge area from Gibraltar to the Norwegian Sea, and its level of occurrence in the survey trawl catches.

The Norwegian surveys to the west of the British Isles since 1979 were all acoustic assessment surveys with blue whiting as the main target. The trawl stations may represent an indication of abundance in the concentrations recorded, but will never give the precise picture. Annual plots for age groups 1, 2 and 3+ are presented in absolute numbers in Figure 6.7.5. Age 1 is more common in the northern and in the southern parts, and less so in the middle of the survey areas. To a lesser extent this tendency also exists for age 2. Ages 3+ are more evenly distributed over the whole area and exhibit a shift to the South from the mid-80s onwards.

6.8 Management Considerations

In last year's report it was suggested that the lowest SSB observed could be considered as MBAL (ICES 1996/Assess:14). In this year's assessment the lowest observed value was 1.5 mill. tonnes, and the spawning stock biomass in 1997 seems to be well above this level. According to a medium-term projection the stock will remain at that level with a catch constraint of 650,000 tonnes per year.

The stock seems to be increasing due to recruiting strong year class. Thus for the time the Working Group did not perform further analyses into other reference points than the traditional recommended ones.

The F_{med} and F_{high} are shown in Figure 6.8.1. A yield-per-recruit analysis was run to estimate the $F_{0.1}$ and F_{max} and the stock summary results are shown in Figures 6.8.2 a–d. The references values are given in the text table below:

F_{96}	: 0.321
$F_{0.1}$	: 0.154
F_{max}	: 0.500
F_{high}	: 0.780
F_{med}	: 0.321

Although some of these values could be considered as limit points in a precautionary advice, the Working Group considered that further analysis is needed to make decisions, taking into account the uncertainties in the assessment and the instability of the VPA when strong year classes enter the fisheries.

6.9 Special Comments

1. The Working Group stresses the importance of annual investigations of the blue whiting stock. It is recommended that surveys aimed at assessing the blue whiting stock biomass in the spawning area during spring should be continued.

2. Due to recruitment of the strong year classes of 1995 and 1996 to the fisheries, the mixed industrial fisheries especially will tend to target the high abundance of this resource, and hence a rather high number of small individuals will be caught. To avoid serious biases in the data set for stock analysis, it is strongly

recommended that the countries participating in this fishery continue to sample the catches frequently and bring both biological data and catch data to the Working Group.

6.10 Sampling

Investigation	Number of samples	Length measurements	Aged individuals
Fishery 1996	542	35705	4723
Survey British Isles	52	5566	4558
Survey Norwegian Sea	101	5571	2429
Southern Fishery	437	47025	1223
Southern Survey	213	13982	2176

7 ECOLOGICAL CONSIDERATIONS

7.1 Barents Sea

7.1.1 Climate

During the period 1989–1995 the temperature in the Barents Sea has been higher than the long-term mean (Figure 7.1.1). After a short reduction in temperature in 1994 the temperature increased in 1995, followed by a new reduction in 1996. This trend has continued up to now. At present most of the Barents Sea has temperatures below the long-term mean. This is most pronounced in the eastern part with temperatures well below the mean and lots of ice, while the temperatures are closer to normal in the west.

Figure 1.4 in Sætre (1997) shows the horizontal temperature distribution in August-September 1996 compared to a warm year 1992, and it is easily seen that a much larger area is open for biological production in a warm year compared to a cold year.

7.1.2 Zooplankton

The standing stock of zooplankton has been investigated in August-September since 1986. *Calanus finmarchicus* is the dominant species in the zooplankton community, especially in the Atlantic water masses, while *Calanus hyperboreus* and *Calanus glacialis* are more important in the arctic water masses. In addition to these copepod species, krill and amphipods are important as food organisms for planktivores like herring and capelin. The amount of zooplankton present in the area is very much dependent on the abundance of zooplankton in the water masses entering the area above the sill between Fugløya and Bear Island. In winter the zooplankton in the Norwegian Sea is in the deeper water masses and thus water masses entering the Barents Sea in winter will be poor in zooplankton while these water masses will carry a significant amount of zooplankton in summer.

Figure 7.1.2 shows the biomass of two size groups of zooplankton (180–1000 μm and >1000 μm) in different areas of the Barents Sea during the last years. This time series shows a significant increase in zooplankton during the period 1991–1994, with a maximum in 1994. After 1994 there has been a marked reduction in all size groups, especially in 1996. The reason for this reduction is a reduced inflow of Atlantic water and thus a lower production of zooplankton or increased feeding pressure from plankton feeders in the area. In 1994 the mean biomass of zooplankton was 12.8 gm^{-2}, in 1995 10.0 gm^{-2} while the mean biomass in 1996 was reduced to half of what was found in 1994. This investigation carried out with dip-nets and a small Mocness trawl, indicates as already mentioned a reduction in all size groups of zooplankton. In contrast, the "Multispecies Group" reported large concentrations of megazooplankton (krill) in the western parts of the Barents Sea during fall 1996. This may be because the latter investigation was carried out with larger pelagic trawls which are much more suitable for krill sampling.

Conclusions:

- The eastern part of the Barents Sea is cold.
- Zooplankton stocks decreasing in the Barents Sea (uncertainty about megazooplankton).

7.1.3 Cod consumption

Bogstad and Mehl (1996) calculated the consumption of various prey species by cod using stomach content data from the joint IMR-PINRO stomach content data base, a model for the gastric evacuation rate of cod and data on sea temperature and the abundance and geographical distribution of cod. The consumption is calculated for three main areas in the Barents Sea and for the first and second half of the year, for age groups 1–11+ separately. On average 6,000 stomachs have been sampled annually since 1984. The calculated consumption from 1984 onwards is given in Table 7.1.1. The consumption estimates in Table 7.1.1 do not include the consumption by mature cod in the period when it is outside the Barents Sea (assumed to be 3 months during the first half of the year). During this period it may consume significant amounts of adult herring (Bogstad and Mehl 1996).

7.1.4 Consumption by minke whales and harp seals

Nilssen *et al.* (1997) and Folkow *et al.* (1997) calculated the consumption by harp seals and minke whales in the Barents Sea using data on energy intake, diet composition, energy density of prey and stock size. For harp seals, the data on diet composition were collected in the period 1990–1996. The food consumption by the 700,000 harp seals (including 100,000 pups) was calculated both for periods with a high and low capelin stock. In the calculations of the annual consumption by 85,000 minke whales in the Barents Sea and in Norwegian coastal waters, data from 1992–1995 were used, but data from 1992 in areas with much capelin were excluded in order to get an estimate for a period with a low capelin stock. Table 7.1.2 compares the consumption by minke whale, harp seal and cod in the Barents Sea for a situation with a high and a low capelin stock.

7.1.5 Herring influence on recruitment of Barents Sea capelin

Based on the estimated spawning stock size and recruitment (at age one) included in the Barents Sea capelin stock summary table (Table 4.3.13) a stock-recruitment plot was constructed including data from the years 1973 to 1995 (Figure 4.3.1). The SSBs and the number of recruits were calculated by the spreadsheet model "Capstock" (ICES 1995/Assess:9, Appendix A). See Section 4.3.4 for details.

Young herring in the Barents Sea is believed to hamper capelin recruitment (Huse and Toresen 1995). To illustrate years with significant amounts of herring (one year old and older) in the Barents Sea (1984, 1985, 1991, 1992, 1993, 1994, 1995 (Table 3.3.5)) these are plotted as filled circles in Figure 4.3.1 and labelled with year, while points for the remaining years are marked with open circles. The years with herring present show a significantly lower R/SSB ratio than the years without herring, apart from the years 1991 and 1995. In 1991, the spawning stock was very large, and the recruitment was not much lower than average. In 1995, the spawning stock was low (about 50,000 t). The recruitment was also low (about 100 bill. 1-year-olds), but the R/SSB ratio was higher than in some of the years without herring present. The amount of herring was not high either in 1991 or 1995 compared to the period 1992–1994, but was at the same level as in 1984–1985 (Table 3.3.5), when the capelin experienced a total recruitment failure.

From the maps showing the herring distribution during the young herring surveys in the Barents Sea (June) and the distribution of capelin larvae during the larval survey in June (Figures 1–9 in Working Document by Bogstad and Gjøsæter), it is evident that the distribution areas of herring and capelin larvae most years show a considerable overlap.

In 1991, however, the distribution area of herring was smaller than in the rest of the period with herring present and covered only a small proportion of the distribution of the capelin larvae. One can only speculate if a lesser degree of spatial overlap between capelin larvae and herring in this year can explain why the capelin recruitment was seemingly better than in other "herring years".

In 1995, very few capelin larvae were detected in June (Figure 8 in Working Document by Bogstad and Gjøsæter), and the larval index was set at 0.0 (Table 4.3.1). The herring distribution area was small, but overlapped completely with the observed capelin larvae. Seemingly, the larvae that gave rise to the year class measured as one-year-olds in 1996 were not detected during the larval survey in 1995, even though that survey did cover the normal distribution area for spring spawned capelin larvae. One possible explanation is that much of the spawning in 1995 took place late in the season and possibly further to the east, and consequently the larvae that emerged from that spawning were not preyed upon by herring to any noticeable degree, and had a high survival rate.

The stock recruitment relationship for capelin based on data from the period 1973–1995 reveals that the relationship seems to be curvilinear in periods without herring present in the Barents Sea (Figure 4.3.1). See Section 4.3.4 for details. In years with more than 2-3 hundred thousand tonnes of herring present, the recruitment fails completely. Observations from two years, 1991 and 1995, seem to contradict this pattern. In both these years there are reasons to believe that the spatial overlap between young herring and capelin larvae was insignificant, and that the effect on the capelin recruitment caused by predation by herring was low.

The following conclusions may be drawn:

- In years without significant amounts of herring in the Barents Sea, a stock-recruitment relationship for Barents Sea capelin may be constructed based on these years, and modelled by a curvilinear S/R model, e.g. the Beverton-Holt or the Ricker model.

- In years with more than 2–3 hundred thousand tonnes of herring in the Barents Sea, either the recruitment fails completely, (if there is a significant overlap in time and space of herring and capelin) or the recruitment follows the general relationship or is only slightly reduced (if there is no or an insignificant overlap in time and/or space between capelin and herring).

7.2 Norwegian Sea

7.2.1 Climate

The variation in inflow of warm Atlantic water masses is of great importance for the climate and thus production of zooplankton and fish in the Norwegian Sea. Figure 7.2.1 shows how the temperature in the core of the Atlantic inflow has varied during the last years. The measurements are taken at the Svinøy section, the Gimsøy section and the Sørkapp section, representative for the southern, central and northern part of the Norwegian Sea. This Figure shows a warm period from 1989–1995, followed by a cooling again since 1995. This cooling was caused by the strongest outbreak of Arctic waters since 1952. In 1996 there was a tendency of a short period of warming, and Atlantic water masses again reached the coastal banks of Northern Iceland.

At present this warming is reversed and the prognosis for 1997 says that the western part of the Norwegian Sea and the waters north of the Faroes will continue to be characterised by a strong influence of relative cold, low salinity Arctic water, while the temperature will be closer to the normal in the eastern part of the area.

7.2.2 Zooplankton

Zooplankton sampling in the Norwegian Sea has taken place the last years, in connection with the Norwegian Sea program. In 1950s and 1960s the zooplankton was investigated in connection with the herring investigations, and Russian investigations have taken place during most of the period. Here only some results from the two last years coverage are presented. The mean abundance of zooplankton along the Svinøy section is presented in Figure 7.2.2. The average plankton biomass was the same the two years, but the plankton bloom started somewhat earlier in 1996 compared to 1995. The horizontal distribution of zooplankton were investigated in May 1996 (not shown here). An increased biomass of zooplankton was found in the western, northern and north-eastern part of the central Norwegian Sea. The lowest biomass, however, was observed in the southern and middle part of the area, i.e. the Atlantic water where the herring had apparently migrated across or was encountered in greatest densities. These investigations will be continued (ICES CM 1997/H:3), and these time series together with historical data sets will give us more information about the zooplankton community in the Norwegian Sea.

Conclusion:

- Western part of Norwegian Sea is cold.

7.3 Icelandic Waters

7.3.1 Climate

In 1996 a decrease in water temperature was noted, especially to the north and east of Iceland. An Icelandic survey in February 1997 confirms this trend: while the water temperature south and west of Iceland was normal, the areas north and east of Iceland were somewhat colder than the long-term mean.

8 RECOMMENDATIONS

8.1 Capelin Symposium

One of the most important levels in the marine food chain is that of pelagic fish. They transfer energy from zooplankton to predators such as other fish, marine mammals and seabirds, some of which are commercially important. Pelagic fish are easily caught and commercially important, thereby filling a dual and often conflicting role as forage and commercial species.

The balance of the food chain is delicate but is maintained in a dynamic equilibrium through natural biological and physical events. However, the equilibrium at all levels, including pelagic fish, can often be shifted in a dramatic and disastrous fashion through human intervention.

In northern marine ecosystems, capelin occupy the dual role of a forage and commercial species. Although the capelin ecosystems differ in many respects, each has undergone profound changes in recent years. For example, in the Barents Sea, capelin have exhibited wide fluctuations in abundance and have recently been at very low levels. At the same time, the cod stock , as well as the Norwegian spring spawning herring, which spend their first years of life in the Barents Sea, have increased. At Iceland, capelin abundance has also fluctuated while that of at least three key predator species. i.e. cod, Greenland halibut and saithe, has declined. In the Newfoundland area, the most important predator, the cod, has declined to historically low levels while seals, another important predator, have increased in abundance.

While the changes just described are simple and selected examples, occurring in complex ecosystems, they serve to illustrate the recent dramatic changes that have occurred within these ecosystems. The reason for these and other variations continue to be investigated and, in many cases, have been the subject of special research projects and symposia. In contrast, while capelin continue to be monitored and studied, it is ironic that as the key element in many northern ecosystems, they have not been the focus of any multinational symposia.

Given the key position of capelin as a cornerstone species, and the fact that there is now considerable historical information available on capelin biology, capelin fisheries, their management and interactions with other predators and competitors, the Working Group recommends that a symposium be organised by ICES to deal with these topics. Participation of scientists involved in the investigations of capelin stocks and their role in the ecosystems on both sides of the Atlantic, as well as in the northern Pacific, should be encouraged. The Working Group suggests that the symposium be titled **Capelin - What Are They Good For?** *Biology, Management and the Ecological Role of Capelin* and be held at Iceland in year 2000 with Hjalmar Vilhjalmsson as convener.

8.2 Blue Whiting Special Meeting

Prior to the late 1960s, there was limited scientific and commercial interest in the blue whiting. With the collapse of the Norwegian spring-spawning herring, attention was diverted to the blue whiting and in 1978, ICES convened the first meeting of a Blue Whiting Study Group. During the 1970s to the present, blue whiting has become the focus of both an important international fishery and increased scientific interest. Many countries collect annual abundance and biological data in support of stock assessment.

Blue whiting is a key research subject in a project of the Norwegian Sea Programme "Mare Cognitum". This project deals with the coexistence and space and food competition between herring, mackerel and blue whiting and their relationships to other species along the continental slope. Stock structure is also being investigated through genetic analyses. The reappearance and increase of the Norwegian spring spawning herring to historical levels, the expansion of mackerel into the Norwegian Sea and the prospects of good recruitment in the blue whiting population in the last two years, offer the opportunity to address the issue of competition among several pelagic stocks in the Norwegian Sea. Blue whiting is also highly migratory and a straddling stock, thereby presenting problems in its management.

As a result of the above considerations, the Working Group recommends that ICES and NEAFC sponsor a special meeting titled **Blue Whiting - What Now?** This meeting would address the biological aspects of blue whiting but would also use blue whiting as the key subject in addressing the problems of managing highly migratory and straddling stocks. It is proposed that this meeting would be held in 1999, hosted by the Nordic House in Torshavn, with co-conveners H. í Jakupsstovu, Dr V.K. Zilanov, Dr R. Bailey, and T. Monstad.

9 REFERENCES AND WORKING DOCUMENTS

9.1 References

Barros, P.C. de. 1995. Quantitative studies of recruitment variations in Norwegian Spring Spawning Herring (*Clupea harengus* L.), with special emphasis on the juvenile stage. Dr. Scient. thesis. Dept. of Fisheries and Marine Biology, University of Bergen, Norway.

Bogstad, B. and S. Mehl. 1996. Interactions between Cod (*Gadus morhua*) and Its Prey Species in the Barents Sea. International Symposium on the Role of Forage Fishes in Marine Ecosystems, Anchorage, Alaska 13-16 November 1996. 23 pp.

Folkow, L. P., Haug, T., Nilssen, K. T., and Nordøy, E. S. 1997. Estimated food consumption of minke whales in Northeast Atlantic waters in 1992-1995. NAMMCO Scientific Committee Working Group on the Role of Minke Whales, Harp seals and Hooded seals in North Atlantic Ecosystems, Tromsø, Norway 10-13 March 1997, SC/5/ME/4, 25 pp.

Gilks, W.R, S. Richardson, and D.J. Spiegelhalter (1996) Markov chain Monte Carlo in practice. Chapman and Hall, London. 486pp.

Gilks, W.R. (1996). Full conditional distributions. *In*: Gilks, W.R, S. Richardson, and D.J. Spiegelhalter (eds) Markov chain Monte Carlo in practice. Chapman and Hall, London. 486pp.

Gundersen, A.C. and H. Gjøsæter (in press). A comparison between abundance estimates of the Barents Sea capelin (*Mallotus villosus* Müller) at the larval, 0-group, and 1-group stage, for the year classes 1981-1994. ICES J. Mar. Sci. XX:000-000.

Halldorsson, O., P. Reynisson, and G. Stefánsson 1986. A method for estimating terminal Fs from a series of acoustic surveys. ICES CM 1986/H:62.

Huse, G. and R. Toresen 1995. Predation by juvenile herring (*Clupea harengus* L.) on Barents Sea capelin (*Mallotus villosus* Müller) larvae. Pp 59-73 in: A. Hylen (ed.) Precision and relevance of pre-recruit studies for fishery management related to fish stocks in the Barents Sea and adjacent waters. Proceedings of the sixth IMR-PINRO Symposium, Bergen 14-17 June 1994.

ICES 1985/H:6. Report of the Workshop on the Acoustic Surveys of Blue Whiting in the Norwegian Sea, Bergen 6-11 May 1985. ICES CM 1985/H:6.

ICES 1987/Assess:4. Report of the Blue Whiting Assessment Working Group, Copenhagen, 24-30 September 1986. ICES CM 1987/Assess:4.

ICES 1991/Assess:2. Report of the Blue Whiting Assessment Working Group, Copenhagen, 12-18 September 1990. ICES CM 1991/Assess:2.

ICES 1991/Assess:17. Report of the Atlanto-Scandian Herring and Capelin Working Group. ICES CM 1991/Assess:17.

ICES 1993/Assess:6. Report of the Atlanto-Scandian Herring and Capelin Working Group, Copenhagen 19-23 Oct. 1992 ICES CM 1993/Assess:6.

ICES 1995/Assess:7. Report of the Blue Whiting Working Group Meeting, Vigo, September 1994. ICES CM 1995/Assess:7.

ICES 1995/Assess:9. Report of the Atlanto-Scandian Herring and Capelin Working Group, Copenhagen 17-21 October 1994. ICES CM 1995/Assess:9. 101 pp.

ICES 1996/Assess:9. Report of the Atlanto-Scandian Herring and Capelin Working Group, Bergen, Norway, 12-18 October 1995. ICES CM 1996/Assess:9.

ICES 1996/Assess:14. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group, Bergen, 23 - 29 April 1996. ICES CM 1996/Assess:14. 158 pp.

Jeffreys, H. 1961. Theory of probability. Oxford U.P. London, UK.

Jakobsson, J., A. Gudmundsdottir and G. Stefánsson 1993. Stock related changes in biological parameters of the Icelandic summer-spawning herring. Fish. Oceanogr. 2:3/4: 260-277.

Monstad, T., S.V. Belikov, E.A. Shamrai 1996. Report of the joint Norwegian-Russian acoustic survey of blue whiting during spring 1996. ICES CM 1996/H:12.

Monstad, T., J. Alvarez and J. Rivoirard 1996. Occurrence of Blue Whiting in trawl catches during surveys from Portugal to Faroe Islands, 1979-1995.

Nilssen, K. T., Pedersen, O-P., Folkow, L. P. and Haug, T. 1997. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Committee Working Group on the Role of Minke Whales, Harp seals and Hooded seals in North Atlantic Ecosystems, Tromsø, Norway 10-13 March 1997, SC/5/ME/7, 21 pp.

Patterson, K.R. and G.D. Melvin 1996. Integrated Catch at Age Analysis Version 1.2. Scottish Fisheries Research Report no. 58 1996. 60 pp.

Patterson, K.R. 1997. Stock assessment and evaluation of uncertainty where model structure is uncertain by a Bayesian method: Norwegian Spring Spawning Herring. Working Document for the Northern Pelagic and Blue Whiting Working Group, 1997.

Raftery, A.E. and S.M. Lewis (1996). Implementing MCMC. *In*: Gilks, W.R, S. Richardson, and D.J. Spiegelhalter (eds) Markov chain Monte Carlo in practice. Chapman and Hall, London. 486pp.

Shepherd, J.G. and M.O. Nicholson. 1991. Multiplicative modelling of catch-at-age data, and its application to catch forecasts. J. Cons. Int. Explor. Mer 47: 284–294.

Skogen, M.D., T. Monstad and E. Svendsen (in press). Investigating the possible separation between a northern and a southern stock of the North East Atlantic Blue Whiting. Submitted to Fisheries Research.

Stefánsson , G. 1987. Analysis of CPUE data from Iceland trawlers, 1973-1987. ICES CM 1987/D:19.

Sætre, R. 1997. Miljørapport 1997, Fisken og Havet, Særnummer 2 - 1997. (In Norwegian with English summary).

9.2 Working Documents

Icelandic Summer-Spawning Herring:

Jónsson, S.T. and Sigurdsson, T. Icelandic Summer Spawning Herring.

Norwegian Spring-Spawning Herring:

Krysov, A. and N. Ushakov. Russian Investigations on Norwegian Spring herring in the Barents Sea and Norwegian Seas in May–July 1996.

Hagen, G.S. Scenario Barents Sea: Estimating Recruitment Models.

Hamre, J. Stock Assessment Based on Tagging.

Patterson, K.R. Stock Assessment and evaluation of uncertainty where model structure is uncertain by a Bayesian method: Norwegian Spring Spawning Herring.

Foote, K.G., Ostrowski, M., Røttingen, I. and Slotte, A. Abundance estimates of Norwegian spring spawning herring wintering in the Vestfjorden system, December 1996.

Slotte, A. The Norwegian fishery on Norwegian spring spawning herring in 1996.

ICES 1997. Report of the ICES Planning Group on Surveys on the Pelagic Fish in the Norwegian Sea. ICES CM 1997/H:3.

Slotte, A. and Dommasnes, A. Cruise report - M/S Michael Sars. Abundance estimation of Norwegian spring spawning herring at spawning grounds in 1997.

Tjelmeland, S. Tuning Norwegian spring spawning herring.

Tjelmeland, S. Recruitment functions and technical reference points for Norwegian spring spawning herring.

Skagen, D.W. Some thoughts on stock-recruitment functions and stochastic long term equilibria, with application to Norwegian spring spawning herring.

Patterson, K.R. Norwegian Spring-Spawning Herring: Recruitment modelling, density-dependent growth and implications for equilibrium yield.

Holst, J.C. and Tjelmeland, S. Restoring historic weights of Norwegian spring spawning herring.

Anon. Report on surveys of the distribution and migration of the Norwegian spring spawning herring and the environment of the Norwegian Sea and adjacent waters in late winter, spring and summer of 1996.

Capelin in the Barents Sea:

Gjøsæter, H. The Barents Sea capelin.

Gjøsæter, H. Updated tables for the historic development of the Barents Sea capelin, based on the spreadsheet model "CAPSTOCK".

Ushakov, N.G. Russian investigations on capelin in the Barents Sea during the spring 1997.

Capelin in the Iceland East-Greenland and Jan-Mayen area:

Vilhjalmsson, H. Capelin in the Iceland , East-Greenland and Jan-Mayen area.

Vilhjalmsson, H. Report on an acoustic survey of capelin in the Iceland-Greenland-Jan Mayen area in October-November 1996.

Blue Whiting:

Monstad, T. Observations of blue whiting in the Norwegian Sea, July/August 1996.

Carrera, P. and Meixide, M. Spanish acoustic survey in 1996.

Ecological Considerations:

Fossum, P. Oceanography, plankton and larval surveys (NSSH).

Bogstad, B. and Gjøsæter, H. Multispecies considerations.

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

Run title : Herring Summer-spawn (run: SVPSTJ02/V02)

At 2-May-97 17:00:27

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

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	705	2634	929	3147	2283	454	1475	421	112	100
2	18853	22551	15098	14347	4629	19187	22499	18015	12872	8172
3	24153	50995	47561	20761	16771	28109	151718	32244	24659	33938
4	10404	13846	69735	60727	12126	38280	30285	141354	21656	23452
5	46358	8738	16451	65328	36871	16623	21599	17043	85210	20681
6	6735	39492	8003	11541	41917	38308	8667	7113	11903	77629
7	5421	7253	26040	9285	7299	43770	14065	3916	5740	18252
8	1395	6354	3050	19442	4863	6813	13713	4113	2336	10986
9	524	1616	1869	1796	13416	6633	3728	4517	4363	8594
10	362	926	494	1464	1032	10457	2381	1828	4053	9675
11	27	400	439	698	884	2354	3436	202	2774	7184
12	128	17	32	1	760	594	554	255	976	3682
13	1	25	54	110	101	75	100	260	480	2918
14	1	51	6	79	62	211	3	3	581	1788
TOTALNUM	115067	154898	189761	208726	143014	211868	274223	231284	177715	227051
TONSLANI	28924	37333	45072	53269	39544	56528	58665	50293	49092	65413
SOPCOF %	100	100	100	100	100	100	100	100	99	100

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

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	29	879	3974	11009	35869	12006	870	6225	7411	1100
2	3144	4757	22628	14345	92758	79782	35560	110079	26221	18723
3	44590	41331	26649	57024	51047	131543	170106	99377	159170	45304
4	60285	99366	77824	34347	87606	43787	87363	150310	86940	92948
5	20622	69331	188654	77819	33436	56083	25146	90824	105542	69878
6	19751	22955	43114	152236	54840	41932	28802	23926	74326	86261
7	46240	20131	8117	32265	109418	36224	18306	20809	20076	37447
8	15232	32201	5897	8713	9251	44765	24268	19164	13797	13207
9	13963	12349	7292	4432	3796	9244	14319	17973	8873	6854
10	10179	10250	4780	4287	2634	2259	3639	16222	9140	4012
11	13216	7378	3449	2517	1826	582	879	2955	7079	1672
12	6224	7284	1410	1226	516	305	300	1433	2376	4179
13	4723	4807	844	1019	262	203	200	345	927	1672
14	2280	1958	348	610	298	102	100	345	124	100
TOTALNUM	260478	334977	394980	401849	483557	458817	409858	559987	522002	383357
TONSLANI	75439	91760	100733	105593	109499	106825	102802	134003	125851	95882
SOPCOF %	100	99	100	100	100	98	100	100	100	100

e:\acfm\wgnpbw97\t-211-22.xls

Table 2.2.1 **Icelandic summer spawners.** Weight at age (kg).

Age in years is number of rings +1.

Run title : Herring Summer-spawn (run: SVPSTJ02/V02)

At 2-May-97 17:00:28

Table 2 Catch weights at age (kg)

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.084	0.073	0.075	0.069	0.061	0.065	0.059	0.049	0.053	0.06
2	0.157	0.128	0.145	0.115	0.141	0.141	0.132	0.131	0.146	0.14
3	0.217	0.196	0.182	0.202	0.191	0.186	0.18	0.189	0.219	0.2
4	0.261	0.247	0.231	0.233	0.246	0.217	0.218	0.217	0.266	0.252
5	0.285	0.295	0.285	0.269	0.269	0.274	0.26	0.245	0.285	0.282
6	0.313	0.314	0.316	0.317	0.298	0.293	0.309	0.277	0.315	0.298
7	0.326	0.339	0.334	0.352	0.33	0.323	0.329	0.315	0.335	0.32
8	0.347	0.359	0.35	0.36	0.356	0.354	0.357	0.322	0.365	0.334
9	0.364	0.36	0.367	0.38	0.368	0.385	0.37	0.351	0.388	0.373
10	0.362	0.376	0.368	0.383	0.405	0.389	0.407	0.334	0.401	0.38
11	0.358	0.38	0.371	0.393	0.382	0.4	0.437	0.362	0.453	0.394
12	0.355	0.425	0.35	0.39	0.4	0.394	0.459	0.446	0.469	0.408
13	0.4	0.425	0.35	0.39	0.4	0.39	0.43	0.417	0.433	0.405
14	0.42	0.425	0.45	0.39	0.4	0.42	0.472	0.392	0.447	0.439
SOPCOFAC	1	1	1.0001	0.9994	0.9988	1.0003	0.9954	0.999	0.9947	0.9986

Table 2 Catch weights at age (kg)

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0.06	0.075	0.063	0.075	0.074	0.063	0.074	0.067	0.069	0.078
2	0.168	0.157	0.131	0.119	0.139	0.144	0.15	0.135	0.129	0.14
3	0.2	0.221	0.206	0.199	0.188	0.19	0.212	0.204	0.178	0.166
4	0.24	0.239	0.246	0.244	0.228	0.232	0.245	0.249	0.236	0.209
5	0.278	0.271	0.261	0.273	0.267	0.277	0.288	0.269	0.276	0.258
6	0.304	0.298	0.291	0.286	0.292	0.317	0.33	0.302	0.292	0.294
7	0.325	0.319	0.331	0.309	0.303	0.334	0.358	0.336	0.314	0.312
8	0.339	0.334	0.338	0.329	0.325	0.346	0.373	0.368	0.349	0.324
9	0.356	0.354	0.352	0.351	0.343	0.364	0.387	0.379	0.374	0.36
10	0.378	0.352	0.369	0.369	0.348	0.392	0.401	0.398	0.381	0.349
11	0.4	0.371	0.389	0.387	0.369	0.444	0.425	0.387	0.401	0.388
12	0.404	0.39	0.38	0.422	0.388	0.399	0.387	0.421	0.409	0.403
13	0.424	0.409	0.434	0.408	0.404	0.419	0.414	0.402	0.438	0.385
14	0.43	0.437	0.409	0.437	0.396	0.428	0.42	0.39	0.469	0.42
SOPCOFAC	0.9999	0.9879	0.9971	1.0038	0.9997	0.9839	0.9997	1.0003	1.0006	0.9999

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-January from purse seine catches

Run title : Herring Summer-spawn (run: SVPSTJ02/V02)

At 2-May-97 17:00:28

Table 5 Proportion mature at age

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0.02	0.04	0.07	0.05	0.03	0.05	0	0.01	0	0.03
3	0.87	0.78	0.65	0.92	0.65	0.85	0.64	0.82	0.9	0.89
4	1	1	0.98	1	0.99	1	1	1	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1

Table 5 Proportion mature at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE										
1	0	0	0	0	0	0	0	0	0	0
2	0.01	0.05	0.06	0	0.01	0.02	0.05	0.05	0.16	0.05
3	0.87	0.9	0.93	0.78	0.72	0.93	1	1	0.98	0.99
4	1	1	1	1	1	1	1	0.99	1	1
5	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1

Table 2.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974–1997.The surveys are conducted in October–November or January. The year given is the following year, i.e. if the survey is conducted in 1973/1974, then 1974 is given.

Rings	74	75	76	77	78	79	80	81	82	83	84	85
1	-	-	-	-	-	-	-	625	3	-	-	-
2	154	5	136	-	212	158	19	361	17	-	171	28
3	-	137	20	-	424	334	177	462	75	-	310	67
4	-	19	133	-	46	215	360	85	159	-	724	56
5	-	21	17	-	19	49	253	170	42	-	80	360
6	-	2	10	-	139	20	51	182	123	-	39	65
7	-	2	3	-	18	111	41	33	162	-	15	32
8	-	-	3	-	18	30	93	29	24	-	27	16
9	-	-	-	-	10	30	10	58	8	-	26	17
10	-	-	-	-	-	20	-	10	46	-	10	18
11	-	-	-	-	-	-	-	-	10	-	5	9
12	-	-	-	-	-	-	-	-	-	-	12	7
13	-	-	-	-	-	-	-	-	-	-	-	4
14	-	-	-	-	-	-	-	-	-	-	-	5
15	-	-	-	-	-	-	-	-	-	-	-	5
5+	-	25	33	-	204	260	448	482	415	-	214	538

Rings	86	87	88	89	90	91	92	93	94	95	96	97
1	201	-	392	285	5	478	410	1418	-	-	845	792
2	652	-	126	725	178	805	745	254	332	-	-	320
3	208	-	352	181	593	227	850	858	533	-	-	139
4	110	-	836	249	177	304	353	687	860	-	515	459
5	86	-	287	381	302	137	273	160	443	-	316	280
6	425	-	53	171	538	176	94	99	55	-	361	410
7	67	-	37	42	185	387	81	87	69	-	166	150
8	41	-	76	23	-	40	210	44	43	-	110	101
9	17	-	25	30	-	10	32	92	86	-	52	50
10	27	-	21	16	-	2	11	39	55	-	29	35
11	26	-	14	10	18	-	-	-	2	-	16	15
12	16	-	17	9	-	-	17	-	-	-	27	65
13	6	-	8	5	-	-	-	-	-	-	19	32
14	6	-	6	3	-	-	-	-	-	-	8	0
15	1	-	3	2	-	-	-	-	-	-	2	-
5+	718	-	547	692	1043	752	718	521	753	-	1105 1106	(1597) 1138

Table 2.4.1 Icelandic summer spawners. Stock abundance and catches by age group (millions) and fishing mortality rate. F_{ac} is the F calculated from the acoustic survey estimates for 1–4-ringers in 1996. F_{96} is the F in 1995 and F_{pav} is the average exploitation pattern for 1988–1992.

Rings in 1996	Year class	Acoustic estimate Dec '96	Catch 1996/1997	F_{ac}	F_{96}	F_{pav}
1	1994	792	1.100	0.001	0.000	0.039
2	1993	320	18.723	0.054	0.011	0.241
3	1992	139	45.304	0.269	0.203	0.561
4	1991	459	92.948	0.176	0.203	0.551
5+	1990	[1597] (1138	225.282	0.181	0.203	1.000

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

Run title : Herring Summer-spawn (run: SVPSTJ02/V02)
At 2-May-97 17:00:28

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	0.002	0.014	0.004	0.013	0.003	0.002	0.007	0.001	0.000	0.000
2	0.040	0.062	0.096	0.070	0.022	0.026	0.116	0.101	0.031	0.008
3	0.182	0.131	0.161	0.165	0.098	0.159	0.257	0.217	0.174	0.097
4	0.126	0.136	0.238	0.282	0.123	0.300	0.229	0.359	0.198	0.223
5	0.253	0.133	0.212	0.325	0.247	0.222	0.246	0.175	0.339	0.263
6	0.187	0.316	0.156	0.202	0.319	0.388	0.154	0.107	0.159	0.520
7	0.331	0.281	0.316	0.243	0.170	0.566	0.214	0.087	0.106	0.345
8	0.266	0.708	0.163	0.366	0.174	0.212	0.306	0.080	0.062	0.270
9	0.199	0.492	0.409	0.123	0.411	0.336	0.154	0.140	0.103	0.300
10	0.354	0.561	0.243	0.573	0.087	0.576	0.173	0.095	0.161	0.309
11	0.056	0.729	0.502	0.558	0.725	0.258	0.333	0.018	0.182	0.419
12	1.137	0.041	0.100	0.002	2.183	1.543	0.080	0.033	0.101	0.346
13	0.007	0.615	0.157	0.509	0.203	1.965	1.159	0.044	0.073	0.432
14	0.317	0.468	0.256	0.322	0.534	0.731	0.321	0.076	0.118	0.369
FBAR 3-12	0.309	0.353	0.250	0.284	0.454	0.456	0.215	0.131	0.159	0.309
W. avg. 4-14	0.220	0.244	0.238	0.293	0.246	0.366	0.224	0.254	0.227	0.358
Avg. 4-14	0.294	0.407	0.250	0.319	0.471	0.645	0.306	0.110	0.146	0.345
Avg. 4-9	0.227	0.344	0.249	0.257	0.241	0.337	0.217	0.158	0.161	0.320

Table 8 Fishing mortality (F) at age

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	FBAR 94-96
AGE											
1	0.000	0.002	0.010	0.011	0.025	0.014	0.001	0.019	0.020	0.002	0.013
2	0.006	0.015	0.052	0.041	0.107	0.064	0.048	0.130	0.092	0.057	0.093
3	0.048	0.094	0.100	0.161	0.179	0.195	0.168	0.163	0.250	0.203	0.205
4	0.223	0.128	0.229	0.162	0.352	0.206	0.172	0.197	0.188	0.203	0.196
5	0.279	0.380	0.338	0.334	0.209	0.355	0.157	0.242	0.185	0.203	0.210
6	0.381	0.501	0.383	0.444	0.370	0.389	0.277	0.197	0.285	0.203	0.228
7	0.596	0.735	0.294	0.487	0.586	0.396	0.261	0.294	0.225	0.203	0.240
8	0.478	0.983	0.434	0.519	0.222	0.448	0.445	0.421	0.288	0.203	0.304
9	0.571	0.794	0.544	0.599	0.397	0.321	0.223	0.612	0.312	0.203	0.376
10	0.610	0.973	0.732	0.634	0.772	0.387	0.180	0.375	0.644	0.203	0.407
11	0.788	1.109	0.947	0.986	0.540	0.336	0.228	0.195	0.248	0.203	0.215
12	0.688	1.298	0.564	0.966	0.481	0.142	0.258	0.614	0.212	0.203	0.343
13	0.874	1.818	0.420	0.923	0.488	0.314	0.118	0.468	0.928	0.203	0.533
14	0.628	1.019	0.539	0.539	0.676	0.316	0.224	0.271	0.271	0.203	0.248
FBAR 3-12	0.466	0.699	0.456	0.529	0.411	0.317	0.237	0.331	0.284	0.203	
W. avg. 4-14	0.380	0.293	0.320	0.366	0.386	0.335	0.208	0.237	0.219	0.203	
Avg. 4-14	0.556	0.885	0.493	0.599	0.463	0.328	0.231	0.353	0.344	0.203	
Avg. 4-9	0.421	0.587	0.370	0.424	0.356	0.352	0.256	0.327	0.247	0.203	

e:\acfm\wgnpbw97\t-211-22.xls

Table 2.4.3 **Icelandic summer spawners.** VPA stock size (thousands) and SSB (tonnes).
Age in years is number of rings + 1.

Run title : Herring Summer-spawn (run: SVPSTJ02/V02)

At 2-May-97 17:00:28

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
AGE										
1	437190	194917	248337	254166	882161	238658	219968	486764	1235403	594935
2	500968	394915	173864	223822	226987	796041	215515	197633	440042	1117733
3	151982	435375	335903	142974	188889	200986	702048	173634	161710	385930
4	92201	114589	345508	258775	109655	154980	155168	491289	126507	122909
5	217328	73545	90534	246454	176544	87702	103924	111660	310532	93911
6	41416	152661	58247	66304	161052	124757	63580	73540	84853	200189
7	20145	31081	100681	45105	49039	105975	76578	49299	59784	65475
8	6270	13088	21243	66405	32002	37442	54467	55941	40887	48642
9	3041	4350	5836	16325	41656	24339	27412	36278	46709	34776
10	1271	2255	2406	3509	13066	24979	15734	21263	28536	38119
11	523	807	1164	1708	1790	10842	12706	11976	17503	21972
12	196	448	352	637	885	784	7577	8239	10644	13204
13	159	57	389	288	576	90	152	6329	7213	8704
14	4	143	28	301	157	425	11	43	5480	6070
TOTAL	1472696	1418230	1384493	1326774	1884459	1808000	1654840	1723887	2575803	2752568
TOTSPBIO	133044	175737	198541	213024	186562	193132	220357	233574	250901	261961

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
AGE											
1	365658	517765	419517	1072391	1539946	900738	1050215	353509	399714	792292	0
2	538224	330834	467658	375816	959872	1359303	803608	949447	313950	354631	715849
3	1003596	484017	294828	401648	326417	780409	1154128	693336	754542	259161	303089
4	316961	865711	398688	241454	309279	246890	581270	882782	532994	531708	191495
5	88955	229583	688948	286891	185862	196792	181832	443006	656088	399736	392880
6	65353	60927	142021	444511	185802	136438	124896	140650	314664	493455	295366
7	107644	40413	33393	87642	257991	116137	83712	85687	104553	214215	364615
8	41940	53650	17541	22516	48746	129905	70755	58378	57795	75550	158284
9	33591	23523	18172	10285	12125	35328	75137	41032	34664	39208	55824
10	23315	17180	9619	9540	5113	7373	23200	54397	20124	22951	28971
11	25316	11467	5876	4186	4577	2138	4531	17537	33844	9565	16958
12	13074	10422	3423	2063	1414	2413	1383	3265	13063	23906	7067
13	8456	5945	2576	1763	710	790	1894	966	1599	9565	17664
14	5111	3193	874	1532	634	395	523	1524	548	572	7067
TOTAL	2637194	2654627	2503134	2962239	3838489	3915051	4157082	3725518	3238144	3226514	2555554
TOTSPBIO	368470	421848	391307	354056	306905	379305	556376	593309	599611	509016	

	GMST 77-94	AMST 77-94
AGE		
1	500677	611791
2	461675	559571
3	360850	445434
4	254238	323034
5	174377	211889
6	108527	129289
7	66208	78655
8	37301	45545
9	20483	27218
10	10939	16715
11	5092	8701
12	2225	4468
13	984	2614
14	375	1469

Table 2.4.4

Herring Icelandic Summer-spawning (Fishing Area Va)

Year	Recruitment Age 1	Spawning Stock Biomass	Landings	Fishing Mortality Age 3-12
1947	179.51	140.72	47.80	0.350
1948	68.01	120.36	56.80	1.597
1949	77.47	90.94	5.40	0.089
1950	197.37	86.95	13.60	0.195
1951	116.48	87.74	15.80	0.257
1952	323.93	100.54	10.50	0.437
1953	197.30	108.25	17.60	0.359
1954	167.41	147.06	11.00	0.148
1955	191.20	169.40	20.50	0.140
1956	469.18	169.86	20.40	0.148
1957	791.38	179.87	22.80	0.201
1958	369.22	199.64	33.50	0.220
1959	555.11	278.23	35.00	0.253
1960	712.88	258.86	28.50	0.071
1961	531.01	286.80	74.00	0.285
1962	525.30	310.08	92.90	0.472
1963	467.07	267.05	130.30	0.775
1964	585.84	189.25	86.50	0.802
1965	507.39	156.61	122.90	1.213
1966	99.67	83.73	58.40	0.764
1967	39.22	89.31	67.70	1.333
1968	178.06	27.41	16.80	0.779
1969	46.32	16.56	20.91	0.946
1970	33.78	19.69	16.45	1.169
1971	70.41	13.00	11.83	1.601
1972	89.87	10.35	0.37	0.173
1973	417.96	28.66	0.26	0.051
1974	131.85	45.92	1.27	0.031
1975	198.66	116.97	13.28	0.115
1976	554.30	129.39	17.17	0.162
1977	437.19	133.04	28.92	0.309
1978	194.92	175.74	37.33	0.353
1979	248.34	198.54	45.07	0.250
1980	254.17	213.02	53.27	0.284
1981	882.16	186.56	39.54	0.454
1982	238.66	193.13	56.53	0.456
1983	219.97	220.36	58.67	0.215
1984	486.76	233.57	50.29	0.131
1985	1,235.40	250.90	49.09	0.159
1986	594.94	261.96	65.41	0.309
1987	365.66	368.47	75.44	0.466
1988	517.77	421.85	91.76	0.699
1989	419.52	391.31	100.73	0.456
1990	1,072.39	354.06	105.59	0.529
1991	1,539.95	306.91	109.50	0.411
1992	900.74	379.31	106.83	0.317
1993	1,050.22	556.38	102.80	0.237
1994	353.51	593.31	134.00	0.331
1995	399.71	599.61	125.85	0.284
1996	792.29	509.02	95.88	0.203
Average	421.95	209.52	52.06	0.440
Unit	Millions	1000 tonnes	1000 tonnes	-

Table 2.5.1

The SAS System 10:07 Tuesday, May 6, 1997

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Input data

Year: 1997								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	600.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0065	0.070
2	716.457	0.1000	0.0860	0.0000	0.5000	0.146	0.0570	0.146
3	322.663	0.1000	0.9910	0.0000	0.5000	0.196	0.1324	0.196
4	191.491	0.1000	0.9990	0.0000	0.5000	0.216	0.2250	0.216
5	392.872	0.1000	1.0000	0.0000	0.5000	0.249	0.2250	0.249
6	295.360	0.1000	1.0000	0.0000	0.5000	0.288	0.2250	0.288
7	364.607	0.1000	1.0000	0.0000	0.5000	0.316	0.2250	0.316
8	158.281	0.1000	1.0000	0.0000	0.5000	0.330	0.2250	0.330
9	55.823	0.1000	1.0000	0.0000	0.5000	0.373	0.2250	0.373
10	28.970	0.1000	1.0000	0.0000	0.5000	0.384	0.2250	0.384
11	16.958	0.1000	1.0000	0.0000	0.5000	0.409	0.2250	0.409
12	7.067	0.1000	1.0000	0.0000	0.5000	0.404	0.2250	0.404
13	17.664	0.1000	1.0000	0.0000	0.5000	0.412	0.2250	0.412
14	7.067	0.1000	1.0000	0.0000	0.5000	0.425	0.2250	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	600.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0065	0.070
2	.	0.1000	0.0860	0.0000	0.5000	0.146	0.0570	0.146
3	.	0.1000	0.9910	0.0000	0.5000	0.196	0.1324	0.196
4	.	0.1000	0.9990	0.0000	0.5000	0.216	0.2250	0.216
5	.	0.1000	1.0000	0.0000	0.5000	0.249	0.2250	0.249
6	.	0.1000	1.0000	0.0000	0.5000	0.288	0.2250	0.288
7	.	0.1000	1.0000	0.0000	0.5000	0.316	0.2250	0.316
8	.	0.1000	1.0000	0.0000	0.5000	0.330	0.2250	0.330
9	.	0.1000	1.0000	0.0000	0.5000	0.373	0.2250	0.373
10	.	0.1000	1.0000	0.0000	0.5000	0.384	0.2250	0.384
11	.	0.1000	1.0000	0.0000	0.5000	0.409	0.2250	0.409
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.2250	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.412	0.2250	0.412
14	.	0.1000	1.0000	0.0000	0.5000	0.425	0.2250	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	600.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0065	0.070
2	.	0.1000	0.0860	0.0000	0.5000	0.146	0.0570	0.146
3	.	0.1000	0.9910	0.0000	0.5000	0.196	0.1324	0.196
4	.	0.1000	0.9990	0.0000	0.5000	0.216	0.2250	0.216
5	.	0.1000	1.0000	0.0000	0.5000	0.249	0.2250	0.249
6	.	0.1000	1.0000	0.0000	0.5000	0.288	0.2250	0.288
7	.	0.1000	1.0000	0.0000	0.5000	0.316	0.2250	0.316
8	.	0.1000	1.0000	0.0000	0.5000	0.330	0.2250	0.330
9	.	0.1000	1.0000	0.0000	0.5000	0.373	0.2250	0.373
10	.	0.1000	1.0000	0.0000	0.5000	0.384	0.2250	0.384
11	.	0.1000	1.0000	0.0000	0.5000	0.409	0.2250	0.409
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.2250	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.412	0.2250	0.412
14	.	0.1000	1.0000	0.0000	0.5000	0.425	0.2250	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

(cont.)

Table 2.5.1 (continued)

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Input data

(cont.)

Year: 2000								
Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	600.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0065	0.070
2	.	0.1000	0.0860	0.0000	0.5000	0.146	0.0570	0.146
3	.	0.1000	0.9910	0.0000	0.5000	0.196	0.1324	0.196
4	.	0.1000	0.9990	0.0000	0.5000	0.216	0.2250	0.216
5	.	0.1000	1.0000	0.0000	0.5000	0.249	0.2250	0.249
6	.	0.1000	1.0000	0.0000	0.5000	0.288	0.2250	0.288
7	.	0.1000	1.0000	0.0000	0.5000	0.316	0.2250	0.316
8	.	0.1000	1.0000	0.0000	0.5000	0.330	0.2250	0.330
9	.	0.1000	1.0000	0.0000	0.5000	0.373	0.2250	0.373
10	.	0.1000	1.0000	0.0000	0.5000	0.384	0.2250	0.384
11	.	0.1000	1.0000	0.0000	0.5000	0.409	0.2250	0.409
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.2250	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.412	0.2250	0.412
14	.	0.1000	1.0000	0.0000	0.5000	0.425	0.2250	0.425
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRSTJ01
Date and time: 06MAY97:10:16

Table 2.5.2

The SAS System 10:07 Tuesday, May 6, 1997

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Detailed tables

Year: 1997	F-factor: 1.0000	Reference F: 0.2250				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0065	3700	259	600000	42000	0	0	0	0
2	0.0570	37794	5525	716457	104746	61615	9008	58610	8569
3	0.1324	38120	7452	322663	63081	319759	62513	304164	59464
4	0.2250	36785	7934	191491	41305	191300	41263	181970	39251
5	0.2250	75469	18784	392872	97786	392872	97786	373711	93017
6	0.2250	56738	16318	295360	84946	295360	84946	280955	80803
7	0.2250	70040	22133	364607	115216	364607	115216	346825	109597
8	0.2250	30405	10043	158281	52280	158281	52280	150562	49730
9	0.2250	10723	3996	55823	20800	55823	20800	53100	19785
10	0.2250	5565	2138	28970	11127	28970	11127	27557	10585
11	0.2250	3258	1332	16958	6936	16958	6936	16131	6598
12	0.2250	1358	548	7067	2854	7067	2854	6722	2715
13	0.2250	3393	1397	17664	7271	17664	7271	16803	6916
14	0.2250	1358	577	7067	3006	7067	3006	6722	2859
Total		374704	98436	3175280	653352	1917343	515005	1823833	489888
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1998	F-factor: 1.0000	Reference F: 0.2250				1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0065	3700	259	600000	42000	0	0	0	0
2	0.0570	28453	4160	539385	78858	46387	6782	44125	6451
3	0.1324	72345	14143	612359	119716	606847	118639	577251	112853
4	0.2250	49129	10597	255752	55166	255496	55111	243036	52423
5	0.2250	26578	6615	138357	34437	138357	34437	131610	32758
6	0.2250	54529	15682	283861	81638	283861	81638	270017	77657
7	0.2250	40994	12954	213406	67436	213406	67436	202998	64147
8	0.2250	50606	16715	263439	87014	263439	87014	250590	82770
9	0.2250	21969	8186	114362	42611	114362	42611	108785	40533
10	0.2250	7748	2976	40334	15492	40334	15492	38367	14737
11	0.2250	4021	1645	20932	8561	20932	8561	19911	8144
12	0.2250	2354	951	12253	4949	12253	4949	11655	4707
13	0.2250	981	404	5106	2102	5106	2102	4857	1999
14	0.2250	2452	1043	12763	5428	12763	5428	12140	5163
Total		365856	96329	3112307	645408	2013542	530200	1915341	504341
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 2.5.2 (continued) The SAS System 10:07 Tuesday, May 6, 1997

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Detailed tables

(cont.)

Year: 1999 F-factor: 1.0000 Reference F: 0.2250

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0065	3700	259	600000	42000	0	0	0	0
2	0.0570	28453	4160	539385	78858	46387	6782	44125	6451
3	0.1324	54465	10648	461015	90128	456865	89317	434584	84961
4	0.2250	93238	20112	485373	104695	484888	104590	461240	99489
5	0.2250	35497	8835	184788	45994	184788	45994	175776	43751
6	0.2250	19203	5523	99967	28751	99967	28751	95092	27348
7	0.2250	39398	12450	205097	64811	205097	64811	195094	61650
8	0.2250	29620	9783	154191	50929	154191	50929	146671	48446
9	0.2250	36564	13624	190342	70921	190342	70921	181058	67462
10	0.2250	15873	6097	82630	31738	82630	31738	78600	30190
11	0.2250	5598	2290	29142	11919	29142	11919	27721	11338
12	0.2250	2905	1173	15124	6108	15124	6108	14386	5811
13	0.2250	1701	700	8853	3644	8853	3644	8421	3466
14	0.2250	709	301	3689	1569	3689	1569	3509	1493
Total		366924	95954	3059596	632066	1961963	517074	1866277	491856
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.0000 Reference F: 0.2250

						1 January		Spawning time	
Age	Absolute F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1	0.0065	3700	259	600000	42000	0	0	0	0
2	0.0570	28453	4160	539385	78858	46387	6782	44125	6451
3	0.1324	54465	10648	461015	90128	456865	89317	434584	84961
4	0.2250	70195	15141	365414	78820	365048	78741	347245	74901
5	0.2250	67367	16768	350695	87288	350695	87288	333592	83031
6	0.2250	25648	7376	133514	38399	133514	38399	127003	36526
7	0.2250	13875	4384	72229	22824	72229	22824	68706	21711
8	0.2250	28466	9402	148188	48947	148188	48947	140961	46559
9	0.2250	21401	7974	111408	41510	111408	41510	105974	39486
10	0.2250	26418	10147	137527	52824	137527	52824	130820	50248
11	0.2250	11469	4691	59702	24418	59702	24418	56791	23227
12	0.2250	4045	1634	21056	8505	21056	8505	20029	8090
13	0.2250	2099	864	10927	4498	10927	4498	10394	4278
14	0.2250	1229	523	6396	2720	6396	2720	6084	2588
Total		358829	93971	3017457	621739	1919944	506773	1826307	482057
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRSTJ01
Date and time : 06MAY97:10:16
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1997	1.0000	0.2250	374704	98436	3175280	653352	1917343	515005	1823833	489888
1998	1.0000	0.2250	365856	96329	3112307	645408	2013542	530200	1915341	504341
1999	1.0000	0.2250	366924	95954	3059596	632066	1961963	517074	1866277	491856
2000	1.0000	0.2250	358829	93971	3017457	621739	1919944	506773	1826307	482057
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRSTJ01
Date and time : 06MAY97:10:16
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

Table 2.5.3

The SAS System 10:07 Tuesday, May 6, 1997

Herring Icelandic Summer-spawning (Fishing Area Va)

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
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
1.0000	0.2250	653352	489770	98436	0.0000	0.0000	645408	504130	0	732519	586572
.	.	.	.	.	0.1000	0.0225	.	504130	10524	721537	576181
.	.	.	.	.	0.2000	0.0450	.	504130	20839	710776	566000
.	.	.	.	.	0.3000	0.0675	.	504130	30949	700230	556023
.	.	.	.	.	0.4000	0.0900	.	504130	40858	689895	546246
.	.	.	.	.	0.5000	0.1125	.	504130	50571	679766	536666
.	.	.	.	.	0.6000	0.1350	.	504130	60091	669839	527277
.	.	.	.	.	0.7000	0.1575	.	504130	69423	660109	518077
.	.	.	.	.	0.8000	0.1800	.	504130	78571	650573	509060
.	.	.	.	.	0.9000	0.2025	.	504130	87539	641227	500223
.	.	.	.	.	1.0000	0.2250	.	504130	96329	632066	491562
.	.	.	.	.	1.1000	0.2475	.	504130	104947	623086	483075
.	.	.	.	.	1.2000	0.2700	.	504130	113396	614284	474755
.	.	.	.	.	1.3000	0.2925	.	504130	121678	605656	466602
.	.	.	.	.	1.4000	0.3150	.	504130	129799	597198	458610
.	.	.	.	.	1.5000	0.3375	.	504130	137760	588907	450776
.	.	.	.	.	1.6000	0.3600	.	504130	145566	580779	443098
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANSTJ02
Date and time : 06MAY97:10:19
Computation of ref. F: Weighted mean, age 4 - 14
Basis for 1997 : F factors

Table 2.5.4

The SAS System 10:07 Tuesday, May 6, 1997

Herring Icelandic Summer-spawning (Fishing Area Va)

Yield per recruit: Input data

Age	Recruit-ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	0.1000	0.0218	0.0000	0.5000	0.067	0.0218	0.067
2	.	0.1000	0.1730	0.0000	0.5000	0.139	0.1730	0.139
3	.	0.1000	0.4442	0.0000	0.5000	0.196	0.4442	0.196
4	.	0.1000	0.6159	0.0000	0.5000	0.238	0.6159	0.238
5	.	0.1000	1.0000	0.0000	0.5000	0.273	1.0000	0.273
6	.	0.1000	1.0000	0.0000	0.5000	0.303	1.0000	0.303
7	.	0.1000	1.0000	0.0000	0.5000	0.327	1.0000	0.327
8	.	0.1000	1.0000	0.0000	0.5000	0.346	1.0000	0.346
9	.	0.1000	1.0000	0.0000	0.5000	0.366	1.0000	0.366
10	.	0.1000	1.0000	0.0000	0.5000	0.377	1.0000	0.377
11	.	0.1000	1.0000	0.0000	0.5000	0.394	1.0000	0.394
12	.	0.1000	1.0000	0.0000	0.5000	0.405	1.0000	0.405
13	.	0.1000	1.0000	0.0000	0.5000	0.409	1.0000	0.409
14	.	0.1000	1.0000	0.0000	0.5000	0.424	1.0000	0.424
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDSTJ02
Date and time: 06MAY97:10:12

Table 2.7.1 Icelandic summer spawners. Basic statistics from stock recruitment model fits.

Model	Parameter				SSE	Model formulae
	α	K	β	γ		
Beverton & Holt	5.127	126.817			29.509	$R = \alpha \cdot SSB/(1 + SSB / K)$
Ricker	3.322	468.895			31.059	$R = \alpha \cdot SSB \cdot e^{-S/K}$
Cushing	20.289		0.551		26.239	$R = \alpha \cdot SSB^{\beta}$
Scnute	633.000	0.00047		0.449	26.239	$R = \alpha \cdot SSB/(1 + SSB / K)^{\gamma}$

e:\acfm\wgnpbw97\t-271.xls

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
1996[4]	462,248	754,976	0	-	1,196,943	1,217,224

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
4 Preliminary, as provided by Working Group members

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	Ireland	Netherlands	Greenland	UK	Germany	Sweden	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	529,838	101,987	30,577[1]	57,084	174,109	-	7,969	2,500	881	556	-	905,501
1996[1]	699,161	119,290	60,681	52,788	164,954	19,541	19,664	-	46,131	11,978	23,033	1,217,224

[1] Preliminary, as provided by Working Group members.

in 1996

Table 3.2.3 Norwegian Spring-Spawning Herring, catch number by age and country. Catch in numbers (million)

Age	Norway	Russia	Iceland	Faroes	Netherlands	Denmark	UK	Germany	Sweden	Ireland	Total
0	0.000	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	0.000
2	12.384	17.201	0.129	0.360	0.000	0.050	0.000	0.000	0.000	0.000	30.124
3	16.321	15.287	1.244	0.800	0.000	0.520	0.018	0.000	0.000	0.000	34.191
4	341.005	162.230	32.779	21.080	32.952	13.750	8.692	20.072	38.598	32.746	703.904
5	850.536	206.576	139.648	55.750	40.354	58.570	81.759	24.581	47.268	40.102	1545.143
6	575.072	73.143	109.942	38.570	8.694	46.110	48.161	5.296	10.184	8.640	923.811
7	248.889	25.774	51.099	17.770	3.246	21.430	21.401	1.977	3.802	3.226	398.614
8	62.841	10.613	12.844	4.270	0.309	5.390	4.435	0.188	0.362	0.307	101.559
9	4.151	0.130	0.465	0.130	0.047	0.200	0.355	0.029	0.055	0.047	5.609
10	5.703	0.248	0.465	0.190	0.064	0.200	0.251	0.039	0.075	0.063	7.298
11	42.016	1.967	9.939	2.990	0.537	4.170	1.535	0.327	0.629	0.533	64.642
12	15.478	1.361	0.000	0.100	0.168	0.000	0.000	0.102	0.196	0.167	17.572
13	406.708	41.993	181.260	54.340	6.269	76.030	26.119	3.819	7.343	6.230	810.109
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Sum	2581.103	556.523	539.814	196.350	92.639	226.420	192.726	56.430	108.511	92.060	4642.575
Tonnes	699161	119290	144676	52788	19664	60681	46131	11978	23033	19541	1196943
Av. weight	271	214	268	269	212	268	239	212	212	212	258

Dutch data used for age distribution of Swedish, Irish and German catch.
9+ Dutch catch distributed on ages 9-14 according to combined Norwegian, Russian, Icelandic age distribution 9-14.
Preliminary Icelandic catch in Division IIa only.

Table 3.2.4 Norwegian Spring-Spawning Herring. Weight at age in the catch, by country (g)

Age	Norway	Russia	Iceland	Faroes	Netherlands	Denmark	UK	Germany	Sweden	Ireland	Total	PRED WG96	Catch in tonnes by age
0	0	0	0	0	0	0	0	0	0	0	0		0
1	0	0	0	0	0	0	0	0	0	0	0		0
2	133	139	109	130	109	109	109	109	109	109	136		4100
3	137	140	101	121	101	101	101	101	101	101	136	121	4648
4	186	168	134	170	134	134	134	134	134	134	168	179	118480
5	220	200	185	206	185	185	185	185	185	185	207	240	319506
6	271	254	244	258	244	244	244	244	244	244	262	295	242231
7	324	295	280	294	280	280	280	280	280	280	309	334	123191
8	349	321	318	325	318	318	318	318	318	318	338	347	34292
9	377	369	332	332	332	332	332	332	332	332	366	362	2055
10	367	387	328	343	328	328	328	328	328	328	361	381	2633
11	375	332	337	343	337	337	337	337	337	337	362	386	23381
12	369	353	353	353	353	353	353	363	353	353	367	399	6445
13	397	366	361	365	361	361	361	361	361	361	380	386	307465
14	0	0	0	0	0	0	0	0	0	0		403	0
15	0	0	0	0	0	0	0	0	0	0			
16+	0	0	0	0	0	0	0	0	0	0			
Average	271	214	268	269	212	268	239	212	212	212	258		1188428

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	1997
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, 1993 and 1997 there was no estimate due to poor weather conditions.

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

Year Age	1992	1993	1994	1995	1996
1		72		380	
2	36	1518	16	183	1465
3	1247	2389	3708	5133	3008
4	1317	3287	4124	5274	13180
5	173	1267	2593	1839	5637
6	16	13	1096	1040	994
7	208	13	34	308	552
8	139	158	25	19	92
9	3742	26	196	13	0
10	69	4435	29	111	7
11			3239	39	41
12				907	15
13+					393
Total	6947	13178	15209	15246	25384

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

Year Age	1991	1992	1993	1994	1995	1996	1997
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	-

In 1997 there was no estimate due to poor weather conditions.

Table 3.3.4 Norwegian spring spawning herring. Estimates obtained in the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions.

Year Age	1996
3	4114
4	22461
5	13244
6	4916
7	2045
8	424
9	14
10	7
11	155
12	0
13+	3134
Total	50504

Table 3.3.5 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	1996 Norway	1996 Russia
Age														
1	21.4						4.4	24.3	32.6	102.7	6.6	0.5	0.0	0.2
2		19.9						5.2	14.0	25.8	59.2	7.7	0.2	0.3
3			3.0						5.7	1.5	18.0	8.0	0.9	2.7
4											1.7	1.1	0.3	0.9
5														0.05

Table 3.3.6 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–1996 (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
1996	0	20	114	8,800	8,934

Table 3.3.7 Norwegian spring-spawning herring. Abundance indicies for 0-group herring in the Barents Sea, 1973–1996.

Year	**Log index**	**Year**	**Log index**
1973	0.05	1985	0.23
1974	0.01	1986	0.00
1975	0.00	1987	0.00
1976	0.00	1988	0.30
1977	0.01	1989	0.58
1978	0.02	1990	0.31
1979	0.09	1991	1.19
1980	0.00	1992	1.05
1981	0.00	1993	0.75
1982	0.00	1994	0.28
1983	1.77	1995	0.16
1984	0.34	1996	0.65

Table 3.3.8 The indices for herring larvae for the period 1981–1997 ($n10^{-12}$).

Year	Index	Year	Index
1981	0.3	1990	18.3
1982	0.7	1991	8.6
1983	2.5	1992	4.6
1984	1.4	1993	24.7
1985	1.1	1994	19.5
1986	0.7	1995	18.2
1987	1.3	1996	27.7
1988	9.2	1997	64.4
1989	13.4		

Table 3.4.1 Tagging data for the 1983+ yearclass

Year	Screened billion	No tagged	Rec. 87 realease	Rec. 88 release	Rec. 89 release	Rec. 90 release	Rec. 91 release	Rec. 92 release	Rec. 93 release	Rec. 94 release
1987		33067								
1988		38152								
1989	0.011739	20620	11							
1990	0.006216	24585	4	9						
1991	0.004525	12558	1	7	5					
1992	0.001704	15262	4	0	2	2				
1993	0.008660	15839	5	13	6	12	9			
1994	0.008950	5364	2	10	6	8	4	11		
1995	0.009128		6	10	5	15	6	9	7	
1996	0.004051		3	2	6	10	2	1	4	3

e:\acfm\wgnpbw97\t-341.xls

Table 3.4.2 Tagging data for the 1986-1989 and 1990 year classes

1986-1989 year class

Year	No. tagged	Screened billion	93 rec.	94 rec.
1993	16416			
1994	17445			
1995		0.012806	6	
1996		0.00675	5	7
1997				

1990 year class

Year	Screened billion	1994 tagging Recaptures
1995		
1996	0.009026	9

Table 3.5.1 Norwegian Spring-Spawning Herring. Summary of the main results of the exploratory modelling procedure.

Run No.	Description	Mean F (Ages 5-12 u	Yield/Biomass Ratio	SSB (Million t)	Residual Variance
1	Baseline	0.33	0.23	5.28	390
2	As 1, new tagging data	0.34	0.23	5.20	389
3	As Run 2 + new December survey without outlier	0.37	0.32	3.69	493
4	As Run 3 with outlier	0.18	0.18	5.56	3800
5	As Run 3, + Barents Sea Juvenile survey	1.15	0.52	2.32	52031
6	As Run 3, + fill in missing values in catches at age	0.36	0.33	3.68	488
7	As Run 6, change from lognormal to gamma error	0.29	0.28	4.40	496
8	As Run 7, include 1991 yc in Feb/Mar and Jan Surveys	0.10	0.10	12.08	809
9	As Run 6, flat selection pattern	0.15	0.17	6.99	805
10	As Run 9, include weak cohorts in surveys	0.45	0.47	2.53	3461
11	As Run 7, flat selection pattern 8-13, linear 5-8	0.36	0.51	5.48	703

Table 3.5.2 Detailed input data to VPA from tagging experiments.

No of Experiments	First Year
8	1987

Experiment	Start Year	Releases	Age
1	1987	33067	4
2	1988	38152	5
3	1989	20620	6
4	1990	24585	7
5	1991	12558	8
6	1992	15262	9
7	1993	15839	10
8	1994	5364	11

Years of Recaptures	First Year
8	1989

Screened	Year	Age	1	2	3	4	5	6	7	8
11739	1989	6	11	-1	-1	-1	-1	-1	-1	-1
6216	1990	7	4	9	-1	-1	-1	-1	-1	-1
4525	1991	8	1	7	5	-1	-1	-1	-1	-1
1704	1992	9	4	0	2	2	-1	-1	-1	-1
8660	1993	10	5	13	6	12	9	-1	-1	-1
8950	1994	11	2	10	6	8	4	11	-1	-1
9128	1995	12	6	10	5	15	6	9	7	-1
4051	1996	13	3	2	6	10	2	1	4	3

Table 3.5.3 Detailed input data to VPA from surveys.

```
Norwegian Spring-Spawning Herring
103
Feb-March Acoustic Survey
1988   1996
1         1      0.1667     0.1667
3          13
1  -255     -146     6805  -202     -1     -1     -1     -1     -1    -1     -1
1    -5     -373     -103  5402   -182     -1     -1     -1     -1    -1     -1
1  -187       -1     -345  -112   4489   -146     -1     -1     -1    -1     -1
1   -59      -54      -12  -354   -122   4148   -102     -1     -1    -1     -1
1   -1        -1       -1    -1     -1     -1     -1     -1     -1    -1     -1
1   -1        -1       -1    -1     -1     -1     -1     -1     -1    -1     -1
1   -128    -676     1375   476    -63    -13   -140    -35   1820    -1     -1
1 -1792    -7621     3807  2151    322    -20     -1   -124    -63  2573     -1
1  -231    -7638   -11243  2586    957    471     -1     -1   -165    -1   2024
December Acoustic Survey
1992   1996
1         1      0.917    0.917
4          13
1     1317    -173   -16      -208   -139   3742     -69    -1    -1      -1
1     3287    1267   -13       -13   -158    -26    4435    -1    -1      -1
1     4124    2593   1096      -34   -25    -196     -29  3239    -1      -1
1     5274    1839   1040      308   -19     -13    -111   -39   907      -1
1   -13180    5637   994       552    92      -1      -7   -41   -15     393
January Acoustic Survey
1991   1996
1         1      0.001    0.001
3          13
1   -220     -70     -20    -180    -150    5500    -440    -1     -1      -1    -1
1   -410    -820    -260     -60    -510    -120    4690   -30     -1      -1    -1
1    -61   -1905    2048    -256     -27    -269    -182  5691   -128      -1    -1
1   -642   -3431    4847    1503    -102     -29    -161  -131   3679      -1    -1
1    -47   -3781    4013    2445    1215     -42     -24  -267    -29    4326    -1
1   -315  -10442  -13557    4312    1271     290     -22   -25   -200     -58  1146
Survey in the Barents Sea
1984       1996
1          1        0.417     0.417
1         1
1      21400
1        -1
1        -1
1        -1
1        -1
1       -1
1       4400
1       24300
1       32600
1       102700
1        6600
1       500
1        -1          ---- >    Observation was zero !
Survey in the Barents Sea
1984       1996
1          1        0.417     0.417
2         2
1       -1
1       19900
1       -1
1       -1
1       -1
1       -1
1       -1
1       5200
1       14000
1       25800
1       59200
1        7700
1        2100
```

Table 3.5.4 NORWEGIAN SPRING-SPAWNING HERRING: recruits as 3-year-olds

6	24	2 (No. surv	no. years	VPA column no.)			
1973	850	0.05	-11	-11	-11	-11	-11
1974	563	0.01	-11	-11	-11	-11	-11
1975	193	0.0025	-11	-11	-11	-11	-11
1976	709	0.0025	-11	-11	-11	-11	-11
1977	333	0.01	-11	-11	-11	-11	-11
1978	409	0.02	-11	-11	-11	-11	-11
1979	846	0.09	-11	-11	-11	-11	-11
1980	97	0.0025	-11	-11	-11	-11	-11
1981	71	0.0025	-11	-11	-11	-11	-11
1982	142	0.0025	-11	-11	-11	-11	-11
1983	30239	1.77	21400	19900	-11	-11	-11
1984	910	0.34	-11	-11	146	-11	-11
1985	1636	0.23	-11	-11	373	-11	-11
1986	186	0.0025	-11	-11	1	-11	-11
1987	182	0.0025	-11	-11	54	-11	70
1988	2031	0.3	-11	-11	-11	-11	820
1989	6229	0.58	4400	5200	-11	1247	1905
1990	11546	0.31	24300	14000	676	2389	3431
1991	18952	1.19	32600	25800	7621	3708	3781
1992	-11	1.05	102700	59200	7638	5133	10442
1993	-11	0.75	6600	7700	-11	3008	-11
1994	-11	0.28	500	250	-11	-11	-11
1995	-11	0.16	100	-11	-11	-11	-11
1996	-11	0.65	-11	-11	-11	-11	-11

BS O-gr (log index)
BS 1-gr (billion)
BS 2-gr (billion)
Spawn4 (billion)
Dec 3 (billion)
Jan 4 (billion)

Table 3.5.5 Analysis by RCT3 ver3.1 of data from file:

```
g:\acfm\wgnpbw\her_noss\nsshnoco.rct

NORWEGIAN SPRING-SPAWNING HERRING: recruits as 3-year-olds

Data for    6 surveys over   24 years :  1973 - 1996

Regression type = C
Tapered time weighting applied
power =    3 over  20 years
Survey weighting not applied

Final estimates shrunk towards mean
Minimum S.E. for any survey taken as    .20
Minimum of   3 points used for regression

Forecast/Hindcast variance correction used.
```

Yearclass = 1992

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	4.63	5.40	1.43	.686	19	1.05	10.27	1.741	.010
BS 1-g	.93	.50	.67	.607	4	11.54	11.24	1.589	.012
BS 2-g	1.05	-.49	.43	.790	4	10.99	11.07	1.034	.028
Spawn4	.81	3.11	1.18	.789	6	8.94	10.37	1.815	.009
Dec 3	1.02	1.46	.04	.998	3	8.54	10.16	.104	.742
Jan 4	1.13	.23	.23	.988	5	9.25	10.73	.393	.192
					VPA Mean =		7.09	2.015	.007

Yearclass = 1993

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	4.66	5.40	1.47	.681	19	.75	8.90	1.731	.012
BS 1-g	.91	.69	.66	.616	4	8.79	8.69	1.232	.024
BS 2-g	1.03	-.33	.43	.795	4	8.95	8.93	.763	.061
Spawn4									
Dec 3	1.02	1.46	.04	.998	3	8.01	9.62	.081	.894
Jan 4									
					VPA Mean =		7.18	2.034	.009

Yearclass = 1994

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	4.70	5.40	1.51	.674	19	.28	6.72	1.772	.344
BS 1-g	.89	.92	.65	.626	4	6.22	6.42	2.457	.179
BS 2-g	1.01	-.14	.42	.801	4	5.53	5.46	2.218	.219
Spawn4									
Dec 3									
Jan 4									
					VPA Mean =		7.28	2.046	.258

Table 3.5.5 continued

Yearclass = 1995

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
BS 0-g	4.74	5.42	1.55	.666	19	.16	6.18	1.875	.469
BS 1-g	.86	1.18	.64	.639	4	4.62	5.14	3.441	.139
BS 2-g									
Spawn4									
Dec 3									
Jan 4									
					VPA Mean =		7.38	2.050	.392

Yearclass = 1996

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
BS 0-g	4.77	5.44	1.59	.657	19	.65	8.55	1.970	.519
BS 1-g									
BS 2-g									
Spawn4									
Dec 3									
Jan 4									
					VPA Mean =		7.50	2.046	.481

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1992	29473	10.29	.17	.16	.85		
1993	13706	9.53	.19	.16	.69		
1994	688	6.53	1.04	.37	.13		
1995	667	6.50	1.28	.55	.19		
1996	3103	8.04	1.42	.52	.14		

Table 3.5.6

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	511260,	163550,	1372160,	569720,	1067599,	517560,	536390,
1,	200000,	760769,	914970,	505500,	707109,	287110,	202370,
2,	60000,	40000,	123290,	58130,	85540,	51010,	62710,
3,	27620,	660,	3930,	74010,	26630,	9300,	11650,
4,	18480,	38380,	6050,	4660,	143550,	27640,	25160,
5,	18550,	17240,	60230,	10090,	14290,	204510,	31420,
6,	54700,	16440,	13630,	35560,	23600,	11430,	255510,
7,	62860,	51560,	20450,	8190,	49030,	18960,	11000,
8,	7950,	60200,	38020,	11090,	12810,	27470,	20390,
9,	8860,	7710,	37790,	31410,	19980,	8530,	26420,
10,	10950,	8270,	7920,	39490,	44040,	19340,	13070,
11,	8690,	10310,	8570,	6170,	46070,	29560,	19830,
12,	19450,	10760,	10770,	9120,	8840,	20320,	27280,
13,	36830,	25350,	10680,	9410,	10060,	5870,	16330,
14,	6640,	34800,	18650,	9880,	13300,	8460,	6300,
15,	10700,	4740,	25630,	21550,	12680,	10360,	8890,
+gp,	23730,	30510,	30810,	51490,	67640,	47700,	47620,
TOTALNUM,	1087269,	1281250,	2703549,	1455471,	2352767,	1305128,	1322340,
TONSLAND,	933000,	1278400,	1254800,	1090600,	1644500,	1359800,	1659400,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	500190,	966699,	1789628,	1288431,	620750,	369320,	480700,	361300,	230300,	392650,
1,	329080,	279810,	198530,	1358079,	1607560,	408110,	211920,	272830,	378090,	66280,
2,	21950,	66640,	32550,	39250,	288480,	104130,	204530,	22030,	285360,	167800,
3,	2330,	1750,	1510,	12170,	3120,	184380,	76040,	11460,	8990,	204870,
4,	37330,	1790,	2680,	1820,	810,	800,	83580,	39900,	25620,	2690,
5,	15380,	11090,	2590,	2810,	410,	310,	530,	204580,	57110,	46660,
6,	22850,	8930,	14660,	2440,	1500,	720,	180,	1370,	219970,	130600,
7,	198530,	19440,	11480,	9620,	1940,	2020,	360,	150,	1950,	288450,
8,	7200,	97350,	24070,	7330,	6160,	1190,	1830,	300,	1490,	3790,
9,	12730,	7070,	110380,	20390,	4920,	5910,	930,	2490,	740,	1430,
10,	18250,	12300,	8860,	116300,	13610,	5260,	10770,	2930,	1910,	1740,
11,	8840,	20090,	12430,	8520,	72810,	11700,	9250,	9560,	4000,	2620,
12,	12120,	9870,	19800,	12970,	4970,	81350,	17410,	8240,	10050,	1100,
13,	14930,	7740,	8850,	15350,	4500,	4420,	92370,	15300,	10780,	6910,
14,	13160,	7090,	7740,	5670,	6300,	5470,	7960,	77280,	13870,	7210,
15,	3370,	6940,	8520,	4720,	2170,	6560,	6040,	4580,	70400,	9670,
+gp,	24770,	18620,	15070,	12170,	3840,	8670,	12490,	29100,	17910,	46000,
TOTALNUM,	1243010,	1543221,	2269350,	2918041,	2643849,	1200320,	1216889,	1063400,	1338540,	1380469,
TONSLAND,	1319500,	986600,	1111100,	1101800,	830100,	848600,	984500,	1281800,	1547700,	1955000,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Table 3.5.6 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	42680,	178360,	56120,	11930,	3050,	34710,	2930,	6590,	3060,	2010,
1,	987710,	43700,	50710,	52940,	4290,	4100,	350,	780,	360,	240,
2,	7040,	38830,	14190,	3320,	8510,	2040,	170,	390,	180,	120,
3,	139230,	9910,	18820,	630,	182,	3538,	239,	10,	327,	2325,
4,	325400,	188050,	80,	1860,	102,	348,	2520,	24,	13,	544,
5,	2660,	138740,	880,	60,	124,	358,	65,	2450,	91,	0,
6,	42130,	1420,	470,	330,	36,	248,	151,	26,	3067,	0,
7,	113200,	9400,	70,	330,	111,	69,	28,	20,	1,	1309,
8,	172080,	13410,	1170,	100,	113,	149,	18,	0,	0,	0,
9,	890,	34510,	3360,	1340,	36,	20,	0,	0,	0,	0,
10,	570,	200,	3600,	2620,	441,	0,	0,	0,	0,	0,
11,	350,	110,	30,	2810,	691,	49,	0,	0,	0,	0,
12,	850,	80,	20,	30,	545,	59,	0,	0,	0,	0,
13,	890,	250,	20,	10,	0,	59,	0,	0,	0,	0,
14,	1750,	260,	20,	20,	2,	0,	18,	0,	0,	0,
15,	1430,	180,	40,	10,	12,	0,	0,	0,	0,	0,
+gp,	9010,	1520,	200,	190,	0,	0,	0,	0,	0,	0,
TOTALNUM,	1847871,	658930,	149800,	78530,	18245,	45748,	6489,	10291,	7099,	6548,
TONSLAND,	1677200,	712200,	67800,	62300,	21100,	13161,	7017,	7619,	13713,	10436,
SOPCOF %,	100,	100,	100,	100,	100,	99,	100,	101,	100,	100,

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	4300,	2010,	3260,	690,	830,	2260,	12700,	3386,	2857,	1381,
1,	620,	240,	380,	80,	110,	110,	468,	170,	1315,	138,
2,	310,	120,	190,	40,	1190,	20,	167,	249,	20722,	309,
3,	2210,	302,	635,	641,	417,	1382,	318,	448,	2150,	53979,
4,	2360,	1216,	187,	581,	459,	789,	2119,	539,	1550,	1759,
5,	34,	2032,	687,	228,	860,	451,	952,	6154,	1650,	1450,
6,	0,	87,	1122,	817,	220,	626,	618,	1820,	13000,	1550,
7,	42,	0,	33,	1584,	451,	196,	682,	1264,	5900,	10500,
8,	1077,	62,	0,	44,	828,	507,	129,	1561,	5500,	7500,
9,	0,	503,	0,	1,	35,	605,	460,	722,	6300,	4200,
10,	0,	0,	253,	0,	10,	12,	733,	1634,	1000,	7700,
11,	0,	0,	0,	269,	11,	4,	14,	648,	3100,	1947,
12,	0,	0,	0,	0,	96,	4,	4,	0,	5000,	6600,
13,	0,	0,	0,	0,	0,	12,	14,	0,	0,	8000,
14,	0,	0,	0,	0,	0,	0,	86,	0,	0,	0,
15,	0,	0,	0,	0,	0,	0,	0,	165,	0,	0,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	264,	247,
TOTALNUM,	10953,	6572,	6747,	4974,	5518,	6978,	19466,	18759,	70309,	107260,
TONSLAND,	22706,	19824,	12864,	18577,	13736,	16655,	23054,	53532,	169872,	225256,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

Table 3.5.6 (continued)

Table 1 Catch numbers at age Numbers*10**-4

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	1385,	1549,	712,	102,	10,	163,	657,	43,	0,	0,
1,	633,	279,	193,	40,	337,	15,	13,	2,	0,	0,
2,	3577,	911,	2520,	1554,	333,	134,	724,	1877,	113,	3012,
3,	1978,	6292,	289,	1863,	844,	1259,	2841,	5853,	5759,	3419,
4,	50139,	2506,	362,	266,	278,	3310,	10687,	18865,	34646,	70390,
5,	1867,	55037,	565,	1188,	141,	498,	8727,	42541,	62281,	154514,
6,	350,	945,	32429,	1085,	1470,	119,	862,	16177,	63784,	92381,
7,	706,	368,	347,	22628,	887,	1198,	365,	1460,	23109,	39861,
8,	2800,	596,	80,	129,	21885,	575,	2960,	765,	1551,	10156,
9,	1200,	1458,	68,	152,	250,	22568,	1863,	3362,	1585,	561,
10,	950,	887,	330,	204,	46,	248,	41011,	3187,	6975,	730,
11,	450,	282,	138,	241,	9,	64,	0,	56988,	8374,	6464,
12,	783,	336,	68,	65,	69,	25,	0,	283,	91188,	1757,
13,	650,	268,	32,	18,	10,	124,	0,	46,	407,	81011,
14,	700,	156,	26,	59,	26,	0,	0,	10,	25,	0,
15,	45,	54,	0,	17,	53,	0,	0,	207,	0,	0,
+gp,	0,	0,	0,	31,	1,	0,	0,	0,	45,	0,
TOTALNUM,	68213,	71925,	38158,	29641,	26648,	30300,	70711,	151666,	299842,	464256,
TONSLAND,	127306,	135301,	103830,	86411,	84683,	104448,	232457,	479228,	905501,	1196943,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	101,

Table 3.5.7

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 2 Catch weights at age (kg)

YEAR	1950	1951	1952	1953	1954	1955	1956
AGE							
0	.0070	.0090	.0080	.0080	.0080	.0080	.0080
1	.0250	.0290	.0260	.0270	.0260	.0270	.0280
2	.0580	.0680	.0610	.0630	.0620	.0630	.0660
3	.1100	.1300	.1150	.1200	.1170	.1190	.1260
4	.1880	.2220	.1970	.2050	.2010	.2040	.2150
5	.2110	.2490	.2210	.2300	.2250	.2290	.2410
6	.2340	.2760	.2450	.2550	.2500	.2540	.2680
7	.2530	.2980	.2650	.2750	.2690	.2740	.2890
8	.2660	.3140	.2790	.2900	.2840	.2890	.3040
9	.2800	.3300	.2930	.3050	.2990	.3040	.3200
10	.2940	.3460	.3080	.3200	.3130	.3180	.3360
11	.3030	.3570	.3170	.3300	.3230	.3280	.3460
12	.3120	.3680	.3270	.3400	.3330	.3380	.3570
13	.3200	.3770	.3350	.3470	.3410	.3460	.3650
14	.3230	.3810	.3390	.3510	.3450	.3500	.3690
15	.3310	.3900	.3460	.3590	.3520	.3580	.3780
+gp	.3350	.3950	.3510	.3640	.3570	.3630	.3830
SOPCOFAC	1.0019	1.0009	.9963	.9994	1.0006	.9995	1.0013

Table 2 Catch weights at age (kg)

YEAR	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
AGE										
0	.0080	.0090	.0090	.0060	.0060	.0090	.0080	.0090	.0090	.0080
1	.0280	.0300	.0300	.0110	.0100	.0230	.0260	.0240	.0160	.0170
2	.0660	.0700	.0710	.0740	.0450	.0550	.0470	.0590	.0480	.0400
3	.1270	.1330	.1350	.1190	.0870	.0850	.0980	.1390	.0890	.0630
4	.2160	.2270	.2310	.1880	.1590	.1480	.1710	.2190	.2170	.2460
5	.2430	.2550	.2590	.2770	.2760	.2880	.2750	.2390	.2340	.2600
6	.2690	.2830	.2870	.3370	.3220	.3330	.2680	.2980	.2620	.2650
7	.2900	.3050	.3100	.3180	.3720	.3600	.3230	.2950	.3310	.3010
8	.3060	.3210	.3270	.3630	.3630	.3520	.3290	.3390	.3600	.4100
9	.3220	.3380	.3440	.3790	.3930	.3500	.3360	.3500	.3670	.4250
10	.3380	.3550	.3600	.3600	.4070	.3740	.3410	.3580	.3860	.4560
11	.3480	.3660	.3720	.4200	.3970	.3840	.3580	.3510	.3950	.4600
12	.3590	.3770	.3830	.4110	.4220	.3740	.3850	.3670	.3930	.4670
13	.3670	.3860	.3920	.4390	.4470	.3940	.3530	.3750	.4040	.4460
14	.3710	.3900	.3970	.4500	.4650	.3990	.3810	.3720	.4010	.4590
15	.3800	.3990	.4060	.4440	.4520	.4110	.3860	.4270	.4290	.4650
+gp	.3850	.4040	.4110	.4480	.4520	.4160	.3860	.4340	.4370	.4740
SOPCOFAC	1.0030	.9985	1.0004	1.0014	1.0017	.9997	1.0003	.9995	.9995	1.0001

Table 2 Catch weights at age (kg)

YEAR	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
AGE										
0	.0090	.0100	.0090	.0080	.0110	.0110	.0060	.0060	.0090	.0070
1	.0150	.0270	.0210	.0580	.0530	.0290	.0530	.0550	.0790	.0620
2	.0360	.0490	.0470	.0850	.1210	.0620	.1060	.1170	.1690	.1320
3	.0660	.0750	.0720	.1050	.1770	.1030	.1610	.1680	.2410	.1890
4	.0930	.1080	.1050	.1710	.2160	.1540	.2130	.2220	.3180	.2500
5	.3050	.1580	.1520	.2560	.2500	.2150	.2390	.2490	.3580	.2800
6	.3050	.3750	.2960	.2160	.2770	.2580	.2550	.2650	.3810	.2980
7	.3100	.3830	.3760	.2770	.3050	.2950	.2770	.2880	.4130	.3230
8	.3330	.3640	.3290	.2980	.3330	.3220	.2870	.2990	.4290	.3360
9	.3590	.3820	.3290	.3040	.3530	.3410	.3240	.3370	.4840	.3790
10	.4130	.4410	.3410	.3050	.3660	.3540	.3380	.3520	.5060	.3960
11	.4460	.4100	.3630	.3090	.3770	.3650	.2570	.2670	.3840	.3000
12	.4010	.4420	.3850	.3570	.3880	.3760	.2570	.3240	.4660	.3640
13	.4080	.5170	.3770	.3480	.3990	.3870	.2570	.3240	.4660	.3640
14	.4390	.4910	.4510	.3570	.4190	.4060	.2570	.3240	.4660	.3640
15	.4270	.4640	.4230	.3670	.4440	.4300	.2570	.3240	.4660	.3640
+gp	.4310	.4870	.4290	.3760	.4440	.4300	.2570	.3240	.4660	.3640
SOPCOFAC	1.0005	.9991	1.0036	1.0030	1.0001	.9935	1.0011	1.0051	1.0002	1.0004

Table 3.5.7 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 2 Catch weights at age (kg)

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0110,	.0120,	.0100,	.0120,	.0100,	.0100,	.0110,	.0090,	.0090,	.0070,
1,	.0910,	.1000,	.0880,	.1010,	.0820,	.0870,	.0900,	.0470,	.0220,	.0770,
2,	.1930,	.2100,	.1810,	.2020,	.1630,	.1590,	.1650,	.1450,	.0220,	.0970,
3,	.3160,	.2740,	.2930,	.2660,	.1960,	.2560,	.2170,	.2180,	.2140,	.0550,
4,	.3500,	.4240,	.3590,	.3990,	.2910,	.3120,	.2650,	.2620,	.2770,	.2490,
5,	.3980,	.4540,	.4160,	.4490,	.3410,	.3780,	.3370,	.3250,	.2950,	.2940,
6,	.4390,	.4950,	.4360,	.4600,	.3680,	.4150,	.3780,	.3460,	.3380,	.3120,
7,	.4950,	.5240,	.4820,	.4850,	.3800,	.4350,	.4100,	.3810,	.3600,	.3520,
8,	.5110,	.5960,	.4820,	.4720,	.3970,	.4490,	.4260,	.4000,	.3810,	.3740,
9,	.5580,	.6130,	.5390,	.6180,	.4360,	.4480,	.4350,	.4130,	.3970,	.3980,
10,	.5830,	.6500,	.5530,	.6450,	.4500,	.5060,	.4440,	.4050,	.4090,	.4020,
11,	.5370,	.5900,	.5180,	.6080,	.4920,	.4930,	.4680,	.4260,	.4170,	.4010,
12,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,
13,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,
14,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,
15,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,
+gp,	.5370,	.5900,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,
SOPCOFAC,	.9991,	.9998,	1.0016,	.9999,	1.0007,	1.0001,	.9981,	.9999,	.9997,	1.0010,

Table 2 Catch weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0100,	.0080,	.0100,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,
1,	.0750,	.0620,	.0600,	.0780,	.0150,	.0750,	.0300,	.0630,	.0630,	.0630,
2,	.0910,	.0750,	.2040,	.1020,	.1040,	.1030,	.1060,	.1020,	.1020,	.1360,
3,	.1240,	.1240,	.1880,	.2300,	.2080,	.1910,	.1530,	.1940,	.1530,	.1370,
4,	.1730,	.1540,	.2640,	.2390,	.2500,	.2330,	.2430,	.2390,	.1920,	.1700,
5,	.2530,	.1940,	.2600,	.2660,	.2880,	.3040,	.2820,	.2800,	.2340,	.2090,
6,	.2320,	.2410,	.2820,	.3050,	.3120,	.3370,	.3200,	.3170,	.2830,	.2580,
7,	.3120,	.2650,	.3060,	.3080,	.3160,	.3650,	.3300,	.3280,	.3280,	.3080,
8,	.3280,	.3040,	.3090,	.3760,	.3300,	.3610,	.3650,	.3560,	.3490,	.3320,
9,	.3490,	.3050,	.3910,	.4070,	.3440,	.3710,	.3730,	.3720,	.3560,	.3480,
10,	.3530,	.3170,	.4220,	.4120,	.3720,	.4030,	.3790,	.3900,	.3740,	.3540,
11,	.3700,	.3080,	.3640,	.4240,	.3540,	.3650,	.3800,	.3790,	.3660,	.3640,
12,	.3850,	.3340,	.4290,	.4280,	.3980,	.3940,	.3850,	.3990,	.3930,	.3510,
13,	.3850,	.3340,	.4290,	.4280,	.3980,	.4040,	.3900,	.4030,	.3870,	.3820,
14,	.3850,	.3340,	.4290,	.4280,	.3980,	.4060,	.3950,	.4050,	.4000,	.3740,
15,	.3850,	.3340,	.4290,	.4280,	.3980,	.4080,	.4000,	.4070,	.4000,	.3740,
+gp,	.3850,	.3340,	.4290,	.4280,	.3980,	.4100,	.4050,	.4050,	.4000,	.3740,
SOPCOFAC,	.9979,	.9998,	1.0007,	.9992,	1.0015,	1.0024,	.9981,	.9997,	1.0000,	1.0059,

Table 3.5.8

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 3 Stock weights at age (kg)

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,
2,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.2040,	.2040,	.2040,	.2040,	.2040,	.1950,	.2050,
5,	.2300,	.2300,	.2300,	.2300,	.2300,	.2130,	.2300,
6,	.2550,	.2550,	.2550,	.2550,	.2550,	.2600,	.2490,
7,	.2750,	.2750,	.2750,	.2750,	.2750,	.2750,	.2750,
8,	.2900,	.2900,	.2900,	.2900,	.2900,	.2900,	.2900,
9,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,
10,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,
11,	.3250,	.3250,	.3250,	.3250,	.3250,	.3250,	.3250,
12,	.3300,	.3300,	.3300,	.3300,	.3300,	.3300,	.3300,
13,	.3400,	.3400,	.3400,	.3400,	.3400,	.3400,	.3400,
14,	.3450,	.3450,	.3450,	.3450,	.3450,	.3450,	.3450,
15,	.3620,	.3620,	.3620,	.3620,	.3620,	.3620,	.3620,
+gp,	.3650,	.3650,	.3650,	.3650,	.3650,	.3650,	.3650,

Table 3 Stock weights at age (kg)

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,
2,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.1360,	.2040,	.2040,	.2040,	.2320,	.2190,	.1850,	.1940,	.1860,	.1850,
5,	.2280,	.2420,	.2520,	.2700,	.2500,	.2910,	.2530,	.2130,	.1990,	.2190,
6,	.2550,	.2920,	.2600,	.2910,	.2920,	.3000,	.2940,	.2640,	.2360,	.2220,
7,	.2620,	.2950,	.2900,	.2930,	.3020,	.3160,	.3120,	.3170,	.2600,	.2490,
8,	.2900,	.2930,	.3000,	.3210,	.3040,	.3240,	.3290,	.3630,	.3630,	.3060,
9,	.3050,	.3050,	.3050,	.3180,	.3230,	.3260,	.3270,	.3530,	.3500,	.3540,
10,	.3150,	.3150,	.3150,	.3200,	.3220,	.3350,	.3340,	.3490,	.3700,	.3770,
11,	.3250,	.3300,	.3250,	.3440,	.3210,	.3380,	.3410,	.3540,	.3600,	.3910,
12,	.3300,	.3400,	.3300,	.3490,	.3440,	.3340,	.3490,	.3570,	.3780,	.3790,
13,	.3400,	.3450,	.3400,	.3700,	.3570,	.3470,	.3410,	.3590,	.3870,	.3780,
14,	.3450,	.3520,	.3450,	.3790,	.3630,	.3540,	.3580,	.3650,	.3900,	.3610,
15,	.3620,	.3600,	.3550,	.3750,	.3650,	.3580,	.3750,	.4020,	.3940,	.3830,
+gp,	.3650,	.3650,	.3600,	.3800,	.3700,	.3580,	.3750,	.4020,	.3940,	.3830,

Table 3 Stock weights at age (kg)

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0080,	.0150,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0470,	.0470,	.0470,	.0470,	.0800,	.0700,	.0850,	.0850,	.0850,	.0850,
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1500,	.1700,	.1700,	.1810,	.1810,
4,	.1800,	.1150,	.1150,	.2090,	.1900,	.1500,	.2590,	.2590,	.2590,	.2590,
5,	.2280,	.2060,	.1450,	.2720,	.2250,	.1400,	.3420,	.3420,	.3420,	.3420,
6,	.2690,	.2660,	.2700,	.2300,	.2500,	.2100,	.3840,	.3840,	.3840,	.3840,
7,	.2700,	.2750,	.3000,	.2950,	.2750,	.2400,	.4090,	.4090,	.4090,	.4090,
8,	.2940,	.2740,	.3060,	.3170,	.2900,	.2700,	.4040,	.4440,	.4440,	.4440,
9,	.3240,	.2850,	.3080,	.3230,	.3100,	.3000,	.4610,	.4610,	.4610,	.4610,
10,	.4200,	.3500,	.3180,	.3250,	.3250,	.3250,	.5200,	.5200,	.5200,	.5200,
11,	.4300,	.3250,	.3400,	.3290,	.3350,	.3350,	.5340,	.5430,	.5430,	.5430,
12,	.3660,	.3630,	.3680,	.3800,	.3450,	.3450,	.5000,	.4820,	.4820,	.4820,
13,	.3680,	.4080,	.3600,	.3700,	.3550,	.3550,	.5000,	.4820,	.4820,	.4820,
14,	.4330,	.3880,	.3930,	.3800,	.3650,	.3650,	.5000,	.4820,	.4820,	.4820,
15,	.4140,	.3780,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,
+gp,	.4140,	.3780,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,

Table 3.5.8 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 3 Stock weights at age (kg)

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0230,	.0850,
3,	.1810,	.1800,	.1780,	.1750,	.1700,	.1700,	.1550,	.1400,	.1480,	.0540,
4,	.2590,	.2940,	.2320,	.2830,	.2240,	.2040,	.2490,	.2040,	.2340,	.2060,
5,	.3430,	.3260,	.3590,	.3470,	.3360,	.3030,	.3040,	.2950,	.2650,	.2650,
6,	.3840,	.3710,	.3850,	.4020,	.3780,	.3550,	.3680,	.3380,	.3120,	.2890,
7,	.4090,	.4090,	.4200,	.4210,	.3870,	.3830,	.4040,	.3760,	.3460,	.3390,
8,	.4440,	.4610,	.4440,	.4650,	.4080,	.3950,	.4240,	.3950,	.3700,	.3680,
9,	.4610,	.4760,	.5050,	.4650,	.3970,	.4130,	.4370,	.4070,	.3950,	.3910,
10,	.5200,	.5200,	.5200,	.5200,	.5200,	.4530,	.4360,	.4130,	.3970,	.3820,
11,	.5430,	.5430,	.5510,	.5340,	.5430,	.4680,	.4930,	.4220,	.4280,	.3880,
12,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,
13,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,
14,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,
15,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,
+gp,	.4820,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,

Table 3 Stock weights at age (kg)

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0100,	.0150,	.0150,	.0080,	.0110,	.0070,	.0080,	.0100,	.0180,	.0180,
2,	.0550,	.0500,	.1000,	.0480,	.0370,	.0300,	.0250,	.0250,	.0250,	.0250,
3,	.0900,	.0980,	.1540,	.2190,	.1470,	.1280,	.0810,	.0750,	.0660,	.0760,
4,	.1430,	.1350,	.1750,	.1980,	.2100,	.2240,	.2010,	.1510,	.1380,	.1180,
5,	.2410,	.1970,	.2090,	.2580,	.2440,	.2960,	.2650,	.2540,	.2300,	.1880,
6,	.2790,	.2770,	.2520,	.2880,	.3000,	.3270,	.3230,	.3180,	.2960,	.2610,
7,	.2990,	.3150,	.3050,	.3090,	.3240,	.3550,	.3540,	.3710,	.3460,	.3160,
8,	.3160,	.3390,	.3670,	.4280,	.3360,	.3450,	.3580,	.3470,	.3880,	.3460,
9,	.3420,	.3430,	.3770,	.3700,	.3430,	.3670,	.3810,	.4120,	.3630,	.3740,
10,	.3430,	.3590,	.3590,	.4030,	.3820,	.3410,	.3690,	.3820,	.4090,	.3900,
11,	.3620,	.3650,	.3950,	.3870,	.3660,	.3610,	.3960,	.4070,	.4140,	.3900,
12,	.3760,	.3760,	.3960,	.4400,	.4250,	.4300,	.3930,	.4100,	.4220,	.3840,
13,	.3760,	.3760,	.3960,	.4400,	.4250,	.4700,	.3740,	.4100,	.4100,	.3980,
14,	.3760,	.3760,	.3960,	.4400,	.4250,	.4700,	.4030,	.4100,	.4100,	.3980,
15,	.3760,	.3760,	.3960,	.4400,	.4250,	.4700,	.4000,	.4100,	.4050,	.3980,
+gp,	.3760,	.3760,	.3960,	.4400,	.4250,	.4500,	.4000,	.4100,	.4470,	.3980,

Table 3.5.9

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 5 Proportion mature at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0800,	.0800,
4,	.1000,	.1000,	.1000,	.1000,	.1000,	.2200,	.2200,
5,	.3000,	.3000,	.3000,	.3000,	.3000,	.3700,	.3700,
6,	.6000,	.6000,	.6000,	.6000,	.6000,	.8500,	.8500,
7,	.9000,	.9000,	.9000,	.9000,	.9000,	1.0000,	1.0000,
8,	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,
10,	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,
12,	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,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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,

Table 5 Proportion mature at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0000,	.0800,	.0800,	.0800,	.0400,	.0000,	.0400,	.0200,	.0000,	.0100,
4,	.0000,	.2200,	.2200,	.2200,	.3500,	.1100,	.0300,	.0600,	.3400,	.1500,
5,	.5000,	.3700,	.3700,	.3700,	.6800,	.6700,	.3200,	.2800,	.3500,	1.0000,
6,	.6000,	.8500,	.8500,	.8500,	.9400,	1.0000,	.9000,	.3200,	.7600,	.9600,
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,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.1000,	.1000,	.1000,	.1000,
3,	.0000,	.0000,	.6200,	.0600,	.1000,	.0000,	.5000,	.5000,	.5000,	.5000,
4,	.0100,	.0000,	.8900,	.1300,	.2500,	.1000,	.9000,	.9000,	1.0000,	.9000,
5,	.2300,	.0100,	.9500,	.3100,	.6000,	.2500,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	.7600,	1.0000,	.1700,	.9000,	.6000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	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,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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 3.5.9 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Table 5 Proportion mature at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.7300,	.1300,	.1000,	.2500,	.3000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.8900,	.9000,	.6200,	.5000,	.5000,	.4800,	.5000,	.5000,	.5000,	.2000,
5,	1.0000,	1.0000,	.9500,	.9700,	.9000,	.7000,	.6900,	.9000,	.9000,	.9000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.7100,	.9500,	1.0000,	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,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.1000,	.1000,	.1000,	.4000,	.1000,	.1000,	.0100,	.0100,	.0000,	.0000,
4,	.3000,	.3000,	.3000,	.8000,	.7000,	.2000,	.3000,	.3000,	.0100,	.0100,
5,	.9000,	.9000,	.9000,	.9000,	1.0000,	.8000,	.8000,	.8000,	.8000,	.4500,
6,	1.0000,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	.9000,	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,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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 3.5.10

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:44

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	.0104,	.0174,	.2455,	.1082,	.4996,	.3874,	.3408,
1,	.1218,	.0390,	.2700,	.2894,	.4172,	.5568,	.5949,
2,	.0658,	.0661,	.0160,	.0505,	.1521,	.0987,	.5133,
3,	.0278,	.0013,	.0119,	.0171,	.0424,	.0320,	.0426,
4,	.0508,	.0465,	.0141,	.0166,	.0396,	.0537,	.1079,
5,	.0410,	.0582,	.0908,	.0279,	.0613,	.0692,	.0756,
6,	.0709,	.0441,	.0566,	.0675,	.0799,	.0606,	.1098,
7,	.0884,	.0839,	.0673,	.0415,	.1185,	.0809,	.0724,
8,	.0446,	.1085,	.0780,	.0449,	.0801,	.0855,	.1111,
9,	.0346,	.0527,	.0873,	.0810,	.1009,	.0667,	.1050,
10,	.0375,	.0389,	.0668,	.1174,	.1477,	.1271,	.1309,
11,	.0369,	.0427,	.0490,	.0645,	.1847,	.1326,	.1760,
12,	.0379,	.0555,	.0544,	.0641,	.1175,	.1099,	.1648,
13,	.0688,	.0602,	.0681,	.0584,	.0886,	.1012,	.1148,
14,	.0780,	.0813,	.0545,	.0788,	.1039,	.0948,	.1424,
15,	.0458,	.0696,	.0753,	.0782,	.1303,	.1043,	.1294,
+gp,	.0458,	.0696,	.0753,	.0782,	.1303,	.1043,	.1294,
FBAR 5-13,	.0512,	.0605,	.0687,	.0630,	.1088,	.0926,	.1178,

Table 8 Fishing mortality (F) at age

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	.3741,	.6958,	.0689,	.1068,	.1360,	.3679,	.0451,	.0621,	.5501,	.1392,
1,	.8901,	.9181,	.7079,	.1421,	.4130,	.2658,	.9250,	.0665,	.1786,	.7196,
2,	.2514,	1.2040,	.5811,	.6955,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,
3,	.0462,	.0414,	.1058,	.7587,	.1583,	.1028,	.1241,	.0612,	.6737,	.3137,
4,	.1763,	.0431,	.0781,	.1698,	.0927,	.0525,	.0588,	.0840,	.1789,	.4085,
5,	.0844,	.0689,	.0769,	.1041,	.0497,	.0442,	.0424,	.1886,	.1573,	.5321,
6,	.0687,	.0612,	.1160,	.0916,	.0705,	.1097,	.0310,	.1391,	.2997,	.5982,
7,	.1106,	.0728,	.0990,	.0985,	.0928,	.1213,	.0698,	.0309,	.2829,	.7536,
8,	.0588,	.0690,	.1150,	.0804,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,
9,	.0892,	.0715,	.0988,	.1278,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,
10,	.0931,	.1105,	.1142,	.1359,	.1117,	.0907,	.2443,	.3075,	.3472,	1.3435,
11,	.1164,	.1332,	.1475,	.1451,	.1120,	.1256,	.2153,	.3356,	.8377,	1.0666,
12,	.1470,	.1744,	.1780,	.2139,	.1120,	.1669,	.2627,	.2856,	.6638,	.5453,
13,	.1210,	.1250,	.2211,	.1929,	.1012,	.1305,	.2735,	.3657,	.6932,	1.3722,
14,	.1209,	.0737,	.1680,	.2036,	.1071,	.1629,	.3439,	.3644,	.6229,	1.4701,
15,	.1000,	.0820,	.1128,	.1389,	.1059,	.1470,	.2571,	.3208,	.6233,	1.1890,
+gp,	.1000,	.0820,	.1128,	.1389,	.1059,	.1470,	.2571,	.3208,	.6233,	1.1890,
FBAR 5-13,	.0988,	.0985,	.1296,	.1322,	.0886,	.1065,	.1505,	.2234,	.4412,	.9442,

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	.1961,	.7997,	.0917,	.3347,	.2440,	.7753,	.0035,	.0118,	.0158,	.0029,
1,	1.7622,	.7439,	1.6598,	.2488,	.4295,	1.7488,	.0311,	.0023,	.0016,	.0031,
2,	.3326,	.6937,	1.7487,	1.2207,	.1197,	.9309,	.7287,	.0902,	.0013,	.0013,
3,	.5034,	3.2305,	2.0406,	.5309,	.2856,	.0976,	.4069,	.1232,	.1495,	.0299,
4,	1.1192,	4.5598,	.2679,	1.4844,	.1420,	1.2896,	.0887,	.0609,	.2242,	.3722,
5,	.8593,	4.7169,	.7589,	.3114,	.3120,	.9586,	.8568,	.1106,	.3211,	.0022,
6,	1.3102,	1.8046,	.6022,	.6839,	.2940,	1.8106,	1.5154,	.9701,	.1862,	.0005,
7,	1.6840,	1.2122,	.3507,	1.1083,	.4854,	1.4080,	1.1117,	.7800,	.0382,	.1071,
8,	1.4826,	.9389,	.4226,	1.1720,	1.6224,	2.9363,	2.4146,	.0087,	.0142,	.0091,
9,	1.3295,	1.5725,	.6072,	1.1825,	2.5146,	1.7511,	.0145,	.0707,	.0102,	.0084,
10,	1.4501,	1.2943,	.6310,	1.3855,	1.9513,	.0384,	.0289,	.0171,	.0889,	.0120,
11,	1.0904,	1.3198,	.6260,	1.5562,	2.3933,	1.5562,	.0466,	.0347,	.0203,	.1143,
12,	1.2609,	.7481,	.8732,	3.8924,	1.8351,	3.9177,	.0090,	.0570,	.0419,	.0241,
13,	1.1298,	1.9495,	.3926,	1.6252,	.2143,	1.1118,	.1057,	.0106,	.0706,	.0510,
14,	1.9709,	1.2386,	.8372,	.8113,	2.7698,	.3248,	1.2391,	.1387,	.0124,	.0887,
15,	1.4776,	1.3590,	.5825,	1.4099,	2.0206,	2.0752,	.5877,	.0164,	.1896,	.0146,
+gp,	1.4776,	1.3590,	.5825,	1.4099,	2.0206,	2.0752,	.5877,	.0164,	.1896,	.0146,
FBAR 5-13,	1.2885,	1.7285,	.5849,	1.4353,	1.2914,	1.7210,	.6781,	.2288,	.0880,	.0365,

Table 3.5.10 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Table 8 Fishing mortality (F) at age

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	.0130,	.0050,	.0039,	.0070,	.0116,	.0157,	.0004,	.0038,	.0018,	.0072,
1,	.0022,	.0018,	.0023,	.0002,	.0028,	.0038,	.0081,	.0000,	.0036,	.0002,
2,	.0099,	.0010,	.0035,	.0006,	.0086,	.0012,	.0144,	.0107,	.0042,	.0021,
3,	.0432,	.0170,	.0097,	.0210,	.0110,	.0177,	.0350,	.0701,	.1771,	.0194,
4,	.0364,	.0286,	.0124,	.0104,	.0178,	.0247,	.0324,	.0726,	.3436,	.2036,
5,	.0331,	.0378,	.0192,	.0178,	.0181,	.0207,	.0357,	.1176,	.3107,	.5874,
6,	.0026,	.1065,	.0250,	.0272,	.0204,	.0156,	.0339,	.0841,	.3644,	.5055,
7,	.2687,	.0030,	.0502,	.0425,	.0179,	.0216,	.0201,	.0853,	.3991,	.5305,
8,	.1144,	.7483,	.0035,	.0843,	.0267,	.0238,	.0168,	.0555,	.5932,	1.2621,
9,	.0107,	.0680,	.0021,	.0332,	.0833,	.0233,	.0257,	.1165,	.3106,	1.2476,
10,	.0098,	.0125,	.0421,	.0025,	.6961,	.0361,	.0337,	.1136,	.2216,	.7229,
11,	.0141,	.0115,	.0148,	.0545,	.3915,	.5458,	.0518,	.0358,	.3072,	.8141,
12,	.1516,	.0166,	.0136,	.0174,	.0236,	.1998,	2.2502,	.0004,	.3938,	2.0556,
13,	.0287,	.2108,	.0196,	.0160,	.0206,	.0035,	3.2655,	.2905,	.0005,	2.1189,
14,	.0626,	.0344,	.3178,	.0233,	.0189,	.0245,	.0294,	.2373,	.4954,	.0006,
15,	.1140,	.0781,	.0416,	.5678,	.0278,	.0224,	.0293,	.0686,	.3721,	1.3378,
+gp,	.1140,	.0781,	.0416,	.5678,	.0278,	.0224,	.0293,	.0686,	.3721,	1.3378,
FBAR 5-13,	.0704,	.1350,	.0211,	.0328,	.1443,	.0989,	.6370,	.0999,	.3223,	1.0939,

Table 8 Fishing mortality (F) at age

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	.0071,	.0008,	.0001,	.0000,	.0000,	.0000,	.0000,	.0001,	.0000,	.0000,
1,	.0082,	.0035,	.0002,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0134,	.0296,	.0817,	.0047,	.0003,	.0001,	.0002,	.0004,	.0001,	.0266,
3,	.0237,	.0423,	.0168,	.1170,	.0045,	.0022,	.0027,	.0033,	.0021,	.0027,
4,	.0214,	.0359,	.0029,	.0183,	.0218,	.0207,	.0217,	.0207,	.0232,	.0305,
5,	.3257,	.0279,	.0096,	.0111,	.0114,	.0469,	.0662,	.1071,	.0836,	.1295,
6,	.2552,	.2570,	.0196,	.0218,	.0162,	.0114,	.1015,	.1591,	.2189,	.1626,
7,	.4283,	.4369,	.1337,	.0162,	.0212,	.0156,	.0415,	.2353,	.3364,	.1957,
8,	.2454,	.7399,	.1496,	.0638,	.0185,	.0162,	.0461,	.1090,	.3958,	.2287,
9,	.6430,	.1844,	.1578,	.4379,	.1604,	.0226,	.0636,	.0642,	.3234,	.2287,
10,	1.0603,	1.4594,	.0548,	.8920,	.2160,	.2240,	.0494,	.1397,	.1740,	.2287,
11,	.0753,	1.0513,	.9128,	.0491,	.0750,	.4895,	.0001,	.0853,	.6070,	.2287,
12,	.8849,	.0702,	.7402,	1.6463,	.0168,	.2957,	.0012,	.4852,	.1808,	.2287,
13,	1.5313,	.8354,	.0081,	.4112,	1.5007,	.0360,	.0016,	.9406,	6.5266,	.2287,
14,	1.3871,	4.5187,	.1592,	.0174,	1.7650,	.0408,	.0000,	.1997,	3.7873,	.2287,
15,	.3651,	.3197,	.0728,	.1381,	.0187,	.0228,	.0496,	.0863,	.0000,	.2287,
+gp,	.3651,	.3197,	.0728,	.1381,	.0187,	.0228,	.0496,	.0863,	.0000,	.2287,
FBAR 5-13,	.6055,	.5625,	.2429,	.3944,	.2262,	.1287,	.0412,	.2584,	.9829,	.2067,

Table 3.5.11

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	7468718,	1439017,	938989,	835774,	397023,	237538,	274748,
1,	262135,	3005056,	574989,	298670,	304950,	97943,	65556,
2,	142169,	94354,	1174987,	178465,	90917,	81694,	22820,
3,	108489,	54120,	35907,	470120,	68987,	31748,	30092,
4,	40139,	90818,	46520,	30541,	397779,	56911,	26464,
5,	49683,	32836,	74612,	39480,	25855,	329072,	46423,
6,	85953,	41044,	26666,	58643,	33045,	20930,	264296,
7,	79906,	68915,	33804,	21689,	47182,	26257,	16956,
8,	19630,	62956,	54542,	27202,	17909,	36072,	20844,
9,	28034,	16160,	48614,	43424,	22385,	14228,	28504,
10,	32034,	23308,	13194,	38344,	34467,	17418,	11456,
11,	25833,	26557,	19296,	10623,	29348,	25591,	13202,
12,	56330,	21430,	21903,	15814,	8572,	21000,	19291,
13,	59637,	46681,	17448,	17855,	12767,	6560,	16194,
14,	9523,	47919,	37831,	14029,	14496,	10057,	5103,
15,	25725,	7581,	38022,	30834,	11160,	11246,	7873,
+gp,	57051,	48798,	45707,	73673,	59530,	51778,	42172,
TOTAL,	8550996,	5127553,	3203029,	2205177,	1576372,	1076043,	911995,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	236506,	278105,	4053428,	1913324,	732827,	177125,	1646403,	905561,	79306,	453492,
1,	79447,	66148,	56387,	1538203,	699079,	260052,	49847,	639834,	345996,	18600,
2,	14702,	13263,	10738,	11294,	542521,	188053,	81052,	8036,	243395,	117663,
3,	5553,	4649,	1618,	2442,	2291,	202892,	70077,	20760,	1959,	81610,
4,	24821,	4564,	3839,	1253,	984,	1683,	157563,	53279,	16807,	859,
5,	20449,	17911,	3762,	3056,	910,	772,	1374,	127875,	42163,	12097,
6,	37047,	16177,	14389,	2998,	2370,	745,	636,	1134,	91146,	31007,
7,	203832,	29771,	13096,	11028,	2355,	1901,	575,	531,	849,	58137,
8,	13576,	157064,	23824,	10209,	8601,	1847,	1450,	461,	443,	551,
9,	16054,	11018,	126171,	18278,	8109,	6833,	1480,	1078,	369,	244,
10,	22088,	12639,	8829,	98378,	13845,	6524,	5334,	1187,	698,	249,
11,	8651,	17322,	9740,	6779,	73913,	10657,	5128,	3596,	752,	425,
12,	9529,	6628,	13050,	7233,	5046,	56879,	8089,	3559,	2213,	280,
13,	14081,	7080,	4792,	9401,	5027,	3883,	41431,	5354,	2302,	981,
14,	12427,	10738,	5378,	3306,	6672,	3910,	2933,	27128,	3197,	991,
15,	3809,	9478,	8586,	3913,	2322,	5160,	2859,	1790,	16219,	1476,
+gp,	27997,	25429,	15186,	10089,	4108,	6819,	5913,	11374,	4126,	7020,
TOTAL,	750569,	687983,	4372815,	3651185,	2110981,	935735,	2082145,	1812539,	851939,	785682,

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	35822,	46385,	96471,	6207,	2098,	9228,	127304,	85011,	29540,	106094,
1,	160413,	11970,	8476,	35785,	1806,	668,	1728,	51577,	34157,	11822,
2,	3682,	11196,	2313,	655,	11344,	478,	47,	681,	20922,	13865,
3,	37672,	1074,	2275,	164,	79,	4092,	77,	9,	253,	8495,
4,	51327,	19600,	37,	254,	83,	51,	3195,	44,	7,	188,
5,	492,	14426,	177,	24,	50,	62,	12,	2516,	36,	5,
6,	6115,	179,	111,	71,	15,	31,	20,	4,	1939,	22,
7,	14673,	1420,	25,	52,	31,	10,	4,	4,	1,	1385,
8,	23551,	2344,	364,	15,	15,	16,	2,	1,	2,	1,
9,	128,	4602,	789,	205,	4,	3,	1,	0,	1,	1,
10,	79,	29,	822,	370,	54,	0,	0,	1,	0,	1,
11,	56,	16,	7,	376,	80,	7,	0,	0,	1,	0,
12,	126,	16,	4,	3,	68,	6,	1,	0,	0,	0,
13,	140,	31,	7,	1,	0,	9,	0,	1,	0,	0,
14,	214,	39,	4,	4,	0,	0,	3,	0,	1,	0,
15,	196,	26,	10,	1,	1,	0,	0,	1,	0,	1,
+gp,	1235,	217,	48,	27,	0,	0,	0,	1,	0,	1,
TOTAL,	335920,	113570,	111938,	44216,	15728,	14661,	132394,	139852,	86860,	141881,

Table 3.5.11 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	50403,	61335,	127558,	14986,	10920,	21920,	4520452,	136687,	247125,	29024,
1,	43011,	20227,	24813,	51661,	6050,	4389,	8773,	1837098,	55364,	100298,
2,	4792,	17449,	8209,	10065,	20999,	2453,	1778,	3538,	746897,	22429,
3,	5630,	1929,	7087,	3326,	4090,	8464,	996,	712,	1423,	302390,
4,	7096,	4641,	1632,	6041,	2803,	3481,	7157,	828,	572,	1026,
5,	111,	5889,	3882,	1388,	5145,	2370,	2923,	5964,	663,	349,
6,	4,	93,	4881,	3277,	1173,	4349,	1998,	2428,	4564,	418,
7,	19,	4,	72,	4097,	2745,	989,	3685,	1663,	1921,	2728,
8,	1071,	13,	3,	59,	3380,	2321,	833,	3109,	1314,	1109,
9,	1,	822,	5,	3,	46,	2832,	1951,	705,	2531,	625,
10,	1,	1,	661,	4,	2,	37,	2382,	1636,	540,	1597,
11,	1,	1,	1,	546,	4,	1,	31,	1982,	1257,	373,
12,	0,	1,	1,	1,	445,	2,	0,	25,	1646,	796,
13,	0,	0,	1,	1,	1,	374,	2,	0,	21,	955,
14,	0,	0,	0,	0,	1,	0,	321,	0,	0,	18,
15,	0,	0,	0,	0,	0,	0,	0,	268,	0,	0,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	91,	35,
TOTAL,	112141,	112405,	178806,	95453,	57804,	53984,	4553283,	1996640,	1065929,	464170,

Table 10 Stock number at age (start of year) Numbers*10**-5

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE											
0,	29622,	303876,	927325,	1718236,	2820610,	4378022,	2036459,	105078,	0,	0,	0,
1,	11715,	11958,	123451,	376978,	698576,	1146775,	1779961,	827922,	42719,	0,	0,
2,	40769,	4724,	4845,	50180,	153266,	283999,	466243,	723677,	336608,	17368,	0,
3,	9100,	16355,	1865,	1815,	20306,	62293,	115457,	189516,	294110,	136848,	6876,
4,	255267,	7649,	13494,	1578,	1390,	17399,	53499,	99111,	162575,	252609,	117469,
5,	720,	215065,	6351,	11581,	1334,	1171,	14669,	45057,	83558,	136719,	210901,
6,	167,	448,	180008,	5414,	9858,	1135,	961,	11817,	34843,	66152,	103377,
7,	217,	111,	298,	151930,	4560,	8348,	966,	748,	8675,	24094,	48393,
8,	1382,	122,	62,	224,	128670,	3842,	7075,	797,	509,	5334,	17052,
9,	270,	930,	50,	46,	181,	108719,	3254,	5815,	615,	295,	3652,
10,	154,	122,	666,	37,	25,	133,	91485,	2628,	4694,	383,	202,
11,	667,	46,	24,	543,	13,	18,	91,	74943,	1967,	3395,	263,
12,	142,	533,	14,	8,	445,	10,	9,	79,	59227,	923,	2324,
13,	88,	50,	427,	6,	1,	376,	7,	8,	42,	42544,	632,
14,	99,	16,	19,	365,	3,	0,	312,	6,	3,	0,	29131,
15,	16,	21,	0,	14,	309,	0,	0,	269,	4,	0,	0,
+gp,	0,	0,	0,	26,	6,	0,	0,	0,	0,	0,	0,
TOTAL,	350396,	562027,	1258900,	2318980,	3839554,	6012248,	4570450,	2087470,	1030147,	686664,	540271,

Table 3.5.12

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Traditional vpa using file input for terminal F

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

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	74687,	14390,	9390,	8358,	3970,	2375,	2747,
1,	20971,	240404,	45999,	23894,	24396,	7835,	5244,
2,	66819,	44347,	552244,	83878,	42731,	38396,	10725,
3,	108489,	54120,	35907,	470121,	68987,	31748,	30092,
4,	81884,	185269,	94901,	62304,	811468,	110976,	54252,
5,	114272,	75523,	171608,	90803,	59467,	700925,	106774,
6,	219180,	104663,	67997,	149540,	84266,	54419,	658097,
7,	219741,	189516,	92962,	59644,	129749,	72207,	46630,
8,	56928,	182571,	158171,	78885,	51936,	104608,	60448,
9,	85504,	49286,	148274,	132443,	68275,	43396,	86937,
10,	100907,	73421,	41563,	120783,	108571,	54866,	36088,
11,	83958,	86312,	62711,	34525,	95381,	83172,	42906,
12,	185888,	70718,	72280,	52186,	28288,	69299,	63662,
13,	202765,	158717,	59324,	60706,	43406,	22303,	55059,
14,	32853,	165321,	130518,	48399,	50011,	34696,	17604,
15,	93124,	27444,	137640,	111620,	40398,	40710,	28500,
+gp,	208238,	178114,	166829,	268907,	217286,	188990,	153926,
TOTALBIO,	1956205,	1900135,	2048315,	1856993,	1928586,	1660922,	1459691,

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	2365,	2781,	40534,	19133,	7328,	1771,	16464,	9056,	793,	4535,
1,	6356,	5292,	4511,	123056,	55926,	20804,	3988,	51187,	27680,	1488,
2,	6910,	6234,	5047,	5308,	254985,	88385,	38094,	3777,	114396,	55302,
3,	5553,	4649,	1618,	2442,	2291,	202893,	70077,	20760,	1959,	81610,
4,	33757,	9310,	7832,	2555,	2283,	3685,	291492,	103361,	31261,	1590,
5,	46624,	43345,	9481,	8252,	2275,	2247,	3477,	272374,	83905,	26491,
6,	94471,	47236,	37412,	8725,	6922,	2235,	1869,	2993,	215104,	68836,
7,	534038,	87824,	37980,	32312,	7112,	6008,	1793,	1682,	2208,	144762,
8,	39370,	460197,	71472,	32772,	26148,	5985,	4769,	1675,	1607,	1685,
9,	48963,	33605,	384821,	58123,	26191,	22275,	4839,	3807,	1292,	863,
10,	69577,	39812,	27810,	314809,	44580,	21854,	17816,	4144,	2583,	940,
11,	28117,	57162,	31654,	23319,	237262,	36019,	17486,	12729,	2706,	1660,
12,	31446,	22535,	43065,	25244,	17359,	189975,	28232,	12704,	8364,	1061,
13,	47875,	24427,	16293,	34784,	17945,	13475,	141281,	19222,	8908,	3706,
14,	42872,	37797,	18554,	12531,	24220,	13841,	10502,	99017,	12468,	3576,
15,	13789,	34120,	30479,	14673,	8474,	18472,	10723,	7196,	63902,	5652,
+gp,	102189,	92816,	54670,	38338,	15201,	24413,	22173,	45724,	16257,	26888,
TOTALBIO,	1154272,	1009143,	823231,	756378,	756502,	674337,	685076,	671407,	595391,	430647,

Traditional vpa using file input for terminal F

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

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	358,	464,	965,	62,	21,	92,	1273,	850,	295,	1061,
1,	12833,	958,	678,	2863,	271,	67,	173,	5158,	3416,	1182,
2,	1731,	5262,	1087,	308,	9075,	334,	40,	579,	17783,	11785,
3,	37672,	1074,	2275,	164,	79,	6138,	130,	16,	458,	15376,
4,	92390,	22540,	42,	532,	157,	76,	8274,	114,	18,	486,
5,	1121,	29718,	256,	65,	112,	87,	41,	8606,	122,	17,
6,	16450,	477,	300,	164,	38,	66,	78,	17,	7446,	85,
7,	39616,	3905,	76,	154,	85,	23,	18,	16,	6,	5666,
8,	69240,	6423,	1113,	49,	43,	44,	8,	6,	7,	5,
9,	416,	13116,	2430,	662,	13,	8,	3,	1,	5,	6,
10,	331,	102,	2614,	1203,	176,	1,	2,	3,	1,	5,
11,	241,	52,	23,	1238,	267,	22,	1,	2,	3,	1,
12,	460,	59,	13,	12,	236,	22,	6,	1,	1,	2,
13,	514,	125,	24,	5,	0,	33,	1,	5,	1,	1,
14,	927,	151,	15,	15,	1,	0,	13,	0,	4,	1,
15,	811,	97,	38,	5,	6,	0,	0,	3,	0,	4,
+gp,	5113,	819,	192,	104,	0,	0,	0,	3,	0,	4,
TOTALBIO,	280223,	85341,	12142,	7605,	10579,	7014,	10063,	15378,	29566,	35685,

Table 3.5.12 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

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

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	504,	613,	1276,	150,	109,	219,	45205,	1367,	2471,	290,
1,	4301,	2023,	2481,	5166,	605,	439,	877,	183709,	5536,	10030,
2,	4073,	14831,	6978,	8555,	17849,	2085,	1511,	3007,	171786,	19064,
3,	10190,	3472,	12614,	5820,	6952,	14389,	1544,	997,	2106,	163291,
4,	18380,	13644,	3787,	17095,	6279,	7102,	17821,	1689,	1338,	2114,
5,	382,	19199,	13935,	4815,	17289,	7182,	8887,	17593,	1756,	925,
6,	16,	344,	18791,	13175,	4435,	15439,	7354,	8206,	14238,	1208,
7,	78,	15,	301,	17248,	10624,	3790,	14889,	6252,	6647,	9249,
8,	4756,	58,	14,	273,	13789,	9168,	3534,	12279,	4862,	4083,
9,	5,	3914,	26,	12,	184,	11697,	8524,	2871,	9998,	2444,
10,	6,	4,	3438,	23,	11,	166,	10384,	6758,	2145,	6100,
11,	4,	5,	4,	2914,	20,	4,	150,	8364,	5381,	1446,
12,	0,	3,	4,	3,	2277,	11,	2,	109,	7044,	3144,
13,	2,	0,	3,	3,	3,	1892,	8,	0,	92,	3774,
14,	1,	2,	0,	2,	3,	2,	1587,	0,	0,	73,
15,	0,	1,	1,	0,	2,	2,	2,	1171,	0,	0,
+gp,	0,	1,	1,	0,	2,	2,	2,	1,	390,	140,
TOTALBIO,	42698,	58129,	63655,	75256,	80434,	73590,	122281,	254375,	235791,	227373,

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	296,	3039,	9273,	17182,	28206,	43780,	20365,	1051,	0,	0,
1,	1172,	1794,	18518,	30158,	76843,	80274,	142397,	82792,	7689,	0,
2,	22423,	2362,	4845,	24086,	56708,	85200,	116561,	180919,	84152,	4342,
3,	8190,	16028,	2871,	3975,	29849,	79734,	93520,	142137,	194113,	104004,
4,	365032,	10326,	23615,	3125,	2919,	38974,	107533,	149658,	224353,	298078,
5,	1736,	423678,	13274,	29879,	3254,	3465,	38872,	114444,	192184,	257032,
6,	466,	1240,	453622,	15593,	29573,	3711,	3105,	37579,	103135,	172658,
7,	649,	351,	909,	469463,	14773,	29637,	3419,	2774,	30015,	76136,
8,	4366,	413,	227,	960,	432332,	13256,	25327,	2767,	1973,	18454,
9,	924,	3191,	188,	170,	622,	399001,	12397,	23957,	2234,	1102,
10,	530,	439,	2391,	148,	97,	453,	337578,	10039,	19197,	1495,
11,	2415,	168,	97,	2100,	47,	64,	362,	305017,	8144,	13239,
12,	534,	2002,	55,	37,	1890,	45,	37,	323,	249939,	3543,
13,	330,	190,	1692,	25,	6,	1769,	25,	33,	171,	169327,
14,	372,	61,	75,	1605,	14,	1,	1259,	23,	11,	0,
15,	60,	80,	1,	61,	1311,	2,	1,	1103,	16,	0,
+gp,	0,	0,	1,	115,	25,	2,	1,	1,	0,	0,
TOTALBIO,	409494,	465361,	531652,	598684,	678470,	779368,	902757,	1054615,	1117326,	1119412,

Table 3.5.13

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Traditional vpa using file input for terminal F

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

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,
AGE							
0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,
3,	0,	0,	0,	0,	0,	2494,	2361,
4,	8026,	18166,	9336,	6128,	79623,	23922,	11632,
5,	33633,	22190,	50257,	26761,	17467,	253719,	38625,
6,	128634,	61591,	39964,	87794,	49410,	45292,	545038,
7,	193108,	166621,	81867,	52662,	113681,	70559,	45605,
8,	55831,	177912,	154606,	77363,	50755,	102174,	58890,
9,	83940,	48297,	144796,	129418,	66584,	42466,	84748,
10,	99033,	72047,	40671,	117596,	105386,	53366,	35088,
11,	82403,	84665,	61475,	33792,	92241,	80855,	41530,
12,	182428,	69279,	70818,	51081,	27541,	67521,	61689,
13,	198378,	155416,	58044,	59454,	42383,	21750,	53620,
14,	32112,	161540,	127876,	47304,	48758,	33857,	17097,
15,	91318,	26848,	134574,	109102,	39282,	39687,	27714,
+gp,	204200,	174244,	163113,	262841,	211280,	184244,	149685,
TOTSPBIO,	1393043,	1238816,	1137396,	1061295,	944389,	1021907,	1173322,

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

YEAR,	1957,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	0,	365,	126,	178,	89,	0,	2727,	407,	0,	779,
4,	0,	2009,	1684,	544,	780,	397,	8564,	6058,	10285,	226,
5,	22772,	15690,	3429,	2977,	1516,	1476,	1091,	73726,	28478,	24745,
6,	55457,	39312,	30966,	7239,	6364,	2178,	1652,	931,	156291,	61319,
7,	520299,	85889,	37046,	31519,	6941,	5847,	1754,	1652,	2114,	132254,
8,	38556,	450227,	69602,	32026,	25553,	5854,	4630,	1638,	1514,	1457,
9,	47806,	32868,	375363,	56531,	25627,	21731,	4733,	3645,	1243,	771,
10,	67906,	38788,	27085,	305935,	43429,	21334,	17127,	3959,	2458,	810,
11,	27377,	55566,	30726,	22641,	231127,	35040,	16859,	12126,	2451,	1470,
12,	30525,	21816,	41675,	24342,	16910,	184049,	27091,	12162,	7710,	990,
13,	46595,	23765,	15699,	33611,	17500,	13102,	135423,	18256,	8188,	3183,
14,	41727,	36961,	17973,	12096,	23605,	13415,	9996,	94053,	11540,	3041,
15,	13448,	33338,	29688,	14255,	8260,	17931,	10295,	6866,	59147,	4944,
+gp,	99666,	90687,	53252,	37246,	14817,	23699,	21288,	43622,	15047,	23519,
TOTSPBIO,	1012134,	927280,	734315,	581141,	422520,	346054,	263231,	279097,	306465,	259506,

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

YEAR,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	3,	52,	1625,	1077,
3,	0,	0,	1133,	9,	8,	0,	62,	8,	222,	7551,
4,	814,	0,	36,	59,	38,	7,	7271,	100,	18,	415,
5,	233,	183,	222,	19,	64,	19,	37,	8384,	116,	16,
6,	14215,	298,	278,	26,	33,	32,	66,	15,	7199,	84,
7,	32978,	3408,	72,	136,	80,	18,	16,	14,	6,	5522,
8,	58810,	5761,	1051,	43,	36,	32,	6,	5,	7,	5,
9,	358,	11041,	2253,	580,	10,	6,	3,	1,	5,	6,
10,	282,	88,	2418,	1032,	143,	1,	2,	3,	1,	5,
11,	213,	45,	22,	1044,	207,	19,	1,	2,	3,	1,
12,	400,	54,	12,	8,	193,	14,	6,	1,	1,	2,
13,	452,	101,	23,	4,	0,	29,	1,	5,	1,	1,
14,	749,	131,	13,	13,	1,	0,	12,	0,	4,	1,
15,	690,	83,	36,	5,	5,	0,	0,	3,	0,	4,
+gp,	4345,	704,	179,	89,	0,	0,	0,	3,	0,	4,
TOTSPBIO,	114540,	21897,	7747,	3066,	816,	179,	7487,	8598,	9208,	14692,

Table 3.5.13 (continued)

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Traditional vpa using file input for terminal F

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

YEAR,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	7296,	444,	1241,	1430,	2052,	1415,	152,	98,	204,	16055,
4,	16056,	12062,	2310,	8412,	3087,	3350,	8750,	826,	637,	408,
5,	375,	18842,	13016,	4593,	15300,	4942,	6019,	15416,	1509,	773,
6,	16,	335,	18465,	12944,	4360,	15186,	5126,	7616,	13524,	1131,
7,	75,	14,	295,	16919,	10447,	3725,	14637,	6106,	6292,	8641,
8,	4632,	53,	13,	266,	13547,	9010,	3475,	12030,	4514,	3545,
9,	5,	3830,	25,	12,	180,	11496,	8376,	2795,	9548,	2125,
10,	6,	4,	3373,	22,	10,	163,	10195,	6582,	2067,	5590,
11,	4,	5,	4,	2855,	19,	4,	147,	8210,	5140,	1313,
12,	0,	3,	4,	3,	2238,	11,	2,	107,	6671,	2521,
13,	2,	0,	3,	3,	3,	1863,	5,	0,	90,	3008,
14,	1,	2,	0,	2,	3,	2,	1559,	0,	0,	72,
15,	0,	1,	1,	0,	2,	2,	2,	1146,	0,	0,
+gp,	0,	1,	1,	0,	2,	2,	2,	1,	370,	121,
TOTSPBIO,	28467,	35596,	38753,	47463,	51252,	51172,	58447,	60933,	50567,	45303,

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

YEAR,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	805,	1572,	282,	1548,	2939,	7853,	921,	1400,	0,	0,
4,	107649,	3041,	6977,	2458,	2008,	7663,	31711,	44138,	2205,	2927,
5,	1490,	374585,	11758,	26461,	3202,	2718,	30433,	89232,	150197,	112476,
6,	447,	1191,	445994,	13795,	29086,	3651,	3028,	36435,	99400,	167344,
7,	612,	331,	884,	415553,	14522,	29150,	3354,	2669,	28590,	73549,
8,	4196,	378,	220,	940,	425109,	13037,	24835,	2696,	1868,	17768,
9,	854,	3086,	183,	160,	603,	392173,	12135,	23450,	2131,	1061,
10,	470,	374,	2342,	133,	94,	436,	330912,	9752,	18585,	1440,
11,	2361,	149,	87,	2058,	46,	60,	357,	297922,	7550,	12747,
12,	482,	1959,	50,	31,	1859,	43,	36,	303,	241806,	3412,
13,	279,	172,	1665,	24,	5,	1736,	24,	29,	88,	163034,
14,	319,	38,	72,	1578,	11,	1,	1240,	23,	7,	0,
15,	57,	76,	1,	59,	1289,	2,	1,	1077,	16,	0,
+gp,	0,	0,	1,	112,	24,	2,	1,	1,	0,	0,
TOTSPBIO,	120020,	386951,	470516,	464912,	480798,	458526,	438988,	509125,	552443,	555759,

Table 3.5.14

Run title : Herring Spring-spawn (run: SVPBJA04/V04)

At 6-May-97 16:11:45

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-13,
1950,	746872448,	19562068,	13930442,	933000,	.0670,	.0512,
1951,	143901840,	19001372,	12388174,	1278400,	.1032,	.0605,
1952,	93898800,	20483174,	11373974,	1254800,	.1103,	.0687,
1953,	83577320,	18569958,	10612954,	1090600,	.1028,	.0630,
1954,	39702324,	19285874,	9443900,	1644500,	.1741,	.1088,
1955,	23753744,	16609234,	10219084,	1359800,	.1331,	.0926,
1956,	27474790,	14596924,	11733226,	1659400,	.1414,	.1178,
1957,	23650590,	11542724,	10121356,	1319500,	.1304,	.0988,
1958,	27810510,	10091432,	9272812,	986600,	.1064,	.0985,
1959,	405342656,	8232309,	7343151,	1111100,	.1513,	.1296,
1960,	191332496,	7563777,	5811414,	1101800,	.1896,	.1322,
1961,	73282680,	7565020,	4225195,	830100,	.1965,	.0886,
1962,	17712464,	6743379,	3460537,	848600,	.2452,	.1065,
1963,	164640192,	6850756,	2632311,	984500,	.3740,	.1505,
1964,	90556112,	6714079,	2790976,	1281800,	.4593,	.2234,
1965,	7930604,	5953912,	3064652,	1547700,	.5050,	.4412,
1966,	45349256,	4306467,	2595061,	1955000,	.7534,	.9442,
1967,	3582164,	2802236,	1145396,	1677200,	1.4643,	1.2885,
1968,	4638508,	853411,	218969,	712200,	3.2525,	1.7285,
1969,	9647114,	121417,	77469,	67800,	.8752,	.5849,
1970,	620676,	76052,	30663,	62300,	2.0318,	1.4353,
1971,	209803,	105789,	8163,	21100,	2.5850,	1.2914,
1972,	922792,	70136,	1786,	13161,	7.3671,	1.7210,
1973,	12730362,	100627,	74866,	7017,	.0937,	.6781,
1974,	8501096,	153784,	85976,	7619,	.0886,	.2288,
1975,	2954025,	295658,	92077,	13713,	.1489,	.0880,
1976,	10609396,	356852,	146921,	10436,	.0710,	.0365,
1977,	5040309,	426977,	284675,	22706,	.0798,	.0704,
1978,	6133525,	581294,	355960,	19824,	.0557,	.1350,
1979,	12755812,	636547,	387531,	12864,	.0332,	.0211,
1980,	1498577,	752559,	474629,	18577,	.0391,	.0328,
1981,	1092020,	804339,	512517,	13736,	.0268,	.1443,
1982,	2191989,	735902,	511717,	16655,	.0325,	.0989,
1983,	452045120,	1222805,	584472,	23054,	.0394,	.6370,
1984,	13668708,	2543749,	609328,	53532,	.0879,	.0999,
1985,	24712478,	2357914,	505671,	169872,	.3359,	.3223,
1986,	2902411,	2273735,	453032,	225256,	.4972,	1.0939,
1987,	2962186,	4094943,	1200204,	127306,	.1061,	.6055,
1988,	30387564,	4653615,	3869514,	135301,	.0350,	.5625,
1989,	92732488,	5316521,	4705155,	103830,	.0221,	.2429,
1990,	171823504,	5986832,	4649123,	86411,	.0186,	.3944,
1991,	282061248,	6784701,	4807982,	84683,	.0176,	.2262,
1992,	437802272,	7793675,	4585262,	104448,	.0228,	.1287,
1993,	203645776,	9027584,	4389877,	232457,	.0530,	.0412,
1994,	10507816,	10546166,	5091257,	479228,	.0941,	.2584,
1995,	0,	11173260,	5524427,	905501,	.1639,	.9829,
1996,	0,	11194128,	5557589,	1196943,	.2154,	.2067,
Arith. Mean ,	85429120,	6330120,	3871519,	591743,	.5084,	.3907,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 3.5.15 Stock summary table with recruitment at age 3

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 5-13	FW5-13
1950	10848868	17937292	13930442	933000	0.0670	0.0512	0.0582
1951	5411967	16009960	12388174	1278400	0.1032	0.0605	0.0683
1952	3590707	14406844	11373974	1254800	0.1103	0.0687	0.0750
1953	47012072	17408662	10612954	1090600	0.1028	0.0630	0.0657
1954	6898701	18574904	9443900	1644500	0.1741	0.1088	0.1130
1955	3174838	16123164	10219084	1359800	0.1331	0.0926	0.0780
1956	3009177	14409750	11733226	1659400	0.1414	0.1178	0.1096
1957	555313	11386416	10121356	1319500	0.1304	0.0988	0.1020
1958	464886	9948366	9272812	986600	0.1064	0.0985	0.0790
1959	161777	7731388	7343151	1111100	0.1513	0.1296	0.1116
1960	244166	6088798	5811414	1101800	0.1896	0.1322	0.1347
1961	229051	4382627	4225195	830100	0.1965	0.0886	0.1046
1962	20289264	5633775	3460537	848600	0.2452	0.1065	0.1452
1963	7007718	6265294	2632311	984500	0.3740	0.1505	0.2488
1964	2076011	6073887	2790976	1281800	0.4593	0.2234	0.2015
1965	195853	4525226	3064652	1547700	0.5050	0.4412	0.2726
1966	8160989	3693220	2595061	1955000	0.7534	0.9442	0.6929
1967	3767200	2653016	1145396	1677200	1.4643	1.2885	1.5151
1968	107355	786576	218969	712200	3.2525	1.7285	3.4539
1969	227476	94119	77469	67800	0.8752	0.5849	0.5950
1970	16362	43722	30663	62300	2.0318	1.4353	1.3296
1971	7862	12117	8163	21100	2.5850	1.2914	1.5497
1972	409205	65200	1786	13161	7.3671	1.7210	1.5767
1973	7658	85767	74832	7017	0.0938	0.6781	1.2302
1974	927	87917	85451	7619	0.0892	0.2288	0.1130
1975	25297	80712	75826	13713	0.1808	0.0880	0.1882
1976	849507	216568	136151	10436	0.0767	0.0365	0.1048
1977	562969	338197	284675	22706	0.0798	0.0704	0.1087
1978	192900	406619	355960	19824	0.0557	0.1350	0.0437
1979	708673	529201	387531	12864	0.0332	0.0211	0.0240
1980	332587	613849	474629	18577	0.0391	0.0328	0.0344
1981	408961	618708	512517	13736	0.0268	0.1443	0.0212
1982	846410	708470	511717	16655	0.0325	0.0989	0.0198
1983	99611	746878	584472	23054	0.0394	0.6370	0.0288
1984	71237	662912	609328	53532	0.0879	0.0999	0.0890
1985	142307	559974	505671	169872	0.3359	0.3223	0.3704
1986	30238990	1979893	453032	225256	0.4972	1.0939	1.0236
1987	909972	3856034	1200204	127306	0.1061	0.6055	0.3564
1988	1635526	4581670	3869514	135301	0.0350	0.5625	0.0310
1989	186460	4990166	4705155	103830	0.0221	0.2429	0.0198
1990	181519	5272563	4649123	86411	0.0186	0.3944	0.0166
1991	2030572	5167124	4807982	84683	0.0176	0.2262	0.0186
1992	6229257	5701133	4585262	104448	0.0228	0.1287	0.0224
1993	11545714	6234360	4389877	232457	0.0530	0.0412	0.0520
1994	18951562	7898543	5091257	479228	0.0941	0.2584	0.0997
1995	29410968	10254846	5524427	905501	0.1639	0.9829?	0.1593
1996	13684750	11150708	5557589	1196943	0.2154	0.2067	0.1618
Arith. Mean	5172791	5468024	3870933	591743	0.5093	0.3907	0.3621
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)			

e:\acfm\wgnpbw97\t-3515.xls

Table 3.6.1

Herring Norwegian Spring-spawners

Prediction with management option table: Input data

Year: 1997								
Age	Stock size	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	688.000	0.1500	0.0000	0.1000	0.1000	0.096	0.0027	0.136
4	11747.000	0.1500	0.3000	0.1000	0.1000	0.118	0.0305	0.168
5	21090.000	0.1500	0.9000	0.1000	0.1000	0.174	0.1295	0.207
6	10338.000	0.1500	1.0000	0.1000	0.1000	0.229	0.1626	0.262
7	4839.000	0.1500	1.0000	0.1000	0.1000	0.286	0.1957	0.309
8	1705.000	0.1500	1.0000	0.1000	0.1000	0.323	0.2287	0.338
9	365.000	0.1500	1.0000	0.1000	0.1000	0.370	0.2287	0.366
10	20.000	0.1500	1.0000	0.1000	0.1000	0.378	0.2287	0.361
11	26.000	0.1500	1.0000	0.1000	0.1000	0.386	0.2287	0.362
12	232.000	0.1500	1.0000	0.1000	0.1000	0.360	0.2287	0.367
13	63.000	0.1500	1.0000	0.1000	0.1000	0.393	0.2287	0.380
14	2913.000	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
15	0.000	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
16+	0.000	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1998								
Age	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	667.000	0.1500	0.0000	0.1000	0.1000	0.096	0.0027	0.136
4	.	0.1500	0.3000	0.1000	0.1000	0.118	0.0305	0.168
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.1295	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.229	0.1626	0.262
7	.	0.1500	1.0000	0.1000	0.1000	0.286	0.1957	0.309
8	.	0.1500	1.0000	0.1000	0.1000	0.323	0.2287	0.338
9	.	0.1500	1.0000	0.1000	0.1000	0.370	0.2287	0.366
10	.	0.1500	1.0000	0.1000	0.1000	0.378	0.2287	0.361
11	.	0.1500	1.0000	0.1000	0.1000	0.386	0.2287	0.362
12	.	0.1500	1.0000	0.1000	0.1000	0.360	0.2287	0.367
13	.	0.1500	1.0000	0.1000	0.1000	0.393	0.2287	0.380
14	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
15	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
16+	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
Age	Recruit- ment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
3	3103.000	0.1500	0.0000	0.1000	0.1000	0.096	0.0027	0.136
4	.	0.1500	0.3000	0.1000	0.1000	0.118	0.0305	0.168
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.1295	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.229	0.1626	0.262
7	.	0.1500	1.0000	0.1000	0.1000	0.286	0.1957	0.309
8	.	0.1500	1.0000	0.1000	0.1000	0.323	0.2287	0.338
9	.	0.1500	1.0000	0.1000	0.1000	0.370	0.2287	0.366
10	.	0.1500	1.0000	0.1000	0.1000	0.378	0.2287	0.361
11	.	0.1500	1.0000	0.1000	0.1000	0.386	0.2287	0.362
12	.	0.1500	1.0000	0.1000	0.1000	0.360	0.2287	0.367
13	.	0.1500	1.0000	0.1000	0.1000	0.393	0.2287	0.380
14	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
15	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
16+	.	0.1500	1.0000	0.1000	0.1000	0.391	0.2287	0.380
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANBJA01
Date and time: 06MAY97:21:42

Table 3.6.2

The SAS System 10:02 Thursday, May 8, 1997

Herring Norwegian Spring-spawners

Prediction with management option table

Year: 1997					Year: 1998					Year: 1999	
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
0.9690	0.2003	10823833	9134279	1500000	0.0000	0.0000	10202281	9770990	0	10761563	10252463
.	.	.	.	.	0.1000	0.0207	.	9753296	183026	10579426	10052681
.	.	.	.	.	0.2000	0.0413	.	9735635	362783	10400615	9856949
.	.	.	.	.	0.3000	0.0620	.	9718007	539334	10225068	9665180
.	.	.	.	.	0.4000	0.0827	.	9700412	712737	10052721	9477294
.	.	.	.	.	0.5000	0.1034	.	9682851	883052	9883516	9293207
.	.	.	.	.	0.6000	0.1240	.	9665322	1050336	9717392	9112842
.	.	.	.	.	0.7000	0.1447	.	9647826	1214646	9554292	8936121
.	.	.	.	.	0.8000	0.1654	.	9630363	1376037	9394158	8762966
.	.	.	.	.	0.9000	0.1860	.	9612933	1534565	9236935	8593305
.	.	.	.	.	1.0000	0.2067	.	9595535	1690281	9082568	8427064
.	.	.	.	.	1.1000	0.2274	.	9578171	1843238	8931003	8264172
.	.	.	.	.	1.2000	0.2480	.	9560838	1993488	8782188	8104560
.	.	.	.	.	1.3000	0.2687	.	9543538	2141081	8636070	7948159
.	.	.	.	.	1.4000	0.2894	.	9526271	2286067	8492600	7794903
.	.	.	.	.	1.5000	0.3101	.	9509036	2428493	8351727	7644725
.	.	.	.	.	1.6000	0.3307	.	9491834	2568407	8213403	7497563
.	.	.	.	.	1.7000	0.3514	.	9474663	2705856	8077581	7353354
.	.	.	.	.	1.8000	0.3721	.	9457525	2840885	7944212	7212037
.	.	.	.	.	1.9000	0.3927	.	9440419	2973539	7813252	7073551
.	.	.	.	.	2.0000	0.4134	.	9423345	3103863	7684655	6937838
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANBJA01
Date and time : 06MAY97:21:42
Computation of ref. F: Simple mean, age 5 - 13
Basis for 1997 : TAC constraints

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	0	0	0	0

Table 4.3.1 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group index in August.

Year	Larval abundance	0-group index
1981	9.7	570
1982	9.9	393
1983	9.9	589
1984	8.2	320
1985	8.6	110
1986	-	125
1987	0.3	55
1988	0.3	187
1989	7.3	1300
1990	13.0	324
1991	3.0	241
1992	7.3	26
1993	3.3	43
1994	0.1	58
1995	0.0	43
1996	2.4	291

Table 4.3.2 Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 1996.

Length (cm)	Age 1	2	3	4	5+	Sum (10^6)	Biomass (10^3 tonnes)	Mean weight (g)
6.5 - 7.0	9258					9258	9.3	1.0
7.0 - 7.5	6114					6114	6.1	1.0
7.5 - 8.0	7133					7133	8.5	1.2
8.0 - 8.5	8520					8520	15.3	1.8
8.5 - 9.0	9910					9910	20.7	2.1
9.0 - 9.5	9866	73				9939	26.9	2.7
9.5 - 10.0	7023					7023	21.9	3.1
10.0 - 10.5	7048	130				7178	26.7	3.7
10.5 - 11.0	5792	135				5927	26.8	4.5
11.0 - 11.5	4597	77				4674	25.9	5.5
11.5 - 12.0	3183	240				3423	22.1	6.5
12.0 - 12.5	1446	161				1607	12.2	7.6
12.5 - 13.0	1026	373	19			1418	12.4	8.7
13.0 - 13.5	621	319	21			961	9.2	9.6
13.5 - 14.0	252	586	66			904	10.0	11.1
14.0 - 14.5	108	712	14			834	10.6	12.7
14.5 - 15.0	10	1056	65			1131	16.3	14.4
15.0 - 15.5		1195	223			1418	23.4	16.5
15.5 - 16.0		1288	211	11		1510	27.6	18.3
16.0 - 16.5		1511	277	4		1792	38.4	21.4
16.5 - 17.0		1695	285	13		1993	47.4	23.8
17.0 - 17.5		1118	381	20		1519	40.1	26.4
17.5 - 18.0		547	206			753	22.3	29.6
18.0 - 18.5		239	190	21		450	15.4	34.2
18.5 - 19.0		44	83			127	4.8	37.9
19.0 - 19.5		29	30			59	2.1	36.4
TSN (10^6)	81907	11528	2071	69	0	95575		
TSB (10^3 tonnes)	236.5	214.7	49.5	1.8	0		502.5	
Mean length (cm)	9.12	15.45	16.62	17.16	0	10.05		
Mean weight (g)	2.9	18.6	23.9	25.5	0			
Condition factor	3.3	4.8	5.1	4.9	0	3.5		

Based on TS value 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{7} \cdot L^{1.91}$

Table 4.3.3 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1. October.

Year	Stock in numbers (10^9)						Stock in weight ('000 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248

Table 4.3.4 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, back-calculated from the survey in September-October.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	46.4	22.0	195.4	704.5	415.0	396.2	3.1	29.5	8.3	88.9
2	2.1	30.0	18.2	179.4	601.4	224.5	73.1	5.1	9.4	12.5
3	0.2	0.3	3.5	16.3	36.9	163.4	25.3	6.4	1.6	2.2
4	0.0	0.0	0.0	0.1	1.4	1.6	3.7	0.3	0.4	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	48.7	52.2	217.1	900.4	1054.7	785.7	105.1	41.4	19.7	103.7
Biomass	69	189	504	2910	4756	3867	730	180	126	309

Table 4.3.5 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 4.3.6 Barents Sea CAPELIN. Catch in numbers (unit: 10^9) by age group and total landings ('000 t) in the autumn season.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.0	0.0	0.0	0.0	2.2	0.9	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	9.3	5.8	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	3.1	7.9	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.9	0.8	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.0	15.5	15.3	0.0	0.0	0.0	0.0
Landings	0	0	0	0	226	232	0	0	0	0

Table 4.3.7 Barents Sea CAPELIN. Fishing mortality coefficients by age group and weighted average for age groups 2-4 in the autumn fishing season.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.10	0.06	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00	1.20	0.86	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00	9.90	9.90	0.00	0.00	0.00	0.00
Wavr (2-4)	0.00	0.00	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00

Table 4.3.8 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.

	1987		1988		1989		1990		1991	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.106	0.317	0.023	0.068	0.016	0.048	0.003	0.009	0.015	0.046
2	0.106	0.317	0.023	0.068	0.014	0.042	0.005	0.016	0.015	0.046
3	0.285	0.854	0.073	0.219	0.158	0.474	0.003	0.009	0.054	0.161
4	0.379	1.137	0.433	1.298	0.117	0.350	0.003	0.009	0.054	0.161
5	0.379	1.137	0.433	1.298	0.117	0.350	0.003	0.009	0.054	0.161
Avr	0.251	0.752	0.197	0.590	0.084	0.253	0.003	0.010	0.038	0.115

Table 4.3.8 (Continued)

	1992		1993		1994		1995		1996	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.059	0.178	0.157	0.471	0.201	0.602	0.073	0.219	0.041	0.122
2	0.059	0.178	0.157	0.471	0.201	0.602	0.073	0.219	0.041	0.122
3	0.110	0.329	0.191	0.573	0.201	0.602	0.019	0.058	0.041	0.122
4	0.072	0.217	0.217	0.651	0.282	0.847	0.044	0.133	0.050	0.149
5	0.072	0.217	0.217	0.651	0.282	0.847	0.044	0.133	0.050	0.149
Avr	0.075	0.224	0.188	0.563	0.221	0.700	0.052	0.152	0.043	0.133

Table 4.3.9 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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	97.1	25.7	218.7	719.0	462.4	600.1	9.2	120.3	13.8	118.2
2	3.6	27.4	19.6	180.3	694.3	382.0	293.7	1.4	10.8	5.7
3	2.8	1.2	26.8	17.0	174.8	547.8	161.9	33.3	1.9	6.5
4	1.8	0.0	0.2	1.6	16.1	25.5	88.6	9.7	2.4	1.4
5	0.1	0.0	0.0	0.0	0.1	0.3	0.5	1.3	0.1	0.3
Sum	105.4	54.4	265.3	917.9	1347.7	1555.8	554.0	166.0	28.9	132.2
Biomass	156	115	723	1984	7035	8287	4355	736	156	313

Table 4.3.10 Barents Sea CAPELIN. Mean weight (g) by age group and weighted average for the whole stock by 1. January.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.83	1.38	1.30	1.52	1.51	1.42	1.38	1.76	2.66	1.16
2	4.25	2.28	3.78	3.57	4.18	4.15	3.91	3.79	4.83	7.31
3	11.12	13.46	13.48	12.67	16.88	9.66	9.48	9.94	12.36	15.19
4	14.85	16.18	18.70	19.86	29.87	21.31	18.54	16.64	18.18	18.43
5	17.83	36.67	0.00	22.00	22.00	33.18	32.50	20.62	20.30	24.83
Avr	1.48	2.12	2.72	2.16	5.22	5.33	7.86	4.43	5.41	2.36

Table 4.3.11 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	0.35	0.65	0.41	0.46	0.65	0.16	0.12	0.10	0.44	0.59
4	0.72	0.82	0.68	1.00	1.00	0.89	0.74	0.71	0.86	0.92
5	1.00	1.00	1.00	1.00	1.00	0.86	0.99	0.92	0.87	1.00
Avr	0.02	0.02	0.04	0.01	0.10	0.07	0.15	0.07	0.10	0.04

Table 4.3.12 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	2	15	0	0	0	1	3
3	7	11	139	141	1384	868	116	34	15	71
4	8	0	2	37	141	77	308	60	38	24
5	1	0	0	0	0	0	0	11	1	7
Sum	16	11	141	180	1540	945	424	104	55	105

Table 4.3.13 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish (unit: 10^9), spawning stock ('000 t) at time of spawning (1. April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated.

Year	Recruitment Age 1	Spawning stock biomass	Landings
1965			224
1966			389
1967			409
1968			537
1969			680
1970			1314
1971			1392
1972			1592
1973	1140	1348	1336
1974	737	355	1149
1975	494	77	1440
1976	434	1104	2587
1977	831	852	2987
1978	855	420	1915
1979	551	164	1783
1980	592	33	1648
1981	466	1677	1986
1982	611	507	1760
1983	612	29	2358
1984	184	144	1478
1985	47	69	868
1986	9	8	123
1987	46	16	0
1988	22	11	0
1989	195	141	0
1990	704	180	0
1991	415	1540	933
1992	396	945	1123
1993	3	424	586
1994	30	104	0
1995	8	55	0
1996	89	105	0

Table 5.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the whole season, landings and remaining spawning stock in the 1985/86–1996/97 seasons.

Season	85/86	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97
Prelim. TAC	700	1100	500	900	900	600	0	500	900	950	800	1100
Rec. TAC	1280	1290	1115	1065	-	250	740	900	1250	850	1390	1600
Landings	1311	1333	1116	1036	808	314	677	788	1179	842	930	1571
Spawn. stock	460	420	400	445	115	330	475	460	460	420	830	422

Table 5.2.1 The international capelin catch 1964–1996 (thousand tonnes).

Year	Winter season				Summer and autumn season					
	Iceland	Norway	Faroes	Season total	Iceland	Norway	Faroes	Others	Season total	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	474.3	206.0	27.6	***65.9	773.8	1,497.4
1997	774.9	-	**22.2	797.1						

*Greenland
**Faroes and Greenland
***Greenland and EU

Table 5.2.2 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 (thousand tonnes) the autumn season (August-December) 1978–1996.

	Year									
Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
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	27.7
3	12.2	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3	6.7
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	34.4
Total weight	655.0	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9	458.6

	Year								
Age	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.3	1.7	0.8	0.3	1.7	0.2	0.6	1.5	0.2
2	13.6	6.0	5.9	2.7	14.0	24.9	15.0	9.7	25.2
3	5.4	1.5	1.0	0.4	2.1	5.4	2.8	1.1	12.7
4	+	+	+	+	+	0.2	+	+	0.2
Total number	19.3	9.2	7.7	3.4	17.8	30.7	18.4	12.3	38.4
Total weight	371.4	121.0	111.2	56.0	298.1	611.6	324.1	205.7	773.7

Table 5.2.3 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 (thousand tonnes) the winter season (January-March) 1979–1997.

	Year									
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
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	23.4
4	4.8	3.5	1.9	0.1	-	3.4	5.4	6.9	15.5	7.2
5	0.1	-	-	-	-	-	-	0.2	-	0.3
Total number	26.7	22.4	10.7	0.9	-	23.6	14.5	17.0	22.4	30.9
Total weight	539.9	392.1	156.0	13.2	-	439.6	348.5	391.8	560.5	657.2

	Year								
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997
2	0.1	1.4	0.5	2.7	0.2	0.6	1.3	0.6	0.9
3	22.9	24.8	7.4	29.4	20.1	22.7	17.6	27.4	29.1
4	7.8	9.6	1.5	2.8	2.5	3.9	5.9	7.7	11.0
5	+	0.1	+	+	+	+	+	+	+
Total number	30.8	35.9	9.4	34.9	22.8	27.2	24.8	35.7	41.0
Total weight	665.1	686.8	202.4	621.1	489.6	567.1	539.8	723.6	797.6

Table 5.2.4 The total international catch in numbers (millions) of capelin in the Iceland-east Greenland-Jan Mayen area in the summer/autumn season of 1996 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	-	-	-		-	
08 - 09	-	-	-		-	
09 - 10	10	-	-		10	+
10 - 11	10	-	-		10	+
11 - 12	21	60	-	-	81	0.2
12 - 13	103	1258	11	-	1372	3.5
13 - 14	62	6572	294	-	6928	17.9
14 - 15	10	8649	2146	5	10810	27.8
15 - 16	10	5703	4476	76	10272	26.5
16 - 17	10	2596	4143	70	6829	17.6
17 - 18	-	610	1607	20	2237	5.8
18 - 19	-	63	195	5	263	0.7
19 - 20	-	+	+	-	+	+
Total	236	25511	12872	176	38813	
%	0.6	65.7	33.2	0.5		100.0
Weight ('000 t)	2.6	444.8	322.7	4.8	773.3	

Table 5.2.5 The total international catch in numbers (millions) of capelin in the Iceland-east Greenland-Jan Mayen area in the winter season of 1997 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	Percentage
8-9	10	-	-	-	10	+
9-10	67	-	-	-	67	0.2
10 - 11	153	6	-	-	159	0.4
11 - 12	82	87	-	-	169	0.4
12 - 13	86	291	-	-	377	0.9
13 - 14	245	1574	27	-	1846	4.5
14 - 15	158	6142	485	-	6785	16.6
15 - 16	34	8639	2099	-	10772	26.3
16 - 17	34	7691	3508		11233	27.4
17 - 18	5	3725	3329	9	7068	17.2
18 - 19	-	812	1269	26	2107	5.1
19 - 20	-	87	252	9	348	0.9
20 - 21	-	-	20	-	20	0.1
Total	873	29054	10989	44	40960	
%	2.1	70.9	26.9	0.1		100.0
Weight ('000 t)	8.4	528.8	258.8	1.1	797.1	

Table 5.3.1 Abundance indices of 0-group capelin 1970–1996 and their division by areas.

Area	Year													
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
NW-Irminger Sea	1	+	+	14	26	3	2	2	+	4	3	10	+	+
W-Iceland	8	7	30	39	44	37	5	19	2	19	18	13	8	3
N-Iceland	2	12	52	46	57	46	10	19	29	25	19	6	5	18
East Iceland	-	+	7	17	7	3	15	3	+	1	+	-	+	1
Total	11	19	89	116	134	89	32	43	31	49	40	29	13	22

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
NW-Irminger Sea	+	1	+	1	3	1	+	8	3	2	3	+	2
W-Iceland	2	8	16	6	22	13	7	2	11	21	12	6	17
N-Iceland	17	19	17	6	26	24	12	43	20	13	69	10	57
East Iceland	9	3	4	1	1	2	2	1	+	15	10	8	6
Total	28	31	37	14	52	40	21	54	34	51	94	24	82

Table 5.3.2 Estimated numbers, mean length and weight of age 1 capelin in during the August surveys of 1982–1996.

	Year														
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Number (10^9)	119	155	286	31	71	101	147	111	36	50	87	33	85	189	138
Mean length (cm)	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	9.3
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	2.9

Table 5.3.3 Acoustic assessment of total capelin abundance of age groups 1–3, 27/10–12/11 1996.

	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)
6.5-6.9	+					+	+	1.0
7.0-7.4	0.2					0.2	0.2	1.0
7.5 - 7.9	1.6	-	-	-	-	1.6	2.1	1.3
8.0 - 8.4	6.5	-	-	-	-	6.5	13.0	2.0
8.5 - 8.9	12.4	-	-	-	-	12.4	24.7	2.0
9.0 - 9.4	18.2	-	-	-	-	18.2	38.1	2.1
9.5 - 9.9	19.1	-	-	-	-	19.1	57.2	3.0
10.0 - 10.4	18.5	-	-	-	-	18.5	58.3	3.2
10.5 - 10.9	14.0	+	-	-	-	14.0	56.5	4.0
11.0 - 11.4	10.9	0.1	-	-	-	10.9	49.8	4.6
11.5 - 11.9	6.0	2.5	0.1	-	-	8.6	46.8	5.4
12.0 - 12.4	2.8	4.3	-	-	-	7.0	46.0	6.6
12.5 - 12.9	0.9	4.7	-	-	-	5.6	42.6	7.6
13.0 - 13.4	0.3	4.9	-	-	-	5.2	45.7	8.8
13.5 - 13.9	03	6.5	0.1	-	6.9	6.9	70.5	10.3
14.0 - 14.4	0.2	12.7	0.4	-	13.3	13.3	156.4	11.8
14.5 - 14.9	0.1	11.7	0.8	-	12.6	12.6	170.2	13.5
15.0 - 15.4	0.1	10.9	1.8	-	12.7	12.7	195.6	15.3
15.5 - 15.9	+	11.2	3.0	-	14.3.	14.3	248.0	17.4
16.0 - 16.4	-	8.0	3.0	-	11.0	11.0	215.0	19.6
16.5 - 16.9	-	4.8	2.8	-	7.7	7.7	168.7	22.0
17.0 - 17.4	-	2.2	2.1	-	4.3	4.3	105.3	24.6
17.5 - 17.9	-	1.3	1.0	-	2.3	2.3	62.4	27,2
18.0 - 18.4	-	0.5	0.7	-	1.2	1.2	36.0	30.3
18.5 - 18.9	-	+	0.2	-	0.2	0.2	6.9	33.7
19.0 - 19.4	-	+	+	-	0.1	0.1	2.0	36.1
19.5 - 19.9	-	-	+	-	+	+	1.4	39.2
Number (10^9)	111.9	86.4	15.9	-	86.4	214.2	-	-
Weight (10^3 t)	365.4	1225.7	328.2	-	1438.3	1919.4	-	-
Mean length (cm)	10.0	14.8	16.3	-	15.5	12.4	-	-
Mean weight (g)	3.3	14.2	20.6	-	16.6	9.0	-	-

Table 5.4.1 The calculated number (billions) of capelin on 1 August 1978–1997 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	1987
1 juvenile	163.8	60.3	66.1	48.9	146.4	124.2	250.5	98.9	156.2	144.0
2 immature	15.3	16.4	4.2	3.7	15.0	42.5	40.9	100.0	29.4	37.2
2 mature	81.9	91.3	35.4	39.7	17.1	53.7	40.7	64.6	35.6	65.4
3 mature	29.1	10.1	10.8	2.8	2.3	9.8	27.9	27.0	65.8	20.1
4 mature	0.4	0.3	+	+	+	0.1	0.4	0.4	0.7	0.1
Number immat.	179.2	76.7	70.3	52.6	161.4	166.7	291.4	198.9	185.6	181.2
Number mature	111.4	101.7	46.2	42.5	19.4	63.6	69.0	92.0	102.1	85.6
Weight immat	750.8	366	283	209	683	985	1067	1168	876	950
Weight mature	1842	1566	750	734	299	960	1204	1455	1974	1495

	Year									
Age/maturity	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 juvenile	80.8	63.9	117.5	132.9	162.9	144.6	224.0	*225.1	*127.5	
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	*45.0	*47	
2 mature	70.3	42.8	31.9	67.7	70.7	86.9	59.8	102.2	100.9	**83.8
3 mature	24.5	15.8	6.8	6.7	6.4	10.9	13.2	24.0	29.6	**30.9
4 mature	0.4	+	+	+	+	0.2	-	+	+	
Number immat.	104.8	74.2	127.6	142.6	179.5	164.7	259.2	270.1	*174.5	
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	126.2	130.5	**114.7
Weight immat	438	309	542	702	747	702	1019	*1180	*692.8	
Weight mature	1472	1038	664	1127	1160	1471	1122	1819	1951	**2019

* Preliminary

** Predicted

Table 5.4.2 The calculated number (billions) of capelin on 1 January 1979–1997 by age and maturity groups. The total number (billions) and weight (thousand 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	1988
2 juvenile	137.6	50.6	55.3	41.2	123.7	105.0	211.6	83.2	131.9	120.5
3 immature	12.8	13.8	3.5	3.0	12.6	35.7	34.3	83.9	25.6	31.2
3 mature	51.8	53.4	16.3	8.0	14.3	39.8	25.2	34.5	22.1	34.1
4 mature	14.8	3.6	4.9	0.5	2.0	7.6	15.6	10.5	37.0	11.7
5 mature	0.3	0.2	+	+	+	0.1	0.3	0.2	0.2	+
Number immat.	150.4	64.4	58.8	44.2	136.3	140.7	245.9	167.1	157.5	151.3
Number mature	66.9	57.2	21.2	8.5	16.3	47.5	41.1	45.2	59.1	45.8
Weight immat.	1028	502	527	292	685	984	1467	1414	1003.0	1083
Weight mature	1358	980	471	171	315	966	913	1059	1355	993
Number sp.st.	29.0	17.5	7.7	6.8	13.5	21.6	20.7	19.6	18.3	18.5
Weight sp. st	600	300	170	140	260	440	460	460	420	400

	Year								
Age/maturity	1989	1990	1991	1992	1993	1994	1995	1996	1997
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	143.7	*154.6	*107.0
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	43.8	*39.5
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8
5 mature	0.3	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	173.2	*198.4	*146.5
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2
Weight immat.	434	291	501	487	622	573	696	*900	*643
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8
Weight sp. st.	440	115	330	475	499	460	420	830	422

* Preliminary/Predicted

Table 5.5.1 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	58.0	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.6	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	77.2	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	102.2	46.3	147.2	29.6
1994	165.0	100.9	16.4	**119.4	**30.9
1995	111.9				

* Invalid due to ice conditions.
** Preliminary

Table 5.5.2 Mean weight (g) in autumn of mature capelin of the 1978–1994 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	15.8
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	20.6

Table 5.5.3 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 thousand 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 1981–1996 is 16.7 and 23.8 g respectively. Numbers are billions; weights in thousand 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	97/98
Year classes	88-87	89-88	90-89	91-90	92-91	93-92	94-93	95-94
Age 2	31.1	39.4	56.4	93.1	89.6	92.5	90.0	83.8
Age 3	8.2	3.7	18.3	22.6	27.0	14.9	35.0	30.9
Fishable stock	724	755	1398	2123	2170	1916	2352	2019
Calculated TAC	170	197	755	1385	1427	1200	1635	1265
Advised TAC	265	740	*900	1250	850	1390	1600	

* 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 5.6.1 Capelin in the Iceland-Greenland-Jan Mayen area. Recruitment of 1 year old fish (unit 10^9) 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	2832	1195	600
1979	60	2135	980	300
1980	66	1130	684	170
1981	49	1038	626	140
1982	146	1020	0	260
1983	124	2070	573	440
1984	251	2427	897	460
1985	99	2811	1312	460
1986	156	3106	1333	420
1987	144	2639	1116	400
1988	81	2101	1037	440
1989	64	1482	808	115
1990	118	1293	314	330
1991	133	1975	677	475
1992	163	2058	788	499
1993	145	2363	1179	460
1994	224	2287	864	420
1995	225	3236	929	830
1996	128	2897	1571	422

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the main fisheries, 1987-1996, as estimated by the Working Group. This table contains catch of UK, instead of only Scotland.

Area	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Norwegian Sea fishery ('Subareas I+II and Duivisions Va,XIVa-b) [1]	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,441
Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	445,881 [2]	421,636	473,165	463,495	218,946	317,237	347,101	378,704	423,282	469,926
Industrial mixed fishery (Divisions IVa-c, Vb and IIIa)	62,689 [3]	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359
Subtotal northern fishery	631,612	522608	591738	528793	337521	445523	448423	429941	551019	612726
Southern fishery (Subareas VII+IX, Divisions VIId,e,g-k)	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099
Grand total	664,431	553446	625,433	561,610	369,524	474,245	480,679	459,414	578,683	637,825

[1] Including Icelandic industrial fishery in Division Va: in 1989, 1995 and 1996.
[2] Including directed fishery also in Divisions VIIg-k, IVa and Subarea XII.
[3] Excluding directed fishery also in Division VIIg-k.

e:\acfm\wgnpbw97\t-621-5.xls

Table 6.2.2 Landings (tonnes) of BLUE WHITING from the directed fisheries in the Norwegian Sea (Subareas I and II, Division Va, XIVa and XIVb) 1987-1996, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Faroes	9,290	-	1,047	-	-	-	-	-	-	345
Germany	1,010	3	1341	-	-	-	-	2	3	32
Iceland [3]	-	-	4,977	-	-	-	-	-	369	302
Netherlands	-	-	-	-	-	-	-	-	72	25
Norway	-	-	-	566	100	912	240	-	-	58
Poland	56	10	-	-	-	-	-	-	-	-
USSR/Russia [1]	112,686	55,816	35,250	1,540	78,603	61,400	43,000	22,250 [2]	23,289	22,302
Estonia	-	-	-	-	-	-	-	-	-	377
Latvia	-	-	-	-	-	-	-	422	-	-
Total	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,441

[1] From 1992 only Russia

[2] Includes Vb.

[3] Icelandic mixed fishery in Va.

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-aea XII) 1987 - 1996, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Denmark	2,655	797	25	-	-	3,167	-	770	-	269
Faroes	70,625	79,339	70,711	43,405	10208 [1]	12,731	14,984	22,548	26,009	18,258
France	-	-	2,190	-	-	-	1,195	-	720	-
Germany	3,850	5,263	4,073	1,699	349	1,307	91	0	6,310	6,844
Ireland	3,300	245	-	-	-	-	-	3	-	-
Netherland	5,627	800	2,078	7,280	17,359	11,034	18,436	21,076	26,703	17,644
Norway	191,012	208,416	258,386	281,036 [1]	114,866 [1]	148,733 [1]	198,916	226,235	261,272	337,434
UK	3,315	5,071	8,020	6,006	3,541	6,849	2,032	4,465	10,583	3,494
USSR/Russia [2]	165,497	121,705	127682	124,069	72,623	115,600	96,000	94,531	83,931	64,547
Japan	-	-	-	-	-	918	1,742	2,574	-	-
Estonia	-	-	-	-	-	6,156	1,033	4,342	7,754	10,605
Latvia	-	-	-	-	-	10,742	10,626	2,160	-	-
Lithauen	-	-	-	-	-	-	2,046	-	-	-
Total	445,881	421,636	473,165	182,459	93,872	168,504	347,101	378,704	423,282	459,095

[1] Including direced fishery also in Division IVa. (H6)
[2] From 1992 only Russia

e:\acfm\wgpnbw97\t-621-5.xls

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 1987-1996, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Denmark	28,541	18,144	26,605	27,052	15,538	31,189	41,053	19,686	12,439	51,832
Faroes	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068
Germany [1]	115	280	3	-	-	25	9	-	-	-
Netherland	-	-	-	20	-	2	46	-	-	-
Norway	24,969	24,898	42,956	29,336 [2]	22,644	31,977	12,333	3,408	78,565	57,458
Sweden	2,013	1,229	3,062	1,503	1,000	2,058	2,867 [3]	3,675	13,000	4,000
UK 1)	0	100	7	0	335	18	252	0	0	1
Total	62,689	45,143	75,958	33,856	39,872	65,974	55,215	28,563	104,004	119,359

[1] Including directed fishery also in Division IVa.

[2] Including mixed industrial fishery in the Norwegian Sea

[3] Unprecise estimates . reported catch of 34265 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) 1987-1996, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Netherlands	-	-	-	450	10	-	-	-	-	-
Norway	4	-	-	-	-	-	-	-	-	-
Portugal	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561
Spain	23,644	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538
UK	23	12	29	13	-	-	-	5	-	-
France	-	-	1	-	-	-	-	-	-	-
Total	32,819	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099

e:\acfm\wgpnbw97\t-621-5.xls

Table 6.3.1 Length distribution, commercial samples, Norway 1996. Directed fishery.

Area	VIIbc	VIa	VIa	Vb
Quarter	1	1	2	2
No sampl	29	1	11	3
21			1	2
22				
23	2	3	3	1
24	35	5	8	9
25	61	5	36	9
26	135	8	46	27
27	216	11	90	46
28	212	4	101	41
29	255	9	116	48
30	335	11	137	33
31	337	8	145	30
32	295	14	142	20
33	275	8	112	25
34	235	5	77	10
35	184	3	50	
36	118	2	27	
37	87	3	6	
38	25		3	
39	6		1	
40	6		2	
41		1		
Total	2819	100	1103	301

Table 6.3.2 Length distribution, commercial samples, Norway 1996. Mixed industrial fishery.

Area	IIa	IVa	IVa	IVa	IIa	IVa
Quarter	1	1	2	3	3	4
No sampl	6	42	81	175	3	29
10			2	1		4
11			1	3		4
12				125	12	65
13	2			555	30	279
14	7		6	814	29	289
15	75	39	99	547	17	145
16	240	94	378	302	13	66
17	191	136	780	262	4	16
18	61	246	1439	353	7	7
19	32	180	1670	334	54	6
20	18	98	1211	541	57	22
21	3	19	597	535	35	72
22		9	287	483	16	162
23	1	2	163	275	8	156
24	4	9	41	81	6	85
25	1	4	140	39	1	41
26		4	127	85	1	66
27		11	136	208	1	96
28		5	83	120		103
29			85	65		106
30			24	16		137
31			6	10	1	153
32				25		102
33			1	19		94
34			1	3		93
35				22		102
36				6		78
37				4		56
38				2		33
39						13
40						7
41						3
42						2
43						1
Total	635	856	7277	5835	292	2664

e:\acfm\wgnpbw97\t-631-2.xls

Table 6.3.3 Length distribution of blue whiting, Russia 1996. Directed fishery.

Area	IIa	Vb'	IIa	Vb'	VIa	VIIbc	VIIg-k	IIa	Vb'
Quarter	1	1	2	2	2	2	2	3	3
12								2	
13	1							4	
14	24					1		14	1
15	127	5				6	1	22	8
16	320	21		1	12	11		21	2
17	427	51	2	42	34	6	2	9	5
18	293	96	19	204	79	22	14	2	3
19	111	107	97	627	108	62	37	1	2
20	67	79	156	1090	193	179	122	31	19
21	36	21	97	855	97	211	113	136	87
22	19	3	77	455	51	228	47	233	124
23	20	2	34	163	42	184	17	145	76
24	15	18	13	61	89	118	8	68	28
25	44	20	34	43	160	53	8	23	5
26	41	30	75	49	213	54	5	24	3
27	21	40	124	53	310	28	6	36	2
28	10	54	114	34	221	16	2	38	1
29	4	42	70	34	198	9	2	23	
30	1	52	70	21	213	6	7	13	2
31	2	48	79	18	174	2	2	8	1
32	1	59	66	14	215	2	2	13	
33	2	36	28	17	189	1	1	18	1
34	1	43	18	13	129	1	3	21	
35	2	28	9	17	75		4	18	
36		23	5	6	57	1	3	5	
37	1	25		8	37		2	5	
38	1	6		5	20			4	
39	2	10		4	12				
40	1	4		1	7				
41	1			1	3			1	
42		1			2				
43									
44									
45									
46	1								
Total	1596	924	1187	3836	2940	1201	408	938	370

Table 6.3.4 Length distribution, commercial samples, Netherlands, 1996.

Area **Quarter**	**IIa** **2**	**VIa** **2**	**VIIj** **1**
15			3
16			24
17			20
18	18		14
19	35		20
20	42	3	44
21	15	2	43
22	5	12	12
23	1	30	2
24		61	
25		78	
26		149	
27		187	
28		173	
29		172	
30		170	
31		139	
32		126	
33		113	
34		87	
35		63	
36		51	
37		37	
38		28	
39		13	
40		6	
41		3	
42		2	
Total	116	1705	132

Table 6.3.5 Length distribution, commercial samples, Denmark, 1996.

Area	IIIa				IVb
Quarter	1	2	3	4	4
8					1
9					-
10					-
11				1	-
12				2	-
13		4		19	-
14	1	11	1	55	7
15	1	9	1	81	6
16	1	6	1	73	6
17	6	8	1	35	2
18	5	8	14	1	
19	1	12	50	-	
20		7	91	-	
21		4	67	7	
22		1	28	7	
23		1	6	3	
24		-	10	-	
25		1	10	2	
26		4	12	1	
27		6	13	1	
28		7	8	2	
29		1	4	1	
30		5	4	-	
31		-	6	-	
32		2	5	1	
33		1	3	-	
34		-	1	-	
35		1	2	-	
36		-	1	-	
37		1		1	
Total	15	100	339	293	22

Table 6.3.6 Length composition (thousands) of commercial blue whiting catches of Portugal and Spain in 1996.

A

PORTUGAL					
	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	1
14	3	0	0	1	4
15	62	2236	134	266	2698
16	76	3313	757	1674	5820
17	93	2462	1486	2865	6907
18	321	1141	1942	2399	5803
19	1559	1887	1670	4021	9138
20	1976	532	657	3447	6612
21	1142	186	647	1320	3295
22	1160	74	555	525	2313
23	1602	100	330	791	2823
24	1790	101	361	615	2866
25	2445	146	372	333	3295
26	2881	134	417	233	3665
27	1529	85	212	162	1988
28	904	74	238	95	1311
29	232	110	190	122	653
30	221	193	220	71	705
31	104	151	168	62	484
32	72	135	108	40	355
33	60	66	113	11	250
34	12	24	60	9	105
35	24	38	49	7	118
36	12	1	9	1	23
37	0	1	4	0	6
38	0	0	0	0	0
39	0	0	0	0	0
40	0	0	0	0	0
TOTAL	18280.1	13190.3	10698.5	19069.2	61238
Landings (t)	1382	476	763	940	3561
N samples	24	38	41	42	145
Fish sampled	2033	4012	3975	4453	14473

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	92	0	0	92
14	0	64	37	0	101
15	60	1276	590	6	1932
16	257	3472	1945	327	6002
17	738	7356	6773	3159	18026
18	1557	9944	19574	8892	39967
19	4974	10756	11691	14664	42085
20	9535	13081	13566	17734	53917
21	12474	16564	11671	18096	58806
22	11100	10420	7609	10522	39652
23	6480	5816	6465	6314	25076
24	4287	3296	3363	2917	13862
25	4764	2797	2846	1946	12353
26	3146	1833	1166	807	6952
27	2622	1294	730	475	5120
28	1901	775	358	227	3261
29	966	499	277	137	1879
30	420	262	156	76	914
31	331	109	123	44	607
32	171	118	53	22	364
33	121	61	25	26	234
34	28	44	15	11	99
35	7	20	5	8	40
36	5	9	1	1	16
37	3	7	2	0	13
38	2	1	0	0	3
39	1	1	0	0	2
40	0	1	2	0	2
TOTAL	65949	89969	89046	86412	331376
Landings (t)	5290	5647	5268	5332	21538
N samples	57	84	78	73	292
Fish sampled	6429	9597	8912	7614	32552

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	92	0	1	93
14	13	88	0	4	105
15	410	1522	0	2698	4630
16	1981	4020	0	5820	11821
17	7654	10372	0	6907	24932
18	14312	25654	0	5803	45770
19	14519	27566	0	9138	51223
20	14245	39667	5	6612	60529
21	15622	43180	4	3295	62101
22	10655	28986	11	2313	41965
23	6016	19050	10	2823	27899
24	3136	10715	10	2866	16728
25	1955	10389	9	3295	15648
26	946	5988	17	3665	10617
27	737	4361	22	1988	7109
28	417	2816	27	1311	4572
29	251	1601	27	653	2533
30	149	735	30	705	1618
31	91	486	29	484	1091
32	72	264	28	355	719
33	32	184	17	250	483
34	25	59	15	105	203
35	8	23	9	118	158
36	0	12	4	23	39
37	3	7	3	6	18
38	0	1	2	0	3
39	0	1	1	0	2
40	2	0	1	0	2
TOTAL	93251	237843	281	61238	392614
Landings (t)	5552	15937	49	3561	25099
N samples	159	114	19	145	437
Fish sampled	15754	15409	1389	14473	47025

e:\acfm\wgnpbw97\t-636.xls

Table 6.3.7 Blue whiting. Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, XIVa + b, Vb, VIa + b, VIIIb,c and VIIg,h,j,k, 1987–1996.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	9.1	3.6	36.5	8.4	63.6	-	-	-+	0.7	3.8
1	280.8	93.2	86.4	537.8	33.4	82.4	36.8	43.6	99.4	497.1
2	361.0	403.2	359.4	353.1	533.2	52.2	130.1	31.2	142.7	327.1
3	580.2	416.2	1,176.7	565.7	384.4	1,508.5	334.5	190.0	337.7	450.5
4	1,780.2	611.2	696.2	709.1	243.9	510.4	1,348.2	361.9	416.2	424.7
5	680.3	1,238.9	785.7	489.2	329.9	200.1	375.7	1,242.4	565.9	248.4
6	118.2	584.9	680.7	562.1	235.3	138.8	196.1	294.2	769.0	429.9
7	94.9	77.8	127.2	291.7	149.9	92.0	107.9	201.3	245.5	619.4
8	117.1	50.7	44.8	75.5	39.9	86.7	59.8	102.5	154.1	213.9
9	99.7	32.4	23.8	26.6	4.3	84.6	37.9	88.3	57.7	87.8
10+	195.0	48.9	37.0	91.8	14.0	14.5	13.6	32.1	40.0	70.2
Total	4,316.5	3,571.0	4,054.4	3,711.0	2,031.8	2,707.2	2,640.5	2,587.5	2,829.0	3,372.8
Tonnes	571,659	477,552	521,415	465,601	297,649	379,549	389,010	401,378	447,015	493,373

Table 6.3.8 Blue whiting. Catch in number (millions) by age group in the mixed industrial fisheries (Sub-area IV, Divisions IIIa, Vb, and Va), 1987–1996.

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	226.8	12.3	1,871.6	0.5	24.9	-	132.2	94.8	3,303.0	811.8
1	174.5	185.1	578.9	874.8	8.4	159.8	166.9	33.1	100.7	1,334.4
2	105.7	84.3	183.7	167.6	397.9	63.9	38.8	20.7	88.3	71.2
3	85.4	83.4	70.0	49.5	42.3	167.1	90.8	17.5	28.7	58.4
4	88.9	40.2	33.5	11.8	11.4	75.1	97.3	36.7	11.0	71.3
5	32.8	44.0	24.1	7.0	11.3	25.2	15.0	6.1	6.0	38.8
6	15.6	24.0	12.2	3.8	11.2	16.7	6.7	3.0	11.4	45.4
7	9.2	3.3	5.9	4.9	6.2	6.7	8.3	1.2	1.8	32.6
8	5.1	2.1	2.1	0.6	3.4	2.7	-	0.6	2.0	14.3
9	3.8	1.0	0.8	0.4	0.7	0.9	-	0.1	1.2	9.0
10+	0.2	0.2	1.0	-	0.2	0.6	-	-	0.8	11.4
Total	748.0	479.9	2,783.8	1,120.9	517.9	518.7	556.1	213.8	3,555.0	2,498.6
Tonnes	59,952	45,110	75,978	63,195	39,872	66,174	55,215	24.888	104,004	119,359

Table 6.3.9 BLUE WHITING. Catch in number (millions) by age group in the Southern area (Divisions VIIIc and IXa), 1986-1996.

Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	32	105	30	41	74	70	19	25	13	3	9
1	93	383	147	200	198	181	139	41	12	96	43
2	218	111	233	175	182	182	205	146	56	123	131
3	168	62	114	93	57	70	95	181	149	55	117
4	68	28	32	61	25	39	43	62	72	38	36
5	15	13	10	27	24	17	12	12	27	44	33
6	6	3	9	15	11	8	6	7	9	20	17
7	1	1	3	6	2	3	2	2	5	6	5
8+	1	1	0	3	2	3	1	1	4	5	3
Total	602	707	578	621	575	573	522	477	347	391	393
Tonnes	33082	32819	30838	33695	32817	32003	28722	32256	29468	27664	25099

e:\acfm\wgnpbw97\t-639.xls

Table 6.3.10 Blue Whiting. Total catch in numbers at age (millions) 1981-1996.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
0	48	3512	437	584	1174	84	341	46	1949	83	161	19	198	42	3307	824
1	258	148	2283	2291	1305	650	838	425	865	1611	267	408	263	307	296	1875
2	348	274	567	2331	2044	816	578	721	718	703	1024	654	305	108	354	529
3	681	326	270	455	1933	1862	728	614	1340	672	514	1642	621	368	422	626
4	334	548	286	260	303	1717	1897	683	791	753	302	569	1571	389	465	532
5	548	264	299	285	188	393	726	1303	837	520	363	217	411	1222	616	320
6	559	276	304	445	321	187	137	618	708	577	258	154	191	281	800	492
7	466	266	287	262	257	201	105	84	139	299	159	110	107	174	254	657
8	634	272	286	193	174	198	123	53	50	78	49	80	65	90	160	230
9	578	284	225	154	93	174	103	33	25	27	5	32	38	79	60	97
10+	1460	673	334	255	259	398	195	50	38	95	10	12	17	31	42	82
Total	5914	6843	5578	7515	8051	6680	5771	4630	7460	5418	3112	3896	3788	3091	6775	6264
Tonnes	909556	576419	570072	641776	695596	826986	664434	553413	625433	561610	369525	474245	480672	459414	578693	637825

Table 6.3.11 Blue Whiting. Mean weights at age for the total catch 1981-1996.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
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	0.018
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	0.041
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	0.080
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	0.102
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	0.116
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	0.147
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	0.170
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	0.214
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	0.230
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	0.238
10+	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	0.279

Table 6.4.1 Blue whiting acoustic biomass estimates (mill.tonnes) in the spawning area. Spawning stock size in brackets.

Year	Russia	Norway	Faroes	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)	-	-
1997	-	-	-	-
Mean	4.8 (4.4)	5.0 (4.6)		5.3 (4.9)

* with calibration factor 1.38

Table 6.4.2 Stratified mean catch (Kg/haul) and standard error of BLUE WHITING in bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		20-500 m		20-750 m	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy	y	sy
1979	June	0	0	33	23	86	35	-	-	31	12	-	-
	October/November	5	5	17	8	103	48	-	-	28	9	-	-
1980	March	0	0	178	173	5	1	-	-	72	69	-	-
	May/June	1	3	4	2	45	18	-	-	11	4	-	-
	October	4	3	10	4	587	306	-	-	117	58	-	-
1981	March	0	0	24	17	186	113	-	-	42	22	-	-
	June	0	0	4	2	178	25	-	-	34	4	-	-
1982	April/May	0	0	3	3	136	39	-	-	26	7	-	-
	September	1	1	85	42	271	123	-	-	86	29	-	-
1983	March	1	1	14	10	259	96	-	-	54	18	-	-
	June	0	0	23	8	177	47	-	-	42	9	-	-
1985	June	0	0	194	146	405	162	-	-	159	68	-	-
	October	4	3	133	84	341	39	-	-	120	35	-	-
1986	June	4	1	59	19	196	31	-	-	65	10	-	-
	October	2	1	357	144	650	111	-	-	276	63	-	-
1987	October	3	0	297	64	747	229	-	-	263	50	-	-
1988	October	4	2	165	47	457	106	-	-	155	28	-	-
1989	July	0	0	42	21	323	143	79	36	-	-	78	24
	October	7	4	70	26	306	84	24	2	-	-	79	16
1990	July	2	2	153	103	242	42	50	5	-	-	96	35
	October	11	5	90	28	762	234	42	10	-	-	153	35
1991	July	1	1	140	40	268	38	64	18	-	-	98	15
	October	8	5	83	18	259	53	121	27	-	-	91	11
1992	February	7	7	43	35	249	21	73	3			68	12
	July	1	1	29	18	216	43	27	5	-	-	47	9
	October	1	1	22	7	208	44	80	3	-	-	54	7
1993	February	0	0	19	14	105	31	36	0	-	-	42	10
	July	0	0	3	3	151	28	55	5	-	-	34	4
	November	0	0	90	0	189	43	6	1	-	-	86	9
1994	October	0	0	374	30	283	32	49	7	-	-	174	11
1995	July	0	0	18	14	130	20	52	3	-	-	35	5
	October	18	15	103	21	328	91	31	12	-	-	94	16
1996	October	25	24	12	2	36	6	25	7			22	8

Table 6.4.3 Stratified mean catch (Kg/haul and Number/haul) and standard error of BLUE WHITING in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September-October.

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	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	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
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36

Number/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
1996	147	82.71	1167	167.20	2097	385.23	1263	142.30

e:\acfm\wgnpbw97\t-643.xls

Table 6.4.4 Available tuning data. Input values used in the Extended Survivors Analysis are framed.

BLUE WHITING-COMBINED

106

Norway Spawning Area/Acoustic

81 96

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	531
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	9973	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
1	8781	7433	8371	2399	4455	4111	1202	459	162	105

USSR Spawning Area/Acoustic

82 96

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
1	15285	10629	4897	6940	1482	653	85	0	19

CPUE Spanish Pair Trawlers

83 96

1 1 0 1

1 6

1	7196	16392	9311	7476	6326	1718
1	13710	27286	14845	4836	1755	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
1	3905	14557	14449	3931	3639	1834

Spanish Survey (Bottom trawl)

85 96

1 1 0.67 0.75

0 7

1	1748	508.3	266.4	104	11.4	3.5	1	0.5
1	1573	26.7	67.5	63.2	28.7	2	2.6	0.2
0	0	0	0	0	0	0	0	0
1	4980	368.7	344.9	37.3	7.2	3	5	0.3
1	1923	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	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	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
1	271	257.9	599.1	116.1	12	4.4	2.3	0.3

Norwegian Sea/Acoustic

81 96

1 1 0.6 0.75

0 11

1	0.001	182	728	4542	3874	2678	2834	2964	2756	2054	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
1	0.001	23464	1057	899	649	436	505	755	69	41	50	0.001

Portuguese Survey (Bottom trawl)

85 96

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
1	251	72	96	15	3	6

e:\acfm\wgnpbw97\t-644.xls

Table 6.4.5 Blue whiting. XSA diagnostics.

```
Lowestoft VPA Version 3.1

   2/05/1997  17:54

Extended Survivors Analysis

BLUE WHITING,1997 WG,ANON,COMBSEX,PLUSGROUP

CPUE data from file bw-tun2.dat

Catch data for  16 years. 1981 to 1996. Ages  0 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
Norway Spawning Area,   1981, 1996,   2,     9,   .170,   .250
USSR Spawning Area/A,   1982, 1996,   3,     9,   .170,   .250
CPUE Spanish Pair Tr,   1983, 1996,   2,     6,   .000,  1.000
Spanish Survey (Bott,   1985, 1996,   2,     7,   .670,   .750
Norwegian Sea acoust,   1981, 1996,   1,     8,   .600,   .750
Portuguese survey (B,   1985, 1996,   2,     5,   .750,   .830


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 converged after   30 iterations


Regression weights
      ,  .751,  .820,  .877,  .921,  .954,  .976,  .990,  .997, 1.000, 1.000


Fishing mortalities
   Age,  1987,  1988,  1989,  1990,  1991,  1992,  1993,  1994,  1995,  1996

     0,  .044,  .005,  .087,  .008,  .022,  .003,  .018,  .004,  .154,  .057
     1,  .110,  .071,  .114,  .096,  .031,  .072,  .053,  .036,  .031,  .122
     2,  .111,  .130,  .165,  .128,  .081,  .100,  .071,  .027,  .053,  .072
     3,  .161,  .165,  .380,  .229,  .130,  .182,  .130,  .114,  .143,  .125
     4,  .411,  .224,  .332,  .381,  .152,  .208,  .265,  .112,  .207,  .269
     5,  .482,  .555,  .471,  .380,  .319,  .157,  .228,  .340,  .260,  .214
     6,  .381, 1.033,  .679,  .707,  .329,  .217,  .201,  .241,  .391,  .343
     7,  .463,  .427,  .687,  .696,  .426,  .226,  .230,  .285,  .358,  .652
     8,  .835,  .450,  .489, 1.130,  .227,  .392,  .202,  .310,  .460,  .646
     9,  .634,  .558,  .397,  .539,  .182,  .225,  .329,  .406,  .347,  .571


XSA population numbers (Thousands)

                                    AGE
YEAR ,          0,         1,         2,         3,         4,         5,         6,         7,         8,         9,

1987 ,    8.74E+06, 8.89E+06, 6.08E+06, 5.40E+06, 6.22E+06, 2.10E+06, 4.78E+05, 3.13E+05, 2.40E+05, 2.42E+05,
1988 ,    1.09E+07, 6.84E+06, 6.52E+06, 4.46E+06, 3.76E+06, 3.38E+06, 1.06E+06, 2.67E+05, 1.62E+05, 8.52E+04,
1989 ,    2.59E+07, 8.85E+06, 5.22E+06, 4.69E+06, 3.09E+06, 2.46E+06, 1.59E+06, 3.09E+05, 1.43E+05, 8.43E+04,
1990 ,    1.18E+07, 1.95E+07, 6.47E+06, 3.62E+06, 2.63E+06, 1.82E+06, 1.26E+06, 6.59E+05, 1.27E+05, 7.17E+04,
1991 ,    8.10E+06, 9.60E+06, 1.45E+07, 4.66E+06, 2.36E+06, 1.47E+06, 1.02E+06, 5.08E+05, 2.69E+05, 3.37E+04,
1992 ,    6.94E+06, 6.48E+06, 7.62E+06, 1.09E+07, 3.35E+06, 1.66E+06, 8.74E+05, 5.99E+05, 2.72E+05, 1.76E+05,
1993 ,    1.20E+07, 5.67E+06, 4.94E+06, 5.65E+06, 7.46E+06, 2.23E+06, 1.16E+06, 5.76E+05, 3.91E+05, 1.50E+05,
1994 ,    1.30E+07, 9.61E+06, 4.40E+06, 3.77E+06, 4.06E+06, 4.69E+06, 1.45E+06, 7.77E+05, 3.75E+05, 2.62E+05,
1995 ,    2.56E+07, 1.06E+07, 7.59E+06, 3.51E+06, 2.75E+06, 2.97E+06, 2.73E+06, 9.33E+05, 4.79E+05, 2.25E+05,
1996 ,    1.65E+07, 1.80E+07, 8.40E+06, 5.89E+06, 2.49E+06, 1.83E+06, 1.88E+06, 1.51E+06, 5.34E+05, 2.47E+05,

Estimated population abundance at 1st Jan 1997

   ,     0.00E+00, 1.28E+07, 1.30E+07, 6.40E+06, 4.26E+06, 1.56E+06, 1.21E+06, 1.09E+06, 6.46E+05, 2.29E+05,

Taper weighted geometric mean of the VPA populations:

   ,     1.29E+07, 9.75E+06, 6.89E+06, 4.92E+06, 3.24E+06, 2.08E+06, 1.24E+06, 6.52E+05, 3.48E+05, 1.88E+05,

Standard error of the weighted Log(VPA populations) :

   ,       .4429,    .4418,    .4145,    .4271,    .4365,    .4279,    .4627,    .5597,    .6886,    .9745,
```

Table 6.4.5 (continued)

1

Log catchability residuals.

Fleet : Norway Spawning Area

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	-.11	99.99	-2.04	.40	99.99	-1.63
3	.00	99.99	-.39	-.89	99.99	-.71
4	-.94	99.99	-.70	-.78	99.99	-.35
5	-.45	99.99	.22	-.68	99.99	-.61
6	-.24	99.99	-.02	-.65	99.99	-1.21
7	-.23	99.99	.44	-.78	99.99	-1.47
8	-.56	99.99	.29	-.85	99.99	-1.07
9	-.93	99.99	-.10	-1.13	99.99	-1.66

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	.02	.50	.70	1.22	.16	-1.39	.33	-.60	.54	.47
3	-.03	.25	1.17	.84	-.13	.45	-.97	-.68	.60	-.20
4	.41	.27	.28	.57	.35	-.57	.37	-.84	.14	.31
5	.05	1.05	.70	.35	.83	-.87	-.64	.10	.04	-.54
6	-1.31	1.28	.87	.93	.70	-.36	-.73	-.63	.46	.07
7	-.48	.22	.38	.88	.60	-.52	-.85	-.03	-.14	.27
8	-.22	.57	-.05	.77	-.11	.03	-.74	.08	.05	.08
9	-1.16	.59	-.04	.18	.22	-.44	-1.13	.30	-.03	-.13

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	-7.2744	-6.4023	-5.9058	-6.0108	-5.9990	-5.9990	-5.9990	-5.9990
S.E(Log q)	.9126	.6843	.5174	.6387	.8385	.6551	.5125	.7442

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	.71	.498	9.73	.25	14	.67	-7.27
3	1.02	-.031	6.25	.27	14	.73	-6.40
4	.84	.482	7.40	.49	14	.45	-5.91
5	.64	1.134	9.11	.52	14	.40	-6.01
6	.56	1.502	9.54	.56	14	.44	-6.00
7	.98	.051	6.23	.43	14	.67	-6.08
8	1.66	-1.752	1.71	.44	14	.77	-6.07
9	1.54	-1.663	3.19	.51	14	.96	-6.30

1

Fleet : USSR Spawning Area/A

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	No data for this fleet at this age					
3	99.99	-2.22	-.36	-.31	.09	.18
4	99.99	-1.02	-.51	-1.37	-1.32	.92
5	99.99	-1.34	.63	-1.09	-1.23	.22
6	99.99	-.85	.14	.29	-.06	-.62
7	99.99	-.72	-.05	.02	-.73	-.44
8	99.99	-.36	-.42	.02	-.75	-.25
9	99.99	-.71	-1.05	.35	-.08	-.09

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-.69	-.68	.48	.50	.29	.11	-.68	99.99	.78	.45
4	.37	-.61	.06	.77	.01	-.11	-.29	99.99	.49	.66
5	.31	.24	.28	.42	.50	-.99	.10	99.99	.34	.21
6	.14	.83	.88	.12	.28	-1.38	-.04	99.99	-.69	.64
7	-.18	.90	2.10	.20	.60	-1.12	.13	99.99	-.51	-.63
8	.65	.44	2.32	.04	.48	-1.13	-.24	99.99	-.81	-.41
9	.66	.45	2.44	-.52	1.48	99.99	.27	99.99	-1.21	-1.69

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	-6.3328	-6.0200	-6.0514	-6.1224	-6.1224	-6.1224	-6.1224
S.E(Log q)	.6471	.6894	.6310	.6902	.8749	.9086	1.2267

Table 6.4.5 (continued)

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,	.87,	.299,	7.50,	.38,	14,	.59,	-6.33,
4,	.71,	.818,	8.60,	.48,	14,	.50,	-6.02,
5,	.59,	1.242,	9.46,	.52,	14,	.37,	-6.05,
6,	.84,	.402,	7.41,	.41,	14,	.60,	-6.12,
7,	85.21,	-2.382,	******,	.00,	14,	61.22,	-6.11,
8,	4.30,	-2.001,	-15.63,	.04,	14,	3.41,	-6.13,
9,	2.78,	-1.702,	-4.65,	.11,	13,	3.08,	-6.04,

1

Fleet : CPUE Spanish Pair Tr

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	99.99,	99.99,	.76,	.10,	-.24,	-.16
3	99.99,	99.99,	.70,	1.02,	-.12,	-.36
4	99.99,	99.99,	.80,	.82,	.98,	.21
5	99.99,	99.99,	1.09,	.25,	.40,	.48
6	99.99,	99.99,	.56,	.68,	-.88,	.47
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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	-.03,	.40,	.49,	.31,	-.75,	.35,	.22,	-.52,	-.18,	-.27
3	-.61,	.60,	.58,	-.43,	-.77,	-.93,	.55,	.60,	-.16,	.06
4	-1.07,	.12,	.64,	-.71,	-.45,	-.16,	-.32,	.15,	.09,	.07
5	-.49,	-.70,	.64,	-.12,	-.19,	-.26,	-.39,	-.29,	-.28,	.79
6	-.45,	.58,	.28,	-.28,	-.26,	-.11,	-.04,	.22,	-.87,	.57
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,	-5.9580,	-5.9131,	-6.2955,	-6.8076,	-7.2367,
S.E(Log q),	.4150,	.6138,	.5553,	.5114,	.5099,

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,	2.14,	-1.761,	-5.21,	.20,	14,	.81,	-5.96,
3,	4.39,	-1.965,	-26.28,	.03,	14,	2.38,	-5.91,
4,	2.84,	-1.869,	-9.69,	.10,	14,	1.42,	-6.30,
5,	1.89,	-1.346,	-.09,	.20,	14,	.93,	-6.81,
6,	1.00,	.009,	7.26,	.45,	14,	.53,	-7.24,

1

Fleet : Spanish Survey (Bott

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	99.99,	99.99,	99.99,	99.99,	.44,	-.34
3	99.99,	99.99,	99.99,	99.99,	.90,	.09
4	99.99,	99.99,	99.99,	99.99,	.75,	.86
5	99.99,	99.99,	99.99,	99.99,	.75,	.31
6	99.99,	99.99,	99.99,	99.99,	.32,	1.78
7	99.99,	99.99,	99.99,	99.99,	-.35,	-.56
8	No data for this fleet at this age					
9	No data for this fleet at this age					

Age	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	99.99,	1.44,	-.22,	-.57,	-1.34,	.87,	.84,	-2.52,	-.08,	1.69
3	99.99,	.29,	.12,	-.71,	-.20,	.12,	-.63,	-.43,	-.26,	1.11
4	99.99,	-.59,	-.95,	.25,	.74,	.56,	-1.51,	-.11,	.06,	.37
5	99.99,	-.48,	-.29,	-.21,	.72,	.78,	-.92,	-.43,	-.18,	.27
6	99.99,	2.27,	-.35,	-2.04,	.61,	1.11,	-1.63,	-.32,	-1.25,	.44
7	99.99,	.41,	.04,	.21,	.75,	.56,	-.90,	-.76,	-1.30,	-1.17
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Table 6.4.5 (continued)

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,	-11.0490,	-11.7175,	-12.2786,	-12.9177,	-13.6640,	-13.6640,
S.E(Log q),	1.2877,	.5800,	.7698,	.5764,	1.3661,	.8065,

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,	.71,	.330,	12.41,	.15,	11,	.97,	-11.05,
3,	.60,	1.358,	13.21,	.60,	11,	.33,	-11.72,
4,	-3.12,	-2.557,	23.46,	.05,	11,	1.88,	-12.28,
5,	6.51,	-2.643,	3.92,	.03,	11,	2.89,	-12.92,
6,	-1.30,	-1.728,	14.56,	.07,	11,	1.60,	-13.66,
7,	36.08,	-2.385,	35.37,	.00,	11,	21.70,	-13.96,

1

Fleet : Norwegian Sea acoust

Age ,	1981,	1982,	1983,	1984,	1985,	1986
1 ,	-.07,	-.29,	.00,	-.05,	.03,	-.03
2 ,	-.29,	-.36,	-.72,	1.69,	2.01,	.30
3 ,	.77,	-.07,	-.63,	-.18,	1.46,	.60
4 ,	.84,	1.03,	-.37,	-.56,	-.14,	1.39
5 ,	.92,	1.21,	.31,	-.19,	.08,	1.68
6 ,	1.17,	1.69,	-.04,	.04,	-.47,	1.65
7 ,	1.18,	1.40,	.30,	-.08,	-.22,	.83
8 ,	1.05,	1.02,	.22,	-1.35,	-.43,	.74
9 ,	No data for this fleet at this age					

Age ,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996
1 ,	.31,	.40,	-.33,	99.99,	99.99,	-.16,	-.01,	99.99,	.06,	-.05
2 ,	1.02,	.63,	-.06,	99.99,	99.99,	-.48,	-2.27,	99.99,	.40,	-.66
3 ,	.80,	.32,	-.76,	99.99,	99.99,	.40,	-.84,	99.99,	.27,	-1.06
4 ,	.74,	.65,	-1.30,	99.99,	99.99,	-.76,	.60,	99.99,	-.11,	-.59
5 ,	.46,	-.24,	-.78,	99.99,	99.99,	-1.11,	.25,	99.99,	.26,	-.60
6 ,	.38,	-.60,	-.67,	99.99,	99.99,	-.60,	.15,	99.99,	-.12,	-.20
7 ,	.57,	.15,	-1.30,	99.99,	99.99,	-.86,	.19,	99.99,	-.56,	.63
8 ,	-.01,	-.72,	-.28,	99.99,	99.99,	-2.06,	-.89,	99.99,	-.87,	-.73
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,	8
Mean Log q,	-8.1328,	-7.5052,	-7.3481,	-7.4641,	-7.6548,	-7.6548,	-7.6548,
S.E(Log q),	1.1754,	.7819,	.8264,	.7867,	.7299,	.7552,	1.0362,

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,	.33,	3.828,	13.27,	.82,	13,	.22,	-7.66,

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,	.35,	1.930,	13.05,	.56,	13,	.36,	-8.13,
3,	.67,	.844,	10.17,	.48,	13,	.53,	-7.51,
4,	.51,	1.780,	11.09,	.66,	13,	.38,	-7.35,
5,	1.73,	-.559,	2.31,	.08,	13,	1.42,	-7.46,
6,	1.54,	-.699,	4.22,	.19,	13,	1.16,	-7.65,
7,	.71,	.963,	9.30,	.62,	13,	.54,	-7.66,
8,	.69,	1.057,	9.65,	.63,	13,	.58,	-8.23,

1

Table 6.4.5 (continued)

Fleet : Portuguese survey (B

Age	1981	1982	1983	1984	1985	1986
1	No data for this fleet at this age					
2	99.99	99.99	99.99	99.99	-.04	99.99
3	99.99	99.99	99.99	99.99	.12	99.99
4	99.99	99.99	99.99	99.99	-.04	99.99
5	99.99	99.99	99.99	99.99	-.61	99.99
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	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	No data for this fleet at this age									
2	.93	.35	.98	.57	-.83	-.42	1.27	-2.23	.59	-.77
3	.17	-1.04	.74	1.49	.72	.08	.24	-.68	.25	-1.94
4	-.91	-2.71	.28	2.27	1.42	1.28	-.39	.10	.53	-2.26
5	-.09	-2.07	.51	1.49	1.20	1.02	-.16	-.52	.18	-1.32
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	-10.3990	-10.6840	-10.9944	-10.9790
S.E(Log q)	1.0741	.9676	1.5237	1.0867

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	1.73	-.422	6.46	.04	11	1.95	-10.40
3	1.97	-.502	6.05	.03	11	2.00	-10.68
4	7.40	-.698	-14.79	.00	11	11.62	-10.99
5	18.91	-1.101	-53.88	.00	11	20.31	-10.98

1

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	.000	.000	.00	0	.000	.000
USSR Spawning Area/A	1	.000	.000	.00	0	.000	.000
CPUE Spanish Pair Tr	1	.000	.000	.00	0	.000	.000
Spanish Survey (Bott	1	.000	.000	.00	0	.000	.000
Norwegian Sea acoust	1	.000	.000	.00	0	.000	.000
Portuguese survey (B	1	.000	.000	.00	0	.000	.000
P shrinkage mean	9748525	.44				.562	.074
F shrinkage mean	18126410	.50				.438	.040

Weighted prediction :

Survivors, at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12794745	.33	16.37	2	49.440	.057

Age 1 Catchability dependent on age and year class strength

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	.000	.000	.00	0	.000	.000
USSR Spawning Area/A	1	.000	.000	.00	0	.000	.000
CPUE Spanish Pair Tr	1	.000	.000	.00	0	.000	.000
Spanish Survey (Bott	1	.000	.000	.00	0	.000	.000
Norwegian Sea acoust	12417409	.300	.000	.00	1	.500	.128
Portuguese survey (B	1	.000	.000	.00	0	.000	.000
P shrinkage mean	6894476	.41				.296	.220

Table 6.4.5 (continued)

F shrinkage mean	37058084	.50				.204	.045

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
13031678	.22	.42	3	1.899	.122

1

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

Year class = 1994

Fleet	Estimated, Survivors	Int, s.e	Ext, s.e	Var, Ratio	N	Scaled, Weights	Estimated F
Norway Spawning Area	10218783	.953	.000	.00	1	.047	.046
USSR Spawning Area/A	1	.000	.000	.00	0	.000	.000
CPUE Spanish Pair Tr	4899913	.433	.000	.00	1	.227	.093
Spanish Survey (Bott	34813264	1.352	.000	.00	1	.023	.014
Norwegian Sea acoust	6529451	.292	.168	.58	2	.486	.071
Portuguese survey (B	2976406	1.127	.000	.00	1	.034	.149
F shrinkage mean	6947286	.50				.183	.067

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
6398709	.21	.15	7	.709	.072

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

Year class = 1993

Fleet	Estimated, Survivors	Int, s.e	Ext, s.e	Var, Ratio	N	Scaled, Weights	Estimated F
Norway Spawning Area	4490572	.572	.354	.62	2	.124	.119
USSR Spawning Area/A	6653968	.677	.000	.00	1	.090	.082
CPUE Spanish Pair Tr	3833641	.359	.115	.32	2	.309	.138
Spanish Survey (Bott	10693599	.555	.439	.79	2	.133	.052
Norwegian Sea acoust	2267204	.686	.669	.97	2	.086	.223
Portuguese survey (B	1839185	.755	1.255	1.66	2	.071	.268
F shrinkage mean	3766401	.50				.187	.140

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
4257067	.20	.19	12	.955	.125

1

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

Year class = 1992

Fleet	Estimated, Survivors	Int, s.e	Ext, s.e	Var, Ratio	N	Scaled, Weights	Estimated F
Norway Spawning Area	2004636	.394	.270	.69	3	.143	.215
USSR Spawning Area/A	3201505	.495	.059	.12	2	.090	.140
CPUE Spanish Pair Tr	1205125	.306	.183	.60	3	.227	.336
Spanish Survey (Bott	1180275	.459	.584	1.27	3	.102	.342
Norwegian Sea acoust	1486701	.270	.151	.56	3	.269	.280
Portuguese survey (B	500032	.684	.878	1.28	3	.045	.674
F shrinkage mean	2304787	.50				.124	.190

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
1557043	.15	.14	18	.958	.269

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

Year class = 1991

Fleet	Estimated, Survivors	Int, s.e	Ext, s.e	Var, Ratio	N	Scaled, Weights	Estimated F
Norway Spawning Area	974755	.342	.227	.67	4	.157	.260
USSR Spawning Area/A	1676910	.489	.136	.28	2	.085	.159
CPUE Spanish Pair Tr	1858182	.269	.166	.62	4	.247	.145
Spanish Survey (Bott	1268336	.370	.208	.56	4	.138	.206
Norwegian Sea acoust	887048	.269	.261	.97	4	.214	.283
Portuguese survey (B	909796	.594	.590	.99	4	.051	.276
F shrinkage mean	966149	.50				.109	.262

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
1210710	.14	.11	23	.785	.214

Table 6.4.5 (continued)

1
Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Norway Spawning Area,	643079,	.322,	.258,	.80,	5,	.171,	.526
USSR Spawning Area/A,	1313949,	.404,	.377,	.93,	3,	.119,	.292
CPUE Spanish Pair Tr,	1422931,	.244,	.160,	.65,	5,	.301,	.272
Spanish Survey (Bott,	902806,	.359,	.194,	.54,	5,	.133,	.401
Norwegian Sea acoust,	860868,	.448,	.227,	.51,	4,	.097,	.417
Portuguese survey (B,	1146582,	.594,	.150,	.25,	4,	.045,	.328
F shrinkage mean ,	1394659,	.50,,,,				.135,	.277

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1090152,	.14,	.10,	27,	.679,	.343

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

Year class = 1989

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Norway Spawning Area,	870579,	.320,	.054,	.17,	6,	.182,	.520
USSR Spawning Area/A,	406906,	.413,	.171,	.41,	4,	.112,	.900
CPUE Spanish Pair Tr,	340792,	.253,	.133,	.53,	5,	.214,	1.009
Spanish Survey (Bott,	296504,	.364,	.252,	.69,	6,	.133,	1.100
Norwegian Sea acoust,	927896,	.448,	.191,	.43,	4,	.106,	.495
Portuguese survey (B,	434609,	.607,	.191,	.31,	4,	.030,	.862
F shrinkage mean ,	1656503,	.50,,,,				.224,	.306

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
645634,	.16,	.14,	30,	.882,	.652

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1988

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Norway Spawning Area,	194976,	.282,	.158,	.56,	7,	.233,	.726
USSR Spawning Area/A,	196291,	.377,	.148,	.39,	5,	.114,	.723
CPUE Spanish Pair Tr,	213545,	.250,	.183,	.73,	5,	.175,	.681
Spanish Survey (Bott,	124318,	.347,	.274,	.79,	6,	.104,	.984
Norwegian Sea acoust,	152483,	.300,	.145,	.48,	5,	.145,	.861
Portuguese survey (B,	364125,	.608,	.291,	.48,	4,	.026,	.452
F shrinkage mean ,	551686,	.50,,,,				.204,	.320

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
229338,	.15,	.11,	33,	.767,	.646

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

Year class = 1987

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
Norway Spawning Area,	109294,	.274,	.158,	.58,	8,	.254,	.591
USSR Spawning Area/A,	65220,	.359,	.312,	.87,	6,	.125,	.855
CPUE Spanish Pair Tr,	103004,	.253,	.163,	.65,	5,	.157,	.618
Spanish Survey (Bott,	105537,	.347,	.369,	1.07,	6,	.093,	.607
Norwegian Sea acoust,	106533,	.303,	.301,	.99,	5,	.113,	.603
Portuguese survey (B,	383830,	.622,	.133,	.21,	4,	.023,	.207
F shrinkage mean ,	165032,	.50,,,,				.235,	.428

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
114422,	.16,	.10,	35,	.645,	.571

1
1

Table 6.4.6 Blue whiting. F-at-age 1981-96.

Run title : BLUE WHIT1997 WG

At 4/05/1997 16:43

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

	YEAR	1981	1982	1983	1984	1985	1986
	AGE						
0		0.01	0.17	0.02	0.05	0.12	0.01
1		0.08	0.04	0.16	0.14	0.15	0.09
2		0.10	0.12	0.19	0.25	0.18	0.13
3		0.17	0.13	0.16	0.23	0.33	0.24
4		0.12	0.20	0.16	0.23	0.24	0.55
5		0.27	0.13	0.16	0.23	0.25	0.56
6		0.28	0.21	0.22	0.37	0.45	0.43
7		0.23	0.20	0.35	0.31	0.37	0.56
8		0.29	0.20	0.35	0.43	0.34	0.55
9		0.25	0.20	0.25	0.33	0.38	0.69
	+gp	0.25	0.20	0.25	0.33	0.38	0.69
FBAR	3- 7	0.21	0.17	0.21	0.27	0.33	0.47

Table 8 Fishing mortality (F) at age

	YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	FBAR 94-96
	AGE											
0		0.04	0.00	0.09	0.01	0.02	0.00	0.02	0.00	0.15	0.06	0.07
1		0.11	0.07	0.11	0.10	0.03	0.07	0.05	0.04	0.03	0.12	0.06
2		0.11	0.13	0.16	0.13	0.08	0.10	0.07	0.03	0.05	0.07	0.05
3		0.16	0.17	0.38	0.23	0.13	0.18	0.13	0.11	0.14	0.12	0.13
4		0.41	0.22	0.33	0.38	0.15	0.21	0.26	0.11	0.21	0.27	0.20
5		0.48	0.56	0.47	0.38	0.32	0.16	0.23	0.34	0.26	0.21	0.27
6		0.38	1.03	0.68	0.71	0.33	0.22	0.20	0.24	0.39	0.34	0.32
7		0.46	0.43	0.69	0.70	0.43	0.23	0.23	0.28	0.36	0.65	0.43
8		0.84	0.45	0.49	1.13	0.23	0.39	0.20	0.31	0.46	0.65	0.47
9		0.63	0.56	0.40	0.54	0.18	0.22	0.33	0.41	0.35	0.57	0.44
	+gp	0.63	0.56	0.40	0.54	0.18	0.22	0.33	0.41	0.35	0.57	
FBAR	3- 7	0.38	0.48	0.51	0.48	0.27	0.20	0.21	0.22	0.27	0.32	

e:\acfm\wgnpbw97\t-646.xls

Table 6.4.7 Blue whiting. Stock size from XSA in 1981-1996.

Run title : BLUE WHITING 1997 WG

At 4/05/1997 16:43

Terminal Fs derived using XSA (With F shrinkage)

Stock number at age (start of year) Numbers*10**-6

YEAR	1981	1982	1983	1984	1985	1986
AGE						
0	5616	24624	24546	13588	11248	10955
1	3688	4555	16983	19701	10597	8146
2	4061	2786	3595	11839	14057	7495
3	4913	3010	2033	2430	7583	9659
4	3228	3407	2169	1420	1578	4460
5	2563	2341	2293	1517	928	1018
6	2564	1603	1678	1607	984	589
7	2553	1593	1062	1099	913	515
8	2822	1668	1064	610	662	515
9	2897	1737	1120	612	325	385
+gp	7275	4096	1653	1007	898	869
TOTAL	42181	51420	58196	55430	49773	44607

Stock number at age (start of year) Numbers*10**-6

YEAR	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	GMST 81-94	AMST 81-94
AGE													
0	8737	10864	25935	11816	8098	6944	11951	12977	25626	16538		12100	13421
1	8893	6845	8853	19471	9599	6485	5668	9606	10587	17989	12795	8820	9935
2	6082	6523	5219	6466	14483	7618	4940	4402	7587	8400	13032	6322	7112
3	5398	4456	4688	3623	4657	10931	5645	3769	3507	5891	6399	4673	5200
4	6224	3761	3093	2626	2359	3348	7464	4060	2753	2490	4257	3181	3514
5	2098	3379	2461	1816	1468	1658	2226	4689	2972	1833	1557	1996	2175
6	478	1061	1587	1258	1017	874	1161	1451	2734	1876	1211	1176	1279
7	313	267	309	659	508	599	576	777	933	1514	1090	687	839
8	240	162	143	127	269	272	391	375	479	534	646	432	666
9	242	85	84	72	34	176	150	262	225	247	229	273	584
+gp	454	128	127	250	63	64	68	101	156	205	209		
TOTAL	39158	37530	52500	48183	42556	38967	40242	42468	57558	57517	41424		

e:\acfm\wgnpbw97\t-647.xls

Table 6.4.8 Blue whiting. Stock summary table 1981-1996.

Run title : BLUE WHITING 1997 WG

At 4/05/1997 16:43

Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3-7
1981	5616195	5365337	4618904	909556	0.20	0.21
1982	24624234	4263799	3339560	576419	0.17	0.17
1983	24545774	3753078	2272266	570072	0.25	0.21
1984	13588098	3489677	1867055	641776	0.34	0.27
1985	11247497	3461265	2117652	695596	0.33	0.33
1986	10954916	3660646	2422612	826986	0.34	0.47
1987	8736760	3174936	2036408	664434	0.33	0.38
1988	10864007	2887347	1731896	553413	0.32	0.48
1989	25935300	2918248	1653583	625433	0.38	0.51
1990	11816179	3137870	1533712	561610	0.37	0.48
1991	8098382	3596387	1874975	369525	0.20	0.27
1992	6943841	3651412	2441621	474245	0.19	0.20
1993	11951255	3573187	2363645	480672	0.20	0.21
1994	12977204	3736053	2319696	459414	0.20	0.22
1995	25625586	4034538	2255332	578693	0.26	0.27
1996	16538370	3748245	2198987	637825	0.29	0.32
Arith. Mean	14378973	3653252	2315494	601604	0.27	0.31
Units	housands)	(Tonnes)	(Tonnes)	(Tonnes)		

e:\acfm\wgnpbw97\t-648.xls

Table 6.4.9 Blue Whiting. Stock Summary Table 1981 - 1996. Based on ICA-run.

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield/SSB ratio	Mean F ages 5- 8
1981	5498630	4673851	3940870	909556	0.2308	0.3171
1982	24326960	3805207	2894079	576419	0.1992	0.2253
1983	24002670	3453452	1996843	570072	0.2855	0.3043
1984	13321590	3348278	1756985	641776	0.3653	0.3412
1985	10878690	3359023	2048579	695596	0.3396	0.3419
1986	10287750	3618161	2426781	826986	0.3408	0.5293
1987	8239500	3076379	1992705	664434	0.3334	0.5697
1988	10006630	2730192	1648706	553413	0.3357	0.6846
1989	21978680	2680171	1535284	625433	0.4074	0.6423
1990	10344750	2778241	1389949	561610	0.4041	0.8805
1991	6800630	3064995	1611288	369524	0.2293	0.3859
1992	4147650	3019883	2038651	474245	0.2326	0.3431
1993	7979730	2834023	1955616	480672	0.2458	0.3177
1994	8519210	2840475	1872813	459414	0.2453	0.3196
1995	41645710	3399970	1676786	578693	0.3451	0.4456
1996	34663150	3816296	1603389	637825	0.3978	0.5802

e:\acfm\wgnpbw97\t-649.xls

Table 6.5.1 Input data for prediction - Blue whiting.

Age	Stock size	Weight in the catch	Weight in the stock	Maturity ogive	Natural mortality	Fishing pattern
0	14235	0.026	0.026	0.00	0.2	0.085
1	12795	0.055	0.055	0.11	0.2	0.075
2	13032	0.083	0.083	0.40	0.2	0.060
3	6399	0.108	0.108	0.82	0.2	0.151
4	4257	0.131	0.131	0.86	0.2	0.233
5	1557	0.155	0.155	0.91	0.2	0.322
6	1211	0.175	0.175	0.94	0.2	0.386
7	1090	0.199	0.199	1.00	0.2	0.512
8	646	0.217	0.217	1.00	0.2	0.560
9	229	0.235	0.235	1.00	0.2	0.524
10+	209	0.265	0.265	1.00	0.2	0.524

e:\acfm\wgnpbw97\t-651.xls

Table 6.5.2 Management option table. Blue whiting. (IFAP run: MANMM05)

Year: 1997					Year: 1998					Year: 1999	
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
0.9609	0.3082	4314295	2433311	600000	0.0000	0.0000	4422304	2713892	0	4765238	3379085
.	.	.	.	.	0.1000	0.0321	.	2713892	74412	4684102	3311163
.	.	.	.	.	0.2000	0.0642	.	2713892	146770	4605147	3245266
.	.	.	.	.	0.3000	0.0962	.	2713892	217146	4528294	3181317
.	.	.	.	.	0.4000	0.1283	.	2713892	285616	4453466	3119242
.	.	.	.	.	0.5000	0.1604	.	2713892	352246	4380591	3058972
.	.	.	.	.	0.6000	0.1925	.	2713892	417104	4309600	3000439
.	.	.	.	.	0.7000	0.2246	.	2713892	480254	4240426	2943579
.	.	.	.	.	0.8000	0.2566	.	2713892	541755	4173007	2888330
.	.	.	.	.	0.9000	0.2887	.	2713892	601666	4107279	2834635
.	.	.	.	.	1.0000	0.3208	.	2713892	660043	4043186	2782435
.	.	.	.	.	1.1000	0.3529	.	2713892	716940	3980671	2731678
.	.	.	.	.	1.2000	0.3850	.	2713892	772407	3919681	2682312
.	.	.	.	.	1.3000	0.4170	.	2713892	826494	3860162	2634287
.	.	.	.	.	1.4000	0.4491	.	2713892	879248	3802067	2587555
.	.	.	.	.	1.5000	0.4812	.	2713892	930715	3745348	2542071
.	.	.	.	.	1.6000	0.5133	.	2713892	980937	3689959	2497792
.	.	.	.	.	1.7000	0.5454	.	2713892	1029957	3635855	2454675
.	.	.	.	.	1.8000	0.5774	.	2713892	1077814	3582997	2412680
.	.	.	.	.	1.9000	0.6095	.	2713892	1124547	3531342	2371768
.	.	.	.	.	2.0000	0.6416	.	2713892	1170193	3480852	2331903
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANMM05
Date and time : 05MAY97:09:52
Computation of ref. F: Simple mean, age 3 - 7
Basis for 1997 : TAC constraints

Table 6.7.1 Total catches of BLUE WHITING in 1978–1996 divided into areas within and beyond areas of national fisheries juridiction of NEAFC contracting parties, as estimated by the Working Group members.

Year	International	Jan Mayen	Norway	Iceland	Greenland	Faroes	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 %)	
1996	34,788	-	67,977	302	-	111,627	387,209	601,903
	(5,7 %)		(11,3 %)	(0 %)	-	(18,6 %)	(64,4 %)	

Table 7.1.1 The Northeast Arctic cod stock's consumption in 1000 tonnes of main prey species in 1984–1995.

	Prey species											
Year	Amp hip.	Krill	Shr-imp	Cape lin	Herr-ing	Polar cod	Cod	Had-dock	Red-fish	Gr. hal.	Oth-ers	Total
1984	27	112	439	734	77	15	23	51	370	0	511	2359
1985	168	57	154	1617	180	3	33	47	225	0	1152	3635
1986	1216	107	140	828	132	140	82	109	312	+	660	3727
1987	1061	65	187	225	32	199	24	4	313	+	666	2778
1988	1246	313	130	336	8	91	9	3	225	0	411	2772
1989	835	247	132	593	3	33	8	11	233	0	744	2838
1990	143	94	202	1679	7	6	20	17	250	0	1620	4038
1991	81	94	209	3093	8	12	27	21	326	8	1202	5083
1992	117	190	444	2849	348	111	57	114	209	28	1160	5627
1993	314	820	388	3644	196	327	328	87	114	2	958	7178
1994	724	924	653	1390	196	822	276	63	99	+	869	6017
1995	1059	287	401	801	221	379	509	175	275	6	1130	5243
Mean	583	276	290	1483	117	178	116	58	246	4	924	4275
%	14	6	7	35	3	4	3	1	6	0	22	100

Table 7.1.2 Consumption by minke whale, harp seal and cod in the Barents Sea when the capelin stock is low and the herring stock is high. 1000 tonnes (wet weight).

Prey	Minke whale consumption	Harp seal consumption (low capelin stock)	Harp seal consumption (high capelin stock)	Cod consumption (1993-1995 average)
Capelin	142	7	258	1945
Herring	633	131	70	204
Cod	256	93	32	371
Haddock	128	14	*	108
Krill	602	215	215	677
Amphipods	0	115	109	699
Shrimp	0	*	*	481
Polar cod	*	326	213	509
Other fish	55	224	142	165[1]
Other crustaceans	0	127	104	986[2]
Total	1816	1253	1143	6146

* indicates that the prey species is included in the 'other' group for this predator.

[1] Redfish and Greenland halibut only

[2] including fish other than Redfish, Greenland halibut and the fish species mentioned in the table.

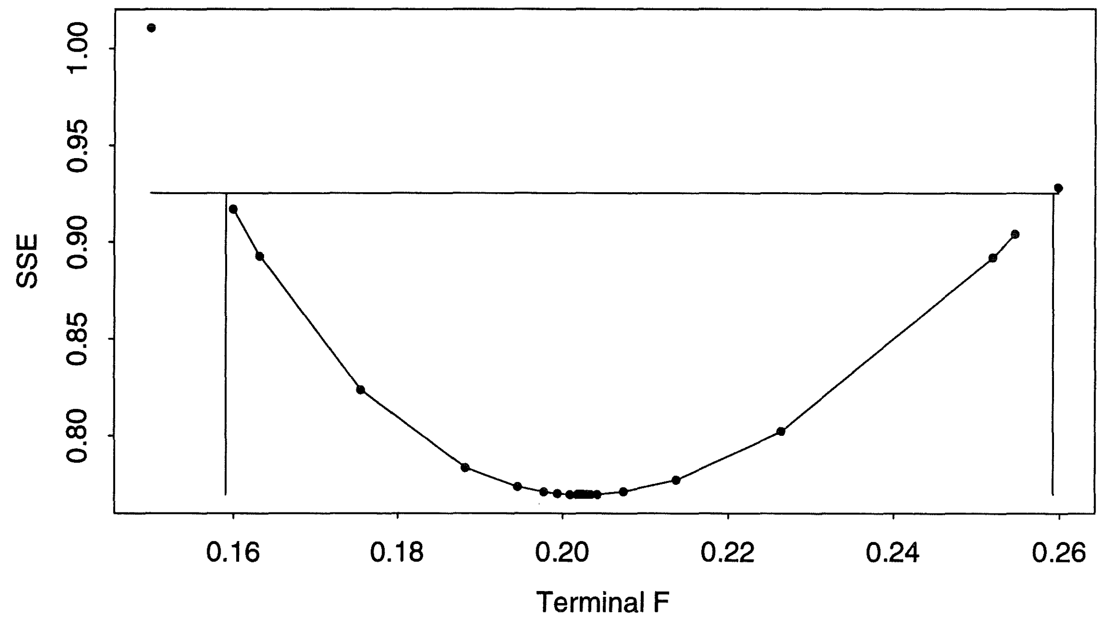
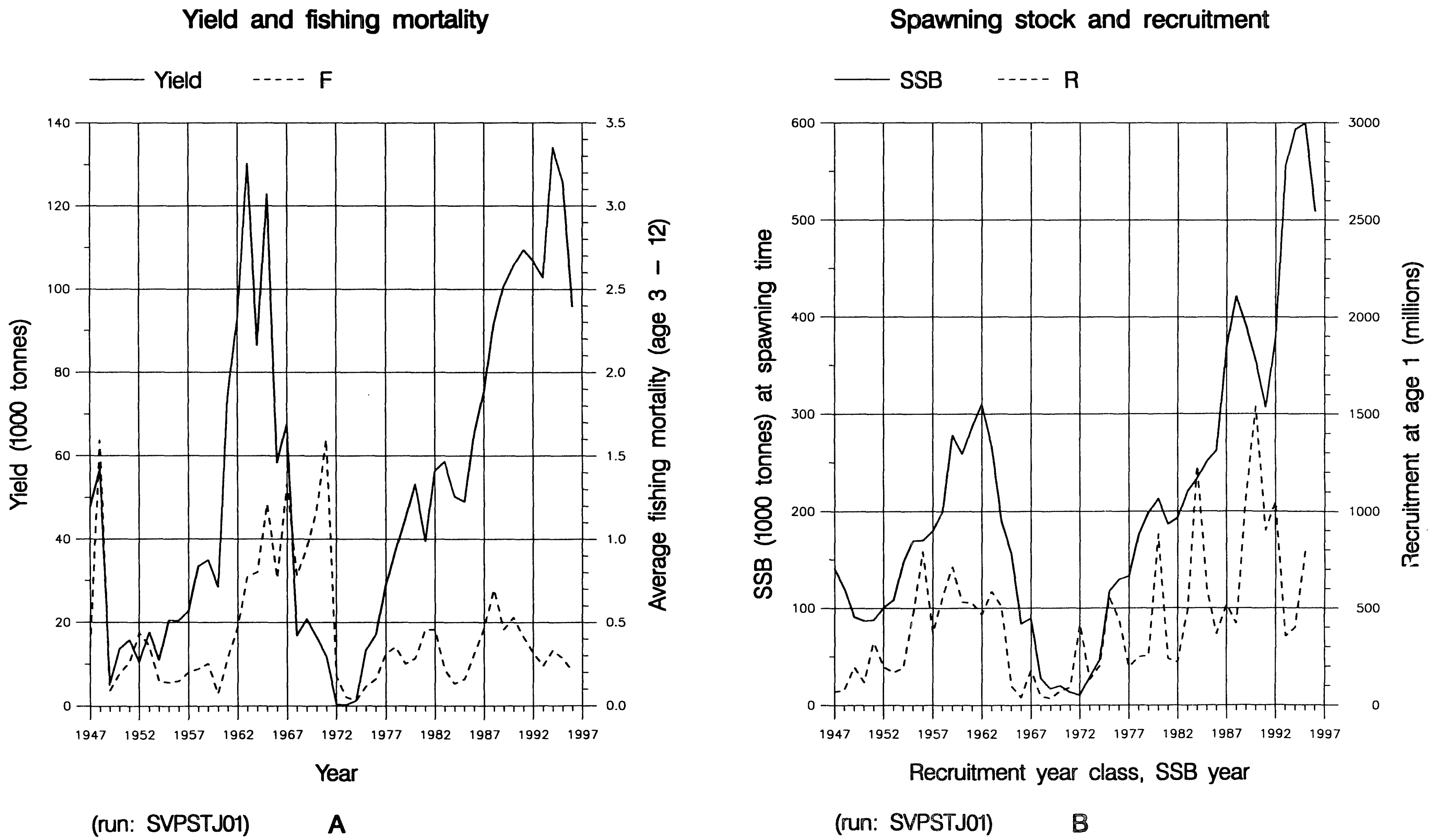


Figure 2.4.1 Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.

Figure 2.4.2

Fish Stock Summary
Herring Icelandic Summer – spawning (Fishing Area Va)
2 – 5 – 1997



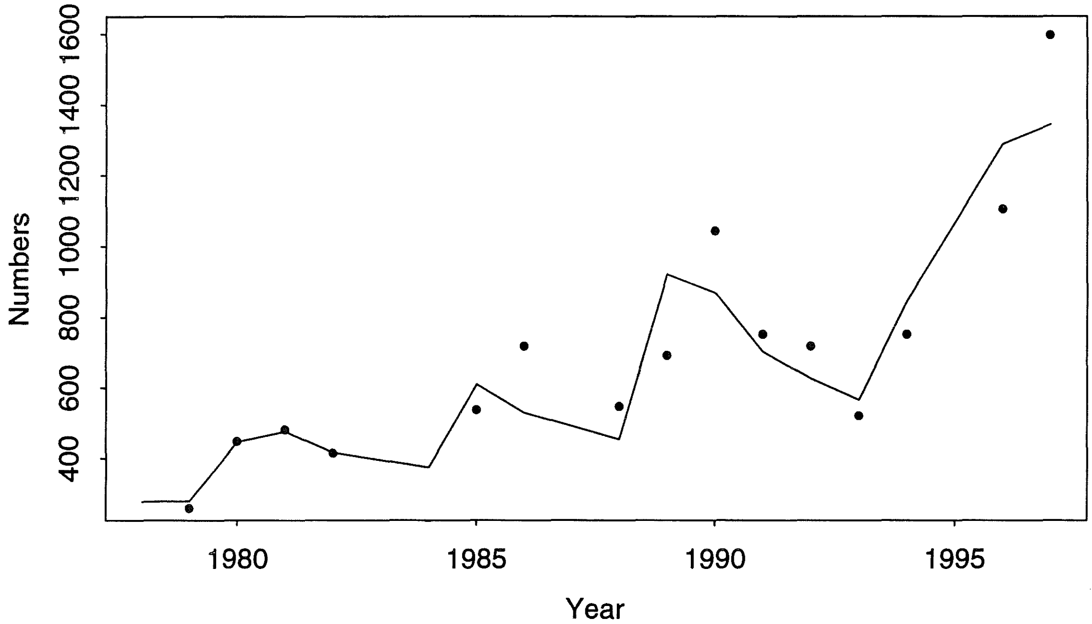


Figure 2.4.3. Icelandic summer spawners. Trends in acoustics and VPA stock numbers.

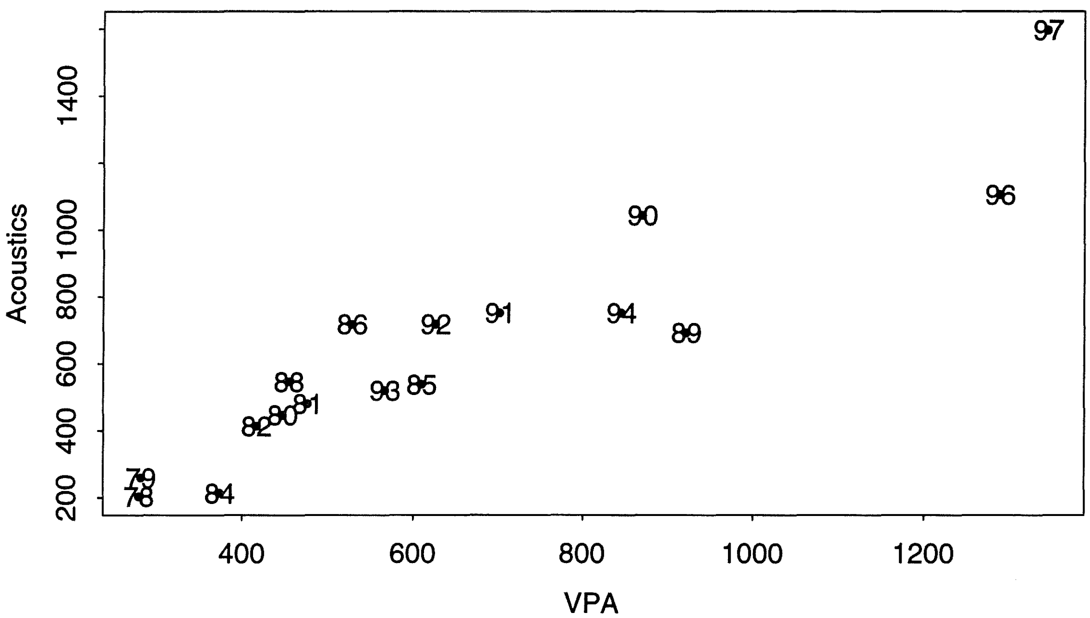
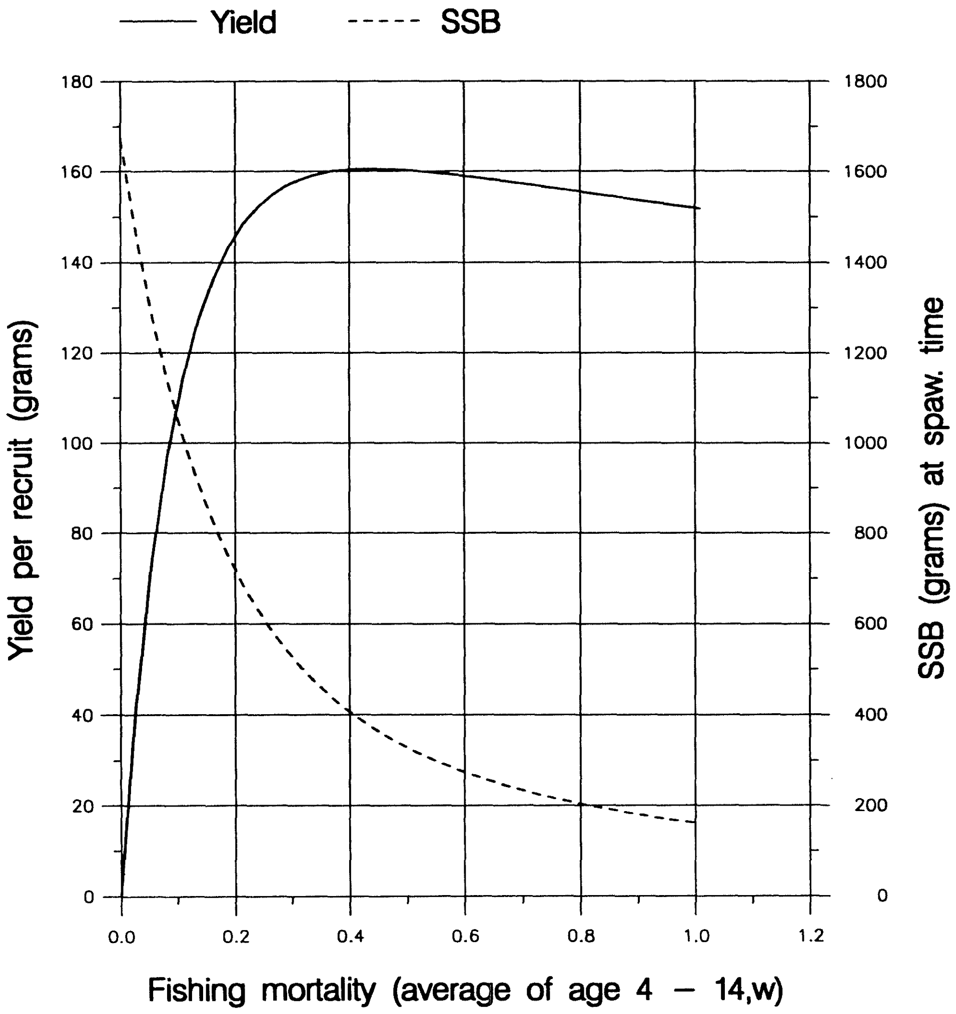


Figure 2.4.4. Icelandic summer spawners. Acoustic estimates vs VPA stock numbers.

Figure 2.5.1

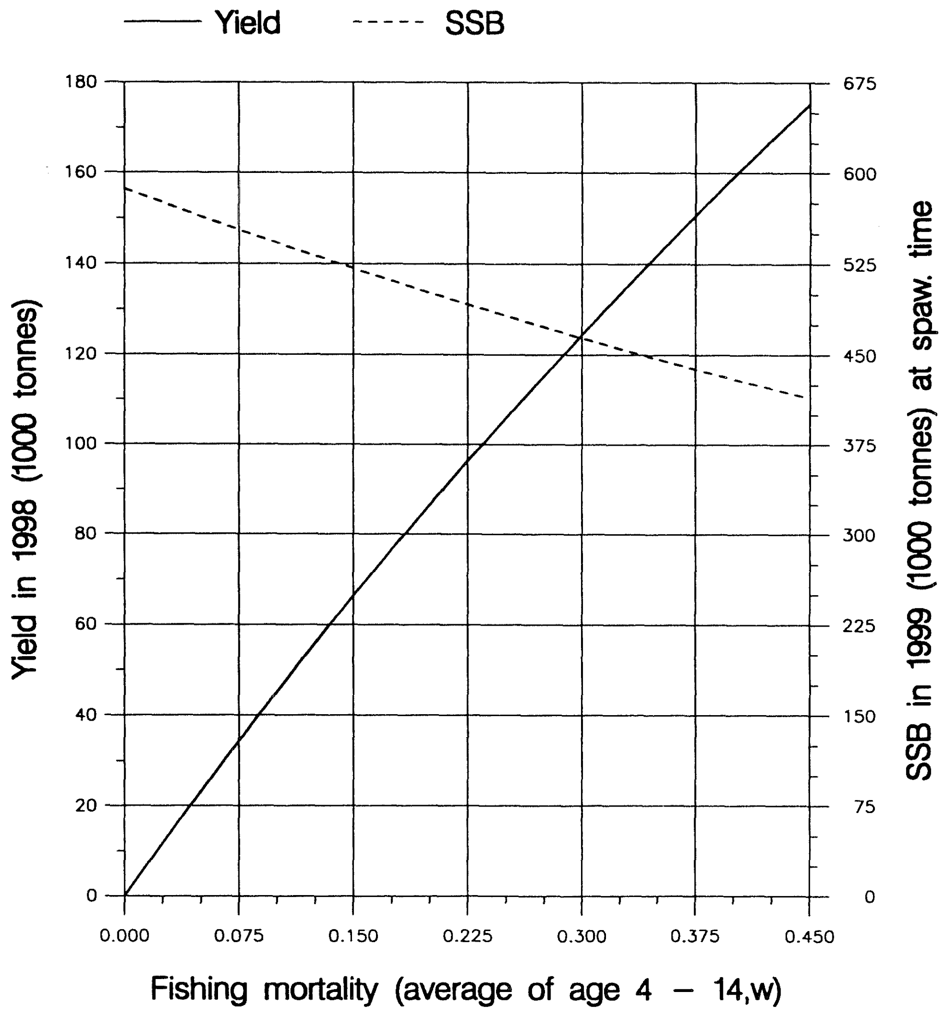
Fish Stock Summary
Herring Icelandic Summer–spawning (Fishing Area Va)
5–5–1997

Long term yield and spawning stock biomass



(run: YLDSTJ01) C

Short term yield and spawning stock biomass



(run: MANSTJ01) D

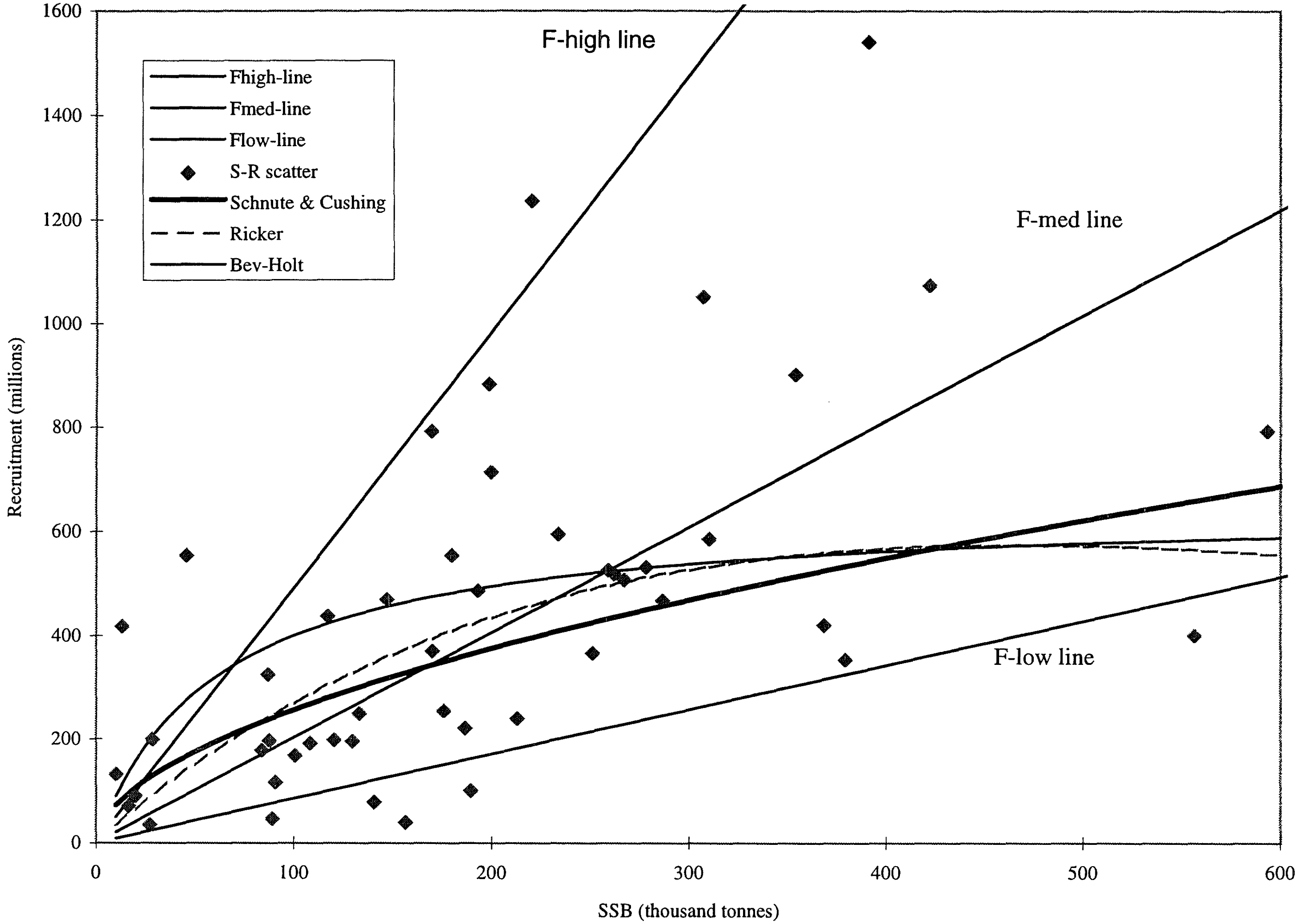


Figure 2.7.1 Icelandic summer spawners. SSB and recruitment 1947-1997.
e:\acfm\wgnpbw97\t-271.xls

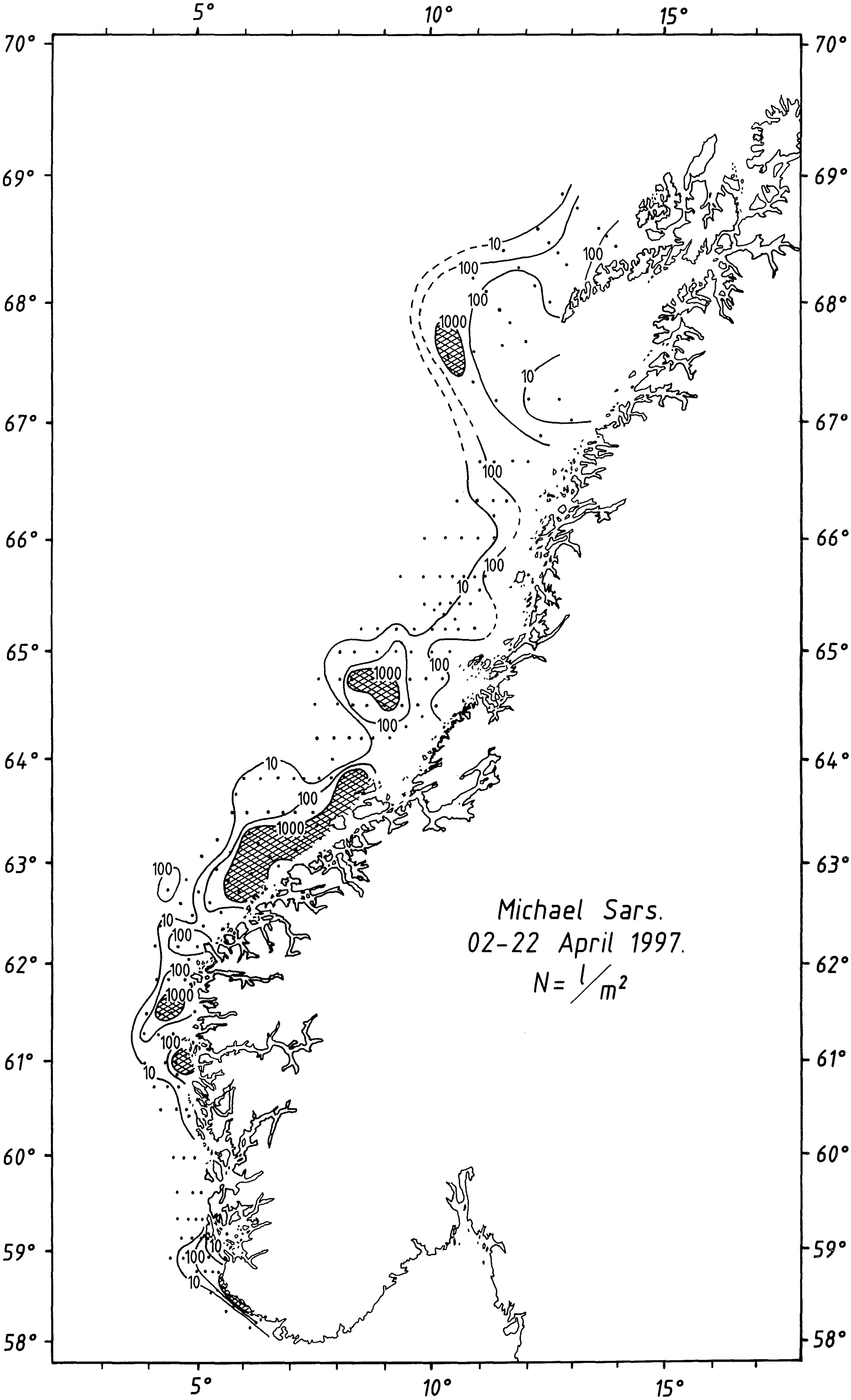
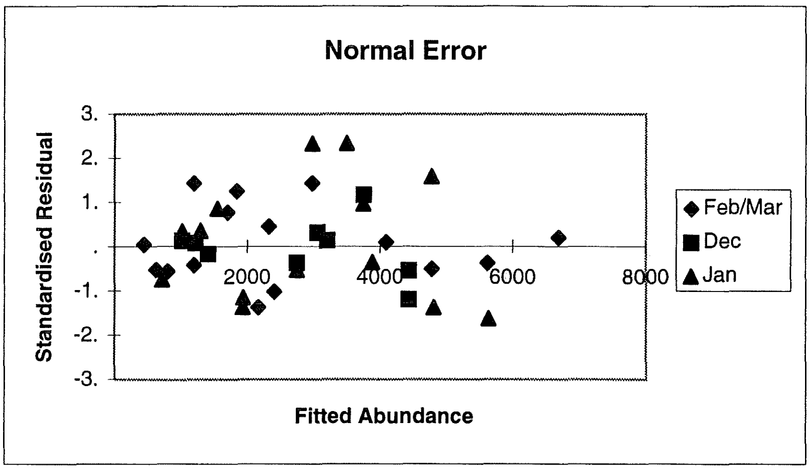
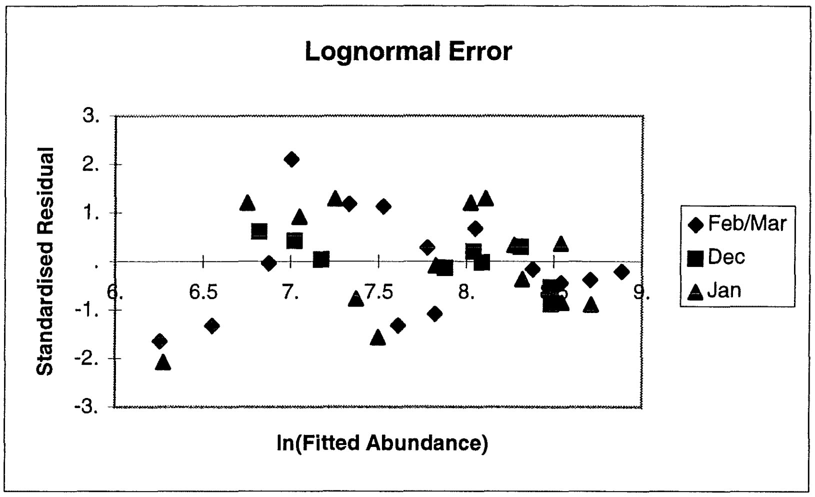


Figure 3.3.1 Distribution of herring larvae found along the Norwegian shelf 2–22 April 1997.





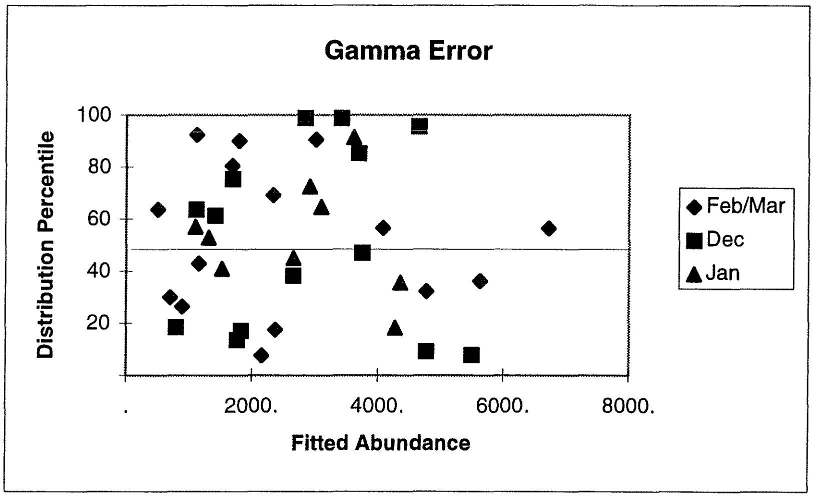


Figure 3.5.1 Residual plots for including acoustic surveys in the model fit with assumptions of either normal, lognormal or gamma error distributions. The tagging model component is included in all three fits.

e:\acfm\wgnpbw97\f-351.xls

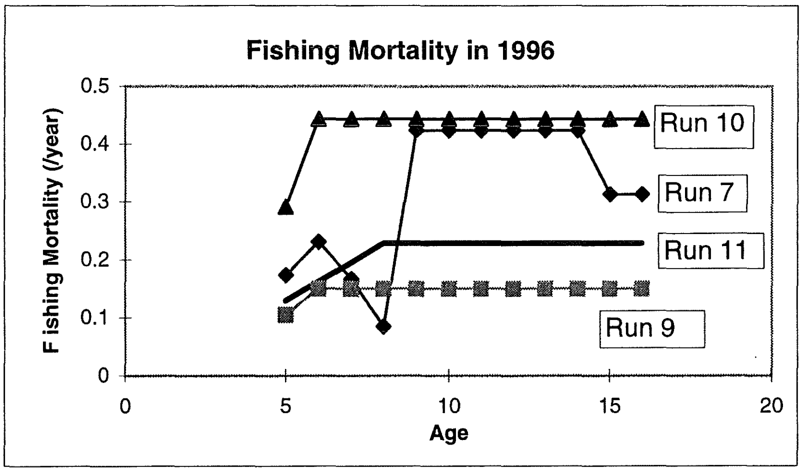


Figure 3.5.2 Comparison of selection patterns from two of the model formulations tested. Run 7, the 'long' parameterisation with younger age-classes estimated individually. Run 9, the 'short' parameterisation with a forced flat-topped exploitation pattern. Run 10, 'short' parameterisation but including all acoustic survey data (ages 5+ in January and February-March surveys and 4+ in December surveys). Run 11, 'medium' parameterisation (estimating age 5 and 13, flat pattern on ages 9-13, linear increase from age 5-9)

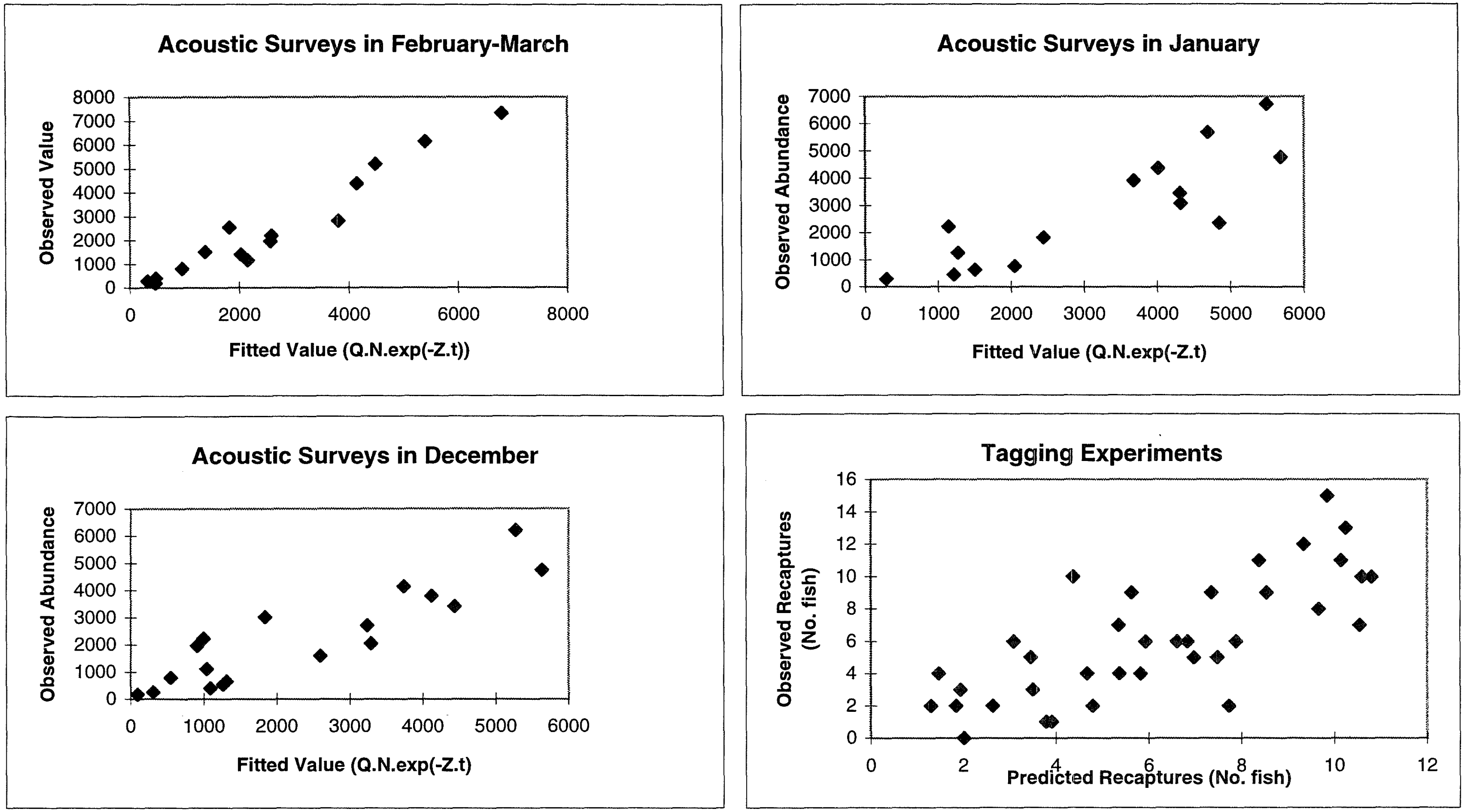
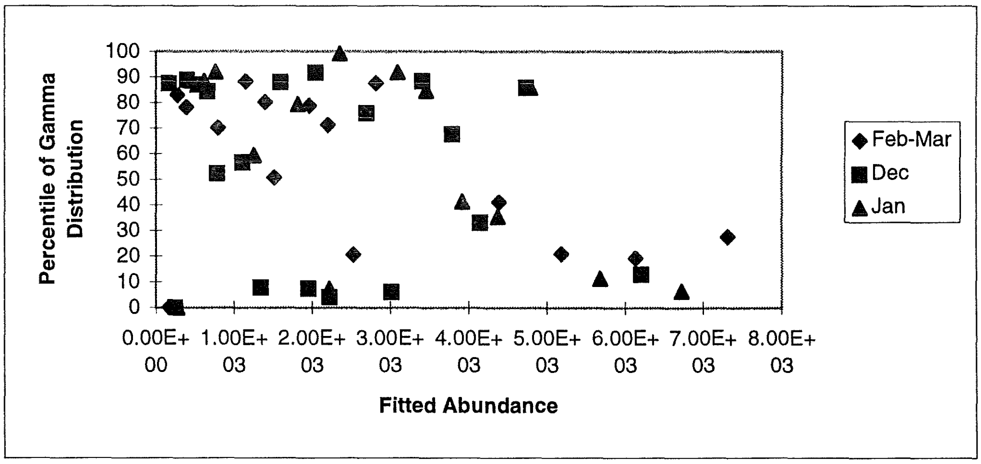
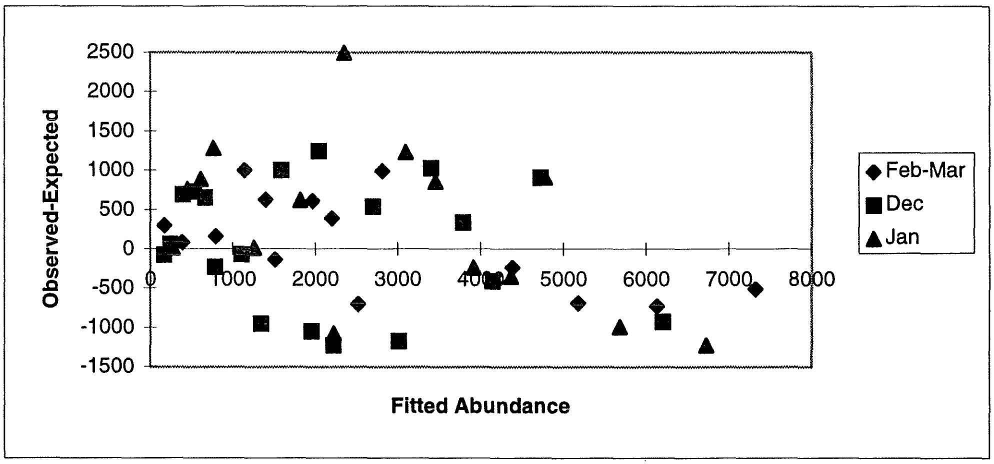


Figure 3.5.3 Observed and expected values for fishery-independent information from the Working Group's stock assessment model. Only values used in the assessment are plotted.





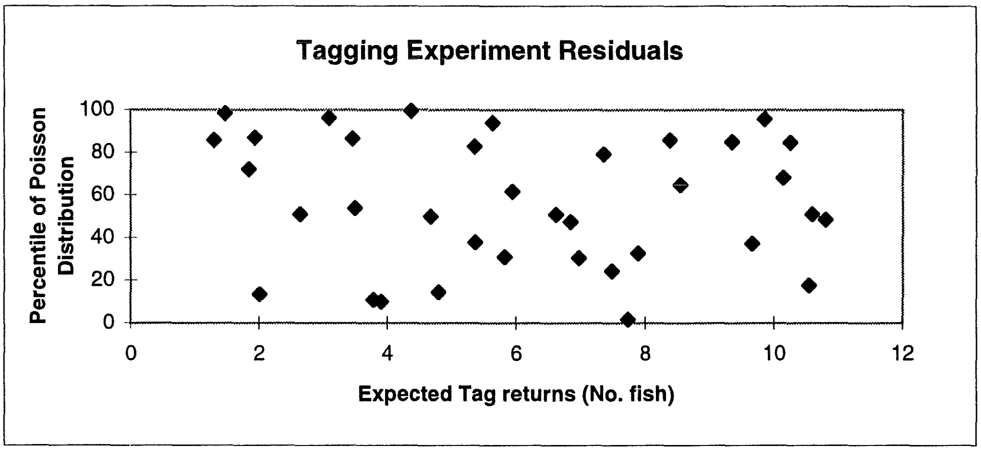
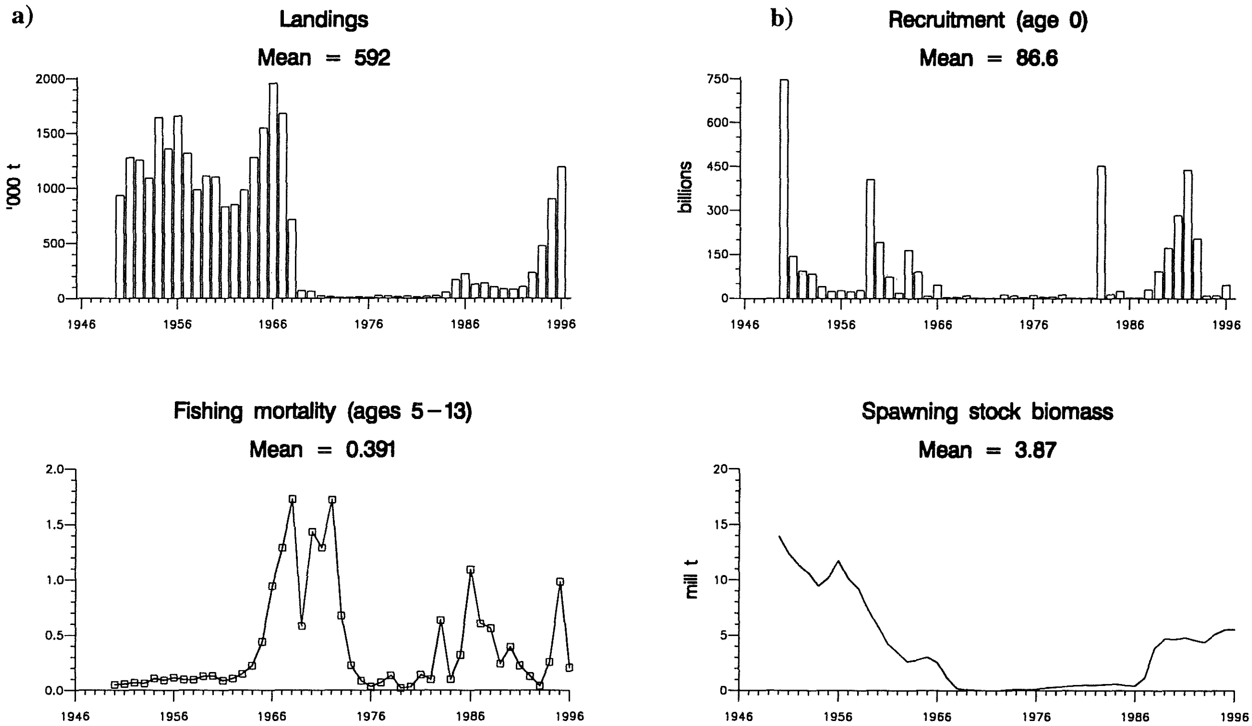


Figure 3.5.4 Norwegian Spring-Spawning Herring. Residual plots for the fishery-independent information used in the Working Group's stock assessment model. Upper panel, Percentiles of the Gamma distribution for the acoustic surveys. Centre panel, conventional residuals for acoustic surveys. Lower panel, percentiles of the Poisson distribution for the observed tag returns.

e:\acfm\wgnpbw97\f-353.xls

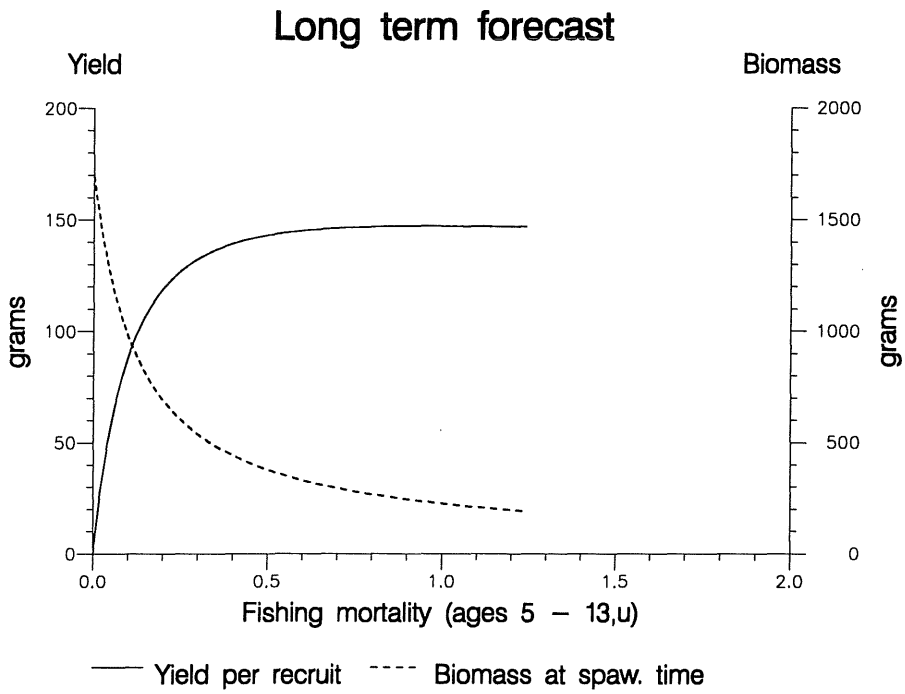
Herring Norwegian Spring – spawners
6 – 5 – 1997



J:\IFAPEXIM\WGNPBW\HER_NOSS\FIN_VPA4.CGM

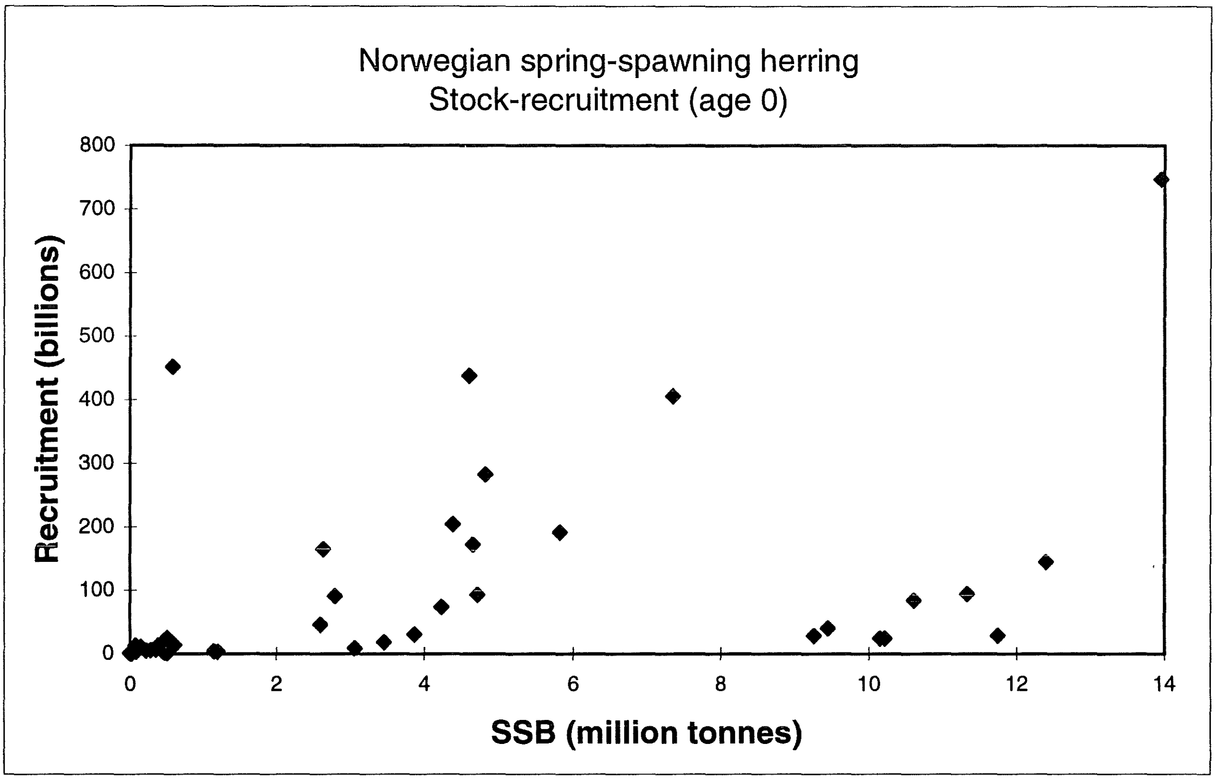
Figure 3.5.5

Herring Norwegian Spring – spawners
6 – 5 – 1997
Yield and Spawning Stock Biomass



J:\IFAPEXIM\WGNPBW\HER_NOSS\FIN_LONG.CGM

Figure 3.5.5 c


Norwegian spring-spawning herring
Stock-recruitment (age 0)
Recruitment (billions)
800
700
600
500
400
300
200
100
0
0
2
4
6
8
10
12
14
SSB (million tonnes)

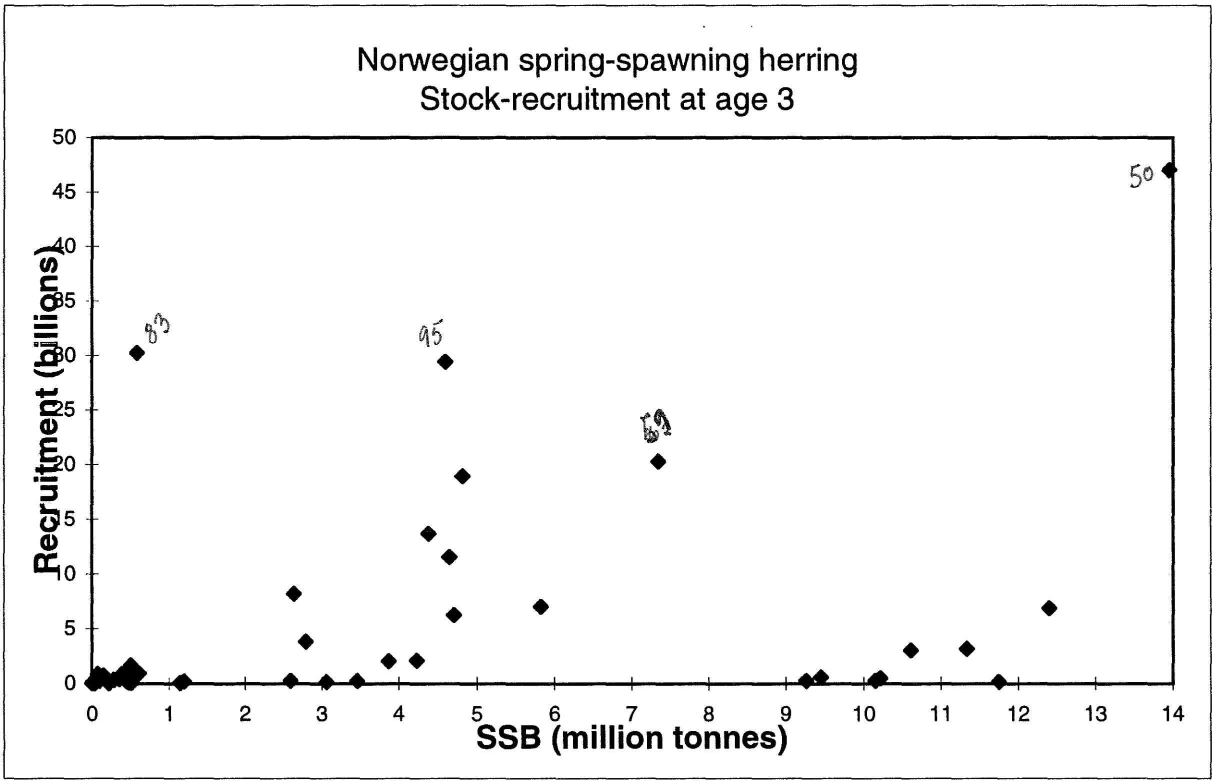
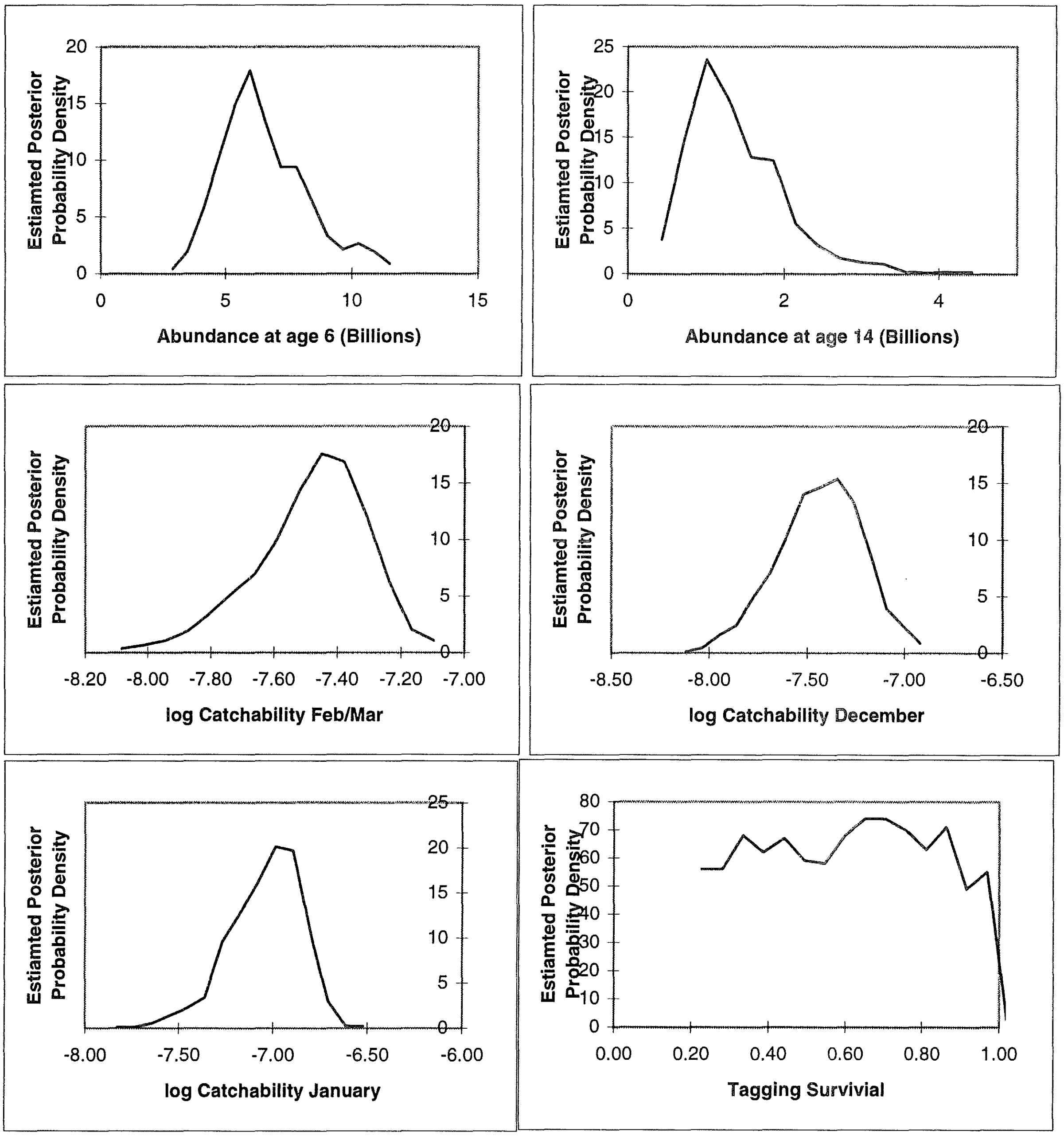

Norwegian spring-spawning herring
Stock-recruitment at age 3
Recruitment (billions)
50
45
40
35
30
25
20
15
10
5
0
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
SSB (million tonnes)
83
95
50

Figure 3.5.6



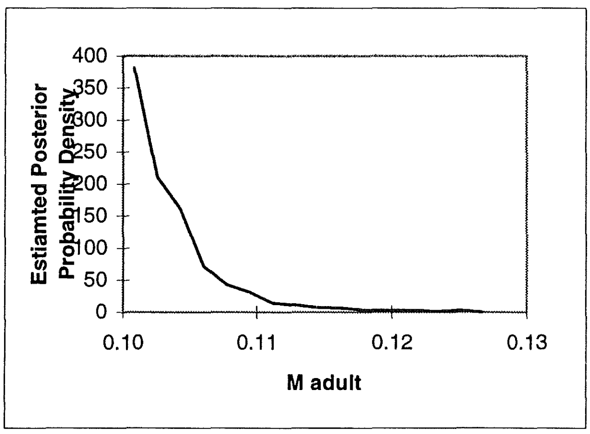


Figure 3.7.1 Estimated Bayes posterior probability distributions for some key parameters in the stock assessment: cohort abundances in 1997, natural mortality, disease-induced mortality, and survival of fish from the tagging experiment. Y-axis divisions indicate the % probability for each of 15 intervals between the range of values from 950 samples.

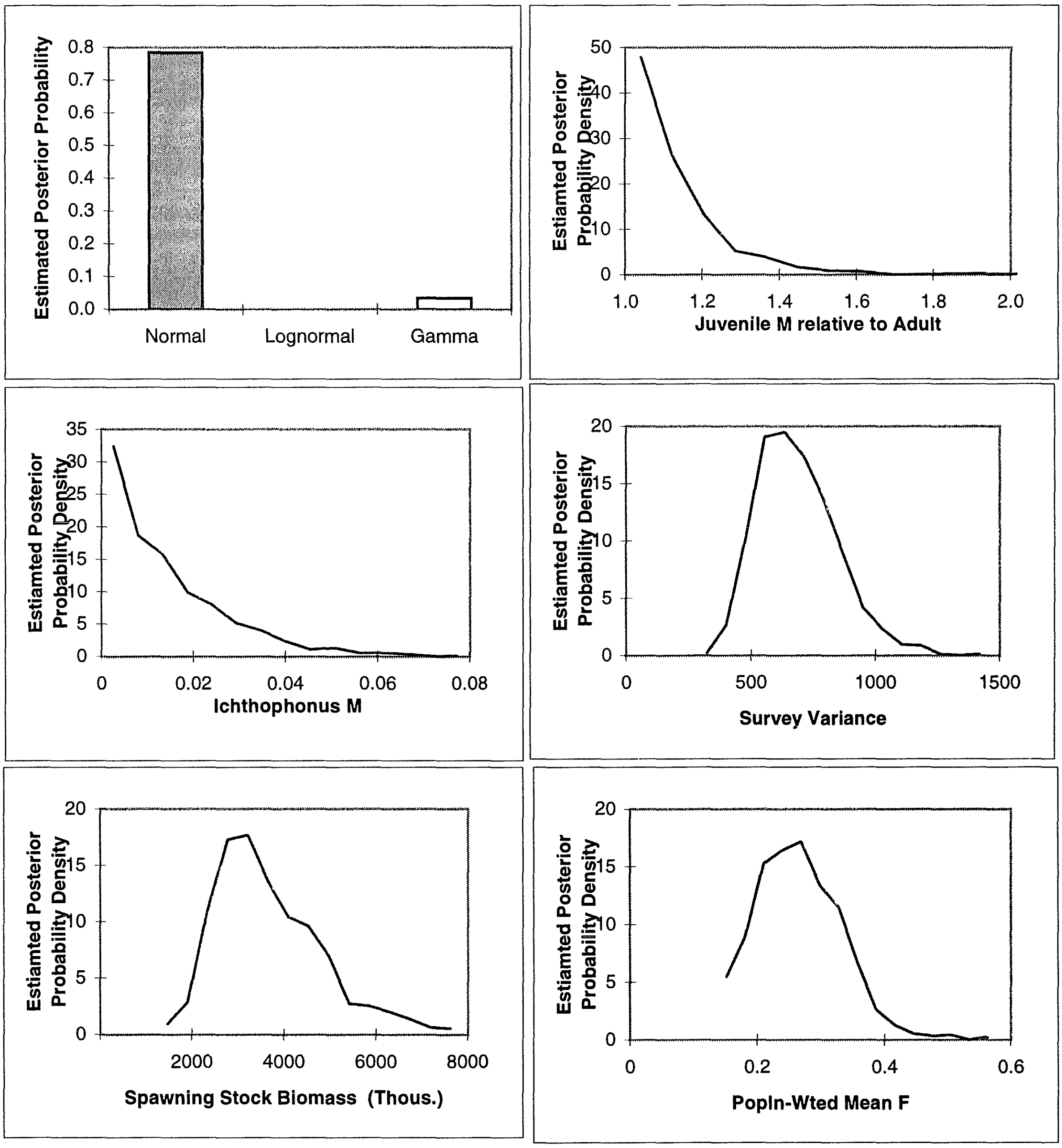


Figure 3.7.2 Estimated Bayes posterior probability distributions for some further parameters in the stock assessment: appropriate error model, survey error variance, and catchabilities for each of three acoustic surveys. Distributions of spawning stock size and fishing mortality are calculated from posterior distributions of parameters in the assesment model. Note the fishing mortality is not comparable to F in the maximum-likelihood assessment. Y-axis divisions indicate the % probability for each of 15 intervals between the range of values from 950 samples (except for error model plot)

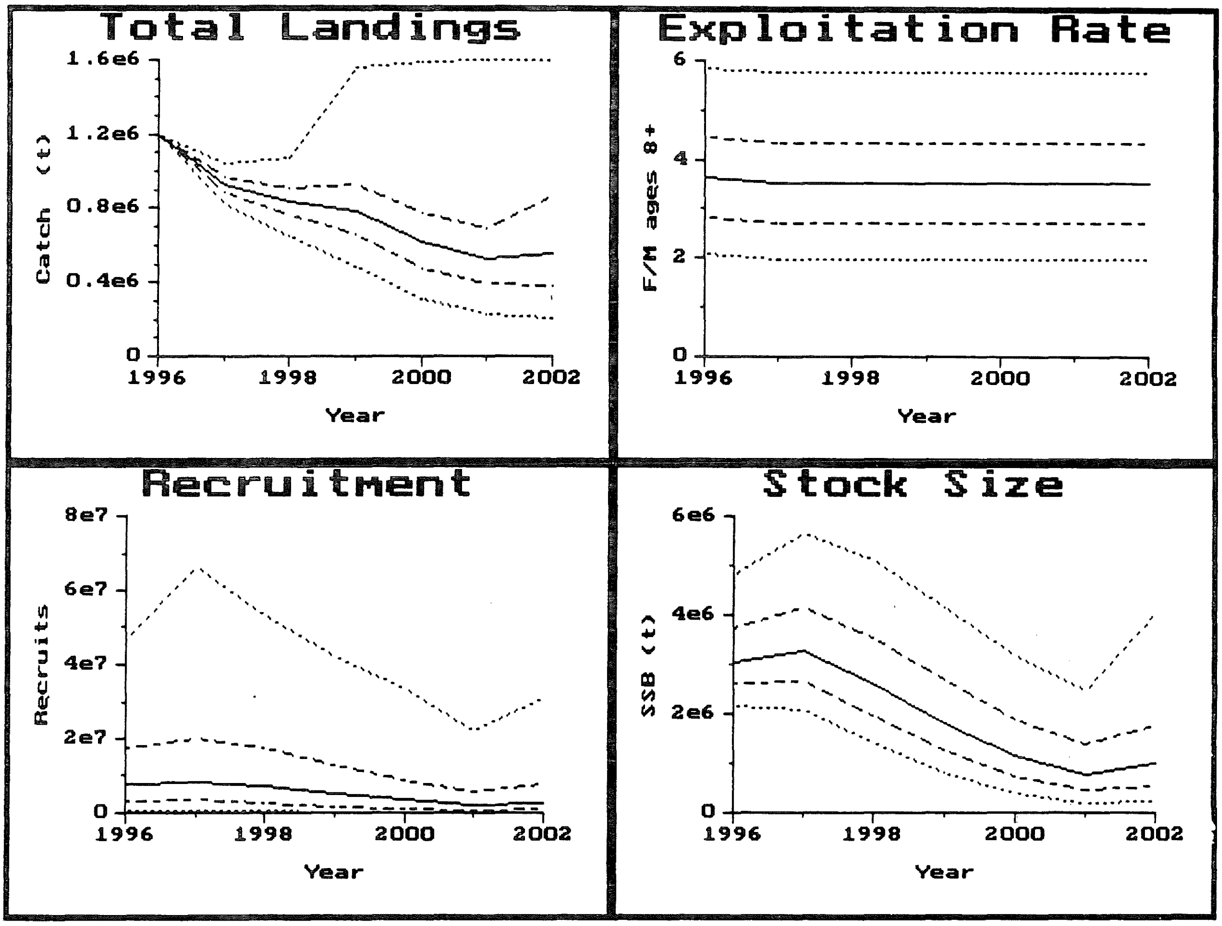


Figure 3.8.1. Norwegian Spring-Spawning Herring. Bayesian Medium-term projection for exploitation rate E in 1997-2002 = E in 1996. Upper left panel, total annual yield from the stock. Upper right panel, exploitation rate (F/M). Lower left panel, recruitment. Lower right panel, spawning stock size at spawning time. Full line, 50th percentile. Dashed line, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles.

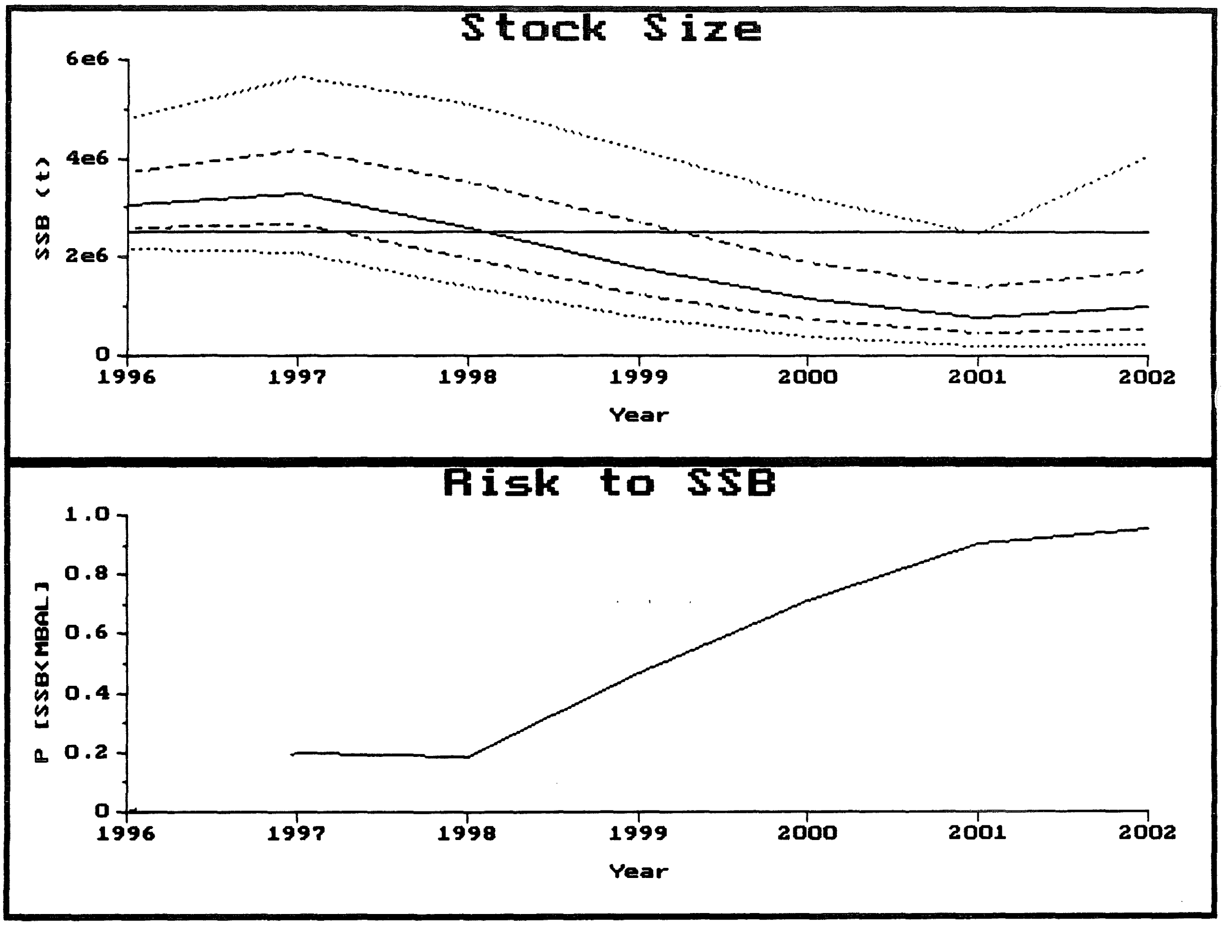


Figure 3.8.2. Norwegian Spring-Spawning Herring. Bayesian Medium-term projection for exploitation rate E in 1997-2002 = E in 1996. Upper panel, spawning stock size at spawning time. Full line, 50th percentile. Dashed line, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. Lower panel, estimated probability that the stock will be less that 2.5 Million tonnes at spawning time each year.

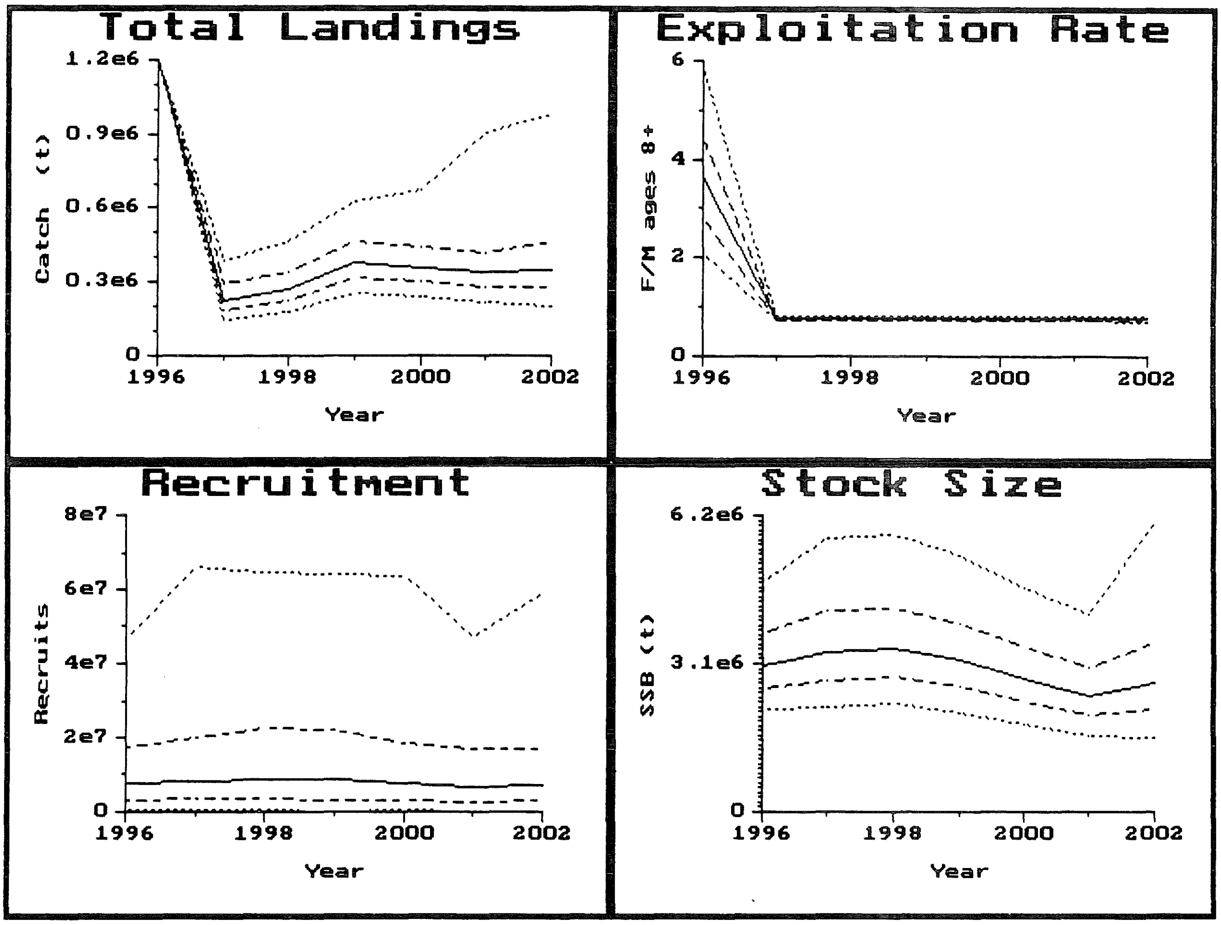


Figure 3.8.3. Norwegian Spring-Spawning Herring. Calculation of Bayes posterior perceptions of stock size and catch after application of a harvest control law limiting catch to the lower value of 1.5 Million tonnes and the catch calculated for F=M, from 1997 onwards. Exploitation pattern estimated for 1996 assumed to hold for the period 1997-2002. Upper left panel, total annual yield from the stock. Upper right panel, exploitation rate (F/M). Lower left panel, recruitment. Lower right panel, spawning stock size at spawning time. Full line, 50th percentile. Dashed line, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles.

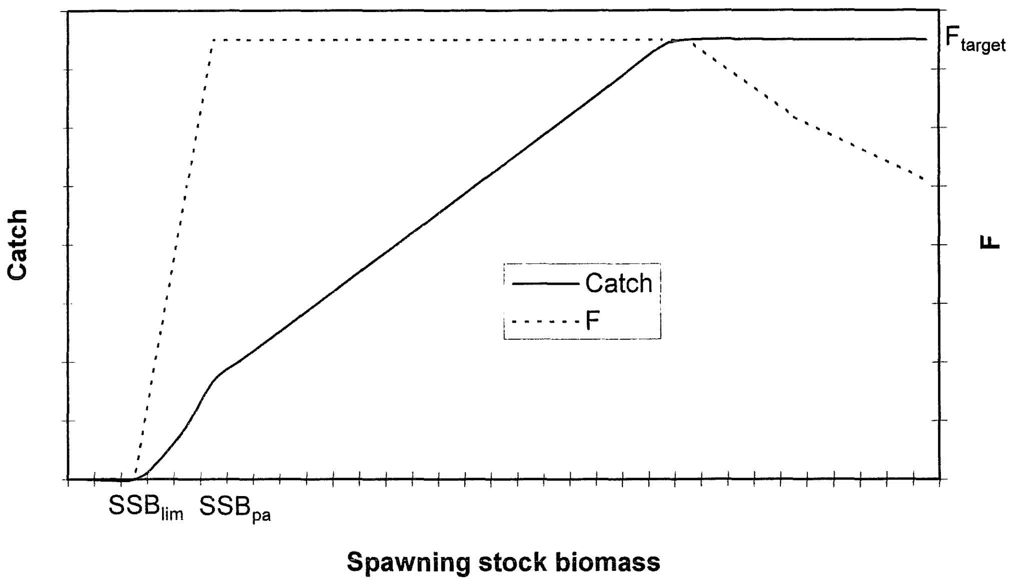


Figure 3.9.1. Schematic presentation of a possible catch control law for Norwegian spring-spawning herring. Fishing mortality (F) and catch as a function of spawning stock biomass (SSB).

Barents Sea capelin

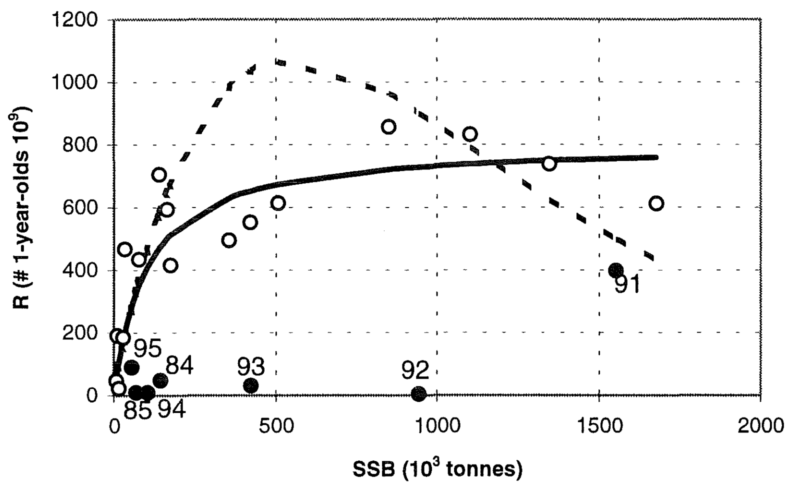


Figure 4.3.1 Stock-recruitment plot for Barents Sea capelin (1973–1995 year class). Open circles are years without herring in the Barents Sea. Filled circles are years with young herring present. The solid line is a Beverton-Holt recruitment model and the dotted line is a Ricker model, both models are based on the years without herring present.

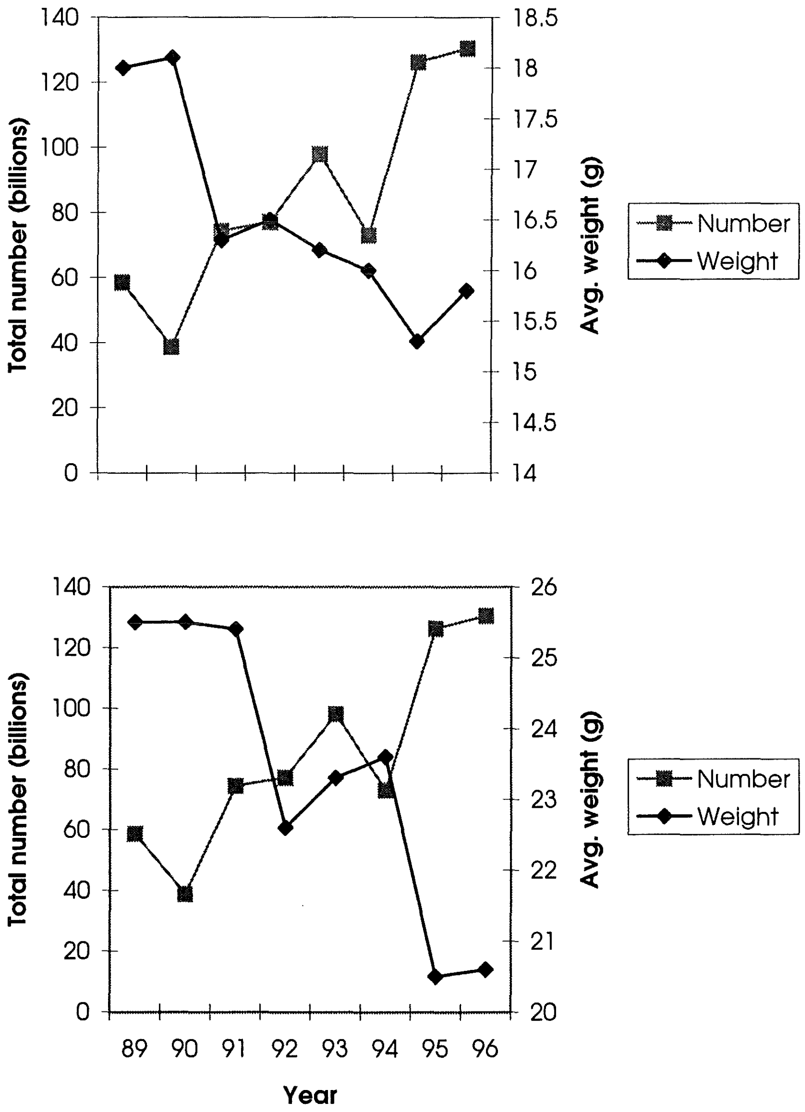


Figure 5.5.1 Trends in average weights of mature age 2 (upper graph) and age 3 (lower graph) capelin and total adult stock in number.

e:\acfm\wgnpbw97\f-5.xls

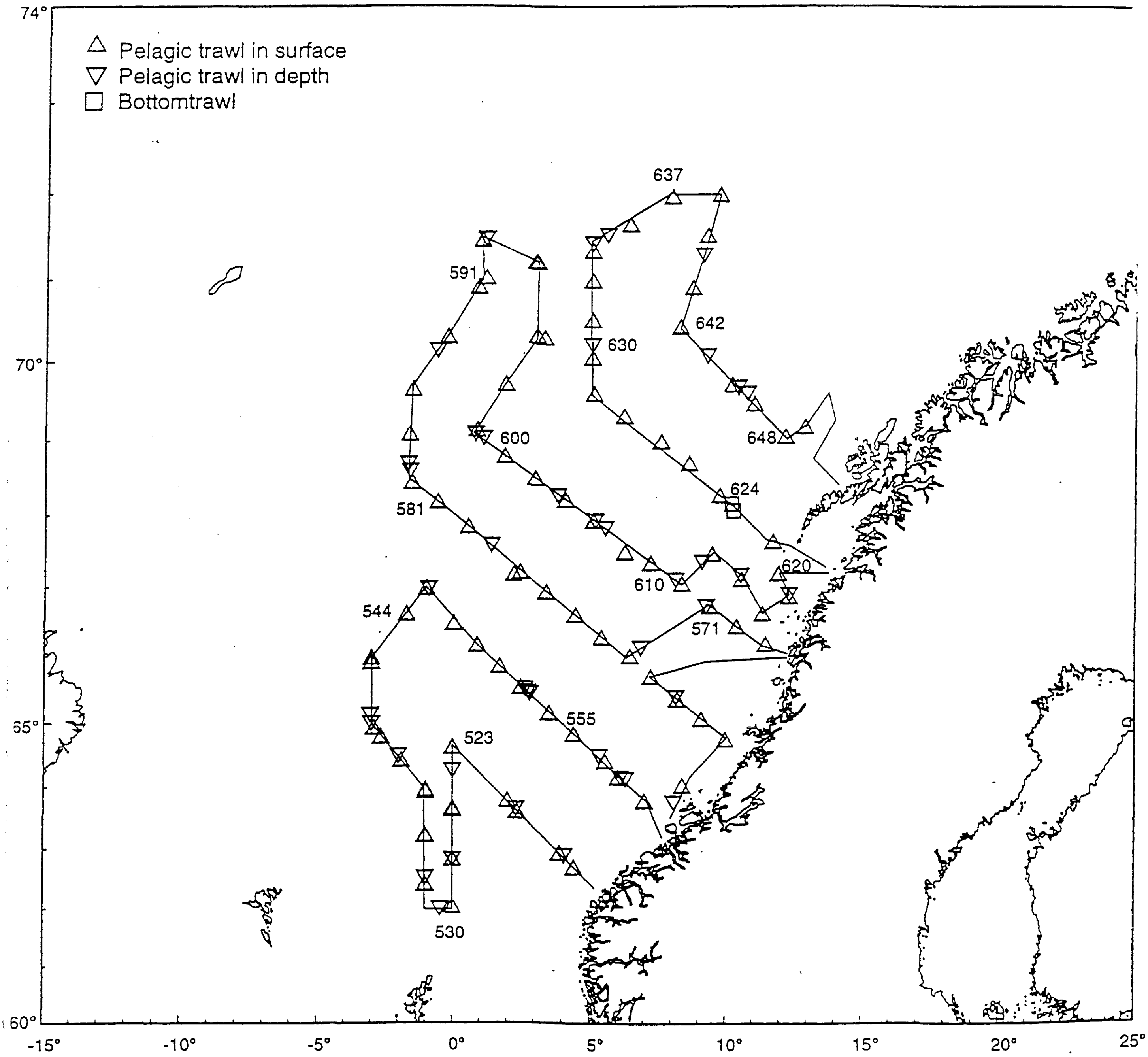


Figure 6.4.1 Cruise track with fishing stations, R.V. "G.O. Sars" 19/7–15/8 1996.

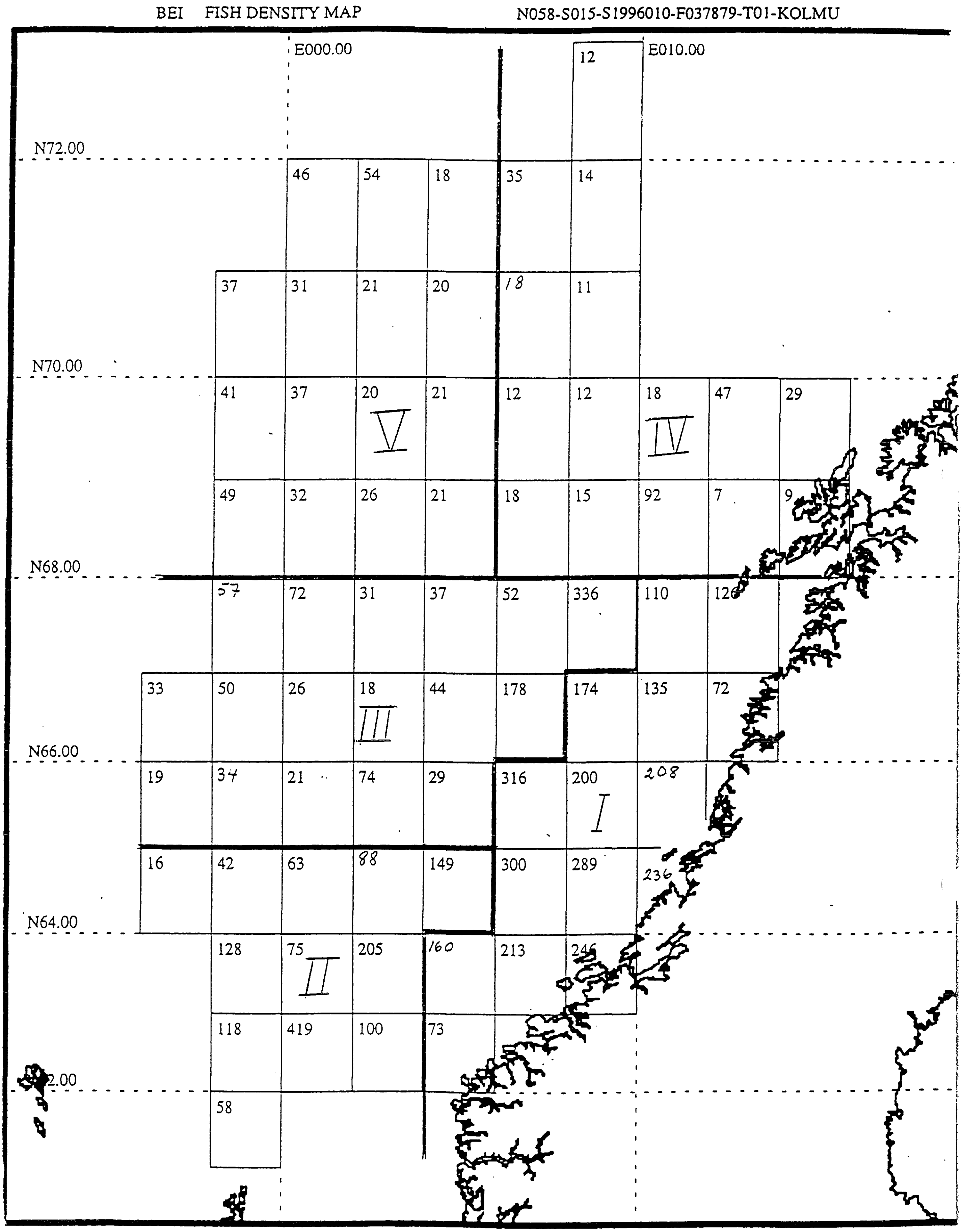


Figure 6.4.2 Distribution of blue whiting, BEI-map of S_A-values. I–V are Sub-areas represented by the length and age compositions in Figure 6.4.3.

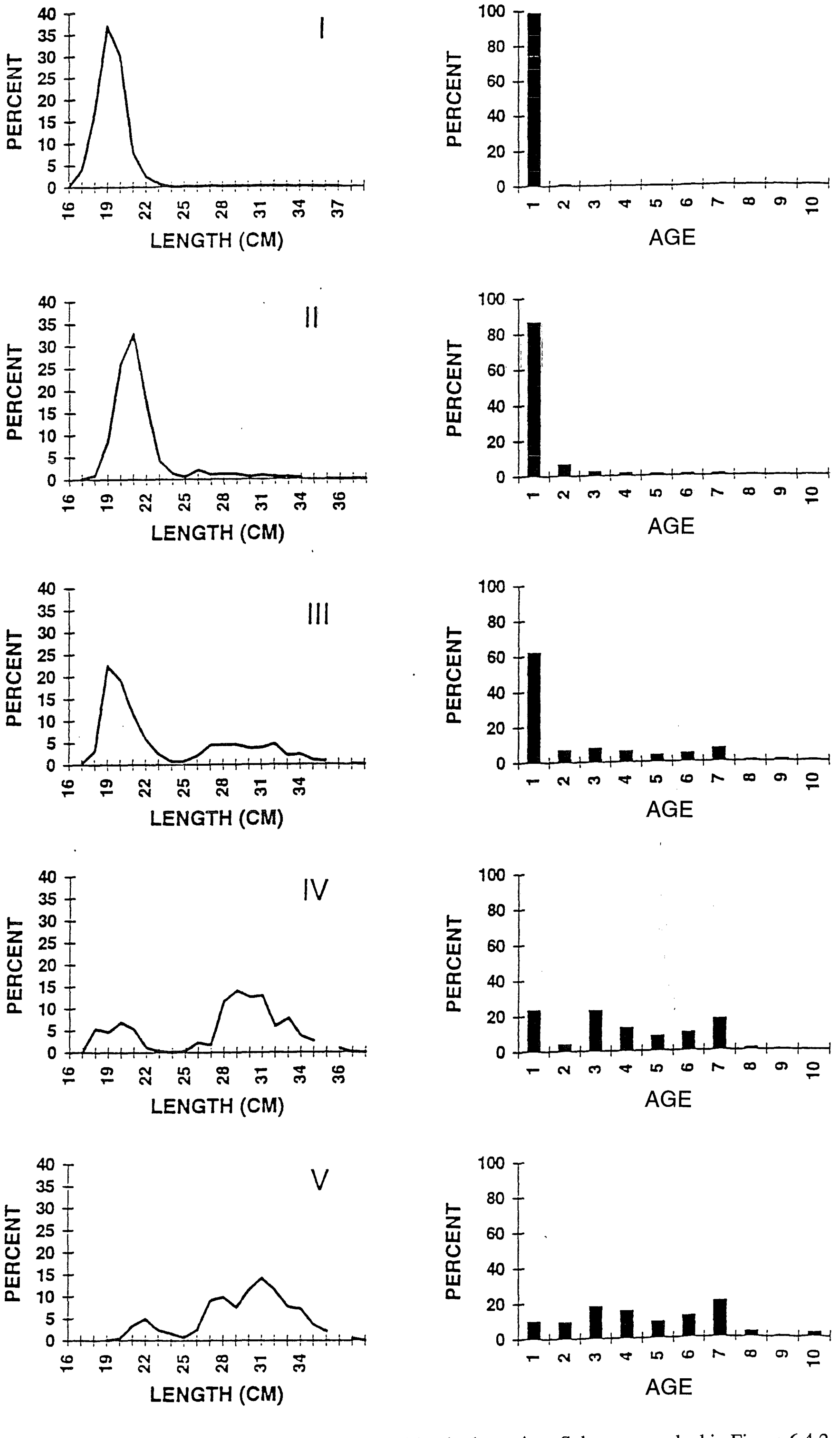


Figure 6.4.3 Length and age compositions of blue whiting in the various Sub-areas marked in Figure 6.4.2.

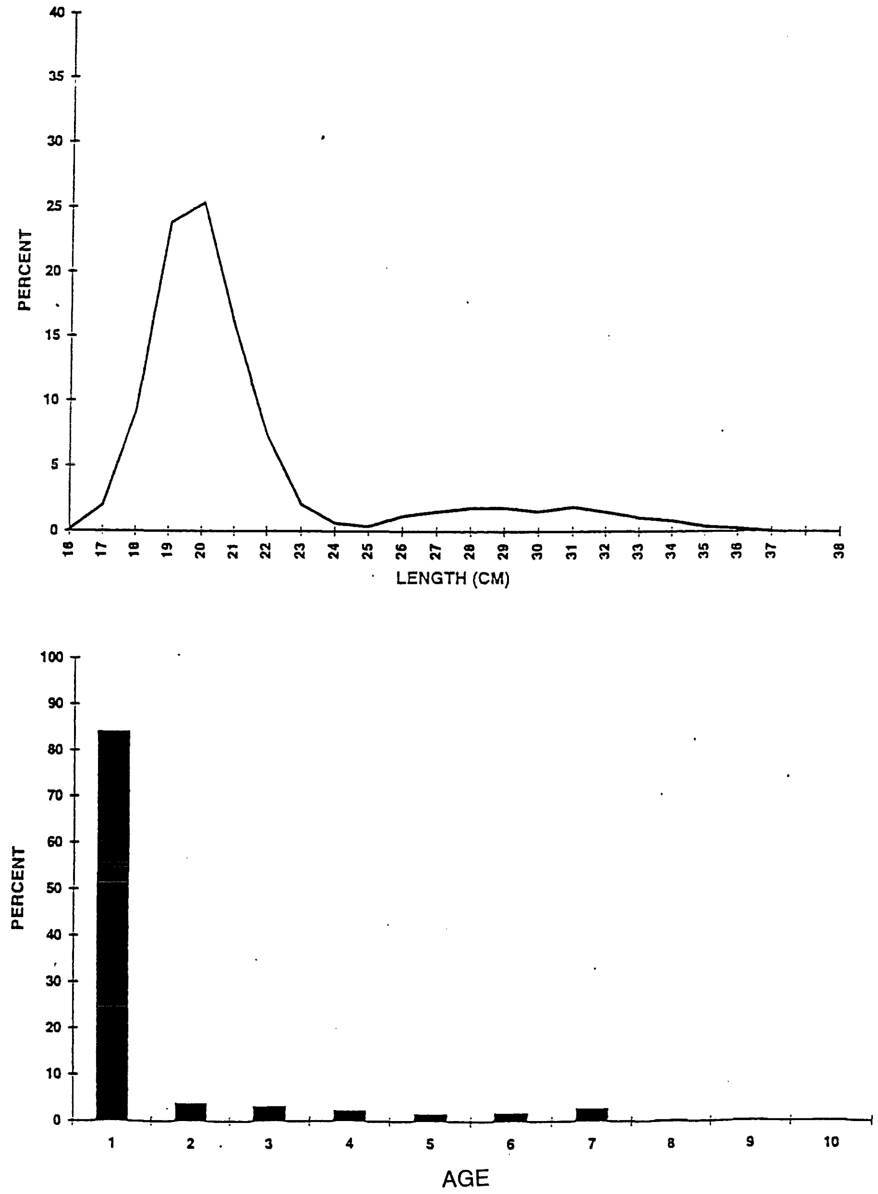


Figure 6.4.4 Total length and age compositions of blue whiting in all areas, weighted by abundance. N = 27.9 x 10^9.

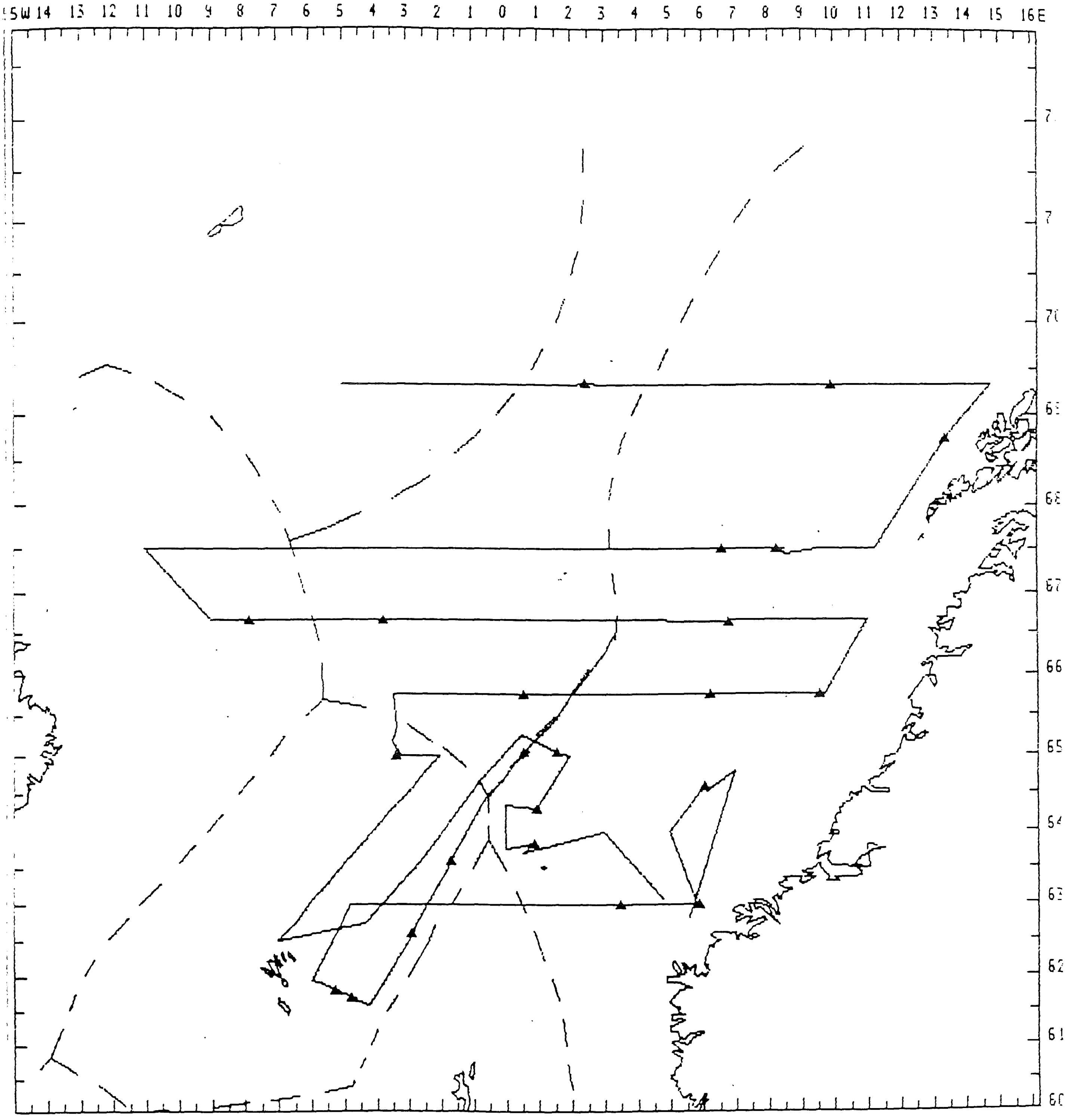


Figure 6.4.5 Cruise track with fishing stations, R.V. "F. Nansen" 12/6–11/7 1996.

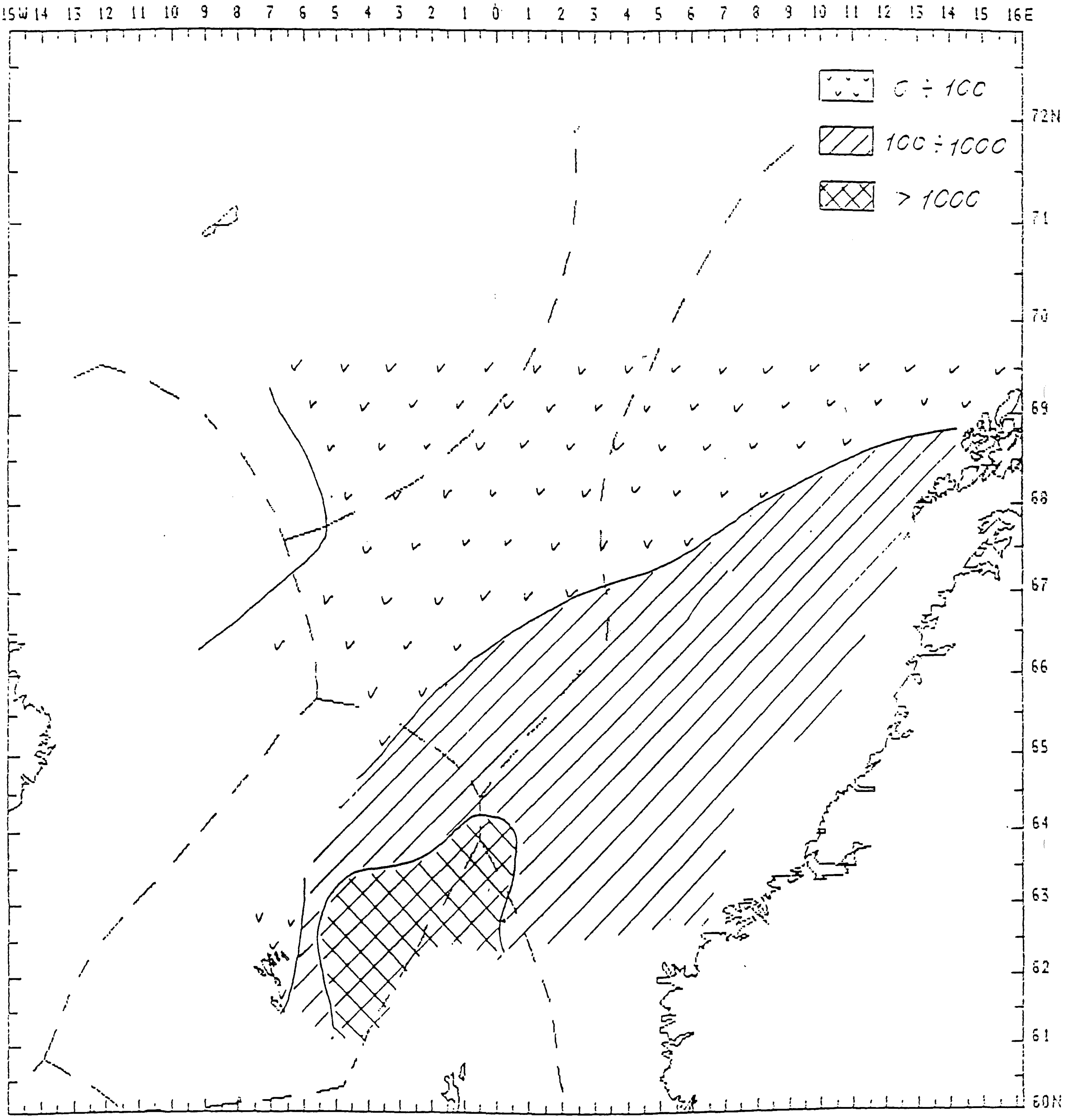


Figure 6.4.6 Distribution of blue whiting in the Norwegian Sea, map of S_A-values.

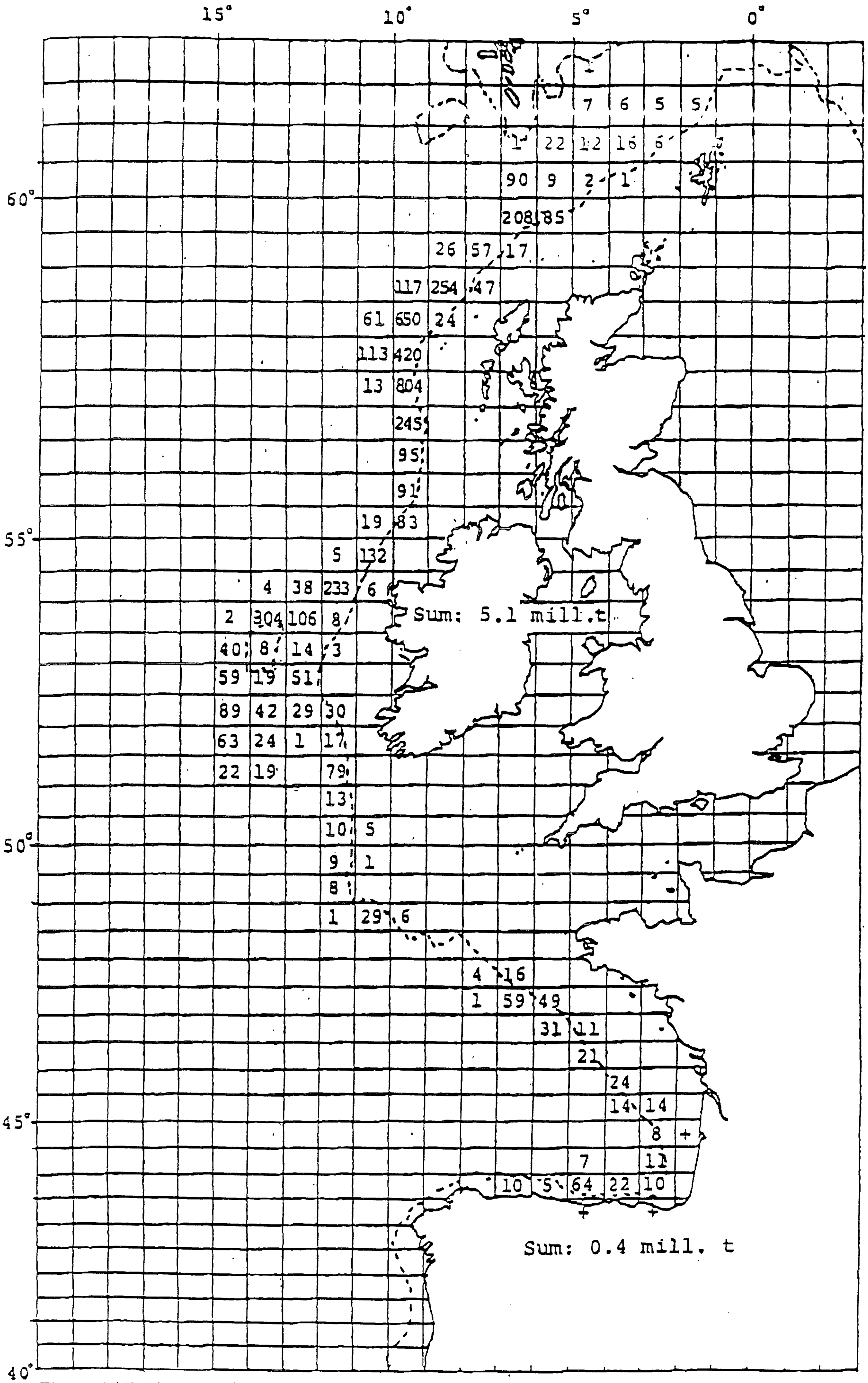


Figure 6.4.7 Biomass estimates (1,000 tonnes) of blue whiting obtained by Norway and Spain, north and south of 48°N respectively, during spring 1996.

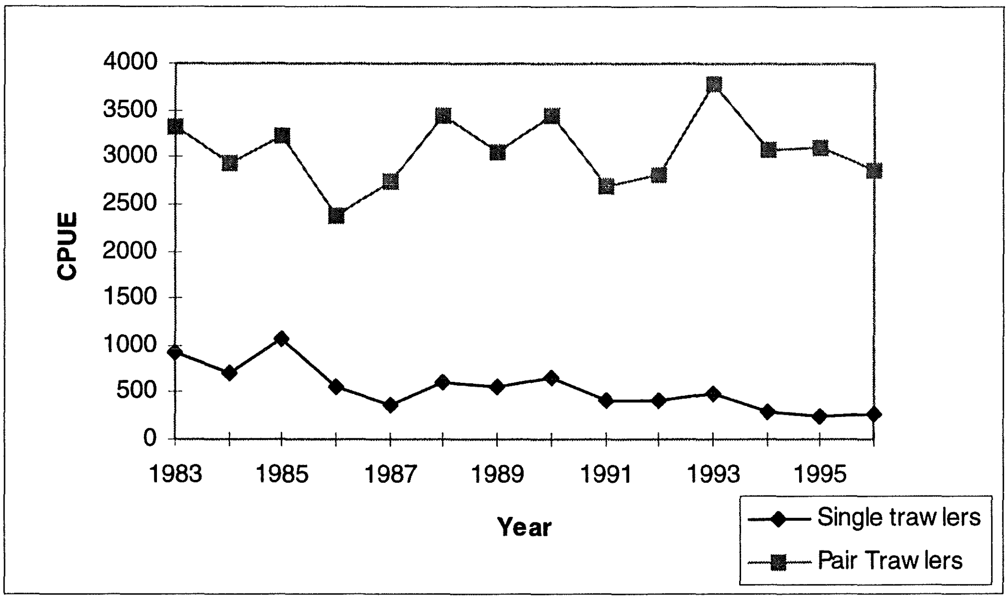


Figure 6.4.8 Blue whiting CPUE from Galician single and pair trawlers in the southern fishery (Div. VIIIc and IXa).

e:\acfm\wgnpbw97\f-648.xls

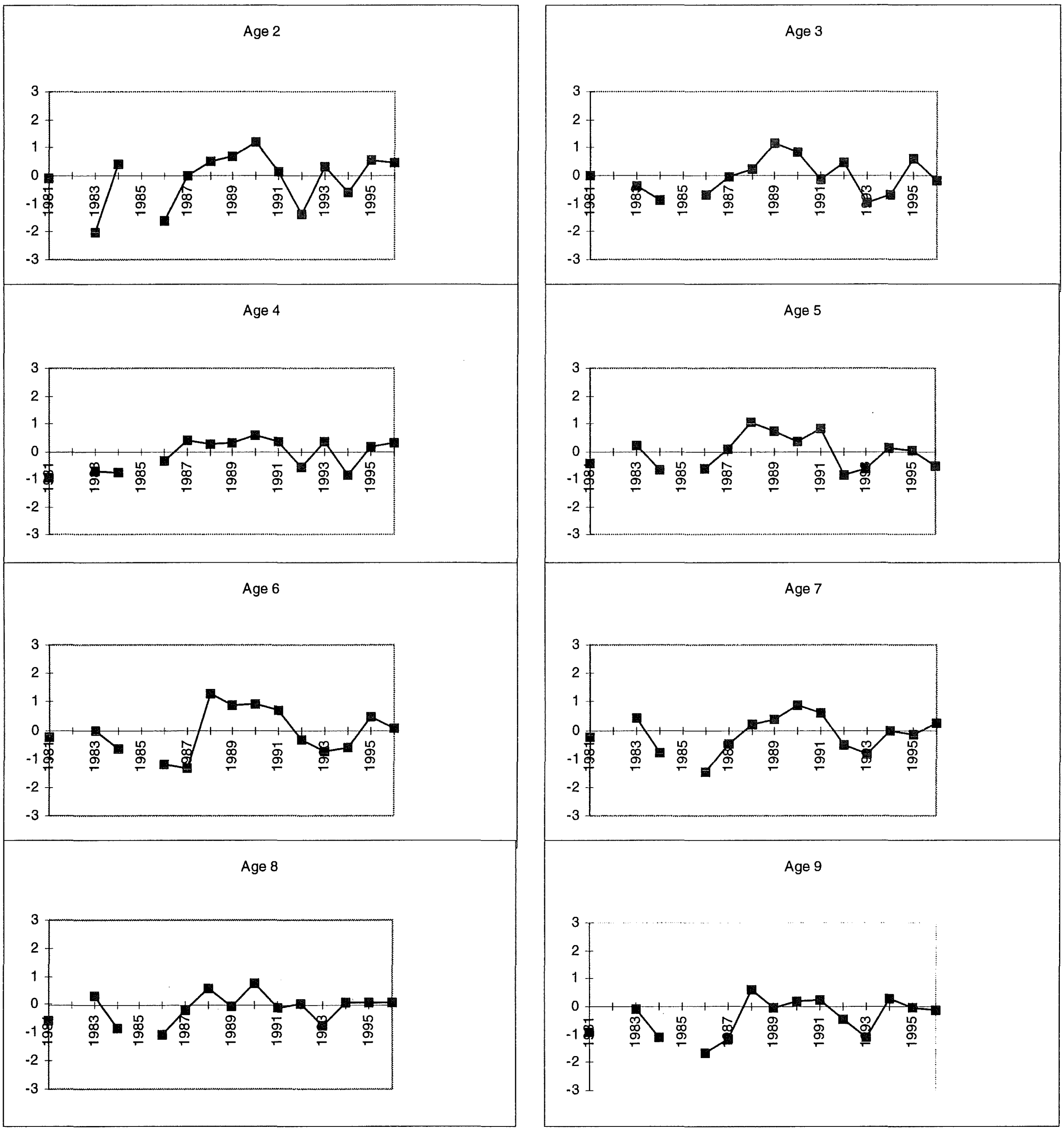


Figure 6.4.9 a Log catchability residuals plots by age and year for the Norwegian acoustic survey in the Spawning area.

e:\acfm\wgnpbw97\f-649a.xls

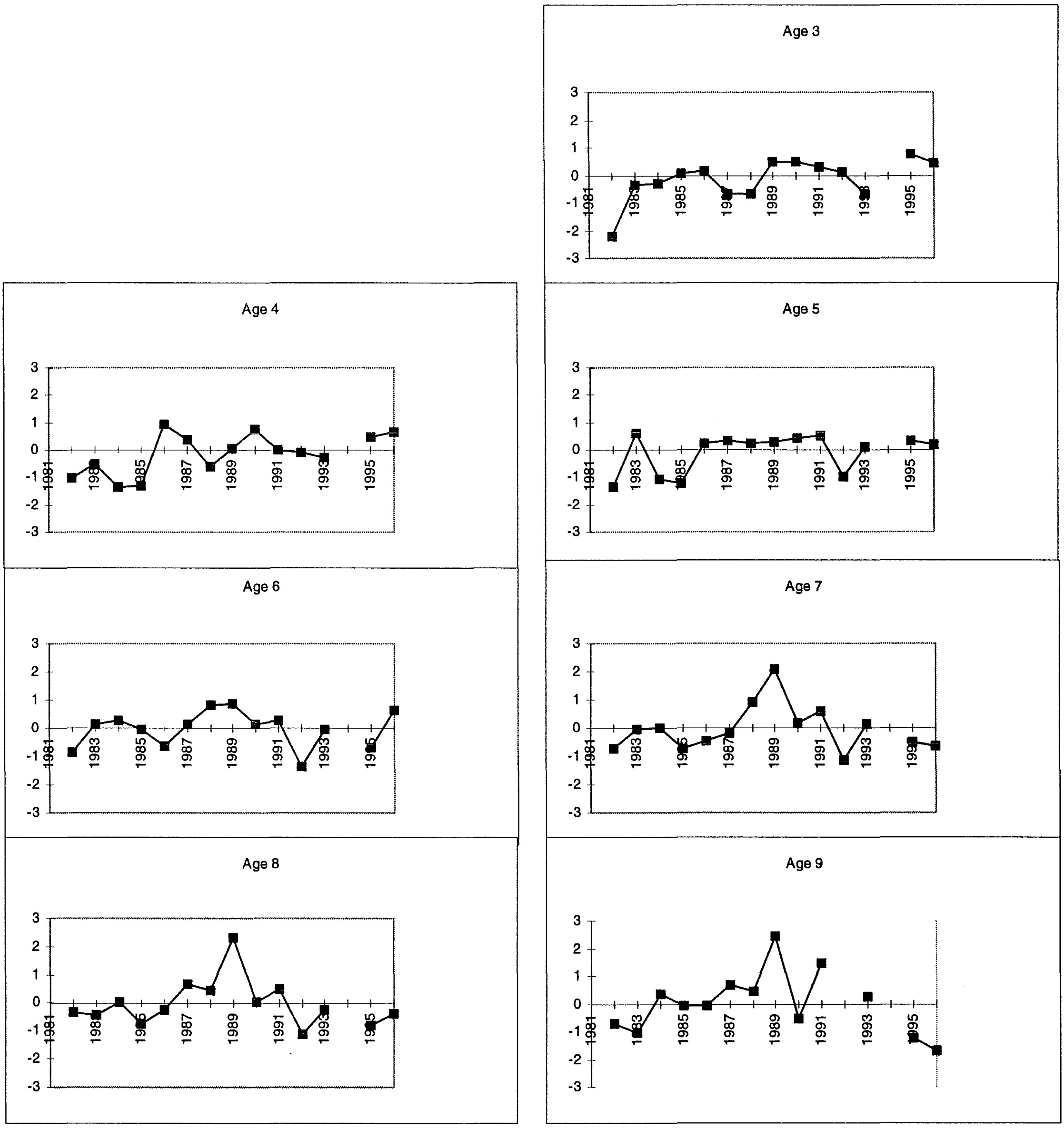


Figure 6.4.9 b Log catchability residuals plots by age and year for the Russian acoustic survey in the Spawning area

e:\acfm\wgnpbw97\f-649b.xls

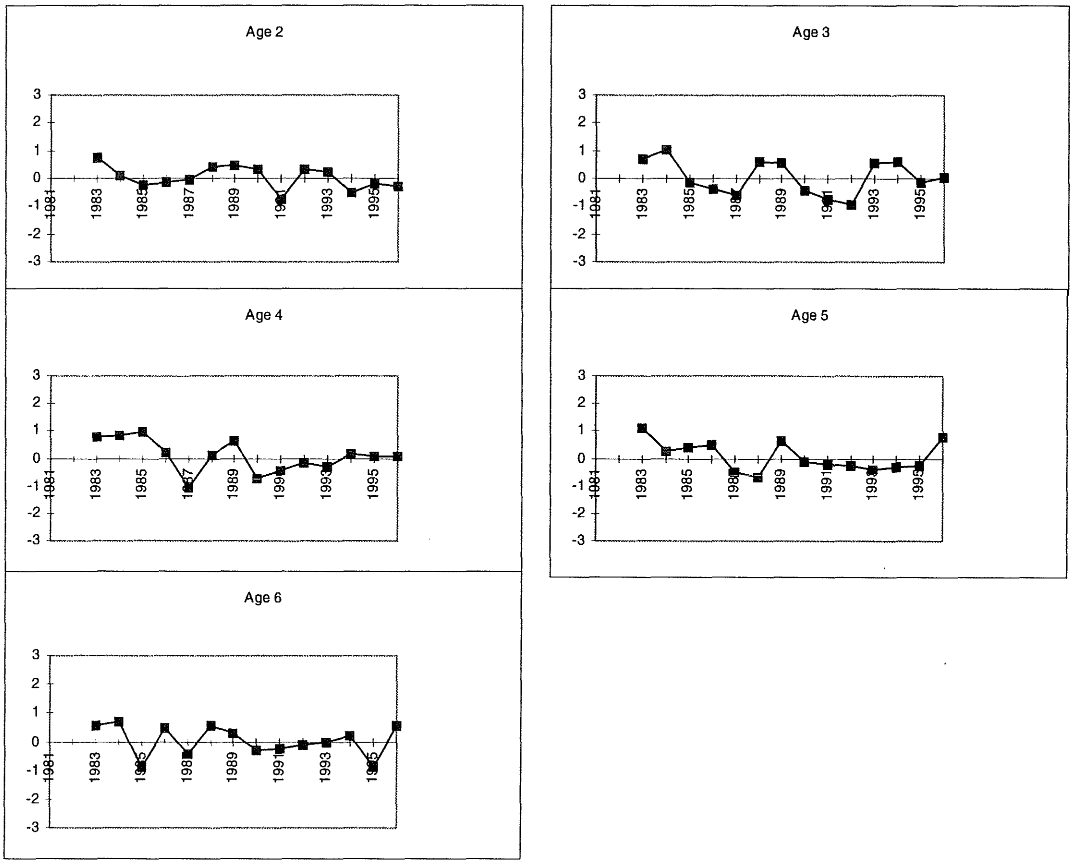


Figure 6.4.9 c Log catchability residuals plots by age and year for the Spanish Pair trawlers.

e:\acfm\wgnpbw97\f-649c.xls

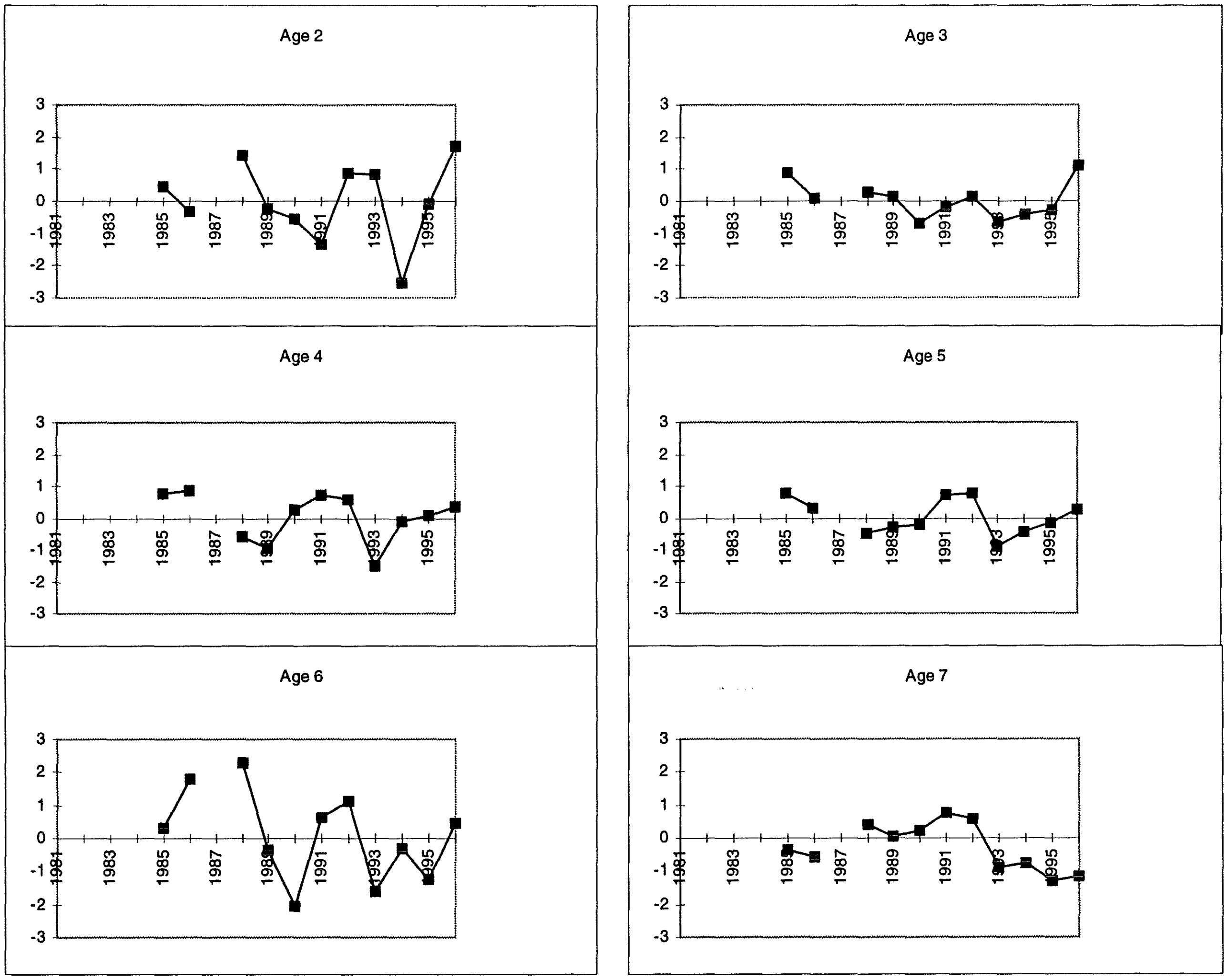


Figure 6.4.9 d Log catchability residuals plots by age and year for the Spanish bottom trawl surveys.

e:\acfm\wgnpbw97\f-649d.xls

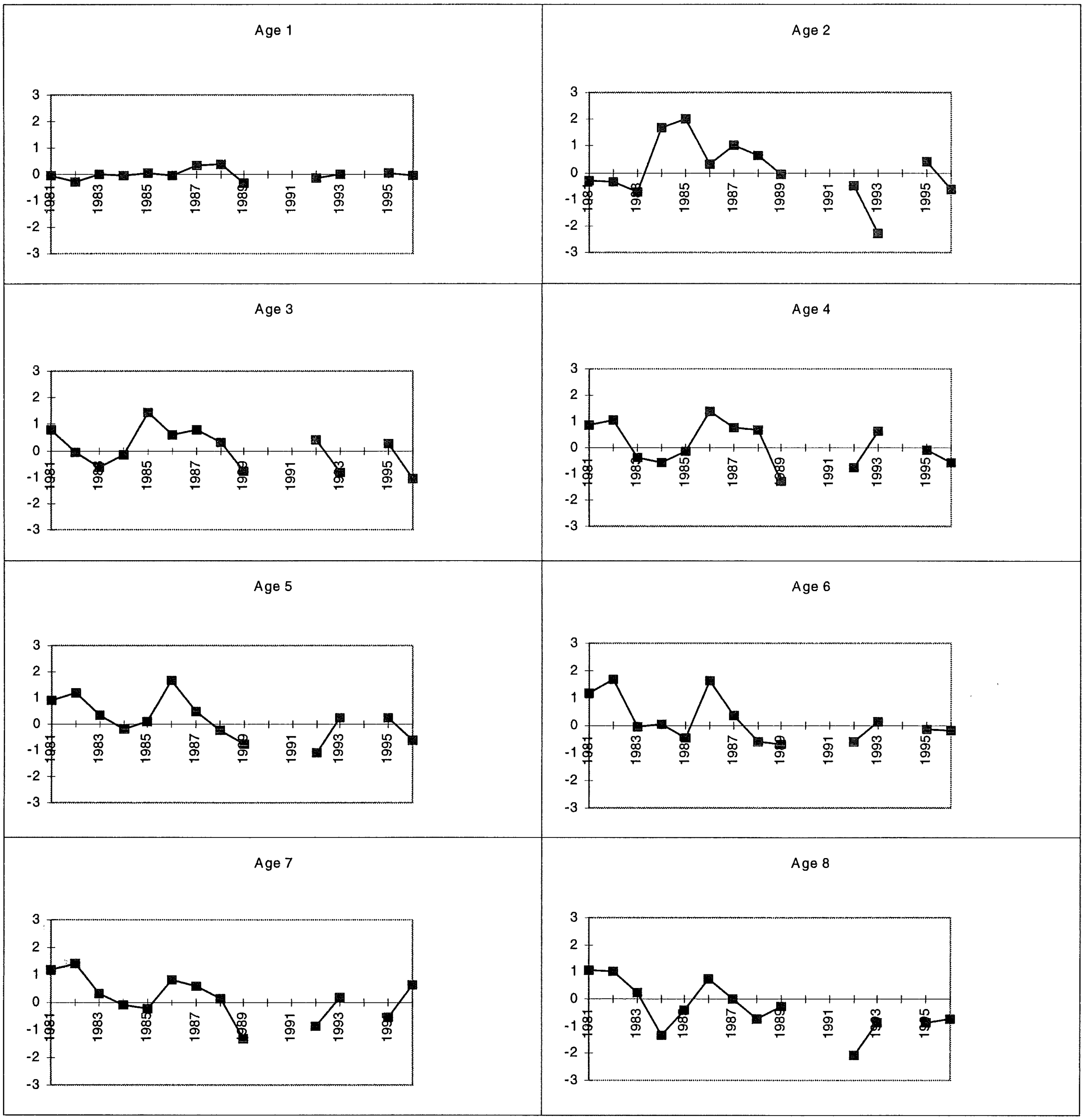


Figure 6.4.9 e Log catchability residuals plots for the Norwegian Sea acoustic surveys.

e:\acfm\wgnpbw97\f-649e.xls

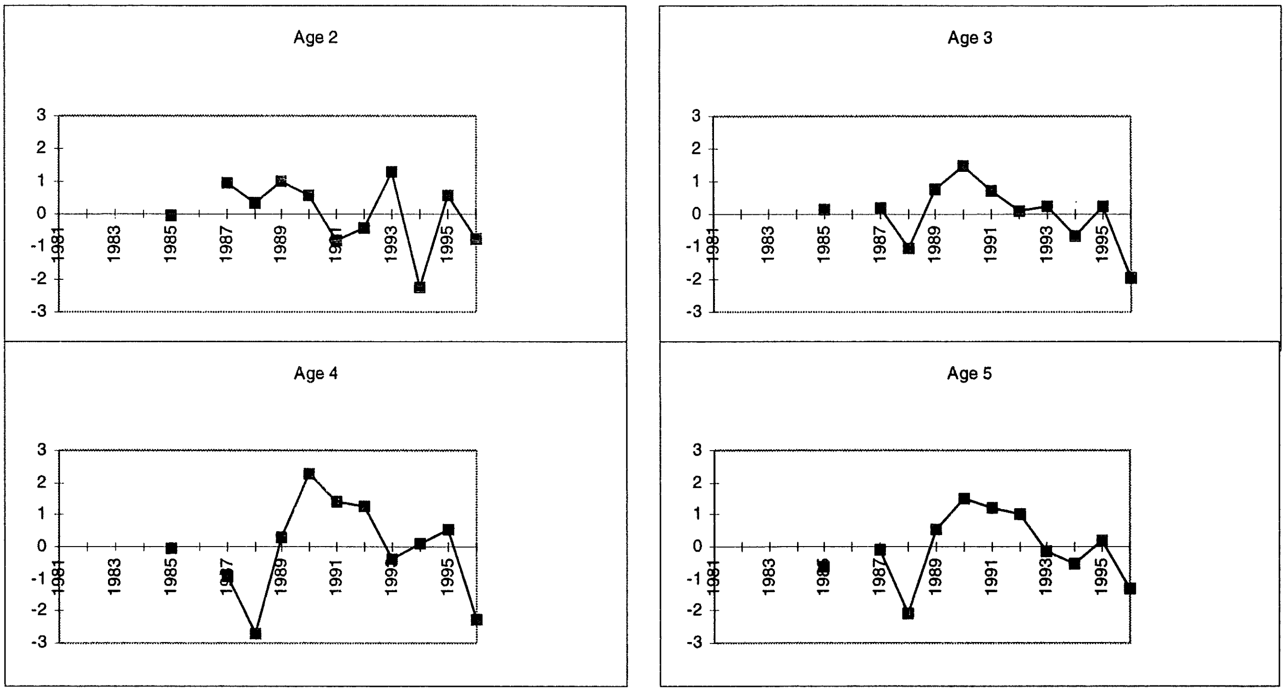


Figure 6.4.9 f Log catchability residuals plots for the Portuguese Bottom trawl surveys.

e:\acfm\wgnpbw97\f-649f.xls

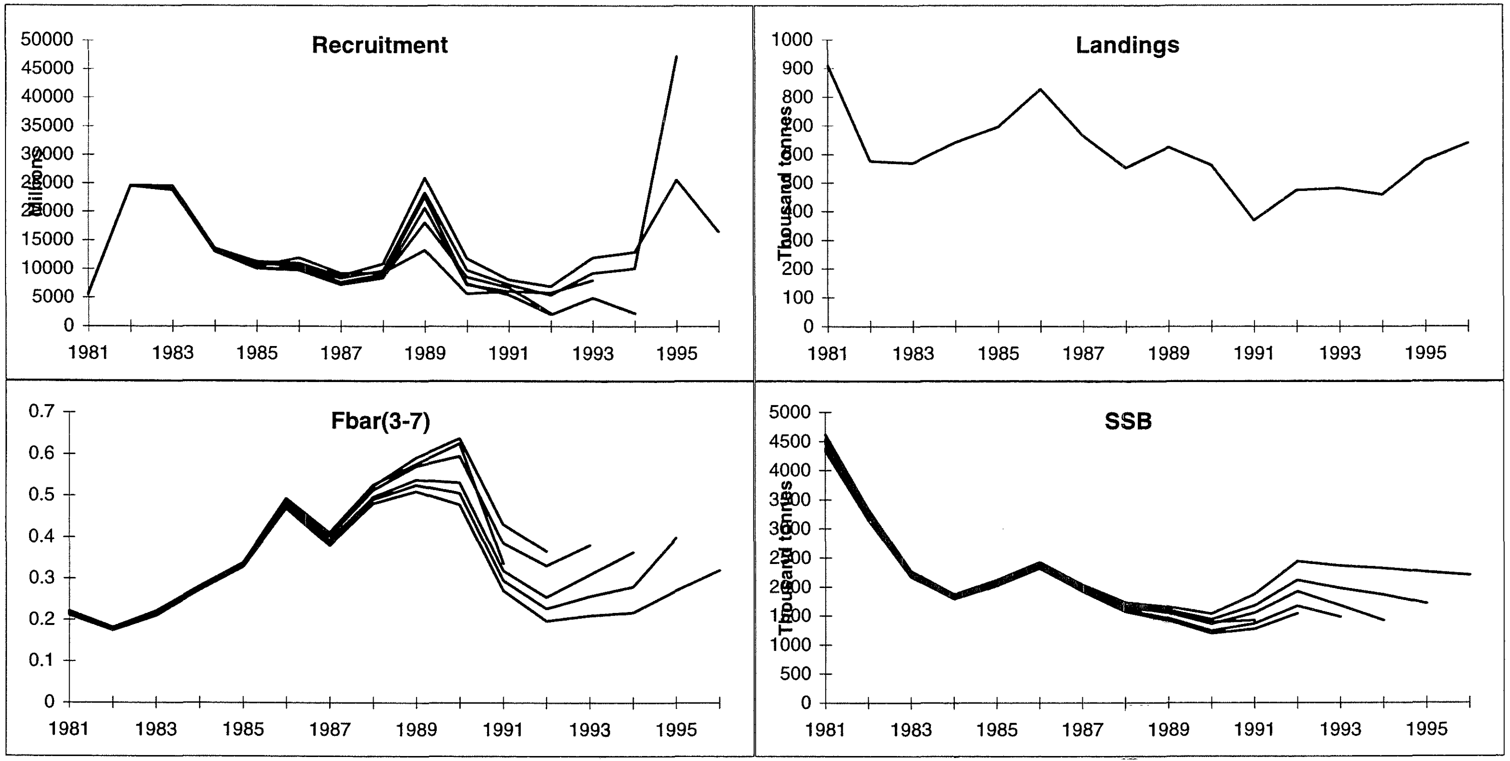


Figure 6.4.10 Blue whiting. Results of retrospective analysis, with terminal Fs derived from Extended Survivors Analysis (XSA).

e:\acfm\wgnpbw97\f-6410.xls

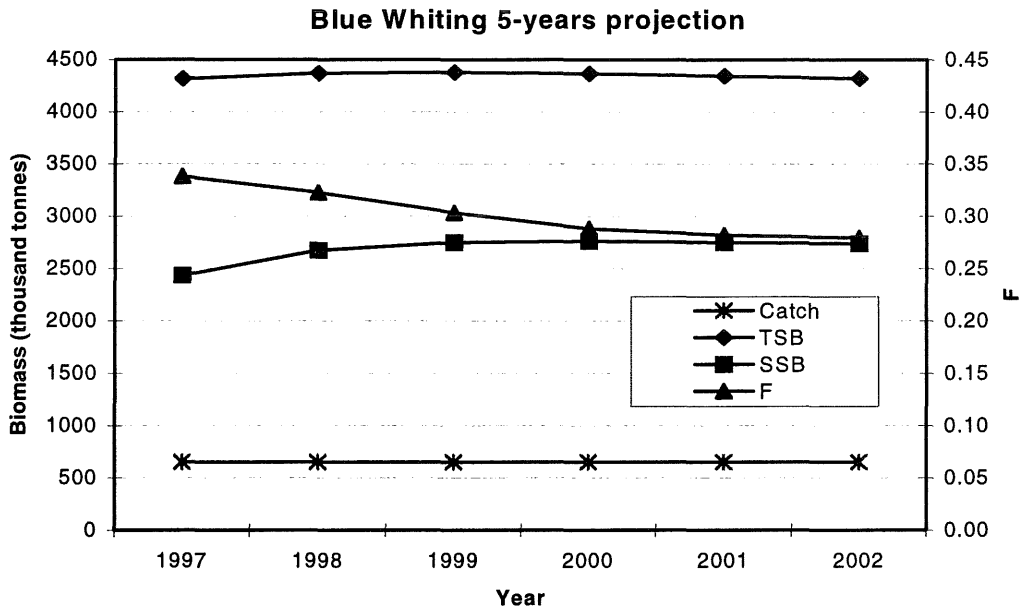


Figure 6.6.1 Medium-term projection of the blue whiting (combined stock). Catch, total stock biomass (TSB)and spawning stock biomass (SSB) refers to the left axis, and fishing mortality (F) to the right one.

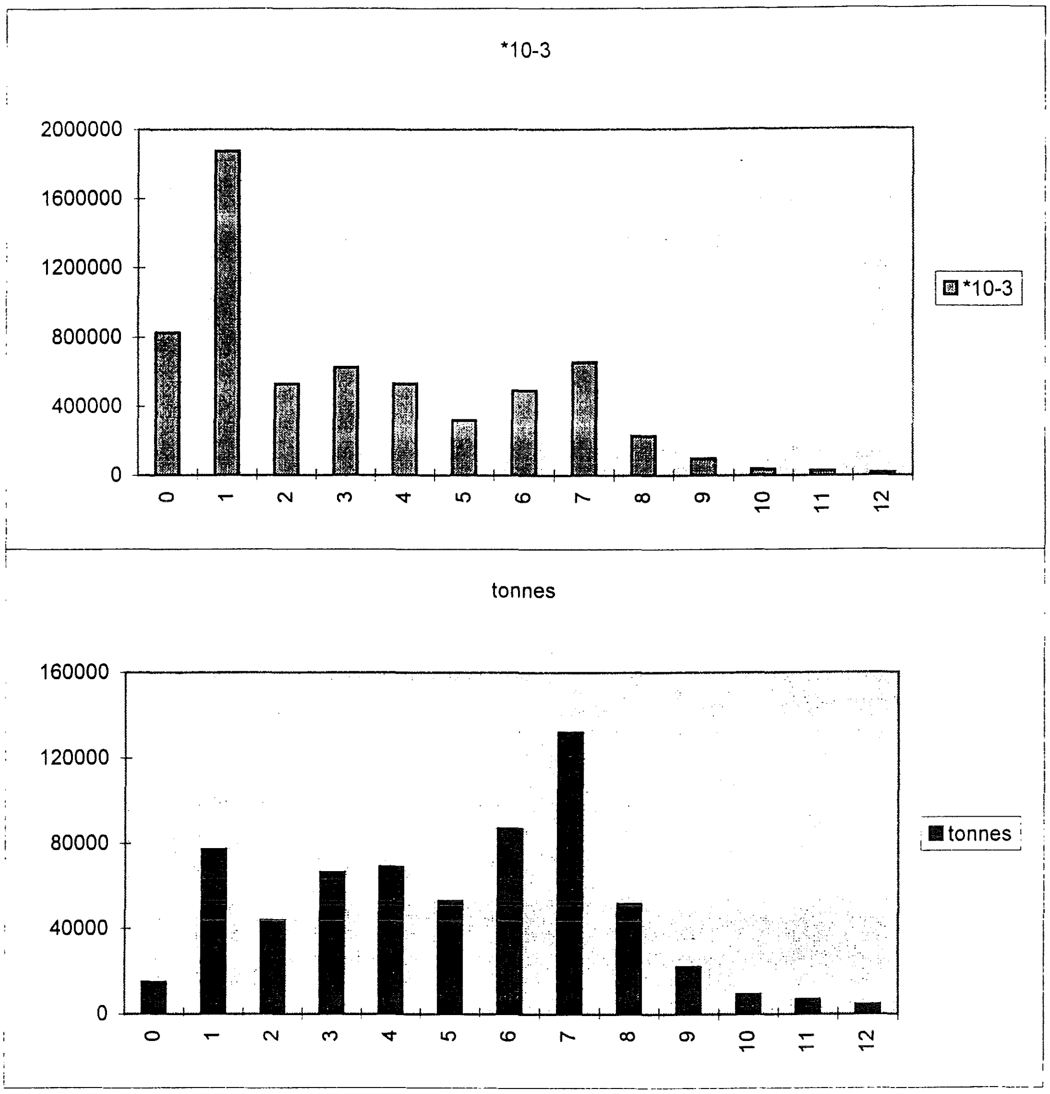


Figure 6.7.1 Total catch of blue whiting in 1996 by age groups, in numbers (upper) and tonnes (lower).

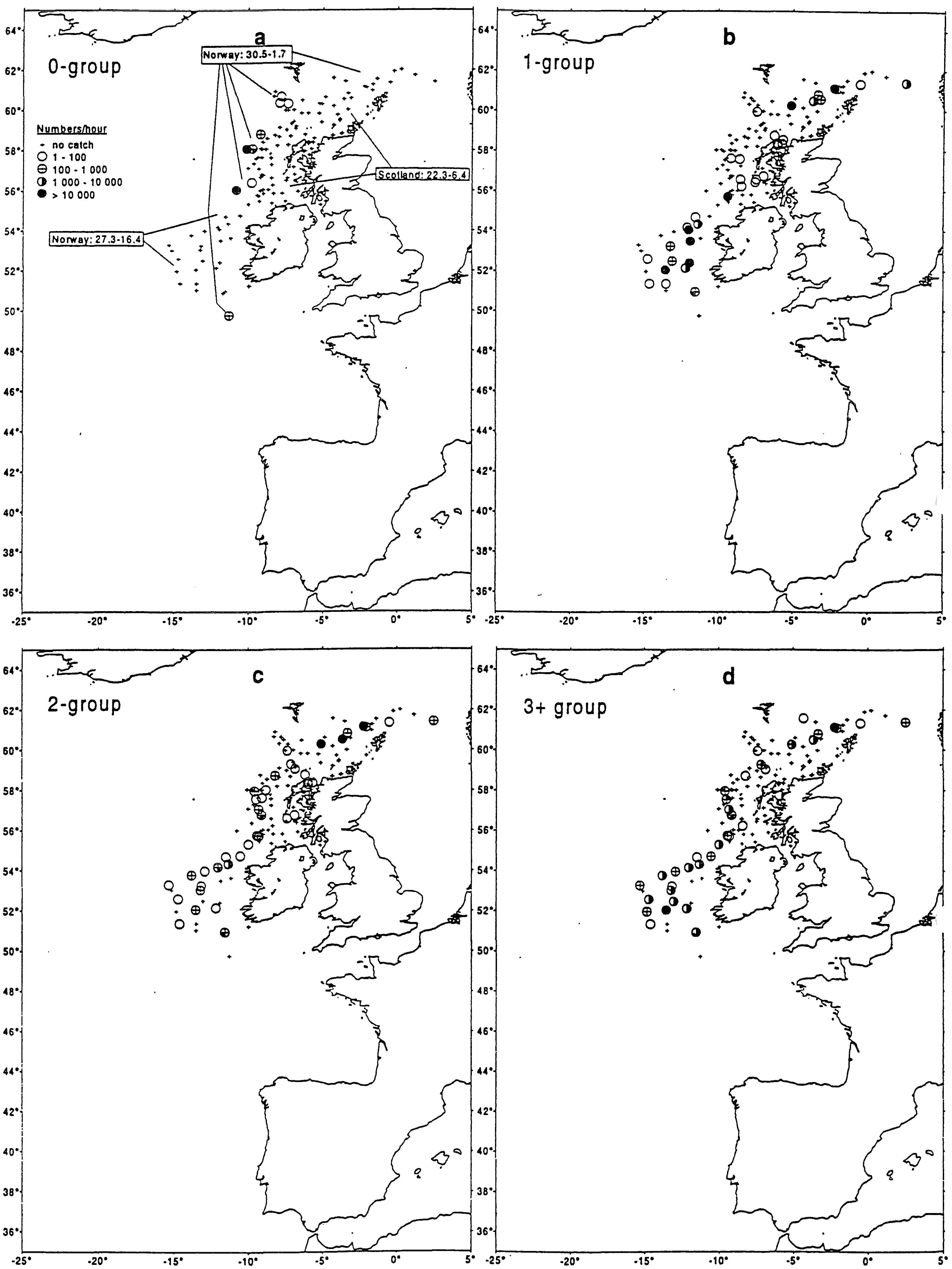


Figure 6.7.2 Survey trawl stations and catch of blue whiting (N/hour) in 1st half of 1995.
a) 0-group, survey nation and date; b) 1-group; c) 2-group; d) 3+ group.

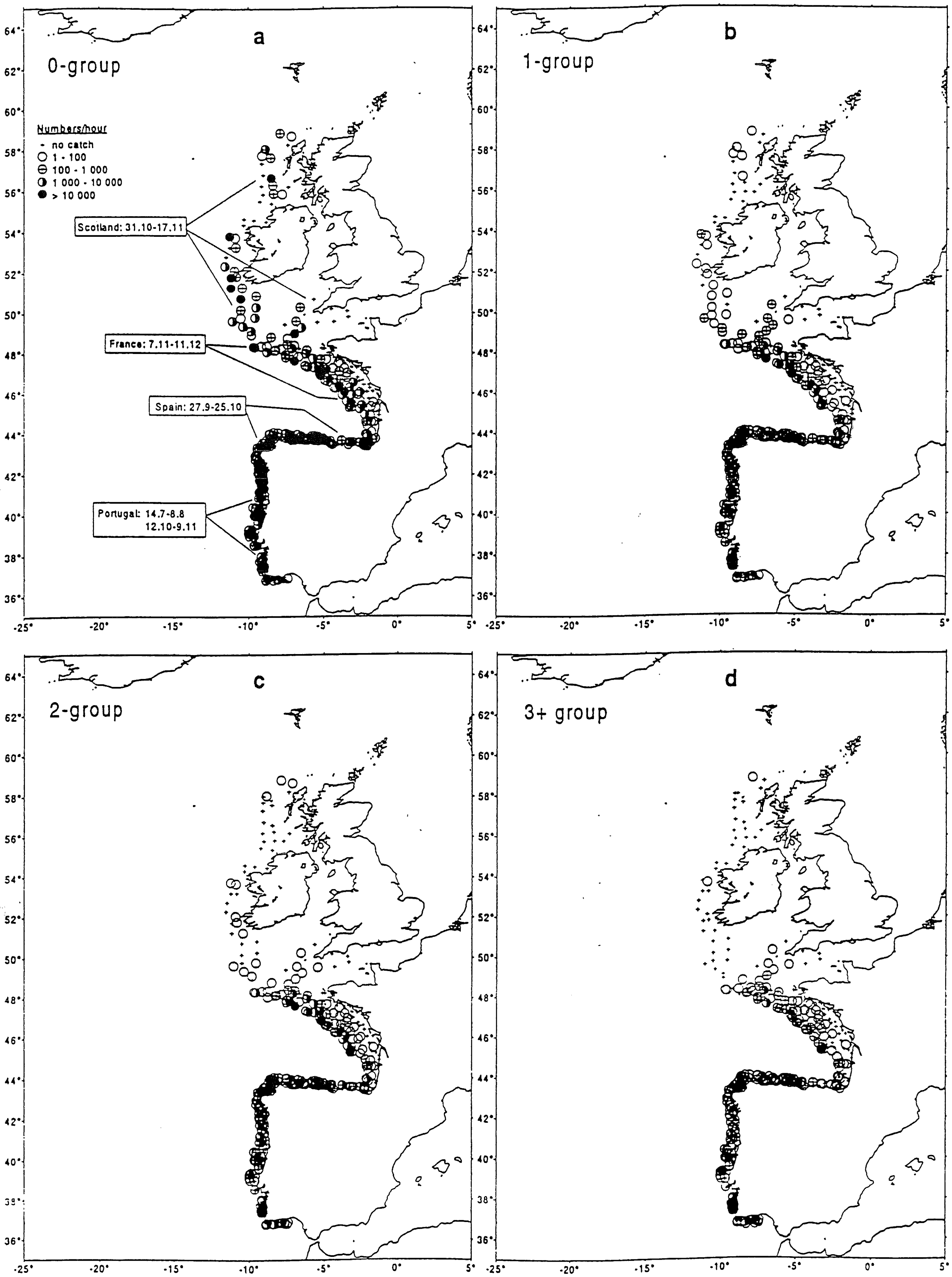


Figure 6.7.3 Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1995.
a) 0-group, survey nation and date; b) 1-group; c) 2-group; d)3+ group.

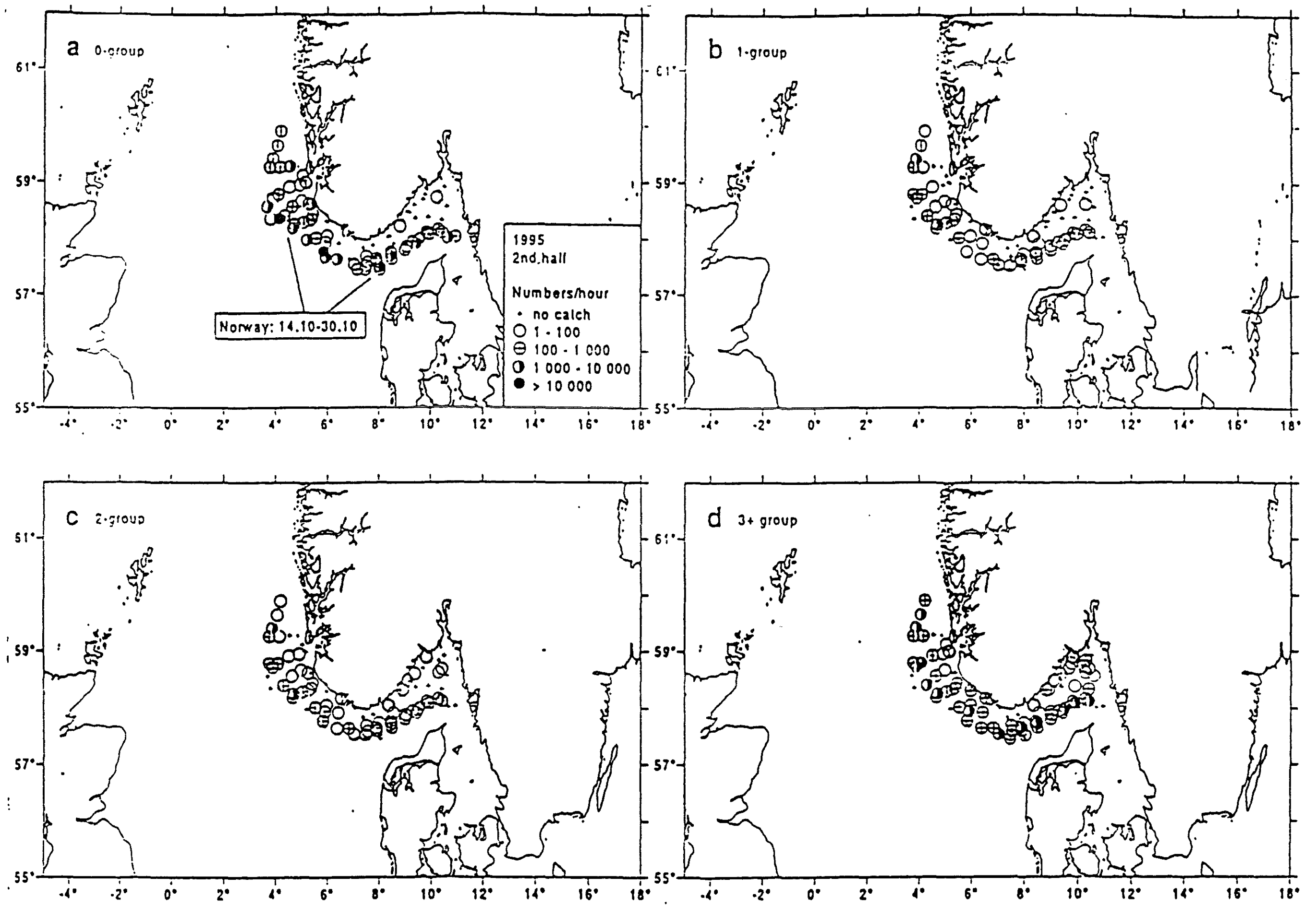


Figure 6.7.4 Survey trawl stations and catch of blue whiting (N/hour) in 2nd half of 1995.
a) 0-group, survey nation and date; b) 1-group; c) 2-group; d)3+ group.

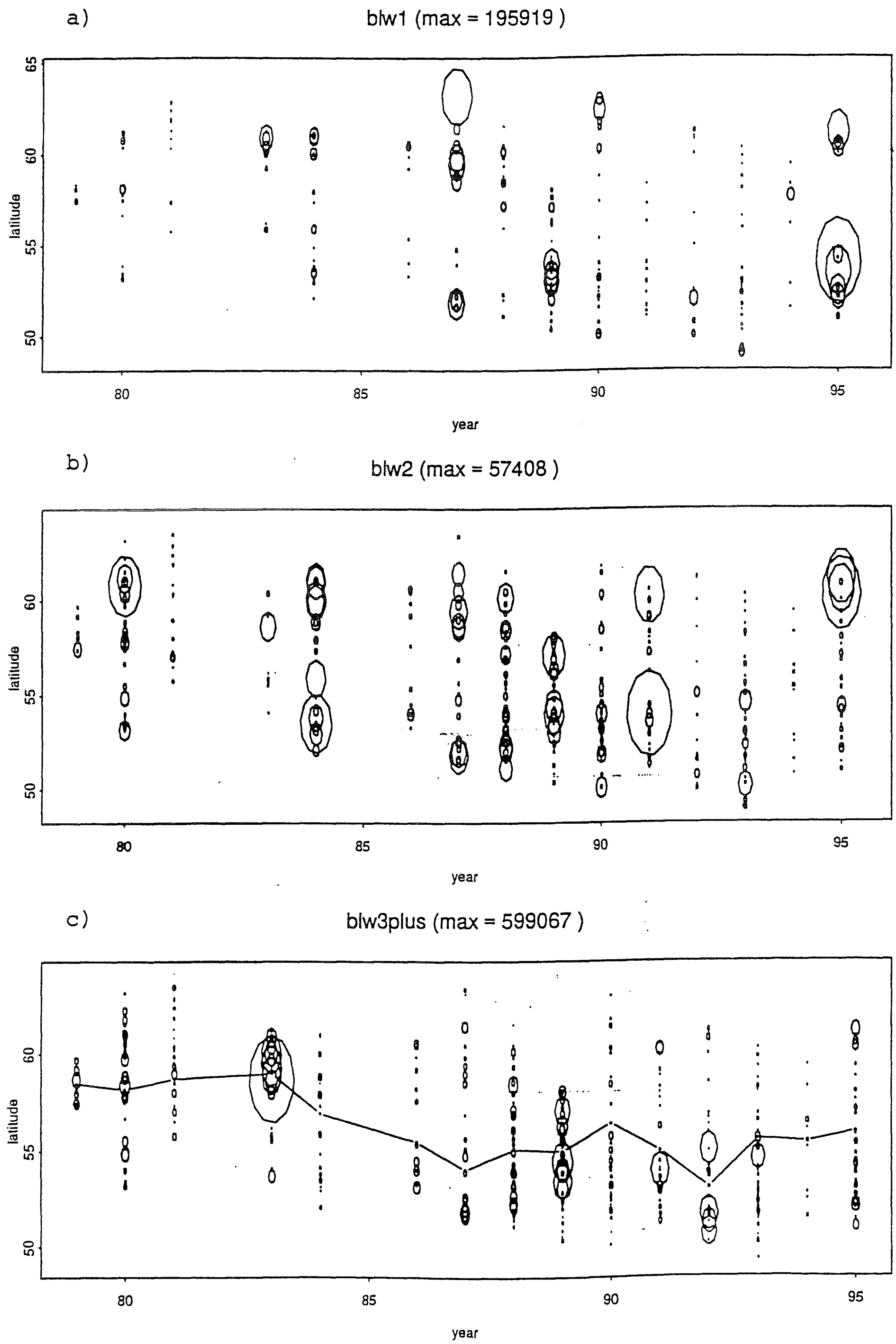


Figure 6.7.5 Catch of blue whiting by age group (in absolute numbers) and latitude, from the Norwegian surveys west of the British Isles 1979–95.
a) 1-group; b) 2-group; c) 3+ group.

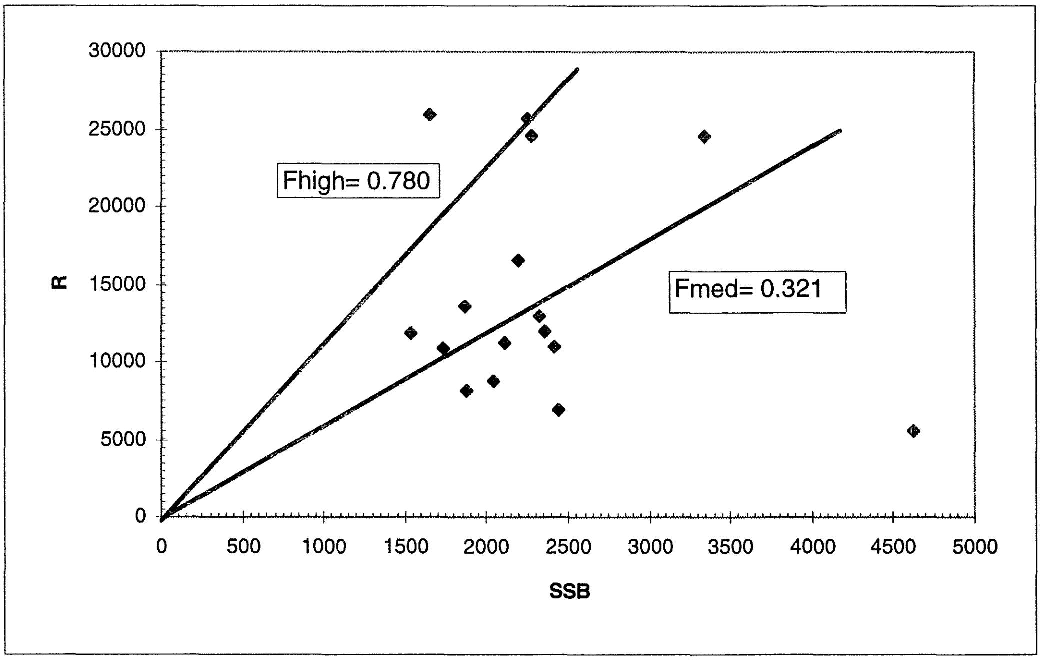


Figure 6.8.1 Blue whiting. Stock recrutment plot with F_{med} and F_{high} replacement lines.

e:\acfm\wgnpbw97\f-681.xls

FISH STOCK SUMMARY
STOCK: blue whiting
6-5-97

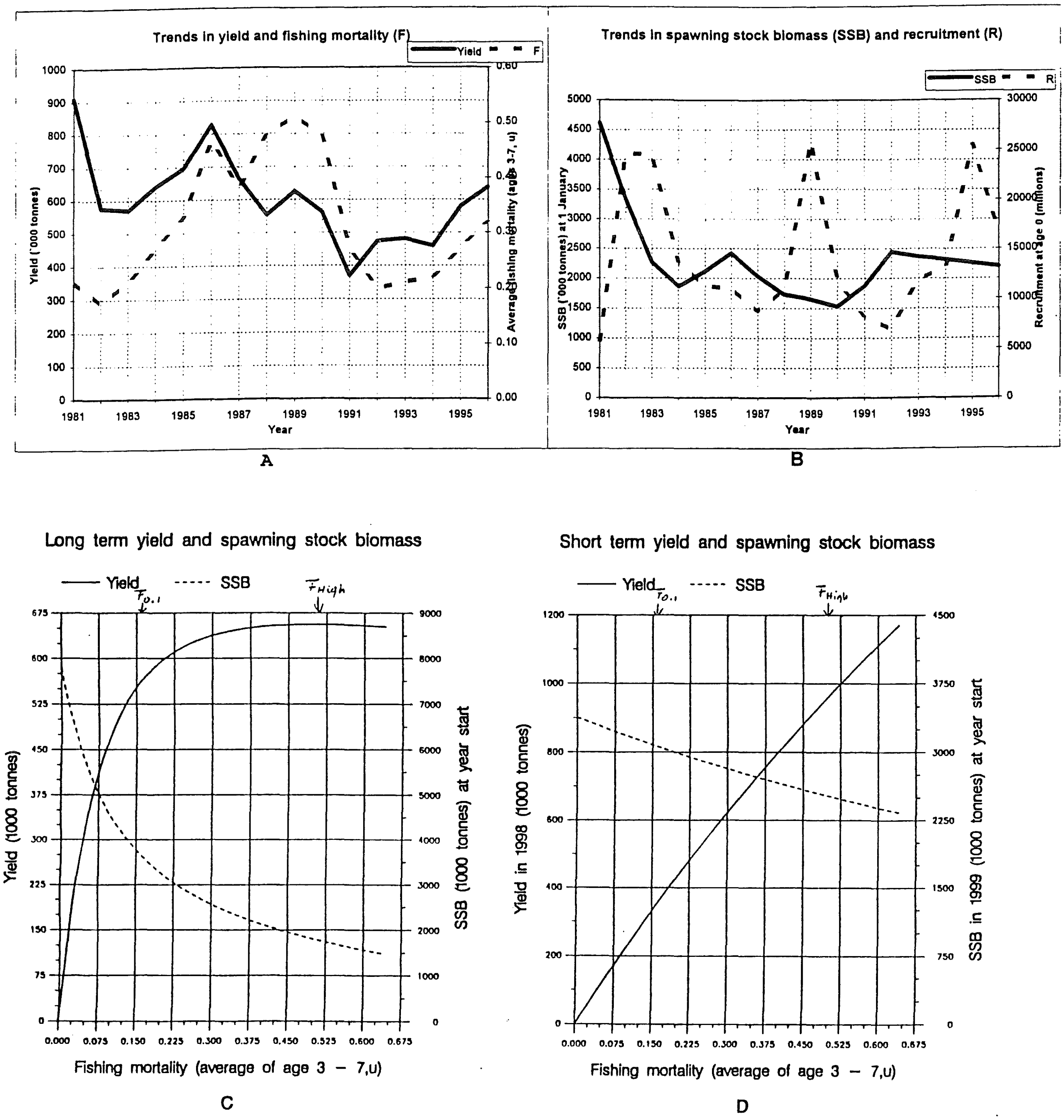


Figure 6.8.2 IFAP run: YLDMM0I MANMM05.

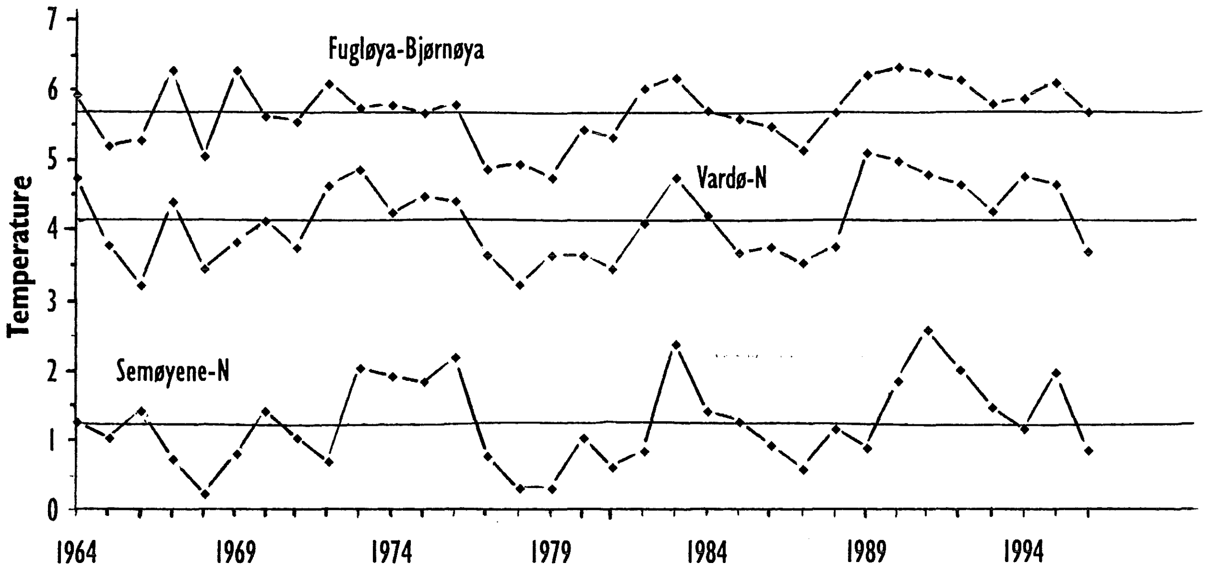


Figure 7.1.1 Mean temperature between 50 and 200 meters in August/September in the section Fugløya-Bjørnøya, Vardø-North and Sem Islands-North, 1964–95.

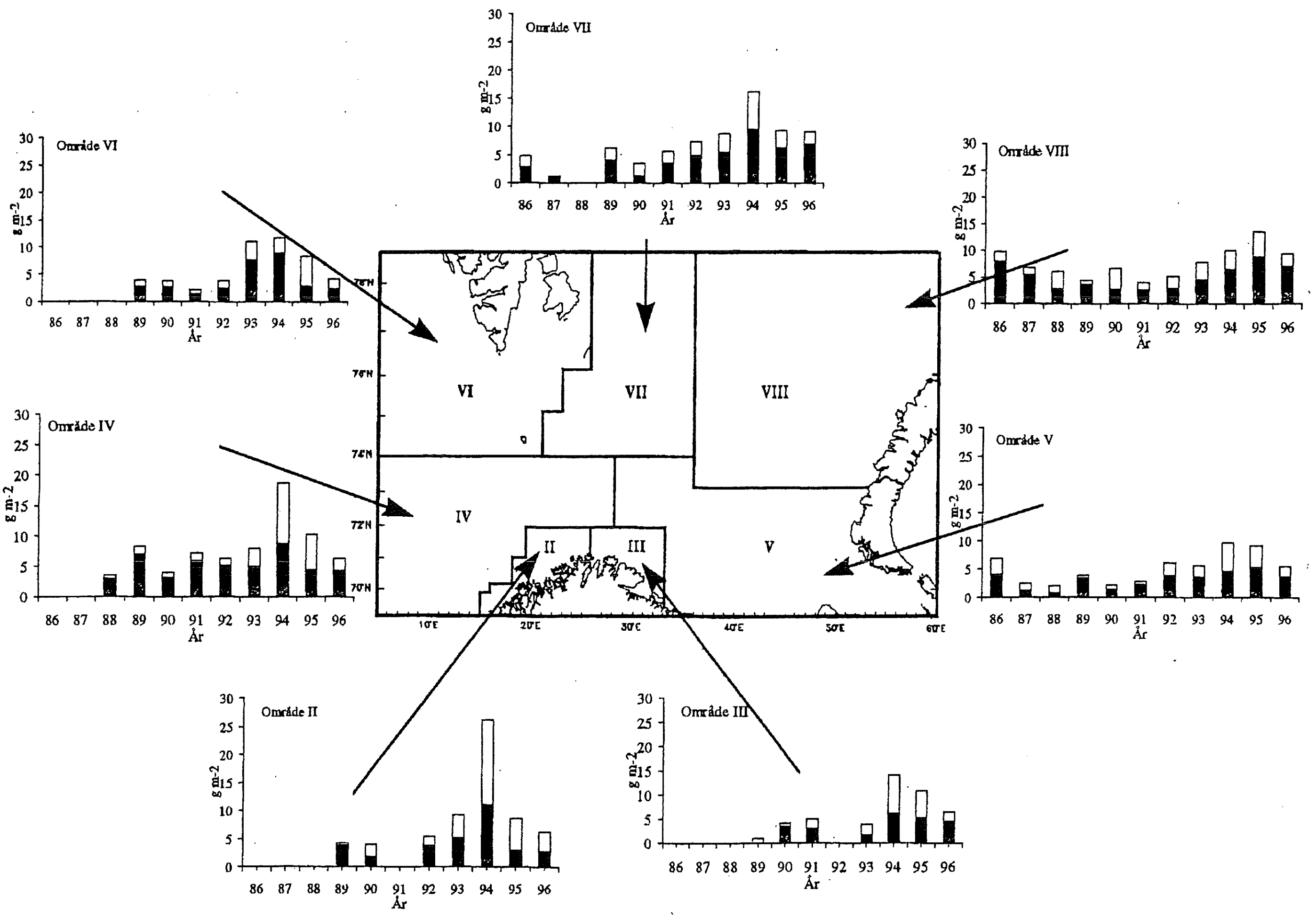


Figure 7.1.2 *Mean values of size separated zooplankton biomass, g m^{-2} (ash free dry weight 1986-90, dry weight 1991-96), from bottom - 0 m in the «multispecies» regions II-VIII. Ash free dry weight is about 80% of dry weight.* □180-1000µg , ■ >1000µg

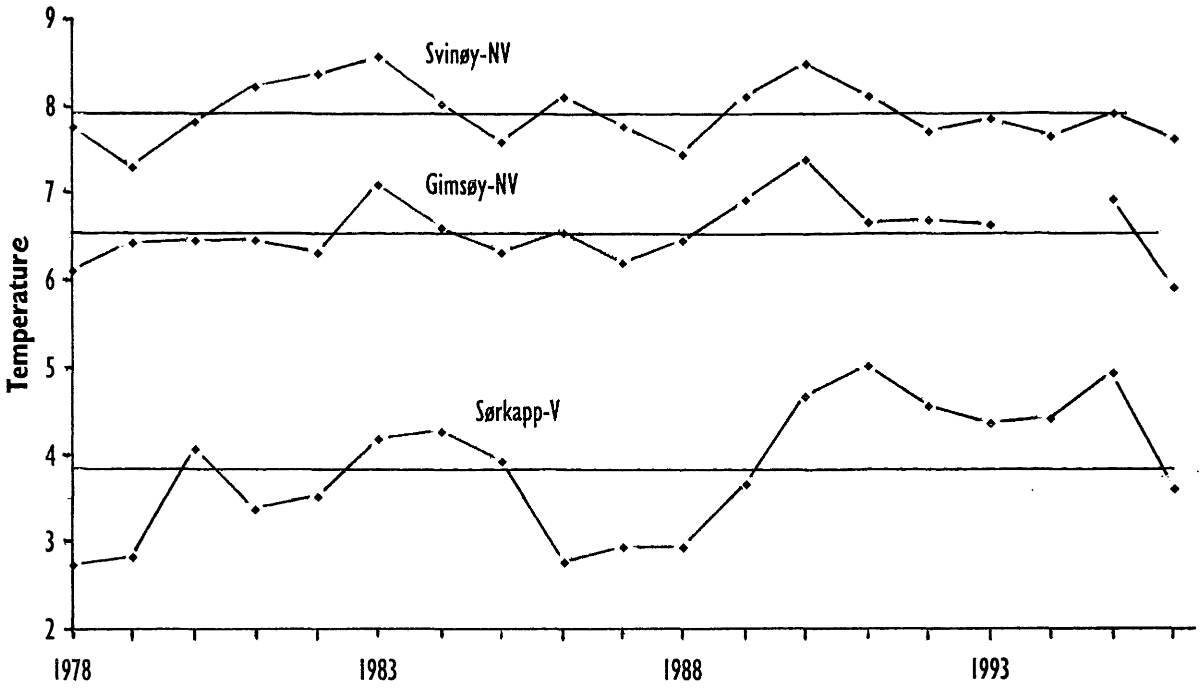


Figure 7.2.1 Temperature observed in July/August, in the core of Atlantic water in the sections Svinøy-NW, Gimsøy-NW and Sørkapp-W, averaged between 50 and 200 meters depth.

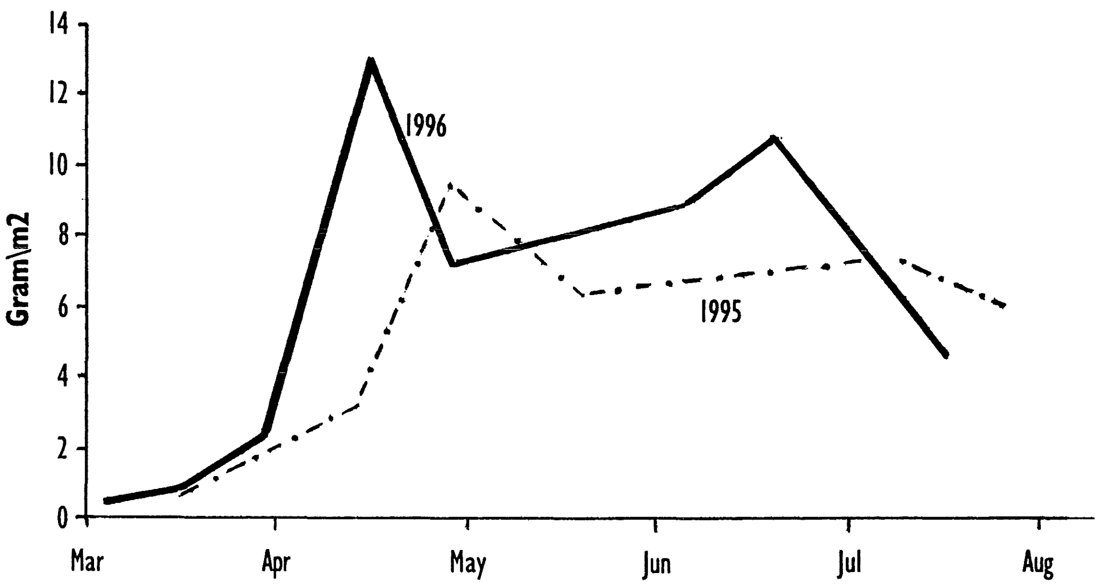


Figure 7.2.2 Plankton biomass (g/m^2, average for all stations) at the Svinøy transect in 1995 and 1996.