Advisory Committee on Fishery Management **ICES CM 2001/ACFM:17**

REPORT OF THE

NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

Reykjavik, Iceland
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1 INTRODUCTION

1.1 Terms of reference

The **Northern Pelagic and Blue Whiting Fisheries Working Group** [WGNPBW] (Chair: A. Gudmundsdottir, Iceland) will meet in Reykjavik, Iceland from 18–27 April 2001 to:

a) assess the status of and provide catch options for 2002 for the Norwegian spring-spawning herring stock;

b) assess the status of and provide catch options for the 2001–2002 season for the Icelandic summer-spawning herring stocks;

c) assess the status of capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 2001 and winter 2002 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) in 2002;

e) assess the status of and provide catch options for 2002 and 2003 for the blue whiting stock;

f) identify major deficiencies in the assessments;

g) review the layout of a Quality Handbook and prepare a workplan for writing such a document. A draft of the Quality Handbook shall be reviewed by the Working Group in 2002;

h) Norway letter 14.12.2000: At their annual meeting in October 2000, Iceland, the Faroe Islands, Russia, the European Community and Norway re-emphasised their commitment to the long-term management arrangement for the Norwegian spring-spawning herring stock in the North-East Atlantic, which was agreed upon in 1999. The long-term management plan is consistent with a precautionary approach, intended to constrain harvesting within safe biological limits and designed to provide for sustainable fisheries. Following the conclusions from the five-party agreement on the management of the Norwegian spring-spawning herring stock for 2001, Norway would request ICES to provide information about the stock development in accordance with the Annex of the Memorandum of Understanding wit NEAFC. Furthermore, ICES is requested to provide catch options for 2001 based on fishing mortalities in the range F=0.8 to 0.15 including F=0.125. Norway would also request ICES to evalutate the probability that the SSB will fall below Bpa of 5,000,000 tonnes and Blim of 2,500,000 tonnes in a 5 and 10-year period at various levels of constant fishing mortalities while the SSB is above Bpa, including values in the range of F=0.05, 0.08, 0.10, 0.125, 0.15, 0.2. From each of these combinations, ICES should evaluate the expected average percentage change in catches from year to year and the expected average catches over the same ten-year period. ICES should particularly continue to evaluate adaptive recovery strategies, including an options with linear reduction in F, in the event SSB falls below Bpa of 5,000,000 tonnes. The strategies should aim at preventing the SSB falls below Bpa of 5,000,000 tonnes. The strategies should aim at preventing the SSB from falling below Blim with a high probability and ensure the safe recovery of the stock to above Bpa at various time horizons;

i) NEAFC letter 28.11.2000: Regarding blue whiting stocks: provide medium-term projections using scenarios as considered appropriate. Such scenarios should illustrate the consequences of forthcoming recruitment levels returning to historic averages.

WGNPBW will report to ACFM at its May 2001 meeting.

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1.3 Non-standard assessment methods

This WG has traditionally developed assessment specific software for several of its stocks, instead of using software that has become standard in ICES. The main motive for this is to be able to take stock-specific biological features into account, as well as the types of data that are available. Thus, for Norwegian spring spawning herring, the stock is dominated by a few very large year classes, which are estimated by tuning to the survey data, while the data for the other year classes generally are of poorer quality and should not be allowed to influence the assessment too strongly. In addition, there are tag recapture data that carry valuable information about the stock abundance. For blue whiting, ICA has been the standard software for some years, but the assessment has always been problematic due to noisy and to some extent conflicting data. This year AMCI was attempted in order to solve some of these problems, or at least get a better understanding of the impact of the various data sources.

Another motive for developing alternative software is to apply insight and solutions made by others to approach problems also for our stocks. Thus, the WG has in some cases preferred to use bootstrap to estimate uncertainty in the assessment rather than deriving the variance from the Hessian matrix (delta method), to take more direct account of the noise in the data. The Sea Star model uses bootstrap, and the AMCI can do both methods. The gradually changing selection pattern in AMCI has some similarity to the time series models (Gudmundson, 1994; Ianelli and Fournier, 1998). The separate handling of outstanding year classes has recently been used for Western horse mackerel (ICES 2001)

For medium projections, no standard has been firmly adopted by ICES, and the choice of method has been mostly dependent on traditions in the group, and on the software used for historic assessment. Thus, assessment by ICA naturally leads to using ICP for medium term predictions. For some of the stocks analysed by this WG, a spreadsheet programme has been used for some years, with the @Risk add-in in EXCEL as a tool for making stochastic predictions. Recent work has shown that the outcome of medium term projections to quite some extent is dependent on the method used, as well as the assumptions made within the method framework, which to some extent carry over from the assessment. (Patterson & al, 2000). The methods also vary with respect to which kind of scenarios they may simulate. This year, the STPR software was used, partly because it allows a range of simulation scenarios, partly because it is independent of ICA, and finally to avoid the use of spreadsheets that are generally error-prone.

This section gives a brief description of the various non-standard methods used by this WG.

1.3.1 SeaStar

The assessment program SeaStar is essentially the same model as used during the 2000 meeting for tuning Norwegian spring spawning herring. Since the 2000 meeting the model program has undergone an internal reviewing process at IMR and the documentation and reporting has been substantially improved. The model is documented on the web site www.assessment.imr.no, where the user guide and the Mathematica code can be found, as well as supplementary documentation material. A provisional user guide and model description is a Working Document to this meeting (WD by Tjelmeland).

1.3.1.1 Tuning

SeaStar is a traditional back-calculating tuning model using a VPA based on Pope's approximation. The stock is assessed by running the VPA, which is dependent on the F-values in the last year and the F-values for the oldest true age group. Taking the historic stock as the expectation value in underlying distributions for the observed survey data the joint probability of observing the survey data is calculated. This probability is referred to as the likelihood function. There is provision for selecting different functions to describe the survey distribution. In the present tuning the gamma distribution with a constant CV is chosen, in accordance with recent practice. Similarly, the probability of observing the tag return data is calculated and included in the likelihood function. It is assumed that the probability of tag returns, which are rare events, follows a Poisson distribution. At the 2000 meeting also a larval observation series was added, where the probability of observation is based on the spawning stock.

The stock is assessed by varying the unknown parameters until the maximum of the likelihood function is reached. The parameters that are varied (free parameters, tuning parameters) are:

Catchabilities for the surveys

CVs of the surveys and of the larval data

Tagging survival

Terminal F-values.

One important modification to the software was made prior to the present meeting. It is observed that the 1985 year-class is much weaker than the 1983 year-class before age 13, after which it increases markedly relative to the 1983 year-class (Figure 1.3.1.1). The most likely reason for this is problems of distinguishing age rings as the fish gets older (WD by Tjelmeland). Therefore, last year fish older than 13 years were pooled both in the survey and in the VPA before the calculation of terms in the likelihood function was carried out. When the 1983 year-class was 13 years old, the ratio between the catch of the 1983 year-class and the catch of the 1985 year-class was calculated and applied to older ages in the same cohorts to redistribute the catch. The tagging data for the 1984 and 1985 year-classes were added to the 1983 year-class for consistency. This year the mean of the ratio of the 1983 year class to the 1985 year class in the catches from age 7 to 13 years (1983 year class) was used in the program to reconstruct both the catch and the survey indices.

SeaStar provides for basing the likelihood only on the strongest year classes. Also, only the terminal F values for the strongest year classes may be used as tuning variables. The rationale for this is to stabilise the tuning by avoiding bias from large relative errors in the catch of weak year classes, which mediated by the catchabilities would propagate also to the stronger year classes. The terminal F values of the weak year classes are linearly interpolated between the terminal F values that are tuning parameters. The terminal F values of the fish younger than the youngest tuned year class is linearly interpolated to zero at age –1.

The uncertainty in the tuning is analysed by bootstrapping. The survey indices and the number of tag returns are resampled from their assumed distributions using the observation values as expectation values. The catch in numbers is resampled by assuming that the errors stem from accidentally transferring catch between neighbouring age groups. The maximum probability of transfer of catch is related to the abundance as

$$\text{transferred} = \text{maxTransferCoefficient}\ (1.0 - \frac{\text{Abs}(\text{stock1} - \text{stock2})}{\text{stock1} + \text{stock2}})$$

where *transferred* is the maximum catch transfer, *stock<i>* is the number caught in the two neighbouring age groups, and *maxTransferCoefficient* is a parameter. The actual catch transferred during resampling has a uniform distribution between 0 and *transferred*.

The bootstrapped replicates are stored on file for later use.

1.3.1.2 Assessment of young herring

At the 2000 meeting the program RCT3 was used to assess the 1994 yearclass and younger herring, i.e. the herring younger than the youngest yearclass for which the terminal F is a tuning parameter. This year, SeaStar was adopted to assess also the younger yearclasses by regressing the recruitment numbers at age 0 as perceived by the VPA to the logarithmic 0-group index in the Barents Sea and to herring measured as one and two year old fish at acoustic surveys in the Barents Sea. Previously, acoustic cruises at the Norwegian coast were used as additional information in RCT3. However, the WG feels that as the younger fish is not considered representatively sampled by these cruises these data should not be used and they were consequently excluded from the assessment of younger herring this year. For consistency with the uncertainty analysis of the older (tuned) ages it is needed that the analysis of younger ages is performed once for each bootstrap replicate since the recruitment in the VPA is different in each replicate.

Three separate regressions are performed: the recruits as 0 years in the VPA is regressed to the logarithmic 0-group index and the herring as one year old and as two year old in the Barents Sea acoustic survey. With the exception of the logarithmic 0-group index all entities are log-transformed before the regression is carried out. In all regressions a time trend was added. The time trend was negligible for the acoustic indices but noticeable for the 0-group index.

The number by age of younger fish as 0-group is calculated by first drawing with equal probability one of those regressions followed by exponentiating the log-based regression added to a draw from the estimated residuals.

1.3.1.3 Medium-term projections

Medium-term projections are performed by first making a draw from the replicates of tuned assessments of older fish. Next, the regressions of younger fish are performed and one draw for each year class as 0-group is made and calculated to the assessment year (2001). Thereafter the parameters in a Beverton-Holt recruitment model (log-scale) are estimated and the stock is projected forward 10 years using the current harvest control rule.

Recruitment model

The recruitment model is a traditional Beverton-Holt model where the parameters are estimated on log-scale. However, the recruitment is highly dynamic with a few outstanding year classes. To better adapt the model to this stock the 10% highest recruitments are excluded from the regression. When a draw from the recruitment model is made these year classes are selected with 10% probability and a draw with equal probability is made. If the highest recruitments are not selected the recruitment is given as the exponentiation of the logarithm of the Beverton-Holt model with a random draw from the residuals added.

Weight at age model

The weight at age is not random in the model, but explicitly given by year.

Maturation at age model

The maturation at age is constant.

Harvest control rule

The harvest control rule is based on a fixed F-value (target F) combined with a catch ceiling. Two reference points are defined, B_{lim} and B_{pa}. When the spawning stock falls below B_{pa} the F-value is linearly interpolated between the target F-value at B_{pa} and a specified lower value at B_{lim}.

Sampling

During simulation the spawning stock and the yield are sampled. Stability of catches is calculated by first calculating the relative change in catches from one year to the next, then averaging over one trajectory and finally taking the median over trajectories.

1.3.2 AMCI

The AMCI (Assessment Model Combining Information from various sources) is similar to ICA in many respects, but is more flexible with respect to separability of fishing mortality, to which data it can use and how the information from various data is combined, which parameters to estimate and with respect to how uncertainty can be estimated. It also has additional diagnostics, compared to some standard assessment models.

The underlying population model is age-disaggregated, describing stock numbers at age in each time step. The stock numbers are related within the year classes through mortalities given by a parametric mortality model. The initial abundance in numbers of each year class is also specified as parameters. Thus, the population is in principle self-contained, being defined uniquely by parameters. Additional models describe the relation between the modelled population and the observed data or data derived from the observations. An objective function measures the deviance of the model from the observations. The parameters are estimated so that the objective function (i.e. the deviance) is at its minimum. Uncertainty in the estimates and in the modelled population can be derived from the derivatives of the objective function with respect to the parameters, or by bootstrapping. This design places the program in the category 'statistical catch at age models'.

Within this framework, AMCI has some special features:

- The observation types that can be related to the model include measures of spawning stock biomass and tag-recapture data, in addition to age-structured catch and survey data.

- Catch data are treated fleet-wise, with individually defined fishing mortality models for each fleet.

- Several selection models are available.

- Recruitments in some years can be substituted by expected values according to a stock-recruitment function.

- The user can choose which parameters one will regard as known and which are to be estimated by attaching ‘active flags’ to the parameters. To some extent, this can be done interactively during a model run, which allows for stepwise estimation of parameters.

- There is a range of different objective functions, which can be combined, and the objective functions can be changed interactively during a model run. Even though including new objective functions requires writing additional code, the structure of the program makes it relatively simple to do so.

- Basically, the fishing mortalities are modelled as separable. It is possible to recursively update the selection at age, allowing for a slow change in the selection, according to the yearly catches. In the extreme, this leads to a VPA-like algorithm.

- The diagnostics include computation of the first and second derivative of each term in the objective function with respect to the parameters (Jacobian matrix).

- The uncertainty in the assessment is primarily estimated by bootstrapping (parametric or non-parametric) of the data. In addition, variances of the parameters and correlations between parameters can be obtained from the Hessian matrix.

- The model runs forwards in time. It is therefore straightforward to extend the time range beyond the present, as a short time prediction, provided that the necessary parameters are specified. If the model is run in bootstrap mode, stochastic recruitments are used for the future years, giving a stochastic prediction with uncertainty at the present stock numbers and future recruitments.

The present version (Version 1.2) is documented in a manual, which was presented to the Working Group.

An earlier version of the model was used by the MHSAWG (ICES CM2001/ACFM:06) as an alternative assessment model for mackerel, in order to make use of the tagging data, and on sardine in order to clarify possible shifts in the selection pattern.

1.3.3 STPR

The STPR is a program for making stochastic medium-term projections (Skagen, 1997, Patterson, & al 2000) and was originally developed for evaluating harvest control rules for North Sea herring (ICES 1997a, Patterson, Skagen, Pastoors, & Lassen, 1997).

It is in most respects rather similar to ICP in that it projects the stock forwards with stochastic parameters, and presents statistics of a large number (normally 1000) of replicas. The stochastic elements are recruitments, weights, maturities and initial stock numbers, while STPR, unlike ICP, takes fishing mortality as fixed inputs. The recruitment is assumed to be log-normally distributed with expectation values according to a stock-recruitment function. For weights and maturities, historical data are used, by drawing a random year each time such data are needed, and using all the data from that year. Initial stock numbers are input. If a covariance matrix can be provided, the initial numbers are regarded as multinormally distributed on the log scale. The model allows two fleets and allows simulating simple harvest control rules, where fishing mortalities or catch ceilings are stated for each of 3 levels of current SSB. For the first (intermediate year), a TAC constraint is always assumed, for the subsequent years, F-constraints can be specified which would overrule the harvest control rule. The harvest control rule can either be applied to the current stock abundance, or to a stock abundance that is altered by a random term to simulate bias in the assessments or overfishing or TAC's. The output includes the distribution of catches, recruitments, SSB's and fishing mortalities for each year. In addition, the probability of exceeding reference levels of SSB each year and at least once in the projection period is tabulated. There is also included a measure of stability, which is the range of catches over the last 5 years, divided by the mean catch over that period.

1.3.4 Iceland summer spawning herring assessment

An ADAPT-type of assessment has been used by the stock assessment of the Icelandic summer spawners for several years. It assumes a one-to-one relationship between the acoustic estimate in numbers and the stock numbers derived from a classical VPA. The objective is to find an F which minimizes $\sum(\log(ac_{4+}) - \log(vpa_{4+}))^2$ over all years in the assessment, where ac_{4+} is the sum of the numbers of 4 ringers and older in the acoustic survey and corresponding for the VPA.

When the abundance of juvenile 2–4 ringed herring has been assessed by acoustic surveys, the resulting abundance estimates have been used in the tuning process. In cases where no such information is available for the youngest age group (2 ringers) the size of this age group is set at 400 millions, which is close to the lower quartile of the recruitment observed since 1980.

1.3.5 Capelin in the Iceland–East Greenland–Jan Mayen area

The preliminary TAC should be set at a level to open the fishery, when appropriate, before the October/November survey, and to keep the residual spawning stock at or above 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. It has been found that, when available, autumn (October/November) acoustic estimates of the abundance of age groups 1 and 2 can be used as 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/November in the year before. A prediction model based on a linear relationship between the historic back-calculated numerical abundance of maturing capelin at age 2 (N_{2mat}) and the autumn acoustic estimates of the same year classes at age 1 ($N_{1acoust}$) is 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 that part of the year class, which did not mature and spawn in the year before. Because autumn surveys of immature capelin of age 2 (N_{2imm}) have usually produced underestimates of varying magnitude such data have little predictive value. Similarly, January/February surveys of this year class only estimate the part that will spawn and thus are no indicators of what will appear in summer of next year.

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 summer should be an indication of what will appear as 3-

group in the following season. A regression relating the back-calculated total abundance of year classes at age 2 (N_{2tot}) on 1 August to their abundance at age 3 (N_{3mat}) is therefore used to predict the numerical abundance of age 3 capelin.

During the last ten years the weight at age of adult capelin has been inversely related to the total adult stock abundance in numbers. Linear regressions of total adult stock in numbers on the mean weight at age in autumn are used for predicting the mean weights of age groups 2 and 3.

The data sets comprising all comparisons of numbers by age and maturity, as well as total numbers and weight at age relevant to these prediction models are given in Tables 5.4.1, 5.5.1.1 and 5.5.1.2.

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 5.5.1.3.

1.3.6 ISVPA

This assessment model is designed specifically to assess stocks where only catch at age data are available, or other data are considered to be too noisy.

Instead of assuming the fishing mortality to be separable, it considers the instantaneous mortality

$\varphi(a,y) = C(a,y)/(N(a,y)*exp(-M(a,y)/2)$

and regards φ as separable:

$\varphi_{a,y} = s_a f_y$

In addition, it puts constraints on the matrix of φ residuals. The objective function which is minimised is the median of the squared log catch residuals. Using the median instead of the sum renders the estimate more robust to outliers in the data.

The separability assumption is widely used in various cohort models (Pope, 1974; Doubleday, 1976; Pope and Shepherd, 1982; Fournier and Archibald, 1982; Deriso et al., 1985; Kimura, 1986; Gudmundsson, 1986; Patterson, 1995; etc.). A simple version of separable cohort model, named ISVPA, was also proposed by Kizner and Vasilyev (Kizner and Vasilyev, 1997; Vasilyev, 1998, 1998a, 2000). The model ISVPA is similar in many aspects to other separable models. But its parameter-estimating procedure is based on some principles of robust statistics which helps to diminish the influence of error (noise) in catch-at-age data on the results if the assessment. Besides, special parameterization of the model makes it unnecessary to use any preliminary assumptions about the age of unit selectivity and about the shape of selectivity pattern. This helps to get unique solution in cases when catch-at-age data are noisy and auxiliary information is too controversial or is not available. Otherwise ISVPA may be used in order to outline stock tendencies from catch-at-age data taken alone.

Basic equations of the model are the consequence of traditional separable VPA and cohort analysis by Pope, which implies the assumption that catch is taken within a short time interval. One of the main differences of ISVPA lies in representation of fishing mortality (it is expressed in terms of fractions).

Following are the main equations of the ***catch-controlled*** version of ISVPA:

$$N_{a,y} = (N_{a+1,y+1}e^{M/2} + C_{a,y})e^{M/2}, \quad (1)$$

$$C_{a,y}=\varphi_{a,y}\, N_{a,y}e^{-M/2}, \quad (2)$$

$$\varphi_{a,y} = s_a\, f_{y,}\ (a=1,..., m-1;\ y=1,...,n-1), \text{ where}$$

a: age index, *m*: total number of age groups, *y*: year index, *n*: total number of years, $N_{a,y}$: abundance of the age group a in year y, $C_{a,y}$: catch from age group a in year y, M: natural mortality coefficient, φ(a,y): fraction of the abundance of age group a, taken as a catch in the middle of the year y (plays the role similar to that of $F_{a,y}$ in traditional VPA), f_y: year factor (or effort factor), s_a: age factor (or selectivity factor).

Selectivity factors are normalized: $\sum_{a=1}^{m} s_a = 1,$ (3)

It is not needed to use in calculations any additional assumption about s_a, except that s_a for the two oldest ages are equal to each other (if the oldest age group is a "+ group", then the three oldest s_a should be equal to each other). This seems to be a rather weak restriction if a sufficient number of ages are included into analysis.

Estimated values of $\varphi_{a,y}$ may be recalculated into instantaneous fishing mortality coefficients $F_{a,y}$ by the formula: $F_{a,y} = -\ln[1-\varphi_{a,y}]$, which is obvious if you rewrite expression (1) as: $\ln[N_{a,y}/N_{a+1,y+1}] = M - \ln[1-\varphi_{a,y}]$ and compare it with the traditional VPA equation: $\ln[N_{a,y}/N_{a+1,y+1}] = M + F_{a,y}$.

The catch-controlled version is more appropriate if there is much more confidence in the precision of catch-at-age data than in the validity of the separability assumption.

The ***effort-controlled*** version of ISVPA is obtained by substitution of the estimated catch, $\hat{C}_{a,y} = s_a f_y N_{a,y} e^{-M/2}$ for $C_{a,y}$ in (1), that is, by replacing equation (1) with

$$N_{a,y} = \frac{N_{a+1,y+1} e^{M}}{1 - s_a f_y}. \quad (4)$$

This version of the ISVPA is more appropriate when catch-at-age data include a very high level of noise, that is rather often, except when fishery is known to be extremely nonseparable.

In practice in most cases both assumptions (that catch-at-age data are precise or fishery is well separable) are rather far from reality. If there are some ideas about their relative validity it is possible to use ***mixed*** version of ISVPA in which the equation of stock dynamics is a mixture (with the coefficient given by user) of equations (1) and (4). In this version of the ISVPA the same weight (or "level of relative confidence") of the two assumptions is used for all points.

Since often the user has no preliminary ideas about relative validity of the above-mentioned assumptions and since the relative weight of these assumptions may be strongly different for different points (*a,y*), the 4th version of ISVPA named ***mixed with weighting by points*** (or ***mixed WBP*** in menu) is also available. In this version for *every point (a,y)* the equations (1) and (4) are weighted by reciprocal squared residuals between the given catch*(a,y)* value and its respective "theoretical" value: $\hat{C}_{a,y} = s_a f_y N_{a,y} e^{-M/2}$ where $N_{a,y}$ is calculated by equation (1) or (4). These weights are recalculated in every iteration within the iterative procedure of the model parameters estimation (see below).

For each version of the ISVPA the algorithm consists of a '*core*', in which all the model parameters are evaluated from the iterative procedure at a given natural mortality coefficient, *M*, and terminal fishing effort, f_n, and an outward '*shell*', a loop in which the best *M* and f_n are fitted. The 'core' is represented in the program ***by 4 iterative procedures***. The first, **"basic"**, iterative procedure ensures unbiased separabilisation:

$$\sum_{a=1}^{m} \varepsilon_{a,y} = 0, \quad \text{and} \quad \sum_{y=1}^{n} \varepsilon_{a,y} = 0 \text{ , where } \quad \varphi_{a,y} = s_a \cdot f_y + \varepsilon_{a,y}.$$

The second **"Logarithmic" (geometrical mean)** procedure ensures unbiased model estimates of log-transformed catches:

$$\sum_{a=1}^{m} [\ln C_{a,y} - \ln \hat{C}^{*}_{a,y}] = 0 \text{ and } \sum_{y=1}^{n} [\ln C_{a,y} - \ln \hat{C}^{*}_{a,y}] = 0 \text{ , where } \hat{C}_{a,y} = s_a f_y N_{a,y} e^{-M/2}$$

It can be simply shown that this procedure provides unbiased estimates of logarithms of all parameters.

The third **“Weighted arithmetical mean”** procedure may be more appropriate when errors corresponding to different age groups hardly can be regarded as equally distributed. In this version inverse selectivities serve as weights. This version ensures unbiased separabilization, but weighted by selectivities.

The 4-th procedure is intended to produce the best fit to catch-at-age data, but the solution will be free from any restriction on bias.

Median minimization. Minimization of the median, *MDN*, of squared residuals (that is, the use of the least median or LMSQ principle) instead of their sum (the classical LSQ-principle) is sometimes thought to be more resistant with respect to outliers, those elements of the data set which overstep considerably reasonable confidence limits and, hence, are suspected of containing extremely high errors (Hampel et al., 1986).

According to this concept, an alternative ISVPA solution may be looked for as providing estimates of M and f_n, which secure a minimum of the median of the distribution of the squared logarithmic residuals,

$$SE_{a,y} = (\ln C_{a,y} - \ln \hat{C}^{*}_{a,y})^2$$

($a = 1,...,m$; $y=1,...,n$). The corresponding loss function will be denoted as $MDN^*(M, f_n)$.

In practice, the median of a random series is estimated by rearranging its elements in a descending or increasing order and taking the central element of the new series or the mean of two central elements (depending on whether the total number of the elements is odd or even). However, when used within the framework of ISVPA, this estimate may sometimes cause a certain roughness of the surface $MDN(M, f_n)$. In order to make the loss function smoother, the median is estimated here as the mean of a number (for example, 10) central elements of the ordered series of $SE_{a,y}$.

Dealing with zeros in catch-at-age matrix. Existence of zeros in catch-at-age matrix is known to be a rather complicated problem (and may be logically controversial in dealing with logarithmic residuals), and it is solved in different ways in different methods. In ISVPA the following algorithm is applied:

1. If $C_{a,y}=0$, then the value of $\varphi_{a,y}$ is taken equal to its “theoretical” value, that is $\varphi_{a,y}= s_a f_y$.

2. Residuals for points of zero catches are taken equal zero.

3. Stock abundance is estimated as follows: if $N_{a+1,y+1}>0$ and $C_{a,y}=0$, then $N_{a,y}$ is calculated by equation (1); if $N_{a+1,y+1}>0$ and $C_{a,y}>0$, then $N_{a,y}$ is calculated by equation (1) or (4) or their mixture according to the version chosen; if $N_{a+1,y+1}=0$, then $N_{a,y}$ is calculated by formula (2) – the same way as for terminal points.

1.4 Quality control

The Working Group was asked to comment on the draft ICES Quality Control (QC) Handbook and stock template. Several general points were raised. The Working Group considered that the stock Annexes should form part of the relevant Working Group’s report to facilitate the work of the Working Group (consulting the previous year’s work during the meeting) and of ACFM (reviewing the work of the Working Group). The Annexes can, of course, also exist as part of the overall QC Handbook.

It was recognised that some ‘stability’ in the methods and assessment details over several years would be advantageous. However, the Working Group does not run assessments without scrutinising the diagnostics for problems. The WG arranges different trial runs with different options and it will improve transparencies if the outcome of such an exercise were documented in the report but not in the annex templates for each stock. The existence of a defined assessment procedure should not lead to blindly applying that procedure, and the Working Group assumes that this is not the intention of a QC Handbook. The current method of writing the Working Group report is, in principle, similar to the proposed process, since the previous year’s report is updated and amended rather than rewritten from scratch every year.

The Wg also notes that common procedures should be implemented for the collection, collation & storage of Fisheries disaggregated data. These are essential to maintain the integrity of archives, which document the origin of assessment input data. Some of this is implemented already on an ad hoc basis with the exchange Execl spreadsheet & sallocl.exe. But there has been no provision to date of a standard input & storage platform as has been recommended by other WG's.

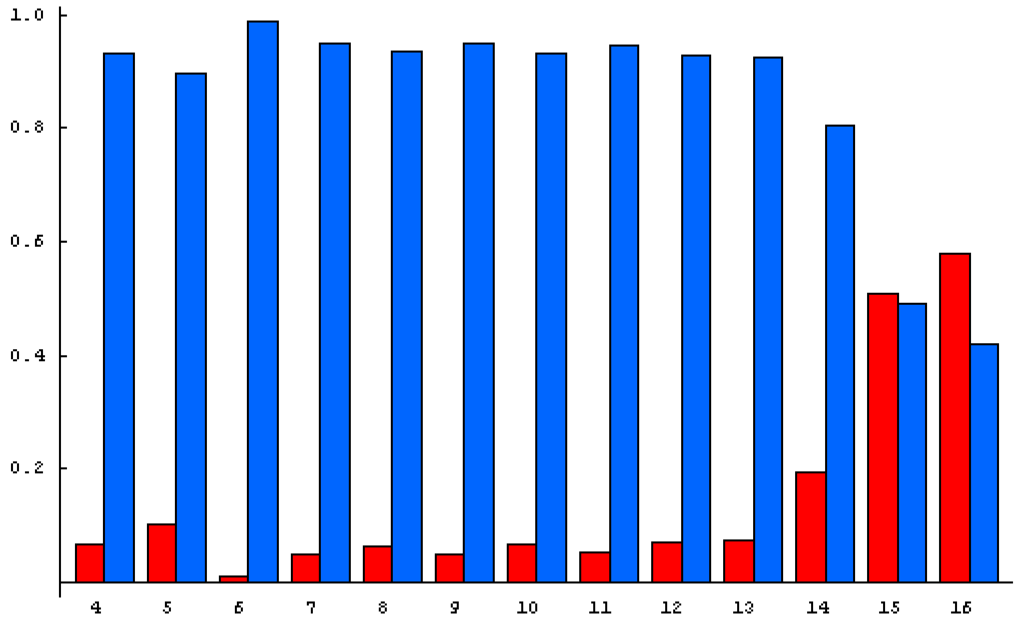


Figure 1.3.1.1. The ratio of the catch of the 1983 year class (blue bars, right) and the 1985 year class (red bars, left) in the catch from 1987 (1983 year class is 4 year old) to 1999 (1983 year class is 16 years old).

2 ECOLOGICAL CONSIDERATIONS

2.1 Barents Sea

2.1.1 Hydrography and ice conditions

The Barents Sea is characterised by large year-to-year fluctuations in heat content and ice coverage caused by variations in heat influx with Atlantic water from the Norwegian Sea (Fig. 2.1.1.1). There was a period of warming up in the western Barents Sea from 1989 to 1995 followed by cooling in 1996-1997 (Figure 2.1.1.3). In winter and spring 1998 the temperature in the Fugløya-Bear Island section (Fig. 2.1.1.2) increased to the long-term mean and in January 1999 the temperature was 1^0C above the long-term mean. This value represents the highest temperature measured in January since 1983. Thereafter the temperature decreased to 0.87^0C above the long-term mean in March, 0.36^0C above the long-term mean in April and 0.3^0C above the long-term mean in summer 1999. During autumn 1999 there was a significant increase in temperature and in January 2000 the temperature was 1.1^0C above the long-term mean.

The reason for the warm periods during the winters of 1999 and 2000 was a late onset of winter cooling due to the warm autumns both in 1998 and 1999. Throughout 2000 the temperature in the western parts of the Barents Sea decreased, and in October the temperature was only 0.1^0C above the long-term mean. In January 2001 the temperature was 0.4^0C above the long term-mean.

In the central parts of the Barents Sea the temperature was 0.5^0C above the long-term mean in the first half of 2000 like it had been in the whole 1999. Later in 2000 the temperature was reduced to the same level as in the western parts of the sea, 0.1^0C above the long-term mean. In March 2001 unexpectedly high temperatures were measured on the Vardø-N section.

In the eastern parts of the sea a significant temperature increase was observed during 2000 with temperatures $0.5\text{-}1.0^0$C above the long-term mean.

Fig. 2.1.1.4 shows the Barents Sea ice index. The variability in ice coverage is closely linked to the temperature of the inflowing Atlantic water. The ice has a relatively short response time to temperature change (about one year), but usually the sea ice distribution in the eastern Barents Sea responds more slowly than in the western part. There was less ice than average in 2000. The somewhat lower index than in 1999 was due to slightly less ice coverage in most of the Barents Sea during winter.

2.1.2 Predicting Barents Sea temperature

Prediction of Barents Sea temperature is complicated by the variation which is governed by processes of both external and local origin operating on different time scales (WD by Ottersen & Loeng). The volume flux and temperature of inflowing Atlantic water masses as well as heat exchange with the atmosphere is important in determining the temperature of the Barents Sea. Thus, both slowly-moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered.

The major changes in Barents Sea climate take place during the winter months. The variability in the amount of heat flowing in with Atlantic water masses from the south is particularly high during this season. Furthermore, variability in low-pressure passages and cloud cover has a strong influence on the winter atmosphere-ocean heat exchange. The difference in temperature between ocean and atmosphere is highest, but highly variable, at this time of year. The air temperature may at times be 30 degrees lower than the SST. Thus, this season is decisive with regard to the degree of loss of energy to the atmosphere.

This seasonal difference is reflected in the merit of simple six months forecasts of Kola-section temperature based on linear regression models. Table 2.1.2.1, shows that the predictive value for a specific month based on values from six months earlier, varies considerably throughout the year. The tendency found was that of persistence across the spring and summer months being higher than for other seasons, allowing for reasonably reliable forecasts from spring until autumn.

Data available until February 2001 allow for a six-month forecast for August 2001. The value for February 2001 of 4.2ºC is inserted into the equation

$T_{August} = 2.37 + 0.67 * T_{February}$,

statistically derived from data for the years 1921-1997 (Table 2.1.2.1).

This gives an objective temperature forecast for August 2001 of 5.2ºC.

This will be above the 1921-1999 mean of 4.67ºC by one standard deviation of the mean (Table 2.1.2.1). However, for the last three years there has been a tendency to a late onset of winter cooling leading to high positive temperature anomalies in January through March while the temperature has approached the mean value during spring and summer. This may be linked to changes in the large-scale climate pattern. The role of the NAO (North Atlantic Oscillation) may have changed since the sharp drop in 1996. Such a high positive anomaly is present also in February 2001 (4.4ºC as compared to the 1921-1999 mean of 3.44). If a development similar to that of the last three years continues one would expect the positive temperature anomaly in August to be less than that arrived at above. We conclude that summer sea temperatures in the southern Barents Sea are expected to lie in the range from average to moderately warm.

Conclusions:

- The winters of 1999 and 2000 were unusually warm due to a late onset of winter cooling.
- In western and central parts of the Barents Sea the temperatures decreased during 2000, and in late 2000 the temperatures were only 0.1^0C above the long-term mean.
- In January 2001 the temperature was 0.4^0C above the long-term mean.
- In the eastern parts the sea temperature increased during 2000 and measured temperatures ranged between 0.5 and 1.0^0C above the long-term mean.
- Summer sea temperatures in the southern Barents Sea in 2001 are predicted to lie in the range from average to moderately warm.

2.1.3 Zooplankton

The standing stock of zooplankton has been monitored in the Barents Sea from the early eighties in connection with the joint Norwegian/Russian 0-group and capelin surveys in August-October. At this time of the year most of the production has taken place and the zooplankton biomass can be seen as an expression of the size of the overwintering population of zooplankton. The samples are taken with dip nets and MOCNESS oblique hauls and are subdivided into three different size categories 180-1000µm, 1000-2000µm and above 2000 µm. The mean values for zooplankton for the whole Barents Sea and in 7 different areas, from 1988 to present, are shown in Figures 2.1.2.1 and 2.1.2.2. There was a marked increase in zooplankton biomass during the period 1991-94. After this period the biomass of zooplankton decreased to a level between the maximum values in 1994 and the low values during the period 1988-1992. This has taken place in all parts of the sea, except for the eastern part where the biomass of zooplankton has been constant. In 1999 and 2000 a slight increase was observed in all parts of the sea, except for the northeastern part where the zooplankton biomass was slightly reduced. Expected temperatures close to the long-term mean in 2001 together with overwintering zooplankton biomass close to the average will create the basis for average zooplankton production and feeding conditions for capelin, herring and juvenile fish in the Barents Sea in 2001.

Conclusions:

- An average abundance of zooplankton biomass and thus feeding conditions for capelin, Norwegian spring-spawning herring and other juvenile fish in the Barents Sea is predicted for 2001.

2.1.4 Consumption of capelin and herring by cod, harp seals and minke whales

Bogstad *et al.* (2000) reviewed the consumption of fish in the Barents Sea by various predators. The three most important predator species are cod, harp seal and minke whale. The consumption by cod of various prey species for the period 1984-1999 is given in Table 2.1.3.1, using the same method as described by Bogstad and Mehl (1997). The consumption by minke whale (Folkow *et al.* 2000) and by harp seal (Nilssen *et al.* 2000) is given in Table 2.1.3.2. These consumption estimates are based on stock size estimates of 85 000 minke whales in the Barents Sea and Norwegian coastal waters (Schweder *et al.*, 1997) and of 2 223 000 harp seals in the Barents Sea (ICES 1999/ACFM:7). The consumption by harp seal is calculated both for situations with high and low capelin stock, while the consumption by minke whale is calculated for a situation with a high herring stock and a low capelin stock. It is worth noting that the abundance estimate of harp seals was revised considerably upwards in 1998 (ICES 1999/ACFM:7), which also increased estimates of the consumption by harp seals correspondingly. Food consumption by harp seals and minke whales combined is at about the same level as the food consumption by cod, and the predation by these two species needs to be considered when calculating the mortality of capelin and young herring in the Barents Sea.

According to Bogstad *et al.* (2000), the total consumption of capelin by these three predators is higher than both the acoustic abundance estimates of capelin and the calculated MOB (M-output-biomass, i.e. the biomass output through natural mortality, see (Gjøsæter 1997)) in several of the years with low capelin abundance. However, the total consumption of herring by the three main predators is much lower than the MOB (based on M=0.9 on ages 1 and 2) in those years. These discrepancies merit consideration in the assessment of the capelin and herring stocks in the Barents Sea.

The consumption estimates in Table 2.1.3.1 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 1997).

2.2 Norwegian Sea

2.2.1 Hydrography and climate

WD by Melle *et al*. gives the status of selected aspects of the Norwegian Sea ecosystem. The Nordic Seas during the last decades have been characterized by increased input of Arctic waters. The Arctic waters to the Norwegian Sea are mainly carried by the East Icelandic Current and also to some extent by the Jan Mayen Current (Fig. 2.1.1.1). During periods of increased Arctic water input, the western extension of Atlantic water is moved eastward. As a result, over the last 25 years the southern and western Norwegian Sea has become colder and fresher while the eastern Norwegian Sea is warmed. Atmospheric forcing drives this trend. Since the mid-1960's the North Atlantic Oscillation index (NAO) has increased (Fig. 2.2.1.1). NAO as it is used here is the normalised air pressure difference at sea level between Lisbon, Portugal and Reykjavik, Iceland and is an indicator of the strength of the westerly winds into the Norwegian Sea. A high NAO index (i.e. stronger westerly winds) will force Atlantic and Arctic waters more eastward.

The Institute of Marine Research, Norway, has measured temperature and salinity in three standard sections in the Norwegian Sea almost regularly since 1978 (Fig. 2.1.1.2). The sections are: 1) the Svinøy section which runs NW from 62.37^{o} N at the Norwegian coast, 2) the Gimsøy section which also runs NW from the Lofoten Islands and 3) the Sørkapp section which is a zonal section at 76.33^{o} N just south of Svalbard.

Fig. 2.2.1.2 shows the time series of summer (July-August) temperature and salinity from 1978 to 2000 in the three sections: Svinøy, Gimsøy and Sørkapp. The values are averaged vertically between 50 and 200 m and horizontally over 3 stations in the core of Atlantic water. The trends for all three sections are similar. The temperatures are increasing while the salinities are decreasing. The largest temperature increase is in the Sørkapp section. In 2000 the temperature and salinity increased in the southernmost section while they decreased in the Gimsøy and Sørkapp sections.

Fig. 2.2.1.3 shows time series of temperature and salinity during the spring in the Svinøy and Gimsøy sections from 1978 to 2001. The values are calculated using the same procedure as mentioned above. The low salinities in 1978 and 1979 are a result of the Great Salinity Anomaly during the 1970's. In 1994 a large salinity anomaly comparable with the anomaly in 1978 and 1979 was seen in the Svinøy section. The temperature was also a minimum that year. The 1994 anomaly was a result of the increased influence of Arctic water from the East Icelandic Current. In 2001 the salinity increased in both sections while the temperature increased in the Svinøy section and remained approximately constant in the Gimsøy section.

Conclusions:

- The trend in temperature and salinity in the standard sections since 1970 has been towards higher temperatures and lower salinities.

- Compared with 1999, temperature and salinity in July-August 2000 increased in the Svinøy section while they decreased in the Gimsøy and Sørkapp sections.

- Temperature and salinity in the Svinøy section increased in March-April 2001 compared with 2000.

- The high winter NAO in 2000 coincided with a further eastward movement of the Arctic front and increased dominance of cold and low salinity water masses in the western and central Norwegian Sea.

- A lower winter NAO in 2001 (preliminary data for December and January) suggests a more western extension of Atlantic water compared with 2000.

2.2.2 Phytoplankton

The development of phytoplankton in the Atlantic water is closely related to the increase of incoming solar irradiance during March and to the development of stratification in the upper mixed layer due to warming. In 1990 the Institute of Marine Research, Norway, started a long-term study of the mechanisms controlling the development of phytoplankton at Ocean Weather Station Mike situated at 66°N, 2°E. Due to problems replacing lost water bottles, no samples were collected during the first eight months of 2000. Therefore, the conditions in the Norwegian Sea in 2000 in terms of primary productivity were not updated.

Fig. 2.2.2.1 shows the development of the phytoplankton bloom for 1997, 1998 and 1999, three years with a marked difference in the time when the spring bloom reached its maximum. In 1997 the spring bloom reached its maximum 20 May (day of the year 140), in 1998 about one month earlier 18 April (day of the year 108). The timing of the bloom in 1999 was similar to that in 1998, but did not show the same high maximum in chlorophyll. This may be related to the weekly measurements in 1999, as opposed to daily measurements in 1997 and 1998. On the other hand, weekly measurements prior to 1997 have revealed pronounced maxima in chlorophyll. The reason for the low algal biomass in 1999 may have been early and strong grazing from a large over-wintered zooplankton stock. Development of the phytoplankton prior to the spring bloom may be separated into two phases. The first phase, from day 1 to about day 50, is characterised by extremely low phytoplankton biomass expressed as chlorophyll *a*. This is the winter season during which phytoplankton growth is mainly limited by the low incoming irradiance typical of this period. The second phase, from about day 50 to day 100, is characterised by a gradual increase of phytoplankton biomass but without reaching bloom conditions. This is the pre-bloom phase during which the increase in biomass is related to the increase in incoming irradiance and the lack of a bloom is due to the deep upper mixed layer still present at this time.

Fig. 2.2.2.2 shows the extension in time for these two phases and the timing of the spring bloom for the period 1991-1999. In a "normal" year the winter season extends to about 2 March. The pre-bloom phase extends on average from the 2 March to 16 April. The spring bloom starts normally on 16 April and reaches its maximum on 21 May, but the year-to-year variations are much larger than those of the previous phases. From 1991 to 1995 the trend was towards earlier spring blooms. This trend was broken in 1996, and thereafter year-to-year variability in the timing of the bloom has been greater.

Conclusions:

- The phytoplankton bloom in 1999 developed similar to that in 1998 and earlier than in 1997.

- Chlorophyll concentrations did not peak in May 1999 as we have observed in previous years.

- Chlorophyll data for 2000 are missing.

2.2.3 Zooplankton

Zooplankton biomass distribution in the Norwegian and Icelandic Seas has been mapped annually in May (since 1995) and in July (since 1994). Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report results based on samples from the upper 200 m are analysed. Total zooplankton biomass (g dry weight m^{-2}) in May was averaged over sampling stations within three water masses, Atlantic water (salinity >35 at 20 m depths), Arctic water (salinity <35, west of 1.4°E) and Coastal water (salinity <35, east of 1.4°E) (Fig. 2.2.3.1). In Atlantic and Arctic water masses zooplankton biomass decreased to a minimum in 1997. Thereafter zooplankton biomass has increased. In the Coastal water masses, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the trend was different with generally low biomass from 1995 to 1997 and a marked increase in 1998 followed by a decrease in 1999 and 2000.

In July the total zooplankton biomass (g dry weight m^{-2}) in the upper 200 m was calculated by integrating biomass at sampling stations over a selected area in the central and eastern Norwegian Sea. There is no obvious trend in the July zooplankton biomass since 1994 (Fig. 2.2.3.2).

Conclusions:

- Average zooplankton biomass in Atlantic water masses of the Norwegian Sea in May 2000 was the highest since 1995.

- Zooplankton biomass in July 2000 was somewhat lower than in 1999.

2.2.4 Herring growth and food availability

Individual growth of the Norwegian spring spawning herring, as measured by condition or length specific weight after the summer feeding period in the Norwegian Sea, has been characterised by large fluctuations during the 1990's (Fig. 2.2.4.1). During 1991 and 1993 individual condition was good, but from 1994 on the condition of the herring started to decline and by 1997 it reached the lowest level during the 1990's. The level observed in 1997 corresponds with the absolute long-term minimum level observed during the period 1935 – 1994 (Holst 1996). After 1997 the condition of the herring in the Norwegian Sea improved, but is still well below the maximum observed during the first four years of the decade.

Since 1994, when the large-scale migration pattern of the herring has been mapped during two annual cruises, May and July-August, the herring have been feeding most heavily in Atlantic water of the central Norwegian Sea. It has been found that the herring condition index obtained after the feeding period in the Norwegian Sea is related to average zooplankton biomass of Atlantic water (Fig. 2.2.4.2). This indicates that variation in the production of zooplankton in Atlantic water is a major reason for the observed variability in herring growth. It was noticed in 1999, however, that the herring was feeding to a large extent in Arctic water where zooplankton biomass is much higher than in Atlantic water. This year herring condition index was especially high while zooplankton biomass in Atlantic water was moderate.

Conclusions:

- Herring condition decreased from 1999 to 2000.

- There is a direct relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-2000.

2.2.5 Predictions for zooplankton biomass and herring feeding conditions

A factor possibly governing zooplankton biomass is the size of the zooplankton spawning stock, or the size of the over-wintering population. Zooplankton biomass in July may represent the over-wintering population, and a linear regression of the biomass in July on the biomass in May the following year explains 61% of the total variation (Fig. 2.2.5.1). The moderate biomass in July 2000 suggests that zooplankton biomass in May 2001 will be moderate (Fig. 2.2.5.1). However, the time series is short, the variability is large and there is no trend in the July zooplankton biomass that could be related to the trend observed in the May data. Thus, this time series should be expanded before it is used for prediction.

The North Atlantic Oscillation index (NAO), is a proxy for the strength and duration of southwesterly winds, and is correlated with the inflow of Atlantic water to the Norwegian Sea. In the Norwegian Sea the winter NAO (December to March) was correlated with zooplankton biomass in May, not within the same year but the following year (Fig. 2.2.5.2). This may be related to the influence of Atlantic inflow on the production of recruits to become the spawning stock next year. The relationship suggests that high zooplankton biomass in May follows a winter with high NAO the previous year. Knowing that the NAO during the winter 1999-2000 was high, a high zooplankton biomass may be expected in May 2001, i.e. 16 g m^{-2} (Fig. 2.2.5.2). The winter NAO for the winter 2000-2001 was not available at the time when this report was finished but preliminary data indicate that the index will be low. Thus, we expect zooplankton biomass for May 2002 to be lower than in 2001. Further, due to the low NAO winter-index for 2000-2001 the biomass in May 2001 may be lower than predicted, similar to the situation in 1996 when a low NAO followed a high index in 1995 (see Fig. 2.2.5.2).

The linear relationship between herring condition in the autumn and zooplankton biomass in Atlantic water in May (Fig. 2.2.4.2) has been used to predict herring condition in December 2001 based on the predicted zooplankton biomass for May 2001 (Fig. 2.2.5.2). The predicted herring condition index for the autumn 2001 is ~0.85.

The time series for the herring condition index was recalculated for the period from 1991 to 2000. A regression of the herring condition index on the NAO winter-index the previous year explained more than 70% of the variation in the data, if the year 1996 was excluded from the data set (Fig. 2.2.5.3). The reason why herring condition in 1996 appeared to be lower than predicted from the NAO is not clear, but as commented on above the zooplankton production this year was lower than what could be predicted from the NAO. The NAO winter-index is known after March, and offers the opportunity to predict the herring condition in the autumn of the following year (18 months time period). Thus, the herring condition index for 2001 is predicted to be 0.88, which is somewhat higher than the prediction from zooplankton biomass. However, both relationships predict that the condition in 2001 will be higher than 0.83, which was the condition index after the 2000 feeding season. Assuming that the NAO winter index for 2001 will be low (preliminary data), the herring condition index for 2002 will be low.

Conclusions:

- A direct, but weak, relationship between zooplankton biomass in July and the zooplankton biomass in May the following year is suggested by the time series from 1994 to 2000.

- The relationship between zooplankton biomass in May and the herring condition in the autumn suggests that herring condition in 2001 will be high (0.85).

- The winter NAO is directly related to zooplankton biomass in May and herring condition in the autumn the following year.

- The NAO winter-index for the winter 1999-2000 predicts zooplankton biomass to be ~15 g m^{-2} in May 2001 and the herring condition index to be 0.88 in the autumn 2001.

- Following a considerable reduction in the NAO index for the winter 2000-2001, as suggested by preliminary atmospheric data, reductions in zooplankton biomass and herring condition in 2002 are expected.

2.3 Icelandic Waters

2.3.1 Hydrography and climate

Due to the proximity of the oceanic Polar Front in the northern North Atlantic, hydrographic conditions in the sea north of Iceland are highly variable. Changes in intensity of the influx of Atlantic water and/or the variable admixture of polar water to the surface layers north of Iceland may lead to marked fluctuations in temperatures and salinities, both in space and time. Off the south and west coasts, where Atlantic water predominates, fluctuations are much smaller.

Climatic conditions in the North Atlantic improved greatly around 1920 and remained good until the mid-1960s when they deteriorated suddenly. In the area north and east of Iceland temperature and salinity declined sharply in 1965 and these severely cold conditions lasted until 1971. After that, climatic conditions of the area north and east of Iceland improved again, but were variable and warm years have alternated with cold years.

During the last few years, there has been a pronounced increase in the intensity of the Irminger Current south and west of Iceland, resulting in temperatures and salinities similar to those recorded in these waters in the 1950s and the early 1960s. There were no signs of a reduction of this flow of warm water off South and West Iceland throughout 2000. As in 1999, the inflow of Atlantic water to the north Icelandic area was quite pronounced and the cold East Icelandic Current was weak and relatively far offshore. This situation prevailed during the quarterly surveys for monitoring environmental conditions of Icelandic waters in August and November 2000 as well as in February 2001. The February 2000 and 2001 surveys also recorded considerable amounts of Atlantic water north of Iceland, which is unusual for that time of the year. The present situation will probably persist throughout during the latter half of 2001 since this large current system is quite stable with changes normally taking months or years.

Nevertheless, there can be large variations of temperature and salinity in the area north and east of Iceland, due mainly to variability in cloud cover and the prevailing wind direction. Such variations mainly affect the uppermost 50-100 m of the water column and sometimes mask the beneficial effects of the warm water inflow from the south and west.

Average values for temperature and salinity in May/June from a standard section (Siglunes) off the central north coast of Iceland are shown for the period 1952-2000 in Figure 2.3.1a and b respectively.

2.3.2 Phytoplankton

The fresh surface layer reduced the positive effects of the warm Atlantic water north of Iceland considerably in 1997 and to a lesser extent in 1998. This layer was, however, pushed northward by the larger warm water influx in 1999 and in February 2000 and 2001 there was still mixed water of high salinity in the area north of Iceland. Experience shows that such mixed water makes for a quicker renewal of nutrients and increases primary production during the growth season. Therefore, a high nutrient content and phytoplankton production is expected in the area north of Iceland in spring and summer of 2001.

2.3.3 Zooplankton

In the area north of Iceland, zooplankton biomass is significantly higher during years with a strong inflow of Atlantic water than in years when Atlantic inflow is weak and salinity lowered in the surface layer. The continued strong inflow of Atlantic water to the north Icelandic area therefore indicates that zooplankton biomass will be above average in spring and summer 2001.

Long-term changes of zooplankton biomass north of Iceland are shown in Figure 2.3.1c. The values represent averages of all stations on the Siglunes section. In north Icelandic waters, the high values of zooplankton in the beginning of the series dropped drastically with the onset of the ‘Great Salinity Anomaly’ of the 1960s. Since then zooplankton biomass was variable throughout the 1970s and 1980s, but has increased in the 1990s as compared to the period 1965-1990.

2.3.4 Herring migrations

Prior to the cold period which began in the mid-1960s, the shelf waters north and east of Iceland as well as the oceanic area between Iceland and Jan Mayen constituted a major part of the feeding grounds of adult Norwegian spring spawning herring. In the late 1960s, the low temperature of Icelandic waters, the Iceland Sea and adjacent areas made them inaccessible to these herring and displaced their feeding grounds eastwards into the Northwestern Norwegian Sea and, finally, northeast to the area west of Bear Island and Spitzbergen. Concurrently, the exploitation rate of the herring stock increased greatly and the stock collapsed (Dragesund *et al*. 1980).

During the 1970s and most of the 1980s, stock abundance was low and the Norwegian Spring spawning herring had no need for extensive feeding migrations to satisfy their food requirements. However, with the maturation of the large 1983 yearclass and its descendants from 1991-1993, stock abundance increased rapidly in the late 1980s and the 1990s (cf. Figure 3.5.6.1b). Although the Norwegian spring spawning herring resumed their feeding migrations westward into the Norwegian Sea around 1990, these migrations did not reach as far to the west as during the warm period prior to the mid-1960s. During the early 1990s, on approaching the eastern boundary of the cold East Icelandic Current in May, the herring generally turned north and northeast and arrived in the area northwest of Lofoten in August-September.

However, with the improvement of the marine climate north and northeast of Iceland since the very cold year of 1995, Norwegian spring spawning herring have begun to reappear in the waters east, northeast and even north of Iceland. Thus, some herring schools were located north of Melrakkaslétta (NE-Iceland) where a catch of 130 t was taken in July 1997 (ICES CM 1997/Y:4), and in 1998 a fishery was conducted off NE-Iceland as well as the eastern north coast in

June and early July (ICES C.M. 1998/D:3). In June 1999 part of the stock, consisting of old and large herring, migrated west at approximately 68°N. In early July these herring were located by an acoustic survey between 14°30'W and 16°W and were subsequently fished upon by Faroese vessels for a short period. Furthermore, some Norwegian spring spawning herring were taken as by-catch in the capelin fishery near 68°N, 18°W around mid-July (ICES C.M. 1999/D:3).

Although a few catches were taken by Faroese vessels northeast and north of Iceland in connection with the capelin fishery in July, very few Norwegian spring spawning herring seem to have migrated to the north Icelandic area in the summer of 2000 in spite of the mild ocean climate. The reasons for this are not clear, but are probably i.a. connected to good feeding conditions in the central and northern Norwegian Sea in May and June. Indeed, most of the herring only migrated west to about 5-6˚W at latitude 70-72 °N before turning and heading to the east and north again.

It seems therefore that, due to the improvement of the marine climate in the last 3-4 years, the herring have been able to migrate considerably farther west and enter the area to the northeast and north of Iceland. However, it is equally clear that the herring only stayed in these waters for a short period and then migrated northeast just south of the Polar Front (ICES C.M. 2000/D:3).

Furthermore, there is little doubt that the warmer climate of Icelandic waters has resulted in a wider distribution of the Icelandic summer-spawning herring in autumn and winter. This is supported by the observation that summer spawning herring were caught at almost all trawl stations off the west, northwest and western north coast of Iceland during groundfish surveys in October 1997 - 20000. In addition, some herring catches were taken in November 2000 about 50 n.m. off the NV-peninsula (Vestfirdir) where a purse seine fishery has not taken place previously.

2.3.5 Capelin distribution

Adult capelin of the stock that spawns at the south and west coasts of Iceland migrate north in spring to feed during summer in the Iceland Sea, i.e. the oceanic area between the north Icelandic shelf, Jan Mayen and Greenland. A southward return migration begins in September and by November the maturing stock has, as a rule, assembled near the shelf edge north and northwest of Iceland. From there a clockwise migration to the spawning grounds south and west of Iceland usually starts in late December. The feeding and spawning migrations of capelin in the Iceland-Greenland-Jan Mayen area have been shown to be quite variable and generally coupled to the hydrography of these waters (Vilhjálmsson 1994).

In November 1998, the acoustic assessment survey failed to locate a large part of the adult stock component, which was subsequently located and assessed east of Iceland in January/February 1999. A similar situation prevailed in autumn 1999 and the January/February 2000 stock assessment survey showed that the underestimation in November 1999 was even larger that in November of the previous year. In addition, in November 2000 only insignificant numbers of adult capelin were found north and east of Iceland and in the Denmark Strait where ice prevented surveying of the EEZ of Greenland.

In late January and early February 2001 it was found that about 3/4 of the capelin spawning stock were located at the shelf edge west of the NW-peninsula of Iceland (Vestfirdir) from where they later migrated directly south to spawning grounds at the west coast and the western south coasts of Iceland. The remainder of the stock was located east of Iceland and migrated 'as usual' to the southwest and west from there to spawn south of Iceland.

The developments described above coincide with observations of a milder ocean climate in Icelandic waters in recent years as well as the observation that hydrographic variability on the Siglunes section is also reflected farther north in the Iceland Sea (Vilhjálmsson 1994). It thus seems that in 1998 and 1999 the return migration from the northern feeding areas must have been delayed and the capelin were distributed outside the survey area north of Iceland, which only reached to 68°30'N. In 2000, however, the capelin were most likely distributed even further west at the end of the feeding period and then probably followed the Greenland shelf to the south and west. In so doing they would be located north of the Dohrn Bank in November and were missed by the autumn 2000 survey due to the ice cover. This scenario would explain the location of most of the spawning stock west of Vestfirdir in January/February 2001 and the similar situation that was encountered in winter 1979. Needless to say, these conclusions are highly speculative due to inadequate data for the oceanic area north of 68°N. Coherent research over several years in the Iceland Sea in spring and summer is necessary in order to resolve such questions.

2.3.6 General summary

The increased intensity, heat content and salinity of the Irminger Current have resulted in an improvement of the ocean climate north and east of Iceland. The simultaneous increase in the intensity of the very cold, south flowing East Greenland Current in 1997 and 1998 apparently hindered to some extent the eastward flow of Atlantic water off the north coast of Iceland, thereby augmenting the branch flowing west across the northern Irminger Sea towards Greenland. Furthermore, this situation caused periodic fluxes of cold, low salinity water into the near-surface layer over the shelf north and east of Iceland. However, in 1997 and 1998 the temperatures of the East Icelandic Current were higher, its southern and western boundary east of Iceland located farther offshore and to the north as compared to most recent years. On the other hand, Atlantic water predominated in the shelf area north of Iceland during spring, summer and autumn of 1999 and 2000. This situation prevailed in February 2001.

Although the zooplankton biomass north of Iceland in the spring of recent years has not reached the pre-1965 levels, the increase is substantial when compared to most years in the period 1965-1990.

Improvements of the marine climate to the east, northeast and north of Iceland in 1997-2000 have enabled Norwegian spring spawning herring to migrate farther west than they had for more than three decades. It is also the most likely cause of anomalous capelin distribution and migrations in 1998/99-2000/01.

Table 2.1.2.1. Linear regression models for monthly 0-200m temperature values in the Kola section based on corresponding temperatures from six months earlier. The equations are derived from data from January 1921 to February 1997. All coefficients of determination (R^2) are significant at the 5% level. The evaluated predictions and corresponding errors for March 1997 (based on September 1996) to February 1998 (based on August 1997) illustrate the seasonal differences in predictive ability. Forecasts depend only on values not used for deriving the equations. Errors are simply given as the difference between the predicted and measured values. From Ottersen *et al.* (2000).

Prediction for month (y)	Predicted on month (x)	Equation	R^2	Predicted 1997/98	Measured 1997/98	Error
March	September	y=0.95 + 0.44x	0.21	3.1	2.5	+0.6
April	October	y=0.53 + 0.49x	0.25	3.0	2.5	+0.5
May	November	y=0.74 + 0.50x	0.22	3.1	2.6	+0.5
June	December	y=0.98 + 0.60x	0.25	3.5	3.1	+0.4
July	January	y=1.60 + 0.67x	0.36	3.9	3.6	+0.3
August	February	y=2.37 + 0.67x	0.41	4.3	4.2	+0.1
September	March	y=2.67 + 0.72x	0.49	4.5	4.6	-0.1
October	April	y=2.71 + 0.75x	0.55	4.6	4.7	-0.1
November	May	y=2.91 + 0.57x	0.38	4.4	4.5	-0.1
December	June	y=2.71 + 0.45x	0.29	4.1	4.1	0.0
January	July	y=1.77 + 0.50x	0.31	3.6	3.6	0.0
February	August	y=1.05 + 0.51x	0.27	3.2	2.9	+0.3
Mean absolute error						0.3

Table 2.1.3.1 The Northeast Arctic cod stock's consumption in 1000 tonnes of main prey species in 1984–2000.

	Prey species											
Year	Other	Amphipod	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Total
1984	502	27	112	431	713	77	15	21	50	359	0	2307
1985	1150	169	58	154	1602	181	3	31	47	222	0	3616
1986	658	1212	107	141	828	132	140	81	109	310	0	3718
1987	675	1075	67	189	227	32	203	25	4	319	0	2816
1988	409	1226	314	128	336	8	91	9	3	221	0	2744
1989	719	794	239	131	575	3	32	8	10	230	0	2742
1990	1556	135	82	192	1578	7	6	19	15	240	0	3830
1991	1081	65	75	186	2870	8	12	26	20	309	7	4658
1992	1006	101	155	369	2428	328	96	54	105	187	19	4847
1993	776	249	696	311	3007	162	275	282	71	99	2	5929
1994	661	554	695	509	1072	145	575	223	48	78	0	4561
1995	843	968	509	357	619	114	250	388	115	191	1	4355
1996	649	622	1141	335	533	46	103	530	68	95	0	4123
1997	499	382	515	313	906	5	113	340	41	36	1	3152
1998	493	380	504	347	766	94	153	175	35	11	0	2958
1999	479	153	303	269	1832	145	231	75	28	20	1	3536
2000	583	164	343	401	1643	70	158	90	83	11	0	3545

Table 2.1.3.2 Annual consumption (1000 tonnes) by minke whales and harp seals in the Barents Sea. The minke whale calculations are based on data from 1992–1995, while those for harp seals are from 1990–1996. For harp seals, the most conservative estimates in Nilssen *et al.* (2000) are used.

Prey	Minke whale consumption	Harp seal consumption (low capelin stock)	Harp seal consumption (high capelin stock)
Capelin	142	23	812
Herring	633	394	213
Cod	256	298	101
Haddock	128	47	*
Krill	602	550	605
Amphipods	0	304	313**
Shrimp	0	*	*
Polar cod	*	880	608
Other fish	55	622	406
Other crustaceans	0	356	312
Total	1817	3491	3371

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

** only Themisto.

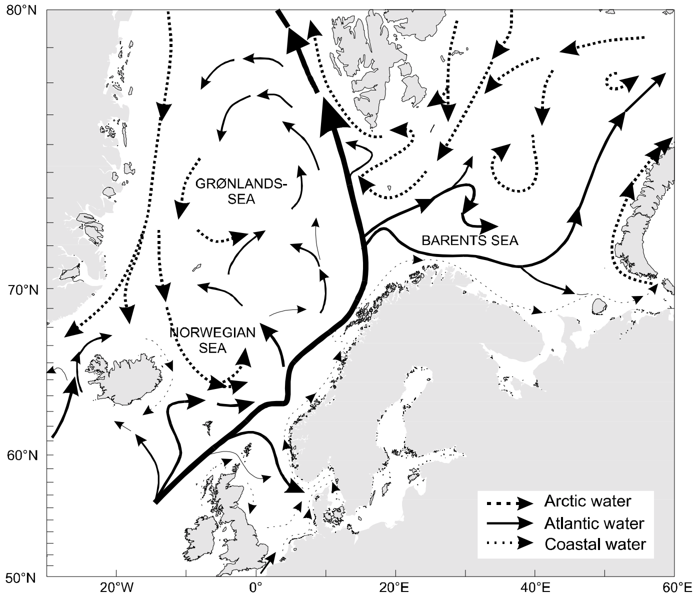


Figure 2.1.1.1. Main surface currents of the Nordic and Barents Seas.

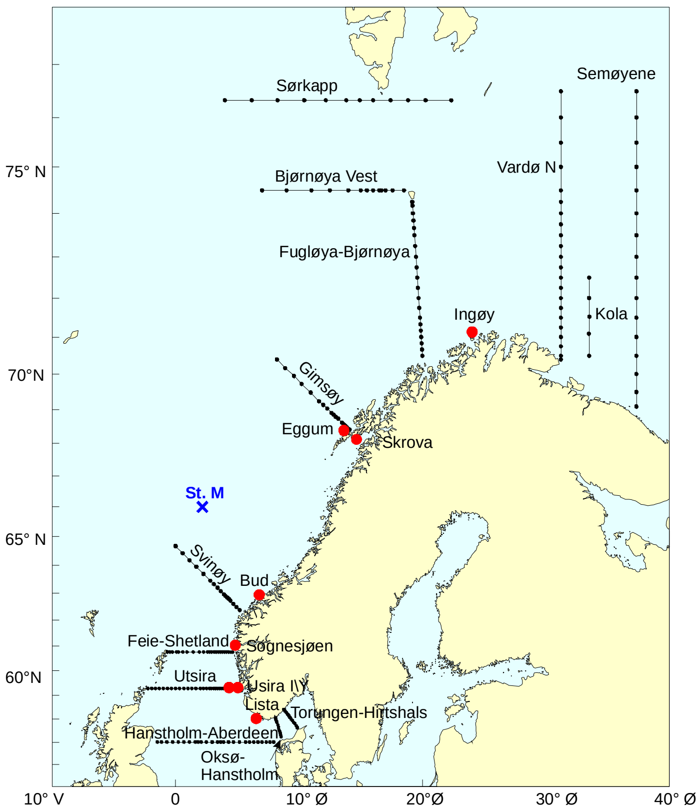
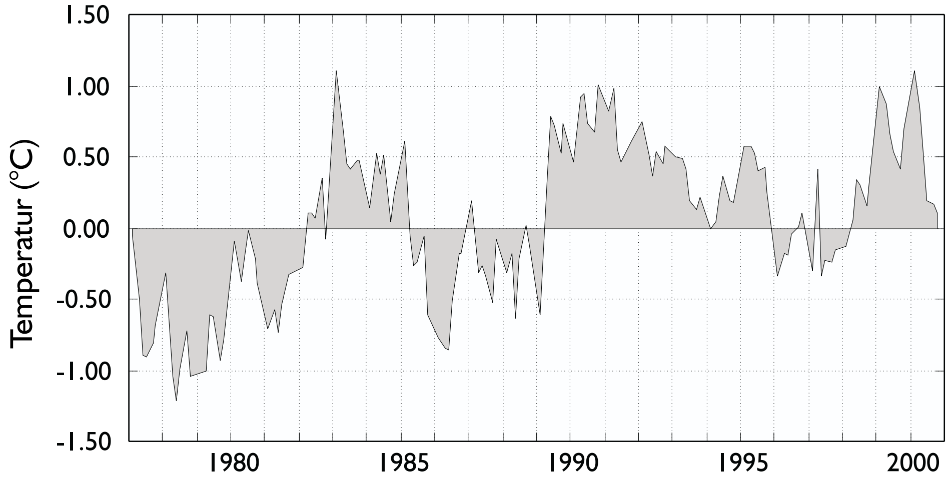


Figure 2.1.1.2. Standard sections and fixed oceanographic stations worked by Institute of Marine Research, Bergen. The University of Bergen is responsible for station M, while the Kola section is operated by PINRO, Murmansk (Anon. 2001).



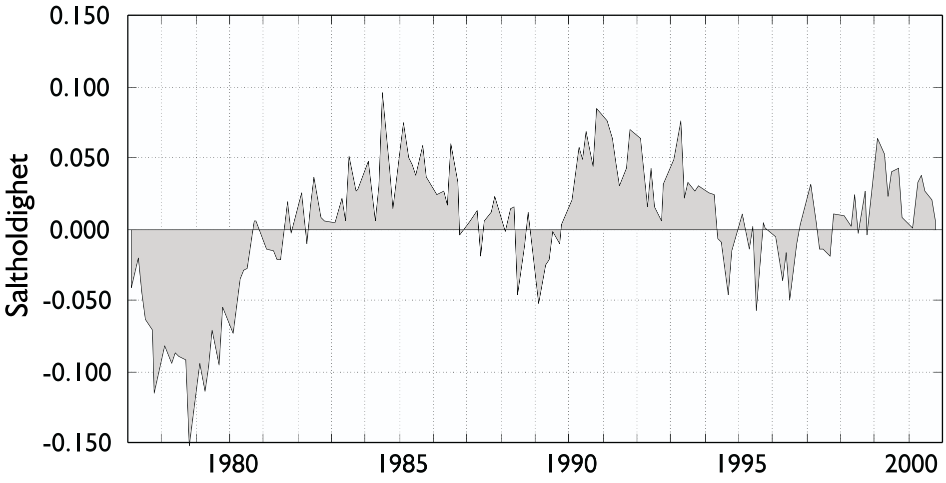


Figure 2.1.1.3. Temperature and salinity anomalies in the Fugløya-Bear Island section during the period 1977-2000.

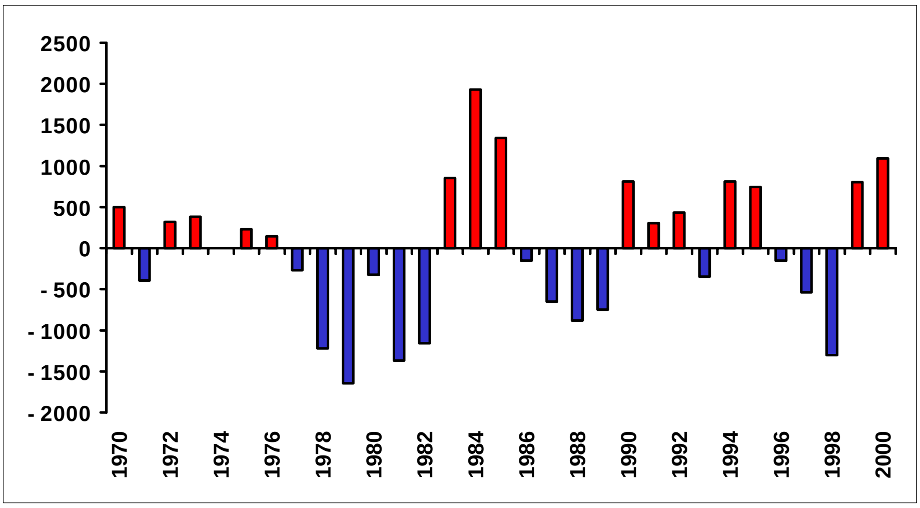


Figure 2.1.1.4 Ice index for the period 1970-2000. Positive values means less ice than average, while negative values show more severe ice conditions (Anon. 2001).

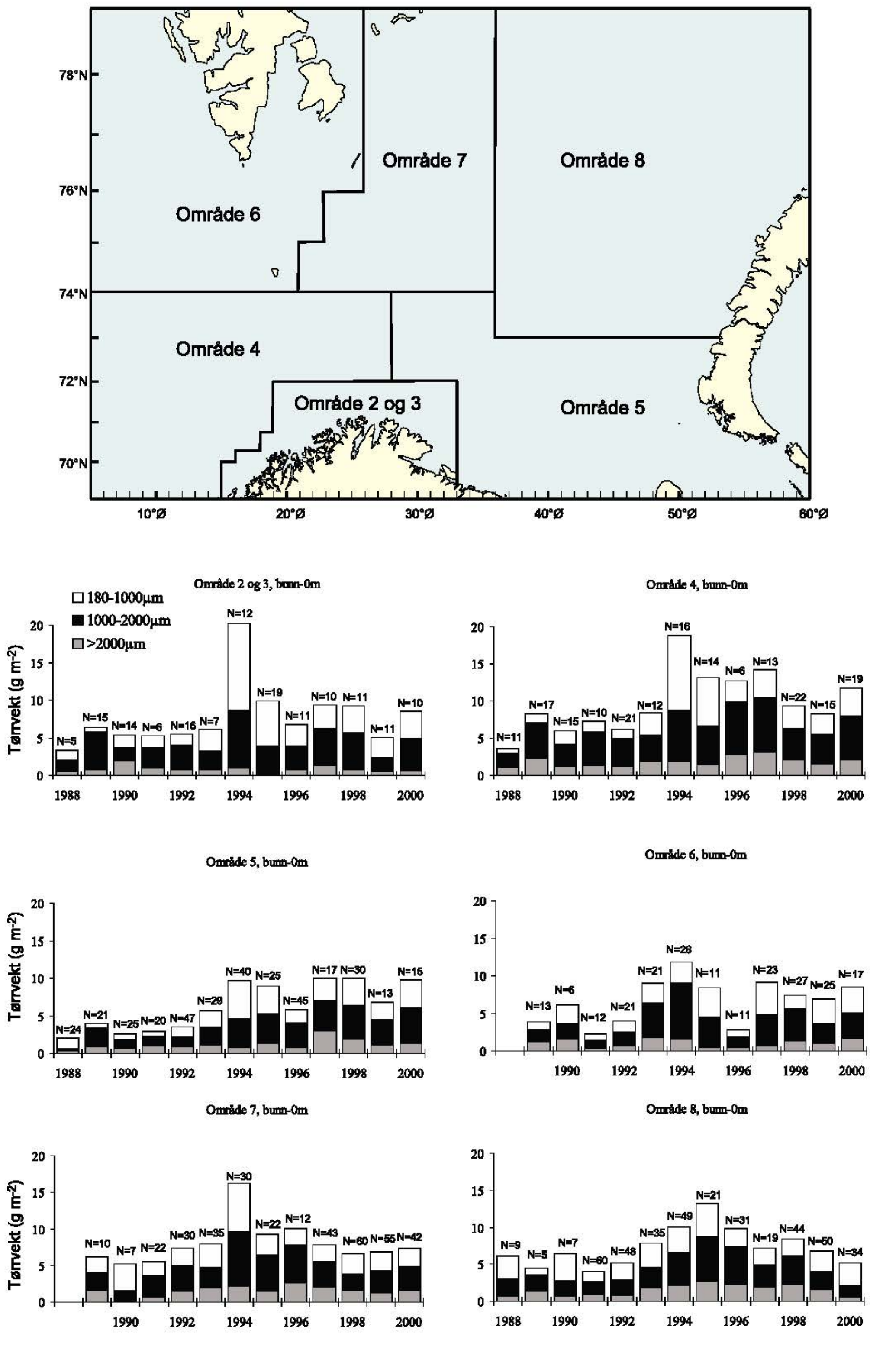


Figure 2.1.2.1. Size separated zooplankton biomass, dry weight gm^{-2}, from bottom-0 m and from 100-0, mean values for the whole Barents Sea, from 1988-2000.

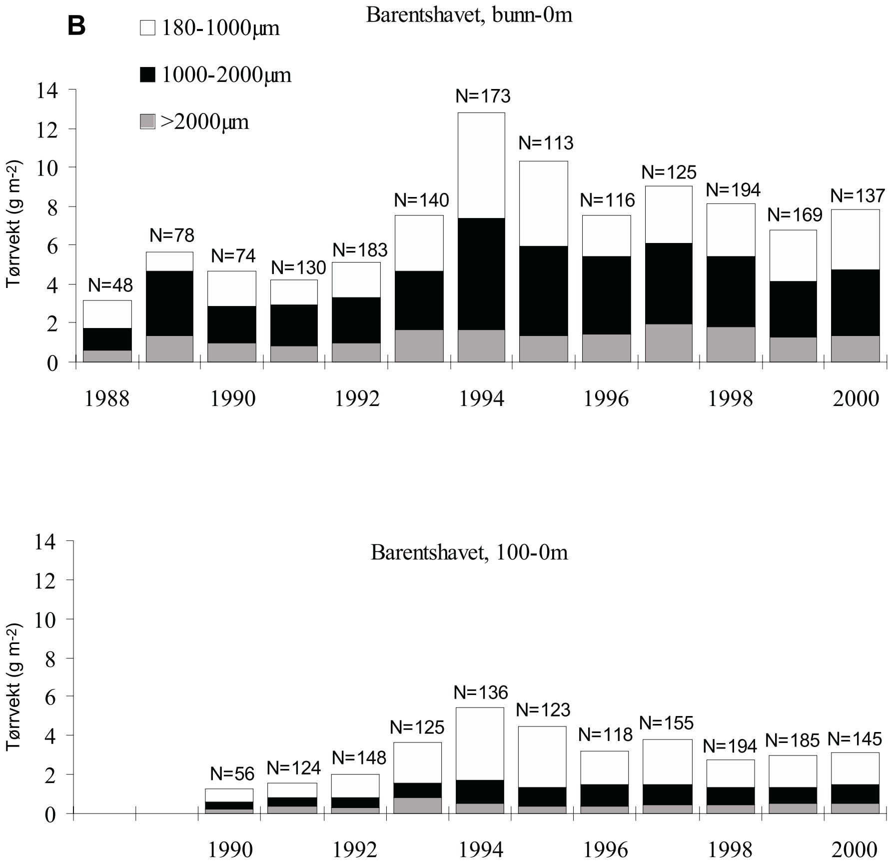


Figure 2.1.2.2. Mean values of size separated zooplankton biomass, dry weight gm^{-2}, from bottom-0 m in 8 different regions of the Barents Sea during the period 1988-2000.

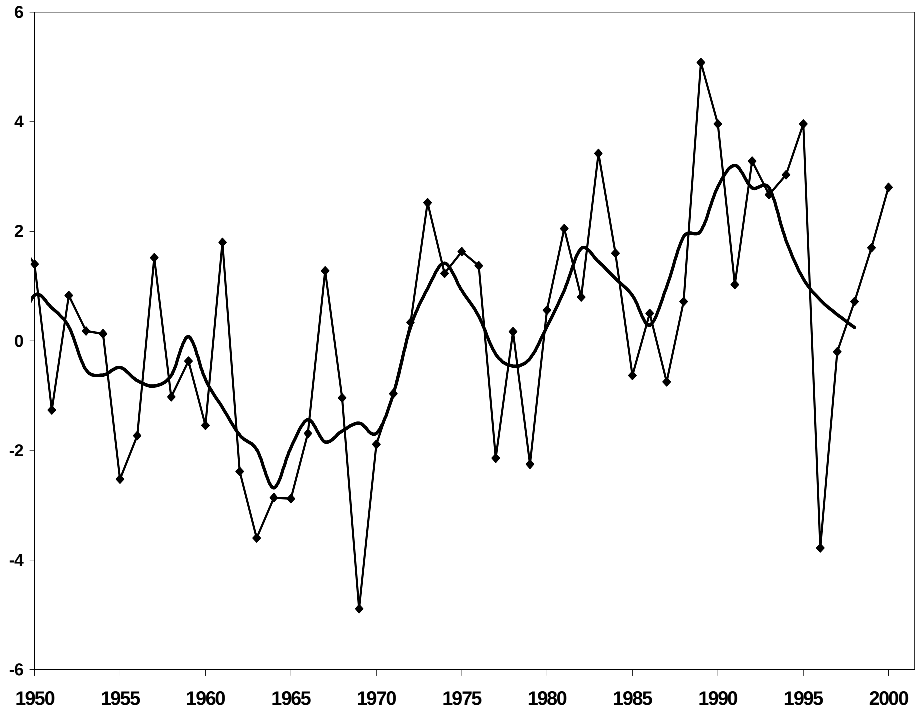


Figure 2.2.1.1. Winter (December-March) North Atlantic Oscillation index (NAO).

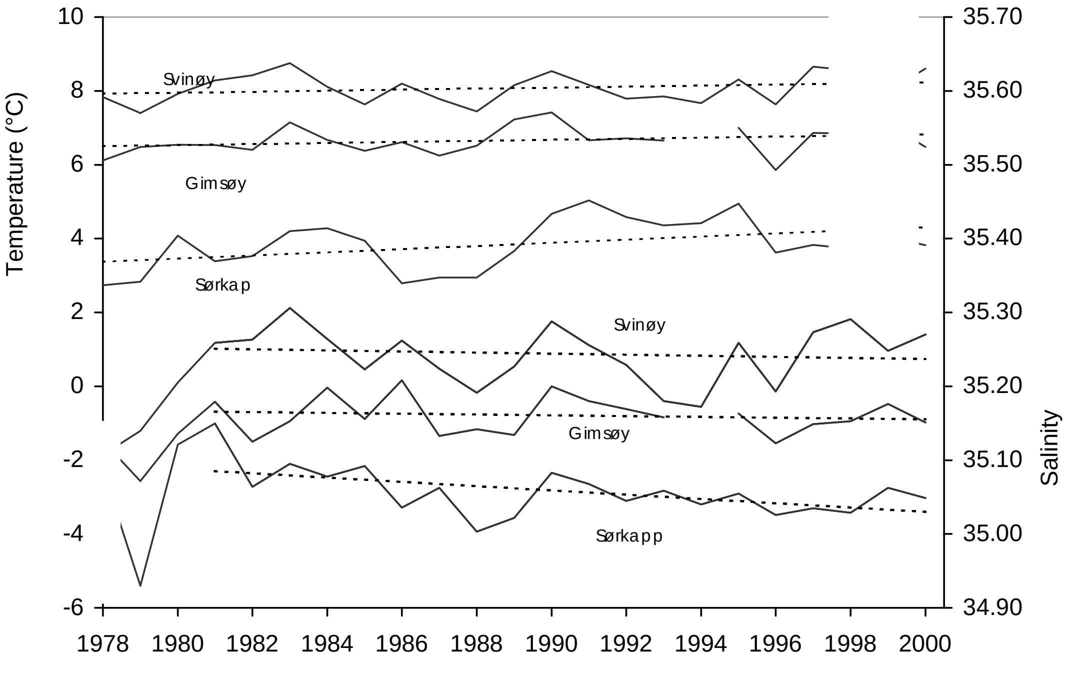
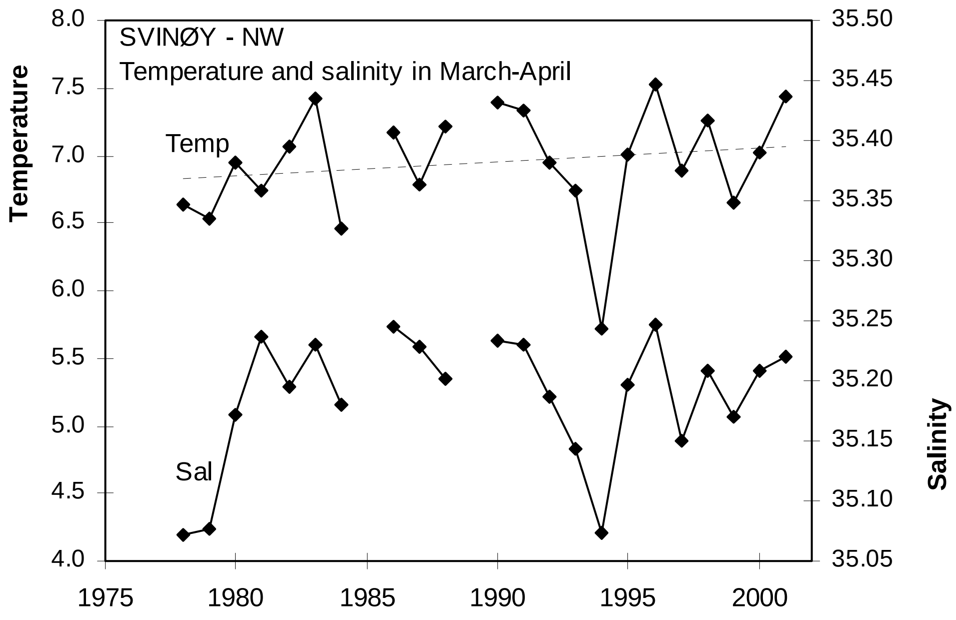


Figure 2.2.1.2. Temperature (ºC) and salinity observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.



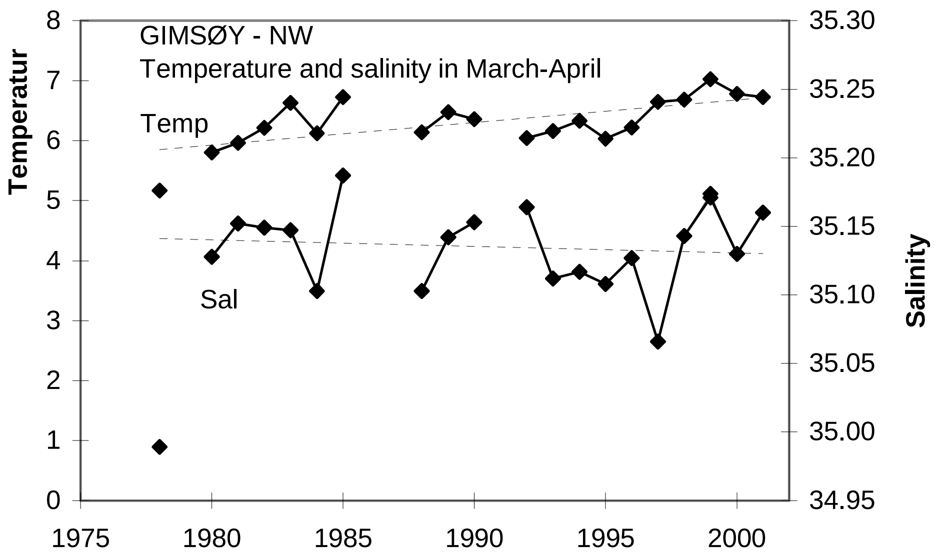


Figure 2.2.1.3. Temperature and salinity in the sections Svinøy – NW and Gimsøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

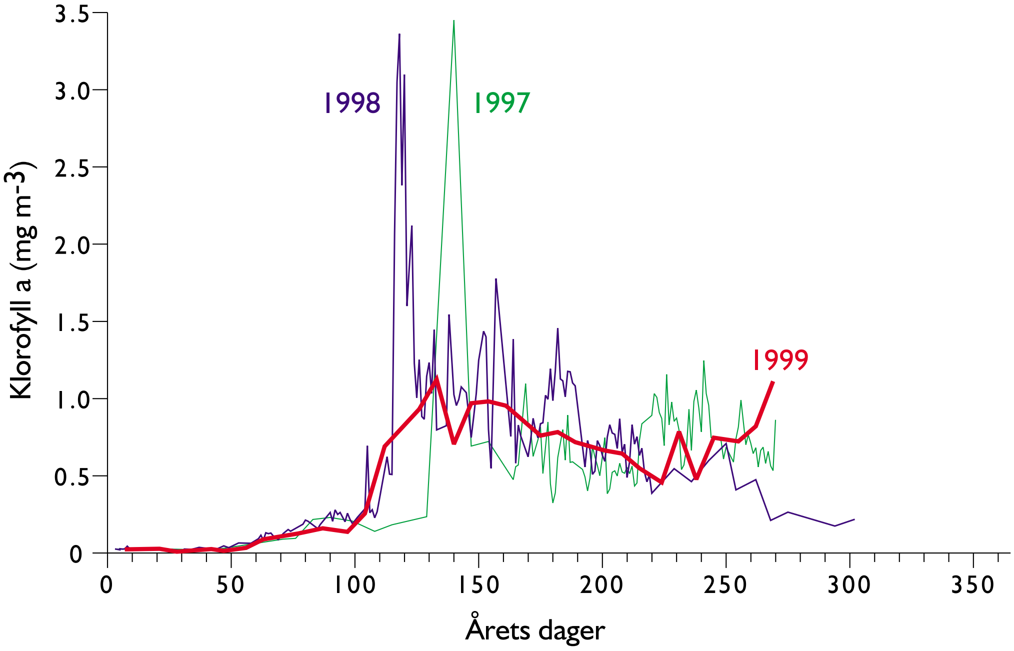


Figure 2.2.2.1. Distribution of chlorophyll *a* at 10 m depth during the year at Weather Station Mike in 1997, 1998 and 1999.

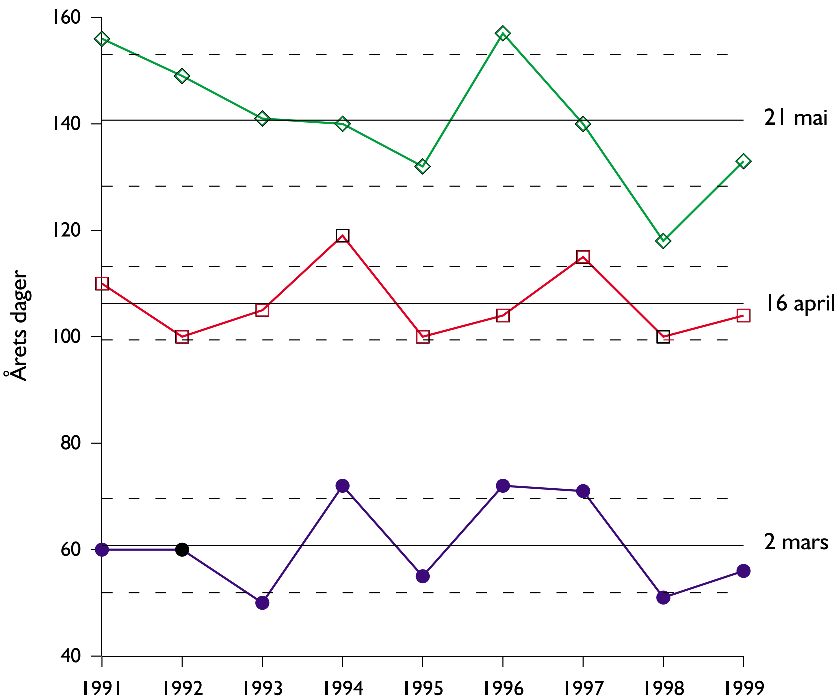


Figure 2.2.2.2. Year to year variation in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 1999. Circles: winter phase; squares: pre-bloom phase; diamonds: spring bloom. Continuous lines represent the average for each period. Broken lines represent one standard deviation for each period.

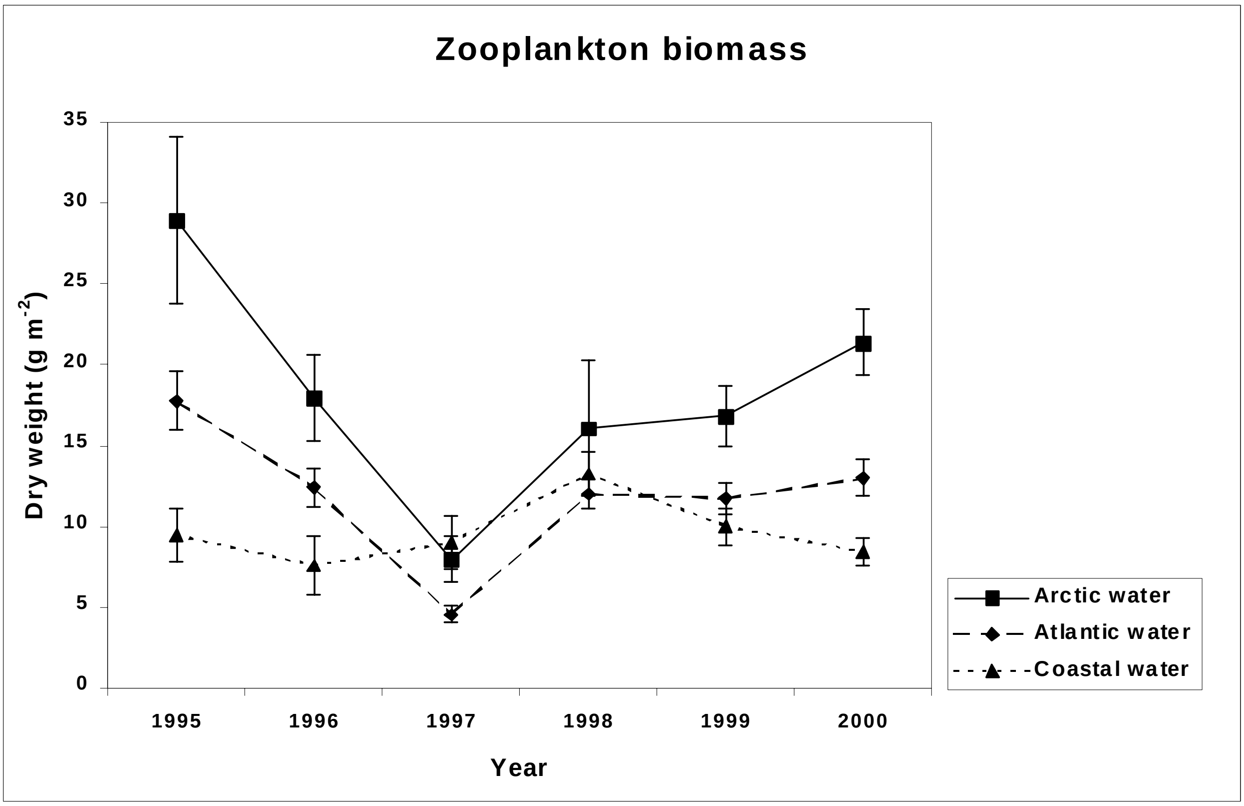


Figure 2.2.3.1. Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

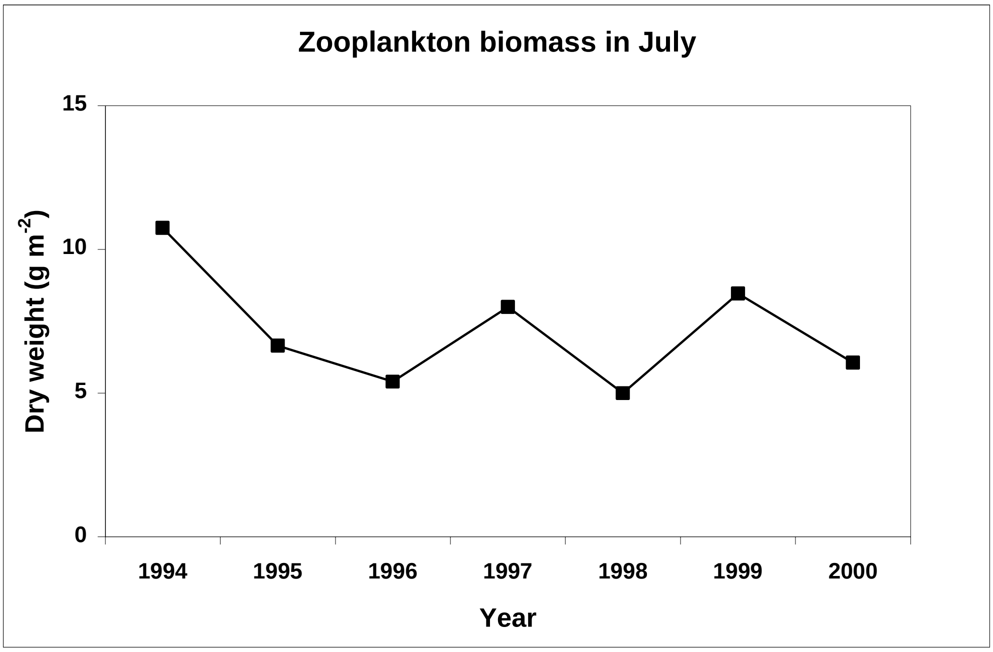


Figure 2.2.3.2. Zooplankton biomass in July-August in the eastern Norwegian Sea (0-200 m). Integrated biomass within a fixed geographical region divided by its area.

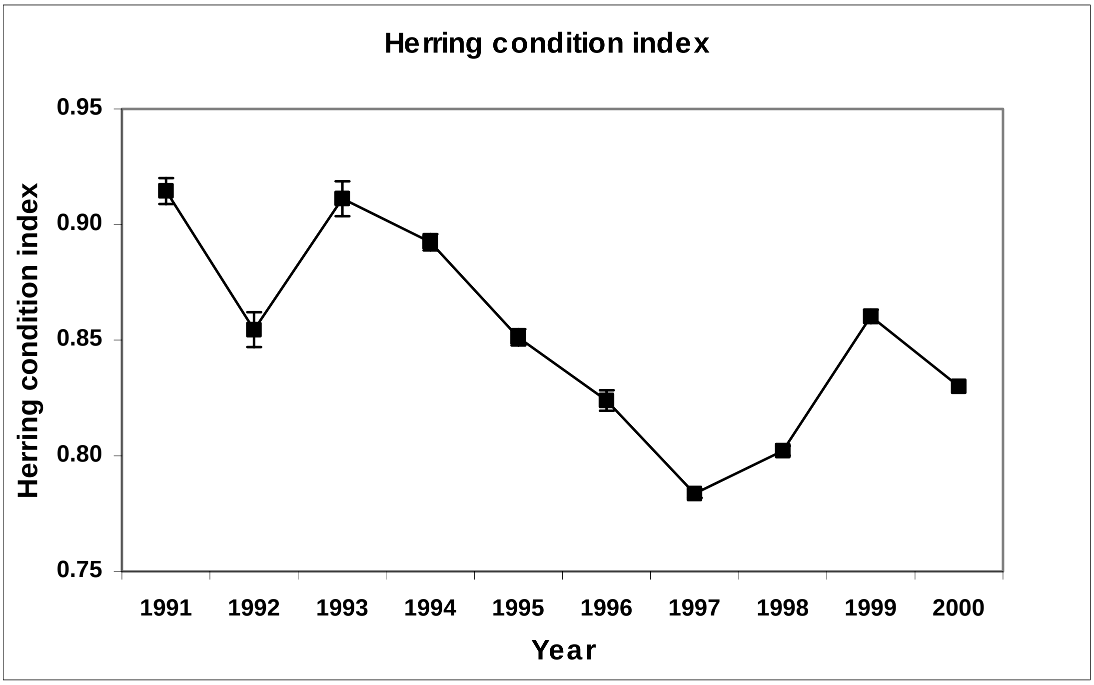


Figure 2.2.4.1. Individual weight to length ratio (herring condition index) for Norwegian spring spawning herring. Data from September, October, and November, for herring 30-35 cm body length. Error bars: 95% confidence limits.

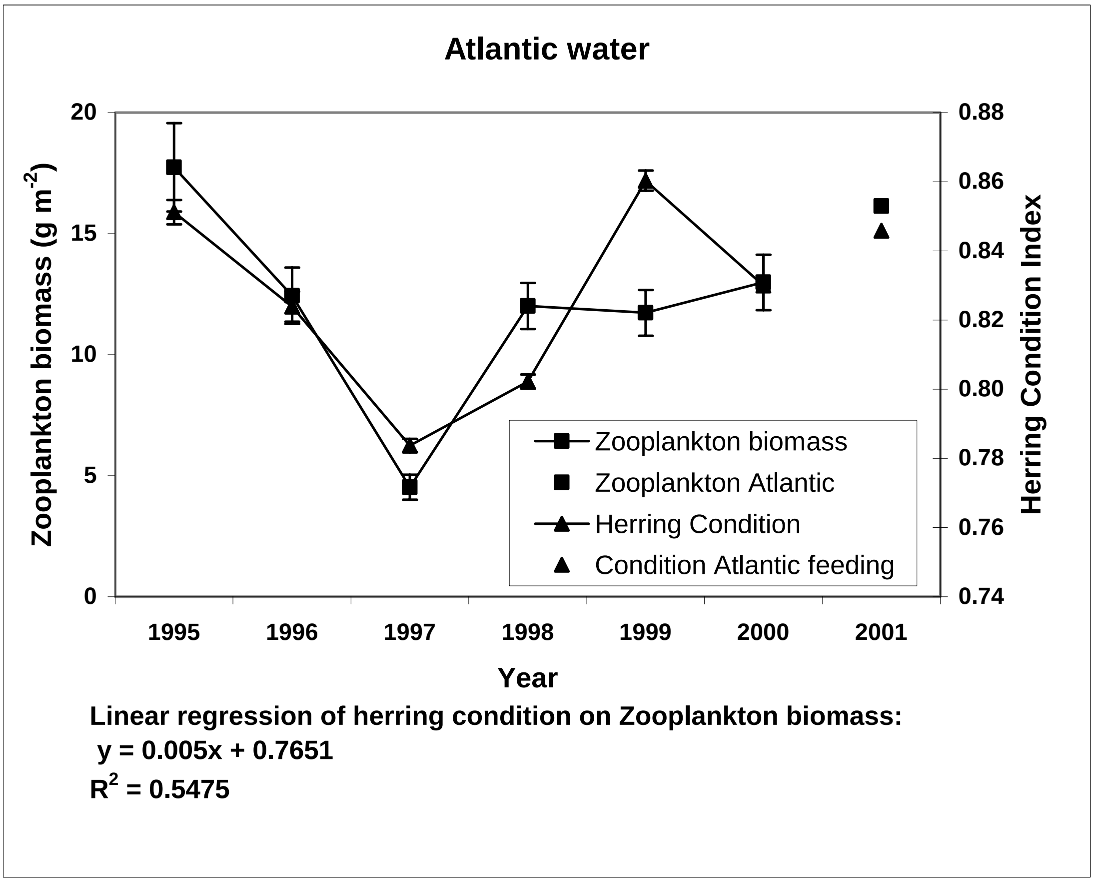


Figure 2.2.4.2. Zooplankton biomass (dry weight) in Atlantic water in the Norwegian Sea in May (0-200 m) and herring condition index (individual weight to length ratio, September-November, 30-35 cm). Error bars: 95% confidence limits. Prognoses for zooplankton biomass in Atlantic water in May and herring condition in December 2001.

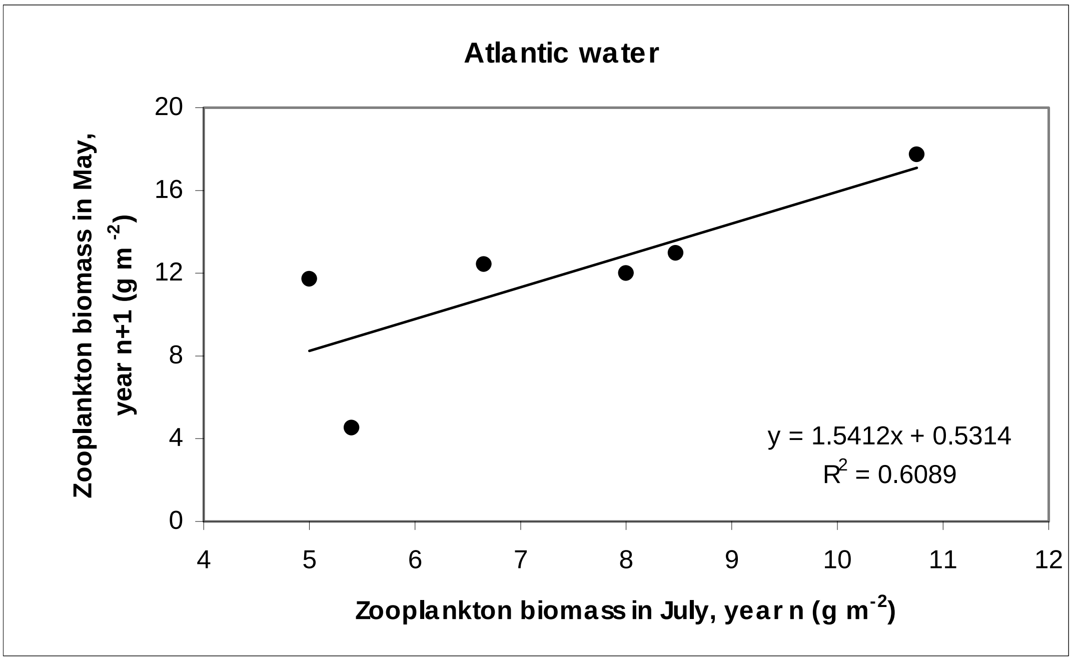
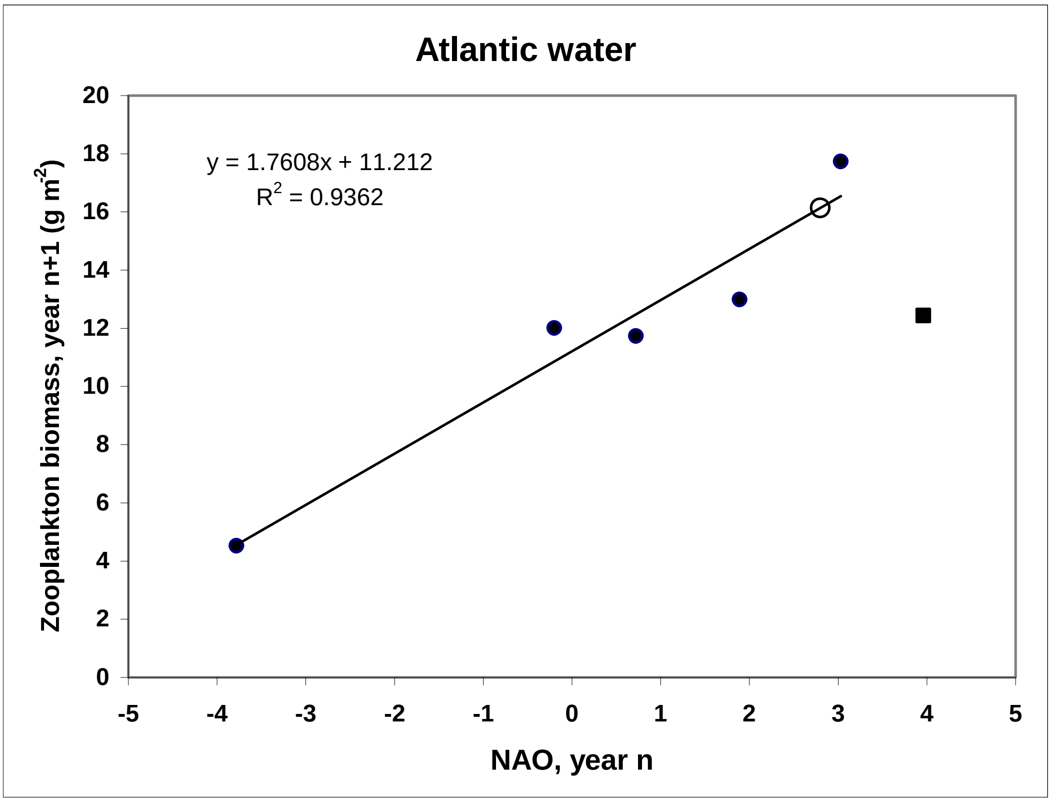


Figure 2.2.5.1. Zooplankton biomass in July (year n) vs. zooplankton biomass in May (year n+1).



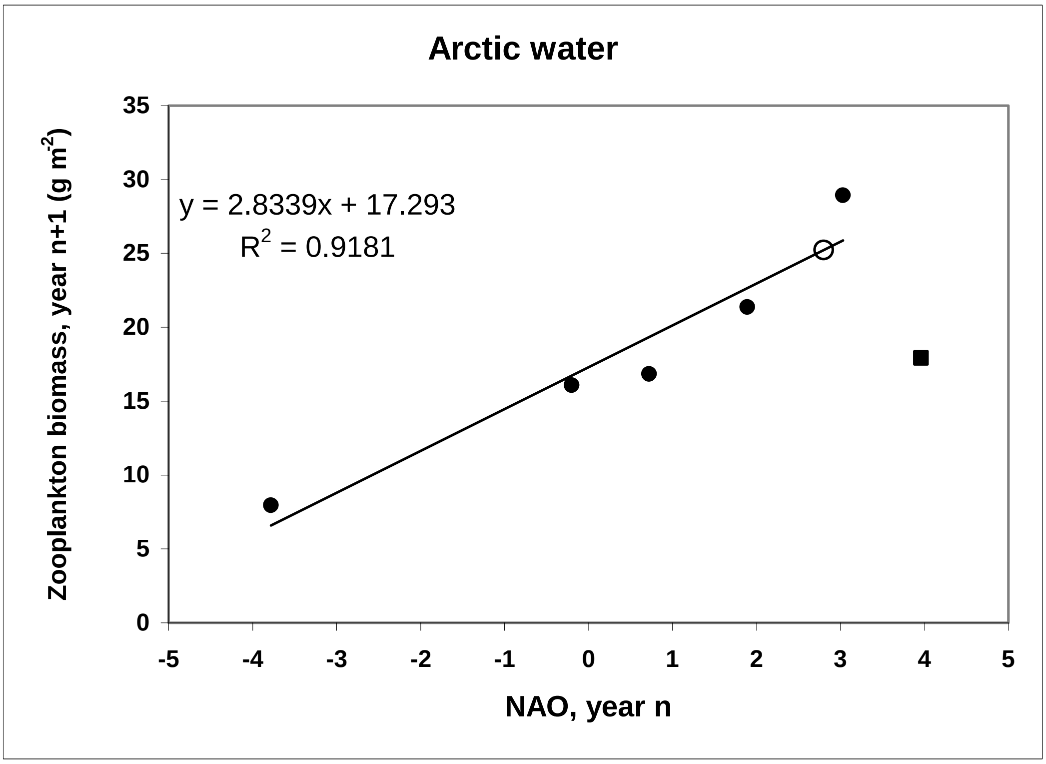


Figure 2.2.5.2. Winter (December-March) North Atlantic oscillation index (NAO) (year n) vs. zooplankton biomass in May (year n+1) (squares). Prediction of biomass May 2000 from NAO during December 1998 to March 1999 (circle) using estimated linear relationship.

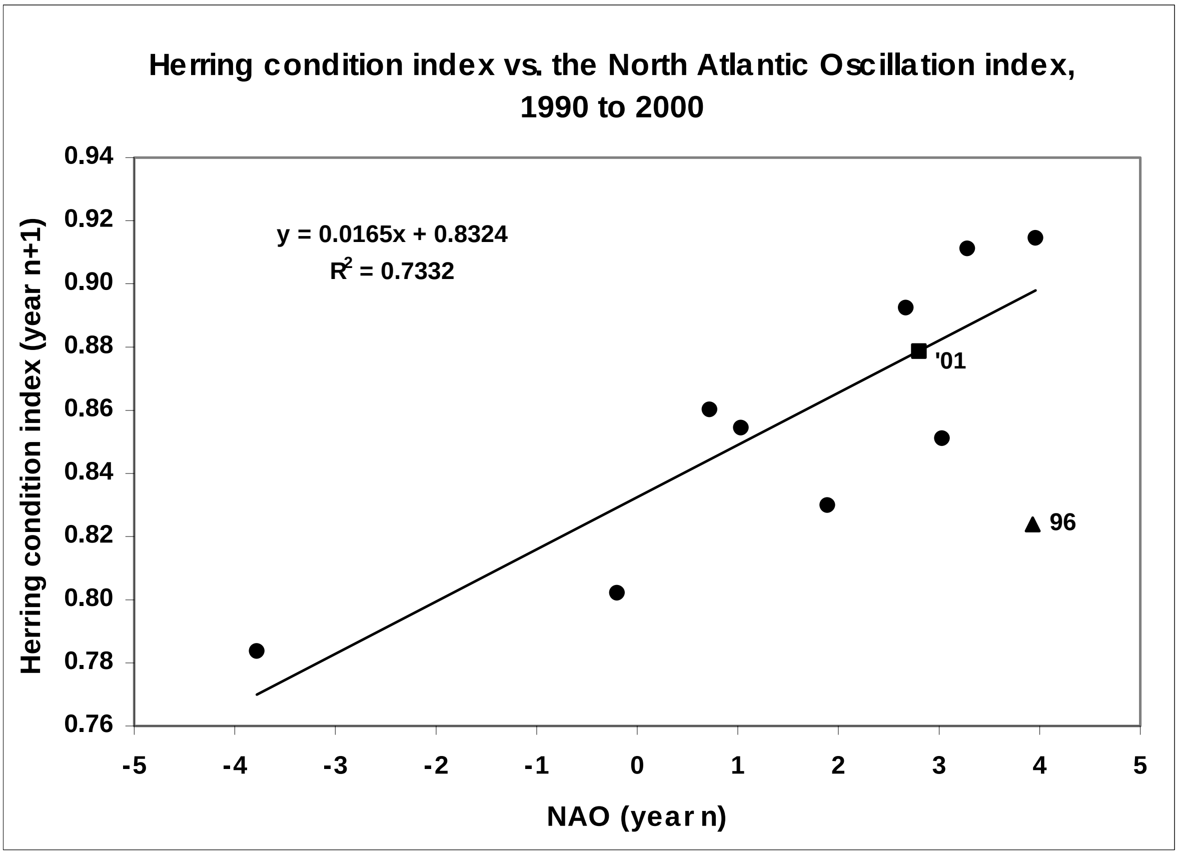


Figure 2.2.5.3. Herring condition index (year n+1) vs. winter NAO (year n). The 1996 was considered an outlier and excluded from the data set prior to estimation of the linear relationship. Prediction of herring condition in the autumn 2000 and 2001 from NAO during winter 2000 (square).

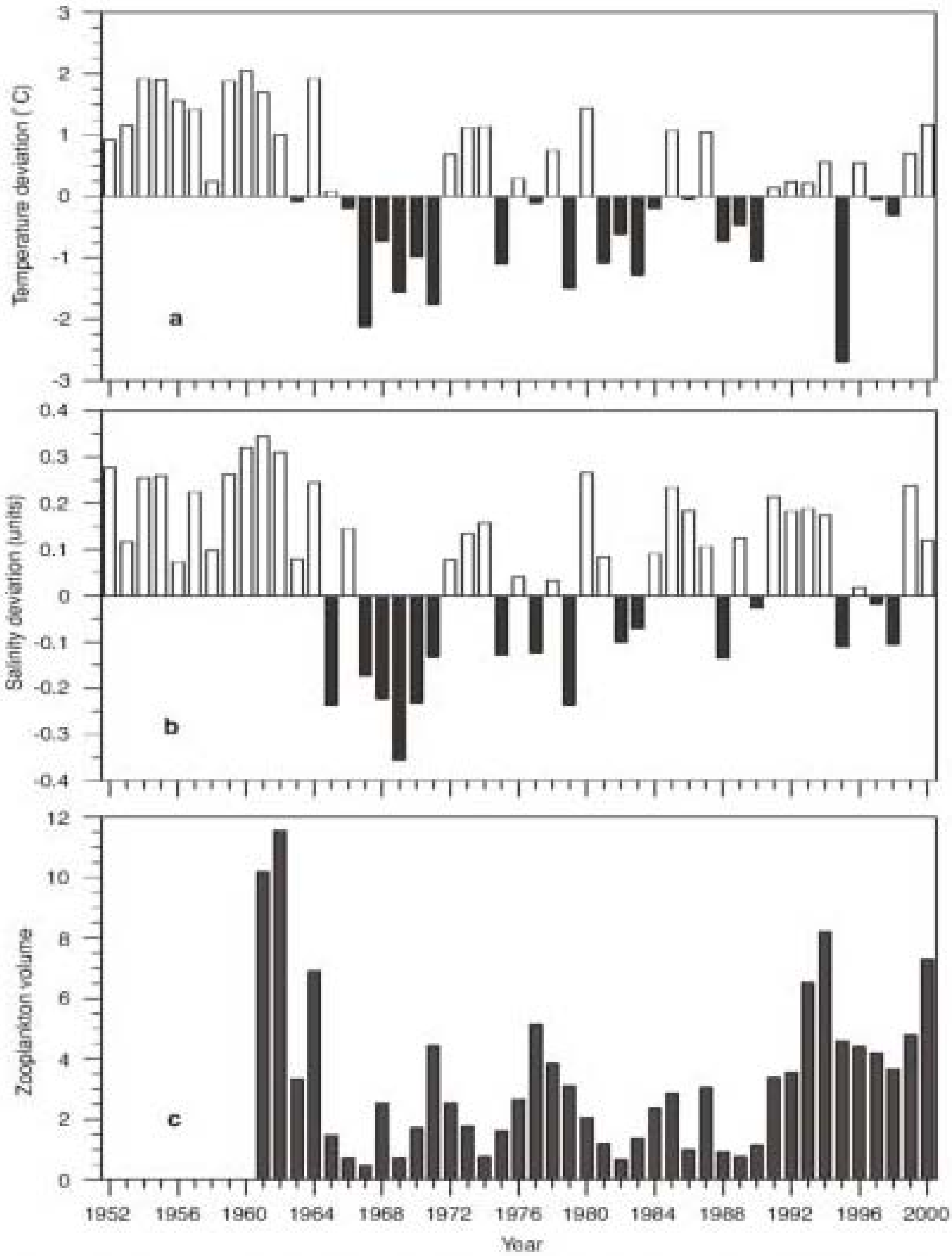


Figure 2.3.1. Temperature (a) and salinity (b) deviations and zooplankton biomass (c) on the Siglunes section off the central north coast of Iceland 1952-2000.

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 TAC and Fisheries

3.1.1 TAC agreements for 2000 and 2001

At the annual meeting in Torshavn, Faroe Islands in October 1999 the coastal states (European Union, Faroe Islands, Iceland, Norway and Russia) agreed to limit their catches to 1 250 000 t in 2000.

At the corresponding annual meeting in Skagen, Denmark in October 2000 the Parties agreed to limit their catches to 850 000 t in 2001.

3.1.2 The Fisheries

3.1.2.1 Description of the fisheries in 2000

Denmark: No information was received on the Danish fishery

The Faroes: The Faroese fishery started in late February in the Norwegian zone (outside the Møre area from 62°N to 63°N). It continued in this area in March. In May the catches were taken in the central part of the Norwegian Sea (in the international zone) and later during the summer the fishery moved northwards into the Jan Mayen area and further north in the international zone towards the Svalbard border. In early August the fishery took place in the southern tip of the Svalbard zone and continued southwards into the Norwegian zone in the area west of Lofoten, northern Norway. The Faroese fishery terminated in early September southwest of the Lofoten peninsula. All catches were taken with purse seine.

A new element in the 1999 fishery was the occurrence of herring in the northern part of the Icelandic zone in July as far west as 18°W, where approximately 6 000 t were caught. In 2000, the second year in a row, herring was taken north off Iceland during the summer fishery for capelin in June and July. Approximately 1000 t were caught on seven different locations (see second and third quarter in Figure 3.1.2.1.1). About two thirds of the catches were confirmed as being "clean" herring catches while the others probably were by-catches in the capelin fishery.

France: There was no information of a French fishery in 2000.

Germany: No information was received of the German fishery in 2000.

Iceland: The fishery started on 21 May and continued during the rest of the month in international waters from about 69°N to 70 °N, between 5°E and the zero meridian. The herring were generally scattered and below purse seining depth. Catch rates were therefore low and only 14 000 t was caught in May. Catch rates improved in June and about 100 000 t were fished during the first three weeks of the month, while the Icelandic fleet followed that part of the stock which migrated to the northwest into the Jan Mayen EEZ and then north between about 3°W and 5°W to 72°N. During the last 10 days of June, the herring migrated rapidly to the northeast and back into international waters. Following the migration, the Icelandic fleet took its last summer catches on 1 July near 74°30'N, 6°E. The catch during 21 June – 1 July was about 64 000 t. Since no catches were taken in the Icelandic or Faroese EEZs in 2000, the total Icelandic summer fishery yielded about 178 000 t, all of which taken in international waters and the Jan Mayen EEZ. Additional 8000 t of herring were fished by Icelandic vessels to the northwest of Lofoten in the Norwegian EEZ, mainly in September. The positions of the Icelandic herring catch in 2000 are shown in Figure 3.1.2.1.4.

Ireland: The Irish fishery was carried out in the Norwegian Sea. One vessel using midwater trawls took part in the fishery. The catches were taken in May-September, and the total catch was 8 939 t.

Netherlands: There were no reports of a Dutch fishery for Norwegian spring-spawning herring in 2000.

Norway: By far the larger part of the Norwegian fishery takes place in northern Norwegian coastal waters (Vestfjorden area) where the herring winters in the period from September until March. The herring occurs in concentrations that are easily available to the fishery. This fishery is carried out by many size categories of vessels. In 2000 approximately 146 000 t were caught in the wintering area in Northern Norway, and 102 000 t in the spawning season. Approximately 8

500 t were caught in the spring/summer fishery in the Norwegian Sea, and the remaining part of the Norwegian quota (approximately 457 000 t) were taken in the period September-December on the herring migrating to, and wintering in, the wintering areas in Northern Norway. Approximately 80% of the Norwegian catches were utilized for human consumption. The positions of the Norwegian herring catches are given in Fig. 3.1.2.1.2.

Russia: In 2000 the Russian vessels started fishing herring within the shelf region of the Norwegian EEZ, near Sklinna and Halten Bank (approximately 65^0 N) and Buagrunnen Bank (approximately 63^0 N) in the beginning of February. In March the fishing occurred in the same regions. In February and March the catch was 69 059 t. In May-June the same vessels conducted fishing in the northern part of the international area in the Norwegian Sea in region of the Polar Front and in the Jan Mayen area. In May-June the catch was 17 394 t. In July two vessels caught herring in the international area in the Norwegian Sea in the region of the Polar Front. In mid-August the fishery started in the eastern part of the international area in the Norwegian Sea, near the boundary of the zone of Spitsbergen. At the beginning of September Russian vessels followed the southward migrating fish and continued their fishery in the Norwegian EEZ. In September the fishery of the herring was prolonged in the EEZ of Norway. The herring migrated southwestwards, along the depths of the continental slope. The majority of vessels conducted fishery to the west of Lofoten islands. The herring now migrated rapidly to the region southwest of Vestfjorden. In August and September the catch was 76 785 t. The entire Russian catch was utilized for human consumption. The positions of the Russian herring catches are given in Fig. 3.1.2.1.3.

Sweden: No information was received on the Swedish fishery.

UK (Scotland): The UK fishery decreased from 19 207 t in 1999, to 14 096 t in 2000.

Summary: Catches by ICES rectangles and quarters for the Russian, Norwegian, Faroese and Icelandic, and EU fisheries are shown in Figures 3.1.2.1.1 - 3.1.2.1.5. In general the development of the international fishery shown by these figures follows the known migration pattern for Norwegian spring spawning herring. The migration pattern, together with environmental factors, was mapped during the ICES PGSPFN (Planning Group on Surveys on Pelagic Fish in the Norwegian Sea) investigations (ICES 2000/D:03). However, there may be two categories of catches that do not exactly confirm to this general migration pattern.

Firstly, the westernmost Faroes catches of herring in the North Iceland-Greenland area in the third quarter of 2000 (Fig 3.1.2.1.1.) are reported from positions where herring catches very seldom have been recorded previously. It should be noted that this was not a directed fishery towards herring but the vessels aimed at capelin schools and caught herring instead (personal report from all the skippers participating in the fishery). The by-catches in the capelin fishery extended into the Greenlandic zone. Unfortunately, there were no biological samples from these by-catches. The Icelandic purse seine fleet, which fished capelin in the same area, did not report herring by-catches.

Secondly, catches reported by EU from the area north of Shetland in the third and fourth quarter (Fig 3.1.2.1.5) are from an area which is considerably south of the main distribution of the stock of Norwegian spring spawning herring at that time of the year. There were no biological samples from these catches.

3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring for the period 1973–2000 (2000 preliminary) are presented in Tables 3.2.1 (by fishery) and 3.2.2 (by country). In previous years, when the stock and the quotas were much smaller, an estimated amount of fish was added to the catches. This has not been done since 1994 (Table 3.2.1).

The combination of national catch-at-age and weight-at-age data for 2000 to obtain the total international catch-at-age and weight-at-age was done using the computer programme VPA95. The official catch, sampled catch and catch as used by the Working Group, together with number of samples, catch-at-age and weight-at-age for each fishery are given in Tables 3.2.3 and 3.2.4.

The working group noted that not all nations participating in the international fishery for Norwegian spring-spawning herring in 2000 had carried out an adequate sampling of their fishery. Denmark had sampled their fishery with two samples (Table 3.2.5). However, Denmark had arranged for further samples taken from Danish catches landed in Norway. Unfortunately, these samples were lost. The allocation of catches for which no samples were taken and the final catch-at-age and weight-at-age by ICES area is given in Table 3.2.5. In general it was decided to use the Icelandic age distribution and weights for unsampled fisheries in the Norwegian Sea in period 2 and 3, and to use the Norwegian age distributions and weight keys for un-sampled fisheries in period 1 and 4.

In addition to the sampling described in Table 3.2.3, size category information was used to calculate the Norwegian catch in number (WD by A. Slotte). In 2000 a major part of the Norwegian catches were sampled for size group composition: 4 033 samples representing 582 939 t or 82 % of the total Norwegian catch. In general the catches used for consumption, are divided into 5 size groups as follows:

Category	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 sub-samples of the catch during the production process. These percentages are registered by the Norwegian sales organisation for pelagic fish. The age composition within each size group is then estimated from age-sampled catches, and the total catch in number calculated (WD by A. Slotte).

3.3 Surveys

3.3.1 Spawning areas

There was no acoustic survey to determine the abundance of herring in the spawning areas in 2001 (Table 3.3.1.1).

3.3.2 Wintering areas

The wintering area was surveyed acoustically in December 2000 (WD by I. Røttingen). The abundance estimate obtained during this survey is given in Table 3.3.2.1. There was no acoustic survey of the wintering area in January 2001 (Table 3.3.2.2).

3.3.3 Feeding areas

The feeding area in the Norwegian Sea was surveyed acoustically during the ICES coordinated herring survey in 23.04 - 02.06 2000 (ICES 2000/D:03). The abundance estimate is given in Table 3.3.3.1.

3.3.4 Nursery area

The nursery area of the Norwegian spring-spawning herring is Norwegian fjord and coastal areas, and in the Barents Sea. Since 1988, when the 1983 yearclass spawned for the first time, the latter area has increased in importance as a nursery area for the herring.

Results from the Russian acoustic survey in the Barents Sea in June 2000 (WD by A. Krysov) are given in Table 3.3.4.1.

The results from the 0-group herring survey in Norwegian Fjords and Coastal areas are given in Table 3.3.4.2 and the results from the joint Norwegian-Russian 0-group survey in the Barents Sea are given in Table 3.3.4.3.

3.3.5 Herring larval survey 2001

The larval survey in 2001 started south of Stavanger (58^0 20'N) the 4th of April (Figure 3.3.5.1). Very few herring larvae were found south of 62 ^{0}N. A maximum value of above 10000 larvae m^{-2} surface was recorded between 64°N and 65°N and more than 1000 larvae m^{-2} surface were found in a large part of the area between 63-64°N. Most of the larvae north of 62°N were in the first post yolksac stages, when the yolksac is resorbed and the dorsal fin starts to develop. At this stage they have started to grow and are beyond the most critical stage for starvation. Another patch of larvae was recorded further north between 68°N and 70°N. More than 100 larvae m^{-2} surface were found in this area. These larvae were in the later yolksac stages, and in the first post yolksac stage.

The index estimated is shown in Table 3.3.5.1 and is the third highest since the recovery of this stock started.

3.4 Tagging Experiments

In 2000 (March-April) 29 350 herring were tagged. An effort to carry on the annual tagging experiments was made in March-April 2001. However, this year the herring left the coast immediately after spawning and consequently no herring were available for tagging. For this reason it will be considered whether future tagging experiments should be carried out in the wintering areas, where the herring are available for tagging from October to January. This would imply tagging on maturing herring instead of spent herring. Preliminary results from ongoing tagging experiments on captive herring indicate that neither tagging mortality nor tag loss is significantly influenced by a shift of tagging season. The working group recommends that these investigations be continued.

Recovery from supervised detector plants has continued, as well as recovery from the standard magnets in the production line of fish processing plants and from individuals (WD by A. Slotte).

During the tagging process, the total length of the herring is measured. For each purse seine catch that is used for tagging, a sample of 100 fish is taken to determine the age distribution within each length group. The age composition in this batch of tagged herring is then estimated from the age distribution in the sample. If it is later found, from the age composition or other criteria, that a batch of tagged herring may have contained herring from one of the local stocks in the fjords, this batch is not used for stock assessment.

Recoveries are made from commercial catches and from tag detectors installed at fish processing factories. For stock assessment purposes, tags are used only from supervised factories where detector efficiency has been tested, and where it is known that the detectors have been working as intended. Two factories fulfilled these criteria in 2000, and a total of 79.458 million herring (24 919 t) were screened at these factories. Altogether more than 100 catches were screened for tags. With the exception of 5 catches, magnet efficiency in 2000 was 100%. In the catches with less than 100% efficiency the number of herring screened was reduced corresponding to the efficiency before being included in the total. The numbers of fish screened given in Table 3.4.1 are thus corrected for efficiency. All tagged herring that were recovered were measured, weighed, and aged.

In 2000, 89 tags that fulfilled the criteria above, were recovered from the year classes 1983+, 1985, 1989, 1990, 1991, 1992, 1993 and 1994 (Table 3.4.1).

3.5 Stock assessment

3.5.1 Model for stock assessment

The model SeaStar described in section 1.3.1 was this year used to conduct the assessment of the Norwegian spring spawning herring stock on a wider basis: tuning of fish that are considered representatively sampled in acoustic surveys, regressing the perceived recruitment of younger fish to observations and for conduction of medium-term simulations. The analysis of uncertainty in SeaStar is based on resampling from the input data and the present integrated analysis provides a consistency in each replicate simulation that is difficult to achieve by using separate tools.

3.5.2 Input data

The year and age range, natural mortality and handling of missing data in the catch at age matrix were unchanged from last year.

The analysis was run for ages 0 to 15 with a 16+ group. M is set equal to 0.15 for ages 3 and older and 0.9 for ages 0 to 2 in all years. The proportion of F and M before spawning is set to 0.1.

The catch at age, weight at age in the stock and in the catch and maturity ogive for the period 1950-2000 are given in Table 3.5.2.1-3.5.2.4. The maturity at age data for the 1991 yearclass was revised on basis of a re-analysis of data obtained in the wintering and spawning area in 1994/1995 (WD by A. Slotte and I. Røttingen).

3.5.2.1 Survey data

The same surveys as used at previous WG meetings were used also this year, i.e. the Barents Sea surveys in May-June were not included (Tables 3.3.1.1, 3.3.2.1, 3.3.2.2, 3.3.3.1 and 3.3.4.1). The age groups included in the tuning are age 4 and older in the December survey and age 5 and older in the other surveys. During the 1998 meeting of this WG some points were perceived as outliers because of the noise they generated in the assessment and were consequently excluded from the analysis. These points have been excluded also in later meetings. Also, acoustic data earlier than 1991 were excluded in 1998 because the WG then felt that the different acoustic equipment before 1991 made the earlier points incomparable to those from 1991 and later years.

3.5.2.2 Tagging data

The same tagging data series as used last year were included in the likelihood function this year (data in Table 3.4.1). The first recoveries used were those obtained two years after release.

3.5.2.3 Larval index series

The larval index (Table 3.3.5.1) used in the tuning last year was used also this year.

3.5.3 Implementation of acoustic surveys and tagging data in the assessment model

3.5.3.1 Survey structural relationship and inclusion of data in the likelihood function

The distribution of the acoustic surveys were assumed to follow the gamma distribution with a constant CV, as used last year, see section 1.3.1. The included age groups are considered fully recruited to the surveys and consequently the catchabilities are assumed equal for all ages and years for each survey. Also this year only terminal F-values for the most abundant year classes were included among the free parameters to be estimated, and only these year classes (1983, 1990, 1991, 1992 and 1993) were included in the likelihood function.

3.5.3.2 Probability of tag recovery

The number of tag returns were assumed to follow the Poisson distribution.

3.5.4 Stock assessment

The parameters estimated in the final run were:

- Catchability of the survey on the spawning grounds
- Catchability of the December survey in Ofoten
- Catchability of the January survey in Ofoten
- Catchability of the international survey in the Norwegian Sea
- CV of the survey probability distributions
- Catchability of the larval survey index
- F in the last year of catch data for the 1983 year-class
- F in the last year of catch data for the 1990 year-class
- F in the last year of catch data for the 1991 year-class
- F in the last year of catch data for the 1992 year-class
- F in the last year of catch data for the 1993 year-class
- Survival of tagged fish in the tagging year

Altogether 12 parameters were estimated.

The following exploratory runs were made:

Run 1. Settings corresponding to the assessment made in 2000. The year-classes 1983, 1990, 1991, 1992 and 1993 were included in the tuning and in the likelihood.

Run 2. As Run 1, but the outliers were included.

Run 3. As Run 1, but the Barents Sea survey was included.

Run 4. As Run 1, but the tags from the 1986-1989 year classes were not included in the likelihood.

Run 5. As Run 1, but the plus group was lowered to 13 years. The plus group was included in the likelihood for the surveys, but not for the tag returns for technical reasons. This may be amended at a later stage.

Run 6. As Run 5, but the plus group was not included in the likelihood.

Run 7. As Run 1, but the first recovery was delayed one year. Thus the first recoveries used were those obtained 3 years after release. This option was used last year, but an error in the software led to it not being implemented.

Run 8. As Run, but 1 the 1994 yearclass was included in the tuning.

These runs are summarized in Table 3.5.4.1. Run 1 is in good agreement with the assessment made last year. The differences in estimates of the spawning stock size in 2001 among runs are quite small, which gives some confidence regarding the robustness of the model.

To give a feel for the uncertainty connected to the various data sources the log-likelihood from each of the input sources divided by the number of terms is tabulated, together with the number of terms in the respective types of input. The variance would not be as informative because it does not have a direct bearing on how the data affect the likelihood since gamma and Poisson distributions are used, not the normal distribution. The log-likelihood per term is comparable to the assessment made last year. The catchabilities are on the same level as last year, except for the Lofoten December survey, for which the catchability is higher this year and closer to the catchabilities for the other surveys.

Nothing in the exploratory runs suggested strong needs to change assumptions from last year and the WG therefore adopted Run 1.

3.5.4.1 Retrospective analysis

A retrospective analysis was performed by setting the assessment year to 2001, 2000, 1999, 1998 and 1997 using the same settings as in Run 1. However, year classes younger than 5 years were deleted from the tuning. Figure 3.5.1 shows the retrospective plot. It should be born in mind that the year classes not included in the tuning are not included in the spawning stock time series shown in the figure. There is good agreement with the assessment made last year. The stock as perceived in an assessment in 1999 is much higher. In that year the last values for the three surveys along the Norwegian coast were all exceptionally high and not in accordance with the general trend of the stock. The reason for this remains unclear.

3.5.4.2 Diagnostics

Figure 3.5.2 shows a quantile-quantile plot of the cumulative density function values for all terms in the likelihood function. Even if the terms in the likelihood function correspond to widely different probability distributions (gamma and Poisson) each term can be characterized by a value between 0 and 1 that is the probability of obtaining an observation below this value. This probability is called the cumulative density value. If the probability distribution assumed is correct, these cumulative density function values should have a uniform distribution between 0 and 1. If the value on the x-axis is, say 0.3, the total number of cumulative density function values smaller than 0.3 is plotted on the y-axis. If the distribution of the data comply with the distributional assumption made in the assessment the points should fall on the straight line. Also, the terms from the different sources of input data (surveys, tags, larval index) should mix well along the line. This is reasonably well achieved. The chosen distributional assumptions seem therefore to work reasonably well, although there seems to be some room for improvement. The choice of distributional function was addressed by this WG in 1999 (ICES 1999/ACFM:18) where it was concluded that the gamma distribution with constant CV was preferable to the gamma distribution with constant variance or the lognormal function. However, this question might be considered further as more data points are obtained.

Figure 3.5.3 shows the likelihood function as function of the tuning parameters, with one parameter varied 50% to each side of the maximum likelihood estimate at a time. The likelihood is highly skewed, discouraging making inference of the parameter covariances from the Hessian, i.e assuming the likelihood is a multinormal function of parameters. This is the main reason why SeaStar relies on bootstrapping for analyzing uncertainty in the assessment.

Figure 3.5.4 shows a histogram of the likelihood by removing one survey term in the likelihood function at a time, each time making a new tuning of the stock. The most extreme points have an influence of about 0.25 million t. Most of the terms have an influence less than 0.1 million t.

3.5.4.3 Stock assessment by ISVPA

Last year an assessment of the Norwegian spring spawning herring stock since 1981 was made by the use of the ISVPA method. (ICES 2000/ACFM:16). The method is described in section 1.3.6.

Use of the ISVPA was attempted, to explore which signals were contained in the catch-at-age data. A run with the ISVPA was provided by Vasiliev (pers.com.). Previous attempts by the WG using several slightly different constraints and options failed to give a significant minimum of the objective function and sometimes gave quite unrealistic results. The WG considers that the present data set is outside the quality range where a robust solution with respect to fishing mortality and stock numbers can be found from catch data only.

3.5.5 Assessment of the 1994 and younger year classes

This year the 1993 year class was used as the oldest tuned year class, the 1994 year class being weak and therefore excluded from the tuning. At the WG meeting last year the assessment of younger year classes was done by RCT3. This year the assessment of younger year classes was done by SeaStar with a somewhat different approach as described in section 1.3.1. The reason for this is to obtain adequate correlation properties between tuned and non-tuned fish. Figure 3.5.5 shows the resulting percentiles of number at age of the younger year classes. Table 3.6.2.1 gives the median of the youngest year classes that are used as input data for the short-term prognosis.

3.5.6 The final VPA

The final VPA was run using the values of the terminal F in 2000 from the Working Group's best estimate (Run 1) described in section 3.5.4 for the 1997 and older year classes. The results from the VPA are given as such:

Fishing mortality:	Table 3.5.6.1.
Stock numbers:	Table 3.5.6.2
Stock biomass at age:	Table 3.5.6.3
Spawning stock biomass:	Table 3.5.6.4
Summary:	Table 3.5.6.5 and Fig 3.5.6.
Summary of fish. mortality:	Table 3.5.6.6

Following the advice given by ACFM at its November 1995 meeting, it was decided to use F_{5-14} weighted by the population number ($F_{5-14,W}$) as the reference F for this stock. The $F_{5-14,W}$ is given in the summary table of fishing mortalities (Table 3.5.6.6).

3.5.7 Yield-per-recruit analysis

The yield pr recruit vs. F is plotted in Figure 3.5.7.

3.6 Short-term predictions

3.6.1 Input data to the short-term prediction

The number at age at January 1, 2001, was taken from the final VPA for the year classes 1997 and older. The number at age for the 1998 and 1999 year classes where taken from the results from the SeaStar tuning model (Fig 3.5.5). The weight at age in the stock in 2001 was set equal to the weight at age obtained from biological samples taken during December 2000 and January 2001. The weight at age in the stock in 2002 was set equal to the 2001 value, while the weight at age for 2003 was set equal to the 1998 value. This is in accordance with the prognosis of the development of the condition factor of herring, as given in Section 2.2.5. The weight at age in the catch for this fishery is more dependant on fleet strategies and international agreement for fishing in various economic zones, and to a lesser degree in environmental factors. The weight in catch for the period 2001-2003 is set equal to the average for the years 1997-2000. The maturity at age in all years was set equal to that estimated for 2000. The natural mortality was set to the same values as used in the assessment, i.e. 0.15 on ages 3 and older.

3.6.2 Results of the short-term prediction

The short-term prediction was made with the use of the MFDP-program, and in the following discussions unweighted fishing mortalities are considered. The results of the short term prediction is given in Table 3.6.2.1 which also includes the input data on stock numbers and weight at age in 2001.

The international agreed TAC of 850 000 t will generate a fishing mortality of approximately 0.16 in 2001.The resulting spawning stock in 2002 will be approximately the same size as in 2001, *i.e.* slightly in excess of 6 million t.

The international agreed maximum fishing mortality of 0.125 will in 2002 generate a catch of 750 thousand t. This catch will result in an increased spawning stock in 2003.

3.7 Assessment of uncertainty

The assessment of uncertainty was based on bootstrapping where the input data are resampled from the assumed distributions as explained in section 1.3.1. The resulting file of assessment replicates is the basis for the medium-term projections. Figure 3.7.1 shows the histogram of the spawning stock biomass in 2001 from 539 bootstrap replicates. The distribution is somewhat skewed and 0.3 million t negatively biased with respect to the assessment without resampling. The standard deviation is 1.0 million t giving a CV of 0.16, considerably lower than the value of 0.3 used in the medium-term projections last year.

3.8 Long-Term Management Plan and Precautionary Reference Points

At the meeting in Torshavn in October 1999 (section 3.1.1), the coastal states (European Union, Faroe Islands, Iceland, Norway and Russia) for Norwegian spring-spawning herring agreed to implement a long-term management plan consisting of the following elements:

1. Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level (Blim) of 2,500,000 tonnes.

2. For the year 2001 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality rate of less than 0.125 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of this fishing mortality rate.

3. Should the SSB fall below a reference point of 5,000,000 tonnes (Bpa), the fishing mortality rate, referred under paragraph 2, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adoptions shall ensure a safe and rapid recovery of the SSB to a level in excess of 5,000,000 tonnes.

4. The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

The WGNPBW has in accordance with the agreed long-term management plan used the following values in the reference run in the medium-term simulations.

Bpa = 5.0 million tones

Blim = 2.5 million tones

Fishing mortality (F) above Bpa = 0.125

3.9 Harvest control rule

3.9.1 Evaluation of adaptive recovering strategies in the event SSB falls below Bpa.

Item 3) in the agreement on long time management (section 3.8) considers management action in case the SSB falls below the agreed B_{pa} of 5 000 000 tonnes. It is stated that if the SSB falls below a reference point of 5 000 000 tonnes (Bpa), the fishing mortality rate of 0.125 shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adoptions shall ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 tonnes.

Further, according the request (section 1.1) from the management agency "ICES should particularly continue to evaluate adaptive recovery strategies, including an option with linear reduction in F, in the event SSB falls below Bpa of 5,000,000 tonnes. The strategies should aim at preventing the SSB from falling below Blim with a high probability and ensure the safe recovery of the stock to above Bpa at various time horizons."

The WGNPBW and ACFM have previously on several occasions evaluated consequences of adapting of F in case of SSB falling below Bpa. Two types of adaptive recovery strategies have been investigated:

a) Restoring SSB to above Bpa within a time constraint

A harvest control rule aiming at restoring the SSB to above Bpa within a time constraint (strategies that would ensure a probability of 50 to 80% of restoring the SSB to above Bpa within 2 to 5 years) was evaluated in 2000. ACFM and WGNPBW made the following comment: "ICES regarded this as a request within the process of evolving management strategies to rebuild SSB within a time constraint to levels above Bpa after it has fallen below that level. The request was regarded as relevant but it was pointed out that this type of general rebuilding approach may not be useful as a rule for stocks that show a highly variable recruitment, including the stock of Norwegian spring-spawning herring. There may be situations when the SSB is fairly low but strong year classes are expected to recruit to the spawning stock in the near future. On the other hand there may be situations when SSB is expected to decline in the short and medium term levels below Bpa since no strong year class has been observed among the recruiting year classes. In the latter case it may not be possible to restore the SSB to levels above Bpa within 2 to 5 years even if the fishery is stopped" (ACFM 2001).

b) Linear reduction in F

This type of harvest control rule has been evaluated several times by WGNPBW. Different reduction rates in F have been considered, and the general conclusions from WGNPBW and ACFM based on these evaluations can be summed up as follows: "Medium-term simulation indicates that the probability of SSB falling below Blim is almost halved when a reduction in F at SSB levels below Bpa = 5.0 million t is applied. An example of such a reduction would be to reduce F linearly to 0.05 as the SSB falls from 5.0 million t to 2.5 million t." (ACFM 1999).

The ICES Study Group on the Precautionary Approach to Fisheries Management (SGPAF) has listed other advantages in applying a linear reduction in F in a harvest control rule in case SSB is falling below Bpa: "The fishery continues at a reduced level after the threshold is crossed, resulting in a continuity of yield; rather than open or close fisheries depending on the stock's position relative to SSBlim. At the same time, more stringent conservation measures are applied as the stock worsens; errors in the estimation of SSB become less critical; additional time and flexibility is obtained to evaluate whether the stock is in a transition phase from one stationary state to another; short-term changes in biomass levels imply only small changes in F rather than permanent or large-scale changes in fishing operations; and small changes in F may be less contentious and more easily accepted than large ones" (ICES 1997/Assess:7). Further, NAFO has in many cases illustrated a linear reduction in fishing mortality in its precautionary framework (ICES 2000/ACFM:17).

The stock of Norwegian spring spawning herring has a highly dynamic recruitment, the development depending on the occurrence of strong year classes, and the action taken if the SSB approaches Bpa will depend on the prospects of the recruitment of such year classes. This element should be regarded as important when considering a suitable harvest control rule. A linear reduction adapts the exploitation rate to the abundance of the spawning stock, and is by the WGNPBW regarded as an appropriate strategy which significantly lowers the risk for the spawning stock to come below Blim, and in this type of harvest control rule will in addition have some practical elements such as the continuation of fisheries even if the Bpa is crossed.

3.9.2 Adoption of F at SSB below Bpa implemented in the medium-term simulations

The default medium-term simulations were run with the same type of continuous reduction in F below Bpa as last year (ICES 2000/ACFM:16). That is a linear reduction in F from F=0.125 (or other relevant levels) at Bpa to F=0.05 at Blim and lower. In accordance with the evaluation made in 3.9.1 this type of adaption will reduce the probability of falling below Blim in the medium term to almost half the probability when not adapting the F at levels below Bpa.

3.10 Medium-term projections

The framework for the range of value for the biological parameters in the medium-term projections is the request from the coastal states of the Norwegian spring-spawning herring (Section 1.1). This request and the projections that have been carried out in order to fulfil it is described in the table below:

Parameter	Request from coastal states	Technical performance values
Fishing mortality for SSB above B_{pa}	0.05, 0.08, 0.10, 0.125, 0.15, 0.2	As requested, in addition a medium term including no fishing (F=0) was run for illustrative purposes
Catch ceiling	None	1.5 million t. One run with catch ceiling of 850 000 t, the level of the TAC for 2001.
Value of B_{pa}	5.0 million t	As requested
Value of B_{lim}	2.5 million t	As requested
Time range	5 and 10 years	As requested
Fishing mortality for F below B_{pa}	Evaluate adaptive recovery strategies, including an option with linear reduction in F, in the event SSB falls below Bpa. The strategies should aim at preventing the SSB from falling below Blim with a high probability and ensure recovery to above Bpa at various time horizons.	Linear decrease in F from 0.125 at B_{pa} to 0.05 at B_{lim} (Section 3.9) (similar decreases were also made with other requested F's (0.05, 0.08, 0.10, 0.15, 0.2)).
Measure of stability of catches	average percentage change in catches from year to year	As requested
Yield	average catches over the same ten year period	Average annual yield (tonnes) of the time range for the simulation run (5 or 10 years).
Risk	Probability that SSB will fall below B_{pa} and Blim in a 5 and 10 year period	As requested, risk to fall below B_{pa} and B_{lim} within the time range for the simulation run (5 or 10 years).

The medium-term projections were done with the SeaStar model as described in Section 1.3.1. It should be noted that the uncertainty in the initial stock is smaller than the uncertainty for the initial stock applied last year. A constraint of 1000 billion 0-group fish was enforced, as was done last year. The Beverton-Holt recruitment model was used also this year with the modification that the largest year classes were treated separately, as described in section1.3.1. Figure 3.10.1 shows the spawning-stock recruitment points used together with the Beverton-Holt function fitted on these points with the largest year classes excluded. Russian data show (Section 3.11) that good recruitment is associated with good egg production. Including egg production into the recruitment function this gives some promise for explaining more of the observed variation.

The projections started at January 1 2001 and the allocated catch for 2001 of 850 000 t was enforced for all simulations. The F-value by age applied during the simulation was obtained from the F-value in the harvest control rule and the exploitation pattern used last year

500 simulations were performed for each harvest control rule. For various harvest control rule parameters, the average yields and probabilities for the SSB to fall below B_{pa} and B_{lim} for the 5-year period 2001-2005 and 10-year period 2002-2011 are given in Table 3.10.1. The average percentage change in annual catch over the 10-year period is also given. The medium-term simulations give a more positive picture of the stock in medium term compared to the medium-term simulation given in last report. The main reason for this is the high estimate (more than 100 billion individuals) of the 1999 yearclass obtained in the acoustic surveys in the Barents Sea in May 2000 (Table 3.3.4.1). However, as the estimates of this year class from different surveys is conflicting, the uncertainty associated with the abundance of this year class may be grater than expressed by the formal statistical estimate. Therefore the results should be interpreted with caution.

According to the table the following conclusions can be drawn:

1. Continued fishing at F=0.125 (international agreed maximum fishing mortality) and a reduction in F below B_{pa} as described in section 3.9, and with a catch ceiling of 1.5 million t, gives a low probability (7%) of the stock falling below Bpa in the medium term (10 years). This harvesting strategy results in a 9% average annual change in the TAC.

2. There are no signals in the medium-term simulations, which indicate that the present agreed long time strategy for this stock is not in accordance with the precautionary approach in fisheries.

Figures 3.10.2 and 3.10.3 show the development of SSB and yield for F=0.125 above B_{pa} =5.0 million t with a linear reduction to F=0.05 at B_{lim}= 2.5 million t and a catch ceiling of 1.5 million t. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis. The spawning stock rises to above 10 million t when the 1998 and 1999 year classes mature followed by a slow decline. The impression is that the harvesting control rule applied corresponds to rational harvesting and stabilization of the stock above B_{pa}.

3.11 Management considerations

The immatures and adults of this stock form a central part of the ecosystem in the Barents Sea and Norwegian Seas, respectively. The herring has an important role as a transformer of the production of zooplankton biomass and energy to a form that is available to organisms at a higher level of the food chain.

The Coastal states European Union, Faroe Islands, Iceland, Norway and Russia have agreed on a long-term management plan and on precautionary reference point (Bpa = 5.0 million t) and limit reference point (Blim = 2.5 million t) for this stock. The limit reference point (2.5 million t) is seen as a spawning stock threshold that, if crossed, can result in a high probability of impaired recruitment, and the Bpa as a safeguard measure (Røttingen 2000).

In a WD by A. Krysov a study on the population fecundity of the Norwegian spring-spawning stock is compared with corresponding year classes and environmental factors, was presented to the WGNPBW. The conclusions were the following:

1. When the spawning stock level is at or above 6.9 million t the probability of resulting weak year classes is low.

2. When the spawning stock is above 3.4 million t, its reproductive success seems to be in tune with environmental variability. In other words, strong year classes will likely be produced under favorable survival conditions, medium year classes under average conditions and only poor year classes when survival conditions are unfavorable. In the 7-year period (1990-1996), when the SSB has been above the level of 3.4 million t, 2 strong, 3 medium and only 2 low abundance year classes of herring at age 3 appeared.

3. As the spawning stock level drops below of 3.4 million t the probability of producing poor year classes increases. For a 27-year period (1963-1989), when the SSB were below 3.4 million t, 23 poor, 2 medium and only 1 abundant year class appeared.

4. If the SSB drops to or below 0,3 million t the probability appearance of a strong year class is extremely low.

The current stock assessment indicates a spawning stock of approximately 6 million t in 2001, stock abundance having declined from 9 million t in 1997. The future prospects indicate an increasing spawning stock if exploited at the agreed level (F=0.125). However, this positive view is based on data on young herring of the 1999 yearclass from the Barents Sea. The survey series from this area give different indications of the size of this year class and thus the present estimate should be regarded as uncertain. The strength of the year class 1999 should be determined in future investigations.

Table 3.2.1 Catches of Norwegian spring spawning herring (tonnes) since 1972.

Year	A	B[1]	C	D	Total	Total catch used in WG
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	462,248	758,035	0	-	1,220,283	1,220,283
1997[5]			0	-	1,426,507	1,426,507
1998[5]			0	-	1,223,131	1,223,131
1999[6]			0	-	1,235,433	1,235,433
2000[7]			0	-	1,207,201	1,207,201

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
[5] Details of catches by fishery and ICES area given in ICES 1999
[6] Details of catches by fishery and ICES area given in ICES 2000
[7] Details of catches by fishery and ICES area given in Tables 3.2.3-3.2.5

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	Nether- lands	Greenland	UK	Germany	France	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	57,084	174,109	-	7,969	2,500	881	556	-	-	905,501
1996	699,161	119,290	60,681	52,788	164,957	19,541	19,664	-	46,131	11,978	-	22,424	1,220,283
1997	860,963	168,900	44,292	59,987	220,154	11,179	8,694	-	25,149	6,190	1,500	19,499	1,426,507
1998	743,925	124,049	35,519	68,136	197,789	2,437	12,827	-	15,971	7,003	605	14,863	1,223,131
1999	740,640	157,328	37,010	55,527	203,381	2,412	5,871	-	19,207	-	-	14,057	1,235,433
2000[1]	713,500	163,261	34,968	68,625	186,035	8,939	-	-	14,096	3,298	-	14,749	1,207,201

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

Table 3.2.3. Catch at age by country.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15+
Norwegian		0	16	1999																					
1	Norway	1	IIa	247606	227374	227374	53	4593	9092	0	0	0	5776	121329	130401	38910	109229	353006	204440	36740	4177	607	0	326	20531
2	Norway	2	IIa	6382	6644	6644	17	772	922	0	0	0	780	2236	168	699	5561	9861	7224	2463	866	0	342	0	2902
3	Norway	3	IIa	119569	119634	119634	7	477	901	0	0	219	8250	60724	2579	13396	39296	129648	38064	7439	2892	0	0	984	3062
4	Norway	4	IIa	337849	337849	337849	21	1510	2071	0	0	6413	55540	282481	6711	36178	103196	301197	288445	56629	17988	0	0	0	168312
5	Norway	1	IVa	0	19632	19632	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	1739	1739	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Norway	3	IVa	0	35	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	1	IIa	60068	60068	60068	136	360	37541	0	0	764	764	34621	2294	12937	38267	74886	66284	14545	3568	2603	2304	4032	7396
9	Russia	2	IIa	0	17217	17217	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Russia	3	IIa	74653	74653	74653	67	453	17327	0	0	4614	13041	36360	4423	6635	29353	91650	45717	6635	2703	982	2723	983	457
11	Russia	4	IIa	0	16	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Russia	2	IIb	0	177	177	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Russia	3	IIb	0	1832	1832	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Russia	4	IIb	0	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Denmark	1	IIa	9242	9242	9242	2	209	209	0	0	0	0	0	369	718	3699	14645	11451	1503	0	0	0	0	0
16	Denmark	2	IIa	0	22720	22720	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Denmark	3	IIa	0	2738	2738	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Iceland	2	IIa	166442	166442	166442	59	2057	2057	0	0	0	0	0	301	8103	37406	145436	178791	62023	22400	7942	10959	100125	7462
19	Iceland	3	IIa	0	7580	7580	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Iceland	4	IIa	0	138	138	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Iceland	2	IIb	10569	10569	10569	3	132	132	0	0	0	0	0	0	619	1282	8002	11276	3463	3076	256	256	1282	0
22	Iceland	3	IIb	0	1326	1326	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Sweden	1	IIa	0	4373	4373	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Sweden	2	IIa	0	6973	6973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Sweden	3	IIa	0	1403	1403	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Germany	1	IIa	0	1976	1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Germany	2	IIa	0	1323	1323	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Germany	3	IIa	0	2382	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Germany	4	IIa	0	353	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	UK(Scot)	1	IIa	0	4893.7	4893.7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	UK(Scot)	2	IIa	0	526	526	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	UK(Scot)	3	IIa	0	8529	8529	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	UK(Scot)	4	IIa	0	251	251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Ireland	3	IIa	0	3959	3959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Ireland	2	IIa	4980	4980	4980	2	145	145	0	0	0	111	3099	221	332	1771	6986	4096	0	0	0	0	0	0
36	Faroes	1	IIa	0	6273	6273	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Faroes	2	IIa	0	36508	36508	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	Faroes	3	IIa	0	20798	20798	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	Faroes	2	IIb	0	1213	1213	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Faroes	3	IIb	0	733	733	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	Faroes	2	XIVa	0	400	400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	Faroes	3	XIVa	0	170	170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	Faroes	2	Va	0	530	530	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	Netherlands	2	IIa	0	3514	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	Netherlands	3	IIa	0	9610	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.2.4. Weight (kg) at age by country.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12	CW 13	CW 14	CW 15+
Norwegian	0	15	1998																						
1	Norway	1	IIa	247806	227974	227974	53	4618	5032	0.000	0.000	0.000	0.130	0.173	0.209	0.262	0.276	0.288	0.300	0.328	0.362	0.371	0.000	0.390	0.390
2	Norway	2	IIa	8382	6644	6644	17	772	922	0.000	0.000	0.000	0.141	0.197	0.261	0.268	0.257	0.271	0.282	0.305	0.332	0.000	0.388	0.000	0.377
3	Norway	3	IIa	119609	119634	119634	7	477	601	0.000	0.000	0.149	0.185	0.251	0.308	0.324	0.336	0.334	0.356	0.371	0.410	0.000	0.000	0.405	0.427
4	Norway	4	IIa	337843	337843	337843	21	1810	2011	0.000	0.000	0.140	0.184	0.241	0.256	0.296	0.315	0.320	0.330	0.362	0.378	0.000	0.000	0.000	0.423
5	Norway	1	IVa	0	19632	19632	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Norway	2	IVa	0	1738	1738	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Norway	3	IVa	0	35	35	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Russia	1	IIa	69058	69058	69058	138	390	27541	0.000	0.000	0.077	0.095	0.169	0.197	0.258	0.262	0.273	0.290	0.306	0.356	0.414	0.401	0.371	0.412
9	Russia	2	IIa	0	17217	17217	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	Russia	3	IIa	74963	74963	74963	87	462	17327	0.000	0.000	0.101	0.151	0.246	0.267	0.318	0.312	0.323	0.345	0.361	0.392	0.452	0.438	0.471	0.483
11	Russia	4	IIa	0	15	15	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Russia	2	IIb	0	177	177	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	Russia	3	IIb	0	1832	1832	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	Russia	4	IIb	0	9	9	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	Denmark	1	IIa	9242	9242	9242	2	208	208	0.000	0.000	0.000	0.000	0.000	0.216	0.267	0.290	0.276	0.287	0.332	0.000	0.000	0.000	0.000	0.000
16	Denmark	2	IIa	0	22720	22720	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Denmark	3	IIa	0	2736	2736	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	Iceland	2	IIa	166442	166442	166442	59	2057	2057	0.000	0.000	0.000	0.000	0.000	0.295	0.314	0.322	0.330	0.344	0.357	0.387	0.410	0.408	0.429	0.438
19	Iceland	3	IIa	0	7560	7560	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	Iceland	4	IIa	0	138	138	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Iceland	2	IIb	10569	10569	10569	3	112	112	0.000	0.000	0.000	0.000	0.000	0.000	0.345	0.336	0.349	0.365	0.378	0.406	0.380	0.405	0.439	0.000
22	Iceland	3	IIb	0	1326	1326	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	Sweden	1	IIa	0	4373	4373	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	Sweden	2	IIa	0	8973	8973	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	Sweden	3	IIa	0	1403	1403	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Germany	1	IIa	0	1975	1975	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	Germany	2	IIa	0	1323	1323	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	Germany	3	IIa	0	2302	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	Germany	4	IIa	0	353	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	UK(Scot)	1	IIa	0	4809.7	4809.7	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
31	UK(Scot)	2	IIa	0	506	506	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
32	UK(Scot)	3	IIa	0	8529	8529	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
33	UK(Scot)	4	IIa	0	251	251	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
34	Ireland	3	IIa	0	3959	3959	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35	Ireland	2	IIa	4980	4980	4980	2	145	145	0.000	0.000	0.000	0.212	0.246	0.274	0.285	0.316	0.323	0.360	0.000	0.000	0.000	0.000	0.000	0.000
36	Faroes	1	IIa	0	6273	6273	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
37	Faroes	2	IIa	0	38508	38508	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	Faroes	3	IIa	0	20798	20798	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
39	Faroes	2	IIb	0	1213	1213	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	Faroes	3	IIb	0	733	733	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
41	Faroes	2	XIVa	0	400	400	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
42	Faroes	3	XIVa	0	170	170	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
43	Faroes	3	Va	0	530	530	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
44	Netherland	2	IIa	0	3514	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	Netherland	3	IIa	0	6610	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.2.5

Summary of Sampling by Country

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	9242.00	34698.00	2	208	208	100.16
Faroes	0.00	65579.00	0	0	0	0.00
Germany	0.00	6043.00	0	0	0	0.00
Iceland	166442.00	174140.00	59	2057	2057	100.09
Ireland	4980.00	8939.00	2	145	145	99.95
Netherlands	0.00	13124.00	0	0	0	0.00
Norway	713500.00	692095.00	98	8566	7577	99.85
Russia	144011.00	161243.00	225	44868	802	99.93
Sweden	0.00	14749.00	0	0	0	0.00
UK(Scot)	0.00	14096.00	0	0	0	0.00
Total IIa	1038175.00	1184706.00	386	55844	10789	99.90

Sum of Offical Catches : 1184706.00
Unallocated Catch : -15869.00
Working Group Catch : 1168837.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	1946.00	0	0	0	0.00
Iceland	10569.00	11895.00	3	112	112	99.99
Russia	0.00	2018.00	0	0	0	0.00
Total IIb	10569.00	15859.00	3	112	112	99.99

Sum of Offical Catches : 15859.00
Unallocated Catch : 0.00
Working Group Catch : 15859.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	21405.00	0	0	0	0.00
Total IVa	0.00	21405.00	0	0	0	0.00

Sum of Offical Catches : 21405.00
Unallocated Catch : 0.00
Working Group Catch : 21405.00

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	530.00	0	0	0	0.00
Total Va	0.00	530.00	0	0	0	0.00

Sum of Offical Catches : 530.00
Unallocated Catch : 0.00
Working Group Catch : 530.00

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	570.00	0	0	0	0.00
Total XIVa	0.00	570.00	0	0	0	0.00

Sum of Offical Catches : 570.00
Unallocated Catch : 0.00
Working Group Catch : 570.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	9242.00	9242.00	2	208	208	100.16
Faroes	0.00	6273.00	0	0	0	0.00
Germany	0.00	1975.00	0	0	0	0.00
Norway	247606.00	247606.00	53	5032	4518	99.57
Russia	69058.00	69058.00	138	27541	350	99.99
Sweden	0.00	4373.00	0	0	0	0.00
UK(Scot)	0.00	4810.00	0	0	0	0.00
Period Total	325906.00	343337.00	193	32781	5076	99.67

Sum of Offical Catches : 343337.00
Unallocated Catch : 0.00
Working Group Catch : 343337.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	22720.00	0	0	0	0.00
Faroes	0.00	40121.00	0	0	0	0.00
Germany	0.00	1323.00	0	0	0	0.00
Iceland	177011.00	177011.00	62	2169	2169	100.08
Ireland	4980.00	4980.00	2	145	145	99.95
Netherlands	0.00	3514.00	0	0	0	0.00
Norway	8382.00	8382.00	17	922	772	100.01
Russia	0.00	17394.00	0	0	0	0.00
Sweden	0.00	8973.00	0	0	0	0.00
UK(Scot)	0.00	506.00	0	0	0	0.00
Period Total	190373.00	284924.00	81	3236	3086	100.08

Sum of Offical Catches : 284924.00
Unallocated Catch : -3514.00
Working Group Catch : 281410.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	2736.00	0	0	0	0.00
Faroes	0.00	22231.00	0	0	0	0.00
Germany	0.00	2392.00	0	0	0	0.00
Iceland	0.00	8886.00	0	0	0	0.00
Ireland	0.00	3959.00	0	0	0	0.00
Netherlands	0.00	9610.00	0	0	0	0.00
Norway	119669.00	119669.00	7	601	477	100.00
Russia	74953.00	76785.00	87	17327	452	99.88
Sweden	0.00	1403.00	0	0	0	0.00
UK(Scot)	0.00	8529.00	0	0	0	0.00
Period Total	194622.00	256200.00	94	17928	929	99.95

Sum of Offical Catches : 256200.00
Unallocated Catch : -12002.00
Working Group Catch : 244198.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Germany	0.00	353.00	0	0	0	0.00
Iceland	0.00	138.00	0	0	0	0.00
Norway	337843.00	337843.00	21	2011	1810	100.00
Russia	0.00	24.00	0	0	0	0.00
UK(Scot)	0.00	251.00	0	0	0	0.00
Period Total	337843.00	338609.00	21	2011	1810	100.00

Sum of Offical Catches : 338609.00
Unallocated Catch : -353.00
Working Group Catch : 338256.00

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	9242.00	34698.00	2	208	208	100.16
Faroes	0.00	68625.00	0	0	0	0.00
Germany	0.00	6043.00	0	0	0	0.00
Iceland	177011.00	186035.00	62	2169	2169	100.08
Ireland	4980.00	8939.00	2	145	145	99.95
Netherlands	0.00	13124.00	0	0	0	0.00
Norway	713500.00	713500.00	98	8566	7577	99.85
Russia	144011.00	163261.00	225	44868	802	99.93
Sweden	0.00	14749.00	0	0	0	0.00
UK(Scot)	0.00	14096.00	0	0	0	0.00
Total for Stock	1048744.00	1223070.00	389	55956	10901	99.90

Sum of Offical Catches : 1223070.00
Unallocated Catch : -15869.00
Working Group Catch : 1207201.00

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  5)   Norway                 1 IVa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : (  6)   Norway                 2 IVa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : (  7)   Norway                 3 IVa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : (  9)   Russia                 2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 11)   Russia                 4 IIa
Using Only
  >>  (  4)  Norway                 4 IIa

  Filling-in for record : ( 12)   Russia                 2 IIb
Using Only
  >>  ( 21)  Iceland                2 IIb

  Filling-in for record : ( 13)   Russia                 3 IIb
Using Only
  >>  ( 21)  Iceland                2 IIb

  Filling-in for record : ( 14)   Russia                 4 IIb
Using Only
  >>  ( 21)  Iceland                2 IIb

  Filling-in for record : ( 16)   Denmark                2 IIa
Using Only
  >>  ( 18)  Iceland                2 IIa

  Filling-in for record : ( 17)   Denmark                3 IIa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : ( 19)   Iceland                3 IIa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : ( 20)   Iceland                4 IIa
Using Only
  >>  (  4)  Norway                 4 IIa

  Filling-in for record : ( 22)   Iceland                3 IIb
Using Only
  >>  ( 21)  Iceland                2 IIb

  Filling-in for record : ( 23)   Sweden                 1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa
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  Filling-in for record : ( 24)   Sweden                 2 IIa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 25)   Sweden                 3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 26)   Germany                1 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 27)   Germany                2 IIa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 30)   UK(Scot)               1 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 31)   UK(Scot)               2 IIa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 32)   UK(Scot)               3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 33)   UK(Scot)               4 IIa
Using Only
  >>  (  4)  Norway                4 IIa

  Filling-in for record : ( 34)   Ireland                3 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 36)   Faroes                 1 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : ( 37)   Faroes                 2 IIa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 38)   Faroes                 3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 39)   Faroes                 2 IIb
Using Only
  >>  ( 21)  Iceland               2 IIb

  Filling-in for record : ( 40)   Faroes                 3 IIb
Using Only
  >>  ( 21)  Iceland               2 IIb

  Filling-in for record : ( 41)   Faroes                 2 XIVa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 42)   Faroes                 3 XIVa
Using Only
  >>  ( 18)  Iceland               2 IIa

  Filling-in for record : ( 43)   Faroes                 3 Va
Using Only
  >>  ( 18)  Iceland               2 IIa
```

Catch Numbers at Age by Area

Ages	IIa	IIb	IVa	Va	XIVa	Total
0	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00
2	14395.07	0.00	0.06	0.00	0.00	14395.14
3	83557.55	0.00	458.89	0.00	0.00	84016.45
4	550072.94	0.00	10306.51	0.00	0.00	560379.44
5	33851.09	0.00	1076.01	2.96	3.19	34933.25
6	107372.86	769.77	2522.73	26.06	28.02	110719.43
7	393204.78	1923.67	9084.43	119.11	128.10	404460.09
8	1255895.00	12307.27	30090.12	463.11	498.06	1299253.63
9	1009165.19	16922.87	17744.64	562.95	605.44	1045001.13
10	209360.06	3845.83	3423.82	168.84	181.58	216980.14
11	66358.27	4615.60	467.84	71.39	76.78	71589.88
12	15775.32	384.13	48.13	25.29	27.20	16260.06
13	22173.63	384.13	70.91	34.88	37.51	22701.06
14	21305.70	1923.67	26.13	31.94	34.35	23321.78
15	69531.66	0.00	2230.70	23.78	25.58	71811.70

Mean Weight at Age by Area (Kg)

Ages	IIa	IIb	IVa	Va	XIVa	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.1235	0.0000	0.1490	0.0000	0.0000	0.1235
3	0.1750	0.0000	0.1341	0.0000	0.0000	0.1748
4	0.2224	0.0000	0.1747	0.0000	0.0000	0.2215
5	0.2428	0.0000	0.2111	0.2850	0.2850	0.2419
6	0.2888	0.3450	0.2624	0.3140	0.3140	0.2886
7	0.3030	0.3360	0.2752	0.3220	0.3220	0.3026
8	0.3098	0.3490	0.2850	0.3300	0.3300	0.3096
9	0.3275	0.3650	0.2986	0.3440	0.3440	0.3277
10	0.3486	0.3780	0.3246	0.3570	0.3570	0.3487
11	0.3813	0.4060	0.3534	0.3870	0.3870	0.3827
12	0.4118	0.3800	0.3710	0.4100	0.4100	0.4109
13	0.4099	0.4050	0.3880	0.4080	0.4080	0.4097
14	0.4171	0.4390	0.3902	0.4290	0.4290	0.4189
15	0.4096	0.0000	0.3865	0.4380	0.4380	0.4089

Table 3.3.1.1 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys on the spawning stock in February-March. Numbers in millions. No survey carried out in 2001.

Year Age	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
2		101	183	44			16		407			106	1516
3	255	5	187	59			128	1792	231			1366	690
4	146	373	0	54			676	7621	7638		381	337	1996
5	6805	103	345	12			1375	3807	11243		1905	1286	164
6	202	5402	112	354			476	2151	2586		10640	2979	592
7		182	4489	122			63	322	957		6708	11791	1997
8			146	4148			13	20	471		1280	7534	7714
9				102			140	1	0		434	1912	4240
10							35	124	0		130	568	553
11							1820	63	165		39	132	71
12								2573	0		0	0	3
13									2024		175	0	0
14											0	392	6
15+											804	437	361
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496	28840	19903

In 1992, 1993 and 1997 there was no estimate due to poor weather conditions.

Table 3.3.2.1 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**	**1997**	**1998**	**1999**	**2000**
1		72		380		9	65	74	56
2	36	1518	16	183	1465	73	1207	159	322
3	1247	2389	3708	5133	3008	661	441	2425	1522
4	1317	3287	4124	5274	13180	1480	1833	296	5260
5	173	1267	2593	1839	5637	6110	3869	837	165
6	16	13	1096	1040	994	4458	12052	2066	497
7	208	13	34	308	552	1843	8242	6601	1869
8	139	158	25	19	92	743	2068	4168	4785
9	3742	26	196	13	0	66	629	755	3635
10	69	4435	29	111	7	0	111	212	668
11			3239	39	41	0	14	0	205
12				907	15	126	0	15	0
13					393	0	392	0	0
14+						842	221	146	168
Total	6947	13178	15209	15246	25384	16411	31144	17754	19152

Table 3.3.2.2 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys I in the wintering areas in January. Numbers in millions. No surveys carried out in 2000 and 2001.

Year Age	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
2	90			73				214	0
3	220	410	61	642	47	315		267	1358
4	70	820	1905	3431	3781	10442		1938	199
5	20	260	2048	4847	4013	13557		4162	1455
6	180	60	256	1503	2445	4312		9647	4452
7	150	510	27	102	1215	1271		6974	12971
8	5500	120	269	29	42	290		1518	7226
9	440	4690	182	161	24	22		743	1876
10		30	5691	131	267	25		16	499
11			128	3679	29	200		4	16
12					4326	58		0	16
13						1146		181	0
14								7	156
15+								314	220
Total	6670	6900	10567	14598	16189	31638	-	25985	30444

In 1997 there was no estimate due to poor weather conditions. In 2000 there was no estimate due to technical problems.

Table 3.3.3.1 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**	**1997**	**1998**	**1999**	**2000**
3	4114	1169	367	2191	1353
4	22461	3599	1099	322	2783
5	13244	18867	4410	965	92
6	4916	13546	16378	3067	384
7	2045	2473	10160	11763	1302
8	424	1771	2059	6077	7194
9	14	178	804	853	5344
10	7	77	183	258	1689
11	155	288	0	5	271
12	0	415	0	14	0
13	3134	60	112	0	114
14		2472	0	158	1135
15+			415	128	1135
Total	50504	44915	35987	25801	21661

Table 3.3.4.1 Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. 1990-2000, Norwegian estimates, for later years, see footnotes.

Year Age	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**[1]	**1997**[2]	**1998**[3]	**1999**[3]	**2000**[3]
1	4.4	24.3	32.6	102.7	6.6	0.5	0.1	2.6	9.5	49.5	105.4
2		5.2	14.0	25.8	59.2	7.7	0.25	0.04	4.7	4.9	27.9
3			5.7	1.5	18.0	8.0	1.8	0.4	0.01	0.00	0.00
4					1.7	1.1	0.6	0.35	0.01	0.00	0.00
5							0.03	0.05	0.00	0.00	0.00

[1] Average of Norwegian and Russian estimates
[2] Combination of Norwegian and Russian estimates as described in 1998 WG report.
[3] Russian estimate

Table 3.3.4.2 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–2000 (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
1997	208	69	544	5 244	6 065
1998	424	273	442	11 640	12 779
1999	121	658	271	6 329	7 379
2000	570	127	996	7 237	8 930

Table 3.3.4.3 Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1973-2000.

Year	Log index	Year	Log index
1973	0.05	1987	0.00
1974	0.01	1988	0.30
1975	0.00	1989	0.58
1976	0.00	1990	0.31
1977	0.01	1991	1.19
1978	0.02	1992	1.05
1979	0.09	1993	0.75
1980	0.00	1994	0.28
1981	0.00	1995	0.16
1982	0.00	1996	0.65
1983	1.77	1997	0.39
1984	0.34	1998	0.59
1985	0.23	1999	0.41
1986	0.00	2000	0.30

Table 3.3.5.1 The indices for herring larvae for the period 1981-2001 ($N*10^{-12}$)

Year	Index 1	Index 2	Year	Index 1	Index 2
1981	0.3		1991	8.6	23.5
1982	0.7		1992	6.3	27.8
1983	2.5		1993	24.7	78.0
1984	1.4		1994	19.5	48.6
1985	2.3		1995	18.2	36.3
1986	1.0		1996	27.7	81.7
1987	1.3	4.0	1997	66.6	147.5
1988	9.2	25.5	1998	42.4	138.6
1989	13.4	28.7	1999	19.9	73.0
1990	18.3	29.2	2000	19.8	127.5
			2001	40.7	

Table 3.4.1. Tagging data for various year classes

Tagging data for the 1983+ year class

Year	Screened billion	Number tagged	Recaptured 87 release	88 release	89 release	90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1987		33067												
1988		38152												
1989	0.010695	20620	12											
1990	0.005489	24585	4	10										
1991	0.005545	12558	1	7	5									
1992	0.001737	15262	4	0	2	2								
1993	0.009372	15839	6	13	6	12	9							
1994	0.009474	5364	2	10	7	8	4	11						
1995	0.011554	859	6	10	5	15	6	9	7					
1996	0.004038	2879	3	2	6	10	2	1	4	3				
1997	0.003867	2266	0	3	1	3	2	3	0	0	0			
1998	0.000509	648	1	3	1	1	2	2	0	0	0	1		
1999	0.000379		0	0	1	1	0	0	1	0	0	0	1	
2000	0.000413		0	1	0	3	0	1	0	0	0	0	0	0

Tagging data for the 1984 year class

Year	Screened billion	Number tagged	Recaptured 88 release	89 release	90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1988		1342											
1989		1175											
1990	0.000157	1097	0										
1991	0.000138	257	0	0									
1992	0.00003	767	0	0	0								
1993	0.000287	479	2	1	1	0							
1994	0.000267	160	0	0	0	2	1						
1995	0.000264	56	0	0	0	0	0	0					
1996	0.000281	113	0	0	0	0	0	0	0				
1997	0	0	0	0	0	0	0	0	0	0			
1998	0.000001	0	0	0	0	0	0	0	0	0	0		
1999	0		0	0	0	0	0	0	0	0	0	0	
2000	0		0	0	0	0	0	0	0	0	0	0	0

Tagging data for the 1985 year class

Year	Screened billion	Number tagged	Recaptured 89 release	90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1989		2982										
1990		1081										
1991	0.000355	1154	0									
1992	0.000114	851	0	0								
1993	0.000573	1465	1	1	1							
1994	0.000345	368	2	0	0	1						
1995	0.000735	167	0	0	0	2	1					
1996	0.000427	564	1	0	0	0	0	0				
1997	0.000888	555	0	2	0	3	1	1	1			
1998	0.000497	778	0	1	0	0	1	0	0	0		
1999	0.000623		1	0	0	0	0	0	0	0	1	
2000	0.000703		0	0	0	0	1	0	0	0	0	2

Tagging data for the 1986 year class

Year	Screened billion	Number tagged	Recaptured 90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1990		381									
1991		165									
1992	0.000017	210	0								
1993	0.000019	52	0	0							
1994	0.000065	256	0	0	0						
1995	0.000104	0	1	0	0	0					
1996	0.000092	213	0	0	1	0	0				
1997	0.000166	15	0	0	0	0	0	0			
1998	0	84	0	0	0	0	0	0	0		
1999	0		0	0	0	0	0	0	0	0	
2000	0.000003		0	0	0	0	0	0	0	0	0

Tagging data for the 1987 year class

Year	Screened billion	Number tagged	Recaptured 91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1991		634								
1992		1146								
1993	0.000329	1569	0							
1994	0.000259	315	0	0						
1995	0.000090	27	1	0	1					
1996	0.000043	0	0	0	1	0				
1997	0.000224	135	0	0	0	0	0			
1998	0.000008	0	0	1	0	0	0	0		
1999	0.000081		0	0	0	0	0	0	0	
2000	0.000000		0	0	0	0	0	0	0	0

Tagging data for the 1988 year class

Year	Screened billion	Number tagged	Recaptured 92 release	93 release	94 release	95 release	96 release	97 release	98 release
1992		5827							
1993		5267							
1994	0.003506	4473	3						
1995	0.003729	1041	4	0					
1996	0.001176	2109	3	3	2				
1997	0.000811	1940	0	0	0	0			
1998	0.000148	215	1	0	1	0	0		
1999	0.000012		0	0	0	0	0	0	
2000	0.000075		0	0	0	0	0	0	0

Tagging data for the 1989 year class

Year	Screened billion	Number tagged	Recaptured 93 release	94 release	95 release	96 release	97 release	98 release
1993		7584						
1994		11873						
1995	0.009463	2348	4					
1996	0.004636	5170	1	5				
1997	0.003346	4103	2	7	0			
1998	0.001183	1176	0	0	0	1		
1999	0.001179		1	0	0	1	1	
2000	0.00079		0	2	0	0	0	1

Tagging data for the 1990 year class

Year	Screened billion	Number tagged	Recaptured 94 release	95 release	96 release	97 release	98 release
1994		10784					
1995		3868					
1996	0.009009	6171	9				
1997	0.009830	4057	7	3			
1998	0.002828	2381	1	1	1		
1999	0.003402		1	2	2	1	
2000	0.003146		0	2	2	0	1

Tagging data for the 1991 year class

Year	Screened billion	Number tagged	Recaptured 95 release	96 release	97 release	98 release
1995		21528				
1996		25683				
1997	0.030952	7129	21			
1998	0.012459	6002	8	6		
1999	0.014968		7	14	4	
2000	0.018461		7	10	1	9

Tagging data for the 1992 year class

Year	Screened billion	Number tagged	Recaptured 96 release	97 release	98 release
1996		8417			
1997		8353			
1998	0.020695	22320	7		
1999	0.023790		4	9	
2000	0.031430		15	7	20

Tagging data for the 1993 year class

Year	Screened billion	Number tagged	Recapt. 97 release	98 release
1997		976		
1998		2015		
1999	0.008046		0	
2000	0.009049		0	3

Tagging data for the 1994 year class

Year	Screened billion	Number tagged	Recapt. 98 release
1998		3752	
1999			
2000	0.002450		1

Tagging data for the 1986 year class

			Recaptured								
Year	Screened billion	Number tagged	90 release	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1990		381									
1991		165									
1992	0.000017	210	0								
1993	0.000019	52	0	0							
1994	0.000065	256	0	0	0						
1995	0.000104	0	1	0	0	0					
1996	0.000092	213	0	0	1	0	0				
1997	0.000166	15	0	0	0	0	0	0			
1998	0	84	0	0	0	0	0	0	0		
1999	0		0	0	0	0	0	0	0	0	
2000	0.000003		0	0	0	0	0	0	0	0	0

Tagging data for the 1987 year class

			Recaptured							
Year	Screened billion	Number tagged	91 release	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1991		634								
1992		1146								
1993	0.000329	1569	0							
1994	0.000259	315	0	0						
1995	0.000090	27	1	0	1					
1996	0.000043	0	0	0	1	0				
1997	0.000224	135	0	0	0	0	0			
1998	0.000008	0	0	1	0	0	0	0		
1999	0.000081		0	0	0	0	0	0	0	
2000	0.000000		0	0	0	0	0	0	0	0

Tagging data for the 1988 year class

			Recaptured						
Year	Screened billion	Number tagged	92 release	93 release	94 release	95 release	96 release	97 release	98 release
1992		5827							
1993		5267							
1994	0.003506	4473	3						
1995	0.003729	1041	4	0					
1996	0.001176	2109	3	3	2				
1997	0.000811	1940	0	0	0	0			
1998	0.000148	215	1	0	1	0	0		
1999	0.000012		0	0	0	0	0	0	
2000	0.000075		0	0	0	0	0	0	0

Tagging data for the 1989 year class

			Recaptured					
Year	Screened billion	Number tagged	93 release	94 release	95 release	96 release	97 release	98 release
1993		7584						
1994		11873						
1995	0.009463	2348	4					
1996	0.004636	5170	1	5				
1997	0.003346	4103	2	7	0			
1998	0.001183	1176	0	0	0	1		
1999	0.001179		1	0	0	1	1	
2000	0.00079		0	2	0	0	0	1

Tagging data for the 1990 year class

Year	Screened billion	Number tagged	Recaptured 94 release	95 release	96 release	97 release	98 release
1994		10784					
1995		3868					
1996	0.009009	6171	9				
1997	0.009830	4057	7	3			
1998	0.002828	2381	1	1	1		
1999	0.003402		1	2	2	1	
2000	0.003146		0	2	2	0	1

Tagging data for the 1991 year class

Year	Screened billion	Number tagged	Recaptured 95 release	96 release	97 release	98 release
1995		21528				
1996		25683				
1997	0.030952	7129	21			
1998	0.012459	6002	8	6		
1999	0.014968		7	14	4	
2000	0.018461		7	10	1	9

Tagging data for the 1992 year class

Year	Screened billion	Number tagged	Recaptured 96 release	97 release	98 release
1996		8417			
1997		8353			
1998	0.020695	22320	7		
1999	0.023790		4	9	
2000	0.031430		15	7	20

Tagging data for the 1993 year class

Year	Screened billion	Number tagged	Recapt. 97 release	98 release
1997		976		
1998		2015		
1999	0.008046		0	
2000	0.009049		0	3

Tagging data for the 1994 year class

Year	Screened billion	Number tagged	Recapt. 98 release
1998		3752	
1999			
2000	0.002450		1

Table 3.5.2.1 Run title: Herring spring-spawn (run: SVPBJA12/V12)

At 23/04/2001 11:43

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

YEAR,	1950,
AGE	
0,	511260,
1,	200000,
2,	60000,
3,	27620,
4,	18480,
5,	18550,
6,	54700,
7,	62860,
8,	7950,
9,	8860,
10,	10950,
11,	8690,
12,	19450,
13,	36830,
14,	6640,
15,	10700,
+gp,	23730,
0 TOTALNUM,	1087270,
TONSLAND,	933000,
SOPCOF %,	100,

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

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
AGE										
0,	163550,	1372160,	569720,	1067600,	517560,	536390,	500190,	966700,	1789630,	1288430,
1,	760770,	914970,	505500,	707110,	287110,	202370,	329080,	279810,	198530,	1358080,
2,	40000,	123290,	58130,	85540,	51010,	62710,	21950,	66640,	32550,	39250,
3,	660,	3930,	74010,	26630,	9300,	11650,	2330,	1750,	1510,	12170,
4,	38380,	6050,	4660,	143550,	27640,	25160,	37330,	1790,	2680,	1820,
5,	17240,	60230,	10090,	14290,	204510,	31420,	15380,	11090,	2590,	2810,
6,	16440,	13630,	35560,	23600,	11430,	255510,	22850,	8930,	14660,	2440,
7,	51560,	20450,	8190,	49030,	18960,	11000,	198530,	19440,	11480,	9620,
8,	60200,	38020,	11090,	12810,	27470,	20390,	7200,	97350,	24070,	7330,
9,	7710,	37790,	31410,	19980,	8530,	26420,	12730,	7070,	110380,	20390,
10,	8270,	7920,	39490,	44040,	19340,	13070,	18250,	12300,	8860,	116300,
11,	10310,	8570,	6170,	46070,	29560,	19830,	8840,	20090,	12430,	8520,
12,	10760,	10770,	9120,	8840,	20320,	27280,	12120,	9870,	19800,	12970,
13,	25350,	10680,	9410,	10060,	5870,	16330,	14930,	7740,	8850,	15350,
14,	34800,	18650,	9880,	13300,	8460,	6300,	13160,	7090,	7740,	5670,
15,	4740,	25630,	21550,	12680,	10360,	8890,	3370,	6940,	8520,	4720,
+gp,	30510,	30810,	51490,	67640,	47700,	47620,	24770,	18620,	15070,	12170,
0 TOTALNUM,	1281250,	2703550,	1455470,	2352770,	1305130,	1322340,	1243010,	1543220,	2269350,	2918040,
TONSLAND,	1278400,	1254800,	1090600,	1644500,	1359800,	1659400,	1319500,	986600,	1111100,	1101800,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
0,	620750,	369320,	480700,	361300,	230300,	392650,	42680,	178360,	56120,	11930,
1,	1607560,	408110,	211920,	272830,	378090,	66280,	987710,	43700,	50710,	52940,
2,	288480,	104130,	204530,	22030,	285360,	167800,	7040,	38830,	14190,	3320,
3,	3120,	184380,	76040,	11460,	8990,	204870,	139230,	9910,	18820,	630,
4,	810,	800,	83580,	39900,	25620,	2690,	325400,	188050,	80,	1860,
5,	410,	310,	530,	204580,	57110,	46660,	2660,	138740,	880,	60,
6,	1500,	720,	180,	1370,	219970,	130600,	42130,	1420,	470,	330,
7,	1940,	2020,	360,	150,	1950,	288450,	113200,	9400,	70,	330,
8,	6160,	1190,	1830,	300,	1490,	3790,	172080,	13410,	1170,	100,
9,	4920,	5910,	930,	2490,	740,	1430,	890,	34510,	3360,	1340,
10,	13610,	5260,	10770,	2930,	1910,	1740,	570,	200,	3600,	2620,
11,	72810,	11700,	9250,	9560,	4000,	2620,	350,	110,	30,	2810,
12,	4970,	81350,	17410,	8240,	10050,	1100,	850,	80,	20,	30,
13,	4500,	4420,	92370,	15300,	10780,	6910,	890,	250,	20,	10,
14,	6300,	5470,	7960,	77280,	13870,	7210,	1750,	260,	20,	20,
15,	2170,	6560,	6040,	4580,	70400,	9670,	1430,	180,	40,	10,
+gp,	3840,	8670,	12490,	29100,	17910,	46000,	9010,	1520,	200,	190,
0 TOTALNUM,	2643850,	1200320,	1216890,	1063400,	1338540,	1380470,	1847870,	658930,	149800,	78530,
TONSLAND,	830100,	848600,	984500,	1281800,	1547700,	1955000,	1677200,	712200,	67800,	62300,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
0,	3050,	34710,	2930,	6590,	3060,	2010,	4300,	2010,	3260,	690,
1,	4290,	4100,	350,	780,	360,	240,	620,	240,	380,	80,
2,	8510,	2040,	170,	390,	180,	120,	310,	120,	190,	40,
3,	182,	3538,	239,	10,	327,	2325,	2210,	302,	635,	641,
4,	102,	348,	2520,	24,	13,	544,	2360,	1216,	187,	581,
5,	124,	358,	65,	2451,	91,	0,	34,	2032,	687,	228,
6,	36,	248,	151,	26,	3067,	0,	0,	87,	1122,	817,
7,	111,	69,	28,	20,	1,	1309,	42,	0,	33,	1584,
8,	113,	149,	18,	0,	0,	0,	1077,	62,	0,	44,
9,	36,	20,	0,	0,	0,	0,	0,	503,	0,	1,
10,	441,	0,	0,	0,	0,	0,	0,	0,	253,	0,
11,	691,	49,	0,	0,	0,	0,	0,	0,	0,	269,
12,	545,	59,	0,	0,	0,	0,	0,	0,	0,	0,
13,	0,	59,	0,	0,	0,	0,	0,	0,	0,	0,
14,	2,	0,	18,	0,	0,	0,	0,	0,	0,	0,
15,	12,	0,	0,	0,	0,	0,	0,	0,	0,	0,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTALNUM,	18245,	45748,	6489,	10291,	7099,	6548,	10953,	6572,	6747,	4975,
TONSLAND,	21100,	13161,	7017,	7619,	13713,	10436,	22706,	19824,	12864,	18577,
SOPCOF %,	100,	99,	100,	101,	100,	100,	100,	100,	100,	100,

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
0,	830,	2260,	12700,	3386,	2857,	1381,	1385,	1549,	712,	102,
1,	110,	110,	468,	170,	1315,	138,	633,	279,	193,	40,
2,	1190,	20,	168,	249,	20722,	309,	3577,	911,	2520,	1554,
3,	417,	1382,	318,	448,	2150,	53979,	1978,	6292,	289,	1863,
4,	459,	789,	2119,	539,	1550,	1759,	50139,	2506,	362,	266,
5,	860,	451,	952,	6154,	1650,	1450,	1867,	55037,	565,	1188,
6,	220,	626,	618,	1820,	13000,	1550,	350,	945,	32429,	1085,
7,	451,	196,	682,	1264,	5900,	10500,	706,	368,	347,	22628,
8,	828,	508,	129,	1561,	5500,	7500,	2800,	596,	80,	129,
9,	35,	605,	460,	722,	6300,	4200,	1200,	1458,	68,	152,
10,	10,	12,	733,	1634,	1000,	7700,	950,	887,	330,	204,
11,	11,	4,	14,	648,	3100,	1947,	450,	282,	138,	242,
12,	96,	4,	4,	0,	5000,	6600,	783,	336,	68,	65,
13,	0,	12,	14,	0,	0,	8000,	650,	268,	32,	18,
14,	0,	0,	86,	0,	0,	0,	700,	157,	26,	59,
15,	0,	0,	0,	165,	0,	0,	45,	54,	0,	17,
+gp,	0,	0,	0,	0,	264,	247,	0,	0,	0,	31,
0 TOTALNUM,	5518,	6978,	19466,	18760,	70309,	107260,	68213,	71925,	38158,	29641,
TONSLAND,	13736,	16655,	23054,	53532,	169872,	225256,	127306,	135301,	103830,	86411,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
0,	10,	163,	657,	43,	0,	0,	0,	0,	0,	0,
1,	337,	15,	13,	2,	0,	0,	0,	0,	0,	0,
2,	333,	134,	724,	810,	113,	3014,	2182,	8289,	503,	1440,
3,	844,	1259,	2841,	3250,	5759,	3437,	13045,	7032,	13763,	8402,
4,	278,	3310,	10687,	11009,	34646,	71363,	27095,	24237,	3582,	56038,
5,	141,	498,	8727,	36392,	62281,	157100,	179578,	36831,	13481,	3493,
6,	1470,	119,	863,	16480,	63784,	94058,	199362,	176032,	42943,	11072,
7,	887,	1198,	365,	1558,	23109,	40628,	76121,	126375,	160496,	40446,
8,	21885,	575,	2960,	814,	1551,	10341,	32649,	38148,	116426,	129925,
9,	250,	22568,	1863,	3733,	1585,	568,	6087,	12997,	29139,	104500,
10,	46,	248,	41011,	3566,	6975,	737,	2002,	4250,	10601,	21698,
11,	9,	64,	0,	64541,	8374,	6609,	3241,	2534,	1452,	7159,
12,	69,	25,	0,	283,	91188,	1757,	9052,	348,	4004,	1626,
13,	10,	124,	0,	46,	407,	83655,	1912,	11260,	720,	2270,
14,	26,	0,	0,	10,	25,	0,	37033,	563,	8860,	2332,
15,	53,	0,	0,	207,	0,	0,	30,	10852,	0,	3447,
+gp,	1,	0,	0,	0,	45,	0,	0,	0,	6398,	3734,
0 TOTALNUM,	26648,	30300,	70711,	142742,	299842,	473266,	589388,	459749,	412369,	397582,
TONSLAND,	84683,	104448,	232457,	479228,	905501,	1220283,	1426507,	1223131,	1235433,	1207201,
SOPCOF %,	100,	100,	100,	102,	100,	101,	100,	100,	100,	100,

Table 3.5.2.2. Run title: Herring spring-spawn (run: SVPBJA12/V12)

At 23/04/2001 11:43

Table 2 Catch weights at age (kg)

YEAR,	1950,
AGE	
0,	.0070,
1,	.0250,
2,	.0580,
3,	.1100,
4,	.1880,
5,	.2110,
6,	.2340,
7,	.2530,
8,	.2660,
9,	.2800,
10,	.2940,
11,	.3030,
12,	.3120,
13,	.3200,
14,	.3230,
15,	.3310,
+gp,	.3350,
0 SOPCOFAC,	1.0019,

Table 2 Catch weights at age (kg)

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
AGE										
0,	.0090,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0090,	.0090,	.0060,
1,	.0290,	.0260,	.0270,	.0260,	.0270,	.0280,	.0280,	.0300,	.0300,	.0110,
2,	.0680,	.0610,	.0630,	.0620,	.0630,	.0660,	.0660,	.0700,	.0710,	.0740,
3,	.1300,	.1150,	.1200,	.1170,	.1190,	.1260,	.1270,	.1330,	.1350,	.1190,
4,	.2220,	.1970,	.2050,	.2010,	.2040,	.2150,	.2160,	.2270,	.2310,	.1880,
5,	.2490,	.2210,	.2300,	.2250,	.2290,	.2410,	.2430,	.2550,	.2590,	.2770,
6,	.2760,	.2450,	.2550,	.2500,	.2540,	.2680,	.2690,	.2830,	.2870,	.3370,
7,	.2980,	.2650,	.2750,	.2690,	.2740,	.2890,	.2900,	.3050,	.3100,	.3180,
8,	.3140,	.2790,	.2900,	.2840,	.2890,	.3040,	.3060,	.3210,	.3270,	.3630,
9,	.3300,	.2930,	.3050,	.2990,	.3040,	.3200,	.3220,	.3380,	.3440,	.3790,
10,	.3460,	.3080,	.3200,	.3130,	.3180,	.3360,	.3380,	.3550,	.3600,	.3600,
11,	.3570,	.3170,	.3300,	.3230,	.3280,	.3460,	.3480,	.3660,	.3720,	.4200,
12,	.3680,	.3270,	.3400,	.3330,	.3380,	.3570,	.3590,	.3770,	.3830,	.4110,
13,	.3770,	.3350,	.3470,	.3410,	.3460,	.3650,	.3670,	.3860,	.3920,	.4390,
14,	.3810,	.3390,	.3510,	.3450,	.3500,	.3690,	.3710,	.3900,	.3970,	.4500,
15,	.3900,	.3460,	.3590,	.3520,	.3580,	.3780,	.3800,	.3990,	.4060,	.4440,
+gp,	.3950,	.3510,	.3640,	.3570,	.3630,	.3830,	.3850,	.4040,	.4110,	.4480,
0 SOPCOFAC,	1.0009,	.9963,	.9994,	1.0006,	.9995,	1.0013,	1.0030,	.9985,	1.0004,	1.0014,

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Table 2 Catch weights at age (kg)

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
0,	.0060,	.0090,	.0080,	.0090,	.0090,	.0080,	.0090,	.0100,	.0090,	.0080,
1,	.0100,	.0230,	.0260,	.0240,	.0160,	.0170,	.0150,	.0270,	.0210,	.0580,
2,	.0450,	.0550,	.0470,	.0590,	.0480,	.0400,	.0360,	.0490,	.0470,	.0850,
3,	.0870,	.0850,	.0980,	.1390,	.0890,	.0630,	.0660,	.0750,	.0720,	.1050,
4,	.1590,	.1480,	.1710,	.2190,	.2170,	.2460,	.0930,	.1080,	.1050,	.1710,
5,	.2760,	.2880,	.2750,	.2390,	.2340,	.2600,	.3050,	.1580,	.1520,	.2560,
6,	.3220,	.3330,	.2680,	.2980,	.2620,	.2650,	.3050,	.3750,	.2960,	.2160,
7,	.3720,	.3600,	.3230,	.2950,	.3310,	.3010,	.3100,	.3830,	.3760,	.2770,
8,	.3630,	.3520,	.3290,	.3390,	.3600,	.4100,	.3330,	.3640,	.3290,	.2980,
9,	.3930,	.3500,	.3360,	.3500,	.3670,	.4250,	.3590,	.3820,	.3290,	.3040,
10,	.4070,	.3740,	.3410,	.3580,	.3860,	.4560,	.4130,	.4410,	.3410,	.3050,
11,	.3970,	.3840,	.3580,	.3510,	.3950,	.4600,	.4460,	.4100,	.3630,	.3090,
12,	.4220,	.3740,	.3850,	.3670,	.3930,	.4670,	.4010,	.4420,	.3850,	.3570,
13,	.4470,	.3940,	.3530,	.3750,	.4040,	.4460,	.4080,	.5170,	.3770,	.3480,
14,	.4650,	.3990,	.3810,	.3720,	.4010,	.4590,	.4390,	.4910,	.4510,	.3570,
15,	.4520,	.4110,	.3860,	.4270,	.4290,	.4650,	.4270,	.4640,	.4230,	.3670,
+gp,	.4520,	.4160,	.3860,	.4340,	.4370,	.4740,	.4310,	.4870,	.4290,	.3760,
0 SOPCOFAC,	1.0017,	.9997,	1.0003,	.9995,	.9995,	1.0001,	1.0005,	.9991,	1.0036,	1.0030,

Table 2 Catch weights at age (kg)

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
0,	.0110,	.0110,	.0060,	.0060,	.0090,	.0070,	.0110,	.0120,	.0100,	.0120,
1,	.0530,	.0290,	.0530,	.0550,	.0790,	.0620,	.0910,	.1000,	.0880,	.1010,
2,	.1210,	.0620,	.1060,	.1170,	.1690,	.1320,	.1930,	.2100,	.1810,	.2020,
3,	.1770,	.1030,	.1610,	.1680,	.2410,	.1890,	.3160,	.2740,	.2930,	.2660,
4,	.2160,	.1540,	.2130,	.2220,	.3180,	.2500,	.3500,	.4240,	.3590,	.3990,
5,	.2500,	.2150,	.2390,	.2490,	.3580,	.2800,	.3980,	.4540,	.4160,	.4490,
6,	.2770,	.2580,	.2550,	.2650,	.3810,	.2980,	.4390,	.4950,	.4360,	.4600,
7,	.3050,	.2950,	.2770,	.2880,	.4130,	.3230,	.4950,	.5240,	.4820,	.4850,
8,	.3330,	.3220,	.2870,	.2990,	.4290,	.3360,	.5110,	.5960,	.4820,	.4720,
9,	.3530,	.3410,	.3240,	.3370,	.4840,	.3790,	.5580,	.6130,	.5390,	.6180,
10,	.3660,	.3540,	.3380,	.3520,	.5060,	.3960,	.5830,	.6500,	.5530,	.6450,
11,	.3770,	.3650,	.2570,	.2670,	.3840,	.3000,	.5370,	.5900,	.5180,	.6080,
12,	.3880,	.3760,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,	.5940,
13,	.3990,	.3870,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,	.5940,
14,	.4190,	.4060,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,	.5940,
15,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,	.5940,
+gp,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,	.5180,	.5940,
0 SOPCOFAC,	1.0001,	.9935,	1.0011,	1.0051,	1.0002,	1.0004,	.9991,	.9998,	1.0016,	.9999,

Table 2 Catch weights at age (kg)

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
0,	.0100,	.0100,	.0110,	.0090,	.0090,	.0070,	.0100,	.0080,	.0100,	.0070,
1,	.0820,	.0870,	.0900,	.0470,	.0220,	.0770,	.0750,	.0620,	.0600,	.0780,
2,	.1630,	.1590,	.1650,	.1450,	.0220,	.0970,	.0910,	.0750,	.2040,	.1020,
3,	.1960,	.2560,	.2170,	.2180,	.2140,	.0550,	.1240,	.1240,	.1880,	.2300,
4,	.2910,	.3120,	.2650,	.2620,	.2770,	.2490,	.1730,	.1540,	.2640,	.2390,
5,	.3410,	.3780,	.3370,	.3250,	.2950,	.2940,	.2530,	.1940,	.2600,	.2660,
6,	.3680,	.4150,	.3780,	.3460,	.3380,	.3120,	.2320,	.2410,	.2820,	.3050,
7,	.3800,	.4350,	.4100,	.3810,	.3600,	.3520,	.3120,	.2650,	.3060,	.3080,
8,	.3970,	.4490,	.4260,	.4000,	.3810,	.3740,	.3280,	.3040,	.3090,	.3760,
9,	.4360,	.4480,	.4350,	.4130,	.3970,	.3980,	.3490,	.3050,	.3910,	.4070,
10,	.4500,	.5060,	.4440,	.4050,	.4090,	.4020,	.3530,	.3170,	.4220,	.4120,
11,	.4920,	.4930,	.4680,	.4260,	.4170,	.4010,	.3700,	.3080,	.3640,	.4240,
12,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,	.4290,	.4280,
13,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,	.4290,	.4280,
14,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,	.4290,	.4280,
15,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,	.4290,	.4280,
+gp,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,	.4290,	.4280,
0 SOPCOFAC,	1.0007,	1.0001,	.9981,	.9999,	.9997,	1.0010,	.9979,	.9998,	1.0007,	.9992,

Table 2 Catch weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
0,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,
1,	.0150,	.0750,	.0300,	.0630,	.0630,	.0630,	.0630,	.0630,	.0630,	.0630,
2,	.1040,	.1030,	.1060,	.1020,	.1020,	.1360,	.0890,	.1110,	.0960,	.1240,
3,	.2080,	.1910,	.1530,	.1940,	.1530,	.1360,	.1670,	.1500,	.1730,	.1750,
4,	.2500,	.2330,	.2430,	.2390,	.1920,	.1680,	.1840,	.2160,	.2280,	.2220,
5,	.2880,	.3040,	.2820,	.2800,	.2340,	.2060,	.2070,	.2210,	.2620,	.2420,
6,	.3120,	.3370,	.3200,	.3170,	.2830,	.2620,	.2320,	.2490,	.2740,	.2890,
7,	.3160,	.3650,	.3300,	.3280,	.3280,	.3090,	.2770,	.2770,	.2920,	.3030,
8,	.3300,	.3610,	.3650,	.3560,	.3490,	.3370,	.3050,	.3160,	.3070,	.3100,
9,	.3440,	.3710,	.3730,	.3720,	.3560,	.3660,	.3310,	.3380,	.3350,	.3280,
10,	.3720,	.4030,	.3790,	.3900,	.3740,	.3600,	.3280,	.3740,	.3620,	.3490,
11,	.3540,	.3650,	.3800,	.3790,	.3660,	.3610,	.3440,	.3720,	.3710,	.3830,
12,	.3980,	.3940,	.3850,	.3990,	.3930,	.3670,	.3430,	.3660,	.3990,	.4110,
13,	.3980,	.4040,	.3900,	.4030,	.3870,	.3790,	.3970,	.3960,	.3960,	.4100,
14,	.3980,	.4060,	.3950,	.4050,	.4000,	.3790,	.3570,	.3770,	.4000,	.4190,
15,	.3980,	.4080,	.4000,	.4070,	.4000,	.3790,	.5100,	.4060,	.4000,	.4090,
+gp,	.3980,	.4100,	.4050,	.4050,	.4000,	.3790,	.5100,	.4060,	.4040,	.4090,
0 SOPCOFAC,	1.0015,	1.0024,	.9981,	1.0192,	1.0000,	1.0075,	.9996,	.9995,	1.0020,	.9996,

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Table 3.5.2.3. Run title: Herring spring-spawn (run: SVPBJA12/V12)

At 23/04/2001 11:43

Table 3 Stock weights at age (kg)

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

Table 3 Stock weights at age (kg)

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
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,	.2040,	.2040,	.2040,	.2040,	.1950,	.2050,	.1360,	.2040,	.2040,	.2040,
5,	.2300,	.2300,	.2300,	.2300,	.2130,	.2300,	.2280,	.2420,	.2520,	.2700,
6,	.2550,	.2550,	.2550,	.2550,	.2600,	.2490,	.2550,	.2920,	.2600,	.2910,
7,	.2750,	.2750,	.2750,	.2750,	.2750,	.2750,	.2620,	.2950,	.2900,	.2930,
8,	.2900,	.2900,	.2900,	.2900,	.2900,	.2900,	.2900,	.2930,	.3000,	.3210,
9,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,	.3050,	.3180,
10,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,	.3150,	.3200,
11,	.3250,	.3250,	.3250,	.3250,	.3250,	.3250,	.3250,	.3300,	.3250,	.3440,
12,	.3300,	.3300,	.3300,	.3300,	.3300,	.3300,	.3300,	.3400,	.3300,	.3490,
13,	.3400,	.3400,	.3400,	.3400,	.3400,	.3400,	.3400,	.3450,	.3400,	.3700,
14,	.3450,	.3450,	.3450,	.3450,	.3450,	.3450,	.3450,	.3520,	.3450,	.3790,
15,	.3620,	.3620,	.3620,	.3620,	.3620,	.3620,	.3620,	.3600,	.3550,	.3750,
+gp,	.3650,	.3650,	.3650,	.3650,	.3650,	.3650,	.3650,	.3650,	.3600,	.3800,

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Table 3 Stock weights at age (kg)

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
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,	.2320,	.2190,	.1850,	.1940,	.1860,	.1850,	.1800,	.1150,	.1150,	.2090,
5,	.2500,	.2910,	.2530,	.2130,	.1990,	.2190,	.2280,	.2060,	.1450,	.2720,
6,	.2920,	.3000,	.2940,	.2640,	.2360,	.2220,	.2690,	.2660,	.2700,	.2300,
7,	.3020,	.3160,	.3120,	.3170,	.2600,	.2490,	.2700,	.2750,	.3000,	.2950,
8,	.3040,	.3240,	.3290,	.3630,	.3630,	.3060,	.2940,	.2740,	.3060,	.3170,
9,	.3230,	.3260,	.3270,	.3530,	.3500,	.3540,	.3240,	.2850,	.3080,	.3230,
10,	.3220,	.3350,	.3340,	.3490,	.3700,	.3770,	.4200,	.3500,	.3180,	.3250,
11,	.3210,	.3380,	.3410,	.3540,	.3600,	.3910,	.4300,	.3250,	.3400,	.3290,
12,	.3440,	.3340,	.3490,	.3570,	.3780,	.3790,	.3660,	.3630,	.3680,	.3800,
13,	.3570,	.3470,	.3410,	.3590,	.3870,	.3780,	.3680,	.4080,	.3600,	.3700,
14,	.3630,	.3540,	.3580,	.3650,	.3900,	.3610,	.4330,	.3880,	.3930,	.3800,
15,	.3650,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,	.3970,	.3910,
+gp,	.3700,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,	.3970,	.3910,

Table 3 Stock weights at age (kg)

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0150,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0800,	.0700,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,
3,	.1000,	.1500,	.1700,	.1700,	.1810,	.1810,	.1810,	.1800,	.1780,	.1750,
4,	.1900,	.1500,	.2590,	.2590,	.2590,	.2590,	.2590,	.2940,	.2320,	.2830,
5,	.2250,	.1400,	.3420,	.3420,	.3420,	.3420,	.3430,	.3260,	.3590,	.3470,
6,	.2500,	.2100,	.3840,	.3840,	.3840,	.3840,	.3840,	.3710,	.3850,	.4020,
7,	.2750,	.2400,	.4090,	.4090,	.4090,	.4090,	.4090,	.4090,	.4200,	.4210,
8,	.2900,	.2700,	.4040,	.4440,	.4440,	.4440,	.4440,	.4610,	.4440,	.4650,
9,	.3100,	.3000,	.4610,	.4610,	.4610,	.4610,	.4610,	.4760,	.5050,	.4650,
10,	.3250,	.3250,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,
11,	.3350,	.3350,	.5340,	.5430,	.5430,	.5430,	.5430,	.5430,	.5510,	.5340,
12,	.3450,	.3450,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,	.5000,
13,	.3550,	.3550,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,	.5000,
14,	.3650,	.3650,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,	.5000,
15,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,	.5000,
+gp,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,	.5000,	.5000,

Table 3 Stock weights at age (kg)

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0150,	.0150,	.0080,
2,	.0850,	.0850,	.0850,	.0850,	.0230,	.0850,	.0550,	.0500,	.1000,	.0480,
3,	.1700,	.1700,	.1550,	.1400,	.1480,	.0540,	.0900,	.0980,	.1540,	.2190,
4,	.2240,	.2040,	.2490,	.2040,	.2340,	.2060,	.1430,	.1350,	.1750,	.1980,
5,	.3360,	.3030,	.3040,	.2950,	.2650,	.2650,	.2410,	.1970,	.2090,	.2580,
6,	.3780,	.3550,	.3680,	.3380,	.3120,	.2890,	.2790,	.2770,	.2520,	.2880,
7,	.3870,	.3830,	.4040,	.3760,	.3460,	.3390,	.2990,	.3150,	.3050,	.3090,
8,	.4080,	.3950,	.4240,	.3950,	.3700,	.3680,	.3160,	.3390,	.3670,	.4280,
9,	.3970,	.4130,	.4370,	.4070,	.3950,	.3910,	.3420,	.3430,	.3770,	.3700,
10,	.5200,	.4530,	.4360,	.4130,	.3970,	.3820,	.3430,	.3590,	.3590,	.4030,
11,	.5430,	.4680,	.4930,	.4220,	.4280,	.3880,	.3620,	.3650,	.3950,	.3870,
12,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,	.4400,
13,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,	.4400,
14,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,	.4400,
15,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,	.4400,
+gp,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,	.3960,	.4400,

Table 3 Stock weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0110,	.0070,	.0080,	.0100,	.0180,	.0180,	.0180,	.0180,	.0180,	.0180,
2,	.0370,	.0300,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,	.0250,
3,	.1470,	.1280,	.0810,	.0750,	.0660,	.0760,	.0960,	.0740,	.1020,	.1190,
4,	.2100,	.2240,	.2010,	.1510,	.1380,	.1180,	.1180,	.1470,	.1500,	.1780,
5,	.2440,	.2960,	.2650,	.2540,	.2300,	.1880,	.1740,	.1740,	.2230,	.2250,
6,	.3000,	.3270,	.3230,	.3180,	.2960,	.2610,	.2290,	.2170,	.2400,	.2710,
7,	.3240,	.3550,	.3540,	.3710,	.3460,	.3160,	.2860,	.2420,	.2640,	.2850,
8,	.3360,	.3450,	.3580,	.3470,	.3880,	.3460,	.3230,	.2780,	.2830,	.2980,
9,	.3430,	.3670,	.3810,	.4120,	.3630,	.3740,	.3700,	.3040,	.3150,	.3110,
10,	.3820,	.3410,	.3690,	.3820,	.4090,	.3900,	.3780,	.3100,	.3450,	.3390,
11,	.3660,	.3610,	.3960,	.4070,	.4140,	.3900,	.3860,	.3590,	.3860,	.3900,
12,	.4250,	.4300,	.3930,	.4100,	.4220,	.3840,	.3600,	.3400,	.3860,	.3980,
13,	.4250,	.4700,	.3740,	.4100,	.4100,	.3980,	.3930,	.3440,	.3860,	.4060,
14,	.4250,	.4700,	.4030,	.4100,	.4100,	.3980,	.3910,	.3850,	.3820,	.4140,
15,	.4250,	.4700,	.4000,	.4100,	.4050,	.3980,	.3910,	.3630,	.3820,	.4220,
+gp,	.4250,	.4500,	.4000,	.4100,	.4470,	.3980,	.3910,	.3750,	.4070,	.4310,

1

Table 3.5.2.4. Run title: Herring spring-spawn (run: SVPBJA12/V12)

At 23/04/2001 11:43

Table 5 Proportion mature at age

YEAR,	1950,
AGE	
0,	.0000,
1,	.0000,
2,	.0000,
3,	.0000,
4,	.1000,
5,	.3000,
6,	.6000,
7,	.9000,
8,	1.0000,
9,	1.0000,
10,	1.0000,
11,	1.0000,
12,	1.0000,
13,	1.0000,
14,	1.0000,
15,	1.0000,
+gp,	1.0000,

Table 5 Proportion mature at age

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
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,	.0000,	.0000,	.0000,	.0800,	.0800,	.0000,	.0800,	.0800,	.0800,
4,	.1000,	.1000,	.1000,	.1000,	.2200,	.2200,	.0000,	.2200,	.2200,	.2200,
5,	.3000,	.3000,	.3000,	.3000,	.3700,	.3700,	.5000,	.3700,	.3700,	.3700,
6,	.6000,	.6000,	.6000,	.6000,	.8500,	.8500,	.6000,	.8500,	.8500,	.8500,
7,	.9000,	.9000,	.9000,	.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,

1

Table 5 Proportion mature at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
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,	.0400,	.0000,	.0400,	.0200,	.0000,	.0100,	.0000,	.0000,	.6200,	.0600,
4,	.3500,	.1100,	.0300,	.0600,	.3400,	.1500,	.0100,	.0000,	.8900,	.1300,
5,	.6800,	.6700,	.3200,	.2800,	.3500,	1.0000,	.2300,	.0100,	.9500,	.3100,
6,	.9400,	1.0000,	.9000,	.3200,	.7600,	.9600,	1.0000,	.7600,	1.0000,	.1700,
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,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
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,	.1000,	.1000,	.1000,	.1000,	.0000,	.0000,	.0000,	.0000,
3,	.1000,	.0000,	.5000,	.5000,	.5000,	.5000,	.7300,	.1300,	.1000,	.2500,
4,	.2500,	.1000,	.9000,	.9000,	1.0000,	.9000,	.8900,	.9000,	.6200,	.5000,
5,	.6000,	.2500,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9500,	.9700,
6,	.9000,	.6000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	.9000,	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,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
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,	.3000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.4000,
4,	.5000,	.4800,	.5000,	.5000,	.5000,	.2000,	.3000,	.3000,	.3000,	.8000,
5,	.9000,	.7000,	.6900,	.9000,	.9000,	.9000,	.9000,	.9000,	.9000,	.9000,
6,	1.0000,	1.0000,	.7100,	.9500,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,
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,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
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,	.0100,	.0100,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
4,	.7000,	.2000,	.3000,	.3000,	.3000,	.3000,	.3000,	.3000,	.3000,	.3000,
5,	1.0000,	.8000,	.8000,	.8000,	.8000,	.9000,	.9000,	.9000,	.9000,	.9000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	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,

1

Table 3.5.4.1. Summary of exploratory runs for Norwegian spring spawning herring.

For explanations of each run, see the text

	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6	Run 7	Run 8
SSB 2001	6.24	6.71	6.52	6.32	6.78	7.99	7.62	5.85
SSB 2000	6.73	7.25	7.10	6.97	7.61	8.60	8.12	6.48
SSB 1999	7.97	8.52	8.38	8.28	9.01	9.95	9.41	7.76
SSB 1998	8.39	8.94	8.82	8.75	9.63	10.43	9.77	8.21
Total log-likelihood	-420.10	-441.56	-531.00	-454.63	-780.13	-406.46	-374.81	-419.79
Log-likelihood surveys per term	-1.54	-1.60	-2.11	-2.31	-5.72	-1.65	-1.59	-1.44
Number survey terms	87.00	97.00	117.00	87.00	89.00	89.00	97.00	93.00
Log-likelihood tag returns per term	-2.03	-2.04	-2.03	-2.15	-2.20	-2.20	-2.00	-2.03
Number tag return terms	110.00	110.00	110.00	89.00	85.00	85.00	80.00	110.00
Log-likelihood larval index per term	-2.95	-2.93	-2.93	-2.94	-3.98	-3.45	-2.91	-2.96
Number larval index terms	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
Catchability Spawning grounds	0.73	0.63	0.63	0.63	0.63	0.53	0.59	0.76
Catchability December in Ofoten	0.63	0.58	0.57		0.70	0.55	0.53	0.65
Catchability January in Ofoten	0.73	0.69	0.69	0.70	0.41	0.68	0.66	0.73
Catchability Young herring in the Barents Sea			0.40	0.41				
Catchability Herring in the Norwegian Sea	0.95	0.87	0.87	0.87	0.87	0.75	0.80	0.95
Terminal F 1983	0.35	0.30	0.28	0.24	0.24	0.35	0.28	0.37
Terminal F 1990	0.19	0.16	0.15	0.16	0.16	0.15	0.15	0.19
Terminal F 1991	0.22	0.20	0.20	0.20	0.20	0.17	0.17	0.22
Terminal F 1992	0.17	0.16	0.16	0.17	0.17	0.13	0.13	0.18
Terminal F 1993	0.15	0.15	0.15	0.16	0.16	0.13	0.13	0.15
Terminal F 1994								0.15
Distribution parameter	0.39	0.38	0.56	0.60	0.60	0.33	0.38	0.38
Catchability larval index	3.63	3.49	3.47	3.44	3.44	2.48	3.35	3.64
Larval distribution parameter	0.58	0.57	0.57	0.57	0.57	0.89	0.56	0.58
Tagging survival	0.46	0.47	0.48	0.51	0.51	0.52	0.45	0.45

Table 3.5.6.1.

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 23/04/2001 11:44
Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1950,
AGE	
0,	.0104,
1,	.1217,
2,	.0658,
3,	.0278,
4,	.0508,
5,	.0410,
6,	.0709,
7,	.0884,
8,	.0446,
9,	.0346,
10,	.0375,
11,	.0369,
12,	.0379,
13,	.0666,
14,	.0780,
15,	.0459,
+gp,	.0459,
0 FBAR 2-13,	.0502,

Table 8 Fishing mortality (F) at age

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
AGE										
0,	.0174,	.2455,	.1082,	.4996,	.3874,	.3408,	.3741,	.6958,	.0689,	.1068,
1,	.0390,	.2699,	.2894,	.4172,	.5567,	.5949,	.8901,	.9181,	.7079,	.1421,
2,	.0661,	.0160,	.0505,	.1521,	.0987,	.5132,	.2514,	1.2040,	.5811,	.6955,
3,	.0013,	.0118,	.0171,	.0424,	.0320,	.0426,	.0462,	.0414,	.1058,	.7587,
4,	.0465,	.0141,	.0165,	.0396,	.0537,	.1079,	.1763,	.0431,	.0781,	.1698,
5,	.0581,	.0908,	.0279,	.0612,	.0692,	.0756,	.0844,	.0689,	.0769,	.1041,
6,	.0440,	.0565,	.0674,	.0799,	.0605,	.1097,	.0687,	.0612,	.1160,	.0916,
7,	.0839,	.0673,	.0415,	.1184,	.0808,	.0723,	.1105,	.0728,	.0990,	.0985,
8,	.1085,	.0779,	.0448,	.0800,	.0854,	.1111,	.0587,	.0689,	.1150,	.0804,
9,	.0527,	.0873,	.0810,	.1009,	.0666,	.1049,	.0891,	.0714,	.0987,	.1278,
10,	.0390,	.0668,	.1173,	.1476,	.1270,	.1307,	.0930,	.1105,	.1140,	.1357,
11,	.0427,	.0490,	.0645,	.1846,	.1325,	.1759,	.1163,	.1330,	.1475,	.1449,
12,	.0556,	.0544,	.0641,	.1175,	.1098,	.1647,	.1469,	.1741,	.1777,	.2138,
13,	.0602,	.0682,	.0584,	.0886,	.1012,	.1147,	.1209,	.1249,	.2207,	.1925,
14,	.0787,	.0545,	.0789,	.1039,	.0949,	.1424,	.1208,	.0736,	.1678,	.2032,
15,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,	.0820,	.1127,	.1387,
+gp,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,	.0820,	.1127,	.1387,
0 FBAR 2-13,	.0549,	.0550,	.0543,	.1011,	.0848,	.1436,	.1135,	.1812,	.1609,	.2344,

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Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
0,	.1360,	.3679,	.0451,	.0621,	.5500,	.1392,	.1961,	.7997,	.0921,	.3347,
1,	.4130,	.2658,	.9250,	.0665,	.1786,	.7192,	1.7622,	.7439,	1.6597,	.2501,
2,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,	.3323,	.6937,	1.7485,	1.2205,
3,	.1583,	.1028,	.1240,	.0612,	.6737,	.3137,	.5034,	3.2066,	2.0406,	.5307,
4,	.0927,	.0525,	.0588,	.0840,	.1789,	.4085,	1.1192,	4.5599,	.2604,	1.4843,
5,	.0497,	.0442,	.0424,	.1886,	.1573,	.5321,	.8593,	4.7169,	.7590,	.2998,
6,	.0705,	.1097,	.0310,	.1391,	.2997,	.5982,	1.3102,	1.8048,	.6023,	.6842,
7,	.0928,	.1213,	.0698,	.0309,	.2829,	.7536,	1.6834,	1.2122,	.3507,	1.1086,
8,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,	1.4826,	.9377,	.4226,	1.1726,
9,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,	1.3296,	1.5726,	.6056,	1.1825,
10,	.1117,	.0907,	.2443,	.3074,	.3472,	1.3436,	1.4501,	1.2945,	.6310,	1.3751,
11,	.1118,	.1256,	.2153,	.3356,	.8375,	1.0666,	1.0905,	1.3198,	.6261,	1.5563,
12,	.1117,	.1666,	.2626,	.2856,	.6639,	.5451,	1.2609,	.7483,	.8732,	3.9033,
13,	.1012,	.1302,	.2729,	.3657,	.6932,	1.3723,	1.1286,	1.9490,	.3927,	1.6255,
14,	.1069,	.1628,	.3429,	.3634,	.6227,	1.4701,	1.9718,	1.2342,	.8364,	.8120,
15,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,	1.3620,	.5776,	1.4061,
+gp,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,	1.3620,	.5776,	1.4061,
0 FBAR 2-13,	.0943,	.1000,	.1666,	.2223,	.4180,	.7882,	1.1292,	2.0013,	.7761,	1.3453,

Table 8 Fishing mortality (F) at age

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
0,	.2441,	.7939,	.0035,	.0118,	.0159,	.0030,	.0130,	.0050,	.0040,	.0068,
1,	.4295,	1.7489,	.0323,	.0023,	.0016,	.0031,	.0023,	.0018,	.0023,	.0002,
2,	.1204,	.9309,	.7288,	.0937,	.0013,	.0013,	.0099,	.0011,	.0035,	.0006,
3,	.2855,	.0983,	.4069,	.1233,	.1561,	.0300,	.0432,	.0171,	.0103,	.0210,
4,	.1419,	1.2887,	.0893,	.0609,	.2243,	.3938,	.0365,	.0286,	.0124,	.0110,
5,	.3119,	.9578,	.8552,	.1115,	.3212,	.0022,	.0354,	.0379,	.0192,	.0179,
6,	.2794,	1.8090,	1.5110,	.9654,	.1880,	.0005,	.0026,	.1147,	.0251,	.0272,
7,	.4857,	1.2502,	1.1078,	.7734,	.0379,	.1083,	.2687,	.0030,	.0544,	.0426,
8,	1.6241,	2.9486,	1.3527,	.0086,	.0141,	.0090,	.1158,	.7485,	.0035,	.0920,
9,	2.5238,	1.7610,	.0147,	.0192,	.0101,	.0083,	.0106,	.0690,	.0021,	.0333,
10,	1.9510,	.0388,	.0293,	.0174,	.0228,	.0119,	.0097,	.0124,	.0427,	.0025,
11,	2.2737,	1.5553,	.0471,	.0351,	.0206,	.0271,	.0140,	.0114,	.0146,	.0553,
12,	1.8357,	2.0473,	.0090,	.0576,	.0424,	.0244,	.0325,	.0165,	.0134,	.0173,
13,	.2170,	1.1132,	.0136,	.0105,	.0714,	.0517,	.0291,	.0391,	.0195,	.0158,
14,	2.7742,	.3301,	1.2442,	.0161,	.0124,	.0899,	.0636,	.0350,	.0474,	.0232,
15,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,	.0422,	.0581,
+gp,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,	.0422,	.0581,
0 FBAR 2-13,	1.0042,	1.3166,	.5138,	.1897,	.0925,	.0557,	.0507,	.0916,	.0184,	.0280,

Table 8 Fishing mortality (F) at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
0,	.0116,	.0148,	.0005,	.0045,	.0010,	.0017,	.0015,	.0009,	.0001,	.0000,
1,	.0027,	.0038,	.0076,	.0000,	.0043,	.0001,	.0020,	.0007,	.0003,	.0000,
2,	.0089,	.0012,	.0144,	.0101,	.0052,	.0025,	.0073,	.0070,	.0166,	.0053,
3,	.0110,	.0182,	.0340,	.0701,	.1654,	.0238,	.0285,	.0226,	.0039,	.0218,
4,	.0178,	.0247,	.0333,	.0705,	.3436,	.1875,	.0264,	.0435,	.0015,	.0042,
5,	.0193,	.0207,	.0357,	.1211,	.3000,	.5875,	.2929,	.0347,	.0117,	.0059,
6,	.0205,	.0166,	.0339,	.0841,	.3781,	.4797,	.2553,	.2236,	.0245,	.0266,
7,	.0179,	.0216,	.0214,	.0853,	.3991,	.5624,	.3946,	.4372,	.1131,	.0203,
8,	.0268,	.0238,	.0169,	.0592,	.5933,	1.2624,	.2676,	.6414,	.1497,	.0531,
9,	.0916,	.0233,	.0257,	.1171,	.3356,	1.2486,	.6434,	.2055,	.1275,	.4384,
10,	.6964,	.0399,	.0338,	.1136,	.2228,	.8276,	1.0630,	1.4616,	.0619,	.6363,
11,	.3917,	.5462,	.0575,	.0359,	.3073,	.8219,	.0924,	1.0588,	.9170,	.0559,
12,	.0240,	.1999,	2.2586,	.0005,	.3953,	2.0562,	.9048,	.0876,	.7529,	1.6749,
13,	.0205,	.0035,	3.2773,	.2937,	.0006,	2.1502,	1.5336,	.8806,	.0102,	.4237,
14,	.0186,	.0243,	.0298,	.2407,	.5035,	.0007,	1.4985,	4.7159,	.1734,	.0220,
15,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,	.0897,	.1527,
+gp,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,	.0897,	.1527,
0 FBAR 2-13,	.1122,	.0783,	.4869,	.0884,	.2872,	.8509,	.4591,	.4253,	.1825,	.2805,

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**
AGE											
0,	.0000,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0004,	.0001,	.0002,	.0002,	.0001,	.0084,	.0217,	.0062,	.0024,	.0540,	.0209,
3,	.0050,	.0026,	.0031,	.0014,	.0022,	.0049,	.0658,	.1320,	.0182,	.0720,	.0741,
4,	.0038,	.0233,	.0256,	.0143,	.0172,	.0319,	.0464,	.1586,	.0872,	.0910,	.1123,
5,	.0026,	.0080,	.0748,	.1080,	.0994,	.0958,	.0995,	.0780,	.1178,	.1090,	.1016,
6,	.0085,	.0025,	.0163,	.1865,	.2637,	.2022,	.1602,	.1268,	.1164,	.1270,	.1234,
7,	.0260,	.0081,	.0091,	.0352,	.4052,	.2527,	.2365,	.1370,	.1546,	.1450,	.1455,
8,	.0233,	.0200,	.0236,	.0239,	.0423,	.3013,	.3123,	.1690,	.1709,	.1710,	.1703,
9,	.1310,	.0286,	.0791,	.0357,	.0563,	.0185,	.2751,	.1861,	.1783,	.2160,	.1935,
10,	.2163,	.1762,	.0632,	.2018,	.0821,	.0318,	.0797,	.2968,	.2154,	.1850,	.2324,
11,	.0455,	.4904,	.0001,	.1270,	.9284,	.0989,	.1800,	.1301,	.1479,	.2090,	.1623,
12,	.0193,	.1664,	.0012,	.3500,	.2510,	.4705,	.1806,	.0250,	.2938,	.2320,	.1836,
13,	1.6296,	.0413,	.0009,	.9446,	1.1850,	.3619,	1.3907,	.3361,	.0627,	.2550,	.2179,
14,	1.9531,	.0483,	.0000,	.1000,	4.0282,	.0007,	.2543,	6.3344,	.4536,	.2780,	2.3553,
15,	.0238,	.0286,	.0592,	.1000,	.0000,	.3033,	.2616,	.1040,	.1300,	.3010,	.1783,
+gp,	.0238,	.0286,	.0592,	.1000,	.0000,	.3033,	.2616,	.1040,	.1300,	.3010,	
0 FBAR 2-13,	.1759,	.0806,	.0248,	.1690,	.2777,	.1566,	.2541,	.1485,	.1305,	.1555,	

Table 3.5.6.2

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 23/04/2001 11:44
Traditional vpa using screen input for terminal F

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

YEAR,	1950,
AGE	
0,	7473747,
1,	262358,
2,	142205,
3,	108558,
4,	40165,
5,	49706,
6,	85994,
7,	79923,
8,	19630,
9,	28024,
10,	32020,
11,	25817,
12,	56309,
13,	61467,
14,	9515,
15,	25669,
+gp,	56929,
0 TOTAL,	8558036,

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

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
AGE										
0,	1439079,	938988,	835771,	397029,	237538,	274748,	236506,	278105,	4053427,	1913386,
1,	3007097,	575014,	298670,	304949,	97946,	65556,	79447,	66148,	56387,	1538204,
2,	94445,	1175817,	178474,	90917,	81693,	22821,	14702,	13263,	10738,	11294,
3,	54134,	35944,	470458,	68991,	31748,	30092,	5554,	4649,	1618,	2442,
4,	90878,	46533,	30573,	398069,	56914,	26464,	24821,	4564,	3839,	1253,
5,	32858,	74664,	39490,	25883,	329322,	46426,	20449,	17911,	3763,	3056,
6,	41064,	26685,	58688,	33055,	20954,	264511,	37050,	16177,	14389,	2999,
7,	68950,	33821,	21705,	47220,	26265,	16977,	204017,	29773,	13096,	11028,
8,	62971,	54572,	27216,	17923,	36105,	20851,	13593,	157223,	23826,	10209,
9,	16159,	48627,	43450,	22398,	14241,	28532,	16060,	11033,	126308,	18279,
10,	23300,	13194,	38355,	34489,	17428,	11467,	22112,	12644,	8841,	98496,
11,	26545,	19288,	10623,	29358,	25611,	13211,	8660,	17343,	9744,	6790,
12,	21416,	21893,	15808,	8572,	21008,	19308,	9537,	6636,	13068,	7237,
13,	46664,	17436,	17846,	12761,	6559,	16201,	14095,	7087,	4799,	9416,
14,	49494,	37816,	14018,	14488,	10052,	5102,	12433,	10750,	5384,	3312,
15,	7575,	39378,	30821,	11151,	11239,	7869,	3809,	9483,	8596,	3918,
+gp,	48758,	47336,	73642,	59483,	51748,	42150,	27995,	25443,	15205,	10102,
0 TOTAL,	5131387,	3207006,	2205608,	1576735,	1076372,	912286,	750839,	688233,	4373027,	3651422,

1

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
0,	732827,	177124,	1646402,	905560,	79326,	453493,	35822,	46386,	96073,	6207,
1,	699104,	260052,	49847,	639834,	345996,	18608,	160413,	11970,	8476,	35624,
2,	542521,	188063,	81052,	8036,	243395,	117663,	3686,	11196,	2313,	655,
3,	2291,	202893,	70081,	20760,	1959,	81610,	37672,	1075,	2275,	164,
4,	984,	1683,	157564,	53282,	16807,	859,	51327,	19600,	37,	254,
5,	910,	772,	1374,	127875,	42166,	12097,	492,	14426,	177,	25,
6,	2370,	745,	636,	1134,	91146,	31010,	6115,	179,	111,	71,
7,	2355,	1901,	575,	531,	849,	58137,	14675,	1420,	25,	52,
8,	8601,	1847,	1450,	461,	443,	551,	23551,	2346,	364,	15,
9,	8109,	6833,	1480,	1078,	369,	244,	128,	4602,	791,	205,
10,	13846,	6524,	5334,	1188,	698,	249,	79,	29,	822,	371,
11,	74015,	10658,	5128,	3596,	752,	425,	56,	16,	7,	376,
12,	5056,	56966,	8091,	3559,	2213,	280,	126,	16,	4,	3,
13,	5030,	3892,	41507,	5355,	2302,	980,	140,	31,	7,	1,
14,	6686,	3913,	2940,	27193,	3198,	991,	214,	39,	4,	4,
15,	2327,	5171,	2862,	1796,	16274,	1476,	196,	26,	10,	1,
+gp,	4117,	6834,	5918,	11413,	4140,	7024,	1235,	216,	49,	27,
0 TOTAL,	2111147,	935871,	2082239,	1812651,	852033,	785697,	335927,	113573,	111544,	44057,

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

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
0	2098	9074	127017	85007	29426	100187	50393	61332	124347	15393
1	1806	668	1668	51461	34155	11775	40609	20224	24812	50355
2	11279	478	47	657	20874	13864	4773	16472	8207	10064
3	79	4065	77	9	243	8476	5629	1921	6690	3325
4	83	51	3172	44	7	179	7080	4641	1626	5699
5	50	62	12	2497	36	5	104	5875	3881	1382
6	16	31	20	4	1922	22	4	86	4868	3277
7	31	10	4	4	1	1371	19	4	66	4086
8	15	16	3	1	2	1	1059	13	3	54
9	4	3	1	1	1	1	1	812	5	3
10	54	0	0	1	0	1	1	1	652	4
11	81	7	0	0	1	0	1	1	1	538
12	68	7	1	0	0	0	0	1	1	1
13	0	9	1	1	0	0	0	0	1	1
14	0	0	3	1	1	0	0	0	0	0
15	1	0	0	1	1	1	0	0	0	0
+gp	0	0	0	1	1	1	0	0	0	0
0 TOTAL	15664	14482	132026	139688	86671	135886	109675	111382	175161	94183

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

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
0	10919	23297	3692372	114045	453975	120696	140887	270905	790196	1447845
1	6216	4388	9333	1500424	46159	184397	48987	57195	110046	321226
2	20468	2520	1777	3766	610017	18686	74962	19877	23237	44730
3	4089	8248	1024	712	1516	246737	7578	30257	8025	9292
4	2803	3481	6971	851	572	1106	207367	6339	25459	6881
5	4851	2370	2923	5804	683	349	789	173837	5224	21879
6	1168	4096	1998	2428	4426	435	167	507	144524	4444
7	2745	985	3467	1662	1921	2610	232	111	349	121388
8	3370	2321	830	2921	1314	1109	1280	135	62	268
9	42	2824	1951	702	2370	625	270	843	61	46
10	2	33	2375	1636	538	1458	154	122	591	46
11	4	1	28	1976	1257	370	549	46	24	478
12	438	2	0	22	1641	796	140	431	14	8
13	1	368	2	0	19	951	88	49	339	6
14	1	0	316	0	0	17	95	16	17	289
15	0	0	0	264	0	0	14	18	0	13
+gp	0	0	0	0	90	35	0	0	0	24
0 TOTAL	57118	54937	3725366	1637215	1126496	580377	483558	560688	1108169	1978862

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

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST	AMST
AGE													
0	3786555	4238149	1116771	330724	92977	1227663	194076	25024	0	0	0	215776	835488
1	588643	1539498	1723093	454005	134460	37801	499131	78906	10174	0	0	81737	329860
2	130598	239304	625912	700556	184584	54667	15369	202931	32081	4136	0	25651	124401
3	18090	53077	97285	254432	284775	75039	22040	6114	81995	13012	1593	8333	48853
4	7825	15492	45567	83471	218691	244574	64269	17762	4612	69298	10422	6032	40990
5	5898	6709	13027	38230	70824	185018	203895	52807	13046	3638	54457	4138	33732
6	18722	5063	5729	10405	29536	55193	144703	158870	42041	9981	2808	2767	27301
7	3724	15978	4347	4851	7431	19529	38809	106105	120451	32210	7566	1778	19901
8	102383	3124	13641	3708	4031	4265	13055	26369	79632	88826	23981	1119	13655
9	219	86094	2635	11467	3116	3326	2716	8222	19167	57772	64436	673	10721
10	25	165	72010	2096	9524	2535	2810	1776	5875	13803	40065	434	8982
11	21	18	119	58182	1474	7551	2113	2233	1136	4077	9874	283	7451
12	389	17	9	103	44105	501	5888	1519	1687	843	2847	178	6800
13	1	329	13	8	62	29536	270	4230	1276	1083	575	101	6324
14	3	0	271	11	3	16	17703	58	2602	1031	722	53	4824
15	244	0	0	233	8	0	14	11815	0	1423	672	30	4128
+gp	5	0	0	0	0	0	0	0	5643	1541	1888		
TOTAL	4663345	6203015	3720431	1952480	1085600	1947217	1226861	704743	421418	302674	221908		

1

Table 3.5.6.3

Run title : Herring spring-spawn (run: SVPBJA12/V12) At
23/04/2001 11:44
Traditional vpa using screen input for terminal F

YEAR,	1950,
AGE	
0,	74737,
1,	20989,
2,	66837,
3,	108558,
4,	81936,
5,	114323,
6,	219285,
7,	219789,
8,	56926,
9,	85474,
10,	100863,
11,	83905,
12,	185821,
13,	208988,
14,	32827,
15,	92923,
+gp,	207790,
0 TOTALBIO,	1961972,

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

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
AGE										
0,	14391,	9390,	8358,	3970,	2375,	2747,	2365,	2781,	40534,	19134,
1,	240568,	46001,	23894,	24396,	7836,	5244,	6356,	5292,	4511,	123056,
2,	44389,	552634,	83883,	42731,	38396,	10726,	6910,	6234,	5047,	5308,
3,	54134,	35944,	470458,	68991,	31748,	30092,	5554,	4649,	1618,	2442,
4,	185391,	94927,	62369,	812060,	110983,	54252,	33756,	9311,	7832,	2555,
5,	75574,	171727,	90828,	59530,	701456,	106781,	46624,	43345,	9482,	8252,
6,	104712,	68046,	149653,	84290,	54480,	658633,	94478,	47236,	37412,	8726,
7,	189613,	93007,	59690,	129854,	72230,	46685,	534524,	87831,	37980,	32312,
8,	182615,	158259,	78927,	51977,	104703,	60469,	39420,	460663,	71477,	32772,
9,	49285,	148313,	132523,	68313,	43434,	87023,	48982,	33650,	385239,	58128,
10,	73395,	41561,	120818,	108642,	54899,	36121,	69653,	39829,	27850,	315187,
11,	86272,	62687,	34524,	95412,	83235,	42936,	28146,	57231,	31669,	23357,
12,	70672,	72246,	52166,	28286,	69326,	63717,	31472,	22562,	43124,	25257,
13,	158658,	59283,	60675,	43388,	22302,	55083,	47924,	24451,	16315,	34841,
14,	170756,	130466,	48363,	49985,	34680,	17603,	42893,	37841,	18574,	12553,
15,	27421,	142548,	111573,	40366,	40685,	28485,	13788,	34139,	30517,	14692,
+gp,	177966,	172778,	268794,	217113,	188878,	153848,	102182,	92867,	54738,	38387,
0 TOTALBIO,	1905812,	2059817,	1857495,	1929304,	1661649,	1460445,	1155027,	1009911,	823918,	756960,

1

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
0,	7328,	1771,	16464,	9056,	793,	4535,	358,	464,	961,	62,
1,	55928,	20804,	3988,	51187,	27680,	1489,	12833,	958,	678,	2850,
2,	254985,	88390,	38094,	3777,	114396,	55302,	1732,	5262,	1087,	308,
3,	2291,	202893,	70081,	20760,	1959,	81610,	37672,	1075,	2275,	164,
4,	2283,	3685,	291492,	103368,	31261,	1590,	92389,	22540,	43,	532,
5,	2275,	2247,	3477,	272374,	83911,	26492,	1121,	29718,	256,	68,
6,	6922,	2235,	1869,	2993,	215104,	68842,	16450,	477,	300,	164,
7,	7112,	6008,	1793,	1682,	2208,	144762,	39622,	3905,	76,	154,
8,	26148,	5986,	4769,	1675,	1607,	1685,	69240,	6428,	1113,	49,
9,	26191,	22275,	4839,	3807,	1292,	863,	416,	13116,	2435,	662,
10,	44585,	21854,	17816,	4145,	2583,	940,	331,	102,	2614,	1207,
11,	237588,	36024,	17486,	12729,	2706,	1660,	241,	52,	23,	1238,
12,	17392,	190266,	28236,	12704,	8363,	1061,	460,	59,	13,	12,
13,	17957,	13504,	141538,	19225,	8908,	3706,	514,	125,	24,	5,
14,	24268,	13851,	10527,	99253,	12471,	3576,	926,	151,	15,	15,
15,	8492,	18513,	10732,	7221,	64121,	5655,	811,	97,	39,	5,
+gp,	15234,	24467,	22192,	45879,	16313,	26900,	5113,	818,	193,	104,
0 TOTALBIO,	756978,	674773,	685393,	671834,	595675,	430668,	280231,	85347,	12145,	7599,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
0,	21,	91,	1270,	850,	294,	1002,	504,	613,	1243,	154,
1,	271,	67,	167,	5146,	3416,	1178,	4061,	2022,	2481,	5036,
2,	9023,	334,	40,	558,	17743,	11785,	4057,	14002,	6976,	8555,
3,	79,	6098,	130,	16,	440,	15341,	10189,	3458,	11908,	5819,
4,	157,	76,	8215,	114,	18,	463,	18337,	13643,	3772,	16128,
5,	112,	87,	41,	8538,	122,	17,	356,	19153,	13934,	4795,
6,	40,	66,	78,	17,	7381,	85,	16,	320,	18744,	13174,
7,	85,	25,	18,	16,	6,	5606,	78,	15,	278,	17204,
8,	43,	44,	10,	6,	7,	5,	4700,	58,	14,	251,
9,	13,	8,	3,	3,	5,	6,	5,	3863,	26,	12,
10,	176,	1,	2,	3,	2,	5,	6,	5,	3390,	23,
11,	271,	22,	1,	2,	3,	2,	4,	5,	4,	2871,
12,	236,	25,	6,	1,	1,	2,	2,	3,	4,	3,
13,	0,	33,	4,	5,	1,	1,	2,	1,	3,	3,
14,	1,	0,	13,	3,	4,	1,	1,	2,	1,	2,
15,	6,	0,	0,	3,	3,	4,	0,	1,	1,	1,
+gp,	0,	0,	0,	3,	3,	4,	0,	1,	1,	1,
0 TOTALBIO,	10532,	6977,	10000,	15283,	29448,	35506,	42318,	57164,	62781,	74033,

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
0,	109,	233,	36924,	1140,	4540,	1207,	1409,	2709,	7902,	14478,
1,	622,	439,	933,	150042,	4616,	18440,	4899,	8579,	16507,	25698,
2,	17398,	2142,	1511,	3201,	140304,	15883,	41229,	9939,	23237,	21470,
3,	6952,	14022,	1586,	997,	2243,	133238,	6820,	29652,	12359,	20350,
4,	6278,	7102,	17359,	1737,	1337,	2278,	296535,	8558,	44553,	13624,
5,	16301,	7180,	8886,	17122,	1810,	925,	1901,	342458,	10918,	56448,
6,	4416,	14541,	7352,	8206,	13809,	1258,	466,	1403,	364199,	12799,
7,	10623,	3773,	14008,	6250,	6647,	8848,	694,	350,	1064,	375088,
8,	13752,	9167,	3519,	11539,	4861,	4082,	4045,	456,	227,	1147,
9,	168,	11664,	8524,	2858,	9361,	2443,	924,	2892,	230,	170,
10,	11,	151,	10354,	6758,	2135,	5570,	529,	439,	2121,	186,
11,	20,	4,	136,	8339,	5380,	1437,	1986,	167,	96,	1850,
12,	2242,	11,	2,	98,	7023,	3143,	527,	1619,	54,	37,
13,	3,	1862,	8,	0,	82,	3757,	329,	183,	1344,	24,
14,	3,	2,	1562,	0,	0,	65,	359,	61,	69,	1273,
15,	2,	2,	2,	1152,	0,	0,	54,	69,	0,	55,
+gp,	2,	2,	2,	1,	383,	137,	0,	0,	0,	105,
0 TOTALBIO,	78902,	72299,	112668,	219441,	204531,	202712,	362705,	409535,	484882,	544803,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
0,	37866,	42381,	11168,	3307,	930,	12277,	1941,	250,	0,	0,
1,	64751,	107765,	137847,	45400,	24203,	6804,	89844,	14203,	1831,	0,
2,	48321,	71791,	156478,	175139,	46146,	13667,	3842,	50733,	8020,	1034,
3,	26592,	67938,	78801,	190824,	187952,	57030,	21159,	4525,	83635,	15484,
4,	16433,	34702,	91590,	126041,	301793,	288598,	75837,	26110,	6918,	123351,
5,	14390,	19860,	34522,	97103,	162895,	347834,	354778,	91883,	29093,	8185,
6,	56165,	16556,	18504,	33087,	87427,	144055,	331370,	344749,	100897,	27049,
7,	12067,	56721,	15388,	17996,	25713,	61713,	110995,	256775,	317991,	91799,
8,	344005,	10776,	48835,	12865,	15639,	14757,	42168,	73305,	225360,	264701,
9,	750,	315964,	10040,	47243,	11310,	12438,	10050,	24996,	60377,	179671,
10,	97,	563,	265719,	8005,	38951,	9886,	10621,	5504,	20269,	46791,
11,	77,	64,	472,	236800,	6102,	29450,	8158,	8017,	4384,	15900,
12,	1654,	74,	37,	421,	186123,	1925,	21195,	5166,	6514,	3356,
13,	6,	1544,	47,	33,	255,	117553,	1059,	14552,	4924,	4396,
14,	13,	1,	1093,	44,	11,	65,	69218,	222,	9939,	4269,
15,	1035,	2,	1,	957,	34,	0,	55,	42890,	0,	6004,
+gp,	19,	2,	1,	0,	0,	0,	0,	0,	22967,	6643,
0 TOTALBIO,	624242,	746704,	870541,	995267,	1095484,	1118051,	1152289,	963881,	903118,	798633,

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Table 3.5.6.4.

Run title : Herring spring-spawn (run: SVPBJA12/V12)
At 23/04/2001 11:44
Traditional vpa using screen input for terminal F

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

YEAR,	1950,
AGE	
0,	0,
1,	0,
2,	0,
3,	0,
4,	8031,
5,	33648,
6,	128696,
7,	193150,
8,	55829,
9,	83911,
10,	98989,
11,	82351,
12,	182362,
13,	204510,
14,	32087,
15,	91121,
+gp,	203759,
0 TOTSPBIO,	1398444,

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

YEAR,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,	1959,	1960,
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,	0,	0,	0,	2494,	2361,	0,	365,	126,	178,
4,	18178,	9338,	6134,	79681,	23924,	11632,	0,	2009,	1684,	544,
5,	22205,	50293,	26768,	17486,	253913,	38627,	22772,	15690,	3429,	2977,
6,	61620,	39993,	87861,	49424,	45343,	545487,	55460,	39312,	30965,	7240,
7,	166707,	81908,	52702,	113774,	70581,	45659,	520777,	85895,	37046,	31519,
8,	177955,	154693,	77404,	50795,	102268,	58910,	38606,	450687,	69608,	32026,
9,	48296,	144835,	129497,	66621,	42503,	84833,	47824,	32913,	375776,	56536,
10,	72021,	40670,	117631,	105456,	53399,	35121,	67982,	38804,	27125,	306308,
11,	84626,	61452,	33791,	92272,	80917,	41559,	27406,	55634,	30741,	22678,
12,	69234,	70784,	51061,	27539,	67548,	61743,	30551,	21842,	41734,	24355,
13,	155357,	58003,	59424,	42365,	21749,	53644,	46643,	23788,	15722,	33668,
14,	166896,	127825,	47269,	48731,	33841,	17096,	41747,	37004,	17993,	12118,
15,	26825,	139410,	109056,	39250,	39664,	27700,	13447,	33356,	29726,	14274,
+gp,	174098,	168975,	262730,	211109,	184134,	149608,	99659,	90738,	53319,	37294,
0 TOTSPBIO,	1244019,	1148177,	1061326,	944504,	1022278,	1173981,	1012876,	928037,	734992,	581715,

1

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
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,	89,	0,	2727,	407,	0,	779,	0,	0,	1133,	9,
4,	780,	397,	8564,	6059,	10285,	226,	814,	0,	37,	59,
5,	1516,	1476,	1091,	73726,	28480,	24745,	233,	183,	222,	20,
6,	6364,	2178,	1652,	931,	156291,	61324,	14215,	298,	278,	26,
7,	6942,	5847,	1754,	1652,	2114,	132254,	32985,	3408,	72,	136,
8,	25553,	5854,	4630,	1638,	1514,	1457,	58810,	5766,	1051,	43,
9,	25627,	21730,	4734,	3645,	1243,	771,	358,	11041,	2258,	580,
10,	43433,	21334,	17127,	3959,	2458,	810,	282,	88,	2418,	1036,
11,	231448,	35044,	16859,	12126,	2452,	1470,	213,	45,	22,	1044,
12,	16943,	184337,	27095,	12162,	7710,	990,	400,	54,	12,	8,
13,	17512,	13130,	135677,	18259,	8188,	3183,	453,	101,	23,	4,
14,	23653,	13425,	10021,	94286,	11543,	3041,	749,	131,	13,	13,
15,	8278,	17972,	10304,	6890,	59367,	4947,	690,	83,	36,	5,
+gp,	14849,	23752,	21307,	43775,	15103,	23531,	4345,	703,	180,	89,
0 TOTSPBIO,	422987,	346478,	263541,	279513,	306746,	259527,	114547,	21901,	7754,	3072,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
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,	3,	51,	1621,	1077,	0,	0,	0,	0,
3,	8,	0,	62,	8,	213,	7534,	7296,	442,	1172,	1430,
4,	38,	7,	7218,	100,	18,	395,	16018,	12061,	2301,	7935,
5,	64,	19,	37,	8318,	116,	16,	350,	18796,	13015,	4574,
6,	34,	32,	66,	15,	7135,	84,	16,	312,	18418,	12943,
7,	80,	19,	16,	14,	6,	5463,	75,	14,	273,	16876,
8,	36,	32,	9,	5,	7,	5,	4577,	53,	13,	245,
9,	10,	6,	3,	3,	5,	6,	5,	3779,	25,	12,
10,	143,	1,	2,	3,	2,	5,	6,	4,	3326,	22,
11,	212,	19,	1,	2,	3,	2,	4,	5,	4,	2813,
12,	193,	20,	6,	1,	1,	2,	2,	3,	4,	3,
13,	0,	29,	4,	5,	1,	1,	2,	1,	3,	3,
14,	1,	0,	12,	3,	4,	1,	1,	2,	1,	2,
15,	5,	0,	0,	3,	3,	4,	0,	1,	1,	1,
+gp,	0,	0,	0,	3,	3,	4,	0,	1,	1,	1,
0 TOTSPBIO,	823,	185,	7440,	8534,	9138,	14598,	28351,	35475,	38558,	46861,

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
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,	2052,	1379,	156,	98,	217,	13094,	670,	2914,	1217,	8001,
4,	3087,	3350,	8522,	850,	637,	440,	87405,	2518,	13165,	10732,
5,	14424,	4941,	6019,	14997,	1557,	773,	1637,	302573,	9669,	50018,
6,	4342,	14300,	5125,	7615,	13099,	1182,	447,	1352,	357901,	11317,
7,	10446,	3709,	13770,	6105,	6292,	8240,	657,	331,	1036,	331880,
8,	13511,	9009,	3460,	11300,	4513,	3545,	3880,	422,	220,	1124,
9,	164,	11464,	8375,	2783,	8917,	2124,	854,	2791,	224,	160,
10,	10,	148,	10166,	6582,	2056,	5051,	469,	373,	2077,	172,
11,	19,	4,	133,	8186,	5140,	1304,	1938,	148,	87,	1812,
12,	2203,	11,	2,	96,	6650,	2521,	474,	1581,	50,	31,
13,	3,	1834,	5,	0,	81,	2985,	278,	166,	1323,	23,
14,	3,	2,	1534,	0,	0,	64,	304,	38,	67,	1251,
15,	2,	2,	2,	1127,	0,	0,	51,	65,	0,	54,
+gp,	2,	2,	2,	1,	364,	118,	0,	0,	0,	102,
0 TOTSPBIO,	50269,	50156,	57271,	59740,	49523,	41441,	99064,	315271,	387035,	416677,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
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,	2618,	6691,	776,	1880,	0,	0,	0,	0,	0,	0,
4,	11327,	6821,	26999,	37196,	89037,	85019,	22309,	7595,	2027,	36124,
5,	14172,	15639,	27004,	75704,	127107,	305451,	311432,	80831,	25492,	7178,
6,	55282,	16306,	18198,	31992,	83884,	139069,	321247,	335336,	98245,	26310,
7,	11857,	55831,	15145,	17666,	24324,	59277,	106787,	249510,	308452,	89130,
8,	338096,	10594,	47994,	12643,	15342,	14106,	40263,	71004,	218242,	256339,
9,	729,	310370,	9813,	46373,	11079,	12230,	9632,	24170,	58427,	173214,
10,	94,	545,	260112,	7728,	38058,	9708,	10380,	5264,	19542,	45250,
11,	76,	60,	465,	230331,	5479,	28726,	7893,	7795,	4256,	15339,
12,	1626,	72,	36,	400,	178808,	1809,	20506,	5076,	6231,	3230,
13,	5,	1515,	46,	29,	223,	111687,	908,	13862,	4820,	4221,
14,	11,	1,	1077,	43,	7,	64,	66475,	116,	9357,	4090,
15,	1017,	2,	1,	934,	34,	0,	53,	41814,	0,	5739,
+gp,	19,	2,	1,	0,	0,	0,	0,	0,	22333,	6350,
0 TOTSPBIO,	436929,	424448,	407667,	462920,	573379,	767146,	917884,	842373,	777423,	672515,

Table 3.5.6.5 VPA Summary table

Run title : Herring spring-spawn (run: SVPBJA12/V12) ,
At 23/04/2001 11:44
Traditional vpa using screen input for terminal F

Table 16 Summary (without SOP correction)

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 2-13,
1950,	747374656,	19619720,	13984440,	933000,	.0667,	.0502,
1951,	143907888,	19058122,	12440190,	1278400,	.1028,	.0549,
1952,	93898752,	20598168,	11481773,	1254800,	.1093,	.0550,
1953,	83577056,	18574948,	10613262,	1090600,	.1028,	.0543,
1954,	39702936,	19293042,	9445040,	1644500,	.1741,	.1011,
1955,	23753764,	16616486,	10222784,	1359800,	.1330,	.0848,
1956,	27474770,	14604452,	11739808,	1659400,	.1413,	.1436,
1957,	23650588,	11550268,	10128764,	1319500,	.1303,	.1135,
1958,	27810502,	10099109,	9280374,	986600,	.1063,	.1812,
1959,	405342656,	8239182,	7349922,	1111100,	.1512,	.1609,
1960,	191338608,	7569599,	5817149,	1101800,	.1894,	.2344,
1961,	73282680,	7569780,	4229869,	830100,	.1962,	.0943,
1962,	17712448,	6747726,	3464778,	848600,	.2449,	.1000,
1963,	164640160,	6853931,	2635414,	984500,	.3736,	.1666,
1964,	90556040,	6718337,	2795131,	1281800,	.4586,	.2223,
1965,	7932618,	5956750,	3067464,	1547700,	.5046,	.4180,
1966,	45349292,	4306677,	2595274,	1955000,	.7533,	.7882,
1967,	3582245,	2802309,	1145466,	1677200,	1.4642,	1.1292,
1968,	4638550,	853466,	219013,	712200,	3.2519,	2.0013,
1969,	9607348,	121451,	77541,	67800,	.8744,	.7761,
1970,	620670,	75989,	30718,	62300,	2.0281,	1.3453,
1971,	209800,	105320,	8231,	21100,	2.5633,	1.0042,
1972,	907351,	69767,	1854,	13161,	7.0991,	1.3166,
1973,	12701698,	100002,	74400,	7017,	.0943,	.5138,
1974,	8500675,	152834,	85341,	7619,	.0893,	.1897,
1975,	2942588,	294481,	91377,	13713,	.1501,	.0925,
1976,	10018746,	355060,	145980,	10436,	.0715,	.0557,
1977,	5039343,	423184,	283511,	22706,	.0801,	.0507,
1978,	6133163,	571644,	354752,	19824,	.0559,	.0916,
1979,	12434718,	627810,	385577,	12864,	.0334,	.0184,
1980,	1539331,	740332,	468611,	18577,	.0396,	.0280,
1981,	1091881,	789022,	502691,	13736,	.0273,	.1122,
1982,	2329740,	722993,	501560,	16655,	.0332,	.0783,
1983,	369237184,	1126681,	572712,	23054,	.0403,	.4869,
1984,	11404527,	2194407,	597396,	53532,	.0896,	.0884,
1985,	45397528,	2045312,	495227,	169872,	.3430,	.2872,
1986,	12069644,	2027118,	414411,	225256,	.5436,	.8509,
1987,	14088709,	3627047,	990639,	127306,	.1285,	.4591,
1988,	27090502,	4095353,	3152713,	135301,	.0429,	.4253,
1989,	79019632,	4848824,	3870353,	103830,	.0268,	.1825,
1990,	144784448,	5448030,	4166772,	86411,	.0207,	.2805,
1991,	378655488,	6242422,	4369287,	84683,	.0194,	.1759,
1992,	423814880,	7467039,	4244479,	104448,	.0246,	.0806,
1993,	111677088,	8705414,	4076670,	232457,	.0570,	.0248,
1994,	33072388,	9952670,	4629204,	479228,	.1035,	.1690,
1995,	9297654,	10954838,	5733795,	905501,	.1579,	.2777,
1996,	122766304,	11180512,	7671458,	1220283,	.1591,	.1566,
1997,	19407624,	11522893,	9178836,	1426507,	.1554,	.2541,
1998,	2502430,	9638809,	8423728,	1223131,	.1452,	.1485,
1999,	0,	9031180,	7774226,	1235433,	.1589,	.1305,
2000,	0,	7986328,	6725150,	1207201,	.1795,	.1555,
Arith. Mean ,	80272339,	6487781,	4171669,	645638,	.4763,	.3228,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 3.5.6.6 Summary of unweighted and weighted fishing mortalities.

Year	FBAR 5-14	FWEI 5-14
1950	0.0536	0.0584
1951	0.0623	0.0696
1952	0.0673	0.0728
1953	0.0646	0.0663
1954	0.1083	0.1124
1955	0.0928	0.0783
1956	0.1202	0.1099
1957	0.1009	0.1026
1958	0.0959	0.0787
1959	0.1333	0.1129
1960	0.1393	0.1359
1961	0.0904	0.1046
1962	0.1121	0.1458
1963	0.1697	0.2525
1964	0.2374	0.2271
1965	0.4594	0.2803
1966	0.9968	0.7002
1967	1.3567	1.5170
1968	1.6790	3.4499
1969	0.6100	0.5949
1970	1.3720	1.3229
1971	1.4277	1.5170
1972	1.3811	1.4873
1973	0.6185	1.1720
1974	0.2015	0.1137
1975	0.0741	0.1899
1976	0.0333	0.1060
1977	0.0582	0.1106
1978	0.1088	0.0439
1979	0.0242	0.0241
1980	0.0327	0.0345
1981	0.1327	0.0217
1982	0.0920	0.0202
1983	0.5791	0.0294
1984	0.1151	0.0910
1985	0.3436	0.3793
1986	0.9997	1.0613
1987	0.6946	0.3985
1988	0.9747	0.0388
1989	0.2342	0.0247
1990	0.3357	0.0190
1991	0.4055	0.0206
1992	0.0990	0.0236
1993	0.0268	0.0554
1994	0.2113	0.1131
1995	0.7342	0.1851
1996	0.1834	0.1526
1997	0.3169	0.1482
1998	0.7819	0.1310
1999	0.1911	0.1578
2000	0.1927	0.1790

Range of ages 5-14.

Table 3.6.2.1 Norwegian spring-spawning herring. Short term prediction.

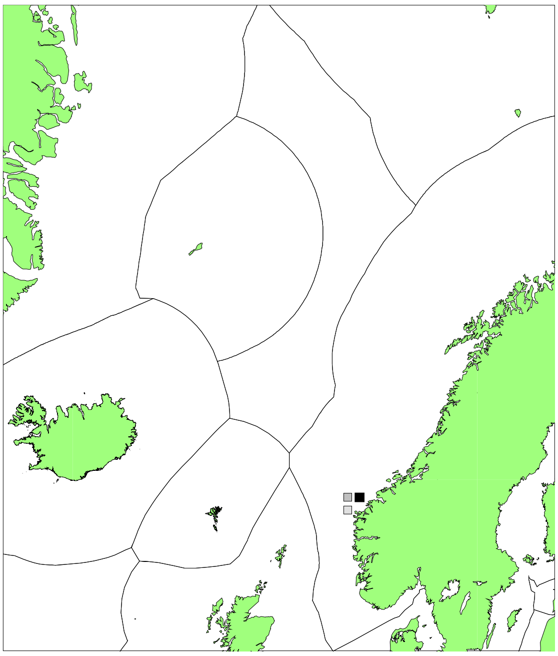
Table includes number (million) at age 1 Jan 2001 and weight at age used for 2001 and 2002.

MFDP version 1
Run: final
Herring spring-spawn
Time and date: 10:52 25.04.01
Fbar age range: 0-16
Input units are millions and kg - output in kilotonnes

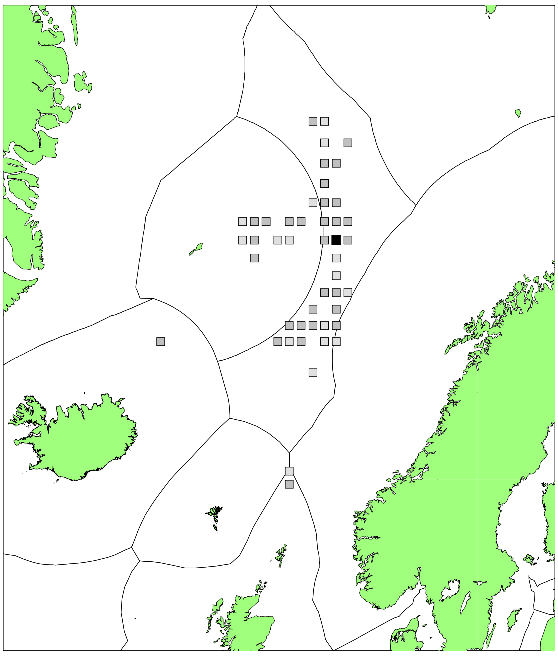
	Input 2001		2001					2002					2003	
age	N	W	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
0	0	0.001	9045	6106	0.06	0.158	850	9853	6420	0.00	0.0000	0	10875	8523
1	6071	0.018							6409	0.03	0.0079	49	10830	8479
2	51442	0.025							6397	0.06	0.0157	98	10784	8435
3	15801	0.075							6386	0.09	0.0236	146	10739	8392
4	1042	0.178							6375	0.12	0.0314	195	10694	8348
5	5446	0.238							6363	0.15	0.0393	242	10650	8305
6	281	0.247							6352	0.18	0.0471	290	10605	8262
7	757	0.296							6341	0.21	0.0550	337	10561	8220
8	2398	0.307							6329	0.24	0.0628	385	10517	8178
9	6444	0.314							6318	0.27	0.0707	431	10474	8136
10	4007	0.328							6307	0.30	0.0785	478	10431	8094
11	987	0.351							6295	0.33	0.0864	524	10387	8053
12	285	0.376							6284	0.36	0.0942	570	10345	8012
13	58	0.406							6273	0.39	0.1021	616	10302	7971
14	72	0.414							6262	0.42	0.1099	662	10260	7931
15	67	0.425							6251	0.45	0.1178	707	10218	7890
16	189	0.425							6240	0.48	0.1256	752	10176	7850
									6229	0.51	0.1335	797	10134	7811
									6218	0.54	0.1413	842	10093	7771
									6207	0.57	0.1492	886	10051	7732
									6196	0.60	0.1571	930	10010	7693

Table 3.10.1. Average yield, probability of falling below Bpa/Blim and average annual percentage change in catch for Norwegian spring spawning herring, 5 and 10 year periods.

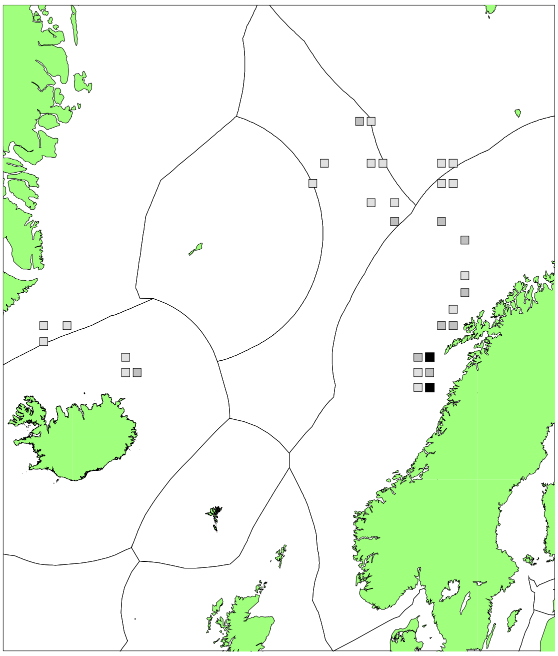
		5 Years				10 years			
	Catch limit	Yield	RiskBlim	RiskBpa	Stability	Yield	RiskBlim	RiskBpa	Stability
F = 0.	1.50	0.17	0.00	0.00	0.25	0.08	0.00	0.00	0.11
F = 0.05	1.50	0.70	0.00	0.00	0.18	0.74	0.00	0.00	0.11
F = 0.08	1.50	0.95	0.00	0.00	0.14	1.01	0.00	0.02	0.09
F = 0.1	1.50	1.07	0.00	0.00	0.15	1.12	0.00	0.03	0.09
F = 0.125	1.50	1.18	0.00	0.00	0.17	1.21	0.00	0.07	0.09
F = 0.15	1.50	1.24	0.00	0.00	0.19	1.26	0.00	0.10	0.09
F = 0.2	1.50	1.32	0.00	0.02	0.19	1.34	0.00	0.13	0.08
F = 0.125	0.85	0.84	0.00	0.00	0.00	0.84	0.00	0.04	0.00



Q1



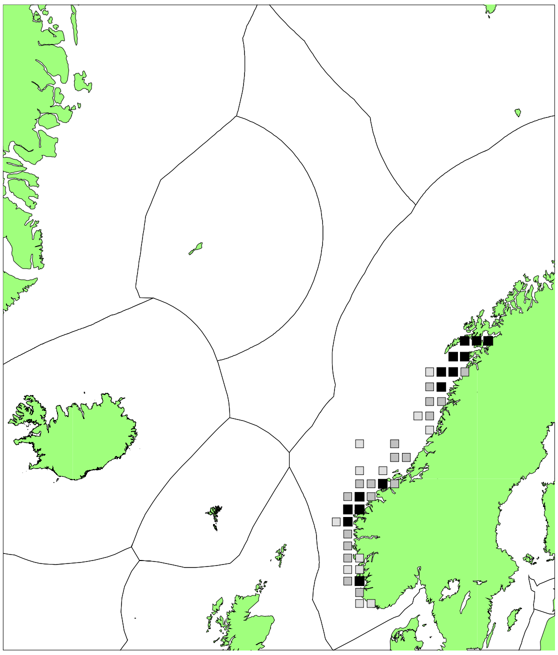
Q2



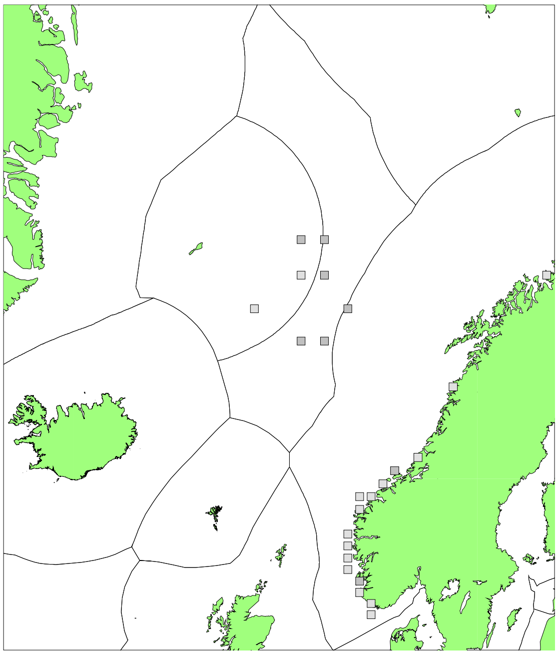
Q3

Q4 – no catches

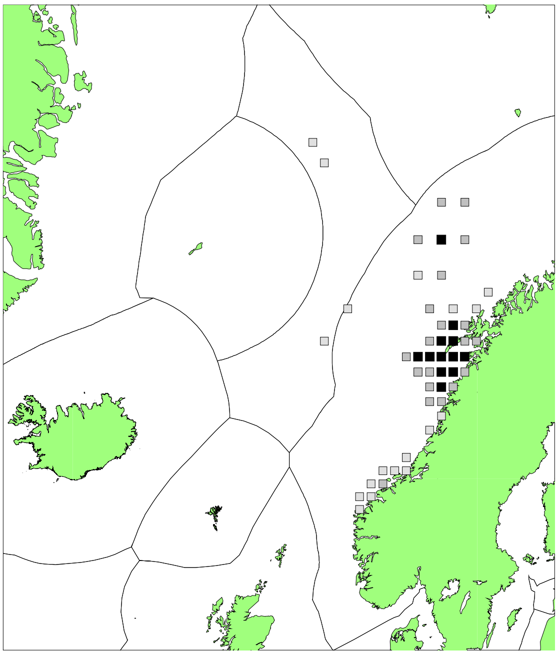
Figure 3.1.2.1.1. Faroese catches of Norwegian spring spawning herring in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-300 t, grey 300-3 000 t, and black > 3 000 t.



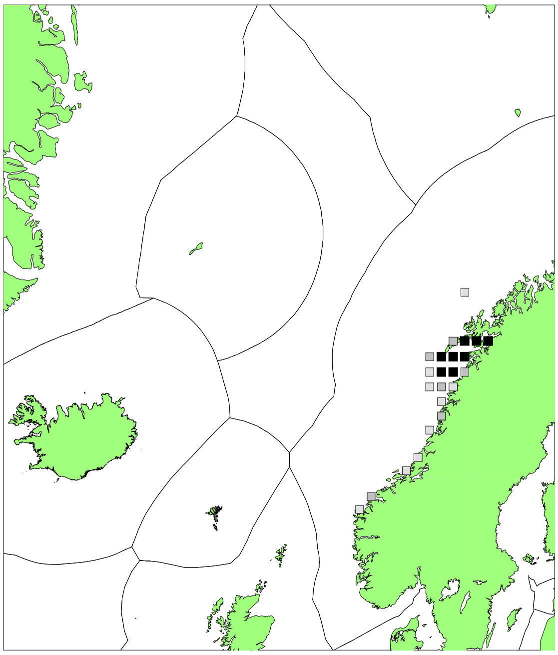
Q1



Q2

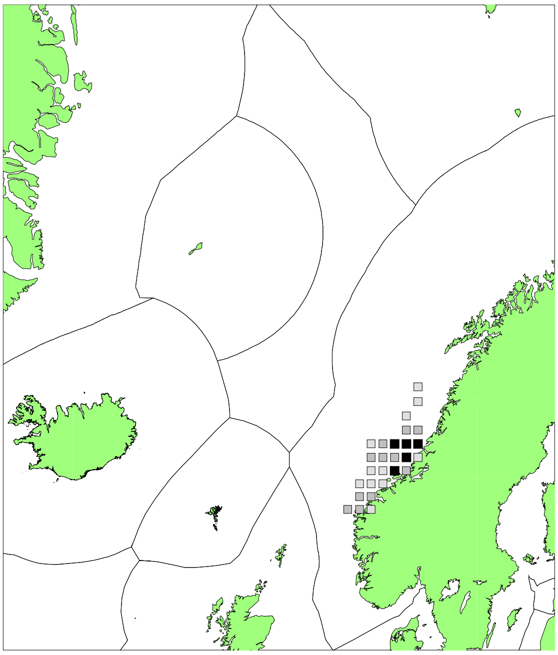


Q3

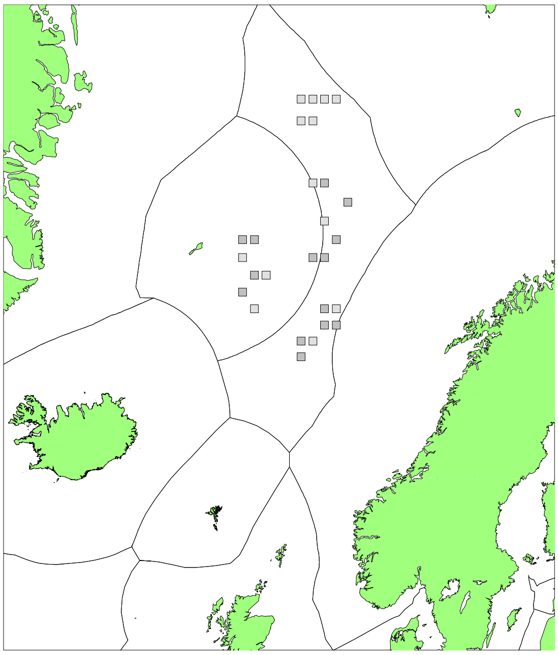


Q4

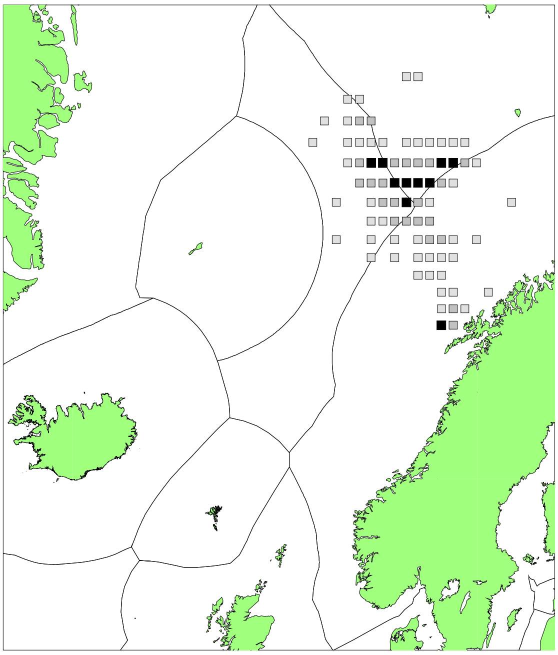
Figure 3.1.2.1.2. Norwegian catches of Norwegian spring spawning herring in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-300 t, grey 300-3 000 t, and black > 3 000 t.



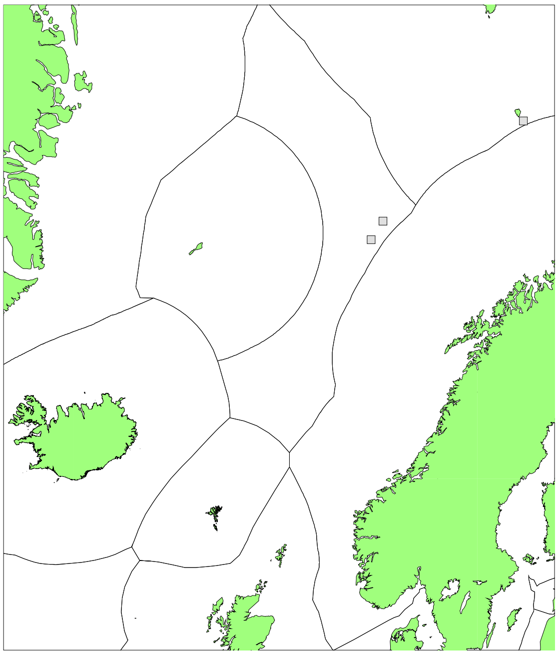
Q1



Q2

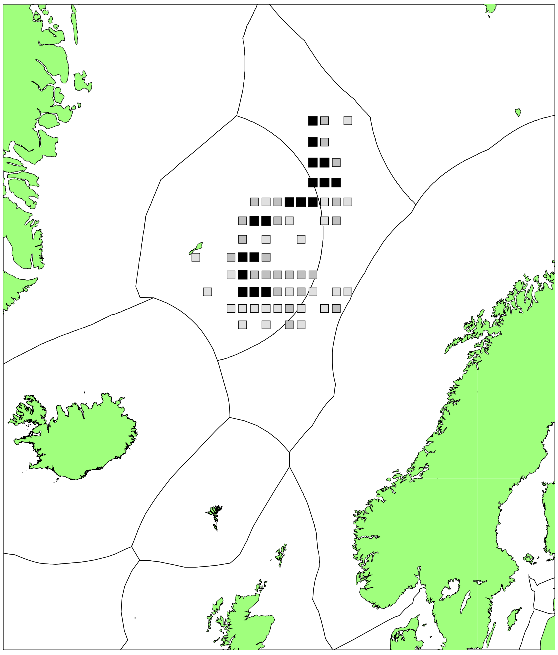


Q3



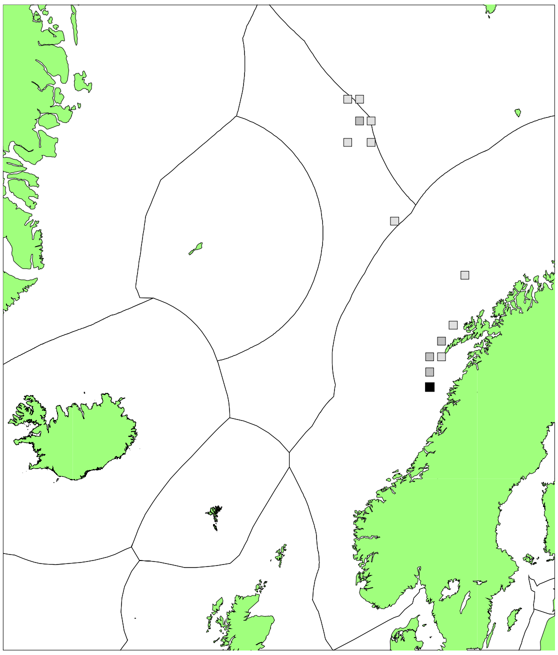
Q4

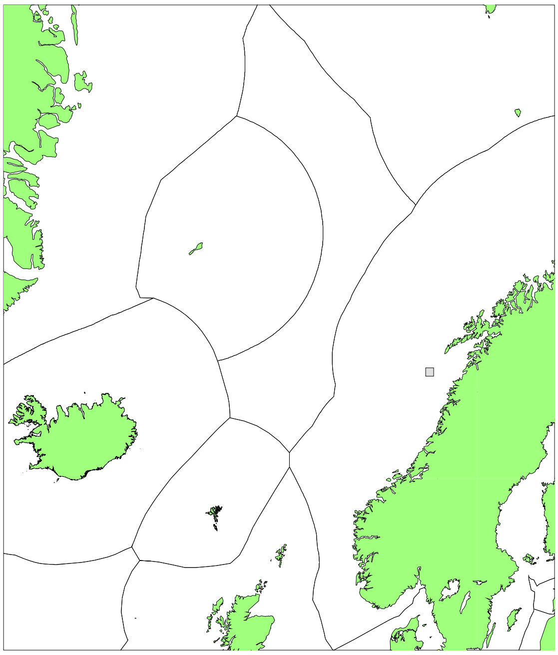
Figure 3.1.2.1.3. Russian catches of Norwegian spring spawning herring in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-300 t, grey 300-3 000 t, and black > 3 000 t.



Q1 – no catches

Q2

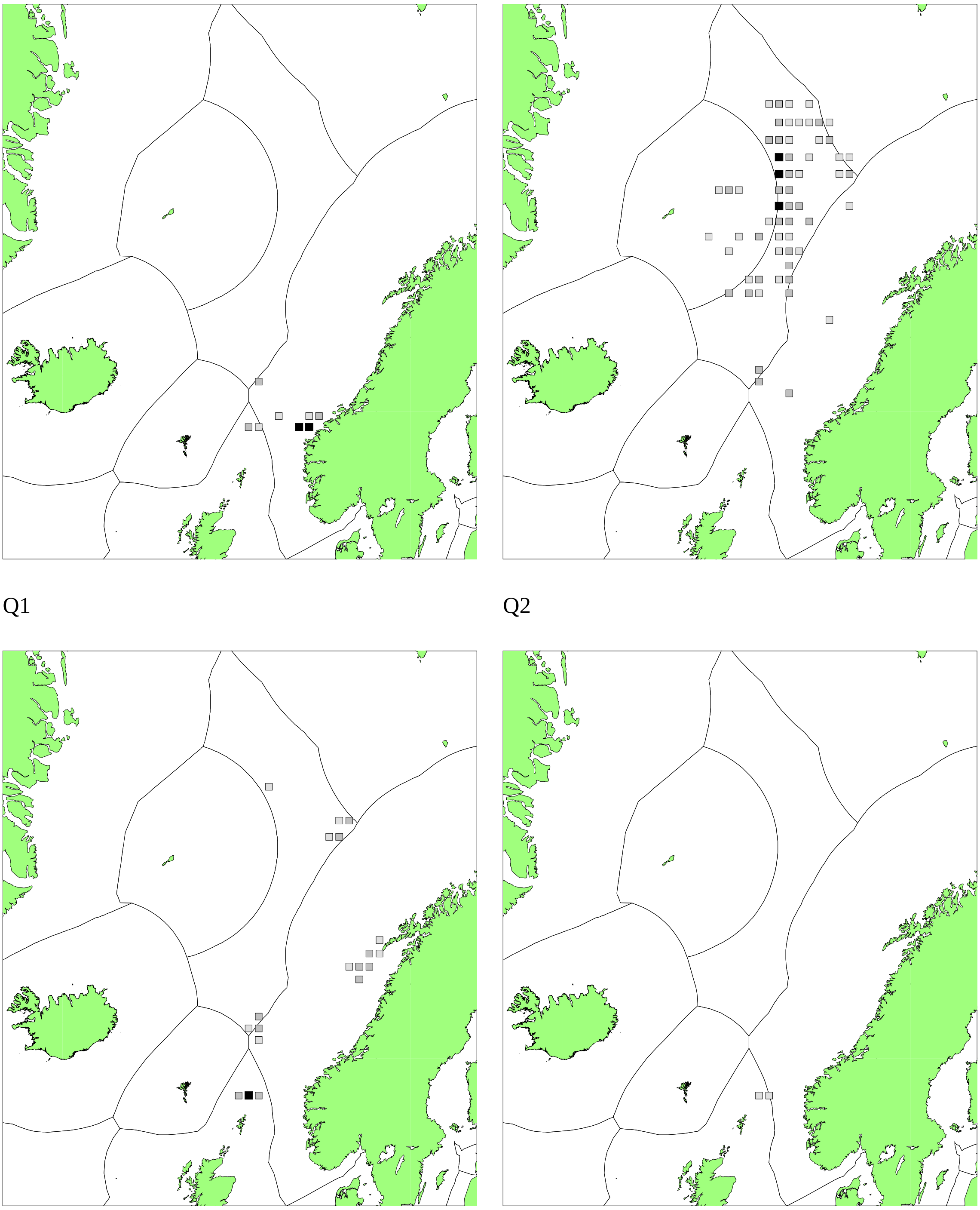




Q3

Q4

Figure 3.1.2.1.4. Icelandic catches of Norwegian spring spawning herring in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-300 t, grey 300-3 000 t, and black > 3 000 t.



Q1 Q2 Q3 Q4

Figure 3.1.2.1.5. EU catches of Norwegian spring spawning herring in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-300 t, grey 300-3 000 t, and black > 3 000 t.

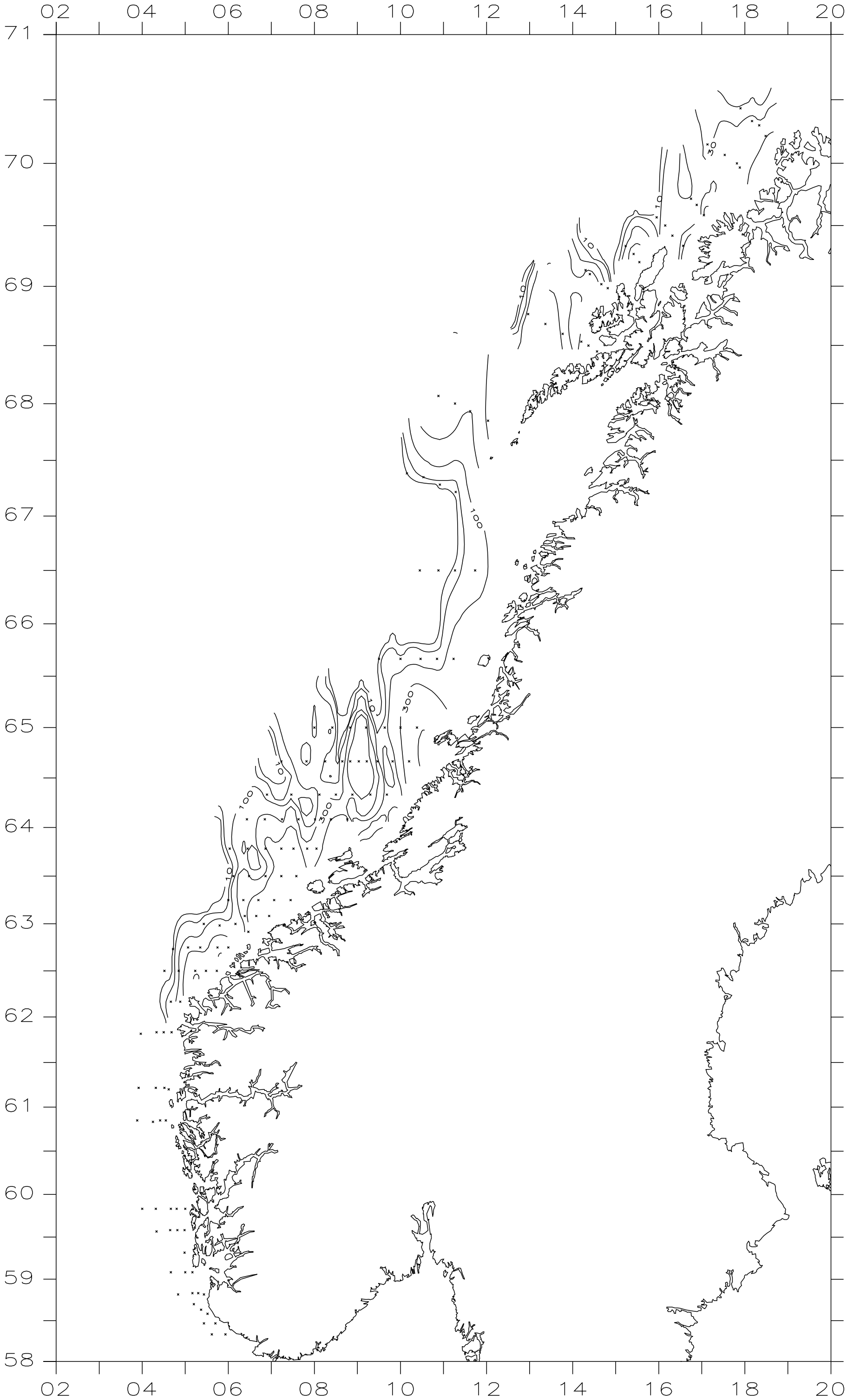


Figure 3.3.5.1 Herring larvae distribution in April 2001.

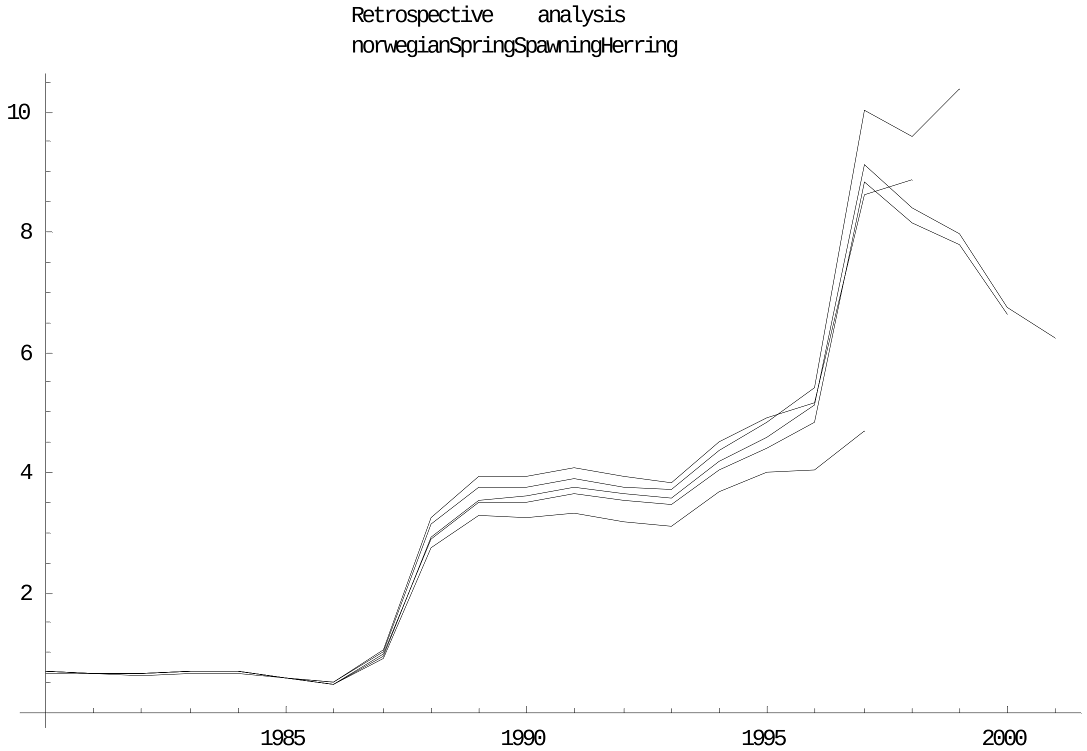


Figure 3.5.1. Retrospective analysis of Norwegian spring spawning herring, spawning stock biomass (million t).

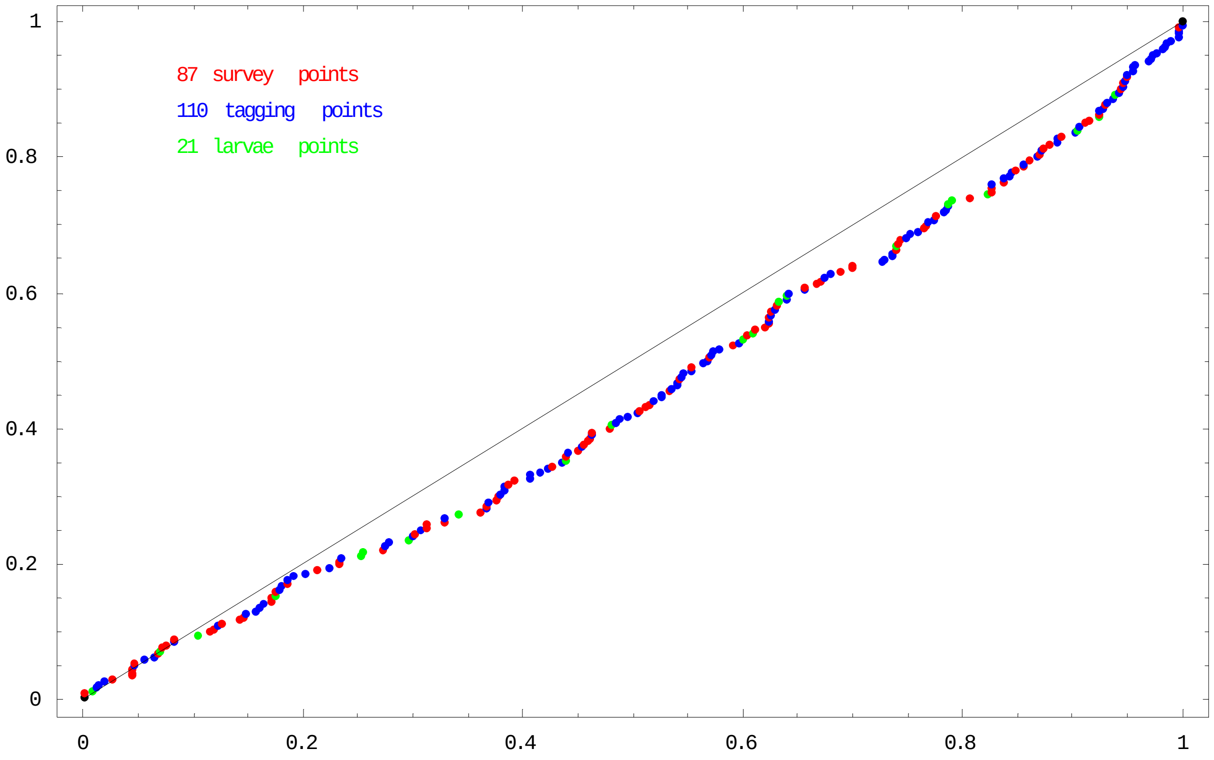


Figure 3.5.2. Quantile-quantile plot for terms in the likelihood for Norwegian spring spawning herring. Explanation is given in the text.

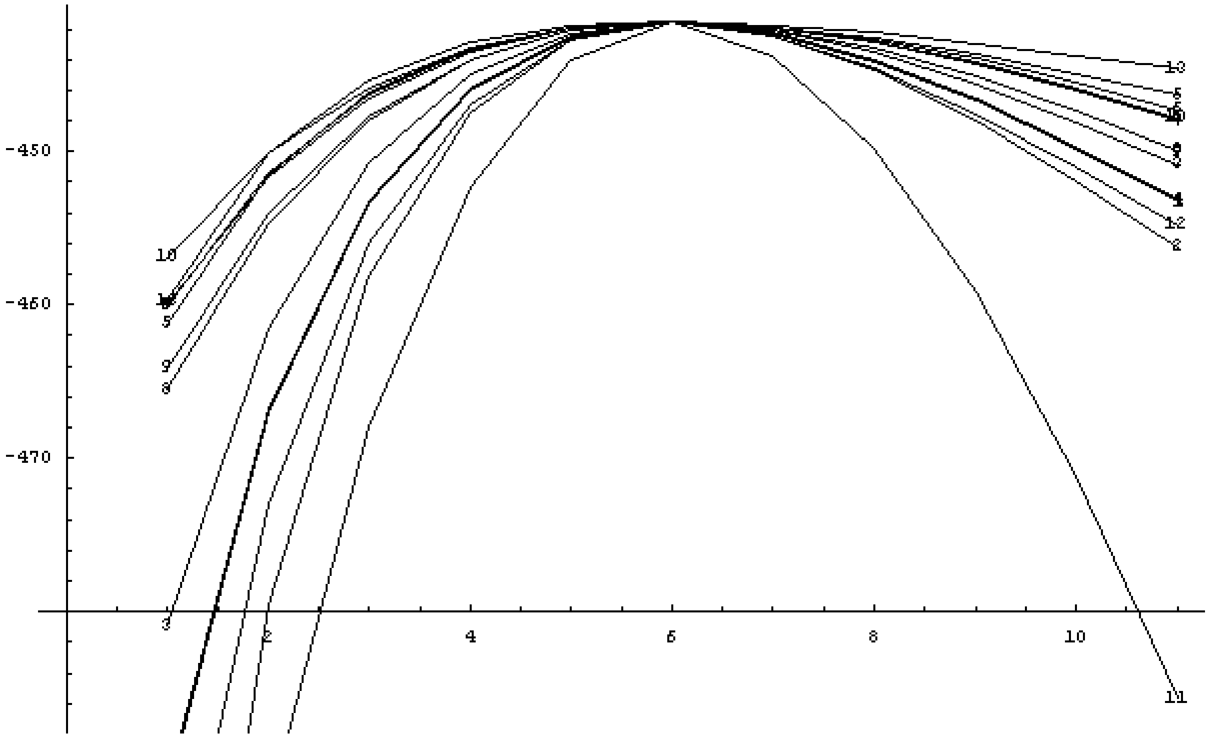


Figure 3.5.3. The likelihood for Norwegian spring spawning herring, parameters varied 50% to each side of their maximum likelihood estimate. Arbitrary values on the x-axis. Parameter ordering as in section 3.5.4.

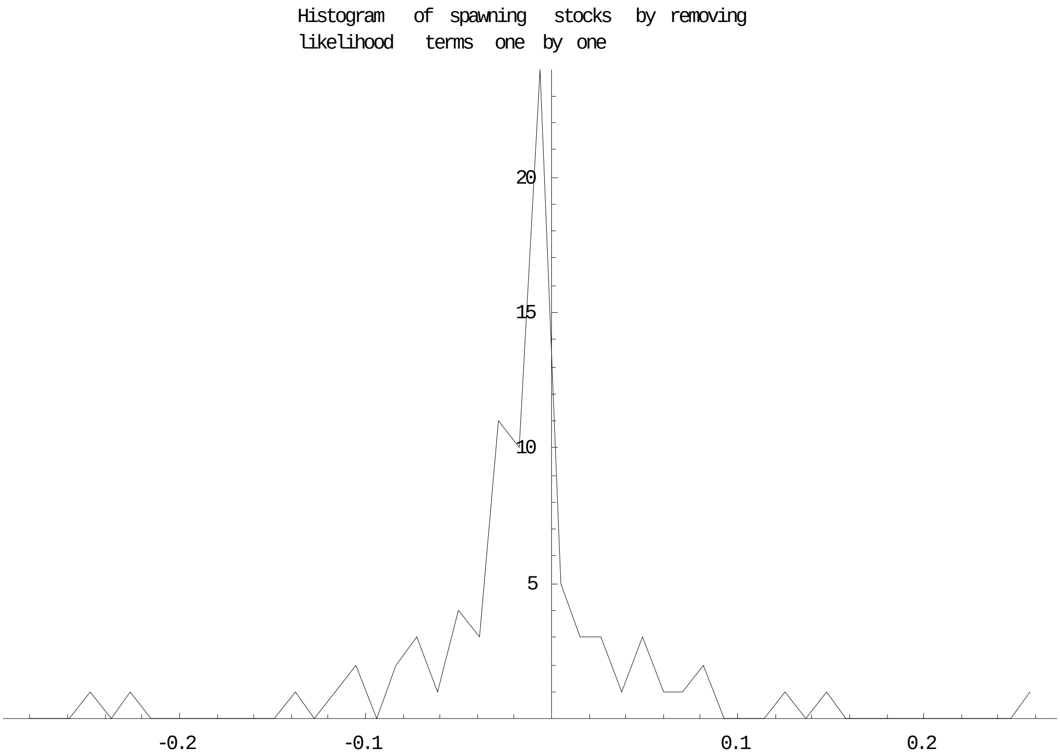


Figure 3.5.4. Histogram of the likelihood of Norwegian spring spawning herring when tuning is performed repeatedly by removing one survey point at a time.

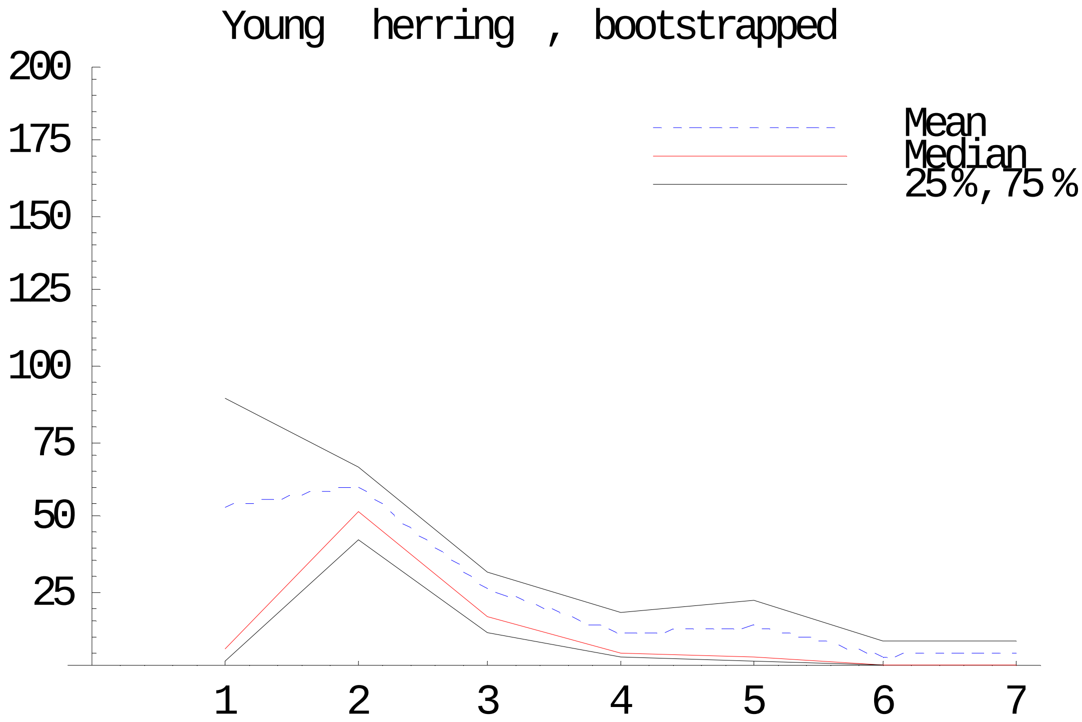


Figure 3.5.5. Mean value, 25, 50 and 75% percentiles (billion) for 1000 bootstrap replicates of young Norwegian spring spawning herring (year classes not in the likelihood).

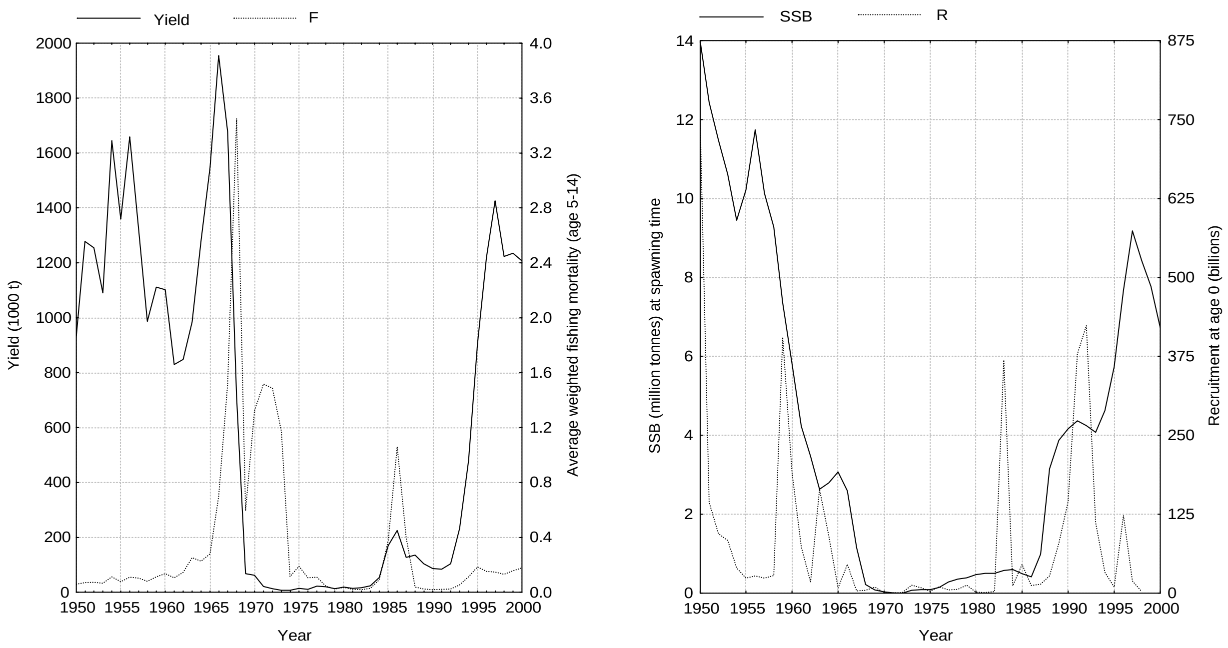


Figure 3.5.6 Stock summary

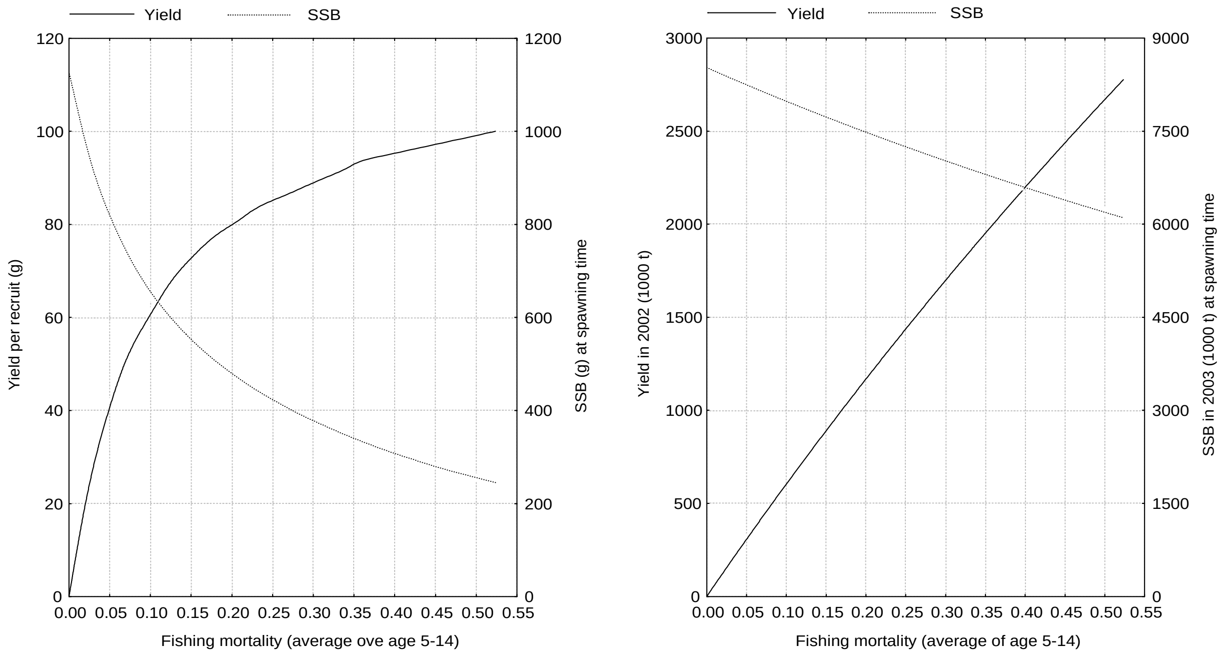


Figure3.5.7 Results of yield per recruit analysis

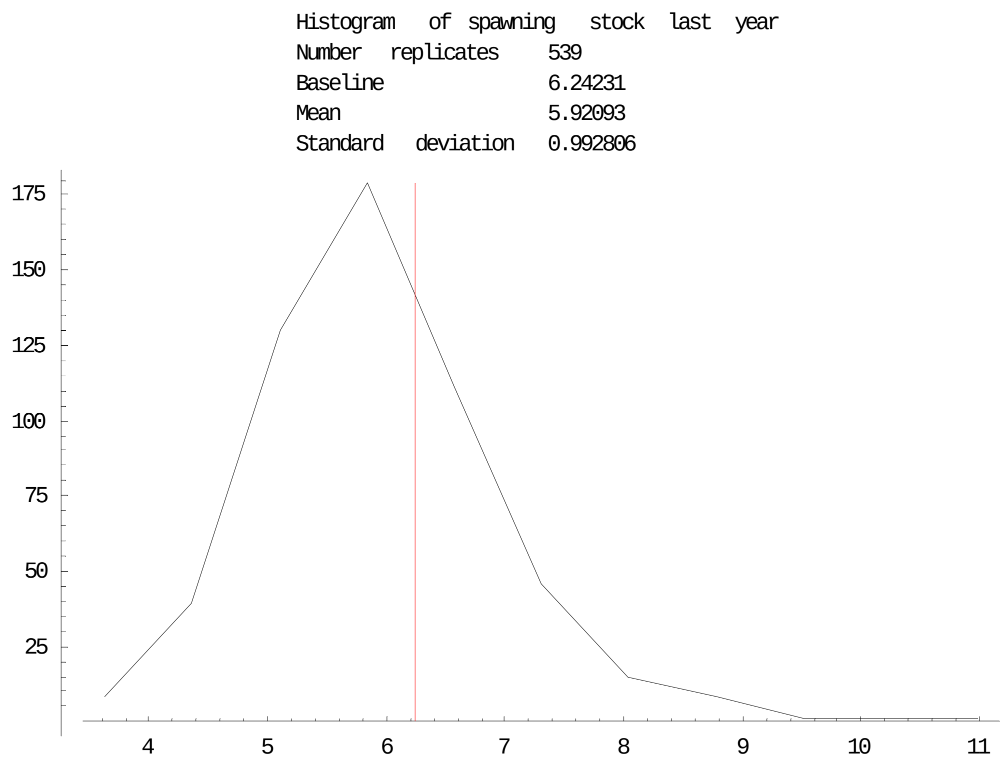


Figure 3.7.1. Histogram of the spawning stock (million t) of Norwegian spring spawning herring from 539 tuning replicates.

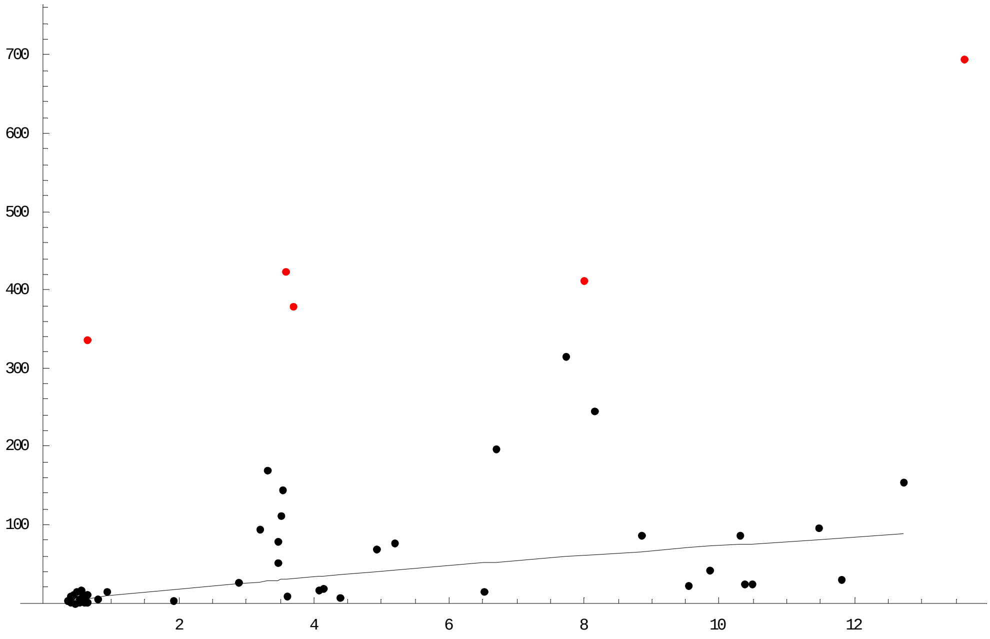


Figure 3.10.1. Spawning stock - recruitment points (million tonnes – billion) for Norwegian spring spawning herring based on Run 1 and the SeaStar VPA (F at oldest true age is calculated as a population weighted average of F for ages 8-13). The line shows a fitted Beverton-Holt relation based on the 90% smallest recruitment values (shown in black).

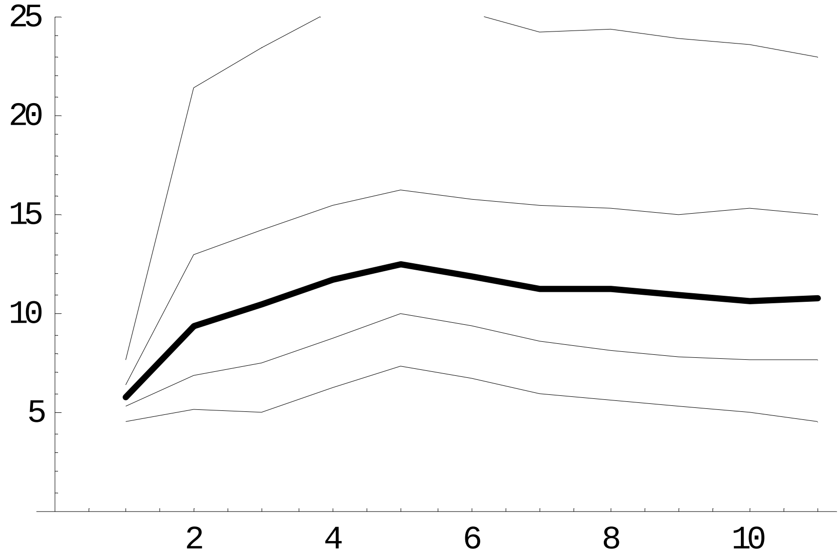


Figure 3.10.2. 10-year stochastic projections of spawning stock biomass (million tonnes) of Norwegian spring spawning herring for F = 0.125 above B_{pa} = 5.0 million t with a linear reduction to F=0.05 at B_{lim}= 2.5 million t and a catch ceiling of 1.5 million t. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis.

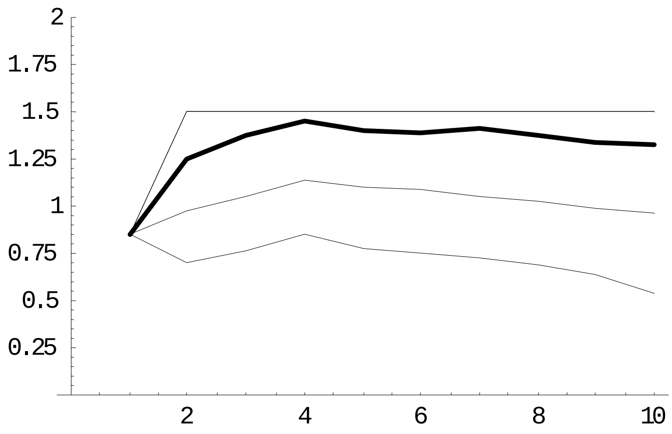


Figure 3.10.3. 10-year stochastic projections of catch (million tonnes) of Norwegian spring spawning herring for F = 0.125 above B_{pa} = 5.0 million t with a linear reduction to F=0.05 at B_{lim}= 2.5 million t and a catch ceiling of 1.5 million t. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis.

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 Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. In recent years no autumn fishery has taken place, except for a small Russian experimental 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. A minimum landing size of 11 cm has been in force for several years. From the autumn of 1986 to the Winter of 1991, and from the Autumn 1993 to the Winter 1999 no fishery took place. The fishery was re-opened in the winter season 1991 and again in the winter season 1999, on a recovered stock.

In its autumn meeting of 2000, ACFM considered a harvest control rule which was consistent with the precautionary approach. This rule defined the harvest level based on a maximum probability of 5% that SSB would fall below B_{lim} (corresponding to a catch of 630 000 t of pre-spawning capelin in 2001). ACFM also recommended that this harvest control rule be applied in 2001 (see also section 4.5). During its Autumn 2000 meeting the Mixed Russian Norwegian Fishery Commission decided to set a quota of 630,000 t on Barents Sea capelin for the winter season 2001, divided by 60% (378 000 t) to Norway and 40% (252 000 t) to Russia.

4.2 Catch Statistics

The international catch by country and season in the years 1965-2000 is given in Table 4.2.1. The catch by age and length groups during the spring season 2000 in Table 4.2.2. The total catch in spring 2000 was 378 000 t. This is 57 000 tonnes below the quota and the maximum TAC recommended by ACFM. The catches taken in the Russian experimental fishery during autumn 2000 are shown in Table 4.2.3.

The catch statistics for the winter-spring season 2001 are not available yet. By April 1 Norway had landed its quota of 378 000 t. During January, February and March, Russia landed 168 000 t.

4.3 Stock Size Estimates

4.3.1 Larval and 0-group estimates in 2000

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 4.3.1.1. These larval abundance estimates do not show a high correlation with year class strength at age one, but should reflect the amount of larvae produced each year (Gundersen & Gjøsæter 1998). The year 1986 was exceptional, in that no larvae were found. This may have been due to late spawning that year, and eggs may have hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 4.3.1.1. Since 1997, permission has not been granted to enter the Russian EEZ during the larval survey, and consequently the total larval distribution area has not been covered. The estimate of $19.1*10^{12}$ larvae in 2000 is the second highest estimate obtained for the period 1981-2000 and about three times the average index. During the international 0-group surveys in August an area-based index for the abundance of 0-group capelin is calculated (Table 4.3.1.1). Gundersen & Gjøsæter (1998) found these indices to be well correlated ($r^2 = 0.75$) with the 1-group acoustic estimates obtained by the annual capelin acoustic surveys in autumn. Data points up to 1994 were included in this analysis. When this regression is updated with the survey results from 1995-1999 the parameters in the regression were slightly changed but the r^2 remained at 0.75. Based on this regression, (ln 1-group estimate = -2.86 + 1.395 · ln 0-group index), the 0-group index obtained in 2000 of 303 would correspond to a year class strength of 157 billion one-year-olds in autumn 2001.

4.3.2 Acoustic stock size estimates in 2000

Two Russian and two Norwegian vessels jointly carried out the 2000 acoustic survey in the period 8 September to 3 October (WD by Bogstad *et al.*). As previously the Norwegian vessels had restricted access to the Russian EEZ, but since four vessels were available to the survey, two of which (partly three) could work in the Russian EEZ, the coverage of the total stock was considered complete. The results from the survey are given in Table 4.3.2.1, and are compared to previous years' results in Table 4.3.2.2. The stock size was estimated at 4.3 million tonnes. The 1999 yearclass (one-year-olds) constituted about 75% by numbers and 40% by weight of the total stock and was the most abundant year class since the 1989 yearclass at the same age. About 50% (2.1 mill t) of the stock biomass consisted of maturing fish (> 14 cm).

4.3.3 Other surveys

During the Norwegian demersal fish survey in February 2001 observations of capelin by acoustics and by pelagic and demersal trawls were made (WD by Gjøsæter). However no stock size estimate was attempted. Samples of cod stomachs during this period give valuable information for the modelling of maturing capelin as prey item for cod (Bogstad and Gjøsæter, 2001). Russian observations of capelin were made during the capelin fishery in 2001 (WD by Ushakov and Prozorkevitch).

4.4 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1991-2000 is given in Tables 4.4.1-4.4.7. The methods and assumptions used for constructing the tables are explained in Appendix A to ICES 1995/Assess: 9. In that report, the complete time series back to 1973 can also be found. It should be noted that several of the assumptions and parameter values used in constructing these tables are provisional and future research may alter some of the tables considerably. For instance, 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. This will also affect the spawning stock biomass estimates given in the stock summary table (Table 4.4.7). Also, it should be noted that these values, coming from a deterministic model cannot directly be compared to those coming from the probabilistic assessment model used for this stock. However, as 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 4.4.1. Catch in number at age and total landings are shown for the spring and autumn seasons in Tables 4.4.2 and 4.4.3. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 4.4.4. Stock size at 1 January in numbers at age and total biomass is shown in Table 4.4.5. Spawning stock biomass per age group is shown in Table 4.4.6. Table 4.4.7 gives an aggregated summary for the entire period 1973-2000.

4.5 Stock assessment autumn 2000

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 2000 meeting (ICES 2000/ACFM:16), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who reported directly to ACFM before its autumn 2000 meeting (Bogstad *et al.,* WD).

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2001 was presented, using the spreadsheet model CapTool, implemented using the @RISK add-on for EXCEL. The projection was based on a probabilistic maturation model with parameters estimated by the model CapSex, (with uncertainty taken into account); data on size and composition of the cod stock (from the Arctic Fisheries Working Group, ICES 2001/ACFM: 2, but made probabilistic in CapTool in accordance with the risk analysis made by the Arctic Fisheries Working Group); and an estimate of the ambient temperature for the cod (with the long-term mean of the Kola section as the mean value and a standard deviation of 1°C).

There is clearly a need for a target biomass reference point for capelin. Calculations of B_{target} were not made, but are planned for the future. A B_{lim} (SSB_{lim}) management approach was suggested for this stock. As last year, the meeting suggested the spawning stock size in 1989 as a $B_{lim.}$ The rationale behind this was that this biomass produced one of the strongest year classes observed during the period 1972-2000. It should also be noted that this year is within the time range for which quantitative stomach content data are available. It can be argued that the SSB in 1989 was sufficiently large to produce a good year class under favourable recruitment conditions in a “non-herring situation” (Gjøsæter and Bogstad, 1998).

Probabilistic prognoses for the maturing stock from October 1, 2000 until April 1, 2001 were made, with a CV of 0.15 on the abundance estimate. The meeting also concluded that capelin recruitment in 2001 could, to some extent, be influenced by the stock of young herring now found in the Barents Sea.

ACFM at its autumn 2000 meeting (ICES CRR 242, 2001) took most of the points in the report into account but took a different view on some topics. ACFM agreed to the view that fishing mortality reference points and a B_{pa} are not relevant for this stock, and that a target escapement management strategy is the most useful way of ensuring a minimum amount of spawners. Further ACFM agreed to the strategy adopted of directing the fishery at the spawning stock just prior to spawning, to allow the capelin to be available to predators as long as possible. However, the idea of a stochastic B_{lim} set equal to the modelled density distribution of the spawning stock in 1989 was not adopted. Rather, ACFM set a

B_{lim} of 200,000t. ACFM advised that a TAC should not exceed 630,000t. This was based on adopting the forecast of the SSB using the limit reference points referred above, and following the harvest control rule that the SSB should fall below B_{lim} with maximum 5% probability. ACFM also considered that adjustments of the harvest control rule should be further investigated for the purpose of taking better account of the uncertainty in the predicted amount of; abundance of spawners, the likely interactions with herring, and the role of capelin as prey item.

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 does not begin until January, advice for this stock must be given during the autumn ACFM meeting and the TAC must be 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 the 2001 ACFM autumn meeting.

4.6 Sampling

The sampling from scientific surveys and from commercial fishing on capelin is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Acoustic survey 2000 (Norway)	199	13997	7271
Acoustic survey 2000 (Russia)	97	12476	5744
Norwegian bottom trawl survey winter 2001	210	7282	2420
Norwegian fishery winter 2001[1]	119	13284	2258
Russian fishery winter 2001	14	2432	443

[1] Preliminary by 15.04.01, samples in course of preparation

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	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
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	156	20	704	31	195	226	929
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
1997	0	0	0	0	0	1	1	1
1998	0	0	0	0	0	1	1	1
1999	50	33	0	83	0	23	23	106
2000	283	95	0	378	0	28	28	406

Table 4.2.2 Barents Sea CAPELIN. International catch in number (10^6) and biomass (t) during the spring season 2000, as used by the Working Group

Length	Age 1		Age 2		Age 3		Age 4		Age 5+		Sum			
cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
5.0-5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5-6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0-6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5-7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0-7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-8.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0-8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5-9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0-9.5	3	7	6	14	0	0	0	0	0	0	9	0	21	0
9.5-10.0	0	0	10	33	0	0	0	0	0	0	10	0	33	0
10.0-10.5	0	0	7	21	0	0	0	0	0	0	7	0	21	0
10.5-11.0	0	0	4	17	0	0	0	0	0	0	4	0	17	0
11.0-11.5	0	0	8	37	0	0	0	0	0	0	8	0	37	0
11.5-12.0	0	0	5	28	14	80	0	0	0	0	19	0	108	0
12.0-12.5	0	0	2	12	5	41	0	0	0	0	7	0	53	0
12.5-13.0	0	0	28	277	11	87	0	0	0	0	39	0	364	0
13.0-13.5	0	0	63	632	50	556	2	16	0	0	115	1	1203	0
13.5-14.0	0	0	0	0	187	2524	17	190	0	0	204	1	2714	1
14.0-14.5	0	0	12	134	415	5869	9	110	0	0	436	3	6113	2
14.5-15.0	0	0	11	127	586	9200	128	1959	4	61	729	5	11348	3
15.0-15.5	0	0	3	45	869	15447	358	6228	19	295	1250	9	22016	6
15.5-16.0	0	0	7	102	781	15164	576	11187	60	1081	1425	10	27534	7
16.0-16.5	0	0	7	128	593	13296	1000	22166	95	1910	1695	12	37500	10
16.5-17.0	0	0	0	0	351	8767	998	24899	242	5668	1591	11	39333	10
17.0-17.5	0	0	0	0	269	7238	1269	34965	481	11983	2020	14	54186	14
17.5-18.0	0	0	0	0	176	5352	965	29675	333	9648	1474	10	44675	12
18.0-18.5	0	0	0	0	127	4390	939	32142	422	13891	1489	10	50423	13
18.5-19.0	0	0	0	0	38	1467	527	19593	391	13834	955	7	34894	9
19.0-19.5	0	0	0	0	21	880	364	14751	313	12250	698	5	27881	7
19.5-20.0	0	0	0	0	0	0	187	8295	110	4761	296	2	13056	3
20.0-20.5	0	0	0	0	0	0	55	2754	21	1004	76	1	3758	1
20.5-21.0	0	0	0	0	0	0	8	417	3	160	11	0	577	0
21.0-21.5	0	0	0	0	0	0	1	28	0	0	1	0	28	0
21.5-22.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.2.3 Barents Sea CAPELIN. Russian catch in number (10^6) and biomass (t) during the autumn season 2000, as used by the Working Group

Length	1		2		3		4		5		Sum			
Cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
8.0-8.5	1	2	0	0	0	0	0	0	0	0	1	0	2	0
8.5-9.0	2	6	0	0	0	0	0	0	0	0	2	0	6	0
9.0-9.5	4	12	0	0	0	0	0	0	0	0	4	0	12	0
9.5-10.0	10	32	0	0	0	0	0	0	0	0	10	1	32	0
10.0-10.5	14	49	0	0	0	0	0	0	0	0	14	1	49	0
10.5-11.0	22	97	0	0	0	0	0	0	0	0	22	1	97	0
11.0-11.5	25	129	0	0	0	0	0	0	0	0	25	2	129	0
11.5-12.0	18	107	3	19	0	0	0	0	0	0	21	1	126	0
12.0-12.5	15	105	11	78	0	0	0	0	0	0	26	2	183	1
12.5-13.0	14	120	33	280	0	3	0	0	0	0	48	3	404	1
13.0-13.5	10	96	68	675	0	4	0	0	0	0	78	5	774	3
13.5-14.0	4	49	122	1396	0	4	0	0	0	0	127	8	1448	5
14.0-14.5	3	39	155	2034	1	19	0	0	0	0	160	10	2091	7
14.5-15.0	1	14	138	2029	6	93	0	0	0	0	145	10	2136	8
15.0-15.5	1	13	133	2236	23	384	0	0	0	0	157	10	2633	9
15.5-16.0	0	0	94	1775	36	671	1	17	0	0	130	9	2462	9
16.0-16.5	0	0	73	1570	63	1350	0	10	0	0	137	9	2931	10
16.5-17.0	0	0	41	992	67	1623	2	45	0	0	110	7	2659	10
17.0-17.5	0	0	20	552	83	2272	3	90	0	0	106	7	2914	10
17.5-18.0	0	0	9	280	50	1513	3	100	0	0	62	4	1893	7
18.0-18.5	0	0	1	39	61	2094	4	118	0	8	66	4	2259	8
18.5-19.0	0	0	1	31	35	1283	5	203	1	26	42	3	1544	6
19.0-19.5	0	0	0	0	16	663	2	88	0	10	18	1	761	3
19.5-20.0	0	0	0	0	3	139	3	128	0	0	6	0	267	1
20.0-20.5	0	0	0	0	2	84	1	54	0	0	3	0	137	0
20.5-21.0	0	0	0	0	0	21	0	0	0	0	0	0	21	0
Sum	146	868	904	13986	447	12219	25	852	1	44	1523	100	27970	100

Table 4.3.1.1 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	0.0	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
1997	6.9	522
1998	14.1	428
1999	36.5	722
2000	19.1	303

Table 4.3.2.1 Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 2000. Based on TS value 19.1 log L –74.0 dB, corresponding to $\sigma = 5.0 \cdot 10^{7} \cdot L^{1.91}$.

Age/Yearclass Length (cm)		1 1999	2 1998	3 1997	4 1996	5+ 1995	Sum (109)	Biomass (103 t)	Mean weight (g)
6.5-	7.0	2.198					2.198	2.2	1.0
7.0-	7.5	9.506					9.506	11.7	1.2
7.5-	8.0	16.249					16.249	24.2	1.5
8.0-	8.5	31.942					31.942	59.0	1.8
8.5-	9.0	56.835					56.835	128.9	2.3
9.0-	9.5	60.610					60.610	168.6	2.8
9.5-	10.0	58.577					58.577	192.1	3.3
10.0-	10.5	66.512	0.073				66.585	273.3	4.1
10.5-	11.0	57.780	0.555				58.335	274.7	4.7
11.0-	11.5	40.027	1.024				41.051	225.9	5.5
11.5-	12.0	26.161	4.315				30.476	193.5	6.3
12.0-	12.5	14.416	5.943				20.359	150.3	7.4
12.5-	13.0	4.880	11.347				16.227	142.6	8.8
13.0-	13.5	2.250	12.448				14.698	152.2	10.4
13.5-	14.0	0.808	13.714	0.198			14.720	176.0	12.0
14.0-	14.5	0.238	14.856	0.119			15.213	208.3	13.7
14.5-	15.0	0.177	13.677	0.460			14.314	225.3	15.7
15.0-	15.5		11.224	1.302	0.089		12.615	228.7	18.1
15.5-	16.0		8.956	3.147		0.056	12.159	244.3	20.1
16.0-	16.5		5.482	4.241			9.723	219.2	22.5
16.5-	17.0		3.756	5.850	0.079		9.685	246.9	25.5
17.0-	17.5		2.140	5.617			7.757	212.1	27.3
17.5-	18.0		0.825	5.415			6.240	198.3	31.8
18.0-	18.5		0.217	4.397	0.107		4.721	161.9	34.3
18.5-	19.0			2.561			2.561	101.2	39.5
19.0-	19.5			0.739	0.333		1.072	41.2	38.5
19.5-	20.0			0.055	0.052		0.107	4.7	44.1
20.0-	20.5				0.122		0.122	5.8	47.7
20.5-	21.0								
TSN (109)		449.166	110.552	34.101	0.782	0.056	594.657		
TSB (103 t)		1699.7	1591.8	951.0	29.5	1.2		4273.1	
Mean length (cm)		9.9	14.2	17.1	18.6	15.8	11.1		
Mean weight (g)		3.8	14.4	27.9	37.7	21.0			7.2
SSN (109)		0.415	61.133	33.903	0.782	0.056	96.289		
SSB (103 t)		6.0	1112.6	948.7	28.2	1.1		2096.7	

Table 4.3.2.2 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
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099

Table 4.4.1 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. August, back-calculated from the survey in September-October.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	415.0	396.2	3.1	29.5	8.3	88.9	111.8	188.4	171.4	472.8
2	600.9	223.9	73.0	5.1	9.4	12.5	44.2	76.5	111.5	116.4
3	36.7	162.8	25.3	6.4	1.6	2.2	2.2	12.1	27.9	39.3
4	1.4	1.6	3.7	0.3	0.4	0.1	0.1	0.7	0.9	0.9
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1
Sum	1054.0	784.4	105.0	41.4	19.7	103.7	158.3	277.8	311.7	629.4
Biomass	6647	5371	991	259	189	467	866	1860	2580	3914

Table 4.4.2 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the spring season.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.4	0.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3	24.0	23.8	4.8	0.0	0.0	0.0	0.0	0.0	0.8	4.5
4	8.2	17.3	26.8	0.0	0.0	0.0	0.0	0.0	1.5	7.4
5	2.7	2.1	1.4	0.0	0.0	0.0	0.0	0.0	0.8	2.5
Sum	35.3	43.4	33.5	0.0	0.0	0.0	0.0	0.0	3.1	14.6
Landings	704	891	586	0	0	0	0	0	83	378

Table 4.4.3 Barents Sea CAPELIN. Catch in numbers (unit:10^9) by age group and total landings ('000 t) in the autumn season.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	2.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.1
2	9.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.9
3	3.1	7.9	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4
4	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	15.5	15.3	0.0	0.0	0.0	0.0	0.0	0.1	1.6	1.5
Landings	226	232	0	0	0	0	1	1	23	28

Table 4.4.4 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.

	1991		1992		1993		1994		1995	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.015	0.046	0.059	0.178	0.157	0.471	0.201	0.602	0.073	0.219
2	0.015	0.045	0.058	0.174	0.157	0.470	0.201	0.602	0.073	0.219
3	0.051	0.153	0.107	0.322	0.190	0.571	0.201	0.602	0.019	0.058
4	0.051	0.154	0.074	0.221	0.214	0.642	0.282	0.847	0.044	0.133
5	0.051	0.154	0.071	0.212	0.214	0.642	0.282	0.847	0.044	0.133
Avr	0.037	0.111	0.074	0.222	0.186	0.559	0.221	0.700	0.052	0.152

Table 4.4.4 (Continued)

Age	1996		1997		1998		1999		2000	
	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142	0.026	0.077
2	0.041	0.122	0.062	0.185	0.026	0.077	0.047	0.142	0.026	0.077
3	0.041	0.122	0.062	0.185	0.071	0.212	0.025	0.074	0.071	0.212
4	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074	0.071	0.212
5	0.050	0.149	0.014	0.041	0.071	0.212	0.025	0.074	0.071	0.212
Avr	0.043	0.133	0.042	0.127	0.053	0.158	0.034	0.101	0.053	0.158

Table 4.4.5 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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	462.4	600.1	9.2	120.3	13.8	118.2	172.0	225.5	238.5	565.8
2	689.5	382.0	293.7	1.4	10.8	5.7	72.5	82.2	165.8	135.3
3	174.8	548.6	162.6	33.3	1.9	6.5	10.2	32.5	67.3	88.1
4	16.0	25.7	89.2	9.8	2.4	1.4	1.8	1.6	8.5	24.7
5	0.1	0.3	0.5	1.3	0.1	0.3	0.1	0.1	0.5	0.8
Sum	1342.8	1556.8	555.2	166.1	28.9	132.2	256.6	341.9	480.6	814.6
Biomass	7011	8299	4372	737	156	313	779	1240	2456	3556

Table 4.4.6 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0	0	0	0	0	0	0	0	0	0
2	19	0	0	0	1	3	1	1	2	24
3	1424	919	129	34	15	71	175	217	666	729
4	142	79	331	60	38	24	49	34	185	428
5	0	0	0	11	1	7	2	2	0	0
Sum	1584	998	460	105	55	105	228	254	853	1181

Table 4.4.7 Barents Sea CAPELIN. Stock summary table. Recruitment (number of 1 year old fish (unit:10^9) and stock biomass ('000 t) given at 1. August, spawning stock ('000 t) at time of spawning (1. April). Landings ('000 t) are the sum of the total landings in the two fishing seasons within the year indicated. The SSB is obtained by projecting the stock forward assuming a natural mortality that does not take the current predation mortality fully into account.

Year	Stock biomass	Recruit-ment Age 1	Spawning stock biomass	Landings
1965				224
1966				389
1967				409
1968				537
1969				680
1970				1314
1971				1392
1972	5831			1592
1973	6630	1140	1242	1336
1974	7121	737	343	1149
1975	8841	494	90	1439
1976	7584	433	1147	2587
1977	6254	830	890	2987
1978	6119	855	460	1916
1979	6576	551	193	1783
1980	8219	592	87	1648
1981	4489	466	1731	1986
1982	4205	611	546	1760
1983	4772	612	47	2358
1984	3303	183	171	1477
1985	1087	47	106	868
1986	157	9	13	123
1987	107	46	16	0
1988	361	22	11	0
1989	771	195	141	0
1990	4901	708	179	0
1991	6647	415	1584	929
1992	5371	396	998	1123
1993	991	3	460	586
1994	259	30	105	0
1995	189	8	55	0
1996	467	89	105	0
1997	866	112	228	1
1998	1860	188	254	1
1999	2580	171	853	106
2000	3914	473	1181	406

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

5.1 The Fishery

5.1.1 Regulation of the fishery

The fishery depends 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 preliminary 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 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 back-calculated 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 1.3.5. 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 2000/2001 season

In accordance with a previously determined procedure, ACFM recommended that the preliminary TAC should not exceed 650 000 t. This is 2/3 of the total TAC predicted for the season, i.e. 975 000 t. This advice was accepted by all parties concerned.

The season opened on 20 June and the fishery began in deep waters north of the shelf edge off the eastern north coast of Iceland. As usual the fishing grounds gradually shifted to the northwest in July. Initially, catch rates were higher than in 1999 and by the end of July the total catch amounted to 245 000 t. After that the capelin had become so scattered that the fishery was abandoned. About 20 000 t were caught off NW-Iceland in November. At that time, fishable concentrations were heavily mixed with juveniles and the fishery stopped.

The total catch in the 2000 summer and autumn season thus amounted to about 265 000 t.

In January 2001, fishable concentrations of adult capelin were located in deep waters off the shelf east of Iceland and a total catch of about 135 000 t of capelin was taken off the southern east coast in January and early February.

On 1 February 2001, a large scale fishery started some 50-60 miles to the west of the Vestfirdir peninsula (NW-Iceland). During February and the first week of March, the fishery followed the migration of these capelin southeastward to the Snæfellsnes peninsula (W-Iceland), then south across Faxafloi and finally eastward along the south coast to the area east of Vestmannaeyjar. Very few catches were taken from the eastern migration until late in this period, which is very unusual for this time of year.

Catch rates were extremely high throughout February and in the first 10 days of March and the total catch was about 540 000 t, almost all taken from the western migration. Due to a week of storms following a short fishers' strike practically no catches were taken by Iceland for about 10 days around mid-March. After that and until the end of March, some 130 000 t were taken by Icelandic and Greenland vessels from both the western and eastern migrations.

The total catch during the 2001 winter season was 806 000 t.

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 1979–2000 and winter 1980–2001 seasons is given by age and years in Tables 5.2.2 and 5.2.3.

The distribution of the catch during the summer-autumn 2000 and winter 2001 seasons is given by length 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-East Greenland-Jan Mayen area has been recorded during surveys carried out in August since 1970. The survey methods and computations of abundance indices were described by Vilhjálmsson and Fridgeirsson (1976). The abundance indices of 0-group capelin, divided according to areas, are given in Table 5.3.1.1.

An acoustic estimate of the abundance of 1-group capelin has also been obtained during the August 0-group surveys (e.g. Vilhjálmsson 1994). Their abundance by number, mean length and weight for the period 1983–2000 is given in Table 5.3.1.2.

5.3.2 Stock abundance in autumn 1999 and winter 2000

An acoustic survey was carried out by two research vessels in the period 10 November-2 December 2000 (Working Document by Hjalmar Vilhjalmsson and Sigurdur Thor Jonsson). The distribution of the stock was fairly wide and more or less continuous, reaching from 28°W, west of the NW-peninsula of Iceland (Vestfirdir), across the outer part of the shelf northwest and north of Iceland to 11°W off the northern and central east coast. The most extensive and dense capelin concentrations were recorded near the shelf edge off the western and central north coast as well as north of Vestfirdir.

Due to drift ice drift it was not possible to carry out an adequate survey of the Denmark Strait and a storm prevented a complete coverage of the more offshore waters off the eastern north coast of Iceland. The capelin were almost exclusively recorded as scattering layers of varying densities, at depths of 50-150 m in darkness but somewhat deeper in the daytime. Most of the densest concentrations, recorded off the western and central north coast as well as north of the NW-peninsula of Iceland, consisted of a mixture of adults and juveniles (both 1- and 2-group) with a predominance of the juvenile component. East and northeast of Iceland there were almost exclusively juveniles.

According to the autumn 2000 survey, the immature stock component amounted to 102.7 and 10.9 * 10^9 fish, belonging to age groups 1 and 2 respectively (year classes 1999 and 1998). The estimated total fishable/spawning stock abundance was only 13.2 * 10^9 fish in early December 2000. The observed mean weight in the fishable stock was 13.4 g and the fishable/spawning stock biomass estimate, therefore, only 176 000 t.

Both total adult stock biomass and the contribution of the older age group were much below expectations and the average weight far below that in the catch taken in June/July. For these reasons it was concluded that the autumn 2000 survey must have failed to locate and assess most of the adult fishable stock. On the other hand the survey appeared to have adequately caught the immature part of the population. Details of the autumn 2000 acoustic estimate of adult capelin are given in Table 5.3.2.1 and those of the immature stock in Table 5.3.2.2.

During 22-31 January 2001, the abundance of mature capelin was assessed near the shelf edge off the Vestfirdir peninsula.. The survey was repeatedly interrupted by storms during the first few days. Following that an assessment was carried out under good weather conditions during 27-31 January. The adult capelin were distributed in large dense schools and scattering layers over a relatively narrow area that reached for 80-90 nautical miles along and just west of the shelf edge. The southern half of this area contained only adult fish, while adult concentrations in the northern half were mixed with 1- and 2-group juveniles. Farther to the northeast the survey recorded only juveniles. The total biomass of adult capelin in this area was estimated to be about 720 000 t. This survey did not cover but part of the immature stock, but it was noted that the weight at age among the immature capelin was much higher than could be expected from the November 2000 assessment.

Surveying of capelin spawning migrations was continued east and southeast of Iceland during 2-15 February 2001. Dense schools were located just east of the shelf edge off the southern east coast and more scattered capelin recordings to the north and east of there. At the time of this survey there were no signs of capelin in the process of migrating into the warmer waters off the eastern south coast. In the second week of February the total abundance of adult capelin in this area was assessed to be about 290 000 t. The February 2001 survey east of Iceland was conducted south of 65˚N and therefore recorded only insignificant numbers of immature capelin.

Although the occurrence of mature capelin off NW-Iceland in winter is not uncommon, the scenario where most of the mature, fishable stock is located west of the Vestfirdir peninsula is highly unusual but not unique. A situation closely resembling that at present occurred in the winter of 1979. Approximately one half of the spawning stock was then located off the Vestfirdir peninsula in January/February and, like in 2001, migrated directly to the spawning grounds west of Iceland. The anomalous distribution of the adult stock in 2000/2001 is most likely due to changes in the oceanographic regime of Icelandic waters and the Iceland Sea (see Section 2.3.4.5)

Details of the winter 2001 acoustic estimate of adult capelin are given in Table 5.3.2.3 and those of the immature stock in Table 5.3.2.4.

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 of 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 and 1 January of the following year for the 1978/79–2000/01 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 1979–2001.

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 average weight at age of adult capelin in autumn (Table 5.5.1.2) is used to calculate stock biomass of the maturing components in summer. 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 Stock prognosis and TAC in the 2000/2001 season

The models (ICES 1993/Assess:6; Section 3.1.5) for predicting the numbers of maturing capelin of ages 2 and 3 from the November 1999 acoustic assessment of the 1998 and 1997 year classes gave estimates of 70.9 and 19.2 billion maturing 2- and 3-group capelin on 1 August 2000.

During the last ten years the weight at age of adult capelin has been inversely related to adult stock abundance in numbers. Plotting these pairs of data as simple linear regressions results in r^2 = 0.66 and 0.76 for age groups 2 and 3 respectively. Applying the appropriate regression equations, $y = -0.034x + 19.3$ for the younger component and

$y = -0.069x + 28.8$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1999 combined, *i.e.* $90.1 * 10^9$ fish, resulted in estimated mean weights of 16.2 and 22.7 g for age groups 2 and 3 respectively.

The fishable stock biomass, obtained by multiplying the stock in numbers by the predicted mean weight of maturing capelin in autumn, was projected forward to spawning time in March 2001 assuming a monthly M = 0.035 and a remaining spawning stock of 400 000 t. This gave a predicted TAC of 975 000 t spread evenly over August 2000-March 2001 (Table 5.5.1.3). Using the same approach as in previous years, *i.e.* that the preliminary TAC be set at 2/3 of the predicted total for the season, the Working Group recommended that a preliminary TAC for the 2000/01 capelin fishery be set at 650 000 t.

According to the January/February 2001 survey results described in section 5.3.2, the estimated fishable/spawning stock was $49.5 * 10^9$ fish in early February 2001. At that time the observed mean weight in the fishable stock was 20.5 g and the stock biomass therefore about 1 010 000 t. With the usual prerequisite of a monthly natural mortality rate of 0.035, a remaining spawning stock of 400 000 t the above abundance estimate indicated a TAC of 610 000 t in the time remaining of the 2001 winter fishery. Counting the catch taken in June 2000–10 February 2001 (400 000 t), this corresponded to a total TAC of some 1 010 000 t for all of the 2000/2001 season.

Routine sampling of the catch taken during 1 February-10 March 2001 revealed a much higher weight at age than could be expected from the winter survey. There was also a corresponding increase in weight at length. The difference between the TAC calculated using survey weights on the one hand and catch weights on the other was 100 000 t. TAC for the winter fishery in February-March 2001 was subsequently raised to 710 000 t, bringing the total TAC for the 2000/2001 season to 1 110 000 t. The difference between predicted TAC and the TAC finally calculated for the 2000/01 season is due to a higher mean weight than expected. About 40 000 t of the calculated TAC remained at the end of the winter fishery. It is estimated that 440 000 t of capelin remained to spawn in 2001.

5.5.2 Stock prognosis and assessment for the 2001/2002 season

Calculations of expected TAC for the 2001/2002 season, based on the method described in section 3.1.5 and data from Table 5.5.1.1, were used for predicting the abundance by number of maturing capelin of ages 2 and 3 on 1 August 2001.

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 = 0.570x + 19.4; R^2 = 0.83, p <0.05. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives y = 0.285x - 7.1; R^2 = 0.51; p <0.05. The two regression plots are shown in Figure 5.5.3.1.

The Working Group decided that the November 2000 estimate of the abundance of 1-group capelin (year class 1999) was realistic and could be used for predicting the abundance of maturing capelin of the 1998 year class on 1 August 2000.

The predictive figures for the 1999 and 1998 year classes are given in Table 5.5.1.1 These gave an estimate of 78.1 and 16.9 billion mature fish, belonging to the 1999 and 1998 year classes respectively.

During the last ten years the weight at age of adult capelin has been inversely related to adult stock abundance in numbers. Plotting these pairs of data as simple linear regressions results in R^2 = 0.66 and 0.76 for age groups 2 and 3 respectively. These two regression plots are shown in Figure 5.5.3.2. Applying the appropriate regression equations,

y = -0.035x + 19.4; r^2 = 0.66; p<0.05 for the younger component, and y = -0.070x + 29.0; r^2 = 0.76; p<0.05 for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 2001 combined, *i.e.* $95.0 * 10^9$ fish, results in estimated mean weights of 16.1 and 22.4 g for age groups 2 and 3 respectively.

Using the predicted mean weight, results in a predicted TAC of 1 050 000 t if spread evenly over the period August 2001-March 2002. This corresponds to a preliminary TAC of 700 000 t. As in previous years, decisions on the final TAC for the 2001/2002 season should be based on surveys carried out in October/November 2001 and/or January/February 2002.

5.5.3 Management of capelin in the Iceland-East 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 has usually begun in June/July and ends in March of the following year when the remainder of the fishable stock spawns and dies. The fishable stock, which is also the maturing 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-East Greenland-Jan Mayen area have been as follows:

Acoustic survey estimates of age 1 juvenile capelin abundance and the estimated total abundance (mature and immature) at age 2 have been used to predict fishable stock abundance by number in the following year (fishing season). Historical average mean weight at age (in later years a relationship between numerical stock abundance and growth), growth rates and natural mortality have been used for calculations and projections of maturing 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 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 the continued setting of a preliminary TAC for the first half of the season.

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/February 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 extra care should be taken when dealing with stock abundance below or above the norm, corresponding to TACs lower than 500 000 or greater than 1 600 000 t.

5.6 Precautionary Approach to Fisheries Management

Due to the short life span of capelin and their high spawning mortality, the main management objective is to maintain enough spawners for the propagation of the stock. Since 1979 the targeted remaining spawning stock for capelin in the Iceland-East Greenland-Jan Mayen area has been 400 000 t. Although there have been large fluctuations in stock abundance during this period, these appear to be environmentally induced and not due to excessive fishing. Therefore, the criterion of maintaining a remaining spawning stock may be defined as B_{lim}, i.e. stock abundance below which no fishery should be permitted.

The definition of other precautionary reference points is more problematic. However, due to uncertainties inherent in predicting the abundance of short-lived species and the importance of capelin as forage fish for predators such as cod, saithe, Greenland halibut, baleen whales and sea birds, extra caution should be taken when stock predictions indicate TACs lower than 500 000 t and greater than 1 600 000 t. In the former case, the fishery should not be opened until after the completion of a stock assessment survey in autumn/winter in that season. The latter simply represents a scenario where predicted stock abundance is beyond the highest historic abundance on record. In such cases the preliminary TAC should not exceed 1 100 000 t.

5.7 Special Comments

In most years, by far the largest capelin can be caught in late June, July and the first half of August. After that, the average size in the catches has usually declined drastically and not increased again until late autumn. There are two main reasons for this. First, the oldest and largest fish migrate ahead of other stock components to feed in the plankton rich oceanic area between Iceland, Greenland and Jan Mayen. Later on, these larger capelin are joined by younger, slower growing adults and even juveniles in parts of the fishing area, the location of which is variable from year to year. Second, as the food supply diminishes in the southern part of the feeding area in August, the fishable stock becomes more scattered and sometimes mixed with juveniles.

The Working Group recommends that the 2001 summer/autumn season be opened around 20 June. In order to prevent catches of juvenile 1- and 2-group capelin it is recommended that the authorities responsible for the management of this stock (Greenland, Iceland and Norway) should monitor the fishery and be prepared for quick intervention on short notice, through area closures, to prevent eventual fishing on concentrations of capelin consisting of a mixture of juveniles and adults.

An overview of stock development during 1978–2000 is given in Table 5.7.1.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 2000	26	6827	2600
Survey 2000	50	4415	4415
Fishery 2001	74	7400	7400
Survey 2001	41	3999	3999

Table 5.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the whole season, landings and remaining spawning stock (000 tonnes) in the 1988/99–2000/01 seasons.

Season	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01
Prelim. TAC	900	900	600	0	500	900	950	800	1100	850	950	650	700
Rec. TAC	1065	-	250	740	900	1250	850	1390	1600	1265	1200	1000	1110
Landings	1036	808	314	677	788	1179	842	930	1571	1245	1100	934	1071
Spawn. stock	445	115	330	475	460	460	420	830	430	490	500	650	440

Table 5.2.1 The international capelin catch 1964–2001 (thousand tonnes).

	Winter season					Summer and autumn season						
Year	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	EU	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	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0		102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1095.4
2001	767.2	-	10.0	28.6	805.8							

Table 5.2.2 The total international catch of capelin in the Iceland-East 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) 1979–2000.

					Year						
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
1	0.6	4.9	0.6	-	0.6	0.5	0.8	+	+	0.3	1.7
2	29.4	17.2	27.9	-	7.2	9.8	25.6	10.0	27.7	13.6	6.0
3	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3	6.7	5.4	1.5
4	-	-	+	-	-	0.1	0.2	0.5	+	+	+
Total number	36.1	27.5	30.5	-	8.6	18.2	42.0	33.8	34.4	19.3	9.2
Total weight	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9	458.6	371.4	121.0

				Year							
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1	0.8	0.3	1.7	0.2	0.6	1.5	0.2	1.8	0.9	0.3	0.2
2	5.9	2.7	14.0	24.9	15.0	9.7	25.2	33.4	25.1	4.7	12.9
3	1.0	0.4	2.1	5.4	2.8	1.1	12.7	10.2	2.9	0.7	3.3
4	+	+	+	0.2	+	+	0.2	0.4	+	+	0.1
Total number	7.7	3.4	17.8	30.7	18.4	12.3	38.4	45.8	28.9	5.7	16.5
Total weight	111.2	56.0	298.1	611.6	324.1	205.7	773.7	763.6	440.5	102.4	265.1

Table 5.2.3 The total international catch of capelin in the Iceland-East 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) 1980–2001.

						Year					
Age	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	1.3	1.7	-	-	2.1	0.4	0.1	+	+	0.1	1.4
3	17.6	7.1	0.8	-	18.1	9.1	9.8	6.9	23.4	22.9	24.8
4	3.5	1.9	0.1	-	3.4	5.4	6.9	15.5	7.2	7.8	9.6
5	-	-	-	-	-	-	0.2	-	0.3	+	0.1
Total number	22.4	10.7	0.9	-	23.6	14.5	17.0	22.4	30.9	30.8	35.9
Total weight	392.1	156.0	13.2	-	439.6	348.5	391.8	560.5	657.2	665.1	686.8

					Year						
Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
2	0.5	2.7	0.2	0.6	1.3	0.6	0.9	0.3	0.5	0.3	0.4
3	7.4	29.4	20.1	22.7	17.6	27.4	29.1	20.4	31.2	36.3	28.9
4	1.5	2.8	2.5	3.9	5.9	7.7	11.0	5.4	7.5	5.4	7.0
5	+	+	+	+	+	+	+	+	+	+	+
Total number	9.4	34.9	22.8	27.2	24.8	35.7	41.0	26.1	39.2	42.0	36.3
Total weight	202.4	621.1	489.6	567.1	539.8	723.6	797.6	481.3	658.9	830.3	805.8

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 2000 by age and length, and the catch in weight (thousand tonnes) by age groups.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
11	6	22	-	-	32	0.2
11.5	12	132	-	-	162	1.0
12	36	1022	-	-	1177	7.2
12.5	36	2235	28	-	2532	15.4
13	36	2603	41	-	2945	17.9
13.5	24	2559	152	-	2945	17.9
14	24	1779	275	-	2158	13.1
14.5	6	1044	510	-	1461	8.9
15	-	728	592	-	1152	7.0
15.5	-	404	523	-	755	4.6
16	-	206	551	30	560	3.4
16.5	-	125	344	-	341	2.1
17	-	22	207	-	146	0.9
17.5	-	-	55	-	32	0.2
18	-	-	-	-	-	0.0
18.5	-	-	-	30	8	0.0
19	-	-	-	-	-	0.0
19.5	-	-	14	-	8	0.0
Total number	182	12882	3292	59	16415	
Percentage	1.1	78.5	20.1	0.4	100.0	100.0
Total weight	2.1	188.5	72.4	2.1	265.1	

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 2001 by age and length, and the catch in weight (thousand tonnes) by age groups.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Percentage
10	29	-	-	-	29	0.1
10.5	34	-	-	-	34	0.1
11	19	5	-	-	24	0.1
11.5	24	-	-	-	24	0.1
12	48	39	-	-	87	0.2
12.5	67	173	5	-	246	0.7
13	48	520	-	-	568	1.6
13.5	77	1344	-	-	1421	4.1
14	48	2611	53	-	2712	7.7
14.5	19	3622	125	-	3767	10.8
15	-	4508	491	-	4999	12.8
15.5	-	4537	771	-	5307	13.7
16	-	3584	1112	5	4700	13.1
16.5	-	2905	1189	-	4093	11.4
17	-	2649	1145	5	3799	10.6
17.5	-	1460	978	5	2442	7.0
18	5	665	747	5	1421	4.1
18.5	-	212	284	-	496	1.4
19	-	39	82	5	125	0.4
19.5	-	10	19	-	29	0.1
Total number	434	28881	7000	24	38339	
Percentage	1.2	79.5	19.2	0.1	100.0	100.0
Total weight	3.9	607.9	193.6	0.8	805.8	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970-2000 and their division by areas.

Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
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
N-Iceland	2	12	52	46	57	46	10	19	29	25	19	6	5
East Iceland	-	+	7	17	7	3	15	3	+	1	+	-	+
Total	11	19	89	116	134	89	32	43	31	49	40	29	13

Area	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NW-Irminger Sea	+	+	1	+	1	3	1	+	8	3	2	3	+
W-Iceland	3	2	8	16	6	22	13	7	2	11	21	12	6
N-Iceland	18	17	19	17	6	26	24	12	43	20	13	69	10
East Iceland	1	9	3	4	1	1	2	2	1	+	15	10	8
Total	22	28	31	37	14	52	40	21	54	34	51	94	24

	1996	1997	1998	1999	2000
NW-Irminger Sea	2	5	+	+	+
W-Iceland	17	14	7	25	1
N-Iceland	57	30	34	51	7
East Iceland	6	12	5	7	4
Total	82	61	46	83	12

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys of 1983–2000.

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

	1997	1998	1999	2000
Number (10^9)	143	87	55	94
Mean length (cm)	9.3	9.0	9.5	9.5
Mean weight (g)	2.8	2.9	3.2	3.1

Table 5.3.2.1 Acoustic abundance estimate of maturing capelin, 10/11-02/12 2000

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (1) 1999	(2) 1998	(3) 1997	Total	Avgwt (g)	BIOMASS (10^{-3}t) (Age) Year class (1) 1999	(2) 1998	(3) 1997	Total
12	0.019	0.011	-	0.03	6.6	0.1	0.1	0	0.2
12.5	0.302	0.566	-	0.868	7.7	2.3	4.3	0	6.7
13	0.470	1.845	-	2.315	9.1	4.3	16.7	0	21
13.5	0.141	1.780	0.018	1.938	10.5	1.5	18.7	0.2	20.4
14	0.027	2.045	0.053	2.124	12.1	0.3	24.8	0.6	25.7
14.5	0.031	2.188	0.031	2.249	14.1	0.4	30.8	0.4	31.6
15	-	1.843	0.174	2.018	16.0	0	29.6	2.8	32.4
15.5	-	0.629	0.067	0.696	19.4	0	12.2	1.3	13.5
16	-	0.257	0.012	0.27	22.6	0	5.8	0.3	6.1
16.5	-	0.228	0.036	0.264	24.8	0	5.7	0.9	6.6
17	-	0.056	0.042	0.098	28.0	0	1.6	1.2	2.7
17.5	-	0.068	0.102	0.17	29.7	0	2	3	5
18	-	0.093	0.031	0.124	34.9	0	3.2	1.1	4.3
Total	0.989	11.608	0.565	13.163	13.4	8.9	155.5	11.8	176.2
Average length (cm)						13.0	14.2	15.8	14.2
Average weight (g)						9.0	13.4	20.8	13.4

Table 5.3.2.2 Acoustic abundance estimate of immature capelin, 10/11-02/12 2000

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (1) 1999	(2) 1998	(3) 1997	Total	Avgwt (g)	BIOMASS (10^{-3}t) (Age) Year class (1) 1999	(2) 1998	(3) 1997	Total
8	0.207	-	-	0.207	1.2	0.3	-	-	0.3
8.5	1.812	-	-	1.812	1.9	3.5	-	-	3.5
9	8.065	-	-	8.065	2.4	19.0	-	-	19.0
9.5	16.093	-	-	16.093	2.9	46.0	-	-	46.0
10	26.038	0.037	-	26.076	3.4	87.3	0.1	-	87.4
10.5	19.266	0.137	-	19.403	4.0	77.3	0.5	-	77.9
11	15.16	0.26	-	15.421	4.8	72.1	1.2	-	73.3
11.5	10.005	0.722	-	10.727	5.6	55.6	4.0	-	59.6
12	3.972	2.317	-	6.289	6.5	25.9	15.1	-	41.1
12.5	1.364	2.533	-	3.897	7.6	10.4	19.3	-	29.7
13	0.557	2.161	-	2.718	9.0	5.0	19.5	-	24.5
13.5	0.106	1.328	0.013	1.448	10.5	1.1	14.0	0.1	15.2
14	0.012	0.935	0.023	0.97	12.1	0.1	11.3	0.3	11.7
14.5	0.004	0.264	0.004	0.272	14.1	0.1	3.7	0.1	3.8
15	-	0.149	0.012	0.162	16.1	-	2.4	0.2	2.6
15.5	-	0.015	0.002	0.017	19.5	-	0.3	0.0	0.3
Total	102.661	10.86	0.055	113.575	4.4	403.7	91.6	0.7	496.0
Average length (cm)						10.3	12.7	14.2	10.6
Average weight (g)						3.9	8.5	13.0	4.4

Table 5.3.2.3 Acoustic estimate of mature capelin, 22/01-15/02 2001

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (2) 1999	(3) 1998	(4) 1997	Total	Avgwt (g)	BIOMASS (10^{-3}t) (Age) Year class (2) 1999	(3) 1998	(4) 1997	Total
12.5	0.416	0.063	-	0.479	7.0	2.9	0.4	-	3.3
13	0.552	0.253	-	0.805	8.3	4.5	2.1	-	6.6
13.5	0.543	0.563	-	1.106	9.9	5.2	5.7	-	10.9
14	0.963	2.743	-	3.705	11.5	10.9	31.7	-	42.6
14.5	0.367	3.840	0.066	4.273	13.3	4.8	51.2	0.9	56.9
15	0.483	5.969	0.451	6.903	15.4	7.3	91.9	7.0	106.2
15.5	0.076	4.561	0.727	5.364	17.9	1.3	81.3	13.3	95.9
16	-	6.389	1.173	7.562	20.4	-	129.9	24.5	154.4
16.5	-	4.564	0.985	5.565	22.9	-	104.3	22.6	126.9
17	-	3.558	1.443	5.002	25.8	-	92.0	37.3	129.3
17.5	-	2.209	1.315	3.542	28.6	-	63.2	37.5	100.7
18	-	1.338	2.094	3.432	32.4	-	43.7	67.3	111.0
18.5	-	0.835	0.404	1.239	36.7	-	30.7	14.8	45.5
19	-	0.018	0.420	0.437	39.7	-	0.8	16.6	17.4
19.5	-	0.040	0.053	0.094	41.1	-	1.7	2.2	3.9
Total	3.401	36.945	9.132	49.508	20.5	36.9	730.6	244.0	1011.5
Average length (cm)						13.8	15.8	17.1	15.9
Average weight (g)						10.9	19.8	26.7	20.5

Table 5.3.2.4 Acoustic estimate of immature capelin, 22/01-15/02 2001

Length (cm)	NUMBERS (10^{-9}) (Age) Year class (2) 1999	(3) 1998	(4) 1997	Total	Avgwt (g)	BIOMASS (10^{-3}t) (Age) Year class (2) 1999	(3) 1998	(4) 1997	Total
9	0.064	-	-	0.064	2.0	0.1	-	-	0.1
9.5	1.399	-	-	1.399	2.8	3.9	-	-	3.9
10	3.248	-	-	3.248	3.1	10.0	-	-	10.0
10.5	4.961	-	-	4.961	3.6	17.8	-	-	17.8
11	5.545	-	-	5.545	4.2	23.3	-	-	23.3
11.5	4.481	-	-	4.481	5.0	22.3	-	-	22.3
12	4.052	0.066	-	4.117	5.9	24.1	0.4	-	24.5
12.5	4.003	0.472	-	4.476	7.1	28.4	3.3	-	31.7
13	3.051	0.901	-	3.952	8.1	24.8	7.4	-	32.2
13.5	2.638	1.085	-	3.724	9.5	25.1	10.3	-	35.4
14	0.987	2.082	-	3.069	11.2	11.1	23.4	-	34.6
14.5	0.338	2.253	0.004	2.595	12.9	4.3	29.1	0.1	33.5
15	0.164	1.579	0.113	1.855	14.9	2.5	23.5	1.6	27.6
15.5	0.018	0.759	0.018	0.796	17.3	0.3	13.1	0.4	13.8
16	-	0.233	0.025	0.258	19.5	-	4.6	0.5	5.1
16.5	-	0.082	0.015	0.097	22.3	-	1.8	0.3	2.1
Total	34.95	9.512	0.174	44.636	7.1	197.9	116.8	2.9	317.5
Average length (cm)						11.6	14.2	15.3	12.2
Average weight (g)						5.7	12.3	16.4	7.1

Table 5.4.1 The calculated number (billions) of capelin on 1 August 1978–2001 by age and maturity groups. The total number (billions) and weight (thousand 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	751	366	283	209	683	985	1067	1168	876	950
Weight mature	2081	1769	847	829	355	1085	1340	1643	2260	1689

	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	144.3	224.1	197.3	191.2	165.4
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	45.1	28.7	35.2
2 mature	70.3	42.8	31.9	67.7	70.7	86.9	59.8	102.2	100.7	90.3
3 mature	24.5	15.8	6.8	6.7	6.4	10.9	13.2	23.0	29.6	19.0
4 mature	0.4	+	+	+	+	0.2	-	+	+	+
Number immat.	104.8	74.2	127.6	142.6	179.5	164.7	259.2	242.4	219.9	200.6
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	125.1	130.3	109.3
Weight immat	438	309	542	702	747	702	1019	1188	985	758
Weight mature	1663	1173	751	1273	1311	1585	1268	1819	1900	1590

	Year			
Age/maturity	1998	1999	2000	2001
1 juvenile	167.9	*138.0	*166.2	
2 immature	19.2	24.4	*25.0	
2 mature	89.5	85.9	65.7	**78.1
3 mature	23.2	12.6	16.0	**16.9
4 mature	+	+		
Number immat.	187.1	*162.4	*191.2	
Number mature	112.7	98.5	81.7	**95.0
Weight immat	621	*612	*715	
Weight mature	1576	1702	1519	**1638

* Preliminary
** Predicted

Table 5.4.2 The calculated number (billions) of capelin on 1 January 1979–2001 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	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	1998
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	188.1	165.2	160.0	138.8
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	24.1	29.5
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4	50.1
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8	7.9
5 mature	0.3	+	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	217.6	203.1	184.1	168.3
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2	58.0
Weight immat.	434	291	501	487	622	573	696	800	672	621
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881	1106
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8	27.6
Weight sp. st.	440	115	330	475	499	460	420	830	430	492

	Year		
Age/maturity	1999	2000	2001
2 juvenile	140.9	*115.8	*139.5
3 immature	16.1	*20.5	*21.7
3 mature	53.2	68.2	46.3
4 mature	16.0	10.0	10.5
5 mature	+	+	+
Number immat.	157.0	*136.3	*161.2
Number mature	69.3	78.2	56.8
Weight immat.	585	*535	*621
Weight mature	1171	1485	1197
Number sp.st.	29.5	34.2	21.3
Weight sp. st.	500	650	450

*Preliminary/Predicted

Table 5.5.1.1 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	100.7	16.4	129.4	19.0
1995	111.9	90.3	30.8	125.5	23.2
1996	128.5	89.5	6.3	108.0	12.6
1997	121.0	85.9	5.0	98.5	15.6
1998	89.8	64.3	11.0	**84.1	
1999	103.0				

* Invalid due to ice conditions.
** Preliminary

Table 5.5.1.2 Mean weight (g) in autumn of maturing capelin.

	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

	Years 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

	Years 1997	1998	1999	2000
Age 2	14.3	14.1	16.8	17.1
Age 3	20.3	18.1	20.6	24.7

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1983/84–2000/2001 seasons.
The last row gives contemporary advice on TACs for comparison.
Age 2 and age 3 = Numbers in billions in age groups at the beginning of season.
Fish.st. = calculated weight of maturing capelin in thousand tonnes (ref. 1 August).
TAC calc = predicted in thousand tonnes.

Season	83/84	84/85	85/86	86/87	87/88	88/89	89/90	90/91	91/92
Year classes	81-80	82-81	83-82	84-83	85-84	86-85	87-86	88-87	89-88
Age 2	63.0	43.4	67.8	34.9	55.5	64.8	43.2	31.1	39.4
Age 3	0.0	26.3	20.2	55.0	13.7	29.0	25.5	8.2	3.7
Fishable stock	1065	1373	1637	1926	1268	1800	1350	724	755
Calculated TAC	465	733	963	1215	642	1105	713	170	197
Advised TAC	573	897	1311	1333	1115	1036	550	265	740

Season	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01
Year classes	90-89	91-90	92-91	93-92	94-93	95-94	96-95	97/96	98 /97
Age 2	56.4	93.1	89.6	92.5	90.0	83.8	94.4	89.2	65.7
Age 3	18.3	22.6	27.0	14.9	35.0	30.9	30.8	23.3	16.0
Fishable stock	1398	2123	2170	1916	2352	2019	2088	1885	1416
Calculated TAC	755	1385	1427	1200	1635	1265	1420	1285	975
Advised TAC	*900	1250	850	1390	1600	1265	1200	1000	**1110

*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.

** In March 2001, 100 000t were added to the 1 010 000 t recommended after the January/February 2001 survey due to due to much higher mean weights in the catch during 1 February-10 March than measured during the survey.

Table 5.7.1 Capelin in the Iceland-East 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	Recruitment	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	144	2363	1179	460
1994	224	2287	864	420
1995	197	3174	929	830
1996	191	3310	1571	430
1997	165	3014	1245	492
1998	168	2197	1100	500
1999	*138	*2314	934	650
2000	*166	*2234	1071	440

*Preliminary

6 BLUE WHITING

6.1 Stock Identity and Stock Separation

Blue whiting stock is treated as a single stock for assessment purposes although morphological, physiological and genetic research has indicated that the southern and northern components of the stock may mix in the spawning area west of the British Isles (ICES C.M. 2000/ACFM:16)

6.2 Fisheries in 2000

Estimates of the total landings of blue whiting in 2000 from the fisheries are given by country in Tables 6.2.1 - 6.2.4 and summarised in Table 6.2.5. In Figure 6.8.1 the distribution of the catches are shown by quarters of the year. The total landings from all blue whiting fisheries in 2000 were 1 412 253 t, which is the highest catch on record, and 156 thousand t greater than in 1999. This exceeded the recommended TAC of 800 000 t by 77 %.

The majority of blue whiting catches were taken, as usual, in the spawning area. The catch there was 997 000 tonnes in 2000, representing an increase of 6% from 1999 when the catch was 941 000 t. In the beginning of the spawning fishery i.e. February – March, the fishery mainly took place from the Porcupine Bank to Rockall. The fishery continued in the area west of Rockall and in the shelf area off the Hebrides. In May the fishery was mainly conducted in the Faroese zone and southeast Icelandic waters (Table 6.2.2. and Figure 6.8.1).

During summer and autumn a significant fishery also took place in the southern part of the Norwegian Sea (Figure 6.8.1). The landings in 2000 from the Norwegian Sea increased by 52% from 1999 and constituted 277 000 t (Table 6.2.1).

The total landings from international waters were 276 857 t of which 31 499 t were landed from international zone in the Norwegian Sea and 245 358 t were landed from the international zone to the west of the British Isles. About 22 % were thus landed from international waters (Table 6.8.1). In autumn 2000 some small catches were taken in the western part of the Barents Sea (Figure 6.8.1).

Denmark and Norway took the bulk of the catch in the mixed industrial fisheries, or 111 000 t of a total catch of 114 000 t. The total catch in this fishery increased from 107 000 t in 1999 to 114 000 t in 2000 (Table 6.2.3.) The fishery in the southern area, mainly conducted by Spain and Portugal, was at an average level in 2000, with a total of 25 000 t (Table 6.2.4.). Data on discards from the Spanish fleets are available for 1994, 1997 and 1999, and has also be estimated for 2000. Discards were not included in the assessment because the time series is too short.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on the combined length composition of the 2000 commercial catches from the directed fisheries in the Norwegian Sea and the spawning area of the blue whiting stock by quarter of the year were provided by The Faroes, Iceland, Ireland, The Netherlands, Norway and Russia. Length composition of blue whiting varied from 11 to 48 cm, with most fish ranging from 25 – 28 cm in length (Table 6.3.1.1). Length compositions from the mixed industrial fisheries were presented by Norway and Denmark. The catches of blue whiting from the mixed industrial fisheries consisted of fishes with lengths of 13 - 37 cm with a mode of 22 cm. A peak at 14 cm fish in the 4th quarter indicates the recruiting 0 - group to the fishery (Table 6.3.1.2). Spain and Portugal caught blue whiting in the Southern area. The Spanish data were used for length distribution of catches, showing a length range from 14 - 40 cm with modal length of 22 cm (Table 6.3.1.3).

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 2000, age compositions were provided by The Faroe Islands, Iceland, Ireland, Norway and Russia, which together accounted for 89 % of the catches. For other nations the catch at age was raised accordingly. The age compositions in the directed fisheries are given in Table 6.3.2.1.

Age compositions for the mixed industrial fisheries in 2000 were provided by Norway, which accounted for 64% of catches. For all other nations Norwegian data were used for allocation. The age compositions are given in Table 6.3.2.2.

For the fisheries in the Southern area, Spain presented age compositions and accounted for 92% of catches. The Spanish data were used for allocation. The age compositions in the southern fishery are given in Table 6.3.2.3.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the landings of blue whiting in the mixed industrial fisheries and for landings in the Southern area, were assumed to give the overall age composition of total landings for the blue whiting stock. The catch numbers at age used in the stock assessment are given in Table 6.3.2.4. The 1995-1997 year classes were the most numerous in the catches followed by the 1999 yearclass, which was the most numerous one in the mixed industrial fishery.

To calculate the total international catch at age, and to document how it was done, the program SALLOC was used (ICES 1998/ACFM:18). The allocation process is illustrated in Tables 6.3.2.5 - 6.3.2.7, which show the disaggregated fisheries assessment data (DISFAD files) presented for directed fisheries, mixed industrial fisheries and southern fisheries. The allocations are shown in Table 6.3.2.8 (ALLOC files).

6.3.3 Weight at age

Mean weight at age data were available from Norway, Russia, The Faroes, Iceland, Ireland, and Spain. Mean weight at age for other countries was based on the allocations shown in Table 6.3.2.8 (ALLOC files) and for the total international catch was estimated by the SALLOC program. Table 6.3.3.1 shows the mean weight-at-age for the total catch during 1981 - 2000 as used in the stock assessment. The weight in the stock was assumed to be the same as the weight in the catch.

6.3.4 Maturity at age

Maturity at age used in the assessment was obtained by combining maturity ogives from the southern and northern areas, weighted by catch in numbers at age (ICES 1995/Assess:7). These are the same as those used since 1994 (Table 6.5.1). However, during the spring survey to the spawning area in 2001, more then 80 % of the 2 year-olds were mature (Figure 6.3.4.1.) comprising more than 50 % of the spawning stock.

6.4 Stock Estimates

6.4.1 Acoustic surveys

6.4.1.1 Surveys in the spawning season

In March - April 2001 the Norwegian R.V. “Johan Hjort” surveyed the blue whiting stock in the shelf edge and bank areas west of The British Isles and in Faroese waters (WD Monstad et al., 2001).

Good recordings of blue whiting were observed from the northwestern part of the Porcupine Bank and northwards along the shelf edge. The highest values were recorded off The Hebrides and the concentrations extended well into the Faroese zone (Figure 6.4.1.1).

The immature part of the stock was estimated at 1 million t (24.4 x 10^9 individuals) while the spawning stock, estimated at 5.6 million t (72.1 x 10^9 individuals), was 2.2 million t lower than the estimate of 2000. The age-stratified estimate is given in Table 6.4.1.1.

There is a decreasing tendency in the observed stock sizes since 1999 and a striking difference from previous years is the dominance of the very young fish. The 1999 year-class dominated the whole area surveyed, and alone made up 2.8 million t, or 46 % in numbers. The 3 and 4 year olds together made up only 28 % in numbers. The 1999 year-class, of which more than 80 % were found to be mature (Figure 6.3.4.1), dominated the spawning stock and constituted more than 50 % of it (Figure 6.4.1.3). The 1996 and 1997 year-classes, which in 2000 jointly represented 71 % of the recorded stock, made up 2.2 million t in 2001 and jointly only 23 % in numbers.

A consequence of this is that significantly smaller fish will be caught in the spawning area and hence a higher number of specimens are needed to fill the quotas than if older year-classes had been more prominent, as in previous years. However, samples from commercial catches taken in the Rockall area, showed that significantly larger fish occurred in that area during March, than was observed in April. In the Faroese zone more westerly than the area surveyed by “Johan Hjort”, also commercial vessels reported such large fish, i.e. more than 30 % in numbers were larger than 27 cm.

Although the spawning stock size in 2001 is at the same level as for the period 1990 – 2000 average, the significantly decreasing tendency, together with the dominance of very young fish in the spawning stock should be observed with attention.

Estimates of total and spawning biomass of blue whiting in the spawning area made by Russian, Norwegian and Faroese surveys since 1983 are given in Table 6.4.1.2. Usually, the acoustic estimates have been well above the assessments, and these estimates have been used as relative indices only.

6.4.1.2 Surveys in the feeding season

Since 1995, Norway, Russia, Iceland and Faroes, and since 1997 also the EU, have co-ordinated their survey effort on pelagic fish stocks in the Norwegian Sea. Holst *et al.* (2000) reported on distributions and migrations of blue whiting in 2000. For both the Icelandic EEZ and Norwegian Sea age stratified estimates of blue whiting were reported, these are given in Tables 6.4.1.3 and 6.4.1.4 respectively.

The Norwegian and Icelandic surveys conducted in July – August in 1998 – 2000, covered approximately the same area from year to year. There is a steady downward trend in the biomass estimate in the surveys and the biomass estimated in 2000 was 57 % lower than in 1998 as shown in the text table below.

Year	Norwegian survey (million t)	Icelandic survey (million t)	Total (million t)
1998	6,6	1,6	8,2
1999	4,2	1,8	6,0
2000	2,5	1,0	3,5

In 1999 the very strong year classes of 1995 and 1996 constituted about 66 % of the total number of fish, but in 2000 those same year classes only comprised about 9 % of the total, while the 1999 yearclass constituted 60 %. In 1999 the 0-group appeared quite numerous in the Icelandic area, which was the first sign of that year class being a strong one. Only 2 years later it became the dominant part of the spawning stock, as mentioned above. The 2000 yearclass was also found to be quite numerous as 0-group in Icelandic waters, although not as strong as the 1999 yearclass. Also these survey results are used as relative indices in the assessment.

6.4.2 Bottom trawl surveys in the southern area

Bottom trawl surveys have been conducted off the Galician (NW Spain) and Portuguese coasts 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 Spanish waters in Division VIIIc. The area covered in the Portuguese survey was also extended in 1989 to the 750 m contour. Stratified mean catches and standard errors from the Spanish and Portuguese surveys are shown in Tables 6.4.2.1 and 6.4.2.2. In both areas the larger mean catch rates are observed in the 100 - 500 m depth range. Since 1988 the highest catch rates in the Spanish survey were observed in 1999 (108 kg/haul), being also relatively high the 2000 values (74 kg/haul). The Portuguese summer surveys generally give higher values than in the autumn surveys, and a better correlation with the Spanish surveys (Figure 6.4.2.1).

6.4.3 Catch per unit effort

CPUE data for Spanish commercial Pair Trawlers in Divisions VIIIc and IXa have been submitted to the Working Group since 1984 and they are used as tuning data (see below).

Also CPUE data from the commercial fleet (pelagic trawl) in the spawning area in 2000 were submitted from Norway. These data were combined by vessel tonnage, class, and month, and added to the time series (since 1982) of overall aggregated CPUE values across areas in the Norwegian blue whiting fisheries (Figure 6.4.3.1). The Figure indicates an overall increasing trend from 1992 to 1998, decreasing to a lower level in 1999 and 2000. As in previous years, the data are not used in the assessment.

6.4.4 Data exploration and preliminary modelling

Based on previous experience, inspection of the data and trial runs prior to the meeting, a number of problems were identified:

1. Index observations with value 0.

2. The surveys cover the distribution area of the stock to a variable extent, and the indices may not be representative for the state of the stock.

3. The rapid increase in the catches to a very high level may render the assessment unstable, if there is conflicting evidence in the data as to how much is left of the various year classes.

4. The choice of length of the separable period in ICA has varied over the years, and it is uncertain which period is the most appropriate.

To address these problems, a series of preliminary runs were made. Three methods, ICA v 1.4 (Patterson 1999), AMCI (section 1.3.2) and ISVPA (section 1.3.6), were used. The options used as standard AMCI v. 1.2 run are described in section 6.4.5. Unless othervice stated, these runs were done without the spawning area acoustic survey for 2001, since these data only became available late in the meeting.

The key ICA run had the same settings as last year except that the number of years with a separability constraint was increased from 4 to 5 years. The options are given in Table 6.4.4.1 and the results in Table 6.4.4.2. Some diagnostic plots are given in Figure 6.4.4.1. While the results from the Norwegian 2001 survey on the spawning grounds are included in this run, they are not included in the other ICA runs mentioned in the text. The inclusion of these data produced no major difference in the results, just a slightly lower reference F and a somewhat higher biomass of the younger age groups. Except for what is mentioned in the text, the other ICA runs had the same settings as the key run.

The results for all models indicated a substantial increase in fishing mortality in the most recent years, but the actual values were very sensitive to the data used. One ‘key’ run with all data was made with ICA and AMCI and various options were compared to these runs.

Sensitivity to observations with zero value in the tuning files in ICA was explored in two ways. Zero-value observations are ignored by ICA and are treated in the same way as missing data (-1). In the view of the WG this represents information that ‘very few’ fish are left, which can be expressed by substituting the zero-value with a small number. However, the lognormal likelihood of such a number is highly dependent on the actual value used. The resulting time series of F’s from four ICA runs where the zero-values were replaced by 0.1, 0.01, 0.001 and –1 respectively, are shown in Figure 6.4.4.2.lower panel. The reference F in year 2000 varies from 0.7 (zero-values ignored), to 2.4 (zero-values = 0.1) and to about 3.4 (zero-values set to 0.01 or 0.001). Thus, ICA is highly sensitive to whether zero-values are ignored or replaced by small values, as well as to the actual value where this value is greater than 0.01. Zero-value observations occurred in the age groups 8, 9 and 10 in the various tuning series.

Figure 6.4.4.2 upper panel shows down weighting (weight equal 0.1) of different combinations of these age groups compared to no down weighting. During these runs zero-values were substituted with 0.1. F in the case of no down weighting is 2.4, as compared to 1.7 where age 10 is down weighted, 1.4 where ages 9 and 10 are down weighted and 1.0 where ages 8, 9 and 10 are down weighted. The sensitivity of ICA to small values in the tuning fleets can thus be counteracted by down weighting of the affected age groups.

It was decided to leave out those age groups that contained zero-values, from the tuning indices. These were ages 9 and 10 in the acoustic surveys on the spawning grounds, ages 9 and 10 in the Russian acoustic survey and ages 8, 9 and 10 in the Norwegian Sea acoustic survey. The rationale for this was that although the index values for these ages may indicate low abundance, the occurrence of zeroes which are not confirmed elsewhere, indicates that these age groups may not be sampled properly; in the sense that the actual amount remaining in the sea is not well measured. The use of small or zero values in the indices for these ages has an impact on the assessment, which is out of proportion with the quality of the data. Alternatively, it would be preferable to assemble these ages in a plus group. It was not possible to do this during the meeting due to the unavailability of data for the older age groups, but this should be looked into for the next meeting.

The effect of the various tuning fleets on the assessment was explored by comparing assessments with only one tuning series to the basic run (all fleets included). ICA assessments are compared in Fig. 6.4.4.3 and AMCI assessments in Fig 6.4.4.4. The ICA and AMCI basic runs are similar although small differences are seen, for instance in the recruitment towards the end of the period. The ICA assessment is seen to be more sensitive to the choice of tuning indices than AMCI. The Spanish CPUE series causes a decrease in SSB in both models, evidently because this index indicates lower recruitment during the last 6 years.

None of the tuning series completely cover the distribution area of the stock. The survey at the spawning grounds is probably the best in this respect. The Spanish CPUE index represents a fleet exploiting blue whiting over a small part of the distribution of this species, and the strong 1995 and 1996 yearclasses were not picked up by this series. The relevance of this index has been questioned by ACFM and the WG was requested in the technical minutes to address this. The Norwegian Sea acoustic survey also covers only part of the area and is based on a cruise track with very wide transect spacing. The sampling on this survey is sparse, and the coverage area does not include Icelandic waters where considerable amounts of blue whiting have been observed in the same period. The Norwegian Sea acoustic survey series indicated a very high F in year 2000 (about 1.0 in the ICA assessment), while the Spanish CPUE index indicated more moderate rise in F (to approximately 0.85). The results with AMCI showed a similar trend, but somewhat smaller differences between the runs using different indices.

The omission of certain indices was considered. Some of the indices, where data are missing in recent years, have little impact. Both the Norwegian Sea acoustic and the Spanish CPUE were considered to cover only part of the area, and not to consistently pick up strong and weak year classes. However, since these indices had little difference to the final results (when the oldest age groups were removed), it was decided to retain the indices in the assessment for the time being. The WG should, however, revisit this issue in the future.

The rapid increase in the catches is expected to give rise to a considerable increase in the fishing mortality, but the various sources of data give conflicting signals as to how great this rise is. The Norwegian Sea acoustic survey indicates that most of the old fish have disappeared, but it is uncertain how well these ages have been sampled.

The period of separable constraint in ICA has been changed from year to year, and a period of 4 years was used by the WG in 2000. To explore the effects on the assessment two ICA runs were made that differed only in the length of the period of separable constraint; 5 and 10 years respectively. The results (Fig 6.4.4.5) show that the F's (upper panel) were higher and the recruitment (middle panel) and the SSB's (lower panel) were lower when a 10-year period is used. Thus ICA is sensitive to the period of separable constraint.

Use of the ISVPA was attempted, to explore which signals were contained in the catch-at-age data. A run with the ISVPA was provided by Vasiliev (pers.com.). Previous attempts by the WG using several slightly different constraints and options failed to give a significant minimum of the objective function and sometimes gave quite unrealistic results. The WG considers that the present data set is outside the quality range where a robust solution with respect to fishing mortality and stock numbers can be found from catch data only.

The WG decided to use the AMCI model in the Blue whiting assessment. The ISVPA model could not be used for reasons mentioned above. The AMCI model seemed to be more stable and less sensitive to which data were included than ICA. The ICA model was found to be sensitive to the period of separable constraint, a problem not relevant in the AMCI model. Another advantage with AMCI is that the bootstrap method for estimating uncertainty is in line with the method used for the assessment of other stocks by this WG.

6.4.5 Stock assessment

There are six tuning fleets available for the blue whiting stock; The Norwegian Sea acoustic survey which covers the feeding area of the northern stock component, the Norwegian and the Russian acoustic surveys on the spawning grounds, the Spanish bottom trawl survey, the Portuguese bottom trawl survey and the CPUE from Spanish pair trawlers, where the last three fleets cover the southern component of the stock. The indices are shown in Table 6.4.5.1.

In 1998 it was decided to leave out the Spanish bottom trawl survey indices and the Portuguese bottom trawl indices, due to large contributions from these fleets in the variance. In 1999, it was decided to split three of the tuning series, the Norwegian Sea acoustic survey, the Norwegian survey and the Russian survey on the spawning grounds. The reason for splitting these index series was the change to a Simrad EK-500 echo sounder in 1991 in the first two series and in the 1992 in the Russian tuning series.

The final assessment was done with the AMCI model v. 1.2 (see section 1.3.2) with the following data and settings:

- Catches at age 0-10, with age 10 treated as a plus group
- Survey indices:

1) Norwegian acoustic survey on the spawning grounds, ages 2-8, 1981-1990
2) Norwegian acoustic survey on the spawning grounds, ages 2-8, 1991-2001
3) Russian acoustic survey on the spawning grounds, ages 3-8, 1982-1991

4) Russian acoustic survey on the spawning grounds, ages 3-8, 1992-1996
5) Spanish pair trawlers CPUE, ages 1-6, 1983-2000
6) Norwegian sea acoustic survey, ages 1-7, 1981-1990
7) Norwegian sea acoustic survey, ages 1-7, 1999-2000

The Norwegian acoustic survey data from the spawning grounds in 2001 became available during the meeting, and were included in the final run, but not in the preliminary runs described above.

The objective functions was a sum of the following partial objective functions:

- Log sum of squares of catches at age, weight 1
- Log sum of squares of yearly yields, weight 100. This acts as a weak penalty on the yearly yields
- Log sum of squares for survey indices at age, weight 1 for each fleet

Catch at age data were down weighted by a factor of 0.1 for age 0 and with a factor of 0.5 for age 1.

Fishing mortality was modelled as separable, but with a gradual change in the selection. The gain factor for change in selection was 0.5 for age 0, 0.2 for age 1 and 0.1 for the older ages. This implies that the selection at ages 0 and 1 is allowed to vary more according to the year-to-year variation in the catches than the selection at the older ages. The selection in 1981 was fixed at values approximately the average of 1981-1989, obtained after one iteration. This was done because the fishing mortality and stock numbers in the initial year tend to be highly correlated. Fishing mortality in 2001 was assumed to be equal to that in 2000, and the recruitment in 2000 was estimated according to the stock-recruitment function. The stock-recruitment function was the 'Ockham's razor', with a constant recruitment at SSB > 1 500 000 t a linear decrease towards 0 below that SSB value. This function was fitted to the data by minimising the sum of the squared log residuals independent of the overall objective function. Survey indices were assumed to be related to the stock numbers by simple proportionality. Catchabilities were estimated at each age and assumed constant over the years.

The model accepts yearly catch at age data, but operates internally on a quarterly basis. The spawning stock is derived from the mean stock numbers in the first quarter, and the survey indices are related to the mean values in the survey season. The yearly fishing mortality was split on quarters assuming 0.35 in the first and in the second quarter, 0.2 in the third quarter and 0.1 in the fourth quarter.

Natural mortality was assumed constant at 0.2 for all ages.

The model was run until 2002. The results for 2001 and 2002 are predicted values assuming a fishing mortality as in 2000. The results are presented in Tables 6.4.5.2 to 6.4.5.6.

A bootstrap run was made where catches at age and survey indices at age, as well as recruitments in the years 2000 - 2002 were drawn randomly. This was done by non-parametric bootstrap, i.e. catch-at-age and survey indices were drawn by using the modelled values and their residuals, and drawing residuals randomly to each data point, which were added to the modelled values. Recruitments were drawn assuming a lognormal distribution. A new parameter estimation was done for each replicate set of data. One hundred replicates were run. The results are summarised in Figure 6.4.5.1. Figure 6.4.5.2 shows cumulative probability distributions for SSB in 2001.

The results show a strong increase in fishing mortality over the last years. The selection pattern seems to be quite stable over the whole period. The strong 1995 and 1996 and older year classes are now considerably reduced, and the stock is now dominated by young fish. The 1999 yearclass looks strong, but may not be as large as the previous large year classes, although the strength of this yearclass is still poorly estimated. This age structure implies that the stock will decline rapidly if the fishing mortality is maintained at the 2000 level in 2001.A crude estimation of the 2001catch data (to date) by the WG, indicates that this may already be the case. The bootstrap run gives an indication of the uncertainty in the assessment. The trend in fishing mortality is consistent irrespective of the actual level, while the strength of the 1999 yearclass still is highly uncertain. The probability that SSB is below the B_{lim} of 1500 000 t already in 2001 is estimated to be approximately 35%.

6.5 Short-Term Projection

Based on the final AMCI run, a deterministic short-term projection was made using the MFDP program and the yield per recruit estimations were made by means of the MFYPR program, with the input stated in Table 6.5.1. The weight in the stock and catch were taken from the average of the last three years values. The selection pattern and the reference F in 2000 from the final AMCI run were used as input values in 2001. The recruitment in 2001-2003 was set as the geometric mean of the recruitment values in the period 1981-1999 in the AMCI run. For all ages the output values in 2001 from the AMCI run were used as the initial stock size. The proportion of F and M before spawning was set to 0.25, taking into account the proportion of the catches that take place before the spawning period.

The results are given in Table 6.5.2a and the standard plots are given in Figure 6.5.1. Continuing fishing at the 2000 level predicts a catch of 1.2 million t in 2001 and 0.9 million t in 2002. This exploitation rate implies a decreasing trend of SSB with 1.5 million t in 2001 and, 1.2 and 1.0 million t in 2002 and 2003 respectively. The predicted total stock biomass will also decrease from 3.6 million t in 2001 to 2.9 and 2.5 million t in the following years.

Additionally a second short-term prediction using the same MFDP program was run with the only difference of introducing as input value a TAC constraint in 2001 of 628 000 t.

The results of this second projection are given in Table 6.5.2b. Continuing fishing at the catch level recommended by ACFM for 2001 (628 000 t) in 2002 would maintain the SSB value at around 1.7 million t in the short term.

6.6 Medium-Term Projection

Medium term projections this year were done using the STPR software (See Section 1.3.3), which appeared to be the most convenient way to use the outputs produced by AMCI.

An 'Ockham’s razor' stock recruitment function was assumed, with a constant expected recruitment at SSB above 1.5 million t, a linear decline towards the origin at lower SSB and a constant coefficient of variation. This function was chosen because there is no clear dependence on the SSB within the range for which there is data. The function is shown in Figure 6.6.1.

Initial numbers were taken from the final AMCI run. The program uses the numbers at the start of the last assessment year, and a catch constraint for that year. Accordingly, the stock numbers at the start of 2000 and the total catch in 2000 were used. Variance-covariances of the initial numbers were derived from the numbers at age in 2000 in the bootstrap runs.

The selection pattern used was that for 2000. This pattern has been relatively stable over the whole time period, as shown in Figure 6.4.5.3. Weights at age were taken from the historical values, and the maturity ogive was the standard ogive used in the assessment.

Preliminary runs of the model indicated a bias problem, with SSB estimates for 2001 far above the assessed value. Using the distribution of the stock numbers at age in 2000 from the bootstrap run as a guideline, it appeared that the log-normal distribution assumed for the initial numbers was far from adequate, and that these numbers had a quite symmetric distribution. Therefore, the program was modified so that initial numbers were drawn from a normally distributed population with variances taken from the bootstrap values. For practical reasons, no attempt was made to include the covariances, but these were not prominent. With this modification, the median predicted SSB for 2001 at F status quo was 1 435 000 t compared to 1 568 000 t estimated by AMCI.

Last year a large number of medium term runs were made to simulate various harvest control rules. Even though the bias problem was not recognised last year, the general inferences made from these runs are still valid, and the Working Group found no need to repeat this. This year, the stock is in a different situation, and medium term projections were made to evaluate which action needs to be taken in the near future. Accordingly, runs were made with two options for F in 2001, one being equal to the F in 2000, the other an F of 0.4, which may be approximately the F that is already realised this year. For the future years, various levels of constant fishing mortality were simulated, in order to outline the risk of bringing the SSB below the limit and pa-levels, and the prospect of bringing it above these levels. The results are summarised in Table 6.6.1.

The results indicate that with $F_{2001} = F_{2000}$, there is a considerable risk that the SSB in 2002 will be below B_{lim}, and that this risk is quite sensitive to the fishing mortality applied in 2001. At low fishing mortality from 2002 onwards, the probability of SSB falling below B_{lim} becomes small within a few years, but this risk persists at fishing mortalities above 0.25. With a lower F of 0.4 in 2001, the risk that SSB shall be below B_{lim} is considerably smaller, and there is a high probability of reaching even the B_{pa} if the future fishing mortality is moderate (below 0.25). Thus, according to the medium term predictions, the rebuilding of the stock will benefit considerably by a rapid reduction of the fishing mortality to low levels, with corresponding low catches in the near future.

6.7 Precautionary Reference Points

The precautionary approach software package was run, which produced only slightly different values for reference points than the ones obtained two years ago. It was decided not to revise the PA reference points. The WG is aware that there may be an inconsistency between the chosen B_{pa} and F_{pa}. Analysis done last year (ICES 2000) suggested that fishing mortality of F_{pa} will not keep the SSB above the B_{pa} level. A more thorough analysis should be carried out later.

6.8 Spatial, temporal and zonal distribution

The available international catch of blue whiting in 1978-2000, divided by areas within and beyond national fisheries jurisdiction as defined by NEAFC, is given in Table 6.8.1 and by quarter and ICES rectangles in Figure 6.8.1.

6.9 Management considerations

The fishery for blue whiting has expanded rapidly in recent years, while no agreement on TAC has been reached. The reported catches in 1998, 1999, and 2000 were all well above 1 million t reaching 1.4 million t in 2000. The catches in 2001 up till April were estimated at 500 000 t. In spite of this very high exploitation rate, the SSB has been at a fairly high level until 1999, due to exceptionally good recruitment during recent years. The year classes of 1995, 1996 and 1997 were all strong, which may also be the case for the 1999 yearclass.

Without these strong year classes the extensive fishery would have led to a severe depletion of the stock before now. The short term prediction indicates that the spawning stock level in 2001 may not only be below the precautionary level (B_{pa} =2.25 million t), but may be approaching the B_{lim} level (1.5 million t) which is the lowest SSB in the time series so far. Last year, the working group warned that such a decline might happen if the catch level of the previous years was maintained. This year’s assessment shows a decrease in the SSB in 2000, after the increase in the SSB observed in 1999 and a sharp increase in fishing mortality in recent years. The fishing mortality in 2000 is estimated at 0.86, which is almost three times F_{pa} (0.32). The results from the Norwegian 2001 survey on the spawning grounds show that 50% of the sampled spawners were of the 1999 year class, which is a shift towards younger age groups.

Both this age composition and the assessment indicate that the stock is currently dependent on good recruitment. Without continuous exceptionally strong recruitment the current level of exploitation is unsustainable. The stock may decline very rapidly and there is a strong need for immediate reduction of the exploitation rate. The WG is concerned that a large proportion of the catches continue to be taken in unregulated fisheries. The WG strongly recommends that the exploitation level be acutely reduced.

6.10 Sampling

Eight countries reported length samples of blue whiting in 2000, and seven of these also had age readings. The coverage of biological sampling for the directed and the southern fishery is considered adequate, while the sampling of the mixed industrial fishery should be improved.

6.11 Recommendations

For the last 4 years only one nation (Norway) has monitored the blue whiting spawning stock. Due to the relative long spawning period (February-May) and the large spawning area with continuous migration to and from the spawning fields, the WG therefore recommends that more nations take part in the surveying of the blue whiting spawning stock in the area to the west of the British Isles and in Faroese waters. This would lead to a synoptic coverage of the stock and the possibility to minimize some of the inherent uncertainties in the estimates.

The coordination for this should be included in the work of the ICES PGSPFN WG.

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the directed fisheries (Sub-areas I and II, Division Va, XIVa and XIVb) 1987–2000, as estimated by the Working Group.

Country	1987	1988	1989 [3])	1990	1991	1992	1993	1994 [2])	1995 [3])	1996	1997	1998	1999	2000
Faroes	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594	11,507	17,980
Germany	1,010	3	1,341	-	-	-	-	2	3	32	-	78	-	-
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iceland	-	-	4,977	-	-	-	-	-	369	302	10,464	64,863[4]	99,092	146,903
Netherlands	-	-	-	-	-	-	-	-	72	25	-	63	435	-
Norway	-	-	-	566	100	912	240	-	-	58	1,386	12,132	5,455	-
Poland	56	10	-	-	-	-	-	-	-	-	-	-	-	-
UK (Eng.&Wales)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
USSR/Russia [1])	112,686	55,816	35,250	1,540	78,603	61,400	43,000	22,250	23,289	22,308	50,559	51,042	65,932	103,941
Estonia	-	-	-	-	-	-	-	-	-	377	161	904	-	-
Latvia	-	-	-	-	-	-	-	422	-	-	-	-	-	-
Denmark													15	7,721
Total	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	173,676	182,436	276,545

[1]) From 1992 only Russia

[2]) Includes Vb for Russia.

[3]) Icelandic mixed fishery in Va.

[4]) include mixed in Va and directed in Vb.

Table 6.2.2 Landings (tonnes) of BLUE WHITING from directed fisheries (Division Vb,VIa,b, VIIb,c. VIIg-k and Sub-area XII) 1987–2000, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998[1]	1999	2000
Denmark	2,655	797	25	-	-	3,167	-	770	-	269	-	5051	19,625	11,856
Faroes	70,625	79,339	70,711	43,405	10,208	12,731	14,984	22,548	26,009	18,258	22,480	26,328	93,234	129,969
France	-	-	2,190	-	-	-	1,195	-	720	6,442	12,446	7,984	6,662	13,481
Germany	3,850	5,263	4,073	1,699	349	1,307	91	-	6,310	6,844	4,724	17,891	3,170	12,655
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	61,438	113,280
Ireland	3,706	4,646	2,014	-	-	781	-	3	222	1,709	25,785	45635	35,240	25,200
Netherlands[2])	5,627	800	2,078	7,280	17,359	11,034	18,436	21,076	26,703	17,644	23,676	27,884	35,408	46,128
Norway	191,012	208,416	258,386	281,036	114,866	148,733	198,916	226,235	261,272	337,434	318,531	519,622	475,004	460,274
UK (Scotland)	3,315	5,071	8,020	6,006	3,541	6,849	2,032	4,465	10,583	14,325	33,398	92,383	98,853	42,478
USSR/Russia [3])	165,497	121,705	127,682	124,069	72,623	115,600	96,000	94,531	83,931	64,547	68,097	79,000	112,247	141,257
Japan	-	-	-	-	-	918	1,742	2,574	-	-	-	-	-	-
Estonia	-	-	-	-	-	6,156	1,033	4,342	7754	10,605	5,517	5,416	-	-
Latvia	-	-	-	-	-	10,742	10,626	2,160	-	-	-	-	-	-
Lithauen	-	-	-	-	-	-	2,046	-	-	-	-	-	-	-
Total	446,287	426,037	475,179	463,495	218,946	318,081	347,101	378,704	423,504	478,077	514,654	827,194	940,881	996,577

[1]) Including some directed fishery also in Division IVa.

[2]) Revised for the years 1987, 1988, 1989, 1992, 1995,1996,1997

[3]) From 1992 only Russia

Table 6.2.3 Landings (tonnes) of BLUE WHITING from the mixed industrial fisheries and caught as by-catch in ordinary fisheries in Divisions IIIa, IVa 1987–2000, as estimated by the WG.

Country	1987	1988	1989	1990	1991	1992	1993 [3])	1994	1995	1996	1997	1998[2]	1999	2000
Denmark	28,541	18,144	26,605	27,052	15,538	31,189	41,053	19,686	12,439	51,832	26,270	56,472	45,013	38,109
Faroes	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	296	265	42
Germany [1])	115	280	3	-	-	25	9	-	-	-	-			-
Netherlands	-	-	-	20	-	2	46	-	-	-	793			-
Norway	24,969	24,898	42,956	29,336	22,644	31,977	12,333	3,408	78,565	57,458	27,394	28,814	48,338	73,006
Sweden	2,013	1,229	3,062	1,503	1,000	2,058	2,867	3,675	13,000	4,000	4,568	9,299	12,993	3,319
UK	-	100	7	-	335	18	252	-	-	1	-			-
Total	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609	114,477

[1]) Including directed fishery also in Division IVa.

[2]) Including mixed industrial fishery in the Norwegian Sea

[3]) Imprecise estimates for Sweden: reported catch of 34265 t in 1993 is replaced by the mean of 1992 and 1994, i.e. 2,867 t, and used in the assessment.

Table 6.2.4 Landings (tonnes) of BLUE WHITING from the Southern areas (Sub-areas VIII and IX and Divisions VIIg-k and VIId,e) 1987–2000, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Netherlands	-	-	-	450	10	-	-	-	-	-	-	10[1]	-	-
Norway	4	-	-	-	-	-	-	-	-	-	-			-
Portugal	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439	1,900	2,625	2,032
Spain	23,644	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538	27,683	27,490	23,777	22,622
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	30,122	29,400	26,402	24,654

[1]) Directed fisheries in VIIIa

Table 6.2.5 Landings (tonnes) of BLUE WHITING from the main fisheries, 1987–2000, as estimated by the Working Group.

Area	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Norwegian Sea Fishery (Subareas I+II and Divisions Va,XIVa-b)	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	173,676	182,436	276,545
Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	446,287	426,037	475,179	463,495	218,946	318,081	347,101	378,704	423,504	478,077	514,654	827,194	940,881	996,577
Industrial mixed Fishery (Divisions Iva-c, Vb and IIIa)	62,689	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091	94,881	106,609	114,477
Subtotal northern Fishery	632,018	527,009	593,752	528,793	337,521	446,367	448,423	429,941	551,241	620,883	642,315	1,095,751	1,229,926	1,387,599
Southern fishery (Subareas VIII+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	30,122	29,400	26,402	24,654
Grand total	664,837	557,847	627,447	561,610	369,524	475,089	480,679	459,414	578,905	645,982	672,437	1,125,151	1,256,328	1,412,253

Table 6.3.1.1.
LENGTH DISTRIBUTIONS BY QUARTER

ALL COUNTRIES
DIRECTED FISHERY

Length (cm)	1.Quarter	2.Quarter	3.Quarter	4.Quarter	Total
11			11		11
12			243		243
13	177	698	681	51	1607
14	527	305	1222	193	2247
15	5584	3401	1750	281	11016
16	30511	17913	2240	1772	52436
17	46552	26601	1836	5303	80292
18	20711	38146	2718	15293	76868
19	9716	38581	1841	14419	64557
20	11822	46388	14918	13183	86311
21	17120	50271	72437	16641	156469
22	36128	64707	159080	38020	297935
23	94168	156143	175112	55994	481417
24	275064	468635	128932	53760	926391
25	545897	936961	130971	71012	1684841
26	665138	1073929	190194	82135	2011396
27	540823	790965	226649	103600	1662037
28	380264	516035	189961	109045	1195305
29	246310	330249	134505	102874	813938
30	180491	201836	97599	84770	564696
31	137761	126450	47802	87046	399059
32	102287	95856	30378	76342	304863
33	77187	77281	16651	50624	221743
34	46222	48191	10429	30263	135105
35	27867	40159	5988	11609	85623
36	19107	26780	4518	6796	57201
37	10395	12442	3829	3186	29852
38	5564	9167	4659	3010	22400
39	6901	4311	1077	1807	14096
40	2431	2532	1842	1511	8316
41	1267	706	9	798	2780
42	747	851	609	480	2687
43		305		374	679
44	61		606	44	711
45				80	80
46			202		202
47				15	15
48				15	15
Total numbers	3544800	5206795	1661499	1042346	11455440
Official catch (t)	182472	464202	184257	102303	933234

Table 6.3.1.2.
LENGTH DISTRIBUTIONS BY QUARTER

Length (cm)	1.Q	2.Q	3.Q	4.Q	Total
11					
12					
13				27 462	27462
14	2598	207		83271	86076
15	6807	553	1645	3900	12905
16	30074	1498	5346	32743	69661
17	48459	1952	2348	38798	91557
18	55132	2038	3635	8988	69793
19	43737	7458	11977	7298	70470
20	22012	24382	32026	6745	85165
21	3743	45873	112737	24518	186871
22	12562	90647	126543	49061	278813
23	19256	65753	78643	36226	199878
24	18738	39108	63897	29082	150825
25	7827	46761	66386	18391	139365
26	7520	35015	63987	14579	121101
27	3743	31214	52261	15396	102614
28	2444	13782	21956	9147	47329
29	1145	1887	14292	4726	22050
30	649	4115	10890	2800	18454
31	1145	3527	1406	540	6618
32			2088	1219	3307
33			1981		1981
34			206	471	677
35			1100		1100
36			206	138	344
37			411		411
Total numbers	284 993	415 770	675967	388037	1767365
Official catch	11702	37233	44184	17994	111113

ALL COUNTRIES
MIXED FISHERY

Table 6.3.1.3.
LENGTH DISTRIBUTIONS BY QUARTER

Length (cm)	1.Q	2.Q	3.Q	4.Q	Total
14	37	6	38	69	150
15	656		2 485	1 427	4 568
16	2 832	59	3 599	5 042	11 532
17	4 887	220	2 015	9 597	16 719
18	7 143	2 265	1 983	5 788	17 179
19	6 767	6 003	5 178	5 812	23 760
20	5 961	13 842	10 743	11 217	41 763
21	10 851	16 632	14 691	11 732	53 906
22	18 411	18 846	17 092	9 960	64 309
23	15 757	16 375	14 161	7 259	53 552
24	9 439	9 851	8 148	4 341	31 779
25	5 202	4 839	4 419	2 562	17 022
26	2 726	2 213	1 904	1 264	8 108
27	1 582	1 453	437	830	4 301
28	772	557	275	263	1 867
29	263	459	149	106	978
30	48	110	13	34	204
31	37	110	11	13	170
32	15	31	8	3	58
33	14	29	3	3	50
34	5	18	1		24
35	2	15	1	2	19
36	1	6	1	2	9
37		6	1		7
38	2		1		4
39		5			5
40		1			1
Total numbers	93 412	93 951	87 357	77 325	352 044
Official catch	6092	6321	5656	4553	22622

ALL COUN
SOUTHER

Table 6.3.2.1 BLUE WHITING. Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, and XIVa+b, Vb, Via+b, VIIbc and VIIg-k) in 1990-2000.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	8	64	-	-	-	1	4	167	15	61	41
1	538	33	82	37	44	99	497	1352	984	544	912
2	353	533	52	130	31	143	327	1079	3535	1180	752
3	566	384	1509	335	190	338	451	751	3211	5257	3119
4	709	244	510	1348	362	416	425	526	929	3235	4834
5	489	330	200	376	1242	566	248	268	346	362	1517
6	562	235	139	196	294	769	430	238	311	186	500
7	292	150	92	108	201	246	619	270	298	143	210
8	76	40	87	60	103	154	214	391	257	146	144
9	27	4	85	38	88	58	88	101	209	66	57
10+	92	14	15	14	32	40	70	164	85	138	139
Total	3,711.0	2,031.8	2,770.2	2,640.6	2,587.5	2,828.9	3,372.8	5,306.8	10,180.0	11,318.0	12,224.9
Tonnes	465,601	297,649	379,549	389,010	401,378	447,015	493,373	545,058	1,000,870	1,123,317	1,273,123

Table 6.3.2.2 BLUE WHITING. Catch in number (million) by age group in the mixed industrial fisheries (Sub-area IV, Divisions IIIa, IVb and Va, 1990-2000.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	1	25 -		132	95	3303	812	29	11	60	56
1	875	8	160	167	33	101	1334	621	576	188	822
2	168	398	64	39	21	88	71	269	524	286	317
3	50	42	167	91	18	29	58	50	259	434	253
4	12	11	75	97	37	11	71	14	47	168	143
5	7	11	25	15	6	6	39	14	6	16	22
6	4	11	17	7	3	11	45	5	4	5	3
7	5	6	7	8	1	2	33	4	3	5	0
8	1	3	3	-	1	2	14	6	4	6	7
9	0	1	1	-	0	1	9	1	4	1	1
10+	-	0	1	-	-	1	11	2	-12	3	1
Total	1,120.9	517.9	518.7	556.0	213.8	3,554.9	2,498.6	1,014.7	1,426.2	1,172.0	1,627.1
Tonnes	63,195	39,872	66,174	55,215	28,563	104,004	119,359	65,091	94,881	106,609	114,477

Table 6.3.2.3 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1990-2000.

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	74	70	19	25	13	3	9	11	18	18	32
1	198	181	139	41	12	96	43	118	97	57	80
2	182	182	205	146	56	123	131	143	122	82	123
3	57	70	95	181	149	55	117	86	71	130	93
4	25	39	43	62	72	38	36	26	69	57	35
5	24	17	12	12	27	44	33	8	32	35	9
6	11	8	6	7	9	20	17	4	7	15	10
7	2	3	2	2	5	6	5	3	2	3	3
8+	2	3	1	1	4	5	3	3	4	2	0
Total	575	573	522	477	347	390	394	402	422	399	384
Tonnes	32,817	32,003	28,722	32,256	29,468	27,664	25,099	30,122	29,400	26,402	24,654

Table 6.3.2.4 Blue Whiting. Total catch in numbers at age (millions) in 1981-2000

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	48	3512	437	584	1174	84	341	46	1955	83
1	258	148	2283	2291	1305	650	839	428	868	1611
2	348	274	567	2331	2044	816	578	727	720	703
3	681	326	270	455	1933	1862	728	619	1344	672
4	334	548	286	260	303	1717	1898	688	794	753
5	548	264	299	285	188	393	726	1313	840	520
6	559	276	304	445	321	187	137	623	710	577
7	466	266	287	262	257	201	105	85	139	299
8	634	272	286	193	174	198	123	53	50	78
9	578	284	225	154	93	174	103	33	25	27
10+	1460	673	334	255	259	398	195	50	38	95
Total	5914	6843	5578	7515	8051	6680	5775	4667	7484	5418
Tonnes	909556	576419	570072	641776	695596	826986	664837	557847	627447	561610

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	161	19	198	42	3308	835	220	43	139	129
1	267	408	263	307	296	1898	2216	1657	788	1814
2	1024	655	305	108	354	536	1580	4181	1549	1192
3	514	1644	621	368	422	634	940	3541	5821	3465
4	302	570	1571	389	466	539	601	1045	3461	5012
5	363	218	411	1222	616	324	307	384	413	1548
6	258	154	191	281	801	499	262	323	207	513
7	159	110	107	174	254	665	293	303	151	213
8	49	80	65	90	160	233	423	264	153	151
9	5	32	38	79	60	99	108	212	69	58
10+	10	12	17	31	42	83	176	86	141	140
Total	3112	3902	3788	3091	6777	6344	7127	12039	12891	14236
Tonnes	369524	475026	480679	459414	578905	645982	672437	1125151	1256328	1412254

Table 6.3.2.5 BLUE WHITING Disaggregated Fisheries Assessment Data from Directed fisheries (DISFAD file)

Record No.	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 6.3.2.6 BLUE WHITING Disaggregated Fisheries Assessment Data from Mixed Industrial fisheries. (DISFAD file)

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7
Blue whiting	0	15	2000														
1	Denmark	2	IIIa	0	355	355	2	0	105	0	0	0	0	0	0	0	0
2	Denmark	3	IIIa	0	2981	2981	5	0	98	0	0	0	0	0	0	0	0
3	Denmark	4	IIIa	0	880	880	1	0	17	0	0	0	0	0	0	0	0
4	Denmark	1	IVa	0	6693	6693	4	0	290	0	0	0	0	0	0	0	0
5	Denmark	2	IVa	0	14368	14368	0	0	0	0	0	0	0	0	0	0	0
6	Denmark	3	IVa	0	9647	9647	3	0	196	0	0	0	0	0	0	0	0
7	Denmark	4	IVa	0	3185	3185	1	0	6	0	0	0	0	0	0	0	0
8	Norway	1	IIa	322	322	322	3	200	184	0	4703	1180	540	137	122	0	0
9	Norway	2	IIa	1469	1469	1469	5	239	429	0	20401	2564	2216	1108	0	123	0
10	Norway	3	IIa	4035	4035	4035	10	536	634	1384	45279	6465	4502	3728	147	97	97
11	Norway	4	IIa	2647	2647	2647	6	151	329	16713	20580	3697	2187	1713	138	276	0
12	Norway	2	IIIa	2	2	2	0	0	0	0	13	5	5	4	0	0	0
13	Norway	1	IVa	6455	6022	6456	4	200	334	0	39823	34902	16044	4500	3991	0	0
14	Norway	2	IVa	17142	26776	17142	11	386	650	0	110341	45846	45813	33321	3737	932	0
15	Norway	3	IVa	29600	35920	29600	25	300	2413	11014	216701	73849	66449	33699	4457	0	169
16	Norway	4	IVa	10931	14734	10932	16	152	842	15326	79129	23271	16733	9506	0	689	0
17	Norway	2	IVb	175	263	175	11	386	650	0	1124	467	467	339	38	9	0
18	Norway	4	IVb	228	263	228	16	152	842	319	1648	485	349	198	0	14	0
19	Sweden	1	IIIa	0	5	5	0	0	0	0	0	0	0	0	0	0	0
20	Sweden	2	IIIa	0	269	269	0	0	0	0	0	0	0	0	0	0	0
21	Sweden	3	IIIa	0	2819	2819	0	0	0	0	0	0	0	0	0	0	0
22	Sweden	4	IIIa	0	116	116	0	0	0	0	0	0	0	0	0	0	0
23	Sweden	3	IVa	0	55	55	0	0	0	0	0	0	0	0	0	0	0
24	Sweden	3	Vb	0	50	50	0	0	0	0	0	0	0	0	0	0	0
25	Sweden	4	Vb	0	5	5	0	0	0	0	0	0	0	0	0	0	0
26	Faroe Islar	2	IIa	0	35	35	0	0	0	0	0	0	0	0	0	0	0
27	Faroe Islar	1	IVa	0	7	7	0	0	0	0	0	0	0	0	0	0	0

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7
Blue whiting	0	15	2000														
1	Denmark	2	IIIa	0	355	355	2	0	105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Denmark	3	IIIa	0	2981	2981	5	0	98	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	Denmark	4	IIIa	0	880	880	1	0	17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	Denmark	1	IVa	0	6693	6693	4	0	290	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Denmark	2	IVa	0	14368	14368	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Denmark	3	IVa	0	9647	9647	3	0	196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Denmark	4	IVa	0	3185	3185	1	0	6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Norway	1	IIa	322	322	322	3	200	184	0.000	0.032	0.075	0.090	0.111	0.150	0.000	0.000
9	Norway	2	IIa	1469	1469	1469	5	239	429	0.000	0.046	0.082	0.087	0.100	0.000	0.126	0.000
10	Norway	3	IIa	4035	4035	4035	10	536	634	0.031	0.054	0.090	0.101	0.122	0.182	0.182	0.209
11	Norway	4	IIa	2647	2647	2647	6	151	329	0.027	0.060	0.102	0.104	0.134	0.178	0.186	0.000
12	Norway	2	IIIa	2	2	2	0	0	0	0.000	0.055	0.071	0.083	0.096	0.106	0.123	0.000
13	Norway	1	IVa	6455	6022	6456	4	200	334	0.000	0.033	0.075	0.091	0.111	0.150	0.000	0.000
14	Norway	2	IVa	17142	26776	17142	11	386	650	0.000	0.055	0.071	0.083	0.096	0.106	0.123	0.000
15	Norway	3	IVa	29600	35920	29600	25	300	2413	0.028	0.056	0.081	0.090	0.117	0.124	0.000	0.190
16	Norway	4	IVa	10931	14734	10932	16	152	842	0.030	0.064	0.101	0.095	0.134	0.000	0.189	0.000
17	Norway	2	IVb	175	263	175	11	386	650	0.000	0.055	0.071	0.083	0.096	0.106	0.123	0.000
18	Norway	4	IVb	228	263	228	16	152	842	0.030	0.064	0.101	0.095	0.134	0.000	0.189	0.000
19	Sweden	1	IIIa	0	5	5	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	Sweden	2	IIIa	0	269	269	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	Sweden	3	IIIa	0	2819	2819	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	Sweden	4	IIIa	0	116	116	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	Sweden	3	IVa	0	55	55	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	Sweden	3	Vb	0	50	50	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	Sweden	4	Vb	0	5	5	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	Faroe Islan	2	IIa	0	35	35	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	Faroe Islan	1	IVa	0	7	7	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6.3.2.7 BLUE WHITING Disaggregated Fisheries Assessment Data from Southern Fisheries. (DISFAD file)

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7
Blue whiting	0	15	2000														
1	Spain	1	VIIIc+IXa	6095	6095	6095	85	280	8380	0	20616	28056	25480	11476	3153	3335	1203
2	Spain	2	VIIIc+IXa	6318	6318	6318	82	280	7756	0	11638	37212	26147	11603	2948	3092	1169
3	Spain	3	VIIIc+IXa	5648	5648	5648	75	158	6349	8703	16676	27010	23469	6899	2042	2436	59
4	Spain	4	VIIIc+IXa	4561	4561	4561	75	448	6363	20437	23808	21144	9698	1872	193	157	13
5	Portugal	1	IXa	0	832	832	0	0	0	0	0	0	0	0	0	0	0
6	Portugal	2	IXa	0	187	187	0	0	0	0	0	0	0	0	0	0	0
7	Portugal	3	IXa	0	735	735	0	0	0	0	0	0	0	0	0	0	0
8	Portugal	4	IXa	0	278	278	0	0	0	0	0	0	0	0	0	0	0

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7
Blue whiting	0	15	2000														
1	Spain	1	VIIIc+IXa	6095	6095	6095	85	280	8380	0.000	0.034	0.056	0.074	0.084	0.107	0.112	0.122
2	Spain	2	VIIIc+IXa	6318	6318	6318	82	280	7756	0.000	0.045	0.056	0.073	0.081	0.102	0.108	0.118
3	Spain	3	VIIIc+IXa	5648	5648	5648	75	158	6349	0.026	0.049	0.065	0.076	0.095	0.091	0.096	0.149
4	Spain	4	VIIIc+IXa	4561	4561	4561	75	448	6363	0.030	0.053	0.072	0.086	0.102	0.144	0.154	0.196
5	Portugal	1	IXa	0	832	832	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	Portugal	2	IXa	0	187	187	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	Portugal	3	IXa	0	735	735	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Portugal	4	IXa	0	278	278	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 6.3.2.8 BLUE WHITING. Allocations files in the blue whiting fisheries.

DIRECTED FISHERIES

Record	no. samples	Type	alloc
1	2	c	9,60
2	3	c	10,33,61
3	1	c	62
4	4	c	14,38,52,70
5	3	c	15,39,71
6	2	c	18,54
7	2	c	21,78
8	2	c	21,78
22	2	c	21,78
23	2	c	21,78
24	1	c	76
25	2	c	21,78
26	3	c	15,39,71
27	2	c	17,53
28	2	c	18,54
29	4	c	20,57,49,77
30	2	c	21,78
31	4	c	20,57,49,77
32	2	c	9,60
34	1	c	67
43	1	c	68
44	2	c	17,53
45	2	c	18,54
47	3	c	42,56,74
48	4	c	20,57,49,77
50	2	c	21,78
51	2	c	21,78
79	4	c	14,38,52,70
80	2	c	17,53
81	2	c	18,54
82	5	c	19,41,46,55,73
83	2	c	21,78
84	2	c	9,60
85	2	c	18,54
86	5	c	19,41,46,55,73
87	4	c	20,57,49,77
88	4	c	20,57,49,77
89	2	c	21,78
90	2	c	21,78
91	2	c	21,78
92	2	c	21,78

MIXED INDUSTRIAL FISHERIES

Record	no. samples	Type	alloc
1	1	c	14
2	1	c	15
3	1	c	16
4	1	c	13
5	1	c	14
6	1	c	15
7	1	c	16
19	1	c	13
20	1	c	14
21	1	c	15
22	1	c	16
23	1	c	15
24	1	c	15
25	1	c	16
26	1	c	9
27	1	c	13

SOUTHERN FISHERIES

Record	no. samples	Type	alloc
5	1	c	1
6	1	c	2
7	1	c	3
8	1	c	4

Table 6.3.3.1 Blue Whiting. Mean weights at age for the total catch in 1981-2000

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.038	0.018	0.020	0.026	0.016	0.030	0.023	0.031	0.014	0.034
1	0.052	0.045	0.046	0.035	0.038	0.040	0.048	0.053	0.059	0.045
2	0.065	0.072	0.074	0.078	0.074	0.073	0.086	0.076	0.079	0.070
3	0.103	0.111	0.118	0.089	0.097	0.108	0.106	0.097	0.103	0.106
4	0.125	0.143	0.140	0.132	0.114	0.130	0.124	0.128	0.126	0.123
5	0.141	0.156	0.153	0.153	0.157	0.165	0.147	0.142	0.148	0.147
6	0.155	0.177	0.176	0.161	0.177	0.199	0.177	0.157	0.158	0.168
7	0.170	0.195	0.195	0.175	0.199	0.209	0.208	0.179	0.171	0.175
8	0.178	0.200	0.200	0.189	0.208	0.243	0.221	0.199	0.203	0.214
9	0.187	0.204	0.204	0.186	0.218	0.246	0.222	0.222	0.224	0.217
10+	0.213	0.231	0.228	0.206	0.237	0.257	0.254	0.260	0.253	0.256

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0.036	0.024	0.028	0.033	0.022	0.018	0.031	0.033	0.035	0.031
1	0.055	0.057	0.066	0.061	0.064	0.041	0.047	0.048	0.063	0.057
2	0.091	0.083	0.082	0.087	0.091	0.080	0.072	0.072	0.078	0.075
3	0.107	0.119	0.109	0.108	0.118	0.102	0.102	0.094	0.088	0.086
4	0.136	0.140	0.137	0.137	0.143	0.116	0.121	0.125	0.109	0.104
5	0.174	0.167	0.163	0.164	0.154	0.147	0.140	0.149	0.142	0.133
6	0.190	0.193	0.177	0.189	0.167	0.170	0.166	0.178	0.170	0.156
7	0.206	0.226	0.200	0.207	0.203	0.214	0.177	0.183	0.199	0.179
8	0.230	0.235	0.217	0.217	0.206	0.230	0.183	0.188	0.193	0.187
9	0.232	0.284	0.225	0.247	0.236	0.238	0.203	0.221	0.192	0.232
10+	0.266	0.294	0.281	0.254	0.256	0.279	0.232	0.248	0.245	0.241

Table 6.4.1.1. Age stratified estimates of blue whiting in the spawning area west of The British Isles, R.V."J.Hjort" March/April 2001. Numbers in millions, weight in thousand t, mean length in cm, mean weight in grams.

Age	1	2	3	4	5	6	7	8	Total
Numbers	16 479	44 162	12 843	13 805	8 292	781	175	51	96 588
Percentage	17	46	13	14	9	1	0	0	100
Mean length	18	24	26	27	28	30	31	32	24
Mean weight	31	64	81	93	107	133	152	189	69
Weight	504	2811	1044	1282	889	95	27	10	6 660,8

Table 6.4.1.3 Age stratified estimates of blue whiting in the Icelandic EEZ in July 2000
Numbers in millions, weight in thousand t, length in cm, mean weight in grams.

Age	0	1	2	3	4	5	6	7	8	10	Total
Numbers	10683	5559	729	455	1150	434	106	25	1	1	19143
Mean length	13.5	22.3	24.1	26.1	27.6	29.4	32.3	32.0	36.0	28.0	18.9
Mean weight	18	72	89	117	137	164	211	188	245	320	50.2
Percentage	55.8	29.1	3.8	2.4	6.0	2.3	0.6	0.1	0.0	0.0	100
Weight	187	403	65	55	158	71	22	5		0	966

Table 6.4.1.4 Age stratified estimates of blue whiting in the Norwegian Sea, R.V. G.O. Sars,July 2000.
Numbers in millions, weight in thousand t, length in cm, mean weight in grams.

Age	0	1	2	3	4	5	6	7	8	10	Total
Numbers	0	25813	3298	2721	3078	23	46	6	0	0	34985
Mean length	0.0	21.8	25.2	26.4	27.6	30.9	33.7	32.8	0.0	0.0	23.0
Mean weight	0	57	92	106	125	178	182	222	0	0	70.4
Percentage	0.0	73.8	9.4	7.8	8.8	0.1	0.1	0.0	0.0	0.0	100.0
Weight	0	1472	303	290	385	4	8	1	0	0	2463.2

Table 6.4.1.2. BLUE WHITING Biomass estimate (million tonnes) in the spawning area.

Year	Russia total	Russia spawning	Norway total	Norway spawning	Faroes total	Faroes spawning
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		
1992	3.6	3.3	4.3	4.2		
1993	3.8	3.7	5.2	5.0		
1994			4.1	4.1		
1995	6.8	6.0	6.7	6.1		
1996	7.1	5.8	5.1	4.5		
1997						
1998			5.5	4.7		
1999			8.9	8.5		
2000			8.3	7.8		
2001			6.7	5.6		
Mean	4.8	4.4	5.6	5.1	4.4	2.0

Table 6.4.2.1 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
1997	7.60	4.44	44.21	10.61	60.18	17.54	44.01	8.00
1998	5.29	1.92	41.09	7.64	73.80	24.06	44.48	7.82
1999	31.41	7.28	108.46	17.24	150.24	39.53	108.12	14.62
2000	39.52	9.73	88.89	14.32	62.23	27.65	74.42	11.25

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
1997	224	121.69	1425	359.12	1254	330.37	1228	234.50
1998	123	44.12	1442	334.24	1823	592.92	1347	251.37
1999	795	218.58	3996	697.66	5279	1521.62	3861	576.10
2000	1574	360.78	3701	568.17	2036	857.01	2940	406.62

Table 6.4.2.2 BLUE WHITING. Stratified mean catch (Kg/haul) and standard error of in bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL: 20-500 m		TOTAL: 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	-	-
	Oct./Nov.	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
1997	June	0	0	3	3	116	42	45	12	-	-	27	7
	October	2	1	54	20	77	13	7	2	-	-	32	8
1998	July	0	0	8	5	105	17	38	3	-	-	25	3
	October	1	1	384	87	427	101	20	2	-	-	212	36
1999	July	1		60		66		25		-	-	37	n/a
	October	0		70		78		18		-	-	41	n/a

Table 6.4.4.1 The ICA log

```
 Enter the name of the index file -->Combbw.ndx
CombbwCN.DAT
CombbwCW.DAT
 Stock weights in 2001  used for the year 2000
CombbwSW.DAT
 Natural mortality in 2001  used for the year 2000
CombbwNM.DAT
 Maturity ogive in 2001  used for the year 2000
CombbwMO.DAT
 Name of age-structured index file (Enter if none) : -->Combbw.tun
 Name of the SSB index file (Enter if none) -->
No indices of spawning biomass to be used.
 No of years for separable constraint ?--> 5
 Reference age for separable constraint ?--> 5
 Constant selection pattern model (Y/N) ?-->y
 S to be fixed on last age ?-->    1.500000000000000
 First age for calculation of reference F ?--> 3
 Last age for calculation of reference F ?--> 7
 Use default weighting (Y/N) ?-->n
Enter relative weights at age
 Weight for age 0-->    0.100000000000000
 Weight for age 1-->    0.500000000000000
 Weight for age 2-->    1.000000000000000
 Weight for age 3-->    1.000000000000000
 Weight for age 4-->    1.000000000000000
 Weight for age 5-->    1.000000000000000
 Weight for age 6-->    1.000000000000000
 Weight for age 7-->    1.000000000000000
 Weight for age 8-->    1.000000000000000
 Weight for age 9-->    1.000000000000000
 Weight for age 10-->    1.000000000000000
Enter relative weights by year
 Weight for year 1996-->    1.000000000000000
 Weight for year 1997-->    1.000000000000000
 Weight for year 1998-->    1.000000000000000
 Weight for year 1999-->    1.000000000000000
 Weight for year 2000-->    1.000000000000000
Enter new weights for specified years and ages if needed
 Enter year, age, new weight or -1,-1,-1 to end.  -1 -1   -1.000000000000000
 Is the last age of Norway Spawning Area/Acoustic 1981-90 a plus-group (Y/N)-->n
 Is the last age of Norway Spawning Area/Acoustic 1991-2001 a plus-group (Y/-->n
 Is the last age of Russian Spawning Area/Acoustic 1982-91 a plus-group (Y/N-->n
 Is the last age of Russian Spawning Area/Acoustic 1992-1996 a plus-group (Y-->n
 Is the last age of CPUE Spanish Pair Trawlers a plus-group (Y/N) ?-->n
 Is the last age of Norwegian Sea acoustic - Blue Wh. 1981-9 a plus-group (Y-->n
 Is the last age of Norwegian Sea acoustic - Blue Wh. 1991 a plus-group (Y-->n
```

Model for Norway Spawning Area/Acoustic 1981-90 is to be A/L/P ?-->L
Model for Norway Spawning Area/Acoustic 1991-2001 is to be A/L/P ?-->L
Model for Russian Spawning Area/Acoustic 1982-91 is to be A/L/P ?-->L
Model for Russian Spawning Area/Acoustic 1992-1996 is to be A/L/P ?-->L
Model for CPUE Spanish Pair Trawlers is to be A/L/P ?-->L
Model for Norwegian Sea acoustic - Blue Wh. 1981-9 is to be A/L/P ?-->L
Model for Norwegian Sea acoustic - Blue Wh. 1991 is to be A/L/P ?-->L
Fit a stock-recruit relationship (Y/N) ?-->n
Enter lowest feasible F--> 5.0000000000000003E-02
Enter highest feasible F--> 1.000000000000000
Mapping the F-dimension of the SSQ surface

```
   F            SSQ
+-------+------------------
   0.05       62.2317842742
   0.10       54.9639443704
   0.15       50.8058346288
   0.20       48.1095760734
   0.25       46.3012953709
   0.30       45.0638627356
   0.35       44.2052132793
   0.40       43.6053129965
   0.45       43.1873364210
   0.50       42.9009597770
   0.55       42.7124525300
   0.60       42.5986961433
   0.65       42.5434980580
   0.70       42.5353069784
   0.75       42.5657396607
   0.80       42.6286346279
   0.85       42.7194313365
   0.90       42.8347602961
   0.95       42.9721799602
   1.00       43.1300207669
```

Lowest SSQ is for F = 0.688

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 10
Year range in the analysis : 1981 . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 7
Parameters to estimate : 73
Number of observations : 487
Conventional single selection vector model to be fitted.
Survey weighting to be Manual (recommended) or Iterative (M/I) ?-->M
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 2--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 3--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 4--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 5--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 6--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 7--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1981-90 at age 8--> 1.000000000000000

Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 2--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 3--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 4--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 5--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 6--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 7--> 1.000000000000000
Enter weight for Norway Spawning Area/Acoustic 1991-2001 at age 8--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 3--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 4--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 5--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 6--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 7--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1982-91 at age 8--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 3--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 4--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 5--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 6--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 7--> 1.000000000000000
Enter weight for Russian Spawning Area/Acoustic 1992-1996 at age 8--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 1--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 2--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 3--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 4--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 5--> 1.000000000000000
Enter weight for CPUE Spanish Pair Trawlers at age 6--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 1--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 2--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 3--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 4--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 5--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 6--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1981-9 at age 7--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 1--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 2--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 3--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 4--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 5--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 6--> 1.000000000000000
Enter weight for Norwegian Sea acoustic - Blue Wh. 1991 at age 7--> 1.000000000000000
Enter estimates of the extent to which errors
in the age-structured indices are correlated
across ages. This can be in the range 0 (independence)
to 1 (correlated errors).
Enter value for Norway Spawning Area/Acoustic 1981-90--> 1.000000000000000
Enter value for Norway Spawning Area/Acoustic 1991-2001--> 1.000000000000000
Enter value for Russian Spawning Area/Acoustic 1982-91--> 1.000000000000000
Enter value for Russian Spawning Area/Acoustic 1992-1996--> 1.000000000000000
Enter value for CPUE Spanish Pair Trawlers--> 1.000000000000000
Enter value for Norwegian Sea acoustic - Blue Wh. 1981-9--> 1.000000000000000
Enter value for Norwegian Sea acoustic - Blue Wh. 1991-> 1.000000000000000
Do you want to shrink the final fishing mortality (Y/N) ?-->N
Aged index weights

```
Norway Spawning Area/Acoustic 1981-90
 Age  :      2    3    4    5    6    7    8
 Wts :    0.143 0.143 0.143 0.143 0.143 0.143 0.143
Norway Spawning Area/Acoustic 1991-2001
 Age  :      2    3    4    5    6    7    8
 Wts :    0.143 0.143 0.143 0.143 0.143 0.143 0.143
Russian Spawning Area/Acoustic 1982-91
 Age  :      3    4    5    6    7    8
 Wts :    0.167 0.167 0.167 0.167 0.167 0.167
Russian Spawning Area/Acoustic 1992-1996
 Age  :      3    4    5    6    7    8
 Wts :    0.167 0.167 0.167 0.167 0.167 0.167
CPUE Spanish Pair Trawlers
 Age  :      1    2    3    4    5    6
 Wts :    0.167 0.167 0.167 0.167 0.167 0.167
Norwegian Sea acoustic - Blue Wh. 1981-9
 Age  :      1    2    3    4    5    6    7
 Wts :    0.143 0.143 0.143 0.143 0.143 0.143 0.143
Norwegian Sea acoustic - Blue Wh. 1991
 Age  :      1    2    3    4    5    6    7
 Wts :    0.143 0.143 0.143 0.143 0.143 0.143 0.143
F in 2000  at age 5  is 0.754581  in iteration 1
 Detailed, Normal or Summary output (D/N/S)-->D
 Output page width in characters (e.g. 80..132) ?--> 80
 Estimate historical assessment uncertainty ?-->n
Succesful exit from ICA
```

Table 6.4.4.2 Output Generated by ICA Version 1.4

Blue whiting combined stock, 2001 WG

Catch in Number x 10 ^ 6

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	48.0	3512.0	437.0	584.0	1174.0	84.0	341.0	46.0
1	258.0	148.0	2283.0	2291.0	1305.0	650.0	838.0	425.0
2	348.0	274.0	567.0	2331.0	2044.0	816.0	578.0	721.0
3	681.0	326.0	270.0	455.0	1933.0	1862.0	728.0	614.0
4	334.0	548.0	286.0	260.0	303.0	1717.0	1897.0	683.0
5	548.0	264.0	299.0	285.0	188.0	393.0	726.0	1303.0
6	559.0	276.0	304.0	445.0	321.0	187.0	137.0	618.0
7	466.0	266.0	287.0	262.0	257.0	201.0	105.0	84.0
8	634.0	272.0	286.0	193.0	174.0	198.0	123.0	53.0
9	578.0	284.0	225.0	154.0	93.0	174.0	103.0	33.0
10	1460.0	673.0	334.0	255.0	259.0	398.0	195.0	50.0

Catch in Number x 10 ^ 6

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	1949.0	83.0	161.1	19.0	197.7	42.0	3306.6	832.6
1	865.0	1611.0	266.7	407.7	263.2	307.0	296.1	1893.5
2	718.0	703.0	1024.5	653.8	305.2	107.9	353.9	534.2
3	1340.0	672.0	514.0	1641.7	621.1	368.0	421.6	632.4
4	791.0	753.0	301.6	569.1	1571.2	389.3	465.4	537.3
5	837.0	520.0	363.2	217.4	411.4	1221.9	616.0	323.3
6	708.0	577.0	258.0	154.0	191.2	281.1	800.2	497.5
7	139.0	299.0	159.2	109.6	107.0	174.3	253.8	663.1
8	50.0	78.0	49.4	79.7	64.8	90.4	159.8	232.4
9	25.0	27.0	5.1	32.0	38.1	79.0	59.7	98.4
10	38.0	95.0	9.6	11.7	17.5	30.6	41.8	82.5

Catch in Number x 10 ^ 6

AGE	1997	1998	1999	2000
0	211.7	43.0	139.0	129.1
1	2131.5	1656.9	788.2	1814.9
2	1519.3	4181.2	1549.1	1192.7
3	904.1	3541.2	5820.8	3465.7
4	577.7	1044.9	3460.6	5014.9
5	295.7	383.7	412.8	1550.1
6	251.6	322.8	207.2	513.7
7	282.1	303.1	151.2	213.1
8	406.9	264.1	153.1	151.4
9	104.3	212.5	68.8	58.3
10	169.2	85.5	140.5	139.8

Predicted Catch in Number x 10 ^ 6

AGE	1996	1997	1998	1999	2000
0	302.8	145.9	111.0	214.1	129.1
1	1309.0	2144.9	1576.6	746.4	2698.8
2	556.6	1419.2	3520.3	1583.9	1383.4
3	657.8	935.6	3491.2	5272.0	4054.3
4	586.5	592.8	1203.3	2628.6	6447.8
5	362.7	275.0	403.7	462.7	1710.6
6	485.4	286.1	309.1	262.9	488.1
7	687.8	336.3	277.0	169.2	224.5
8	273.2	443.6	295.1	133.8	121.2
9	98.4	96.6	220.9	77.2	55.9

Weights at age in the catches (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.03800	0.01800	0.02000	0.02600	0.01600	0.03000	0.02300	0.03100
1	0.05200	0.04500	0.04600	0.03500	0.03800	0.04000	0.04800	0.05300
2	0.06500	0.07200	0.07400	0.07800	0.07400	0.07300	0.08600	0.07600
3	0.10300	0.11100	0.11800	0.08900	0.09700	0.10800	0.10600	0.09700
4	0.12500	0.14300	0.14000	0.13200	0.11400	0.13000	0.12400	0.12800
5	0.14100	0.15600	0.15300	0.15300	0.15700	0.16500	0.14700	0.14200
6	0.15500	0.17700	0.17600	0.16100	0.17700	0.19900	0.17700	0.15700
7	0.17000	0.19500	0.19500	0.17500	0.19900	0.20900	0.20800	0.17900
8	0.17800	0.20000	0.20000	0.18900	0.20800	0.24300	0.22100	0.19900
9	0.18700	0.20400	0.20400	0.18600	0.21800	0.24600	0.22200	0.22200
10	0.21300	0.23100	0.22800	0.20600	0.23700	0.25700	0.25400	0.26000

Weights at age in the catches (Kg)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.01400	0.03400	0.03600	0.02400	0.02800	0.03300	0.02200	0.01800
1	0.05900	0.04500	0.05500	0.05700	0.06600	0.06100	0.06400	0.04100
2	0.07900	0.07000	0.09100	0.08300	0.08200	0.08700	0.09100	0.08000
3	0.10300	0.10600	0.10700	0.11900	0.10900	0.10800	0.11800	0.10200
4	0.12600	0.12300	0.13600	0.14000	0.13700	0.13700	0.14300	0.11600
5	0.14800	0.14700	0.17400	0.16700	0.16300	0.16400	0.15400	0.14700
6	0.15800	0.16800	0.19000	0.19300	0.17700	0.18900	0.16700	0.17000
7	0.17100	0.17500	0.20600	0.22600	0.20000	0.20700	0.20300	0.21400
8	0.20300	0.21400	0.23000	0.23500	0.21700	0.21700	0.20600	0.23000
9	0.22400	0.21700	0.23200	0.28400	0.22500	0.24700	0.23600	0.23800
10	0.25300	0.25600	0.26600	0.29400	0.28100	0.25400	0.25600	0.27900

Weights at age in the catches (Kg)

AGE	1997	1998	1999	2000
0	0.03100	0.03300	0.03500	0.03100
1	0.04700	0.04800	0.06300	0.05700
2	0.07200	0.07200	0.07800	0.07500
3	0.10200	0.09400	0.08800	0.08600
4	0.12100	0.12500	0.10900	0.10400
5	0.14000	0.14900	0.14200	0.13300
6	0.16600	0.17800	0.17000	0.15600
7	0.17700	0.18300	0.19900	0.17900
8	0.18300	0.18800	0.19300	0.18700
9	0.20300	0.22100	0.19200	0.23200
10	0.23200	0.24800	0.24500	0.24100

Weights at age in the stock (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.03800	0.01800	0.02000	0.02600	0.01600	0.03000	0.02300	0.03100
1	0.05200	0.04500	0.04600	0.03500	0.03800	0.04000	0.04800	0.05300
2	0.06500	0.07200	0.07400	0.07800	0.07400	0.07300	0.08600	0.07600
3	0.10300	0.11100	0.11800	0.08900	0.09700	0.10800	0.10600	0.09700
4	0.12500	0.14300	0.14000	0.13200	0.11400	0.13000	0.12400	0.12800
5	0.14100	0.15600	0.15300	0.15300	0.15700	0.16500	0.14700	0.14200
6	0.15500	0.17700	0.17600	0.16100	0.17700	0.19900	0.17700	0.15700
7	0.17000	0.19500	0.19500	0.17500	0.19900	0.20900	0.20800	0.17900
8	0.17800	0.20000	0.20000	0.18900	0.20800	0.24300	0.22100	0.19900
9	0.18700	0.20400	0.20400	0.18600	0.21800	0.24600	0.22200	0.22200
10	0.21300	0.23100	0.22800	0.20600	0.23700	0.25700	0.25400	0.26000

Weights at age in the stock (Kg)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.01400	0.03400	0.03600	0.02400	0.02800	0.03300	0.02200	0.01800
1	0.05900	0.04500	0.05500	0.05700	0.06600	0.06100	0.06400	0.04100
2	0.07900	0.07000	0.09100	0.08300	0.08200	0.08700	0.09100	0.08000
3	0.10300	0.10600	0.10700	0.11900	0.10900	0.10800	0.11800	0.10200
4	0.12600	0.12300	0.13600	0.14000	0.13700	0.13700	0.14300	0.11600
5	0.14800	0.14700	0.17400	0.16700	0.16300	0.16400	0.15400	0.14700
6	0.15800	0.16800	0.19000	0.19300	0.17700	0.18900	0.16700	0.17000
7	0.17100	0.17500	0.20600	0.22600	0.20000	0.20700	0.20300	0.21400
8	0.20300	0.21400	0.23000	0.23500	0.21700	0.21700	0.20600	0.23000
9	0.22400	0.21700	0.23200	0.28400	0.22500	0.24700	0.23600	0.23800
10	0.25300	0.25600	0.26600	0.29400	0.28100	0.25400	0.25600	0.27900

Weights at age in the stock (Kg)

AGE	1997	1998	1999	2000
0	0.03100	0.03300	0.03500	0.03100
1	0.04700	0.04800	0.06300	0.05700
2	0.07200	0.07200	0.07800	0.07500
3	0.10200	0.09400	0.08800	0.08600
4	0.12100	0.12500	0.10900	0.10400
5	0.14000	0.14900	0.14200	0.13300
6	0.16600	0.17800	0.17000	0.15600
7	0.17700	0.18300	0.19900	0.17900
8	0.18300	0.18800	0.19300	0.18700
9	0.20300	0.22100	0.19200	0.23200
10	0.23200	0.24800	0.24500	0.24100

Natural Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
1	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
9	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
10	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Natural Mortality (per year)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
1	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
2	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
9	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000
10	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

Natural Mortality (per year)

AGE	1997	1998	1999	2000
0	0.20000	0.20000	0.20000	0.20000
1	0.20000	0.20000	0.20000	0.20000
2	0.20000	0.20000	0.20000	0.20000
3	0.20000	0.20000	0.20000	0.20000
4	0.20000	0.20000	0.20000	0.20000
5	0.20000	0.20000	0.20000	0.20000
6	0.20000	0.20000	0.20000	0.20000
7	0.20000	0.20000	0.20000	0.20000
8	0.20000	0.20000	0.20000	0.20000
9	0.20000	0.20000	0.20000	0.20000
10	0.20000	0.20000	0.20000	0.20000

Proportion of fish spawning

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
2	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
3	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200
4	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600
5	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100
6	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400
7	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
9	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

Proportion of fish spawning

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100	0.1100
2	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000	0.4000
3	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200	0.8200
4	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600	0.8600
5	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100	0.9100
6	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400	0.9400
7	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
9	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

Proportion of fish spawning

AGE	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000
1	0.1100	0.1100	0.1100	0.1100
2	0.4000	0.4000	0.4000	0.4000
3	0.8200	0.8200	0.8200	0.8200
4	0.8600	0.8600	0.8600	0.8600
5	0.9100	0.9100	0.9100	0.9100
6	0.9400	0.9400	0.9400	0.9400
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000

AGE-STRUCTURED INDICES

Norway Spawning Area/Acoustic 1981-90

AGE	1981	1982	1983	1984	1985	1986	1987	1988
2	2372.	999990.	297.	15767.	999990.	1003.	4960.	9712.
3	7583.	999990.	2108.	1721.	999990.	5829.	8417.	9090.
4	3253.	999990.	2723.	1616.	999990.	4122.	22589.	12367.
5	3647.	999990.	6511.	1719.	999990.	624.	4735.	20392.
6	4611.	999990.	3735.	1858.	999990.	228.	282.	7355.
7	4638.	999990.	3650.	1128.	999990.	203.	417.	723.
8	3654.	999990.	3153.	567.	999990.	250.	385.	599.

Norway Spawning Area/Acoustic 1981-90

AGE	1989	1990
2	6787.	14169.
3	22270.	12670.
4	9973.	11228.
5	10504.	5587.
6	7803.	6556.
7	933.	3273.
8	293.	516.

Norway Spawning Area/Acoustic 1991-2001

AGE	1991	1992	1993	1994	1995	1996	1997	1998
2	11147.	1232.	4489.	1603.	8538.	8781.	999990.	18218.
3	6340.	26123.	3321.	2950.	9874.	7433.	999990.	34991.
4	8497.	4719.	26771.	4476.	7906.	8371.	999990.	4697.
5	7407.	1574.	2643.	11354.	6861.	2399.	999990.	1674.
6	4558.	1386.	1270.	1742.	9467.	4455.	999990.	279.
7	2019.	810.	557.	1687.	1795.	4111.	999990.	407.
8	545.	616.	426.	908.	1083.	1202.	999990.	381.

Norway Spawning Area/Acoustic 1991-2001

AGE	1999	2000	2001
2	19034.	8613.	44162.
3	60309.	31011.	12843.
4	26103.	41382.	13805.
5	1481.	6843.	8292.
6	316.	898.	718.
7	72.	427.	175.
8	153.	228.	51.

Russian Spawning Area/Acoustic 1982-91

AGE	1982	1983	1984	1985	1986	1987	1988	1989
3	540.	2330.	2900.	13220.	18750.	4480.	3710.	11910.
4	2750.	2930.	800.	930.	23180.	19170.	4550.	7120.
5	1340.	9390.	1100.	580.	2540.	5860.	8610.	6670.
6	1380.	3880.	4200.	1780.	610.	1070.	4130.	6970.
7	1570.	1970.	2200.	860.	620.	500.	1270.	4580.
8	2350.	1370.	1200.	610.	750.	810.	480.	2750.

Russian Spawning Area/Acoustic 1982-91

AGE	1990	1991
3	9740.	10300.
4	12140.	5350.
5	5740.	5130.
6	2580.	2630.
7	1470.	1770.
8	220.	870.

Russian Spawning Area/Acoustic 1992-1996

AGE	1992	1993	1994	1995	1996
3	20010.	4728.	999990.	12657.	15285.
4	6700.	12337.	999990.	10028.	10629.
5	1350.	5304.	999990.	8942.	4897.
6	440.	2249.	999990.	2651.	6940.
7	390.	1316.	999990.	1093.	1482.
8	170.	621.	999990.	408.	653.

CPUE Spanish Pair Trawlers

AGE	1983	1984	1985	1986	1987	1988	1989	1990
1	7196.	13710.	14573.	3721.	25328.	7778.	15272.	21444.
2	16392.	27286.	23823.	14131.	13153.	21473.	18486.	19407.
3	9311.	14845.	14126.	14745.	6664.	18436.	17160.	5194.
4	7476.	4836.	6256.	7113.	2938.	6391.	8374.	1803.
5	6326.	1755.	1232.	1278.	1029.	1300.	3760.	1357.
6	1718.	1750.	217.	505.	166.	781.	1003.	451.

CPUE Spanish Pair Trawlers

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	15924.	10007.	4036.	543.	9090.	3905.	8742.	5884.
2	15370.	24235.	13991.	6066.	14409.	14557.	15875.	13236.
3	4989.	9671.	22493.	15917.	6833.	14449.	11134.	9803.
4	2329.	4316.	7979.	7474.	4551.	3931.	3698.	10844.
5	1045.	1194.	1354.	2990.	1990.	3639.	1046.	5229.
6	440.	462.	658.	1055.	623.	1834.	450.	1153.

CPUE Spanish Pair Trawlers

AGE	1999	2000
1	2048.	6207.
2	10268.	15518.
3	20242.	13987.
4	9833.	5375.
5	6287.	1264.
6	3047.	1414.

Norwegian Sea acoustic - Blue Wh. 1981-9

AGE	1981	1982	1983	1984	1985	1986	1987	1988
1	182.	184.	22356.	30380.	5969.	2324.	8204.	4992.
2	728.	460.	396.	13916.	23876.	2380.	4032.	2880.
3	4542.	1242.	468.	833.	12502.	7224.	5180.	2640.
4	3874.	4715.	756.	392.	658.	6944.	5572.	3480.
5	2678.	3611.	1404.	539.	423.	1876.	1204.	912.
6	2834.	3128.	576.	539.	188.	952.	224.	120.
7	2964.	2323.	468.	343.	235.	336.	168.	96.

Norwegian Sea acoustic - Blue Wh. 1981-9

AGE	1989	1990
1	1172.	999990.
2	1125.	999990.
3	812.	999990.
4	379.	999990.
5	410.	999990.
6	212.	999990.
7	22.	999990.

Norwegian Sea acoustic - Blue Wh. 1991++

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	999990.	792.	830.	999990.	6974.	23464.	30227.	24244.
2	999990.	1134.	125.	999990.	2811.	1057.	25638.	47815.
3	999990.	6939.	1070.	999990.	1999.	899.	1524.	16282.
4	999990.	766.	6392.	999990.	1209.	649.	779.	556.
5	999990.	247.	1222.	999990.	1622.	436.	300.	212.
6	999990.	172.	489.	999990.	775.	505.	407.	100.
7	999990.	90.	248.	999990.	173.	755.	260.	64.

Norwegian Sea acoustic - Blue Wh. 1991++

AGE	1999	2000
1	14367.	25813.
2	9750.	3298.
3	23701.	2721.
4	9754.	3078.
5	1733.	23.
6	466.	46.
7	79.	6.

Fishing Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.0096	0.1727	0.0201	0.0479	0.1127	0.0084	0.0418	0.0044
1	0.0835	0.0369	0.1622	0.1392	0.1434	0.0842	0.1083	0.0672
2	0.0998	0.1197	0.1931	0.2476	0.1775	0.1254	0.1002	0.1281
3	0.1617	0.1278	0.1660	0.2340	0.3342	0.2431	0.1572	0.1469
4	0.1143	0.1892	0.1578	0.2384	0.2413	0.5603	0.4178	0.2167
5	0.2866	0.1242	0.1495	0.2330	0.2714	0.5622	0.4916	0.5693
6	0.3208	0.2286	0.2055	0.3456	0.4458	0.4740	0.3889	1.0618
7	0.3055	0.2485	0.3935	0.2744	0.3443	0.5601	0.5369	0.4395
8	0.3442	0.2941	0.4608	0.5030	0.2957	0.4874	0.8184	0.5761
9	0.3302	0.2550	0.4226	0.4859	0.4859	0.5422	0.5091	0.5396
10	0.3302	0.2550	0.4226	0.4859	0.4859	0.5422	0.5091	0.5396

Fishing Mortality (per year)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.0789	0.0080	0.0233	0.0033	0.0294	0.0045	0.1263	0.0075
1	0.1062	0.0865	0.0319	0.0756	0.0578	0.0582	0.0395	0.0674
2	0.1546	0.1179	0.0728	0.1018	0.0745	0.0303	0.0882	0.0969
3	0.3695	0.2118	0.1185	0.1596	0.1327	0.1208	0.1581	0.2342
4	0.2857	0.3665	0.1387	0.1863	0.2258	0.1151	0.2206	0.3428
5	0.4476	0.3084	0.3025	0.1404	0.1993	0.2750	0.2681	0.2676
6	0.7090	0.6422	0.2474	0.2025	0.1765	0.2035	0.2918	0.3503
7	0.7388	0.7589	0.3636	0.1576	0.2112	0.2416	0.2857	0.4382
8	0.5122	1.3556	0.2630	0.3124	0.1316	0.2777	0.3645	0.5670
9	0.5954	0.5811	0.2641	0.2714	0.2415	0.2347	0.2982	0.4014
10	0.5954	0.5811	0.2641	0.2714	0.2415	0.2347	0.2982	0.4014

Fishing Mortality (per year)

AGE	1997	1998	1999	2000
0	0.0075	0.0116	0.0112	0.0212
1	0.0673	0.1044	0.1007	0.1901
2	0.0968	0.1501	0.1449	0.2734
3	0.2339	0.3626	0.3499	0.6603
4	0.3424	0.5308	0.5123	0.9668
5	0.2672	0.4143	0.3999	0.7546
6	0.3498	0.5423	0.5235	0.9877
7	0.4377	0.6785	0.6549	1.2358
8	0.5662	0.8778	0.8473	1.5988
9	0.4009	0.6215	0.5998	1.1319
10	0.4009	0.6215	0.5998	1.1319

Population Abundance (1 January) x 10 ^ 6

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	5550.	24356.	24190.	13774.	12129.	11072.	9179.	11598.
1	3550.	4501.	16778.	19410.	10750.	8872.	8989.	7208.
2	4037.	2674.	3551.	11680.	13827.	7626.	6677.	6604.
3	5020.	2991.	1942.	2397.	7466.	9480.	5508.	4945.
4	3407.	3497.	2155.	1347.	1553.	4376.	6086.	3854.
5	2415.	2488.	2369.	1507.	869.	999.	2046.	3281.
6	2236.	1485.	1799.	1670.	977.	542.	466.	1024.
7	1943.	1328.	967.	1199.	968.	512.	276.	259.
8	2388.	1172.	848.	534.	746.	562.	240.	132.
9	2255.	1386.	715.	438.	264.	455.	282.	87.
10	5696.	3285.	1062.	725.	737.	1040.	535.	131.

Population Abundance (1 January)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	28310.	11547.	7717.	6332.	7522.	10344.	30676.	44688.
1	9454.	21420.	9379.	6173.	5167.	5980.	8431.	22135.
2	5518.	6960.	16084.	7438.	4686.	3993.	4619.	6636.
3	4757.	3870.	5065.	12244.	5500.	3561.	3171.	3463.
4	3496.	2691.	2564.	3683.	8546.	3943.	2584.	2217.
5	2540.	2151.	1527.	1827.	2503.	5583.	2878.	1697.
6	1520.	1329.	1294.	924.	1300.	1679.	3472.	1802.
7	290.	613.	573.	827.	618.	892.	1122.	2123.
8	136.	113.	235.	326.	578.	410.	574.	690.
9	61.	67.	24.	148.	195.	415.	254.	326.
10	93.	236.	45.	54.	90.	161.	178.	274.

x 10 ^ 6

Population Abundance (1 January)

AGE	1997	1998	1999	2000	2001
0	21564.	10603.	21182.	6802.	13848.
1	36314.	17524.	8581.	17149.	5453.
2	16941.	27796.	12925.	6352.	11610.
3	4931.	12590.	19585.	9155.	3957.
4	2243.	3195.	7173.	11300.	3873.
5	1288.	1304.	1539.	3518.	3519.
6	1063.	807.	706.	844.	1355.
7	1039.	613.	384.	342.	257.
8	1122.	549.	255.	163.	81.
9	320.	521.	187.	89.	27.
10	562.	202.	340.	223.	83.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1996	1997	1998	1999	2000
0	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000

Predicted Age-Structured Index Values

Norway Spawning Area/Acoustic 1981-90 Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988
2	2555.	999990.	2204.	7167.	999990.	4801.	4226.	4155.
3	7797.	999990.	3014.	3667.	999990.	14473.	8562.	7704.
4	6832.	999990.	4283.	2632.	999990.	7991.	11451.	7563.
5	5296.	999990.	5348.	3342.	999990.	2068.	4298.	6781.
6	4573.	999990.	3770.	3399.	999990.	1074.	940.	1794.
7	4023.	999990.	1966.	2499.	999990.	1006.	545.	521.
8	4891.	999990.	1695.	1058.	999990.	1116.	444.	258.

Norway Spawning Area/Acoustic 1981-90 Predicted

AGE	1989	1990
2	3453.	4389.
3	7072.	5948.
4	6762.	5119.
5	5386.	4696.
6	2867.	2542.
7	548.	1153.
8	270.	188.

Norway Spawning Area/Acoustic 1991-2001 Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998
2	15299.	7032.	4456.	3832.	4380.	6280.	999990.	26013.
3	10306.	24701.	11159.	7243.	6400.	6877.	999990.	24339.
4	6968.	9911.	22805.	10771.	6903.	5772.	999990.	7998.
5	2595.	3212.	4346.	9539.	4924.	2904.	999990.	2164.
6	1514.	1092.	1545.	1983.	4026.	2064.	999990.	888.
7	636.	959.	708.	1016.	1266.	2320.	999990.	637.
8	318.	437.	805.	553.	760.	877.	999990.	654.

Norway Spawning Area/Acoustic 1991-2001 Predicted

AGE	1999	2000	2001
2	12110.	5793.	10588.
3	37963.	16626.	7185.
4	18024.	25810.	8846.
5	2561.	5436.	5436.
6	779.	846.	1357.
7	401.	316.	238.
8	305.	167.	83.

Russian Spawning Area/Acoustic 1982-91 Predicted

AGE	1982	1983	1984	1985	1986	1987	1988	1989
3	3707.	2388.	2905.	8859.	11466.	6783.	6104.	5603.
4	5858.	3635.	2233.	2574.	6781.	9718.	6418.	5739.
5	4820.	4566.	2854.	1632.	1765.	3669.	5789.	4598.
6	3295.	4012.	3617.	2072.	1143.	1000.	1909.	3050.
7	3254.	2298.	2922.	2324.	1176.	637.	609.	641.
8	3220.	2249.	1404.	2049.	1481.	589.	342.	358.

Russian Spawning Area/Acoustic 1982-91 Predicted

AGE	1990	1991
3	4712.	6288.
4	4344.	4341.
5	4009.	2850.
6	2704.	2860.
7	1348.	1369.
8	249.	649.

Russian Spawning Area/Acoustic 1992-199 Predicted

AGE	1992	1993	1994	1995	1996
3	27371.	12365.	999990.	7092.	7620.
4	9855.	22676.	999990.	6864.	5739.
5	3595.	4864.	999990.	5512.	3250.
6	1165.	1649.	999990.	4297.	2203.
7	770.	569.	999990.	1017.	1864.
8	257.	474.	999990.	447.	516.

CPUE Spanish Pair Trawlers Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990
1	10153.	11883.	6567.	5582.	5588.	4574.	5883.	13463.
2	6729.	21537.	26406.	14948.	13254.	12927.	10658.	13694.
3	4257.	5079.	15044.	19993.	12126.	10944.	9418.	8292.
4	3619.	2172.	2501.	6008.	8974.	6283.	5506.	4072.
5	2615.	1595.	902.	897.	1903.	2936.	2415.	2193.
6	1340.	1160.	646.	353.	317.	497.	881.	796.

CPUE Spanish Pair Trawlers Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	6058.	3901.	3294.	3812.	5425.	14045.	23044.	10916.
2	32368.	14752.	9422.	8207.	9224.	13193.	33685.	53814.
3	11369.	26925.	12258.	7985.	6979.	7336.	10448.	25014.
4	4347.	6097.	13870.	6764.	4205.	3393.	3434.	4452.
5	1562.	2026.	2695.	5787.	2993.	1765.	1340.	1261.
6	944.	690.	983.	1252.	2478.	1249.	737.	508.

CPUE Spanish Pair Trawlers Predicted

AGE	1999	2000
1	5355.	10234.
2	25090.	11563.
3	39158.	15673.
4	10088.	12662.
5	1498.	2870.
6	448.	426.

Norwegian Sea acoustic - Blue Wh. 1981- Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988
1	1196.8	1565.7	5363.1	6301.9	3480.3	2989.2	2979.7	2456.5
2	1530.0	999.8	1263.7	4006.2	4972.5	2840.5	2529.8	2455.4
3	2772.1	1690.0	1069.3	1260.5	3669.0	4954.4	3050.5	2758.0
4	2252.5	2197.9	1383.8	819.0	942.5	2141.0	3278.5	2377.6
5	1477.1	1698.0	1589.7	955.7	536.9	507.3	1089.6	1658.2
6	1104.2	780.3	960.5	811.3	443.7	241.5	219.9	306.9
7	979.5	695.7	459.4	617.3	475.3	217.5	119.2	119.1

Norwegian Sea acoustic - Blue Wh. 1981- Predicted

AGE	1989	1990
1	3138.3	*******
2	2015.2	*******
3	2282.8	*******
4	2058.8	*******
5	1393.6	*******
6	577.8	*******
7	109.1	*******

Norwegian Sea acoustic - Blue Wh. 1991+ Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	999990.	4305.	3647.	999990.	6025.	15523.	25469.	11987.
2	999990.	2849.	1828.	999990.	1786.	2550.	6511.	10305.
3	999990.	6336.	2898.	999990.	1643.	1704.	2427.	5681.
4	999990.	1653.	3735.	999990.	1133.	895.	906.	1137.
5	999990.	420.	553.	999990.	607.	358.	272.	249.
6	999990.	246.	352.	999990.	870.	434.	256.	171.
7	999990.	155.	112.	999990.	193.	329.	161.	81.

Norwegian Sea acoustic - Blue Wh. 1991+ Predicted

AGE	1999	2000
1	5884.	11071.
2	4809.	2167.
3	8913.	3379.
4	2584.	2995.
5	297.	534.
6	151.	132.
7	52.	31.

Fitted Selection Pattern

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	0.0335	1.3904	0.1346	0.2054	0.4154	0.0150	0.0851	0.0077
1	0.2912	0.2973	1.0848	0.5973	0.5285	0.1497	0.2204	0.1180
2	0.3481	0.9637	1.2913	1.0624	0.6540	0.2230	0.2038	0.2250
3	0.5641	1.0288	1.1102	1.0041	1.2316	0.4325	0.3197	0.2581
4	0.3987	1.5228	1.0556	1.0232	0.8892	0.9966	0.8499	0.3807
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.1193	1.8399	1.3746	1.4834	1.6429	0.8431	0.7910	1.8652
7	1.0661	2.0006	2.6315	1.1775	1.2687	0.9963	1.0921	0.7721
8	1.2010	2.3671	3.0819	2.1587	1.0896	0.8670	1.6648	1.0120
9	1.1523	2.0529	2.8266	2.0852	1.7904	0.9644	1.0356	0.9480
10	1.1523	2.0529	2.8266	2.0852	1.7904	0.9644	1.0356	0.9480

Fitted Selection Pattern

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	0.1762	0.0258	0.0770	0.0236	0.1475	0.0163	0.4713	0.0280
1	0.2373	0.2805	0.1053	0.5384	0.2899	0.2118	0.1473	0.2519
2	0.3453	0.3823	0.2406	0.7256	0.3736	0.1101	0.3290	0.3623
3	0.8254	0.6868	0.3917	1.1373	0.6660	0.4393	0.5900	0.8751
4	0.6381	1.1883	0.4585	1.3271	1.1326	0.4185	0.8230	1.2812
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.5838	2.0825	0.8178	1.4426	0.8855	0.7400	1.0885	1.3090
7	1.6504	2.4608	1.2020	1.1229	1.0595	0.8786	1.0658	1.6377
8	1.1442	4.3956	0.8693	2.2259	0.6600	1.0099	1.3597	2.1188
9	1.3302	1.8842	0.8731	1.9339	1.2116	0.8535	1.1126	1.5000
10	1.3302	1.8842	0.8731	1.9339	1.2116	0.8535	1.1126	1.5000

Fitted Selection Pattern

AGE	1997	1998	1999	2000
0	0.0280	0.0280	0.0280	0.0280
1	0.2519	0.2519	0.2519	0.2519
2	0.3623	0.3623	0.3623	0.3623
3	0.8751	0.8751	0.8751	0.8751
4	1.2812	1.2812	1.2812	1.2812
5	1.0000	1.0000	1.0000	1.0000
6	1.3090	1.3090	1.3090	1.3090
7	1.6377	1.6377	1.6377	1.6377
8	2.1188	2.1188	2.1188	2.1188
9	1.5000	1.5000	1.5000	1.5000
10	1.5000	1.5000	1.5000	1.5000

STOCK SUMMARY

Year	Recruits Age 0 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 7	SoP (%)
1981	5550240	4678474	3496846	909556	0.2601	0.2377	98
1982	24356160	3851389	2648940	576419	0.2176	0.1837	93
1983	24189990	3474630	1791259	570072	0.3183	0.2145	101
1984	13774480	3380880	1562920	641776	0.4106	0.2651	101
1985	12128640	3416501	1819209	695596	0.3824	0.3274	99
1986	11071540	3731749	2125704	826986	0.3890	0.4799	97
1987	9179300	3247543	1803309	664431	0.3685	0.3985	100
1988	11597640	2969068	1532708	553446	0.3611	0.4868	99
1989	28310490	3050941	1463991	625433	0.4272	0.5101	95
1990	11547080	3330862	1415128	561610	0.3969	0.4576	100
1991	7717350	3849107	1872460	369524	0.1973	0.2341	99
1992	6331630	3898821	2456247	474245	0.1931	0.1693	99
1993	7522430	3662506	2358046	480679	0.2038	0.1891	99
1994	10344360	3628270	2271753	459414	0.2022	0.1912	100
1995	30675990	3852941	2017171	578683	0.2869	0.2449	100
1996	44687970	4175934	1847190	644273	0.3488	0.3266	101
1997	21564440	5310772	1987498	646652	0.3254	0.3262	100
1998	10602820	5494010	2515858	1125151	0.4472	0.5057	99
1999	21181860	5378850	2682051	1256328	0.4684	0.4881	99
2000	6802300	4393463	2085705	1413145	0.6775	0.9210	99

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 10
Year range in the analysis : 1981 . . . 2000
Number of indices of SSB : 0
Number of age-structured indices : 7

Parameters to estimate : 73

Number of observations : 487

Conventional single selection vector model to be fitted.

PARAMETER ESTIMATES

Parm. No.		Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year								
1	1996	0.2676	18	0.1865	0.3840	0.2226	0.3217	0.2722
2	1997	0.2672	17	0.1886	0.3786	0.2237	0.3192	0.2715
3	1998	0.4143	17	0.2961	0.5798	0.3490	0.4918	0.4204
4	1999	0.3999	17	0.2825	0.5661	0.3349	0.4775	0.4062
5	2000	0.7546	21	0.4990	1.1410	0.6111	0.9318	0.7716
Separable Model: Selection (S) by age								
6	0	0.0280	53	0.0098	0.0803	0.0164	0.0480	0.0324
7	1	0.2519	26	0.1497	0.4237	0.1932	0.3284	0.2609
8	2	0.3623	21	0.2369	0.5540	0.2917	0.4500	0.3709
9	3	0.8751	20	0.5829	1.3139	0.7112	1.0767	0.8941
10	4	1.2812	19	0.8673	1.8925	1.0499	1.5633	1.3068
	5	1.0000		Fixed : Reference Age				
11	6	1.3090	19	0.8853	1.9355	1.0722	1.5981	1.3353
12	7	1.6377	18	1.1331	2.3671	1.3571	1.9763	1.6669
13	8	2.1188	17	1.5118	2.9695	1.7836	2.5170	2.1504
	9	1.5000		Fixed : Last true age				
Separable model: Populations in year 2000								
14	0	6802301	114	727902	63567972	2175007	21274090	13030880
15	1	17148887	34	8754001	33594276	12168621	24167432	18188376
16	2	6352067	23	4025403	10023531	5033160	8016585	6526445
17	3	9155126	18	6355105	13188820	7599338	11029426	9315307
18	4	11300372	16	8113418	15739163	9542893	13381520	11462981
19	5	3518459	16	2537949	4877780	2978311	4156569	3567668
20	6	844461	16	616596	1156533	719278	991431	855401
21	7	342229	16	246211	475694	289303	404839	347094
22	8	163444	19	112335	237807	134984	197906	166463
23	9	89413	24	55025	145291	69796	114544	92198
Separable model: Populations at age								
24	1996	326263	35	164100	648672	229770	463278	346947
25	1997	320474	26	191544	536189	246462	416713	331716
26	1998	521253	23	331613	819341	413843	656539	535316
27	1999	186952	23	118137	295852	147919	236286	192150

Age-structured index catchabilities

Norway Spawning Area/Acoustic 1981-90

Linear model fitted. Slopes at age :

28	2	Q	.6741E-03	29	.5074E-03	.1619E-02	.6741E-03	.1219E-02	.9470E-03
29	3	Q	.1676E-02	29	.1261E-02	.4025E-02	.1676E-02	.3029E-02	.2354E-02
30	4	Q	.2142E-02	29	.1612E-02	.5145E-02	.2142E-02	.3873E-02	.3009E-02
31	5	Q	.2429E-02	29	.1828E-02	.5834E-02	.2429E-02	.4391E-02	.3412E-02
32	6	Q	.2282E-02	29	.1718E-02	.5481E-02	.2282E-02	.4125E-02	.3206E-02
33	7	Q	.2302E-02	29	.1733E-02	.5530E-02	.2302E-02	.4162E-02	.3234E-02
34	8	Q	.2296E-02	29	.1728E-02	.5514E-02	.2296E-02	.4150E-02	.3225E-02

Norway Spawning Area/Acoustic 1991-2001

Linear model fitted. Slopes at age :

35	2	Q	.1007E-02	27	.7756E-03	.2255E-02	.1007E-02	.1736E-02	.1372E-02
36	3	Q	.2176E-02	27	.1679E-02	.4838E-02	.2176E-02	.3734E-02	.2956E-02
37	4	Q	.2918E-02	27	.2251E-02	.6494E-02	.2918E-02	.5010E-02	.3966E-02
38	5	Q	.1888E-02	27	.1456E-02	.4208E-02	.1888E-02	.3245E-02	.2568E-02
39	6	Q	.1286E-02	27	.9915E-03	.2866E-02	.1286E-02	.2210E-02	.1749E-02
40	7	Q	.1250E-02	27	.9619E-03	.2799E-02	.1250E-02	.2155E-02	.1703E-02
41	8	Q	.1492E-02	27	.1144E-02	.3390E-02	.1492E-02	.2598E-02	.2046E-02

Russian Spawning Area/Acoustic 1982-91

Linear model fitted. Slopes at age :

42	3	Q	.1327E-02	24	.1049E-02	.2743E-02	.1327E-02	.2167E-02	.1748E-02
43	4	Q	.1818E-02	24	.1437E-02	.3756E-02	.1818E-02	.2968E-02	.2394E-02
44	5	Q	.2074E-02	24	.1639E-02	.4284E-02	.2074E-02	.3386E-02	.2731E-02
45	6	Q	.2428E-02	24	.1919E-02	.5017E-02	.2428E-02	.3965E-02	.3197E-02
46	7	Q	.2692E-02	24	.2127E-02	.5561E-02	.2692E-02	.4395E-02	.3545E-02
47	8	Q	.3047E-02	24	.2408E-02	.6295E-02	.3047E-02	.4975E-02	.4012E-02

Russian Spawning Area/Acoustic 1992-199

Linear model fitted. Slopes at age :

48	3	Q	.2411E-02	38	.1660E-02	.7619E-02	.2411E-02	.5246E-02	.3835E-02
49	4	Q	.2902E-02	38	.1998E-02	.9173E-02	.2902E-02	.6315E-02	.4617E-02
50	5	Q	.2113E-02	38	.1455E-02	.6683E-02	.2113E-02	.4600E-02	.3363E-02
51	6	Q	.1372E-02	38	.9443E-03	.4345E-02	.1372E-02	.2990E-02	.2185E-02
52	7	Q	.1004E-02	39	.6902E-03	.3186E-02	.1004E-02	.2190E-02	.1600E-02
53	8	Q	.8781E-03	39	.6029E-03	.2800E-02	.8781E-03	.1922E-02	.1403E-02

CPUE Spanish Pair Trawlers

Linear model fitted. Slopes at age :

54	1	Q	.7253E-03	18	.6069E-03	.1257E-02	.7253E-03	.1051E-02	.8885E-03
55	2	Q	.2306E-02	18	.1932E-02	.3984E-02	.2306E-02	.3337E-02	.2822E-02
56	3	Q	.2632E-02	18	.2205E-02	.4541E-02	.2632E-02	.3805E-02	.3219E-02
57	4	Q	.2008E-02	18	.1683E-02	.3464E-02	.2008E-02	.2903E-02	.2456E-02
58	5	Q	.1314E-02	18	.1101E-02	.2268E-02	.1314E-02	.1900E-02	.1608E-02
59	6	Q	.9125E-03	18	.7644E-03	.1576E-02	.9125E-03	.1320E-02	.1116E-02

Norwegian Sea acoustic - Blue Wh. 1981-

Linear model fitted. Slopes at age :

60	1	Q	.4082E-03	27	.3122E-03	.9325E-03	.4082E-03	.7133E-03	.5610E-03
61	2	Q	.4640E-03	27	.3549E-03	.1060E-02	.4640E-03	.8108E-03	.6377E-03
62	3	Q	.7048E-03	27	.5392E-03	.1610E-02	.7048E-03	.1232E-02	.9688E-03
63	4	Q	.8174E-03	27	.6253E-03	.1867E-02	.8174E-03	.1428E-02	.1123E-02
64	5	Q	.8494E-03	27	.6498E-03	.1941E-02	.8494E-03	.1484E-02	.1168E-02
65	6	Q	.7020E-03	27	.5370E-03	.1604E-02	.7020E-03	.1227E-02	.9648E-03
66	7	Q	.7090E-03	27	.5424E-03	.1620E-02	.7090E-03	.1239E-02	.9745E-03

Norwegian Sea acoustic - Blue Wh. 1991+

Linear model fitted. Slopes at age :

67	1	Q	.8400E-03	30	.6265E-03	.2075E-02	.8400E-03	.1548E-02	.1195E-02
68	2	Q	.4696E-03	30	.3513E-03	.1149E-02	.4696E-03	.8596E-03	.6650E-03
69	3	Q	.6596E-03	30	.4938E-03	.1610E-02	.6596E-03	.1205E-02	.9332E-03
70	4	Q	.5825E-03	30	.4361E-03	.1422E-02	.5825E-03	.1065E-02	.8242E-03
71	5	Q	.2892E-03	30	.2164E-03	.7064E-03	.2892E-03	.5287E-03	.4092E-03
72	6	Q	.3493E-03	30	.2612E-03	.8560E-03	.3493E-03	.6401E-03	.4950E-03
73	7	Q	.2387E-03	30	.1780E-03	.5897E-03	.2387E-03	.4398E-03	.3395E-03

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1996	1997	1998	1999	2000
0	1.012	0.372	-0.949	-0.432	0.000
1	0.369	-0.006	0.050	0.054	-0.397
2	-0.041	0.068	0.172	-0.022	-0.148
3	-0.039	-0.034	0.014	0.099	-0.157
4	-0.088	-0.026	-0.141	0.275	-0.251
5	-0.115	0.072	-0.051	-0.114	-0.099
6	0.024	-0.128	0.043	-0.238	0.051
7	-0.037	-0.176	0.090	-0.112	-0.052
8	-0.162	-0.086	-0.111	0.135	0.222
9	0.000	0.077	-0.039	-0.115	0.041

AGE-STRUCTURED INDEX RESIDUALS

Norway Spawning Area/Acoustic 1981-90

Age	1981	1982	1983	1984	1985	1986	1987	1988
2	-0.074	*******	-2.004	0.788	*******	-1.566	0.160	0.849
3	-0.028	*******	-0.357	-0.756	*******	-0.909	-0.017	0.165
4	-0.742	*******	-0.453	-0.488	*******	-0.662	0.679	0.492
5	-0.373	*******	0.197	-0.665	*******	-1.198	0.097	1.101
6	0.008	*******	-0.009	-0.604	*******	-1.550	-1.204	1.411
7	0.142	*******	0.619	-0.796	*******	-1.600	-0.268	0.328
8	-0.292	*******	0.621	-0.624	*******	-1.496	-0.143	0.842

Norway Spawning Area/Acoustic 1981-90

Age	1989	1990
2	0.676	1.172
3	1.147	0.756
4	0.388	0.785
5	0.668	0.174
6	1.001	0.948
7	0.532	1.043
8	0.083	1.010

Norway Spawning Area/Acoustic 1991-2001

Age	1991	1992	1993	1994	1995	1996	1997	1998
2	-0.317	-1.742	0.007	-0.871	0.668	0.335	*******	-0.356
3	-0.486	0.056	-1.212	-0.898	0.434	0.078	*******	0.363
4	0.198	-0.742	0.160	-0.878	0.136	0.372	*******	-0.532
5	1.049	-0.713	-0.497	0.174	0.332	-0.191	*******	-0.257
6	1.102	0.238	-0.196	-0.130	0.855	0.769	*******	-1.158
7	1.156	-0.168	-0.240	0.507	0.350	0.572	*******	-0.449
8	0.539	0.344	-0.636	0.496	0.354	0.316	*******	-0.540

Norway Spawning Area/Acoustic 1991-2001

Age	1999	2000	2001
2	0.452	0.397	1.428
3	0.463	0.623	0.581
4	0.370	0.472	0.445
5	-0.548	0.230	0.422
6	-0.903	0.060	-0.637
7	-1.718	0.300	-0.307
8	-0.690	0.310	-0.490

Russian Spawning Area/Acoustic 1982-91

Age	1982	1983	1984	1985	1986	1987	1988	1989
3	-1.926	-0.024	-0.002	0.400	0.492	-0.415	-0.498	0.754
4	-0.756	-0.216	-1.027	-1.018	1.229	0.679	-0.344	0.216
5	-1.280	0.721	-0.953	-1.035	0.364	0.468	0.397	0.372
6	-0.870	-0.033	0.149	-0.152	-0.628	0.067	0.772	0.826
7	-0.729	-0.154	-0.284	-0.994	-0.640	-0.243	0.735	1.966
8	-0.315	-0.496	-0.157	-1.212	-0.681	0.318	0.338	2.039

Russian Spawning Area/Acoustic 1982-91

Age	1990	1991
3	0.726	0.493
4	1.028	0.209
5	0.359	0.588
6	-0.047	-0.084
7	0.086	0.257
8	-0.125	0.293

Russian Spawning Area/Acoustic 1992-199

Age	1992	1993	1994	1995	1996
3	-0.313	-0.961	*******	0.579	0.696
4	-0.386	-0.609	*******	0.379	0.616
5	-0.979	0.087	*******	0.484	0.410
6	-0.974	0.311	*******	-0.483	1.147
7	-0.680	0.838	*******	0.072	-0.229
8	-0.413	0.271	*******	-0.092	0.236

CPUE Spanish Pair Trawlers

Age	1983	1984	1985	1986	1987	1988	1989	1990
1	-0.344	0.143	0.797	-0.406	1.511	0.531	0.954	0.466
2	0.890	0.237	-0.103	-0.056	-0.008	0.507	0.551	0.349
3	0.783	1.073	-0.063	-0.304	-0.599	0.521	0.600	-0.468
4	0.725	0.800	0.917	0.169	-1.117	0.017	0.419	-0.815
5	0.883	0.095	0.311	0.354	-0.615	-0.815	0.443	-0.480
6	0.248	0.411	-1.091	0.357	-0.647	0.451	0.130	-0.568

CPUE Spanish Pair Trawlers

Age	1991	1992	1993	1994	1995	1996	1997	1998
1	0.966	0.942	0.203	-1.949	0.516	-1.280	-0.969	-0.618
2	-0.745	0.496	0.395	-0.302	0.446	0.098	-0.752	-1.403
3	-0.824	-1.024	0.607	0.690	-0.021	0.678	0.064	-0.937
4	-0.624	-0.346	-0.553	0.100	0.079	0.147	0.074	0.890
5	-0.402	-0.529	-0.688	-0.660	-0.408	0.723	-0.248	1.422
6	-0.763	-0.401	-0.401	-0.171	-1.381	0.384	-0.493	0.819

CPUE Spanish Pair Trawlers

Age	1999	2000
1	-0.961	-0.500
2	-0.893	0.294
3	-0.660	-0.114
4	-0.026	-0.857
5	1.434	-0.820
6	1.916	1.201

Norwegian Sea acoustic - Blue Wh. 1981-

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	-1.883	-2.141	1.428	1.573	0.539	-0.252	1.013	0.709
2	-0.743	-0.776	-1.160	1.245	1.569	-0.177	0.466	0.160
3	0.494	-0.308	-0.826	-0.414	1.226	0.377	0.530	-0.044
4	0.542	0.763	-0.605	-0.737	-0.359	1.177	0.530	0.381
5	0.595	0.755	-0.124	-0.573	-0.238	1.308	0.100	-0.598
6	0.943	1.388	-0.511	-0.409	-0.859	1.372	0.018	-0.939
7	1.107	1.206	0.019	-0.588	-0.704	0.435	0.343	-0.216

Norwegian Sea acoustic - Blue Wh. 1981-

Age	1989	1990
1	-0.985	*******
2	-0.583	*******
3	-1.034	*******
4	-1.692	*******
5	-1.224	*******
6	-1.003	*******
7	-1.602	*******

Norwegian Sea acoustic - Blue Wh. 1991+

Age	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	-1.693	-1.480	*******	0.146	0.413	0.171	0.704
2	*******	-0.921	-2.683	*******	0.454	-0.881	1.371	1.535
3	*******	0.091	-0.996	*******	0.196	-0.639	-0.465	1.053
4	*******	-0.769	0.537	*******	0.065	-0.322	-0.151	-0.715
5	*******	-0.531	0.793	*******	0.983	0.198	0.099	-0.161
6	*******	-0.358	0.328	*******	-0.116	0.151	0.463	-0.536
7	*******	-0.544	0.797	*******	-0.109	0.829	0.477	-0.235

Norwegian Sea acoustic - Blue Wh. 1991+

Age	1999	2000
1	0.893	0.847
2	0.707	0.420
3	0.978	-0.216
4	1.328	0.027
5	1.765	-3.145
6	1.125	-1.057
7	0.428	-1.642

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1996 to 2000	
Variance	0.0413
Skewness test stat.	-0.3999
Kurtosis test statistic	-0.2396
Partial chi-square	0.0720
Significance in fit	0.0000
Degrees of freedom	23

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR Norway Spawning Area/Acoustic 1981-90

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.1974	0.0703	0.0592	0.0766	0.1655	0.1050	0.0991
Skewness test stat.	-0.9627	0.3659	0.0450	-0.1881	-0.1450	-0.8554	-0.5347
Kurtosis test statisti	-0.4904	-0.5293	-1.0367	-0.4384	-0.7639	-0.2702	-0.3873
Partial chi-square	0.1702	0.0556	0.0474	0.0653	0.1582	0.1046	0.1091
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR Norway Spawning Area/Acoustic 1991-2001

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8
Variance	0.1108	0.0600	0.0379	0.0417	0.0828	0.0868	0.0379
Skewness test stat.	-0.5800	-1.0842	-1.0270	0.5831	-0.0424	-1.0471	-0.4833
Kurtosis test statisti	-0.0491	-0.4790	-0.6796	-0.3748	-0.7515	0.3855	-1.1137
Partial chi-square	0.1119	0.0582	0.0367	0.0467	0.1034	0.1247	0.0578
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9	9
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR Russian Spawning Area/Acoustic 1982-91

Linear catchability relationship assumed

Age	3	4	5	6	7	8
Variance	0.1088	0.1101	0.0974	0.0461	0.1217	0.1254
Skewness test stat.	-1.7866	0.1846	-1.0771	0.1218	1.5371	1.4624
Kurtosis test statisti	0.7971	-0.8148	-0.7295	-0.3221	0.5562	0.8413
Partial chi-square	0.1165	0.1186	0.1086	0.0535	0.1610	0.1770
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	10	10	10	10	10	10
Degrees of freedom	9	9	9	9	9	9
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR Russian Spawning Area/Acoustic 1992-199

Linear catchability relationship assumed

Age	3	4	5	6	7	8
Variance	0.1024	0.0579	0.0761	0.1442	0.0680	0.0171
Skewness test stat.	-0.2531	0.0085	-0.7716	0.1968	0.3170	-0.3660
Kurtosis test statisti	-0.6421	-0.7378	-0.3504	-0.5707	-0.4491	-0.5768
Partial chi-square	0.0333	0.0189	0.0277	0.0577	0.0314	0.0088
Significance in fit	0.0016	0.0007	0.0012	0.0036	0.0015	0.0002
Number of observations	4	4	4	4	4	4
Degrees of freedom	3	3	3	3	3	3
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR CPUE Spanish Pair Trawlers

Linear catchability relationship assumed

Age	1	2	3	4	5	6
Variance	0.1440	0.0610	0.0728	0.0638	0.0915	0.1130
Skewness test stat.	-0.6266	-1.4125	-0.0558	-0.2483	1.2145	0.8487
Kurtosis test statisti	-0.6192	-0.1482	-1.1353	-0.8137	-0.6462	-0.0271
Partial chi-square	0.2807	0.1036	0.1329	0.1275	0.2065	0.2967
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	18	18	18	18	18	18
Degrees of freedom	17	17	17	17	17	17
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR Norwegian Sea acoustic - Blue Wh. 1981-

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7
Variance	0.2767	0.1273	0.0748	0.1177	0.0875	0.1384	0.1150
Skewness test stat.	-0.5490	0.6285	0.1698	-0.6684	0.2134	0.5830	-0.3230
Kurtosis test statisti	-0.7766	-0.6317	-0.5609	-0.4292	-0.4923	-0.8763	-0.4269
Partial chi-square	0.2858	0.1295	0.0769	0.1248	0.1021	0.1793	0.1644
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	9	9	9	9	9	9	9
Degrees of freedom	8	8	8	8	8	8	8
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

DISTRIBUTION STATISTICS FOR Norwegian Sea acoustic - Blue Wh. 1991+

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7
Variance	0.1487	0.2844	0.0771	0.0671	0.3053	0.0644	0.0978
Skewness test stat.	-1.0540	-0.8829	0.3337	0.8999	-1.3723	0.1061	-1.0394
Kurtosis test statisti	-0.4764	-0.2453	-0.6482	-0.0994	0.5170	-0.3376	-0.0586
Partial chi-square	0.1221	0.2489	0.0647	0.0616	0.3475	0.0889	0.1719
Significance in fit	0.0000	0.0001	0.0000	0.0000	0.0002	0.0000	0.0000
Number of observations	8	8	8	8	8	8	8
Degrees of freedom	7	7	7	7	7	7	7
Weight in the analysis	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429	0.1429

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	270.5451	487	73	414	0.6535
Catches at age	3.1239	50	27	23	0.1358
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	37.8841	56	7	49	0.7731
Norway Spawning Area/Acoustic 1991-200	28.8446	70	7	63	0.4579

Russian Spawning Area/Acoustic 1982-91	32.9142	60	6	54	0.6095
Russian Spawning Area/Acoustic 1992-19	8.3815	24	6	18	0.4656
CPUE Spanish Pair Trawlers	55.7065	108	6	102	0.5461
Norwegian Sea acoustic - Blue Wh. 1981	52.4908	63	7	56	0.9373
Norwegian Sea acoustic - Blue Wh. 1991	51.1995	56	7	49	1.0449

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	7.1233	487	73	414	0.0172
Catches at age	0.9508	50	27	23	0.0413
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	0.7731	56	7	49	0.0158
Norway Spawning Area/Acoustic 1991-200	0.5887	70	7	63	0.0093
Russian Spawning Area/Acoustic 1982-91	0.9143	60	6	54	0.0169
Russian Spawning Area/Acoustic 1992-19	0.2328	24	6	18	0.0129
CPUE Spanish Pair Trawlers	1.5474	108	6	102	0.0152
Norwegian Sea acoustic - Blue Wh. 1981	1.0712	63	7	56	0.0191
Norwegian Sea acoustic - Blue Wh. 1991	1.0449	56	7	49	0.0213

Table 6.4.5.1 Tuning data for the blue whiting assessment with input values framed

BLUE WHITING-COMBINED

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Norway Spawning Acoustic 1981-90

1981	1990								
1	1	0.17	0.25						
2	10								
1	2372	7683	3253	3647	4611	4838	3654	2581	1785
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	297	2108	2723	8511	3735	3850	3153	2279	1102
1	15767	1721	1816	1718	1868	1128	567	440	348
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	1003	6839	4122	624	239	303	258	137	170
1	4960	9417	22589	4735	282	417	385	159	27
1	8712	9080	12367	28392	7365	723	598	326	396
1	6767	22270	0873	18504	7683	833	200	177	46
1	14169	12670	11329	5597	6586	2373	518	183	108

Norwegian Sea acoustic 1981-90

1981	1990												
1	1	0.6	0.75										
8	11												
1	0	182	729	4642	3874	2678	2834	2964	2798	2854	1308	1082
1	2680	184	460	1342	4715	3611	2128	3323	1679	874	414	253
1	0280	22356	398	480	758	1404	576	468	432	324	218	180
1	1682	30380	13918	833	392	539	539	343	49	49	48	49
1	2256	5868	23878	12502	658	423	188	236	141	376	141	47
1	6040	3324	2388	7224	6944	1876	852	336	389	140	196	56
1	3182	6304	4022	5180	5572	1284	324	168	58	94	28	39
1	6780	4892	2088	2840	3480	912	120	98	34	48	-1	0
1	20430	1172	1125	812	378	410	212	22	32	-1	8	1
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

Norway Spawning Acoustic 1981-2001

1981	2001								
1	1	0.17	0.25						
2	10								
1	11147	6340	8497	7407	4569	2819	546	86	16
1	1232	30123	4719	1574	1306	810	616	257	19
1	4409	3321	26771	3643	1270	557	426	100	22
1	1603	2060	4476	11354	1142	1657	908	770	207
1	8536	9674	7808	8061	9487	1795	1060	482	149
1	8781	7433	6371	2366	4465	4111	1202	499	162
1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1	18216	34981	4897	1674	279	407	301	351	86
1	18034	80309	26103	1481	316	72	153	141	0
1	8613	31011	41392	8943	688	427	229	139	115
1	44162	12043	13805	8292	710	175	51		

Norwegian Sea acoustic 1981-2000

1981	2000											
1	1	0.6	0.75									
8	11											
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0
1	0	792	1134	6839	706	247	172	98	11	18	1	3
1	0	830	125	1070	8302	1222	489	248	58	88	71	0
1	0	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0
1	0	8974	2611	1999	1208	1622	776	173	81	1	15	0
1	0	23484	1067	899	649	436	505	756	89	41	58	0
1	0	30227	25628	1534	779	380	407	268	137	123	108	0
1	0	24344	47815	16282	558	212	100	64	10	355	37	0
1	0	14367	9758	23701	8754	1733	466	78	48	91	34	0
1	0	25813	3298	2721	3079	33	46	6				

Russian spawning acoustic 1982-91

1982	1991							
1	1	0.17	0.26					
3	10							
1	540	2750	1340	1380	1570	2380	1730	1290
1	2330	2930	5590	3880	1970	1370	790	680
1	2900	800	1100	4200	2200	1280	1708	1200
1	13220	930	580	1780	860	610	908	540
1	18750	23180	2540	610	820	780	648	710
1	4480	19170	5880	1070	500	810	868	870
1	3710	4950	8610	4130	1270	480	258	280
1	11910	7120	6670	6970	4890	2790	1808	810
1	9740	12140	5740	2500	1470	220	68	10
1	18300	5350	5130	2630	1770	870	308	220

Russian spawning acoustic 1992-96

1992	1996							
1	1	0.17	0.26					
3	10							
1	28010	6700	1350	440	390	170	8	0
1	4728	12337	5384	2249	1316	621	368	160
1	-1	-1	-1	-1	-1	-1	-1	-1
1	13667	10828	9942	3661	1899	489	131	14
1	15285	10829	4887	8940	1452	653	65	0

CPUE Spanish Pair Trawlers

1983	2000					
1	1	0	1			
1	6					
1	7196	16392	5511	7476	6326	1716
1	13710	27286	14845	4836	1756	1790
1	14673	20823	14126	6266	1232	217
1	3721	14131	14746	7113	1278	686
1	25326	13153	6684	2006	1829	186
1	7778	21473	18406	6391	1300	781
1	15272	18486	17180	8374	3760	1083
1	21444	19407	6194	1903	1367	461
1	15924	15370	4989	2329	1845	440
1	10007	24235	9671	4316	1194	482
1	4036	13991	22483	7979	1354	686
1	543	6066	19917	7474	2990	1066
1	9090	14409	6933	4551	1990	623
1	3905	14657	14449	3931	3639	1034
1	8742	15875	11134	3606	1846	480
1	5984	13236	9903	10944	5229	1153
1	3048	10368	20242	9633	6287	3047
1	8207	15518	13087	5375	1264	1414

Spanish Survey (Bottom trawl)

1986	2000							
1	1	0.87	0.75					
0	7							
1	1748.4	508.3	288.4	104	11.4	3.5	1	0.5
1	1572.6	26.7	67.5	63.2	26.7	2	2.6	0.2
1	-1	-1	-1	-1	-1	-1	-1	-1
1	4979.6	368.7	344.9	37.3	7.2	3	5	0.3
1	1923.3	163	51.2	28.6	3.8	2.8	0.7	0.2
1	1526	74.9	46.1	10.7	10.4	2.4	0.1	0.5
1	4003.2	95.2	49.6	24.5	17.5	5.1	1.5	0.8
1	298.6	428.2	233.3	77	20.4	8.9	2.3	0.9
1	116.7	107.6	160.8	19.4	6.6	1.6	0.2	0.2
1	1415.4	30.9	4.8	16	13.6	6.1	0.9	0.3
1	1309	58.5	93.1	17.3	10.2	4.4	0.6	0.2
1	271	287.9	588.1	116.1	12	4.4	2.3	0.3
1	508.8	584.5	106.3	10.2	3.8	0.4	0.1	0.1
1	668.1	351.6	362.8	86.9	22.8	6.4	0.1	0.8
1	-1	-1	-1	-1	-1	-1	-1	-1
1	2768.4	157.7	72.1	24.8	3.3	0.5	0.1	0.3

Portuguese Survey (Bottom trawl)

1986	1999					
1	1	0.76	0.93			
0	5					
1	719	1467	308	129	18	6
1	-1	-1	-1	-1	-1	-1
1	4767	1190	366	110	26	19
1	4019	159	219	27	3	4
1	836	680	318	143	46	41
1	1936	519	278	262	271	67
1	1446	144	154	189	124	56
1	109	164	128	200	147	69
1	43	134	431	127	59	23
1	2677	1595	12	34	59	31
1	2406	280	342	79	57	42
1	251	72	98	15	3	6
1	2428	3206	778	27	9	1
1	4543	1281	14	11	2	2

Table 6.4.5.2.a Modelled catches by year (tonnes)

Blue Whiting, Output from final AMCI run

Modelled catches by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	249276.6	2287121.1	2294636.9	1172026.6	993862.5	640832.3	379107.5	220144.7
1	258806.0	226638.8	1126631.7	2230655.8	1465106.8	1313784.6	1060305.9	707965.9
2	379359.6	225708.6	344958.0	1361957.2	2276835.6	1703138.5	1160922.5	1014222.8
3	749819.6	323409.0	276121.2	405738.6	1285178.9	2370516.9	1242720.8	912201.3
4	577608.8	487411.6	309975.2	272085.8	326158.6	1122886.1	1501898.8	859038.8
5	501155.8	323044.3	389810.8	259531.7	189755.1	263752.8	594120.3	853939.9
6	623781.7	311074.9	306861.7	393911.1	223603.6	178109.5	157584.5	390648.3
7	556108.4	305392.9	238527.1	240153.1	247556.2	146553.8	81350.3	79662.3
8	593009.4	290133.5	248326.3	189023.7	154419.8	172043.5	73478.0	42904.6
9	516235.8	253749.3	193020.6	161172.7	98559.4	97247.2	74996.8	28435.2
10	927122.4	609356.8	540966.4	472605.3	345233.8	286736.3	156678.2	88238.6

	1989	1990	1991	1992	1993	1994	1995	1996
0	1291755.8	305584.7	93251.1	50076.4	122430.8	98236.0	1766654.4	2265530.6
1	972791.6	1996678.9	332220.8	263918.9	218021.0	261773.4	415095.3	1678545.9
2	980565.9	1071134.2	1024855.1	516104.2	313247.9	239546.0	367330.4	615306.2
3	1119463.8	870308.7	450981.4	1247830.3	556596.4	347963.3	372356.5	569097.6
4	859912.7	800681.3	296282.8	449129.9	1126224.6	496282.7	407253.5	427583.4
5	685251.6	541387.4	248001.7	263972.3	354671.7	897548.4	533874.7	403053.0
6	692355.5	432468.5	174334.7	222371.8	216629.5	291183.2	898711.2	495784.0
7	228728.3	309267.3	91991.4	111203.8	131133.0	136926.8	240089.0	702696.6
8	54632.6	125025.9	82537.8	71517.4	77022.4	95001.1	126905.2	209157.2
9	21720.8	21991.7	25777.7	54534.2	41535.4	50106.7	78067.7	93811.5
10	63931.6	46644.3	12295.3	16751.5	26556.9	30657.5	44986.9	66196.4

	1997	1998	1999	2000	2001	2002
0	637507.2	242801.1	341473.9	260325.6	204075.5	162761.7
1	2682968.2	1706083.4	849956.4	2811852.0	1870344.3	1466207.7
2	1848525.7	4230612.0	1942949.3	1497078.4	3000616.2	1995903.6
3	768117.4	3171002.7	5197777.2	3580010.1	1514636.2	3035807.7
4	502971.6	883565.1	2583030.3	5762657.6	1986084.8	840275.8
5	308631.5	455376.9	515136.9	1930955.2	2082831.0	717842.2
6	287218.3	287985.4	282489.1	458339.1	843794.9	910162.1
7	289770.5	227790.7	147491.1	204199.0	141489.2	260479.4
8	457105.9	242216.6	121231.0	107216.8	63401.2	43930.6
9	111801.5	307426.8	100087.7	61330.5	18123.9	10717.3
10	79721.8	96811.9	111741.8	105926.8	28645.7	7851.9

Table 6.4.5.2.b Observed catches by year (tonnes)
Blue Whiting, Output from final AMCI run

Observed catches by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	47997.0	3511997.0	436997.0	583997.0	1173997.0	83997.0	340997.0	45997.0
1	257997.0	147997.0	2282997.0	2290997.0	1304997.0	649997.0	837997.0	424997.0
2	347997.0	273997.0	566997.0	2330997.0	2043997.0	815997.0	577997.0	720997.0
3	680997.0	325997.0	269997.0	454997.0	1932997.0	1861997.0	727997.0	613997.0
4	333997.0	547997.0	285997.0	259997.0	302997.0	1716997.0	1896997.0	682997.0
5	547997.0	263997.0	298997.0	284997.0	187997.0	392997.0	725997.0	1302997.0
6	558997.0	275997.0	303997.0	444997.0	320997.0	186997.0	136997.0	617997.0
7	465997.0	265997.0	286997.0	261997.0	256997.0	200997.0	104997.0	83997.0
8	633997.0	271997.0	285997.0	192997.0	173997.0	197997.0	122997.0	52997.0
9	577997.0	283997.0	224997.0	153997.0	92997.0	173997.0	102997.0	32997.0
10	1459997.0	672997.0	333997.0	254997.0	258997.0	397997.0	194997.0	49997.0

	1989	1990	1991	1992	1993	1994	1995	1996
0	1948997.0	82997.0	161077.0	18997.0	197686.0	41996.0	3306607.0	832584.0
1	864997.0	1610997.0	266683.0	407727.0	263181.0	306948.0	296097.0	1893450.0
2	717997.0	702997.0	1024465.0	653835.0	305177.0	107932.0	353946.0	534218.0
3	1339997.0	671997.0	513956.0	1641711.0	621082.0	367959.0	421557.0	632358.0
4	790997.0	752997.0	301624.0	569091.0	1571233.0	389261.0	465355.0	537277.0
5	836997.0	519997.0	363201.0	217383.0	411364.0	1221916.0	615991.0	323321.0
6	707997.0	576997.0	258035.0	154041.0	191238.0	281117.0	800198.0	497455.0
7	138997.0	298997.0	159150.0	109577.0	107002.0	174253.0	253815.0	663130.0
8	49997.0	77997.0	49428.0	79660.0	64766.0	90426.0	159794.0	232417.0
9	24997.0	26997.0	5057.0	31984.0	38115.0	79011.0	59667.0	98412.0
10	37997.0	94997.0	9567.0	11703.0	17473.0	30611.0	41808.0	82518.0

	1997	1998	1999	2000
0	211661.0	42982.0	138997.0	129114.0
1	2131491.0	1656923.0	788197.0	1814848.0
2	1519324.0	4181172.0	1549097.0	1192654.0
3	904071.0	3541228.0	5820797.0	3465736.0
4	577673.0	1044894.0	3460597.0	5014859.0
5	295668.0	383655.0	412797.0	1550060.0
6	251639.0	322774.0	207197.0	513660.0
7	282053.0	303055.0	151197.0	213054.0
8	406907.0	264102.0	153097.0	151426.0
9	104317.0	212449.0	68797.0	58274.0
10	169232.0	85510.0	140497.0	139788.0

Table 6.4.5.2.c Log catch residuals
Blue Whiting, Output from final AMCI run

log (Obs/mod)

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.6	0.4	-1.7	-0.7	0.2	-2.0	-0.1	-1.6
1	0.0	-0.4	0.7	0.0	-0.1	-0.7	-0.2	-0.5
2	-0.1	0.2	0.5	0.5	-0.1	-0.7	-0.7	-0.3
3	-0.1	0.0	0.0	0.1	0.4	-0.2	-0.5	-0.4
4	-0.5	0.1	-0.1	0.0	-0.1	0.4	0.2	-0.2
5	0.1	-0.2	-0.3	0.1	0.0	0.4	0.2	0.4
6	-0.1	-0.1	0.0	0.1	0.4	0.0	-0.1	0.5
7	-0.2	-0.1	0.2	0.1	0.0	0.3	0.3	0.1
8	0.1	-0.1	0.1	0.0	0.1	0.1	0.5	0.2
9	0.1	0.1	0.2	0.0	-0.1	0.6	0.3	0.1
10	0.5	0.1	-0.5	-0.6	-0.3	0.3	0.2	-0.6

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.4	-1.3	0.5	-1.0	0.5	-0.8	0.6	-1.0
1	-0.1	-0.2	-0.2	0.4	0.2	0.2	-0.3	0.1
2	-0.3	-0.4	0.0	0.2	0.0	-0.8	0.0	-0.1
3	0.2	-0.3	0.1	0.3	0.1	0.1	0.1	0.1
4	-0.1	-0.1	0.0	0.2	0.3	-0.2	0.1	0.2
5	0.2	0.0	0.4	-0.2	0.1	0.3	0.1	-0.2
6	0.0	0.3	0.4	-0.4	-0.1	0.0	-0.1	0.0
7	-0.5	0.0	0.5	0.0	-0.2	0.2	0.1	-0.1
8	-0.1	-0.5	-0.5	0.1	-0.2	0.0	0.2	0.1
9	0.1	0.2	-1.6	-0.5	-0.1	0.5	-0.3	0.0
10	-0.5	0.7	-0.3	-0.4	-0.4	0.0	-0.1	0.2

	1997	1998	1999	2000
0	-1.1	-1.7	-0.9	-0.7
1	-0.2	0.0	-0.1	-0.4
2	-0.2	0.0	-0.2	-0.2
3	0.2	0.1	0.1	0.0
4	0.1	0.2	0.3	-0.1
5	0.0	-0.2	-0.2	-0.2
6	-0.1	0.1	-0.3	0.1
7	0.0	0.3	0.0	0.0
8	-0.1	0.1	0.2	0.3
9	-0.1	-0.4	-0.4	-0.1
10	0.8	-0.1	0.2	0.3

Table 6.4.5.3.a Modelled survey indices Norwegian spawninggrounds acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	2263.8	1639.7	1981.2	5781.2	9013.2	5667.3	4568.1	4554.7
3	7452.5	4000.4	2942.2	3440.0	9568.7	14587.2	8945.9	7498.7
4	6616.5	6828.4	3770.6	2687.3	3002.2	7975.9	11618.8	7498.1
5	6032.9	4936.0	5263.8	2803.6	1900.2	2048.2	5045.6	7599.2
6	5309.1	3320.0	2829.3	2906.6	1456.1	948.2	949.7	2425.3
7	4354.1	3002.8	1972.8	1598.4	1523.6	711.1	424.3	456.1
8	4224.0	2568.8	1864.0	1153.4	863.8	780.7	323.6	202.5
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990
0	-1.0	-1.0
1	-1.0	-1.0
2	3815.1	4450.2
3	7567.5	6207.3
4	6416.4	6191.8
5	5015.4	4094.8
6	3652.2	2234.3
7	1167.0	1628.0
8	223.4	545.1
9	-1.0	-1.0
10	-1.0	-1.0

Table 6.4.5.3.b Observed survey indices Norwegian spawninggrounds acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	2372.0	-1.0	297.0	15767.0	-1.0	1003.0	4960.0	9712.0
3	7583.0	-1.0	2108.0	1721.0	-1.0	5829.0	8417.0	9090.0
4	3253.0	-1.0	2723.0	1616.0	-1.0	4122.0	22589.0	12367.0
5	3647.0	-1.0	6511.0	1719.0	-1.0	624.0	4735.0	20392.0
6	4611.0	-1.0	3735.0	1858.0	-1.0	228.0	282.0	7355.0
7	4638.0	-1.0	3650.0	1128.0	-1.0	203.0	417.0	723.0
8	3654.0	-1.0	3153.0	567.0	-1.0	250.0	385.0	599.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990
0	-1.0	-1.0
1	-1.0	-1.0
2	6787.0	14169.0
3	22270.0	12670.0
4	9973.0	11228.0
5	10504.0	5587.0
6	7803.0	6556.0
7	933.0	3273.0
8	293.0	516.0
9	-1.0	-1.0
10	-1.0	-1.0

Table 6.4.5.3.c Log survey index residuals Norwegian spawninggrounds acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.05	0.00	-1.90	1.00	0.00	-1.73	0.08	0.76
3	0.02	0.00	-0.33	-0.69	0.00	-0.92	-0.06	0.19
4	-0.71	0.00	-0.33	-0.51	0.00	-0.66	0.66	0.50
5	-0.50	0.00	0.21	-0.49	0.00	-1.19	-0.06	0.99
6	-0.14	0.00	0.28	-0.45	0.00	-1.43	-1.21	1.11
7	0.06	0.00	0.62	-0.35	0.00	-1.25	-0.02	0.46
8	-0.14	0.00	0.53	-0.71	0.00	-1.14	0.17	1.08
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1989	1990
0	0.00	0.00
1	0.00	0.00
2	0.58	1.16
3	1.08	0.71
4	0.44	0.60
5	0.74	0.31
6	0.76	1.08
7	-0.22	0.70
8	0.27	-0.05
9	0.00	0.00
10	0.00	0.00

Table 6.4.5.3.d Modelled survey indices Norwegian spawninggrounds acoustic survey (1991-2001)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	15059.6	6959.0	4423.9	3658.9	4393.4	5759.7
3	-1.0	-1.0	9725.5	24537.6	11280.6	7197.3	5945.0	6954.8
4	-1.0	-1.0	6664.7	9268.9	23162.4	10696.6	6783.7	5369.2
5	-1.0	-1.0	2800.8	2887.4	3973.4	9920.2	4564.7	2751.6
6	-1.0	-1.0	1085.7	1362.0	1400.2	1936.7	4774.5	2062.7
7	-1.0	-1.0	608.2	699.2	876.3	911.0	1252.8	2893.2
8	-1.0	-1.0	529.3	429.3	489.9	622.5	637.5	814.4
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000	2001
0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0
2	17069.3	27555.8	12294.9	5785.7	11596.4
3	8895.8	25874.2	39769.7	16923.7	7160.1
4	6006.0	7431.5	19707.8	28089.1	9680.8
5	2050.8	2214.6	2442.8	5889.2	6352.4
6	1174.6	843.1	813.3	823.1	1515.2
7	1159.7	634.6	390.7	345.1	239.1
8	1747.7	669.7	306.1	163.1	96.5
9	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.e Observed survey indices Norwegian spawninggrounds acoustic survey (1991-2001)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	11147.0	1232.0	4489.0	1603.0	8538.0	8781.0
3	-1.0	-1.0	6340.0	26123.0	3321.0	2950.0	9874.0	7433.0
4	-1.0	-1.0	8497.0	4719.0	26771.0	4476.0	7906.0	8371.0
5	-1.0	-1.0	7407.0	1574.0	2643.0	11354.0	6861.0	2399.0
6	-1.0	-1.0	4558.0	1386.0	1270.0	1742.0	9467.0	4455.0
7	-1.0	-1.0	2019.0	810.0	557.0	1687.0	1795.0	4111.0
8	-1.0	-1.0	545.0	616.0	426.0	908.0	1083.0	1202.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000	2001
0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	18218.0	19034.0	8613.0	44162.0
3	-1.0	34991.0	60309.0	31011.0	12843.0
4	-1.0	4697.0	26103.0	41382.0	13805.0
5	-1.0	1674.0	1481.0	6843.0	8292.0
6	-1.0	279.0	316.0	898.0	718.0
7	-1.0	407.0	72.0	427.0	175.0
8	-1.0	381.0	153.0	228.0	51.0
9	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.f Log survey index residuals Norwegian spawninggrounds acoustic survey (1991-2001)

Blue Whiting. Output from final AMCI run

Survey residuals by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	-0.30	-1.73	0.01	-0.83	0.66	0.42
3	0.00	0.00	-0.43	0.06	-1.22	-0.89	0.51	0.07
4	0.00	0.00	0.24	-0.68	0.14	-0.87	0.15	0.44
5	0.00	0.00	0.97	-0.61	-0.41	0.13	0.41	-0.14
6	0.00	0.00	1.43	0.02	-0.10	-0.11	0.68	0.77
7	0.00	0.00	1.20	0.15	-0.45	0.62	0.36	0.35
8	0.00	0.00	0.03	0.36	-0.14	0.38	0.53	0.39
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1997	1998	1999	2000	2001
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	0.00	-0.41	0.44	0.40	1.34
3	0.00	0.30	0.42	0.61	0.58
4	0.00	-0.46	0.28	0.39	0.35
5	0.00	-0.28	-0.50	0.15	0.27
6	0.00	-1.11	-0.95	0.09	-0.75
7	0.00	-0.44	-1.69	0.21	-0.31
8	0.00	-0.56	-0.69	0.33	-0.64
9	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00

Table 6.4.5.3.g Modelled survey indices Russian spawninggrounds acoustic survey (1982-1991)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	3276.6	2409.9	2817.6	7837.4	11947.9	7327.3	6142.0
4	-1.0	5771.1	3186.7	2271.2	2537.4	6740.9	9819.8	6337.1
5	-1.0	4245.1	4527.1	2411.2	1634.3	1761.6	4339.4	6535.6
6	-1.0	3786.1	3226.6	3314.7	1660.6	1081.3	1083.1	2765.8
7	-1.0	3645.4	2394.9	1940.4	1849.7	863.3	515.1	553.7
8	-1.0	3333.0	2418.5	1496.5	1120.8	1013.0	419.9	262.7
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990	1991
0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0
3	6198.3	5084.2	6172.7
4	5422.9	5233.1	4516.7
5	4313.5	3521.7	3590.5
6	4165.0	2548.0	2230.5
7	1416.7	1976.3	1257.0
8	289.9	707.3	1072.0
9	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0

Table 6.4.5.3.h Observed survey indices Russian spawninggrounds acoustic survey (1982-1991)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	540.0	2330.0	2900.0	13220.0	18750.0	4480.0	3710.0
4	-1.0	2750.0	2930.0	800.0	930.0	23180.0	19170.0	4550.0
5	-1.0	1340.0	9390.0	1100.0	580.0	2540.0	5860.0	8610.0
6	-1.0	1380.0	3880.0	4200.0	1780.0	610.0	1070.0	4130.0
7	-1.0	1570.0	1970.0	2200.0	860.0	620.0	500.0	1270.0
8	-1.0	2350.0	1370.0	1200.0	610.0	750.0	810.0	480.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990	1991
0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0
3	11910.0	9740.0	10300.0
4	7120.0	12140.0	5350.0
5	6670.0	5740.0	5130.0
6	6970.0	2580.0	2630.0
7	4580.0	1470.0	1770.0
8	2750.0	220.0	870.0
9	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0

Table 6.4.5.3.i Log survey index residuals Russian spawninggrounds acoustic survey (1982-1991)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	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
3	0.00	-1.80	-0.03	0.03	0.52	0.45	-0.49	-0.50
4	0.00	-0.74	-0.08	-1.04	-1.00	1.24	0.67	-0.33
5	0.00	-1.15	0.73	-0.78	-1.04	0.37	0.30	0.28
6	0.00	-1.01	0.18	0.24	0.07	-0.57	-0.01	0.40
7	0.00	-0.84	-0.20	0.13	-0.77	-0.33	-0.03	0.83
8	0.00	-0.35	-0.57	-0.22	-0.61	-0.30	0.66	0.60
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1989	1990	1991
0	0.00	0.00	0.00
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.65	0.65	0.51
4	0.27	0.84	0.17
5	0.44	0.49	0.36
6	0.51	0.01	0.16
7	1.17	-0.30	0.34
8	2.25	-1.17	-0.21
9	0.00	0.00	0.00
10	0.00	0.00	0.00

Table 6.4.5.3.j Modelled survey indices Russian spawninggrounds acoustic survey (1992-1996)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	27569.3	12674.3	8086.6	6679.5	7814.0
4	-1.0	-1.0	-1.0	9546.3	23855.5	11016.7	6986.6	5529.9
5	-1.0	-1.0	-1.0	3507.6	4827.0	12051.1	5545.3	3342.7
6	-1.0	-1.0	-1.0	1351.6	1389.5	1921.8	4737.8	2046.9
7	-1.0	-1.0	-1.0	547.0	685.5	712.7	980.1	2263.4
8	-1.0	-1.0	-1.0	305.9	349.1	443.6	454.3	580.3
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.k Observed survey indices Russian spawninggrounds acoustic survey (1992-1996)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
2	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
3	-1.0	-1.0	-1.0	20010.0	4728.0	-1.0	12657.0	15285.0
4	-1.0	-1.0	-1.0	6700.0	12337.0	-1.0	10028.0	10629.0
5	-1.0	-1.0	-1.0	1350.0	5304.0	-1.0	8942.0	4897.0
6	-1.0	-1.0	-1.0	440.0	2249.0	-1.0	2651.0	6940.0
7	-1.0	-1.0	-1.0	390.0	1316.0	-1.0	1093.0	1482.0
8	-1.0	-1.0	-1.0	170.0	621.0	-1.0	408.0	653.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.l Log survey index residuals Russian spawninggrounds acoustic survey (1992-1996)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	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
3	0.00	0.00	0.00	-0.32	-0.99	0.00	0.64	0.67
4	0.00	0.00	0.00	-0.35	-0.66	0.00	0.36	0.65
5	0.00	0.00	0.00	-0.95	0.09	0.00	0.48	0.38
6	0.00	0.00	0.00	-1.12	0.48	0.00	-0.58	1.22
7	0.00	0.00	0.00	-0.34	0.65	0.00	0.11	-0.42
8	0.00	0.00	0.00	-0.59	0.58	0.00	-0.11	0.12
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6.4.5.3.m Modelled survey indices Spanish CPUE (1983-2000)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	7574.0	11902.0	7543.4	6058.3	5980.2	5008.3
2	-1.0	-1.0	6136.0	17346.2	26802.7	16426.5	13573.2	13758.4
3	-1.0	-1.0	4257.0	4822.4	13122.0	19238.1	12191.1	10460.4
4	-1.0	-1.0	3056.1	2103.7	2317.9	5786.0	8622.7	5724.5
5	-1.0	-1.0	2446.3	1253.1	836.1	844.6	2133.5	3252.5
6	-1.0	-1.0	1040.5	1014.9	490.4	297.2	311.9	804.4
7	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	5849.0	13169.1	6008.2	3824.7	3159.9	3807.9	5025.8	14963.1
2	11318.4	13316.9	32903.1	15137.7	9646.5	8009.0	9491.6	12232.8
3	10185.6	8444.2	11382.4	28512.5	13139.8	8396.9	6777.2	7679.1
4	4717.5	4594.7	4540.0	6260.0	15637.8	7256.4	4467.1	3382.5
5	2030.4	1675.0	1999.0	2052.8	2833.2	7061.9	3133.4	1810.9
6	1140.5	691.7	745.3	932.5	967.0	1343.2	3186.9	1302.9
7	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000
0	-1.0	-1.0	-1.0	-1.0
1	24375.2	10957.5	5274.9	10721.5
2	36213.9	56502.1	25123.4	10907.9
3	9747.2	26604.6	40290.0	14617.3
4	3747.8	4258.4	10946.6	12637.1
5	1341.8	1332.2	1457.3	2865.0
6	738.6	474.3	454.3	345.3
7	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.n Observed survey indices Spanish CPUE (1983-2000)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	7196.0	13710.0	14573.0	3721.0	25328.0	7778.0
2	-1.0	-1.0	16392.0	27286.0	23823.0	14131.0	13153.0	21473.0
3	-1.0	-1.0	9311.0	14845.0	14126.0	14745.0	6664.0	18436.0
4	-1.0	-1.0	7476.0	4836.0	6256.0	7113.0	2938.0	6391.0
5	-1.0	-1.0	6326.0	1755.0	1232.0	1278.0	1029.0	1300.0
6	-1.0	-1.0	1718.0	1750.0	217.0	505.0	166.0	781.0
7	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	15272.0	21444.0	15924.0	10007.0	4036.0	543.0	9090.0	3905.0
2	18486.0	19407.0	15370.0	24235.0	13991.0	6066.0	14409.0	14557.0
3	17160.0	5194.0	4989.0	9671.0	22493.0	15917.0	6833.0	14449.0
4	8374.0	1803.0	2329.0	4316.0	7979.0	7474.0	4551.0	3931.0
5	3760.0	1357.0	1045.0	1194.0	1354.0	2990.0	1990.0	3639.0
6	1003.0	451.0	440.0	462.0	658.0	1055.0	623.0	1834.0
7	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000
0	-1.0	-1.0	-1.0	-1.0
1	8742.0	5884.0	2048.0	6207.0
2	15875.0	13236.0	10268.0	15518.0
3	11134.0	9803.0	20242.0	13987.0
4	3698.0	10844.0	9833.0	5375.0
5	1046.0	5229.0	6287.0	1264.0
6	450.0	1153.0	3047.0	1414.0
7	-1.0	-1.0	-1.0	-1.0
8	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.o Log survey index residuals Spanish CPUE (1983-2000)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	-0.05	0.14	0.66	-0.49	1.44	0.44
2	0.00	0.00	0.98	0.45	-0.12	-0.15	-0.03	0.45
3	0.00	0.00	0.78	1.12	0.07	-0.27	-0.60	0.57
4	0.00	0.00	0.89	0.83	0.99	0.21	-1.08	0.11
5	0.00	0.00	0.95	0.34	0.39	0.41	-0.73	-0.92
6	0.00	0.00	0.50	0.54	-0.82	0.53	-0.63	-0.03
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.96	0.49	0.97	0.96	0.24	-1.95	0.59	-1.34
2	0.49	0.38	-0.76	0.47	0.37	-0.28	0.42	0.17
3	0.52	-0.49	-0.82	-1.08	0.54	0.64	0.01	0.63
4	0.57	-0.94	-0.67	-0.37	-0.67	0.03	0.02	0.15
5	0.62	-0.21	-0.65	-0.54	-0.74	-0.86	-0.45	0.70
6	-0.13	-0.43	-0.53	-0.70	-0.38	-0.24	-1.63	0.34
7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1997	1998	1999	2000
0	0.00	0.00	0.00	0.00
1	-1.03	-0.62	-0.95	-0.55
2	-0.82	-1.45	-0.89	0.35
3	0.13	-1.00	-0.69	-0.04
4	-0.01	0.93	-0.11	-0.85
5	-0.25	1.37	1.46	-0.82
6	-0.50	0.89	1.90	1.41
7	0.00	0.00	0.00	0.00
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00

Table 6.4.5.3.p Modelled survey indices Norwegian Sea acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	1141.2	1379.1	4094.5	6434.3	4078.0	3275.1	3232.9	2707.5
2	1361.9	1001.4	1188.0	3358.3	5189.1	3180.2	2627.8	2663.7
3	2767.8	1524.0	1102.4	1248.8	3398.0	4981.8	3157.0	2708.8
4	2160.9	2294.5	1242.8	855.5	942.6	2353.0	3506.6	2328.0
5	1702.9	1445.0	1514.0	775.6	517.4	522.7	1320.4	2012.9
6	1282.5	838.3	695.2	678.1	327.7	198.6	208.4	537.5
7	1132.9	818.0	519.6	399.0	371.6	159.0	97.7	108.7
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990
0	-1.0	-1.0
1	3162.0	7119.3
2	2191.3	2578.2
3	2637.6	2186.7
4	1918.5	1868.5
5	1256.6	1036.6
6	762.0	462.1
7	266.4	376.2
8	-1.0	-1.0
9	-1.0	-1.0
10	-1.0	-1.0

Table 6.4.5.3.q Observed survey indices Norwegian Sea acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	182.0	184.0	22356.0	30380.0	5969.0	2324.0	8204.0	4992.0
2	728.0	460.0	396.0	13916.0	23876.0	2380.0	4032.0	2880.0
3	4542.0	1242.0	468.0	833.0	12502.0	7224.0	5180.0	2640.0
4	3874.0	4715.0	756.0	392.0	658.0	6944.0	5572.0	3480.0
5	2678.0	3611.0	1404.0	539.0	423.0	1876.0	1204.0	912.0
6	2834.0	3128.0	576.0	539.0	188.0	952.0	224.0	120.0
7	2964.0	2323.0	468.0	343.0	235.0	336.0	168.0	96.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1989	1990
0	-1.0	-1.0
1	1172.0	-1.0
2	1125.0	-1.0
3	812.0	-1.0
4	379.0	-1.0
5	410.0	-1.0
6	212.0	-1.0
7	22.0	-1.0
8	-1.0	-1.0
9	-1.0	-1.0
10	-1.0	-1.0

Table 6.4.5.3.r Log survey index residuals Norwegian Sea acoustic survey (1981-1990)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1981	1982	1983	1984	1985	1986	1987	1988
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	-1.84	-2.01	1.70	1.55	0.38	-0.34	0.93	0.61
2	-0.63	-0.78	-1.10	1.42	1.53	-0.29	0.43	0.08
3	0.50	-0.20	-0.86	-0.40	1.30	0.37	0.50	-0.03
4	0.58	0.72	-0.50	-0.78	-0.36	1.08	0.46	0.40
5	0.45	0.92	-0.08	-0.36	-0.20	1.28	-0.09	-0.79
6	0.79	1.32	-0.19	-0.23	-0.56	1.57	0.07	-1.50
7	0.96	1.04	-0.10	-0.15	-0.46	0.75	0.54	-0.12
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1989	1990
0	0.00	0.00
1	-0.99	0.00
2	-0.67	0.00
3	-1.18	0.00
4	-1.62	0.00
5	-1.12	0.00
6	-1.28	0.00
7	-2.49	0.00
8	0.00	0.00
9	0.00	0.00
10	0.00	0.00

Table 6.4.5.3.s Modelled survey indices Norwegian Sea acoustic survey (1991-2000)

Blue Whiting, Output from final AMCI run

Modelled surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	6603.6	4203.7	3473.0	4185.3	5523.8	16445.9
2	-1.0	-1.0	6278.0	2888.3	1840.6	1528.1	1811.0	2334.0
3	-1.0	-1.0	2588.8	6484.9	2988.5	1909.8	1541.4	1746.5
4	-1.0	-1.0	1135.8	1566.0	3912.0	1815.3	1117.5	846.2
5	-1.0	-1.0	394.0	404.6	558.5	1392.0	617.6	357.0
6	-1.0	-1.0	246.1	308.0	319.3	443.6	1052.5	430.3
7	-1.0	-1.0	97.5	111.2	140.7	146.2	192.8	421.7
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000
0	-1.0	-1.0	-1.0	-1.0
1	26790.7	12043.3	5797.6	11784.0
2	6909.7	10780.7	4793.6	2081.3
3	2216.9	6050.9	9163.5	3324.6
4	937.6	1065.3	2738.5	3161.4
5	264.5	262.6	287.3	564.7
6	243.9	156.6	150.0	114.0
7	167.7	80.9	48.7	31.7
8	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.t Observed survey indices Norwegian Sea acoustic survey (1991-2000)

Blue Whiting, Output from final AMCI run

Observed surveys indices by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
1	-1.0	-1.0	-1.0	792.0	830.0	-1.0	6974.0	23464.0
2	-1.0	-1.0	-1.0	1134.0	125.0	-1.0	2811.0	1057.0
3	-1.0	-1.0	-1.0	6939.0	1070.0	-1.0	1999.0	899.0
4	-1.0	-1.0	-1.0	766.0	6392.0	-1.0	1209.0	649.0
5	-1.0	-1.0	-1.0	247.0	1222.0	-1.0	1622.0	436.0
6	-1.0	-1.0	-1.0	172.0	489.0	-1.0	775.0	505.0
7	-1.0	-1.0	-1.0	90.0	248.0	-1.0	173.0	755.0
8	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0

	1997	1998	1999	2000
0	-1.0	-1.0	-1.0	-1.0
1	30227.0	24244.0	14367.0	25813.0
2	25638.0	47815.0	9750.0	3298.0
3	1524.0	16282.0	23701.0	2721.0
4	779.0	556.0	9754.0	3078.0
5	300.0	212.0	1733.0	23.0
6	407.0	100.0	466.0	46.0
7	260.0	64.0	79.0	6.0
8	-1.0	-1.0	-1.0	-1.0
9	-1.0	-1.0	-1.0	-1.0
10	-1.0	-1.0	-1.0	-1.0

Table 6.4.5.3.u Log survey index residuals Norwegian Sea acoustic survey (1991-2000)

Blue Whiting, Output from final AMCI run

Survey residuals by year

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	-1.67	-1.43	0.00	0.23	0.36
2	0.00	0.00	0.00	-0.93	-2.69	0.00	0.44	-0.79
3	0.00	0.00	0.00	0.07	-1.03	0.00	0.26	-0.66
4	0.00	0.00	0.00	-0.72	0.49	0.00	0.08	-0.27
5	0.00	0.00	0.00	-0.49	0.78	0.00	0.97	0.20
6	0.00	0.00	0.00	-0.58	0.43	0.00	-0.31	0.16
7	0.00	0.00	0.00	-0.21	0.57	0.00	-0.11	0.58
8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	1997	1998	1999	2000
0	0.00	0.00	0.00	0.00
1	0.12	0.70	0.91	0.78
2	1.31	1.49	0.71	0.46
3	-0.37	0.99	0.95	-0.20
4	-0.19	-0.65	1.27	-0.03
5	0.13	-0.21	1.80	-3.20
6	0.51	-0.45	1.13	-0.91
7	0.44	-0.23	0.48	-1.67
8	0.00	0.00	0.00	0.00
9	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00

Table 6.4.5.4 Fishing mortalities at age and $F_{ref}=F_{(3-7)}$

Blue Whiting

	1981	1982	1983	1984	1985	1986	1987	1988
0	0.0594	0.1676	0.1080	0.0876	0.0912	0.0618	0.0450	0.0223
1	0.0903	0.0659	0.1089	0.1360	0.1407	0.1563	0.1289	0.1036
2	0.1300	0.1060	0.1353	0.1859	0.2002	0.2410	0.2015	0.1751
3	0.1966	0.1561	0.1827	0.2330	0.2681	0.3303	0.2781	0.2409
4	0.2348	0.1894	0.2201	0.2756	0.2976	0.3968	0.3606	0.3155
5	0.2576	0.1995	0.2276	0.2898	0.3149	0.4182	0.3781	0.3589
6	0.3226	0.2521	0.2955	0.3781	0.4355	0.5498	0.4759	0.4599
7	0.3318	0.2586	0.3123	0.3977	0.4346	0.5727	0.5260	0.4721
8	0.3672	0.2888	0.3464	0.4373	0.4831	0.6178	0.6404	0.5896
9	0.3275	0.2643	0.3174	0.3974	0.4298	0.6476	0.6074	0.5528
10	0.2821	0.2270	0.2547	0.3052	0.3240	0.4247	0.3853	0.3305
Fref	0.2687	0.2111	0.2477	0.3149	0.3501	0.4536	0.4037	0.3694

	1989	1990	1991	1992	1993	1994	1995	1996
0	0.0575	0.0320	0.0153	0.0100	0.0202	0.0122	0.0704	0.0559
1	0.1212	0.1109	0.0413	0.0514	0.0514	0.0512	0.0614	0.0828
2	0.2039	0.1902	0.0764	0.0834	0.0796	0.0734	0.0944	0.1216
3	0.2979	0.2809	0.1141	0.1256	0.1217	0.1191	0.1561	0.2070
4	0.3755	0.3608	0.1452	0.1589	0.1595	0.1518	0.1992	0.2699
5	0.4474	0.4310	0.1800	0.1862	0.1816	0.1842	0.2422	0.3094
6	0.5558	0.5696	0.2388	0.2432	0.2295	0.2226	0.2837	0.3715
7	0.5398	0.5204	0.2236	0.2360	0.2211	0.2221	0.2888	0.3752
8	0.7007	0.6482	0.2528	0.2715	0.2550	0.2470	0.3300	0.4392
9	0.6852	0.6915	0.2626	0.2640	0.2502	0.2624	0.3297	0.4347
10	0.3781	0.4711	0.1862	0.1898	0.1748	0.1702	0.2179	0.2949
Fref	0.4433	0.4325	0.1804	0.1900	0.1827	0.1800	0.2340	0.3066

	1997	1998	1999	2000	2001	2002
0	0.0345	0.0273	0.0179	0.0205	0.0205	0.0205
1	0.0813	0.1138	0.1176	0.1871	0.1871	0.1871
2	0.1233	0.1777	0.1832	0.3116	0.3116	0.3116
3	0.2193	0.3206	0.3442	0.5978	0.5978	0.5978
4	0.2851	0.4208	0.4703	0.8048	0.8048	0.8048
5	0.3187	0.4524	0.4657	0.7895	0.7895	0.7895
6	0.3788	0.5558	0.5669	1.0208	1.0208	1.0208
7	0.3874	0.5884	0.6247	1.1048	1.1048	1.1048

8	0.4484	0.6563	0.7333	1.4372	1.4372	1.4372
9	0.4463	0.6231	0.6317	1.0947	1.0947	1.0947
10	0.3953	0.5632	0.6245	1.2661	1.2661	1.2661
Fref	0.3178	0.4676	0.4944	0.8636	0.8636	0.8636

Table 6.4.5.5 Stocknumbers at age at 1 jan (*10^6)

Blue Whiting

	1981	1982	1983	1984	1985	1986	1987	1988
0	4492.2	15381.1	23270.0	14505.5	11838.0	11101.6	8959.0	10373.4
1	3232.0	3830.4	11769.4	18899.6	12023.7	9777.5	9442.9	7750.1
2	3351.7	2417.7	2936.0	8642.1	13506.6	8552.3	6846.9	6796.0
3	4520.3	2409.6	1780.3	2099.6	5875.3	9052.2	5502.3	4583.0
4	2968.9	3040.3	1687.7	1214.3	1361.7	3679.0	5326.6	3411.2
5	2372.7	1922.1	2059.6	1108.7	754.7	827.9	2025.5	3040.7
6	2430.1	1501.4	1289.0	1343.0	679.4	451.0	446.1	1136.2
7	2115.6	1440.9	955.4	785.4	753.3	359.9	213.1	227.0
8	2071.5	1243.1	910.9	572.4	432.0	399.4	166.2	103.1
9	1985.8	1174.7	762.4	527.4	302.6	218.2	176.3	71.7
10	4054.7	3227.4	2587.5	1930.6	1340.0	888.9	526.0	336.7

	1989	1990	1991	1992	1993	1994	1995	1996
0	23994.5	10094.0	6370.7	5235.3	6372.6	8411.8	27002.2	43301.7
1	9179.3	20497.0	8846.1	5676.8	4690.1	5651.0	7518.9	22772.3
2	5720.6	6657.3	15020.1	6949.2	4414.7	3647.4	4395.5	5789.5
3	4670.2	3819.7	4506.7	11392.8	5234.1	3338.0	2774.8	3274.6
4	2949.0	2838.7	2361.4	3291.9	8227.1	3794.4	2426.0	1943.5
5	2037.2	1658.6	1620.2	1672.1	2299.2	5742.9	2669.0	1627.4
6	1738.9	1066.3	882.5	1108.0	1136.4	1569.9	3910.9	1715.1
7	587.3	816.7	493.9	569.0	711.3	739.6	1028.8	2411.1
8	115.9	280.3	397.4	323.4	368.0	466.9	484.9	631.1
9	46.8	47.1	120.0	252.7	201.8	233.4	298.6	285.4
10	218.0	133.1	77.9	104.3	178.2	210.9	247.2	278.5

	1997	1998	1999	2000	2001	2002
0	19554.2	9374.5	19955.0	13307.8	10432.3	8320.4
1	37051.6	17094.1	8254.1	17734.9	11796.7	9247.7
2	17163.0	27967.4	12490.4	6008.2	12042.3	8010.1
3	4197.3	12421.4	19169.2	8514.0	3602.1	7219.8
4	2179.7	2759.9	7380.7	11124.1	3833.9	1622.0
5	1214.9	1342.0	1483.6	3775.6	4072.5	1403.6
6	977.9	723.2	698.9	762.5	1403.7	1514.1
7	968.4	548.2	339.6	324.6	224.9	414.1
8	1356.5	538.3	249.2	148.9	88.0	61.0
9	333.0	709.2	228.6	98.0	29.0	17.1
10	262.0	240.7	257.4	156.5	42.3	11.6

Table 6.4.5.6 Results of stock assessment

`Blue Whiting, Output from final AMCI run`

Year	Landings (t)	Recruits Age 0 (*10^6)	SSB (t)	Mean F at ages 3-7	SoP (%)
1981	924804	4492.2	3184545	0.2687	106%
1982	613859	15381.1	2552147	0.2111	113%
1983	562084	23270.0	1994150	0.2477	104%
1984	630753	14505.5	1605464	0.3149	103%
1985	696998	11838.0	1754716	0.3501	100%
1986	849665	11101.6	1981717	0.4536	103%
1987	664837	8959.0	1777407	0.4037	100%
1988	557847	10373.4	1587846	0.3694	99%
1989	627447	23994.5	1531116	0.4433	105%
1990	561610	10094.0	1426406	0.4325	100%
1991	369524	6370.7	1835488	0.1804	100%
1992	475089	5235.3	2408502	0.1900	100%
1993	480679	6372.6	2336440	0.1827	100%
1994	459414	8411.8	2280728	0.1800	100%
1995	578905	27002.2	2071278	0.2340	100%
1996	645982	43301.7	1902963	0.3066	98%
1997	672437	19554.2	1976148	0.3178	96%
1998	1125151	9374.5	2640087	0.4676	101%
1999	1256328	19955.0	2783383	0.4944	101%
2000	1412253	13307.8	2245721	0.8636	100%

Table 6.5.1. Blue Whiting. Input data for the deterministic short-term prediction

MFDP version 1
Run: spred
Time and date: 10:27 25/04/2001
Fbar age range: 3-7

2001								
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
0	12321	0.2	0.00	0.25	0.25	0.033	0.021	0.033
1	11797	0.2	0.11	0.25	0.25	0.056	0.187	0.056
2	12042	0.2	0.40	0.25	0.25	0.075	0.312	0.075
3	3602	0.2	0.82	0.25	0.25	0.089	0.598	0.089
4	3834	0.2	0.86	0.25	0.25	0.113	0.805	0.113
5	4073	0.2	0.91	0.25	0.25	0.141	0.790	0.141
6	1404	0.2	0.94	0.25	0.25	0.168	1.021	0.168
7	225	0.2	1.00	0.25	0.25	0.187	1.105	0.187
8	88	0.2	1.00	0.25	0.25	0.189	1.437	0.189
9	29	0.2	1.00	0.25	0.25	0.215	1.095	0.215
10	42	0.2	1.00	0.25	0.25	0.245	1.266	0.245

2002								
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
0	12321	0.2	0.00	0.25	0.25	0.033	0.021	0.033
1	.	0.2	0.11	0.25	0.25	0.056	0.187	0.056
2	.	0.2	0.40	0.25	0.25	0.075	0.312	0.075
3	.	0.2	0.82	0.25	0.25	0.089	0.598	0.089
4	.	0.2	0.86	0.25	0.25	0.113	0.805	0.113
5	.	0.2	0.91	0.25	0.25	0.141	0.790	0.141
6	.	0.2	0.94	0.25	0.25	0.168	1.021	0.168
7	.	0.2	1.00	0.25	0.25	0.187	1.105	0.187
8	.	0.2	1.00	0.25	0.25	0.189	1.437	0.189
9	.	0.2	1.00	0.25	0.25	0.215	1.095	0.215
10	.	0.2	1.00	0.25	0.25	0.245	1.266	0.245

2003								
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
0	12321	0.2	0.00	0.25	0.25	0.033	0.021	0.033
1	.	0.2	0.11	0.25	0.25	0.056	0.187	0.056
2	.	0.2	0.40	0.25	0.25	0.075	0.312	0.075
3	.	0.2	0.82	0.25	0.25	0.089	0.598	0.089
4	.	0.2	0.86	0.25	0.25	0.113	0.805	0.113
5	.	0.2	0.91	0.25	0.25	0.141	0.790	0.141
6	.	0.2	0.94	0.25	0.25	0.168	1.021	0.168
7	.	0.2	1.00	0.25	0.25	0.187	1.105	0.187
8	.	0.2	1.00	0.25	0.25	0.189	1.437	0.189
9	.	0.2	1.00	0.25	0.25	0.215	1.095	0.215
10	.	0.2	1.00	0.25	0.25	0.245	1.266	0.245

Input units are millions and kg - output in kilotonnes

Table 6.5.2. Blue Whiting. Prediction with management option table:

a) Basis for 2001: F2001 = F2000; Recruitment: GM 1981-1999 = 12 321 millions

b) Basis for 2001: TAC constraint = 628 000 t; Recruitment: GM 1981-1999 = 12 321 millions

a)

MFDP version 1
Run: spred
Blue whiting combined stock, 2001 WG
Time and date: 10:27 25/04/2001
Fbar age range: 3-7

Basis for 2001: F2001 = F2000; Recruitment: GM 1981-1999 = 12 321 millions

		2001					2002			2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
3611	1514	1	0.8638	1159	2938	1430	0.0	0.000	0	3524	1925
					.	1406	0.1	0.086	119	3394	1786
					.	1382	0.2	0.173	231	3273	1659
					.	1359	0.3	0.259	335	3160	1543
					.	1336	0.4	0.346	433	3053	1437
					.	1314	0.5	0.432	525	2954	1340
					.	1292	0.6	0.518	612	2860	1251
					.	1270	0.7	0.605	693	2772	1170
					.	1249	0.8	0.691	769	2690	1095
					.	1229	0.9	0.777	841	2612	1026
					.	1208	1.0	0.864	909	2539	963
					.	1188	1.1	0.950	973	2470	905
					.	1169	1.2	1.037	1033	2405	851
					.	1150	1.3	1.123	1090	2343	802
					.	1131	1.4	1.209	1145	2285	756
					.	1112	1.5	1.296	1196	2230	713
					.	1094	1.6	1.382	1244	2179	674
					.	1077	1.7	1.469	1290	2129	637
					.	1059	1.8	1.555	1334	2083	604
					.	1042	1.9	1.641	1375	2038	572
					.	1025	2.0	1.728	1415	1996	543

b)

MFDP version 1
Run: spred2
Blue whiting combined stock, 2001 WG
Time and date: 10:29 25/04/2001
Fbar age range: 3-7

Basis for 2001: TAC constraint = 628 000 t; Recruitment: GM 1981-1999 = 12 321 millions

		2001					2002			2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
3611	1660	0.4628	0.3997	628	3510	1887	0.0	0.000	0	4075	2406
					.	1853	0.1	0.086	159	3904	2220
					.	1820	0.2	0.173	307	3745	2050
					.	1788	0.3	0.259	445	3597	1896
					.	1756	0.4	0.346	573	3459	1757
					.	1725	0.5	0.432	693	3330	1629
					.	1695	0.6	0.518	806	3209	1513
					.	1665	0.7	0.605	911	3096	1407
					.	1635	0.8	0.691	1010	2991	1311
					.	1607	0.9	0.777	1102	2892	1222
					.	1579	1.0	0.864	1189	2800	1141
					.	1551	1.1	0.950	1270	2713	1067
					.	1524	1.2	1.037	1347	2631	999
					.	1498	1.3	1.123	1419	2555	936
					.	1472	1.4	1.209	1487	2483	878
					.	1446	1.5	1.296	1551	2415	825
					.	1422	1.6	1.382	1611	2351	776
					.	1397	1.7	1.469	1668	2291	731
					.	1373	1.8	1.555	1722	2234	690
					.	1350	1.9	1.641	1773	2180	651
					.	1327	2.0	1.728	1822	2129	615

Input units are millions and kg - output in kilotonnes

Table 6.6.1. Blue Whiting. Medium term projections

Blue whiting: Medium term predictions

	Probabilities (%)				Year when risk	Year when prob.		Catch in			Catch in	
	B<Blim	B<Blim	B>Bpa	B>Bpa	B<Blim	B>Bpa		2001			2002	
	2002	2010	2002	2010	is below 10%	is above 90%	25%	50%	75%	25%	50%	75%
Fixed F in all years from 2002 onwards; F2001 = 0.4												
F-value from 2002												
0.00	1	0	53	100	2002	2003	723	784	853	0	0	0
0.10	1	0	48	100	2002	2003				202	222	278
0.15	1	0	45	97	2002	2003				297	325	358
0.20	1	0	43	85	2002	2003				388	425	468
0.25	1	0	41	62	2002	2004				475	520	573
0.32	1	9	37	30	2002	-				591	647	714
Fixed F in all years from 2002 onwards; F2001 = 0.86 (F 2000)												
F-value from 2002												
0.00	19	0	11	100	2003	2004	1321	1434	1561	0	0	0
0.10	23	0	2	100	2003	2006				149	164	182
0.15	25	0	2	96	2003	2007				220	242	267
0.20	27	0	2	83	2003	-				287	316	350
0.25	29	1	1	60	2004	-				352	388	429
0.32	32	12	1	27	-	-				439	483	536
F at F2000 in all years												
0.864	61	100	0	0	-	-	1321	1434	1561	972	1077	1197

Table 6.8.1.Total catches of BLUE WHITING in 1978-2000 in and beyond EEZs, estimated by the WG.
Note: not all countries are included, hence not quite coincidence with the catch assessment.

Year	Internat.	J. Mayen	Norway	Iceland	Grennland	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	1,121,366
	55%		7%	1%	-	20%	17%	
1980	567,693		152,095	4,562	8,757	164,342	160,361	1,057,810
	54%		14%	-	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%			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%		-	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%		17%	-		19%	50%	
1996	34,788		69,977	302		111,627	387,209	603,903
	6%		11%	-		19%	64%	
1997	46,961		53,592	10,464		151,791	368,398	631,206
	8%		9%	2%		24%	58%	
1998	271,873	4,770	105,674	90,649		129,799	498,399	1,101,164
	25%		10%	8%		12%	45%	
1999	276,256		73,623	111,504		224,588	426,557	1,112,528
	25%		7%	10%		20%	38%	
2000	276,857	8,731	122,699	158,895		298,120	414,438	1,279,740
	22%	1%	10%	12%		24%	33%	

Table 6.10.1 BLUE WHITING. Sampling in fishery during 2000.

Country	**No. of samples**	**No. fish aged**	**No. fish measured**
DIRECTED FISHERIES			
Faroe Islands	54	2472	5462
Iceland	137	2343	12052
Ireland	7	681	681
Norway	70	2195	6264
Russia	192	1296	38053
MIXED INDUSTRIAL FISHERIES			
Denmark	16	0	712
Norway	107	2702	7307
SOUTHERN FISHERIES			
Portugal	236	830	25783
Spain	317	1166	28848

Country	**No. of samples**	**No. fish aged**	**No. fish measured**
TOTAL	1136	13685	125162

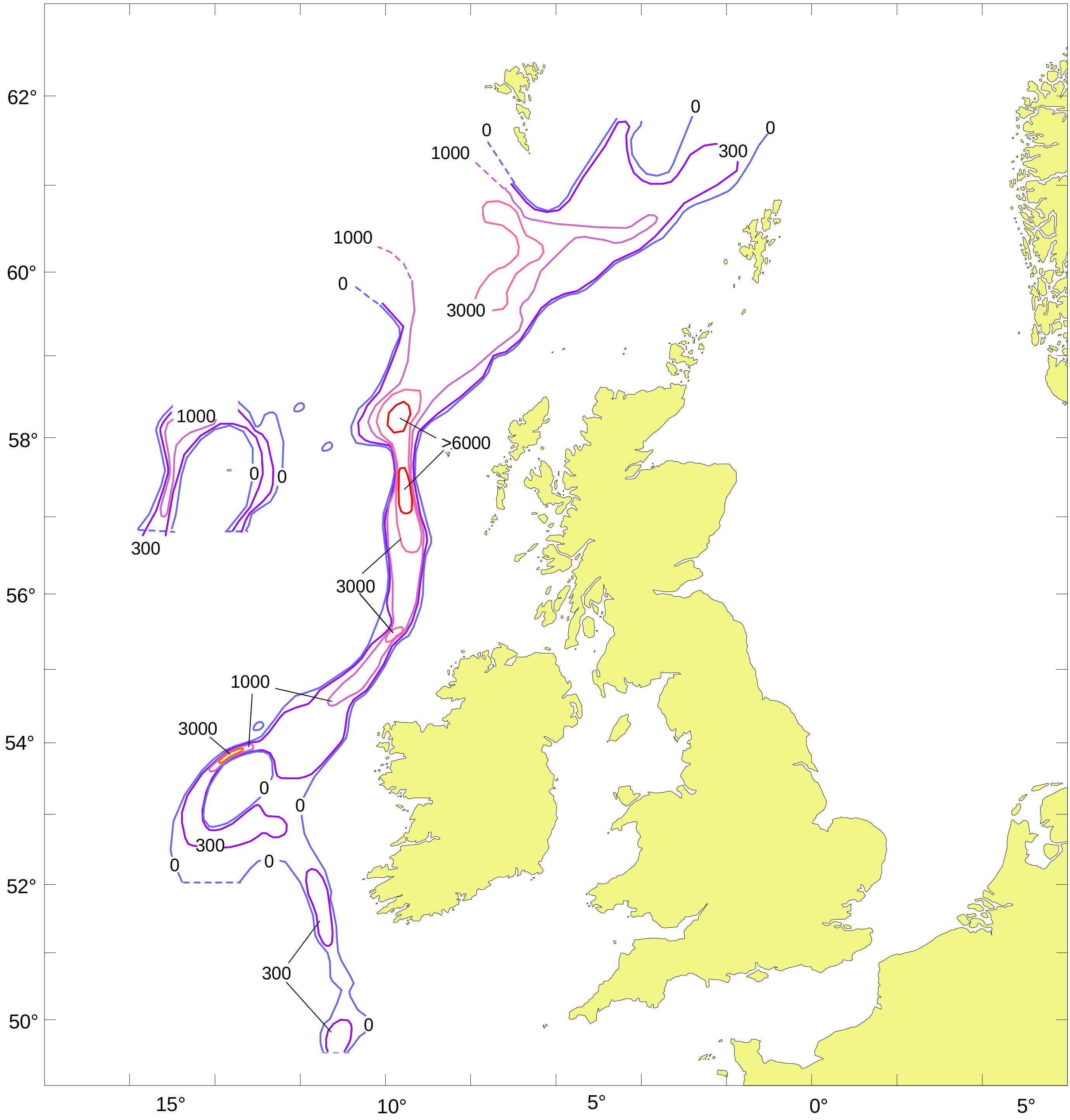


Figure 6.4.1.1. Distribution of blue whiting, R.V. "Johan Hjort" ,spring 2001.

Echo intensity (S_A-values) in $m^2/(n.mile)^2$

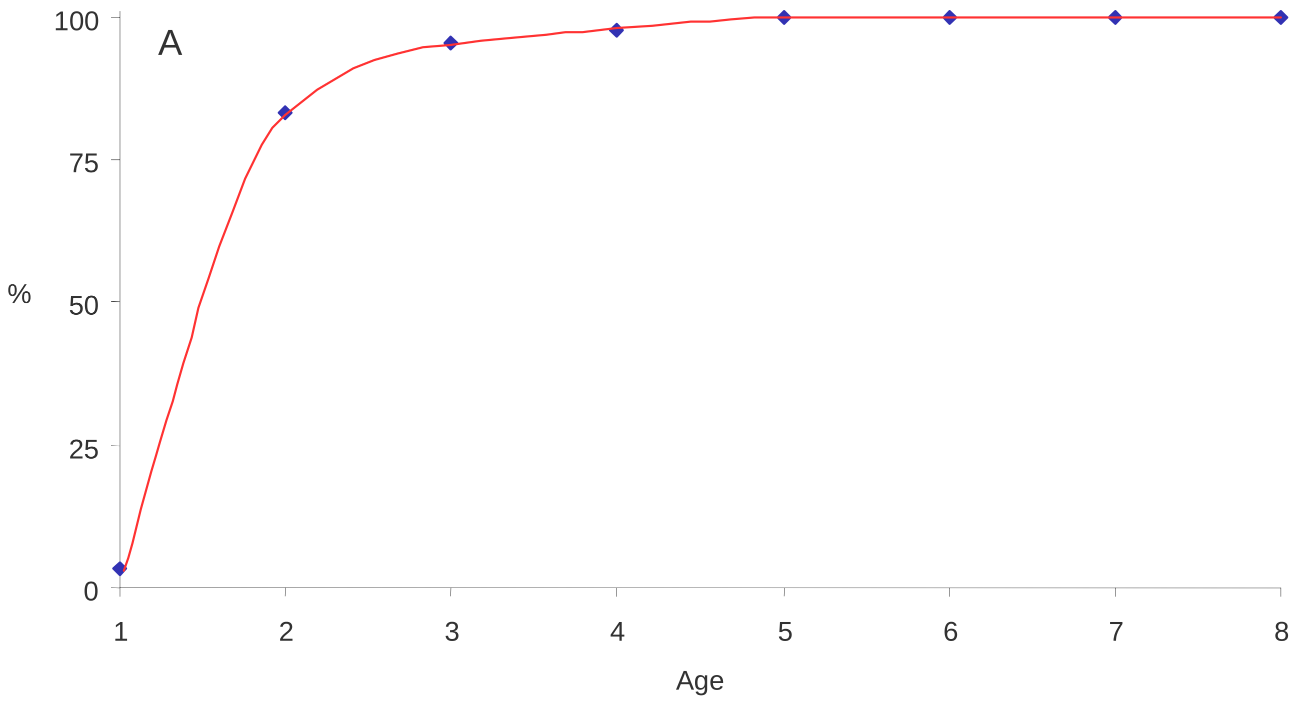


Figure 6.3.4.1. Maturity ogive of blue whiting in the area to the west of The British Isles, by age (A) and length (B), spring 2001.

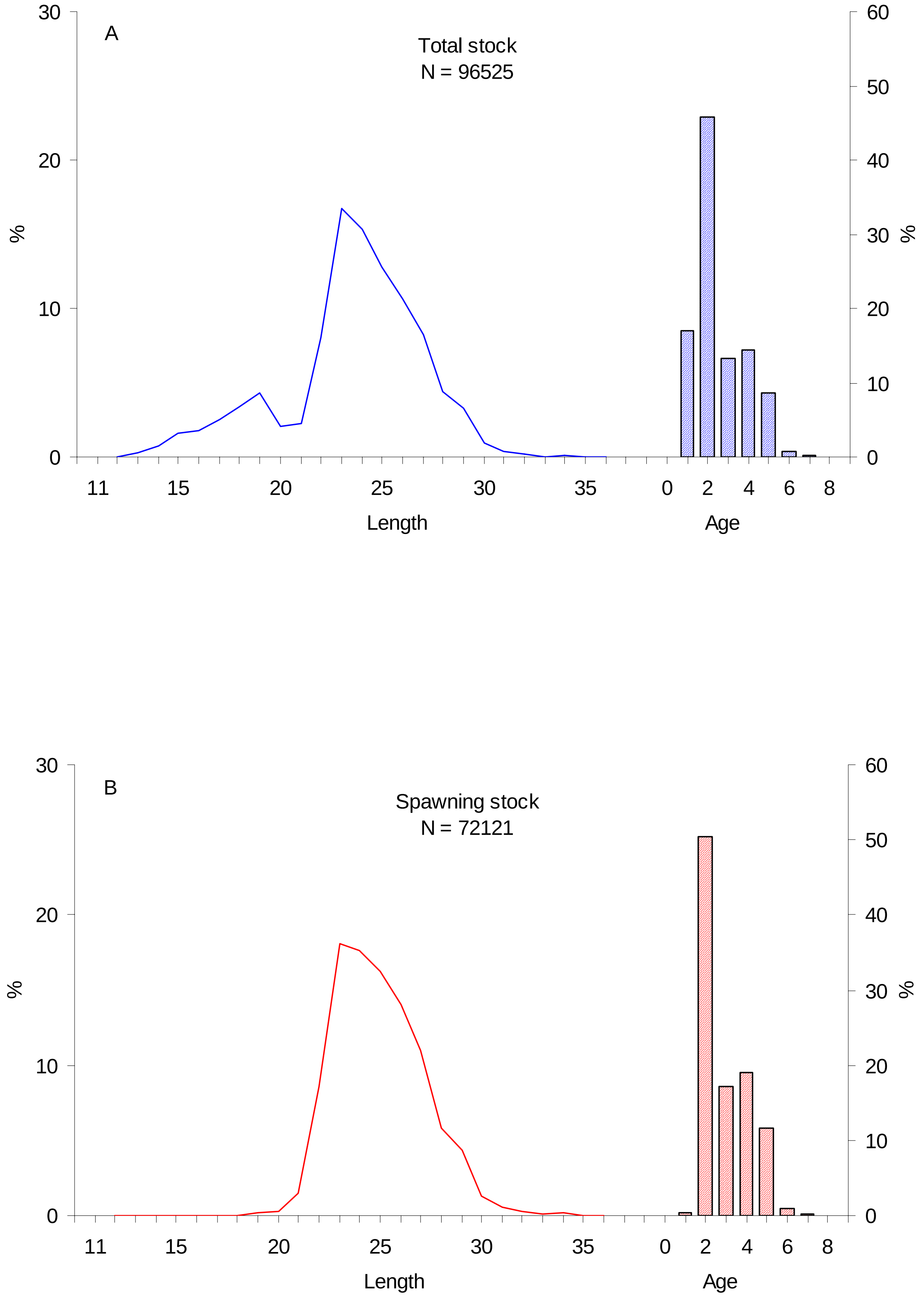


Figure 6.4.1.3 Total (A) and spawning (B) stocks length and age distribution of blue whiting in the area to the west of The British Isles, spring 2001. $N*10^{-6}$, weighted by abundance.

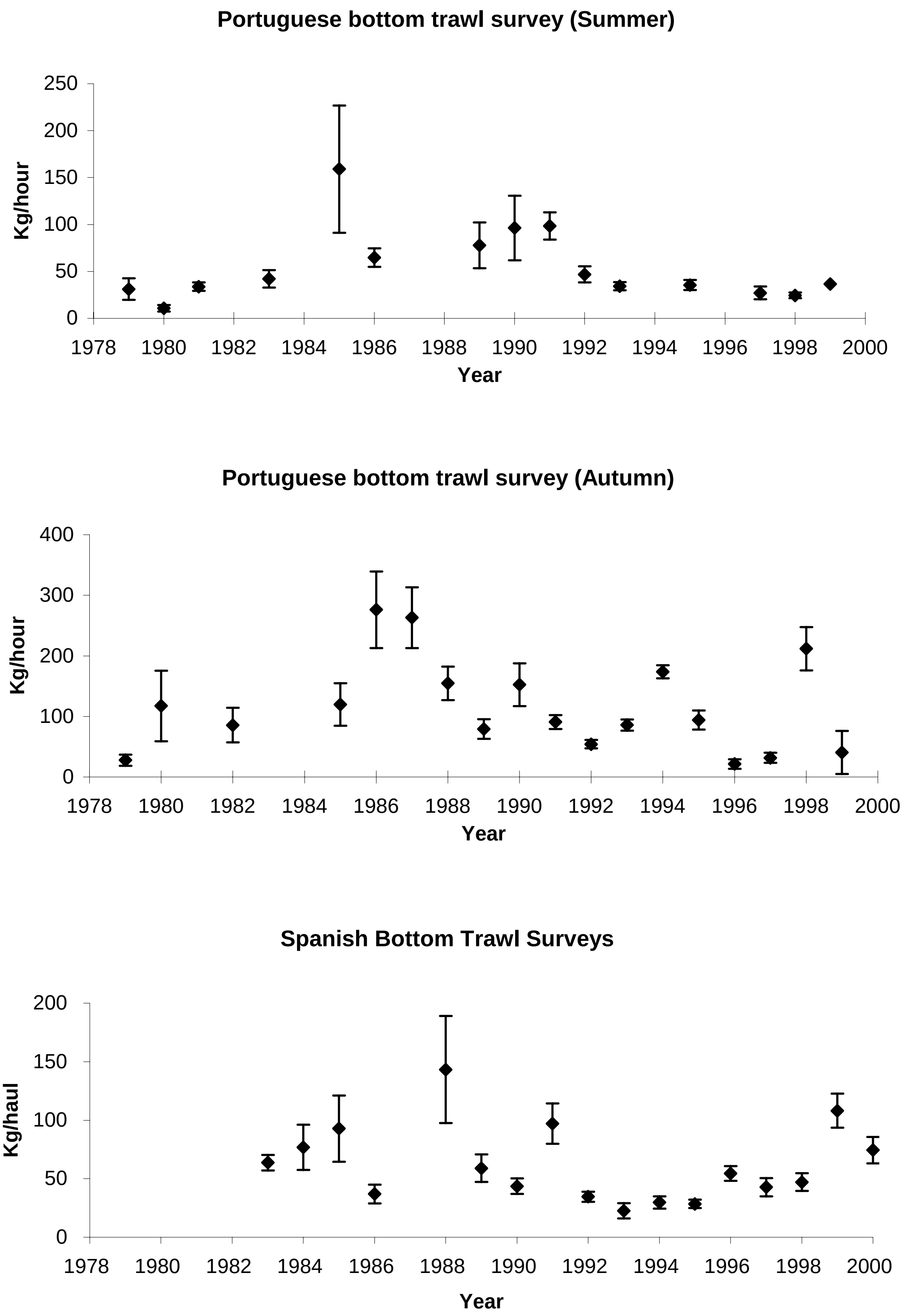


Figure 6.4.2.1 Mean catch rates in the bottom trawl surveys from the southern area.

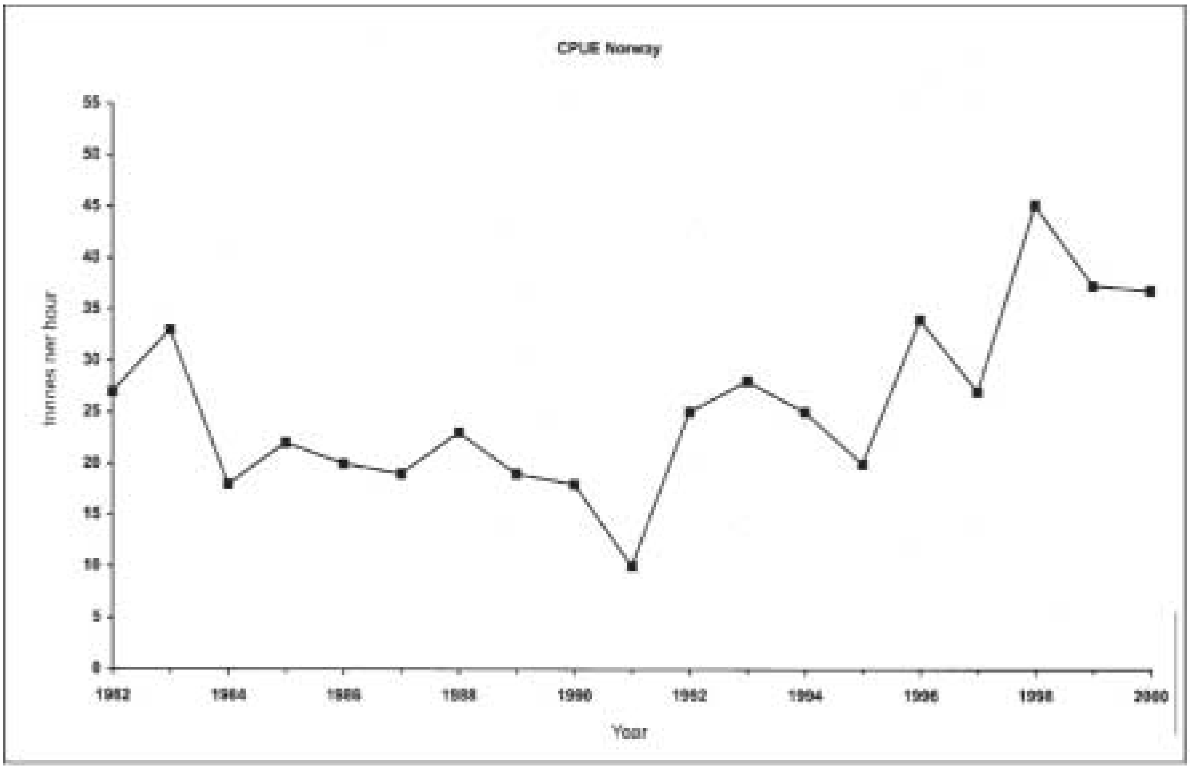


Figure 6.4.3.1. Blue whiting. Overall aggregated CPUE from the Norwegian directed fisheries 1982 – 2000 (tonnes/hour).

Figure 6.4.4.1 ICA dignostics

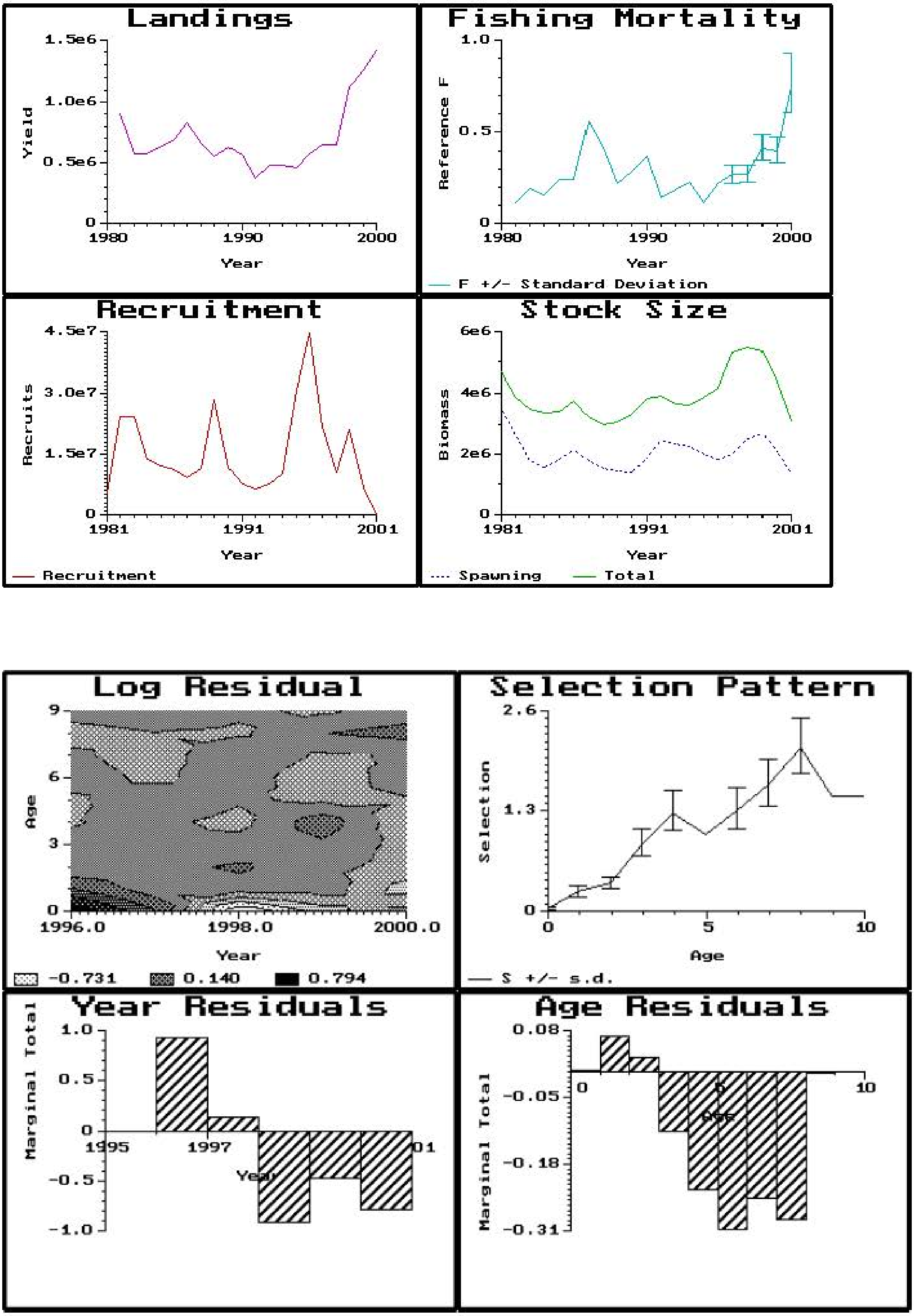
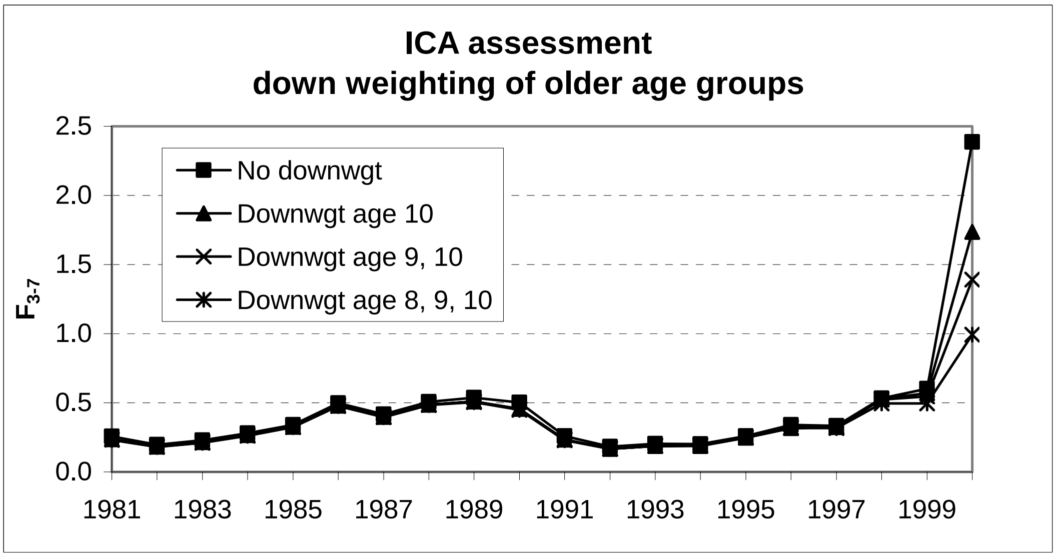


Figure 6.4.4.2. Sensitivity of ICA assessments to small values in tuning fleet data



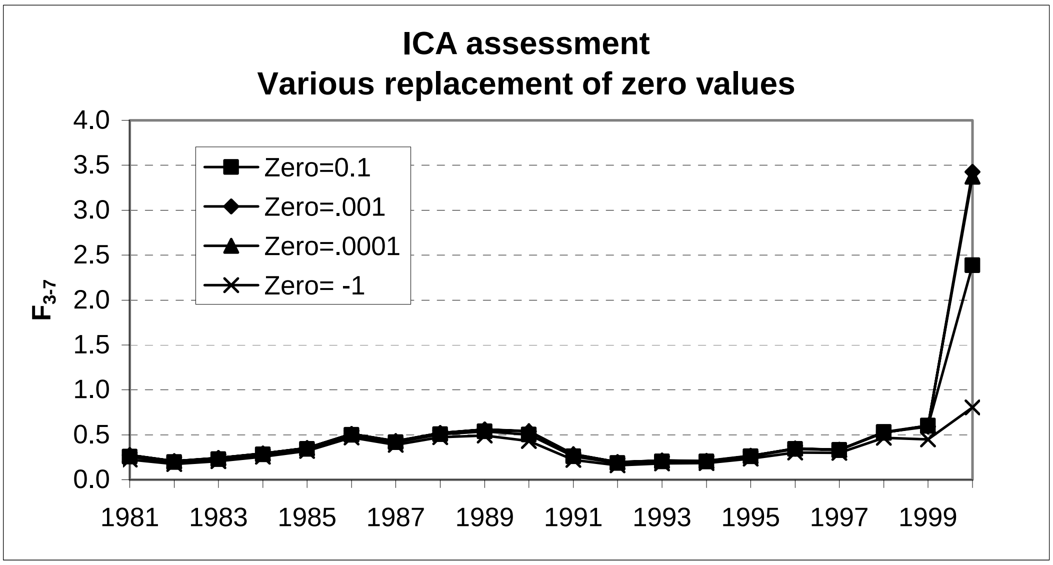


Figure 6.4.4.3. Results of the ICA assessment single fleet tuning

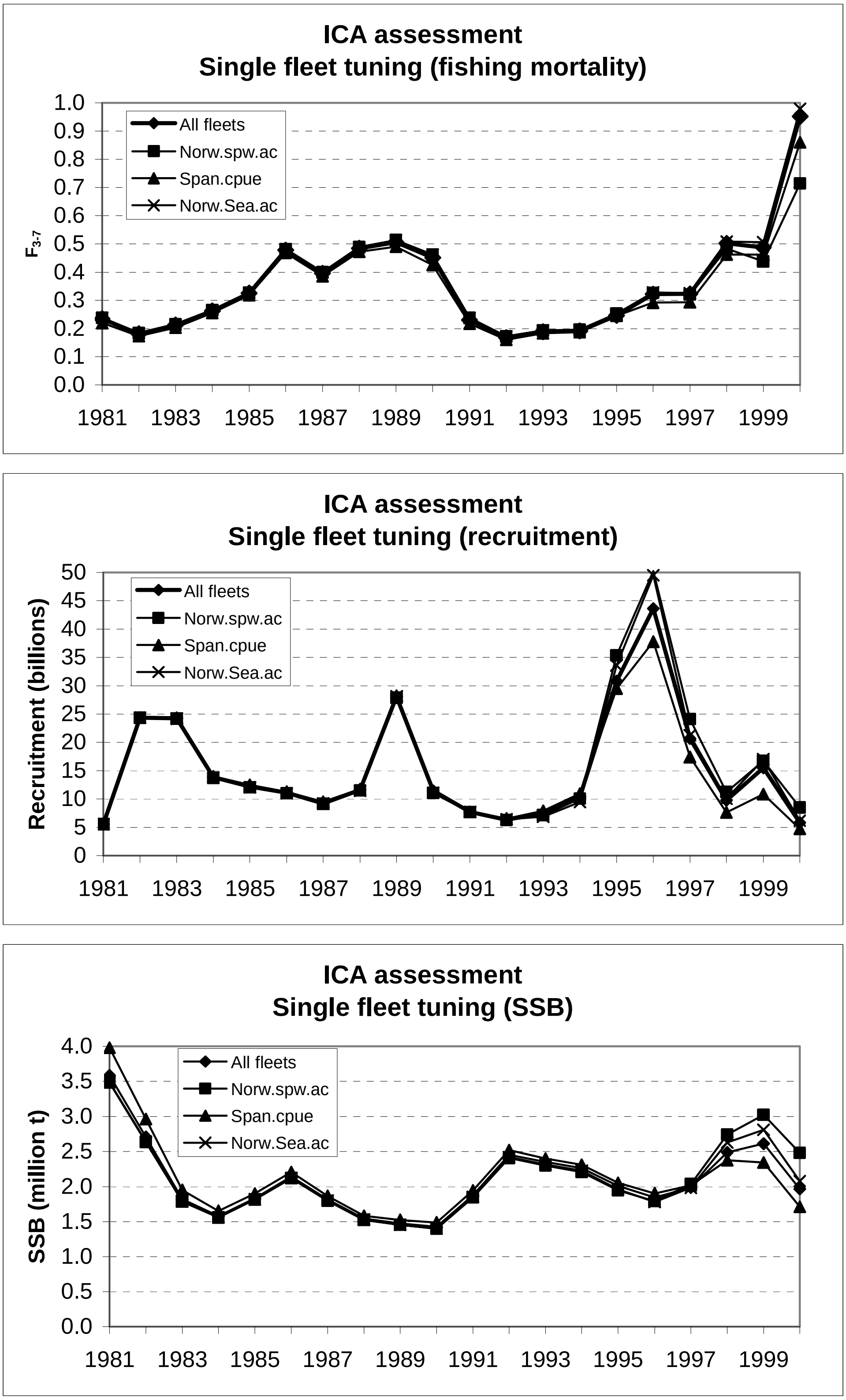
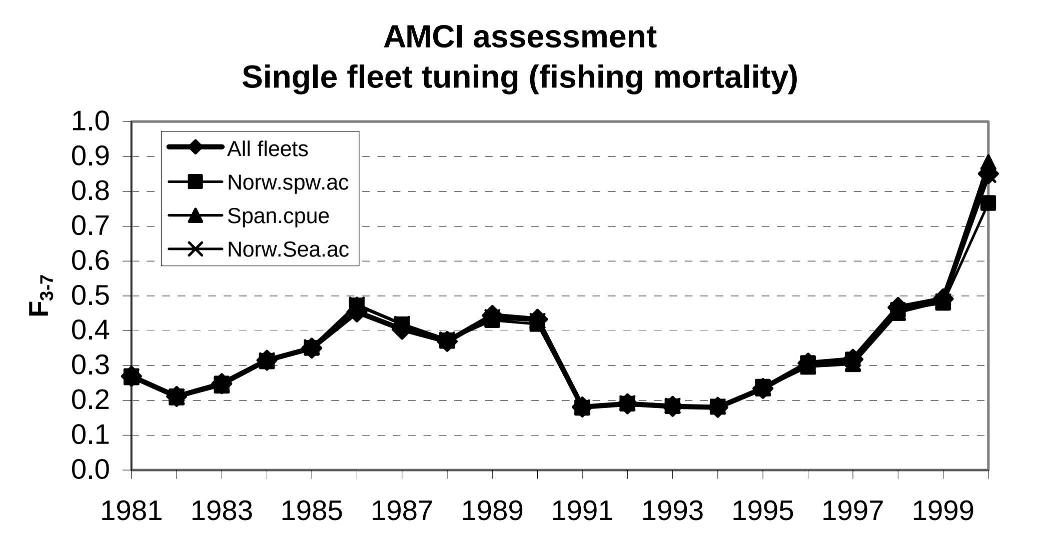
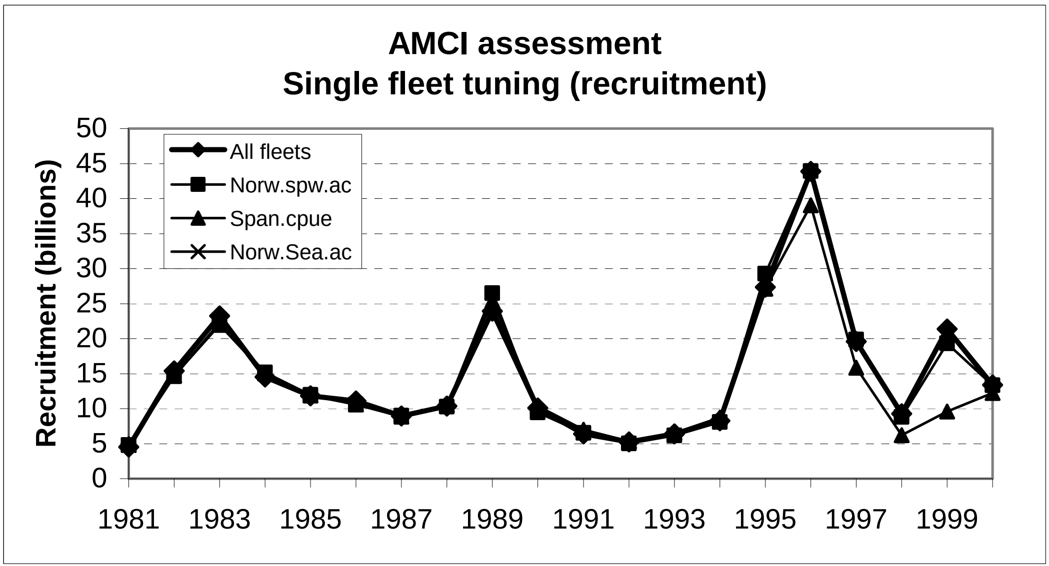


Figure 6.4.4.4. Results of the AMCI assessment single fleet tuning





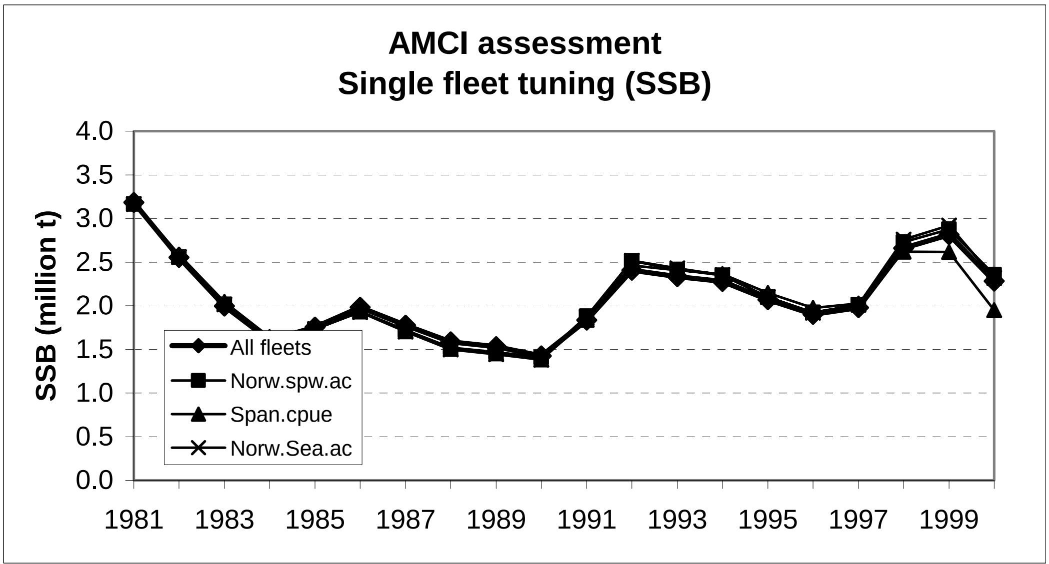
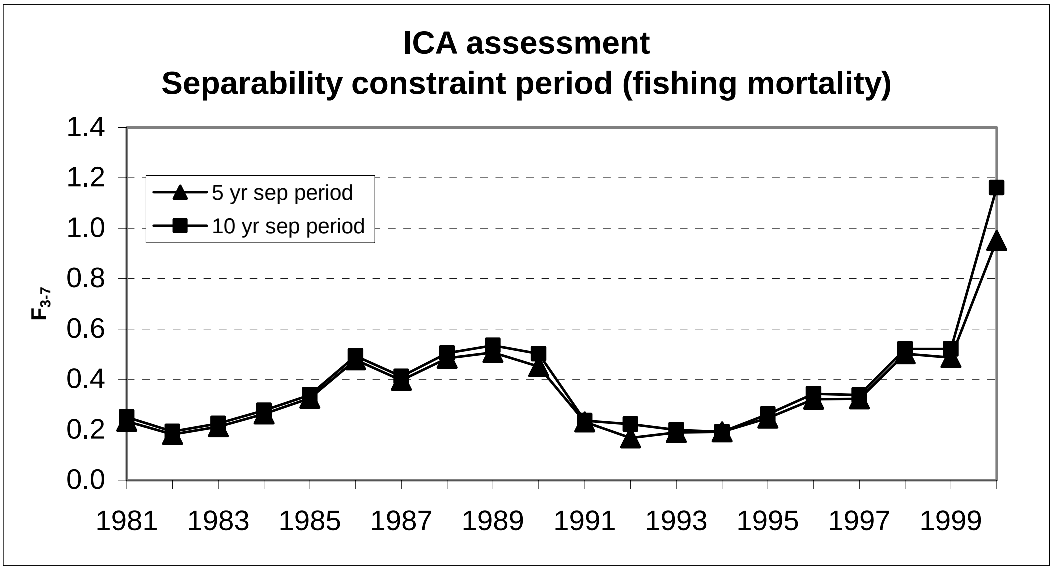
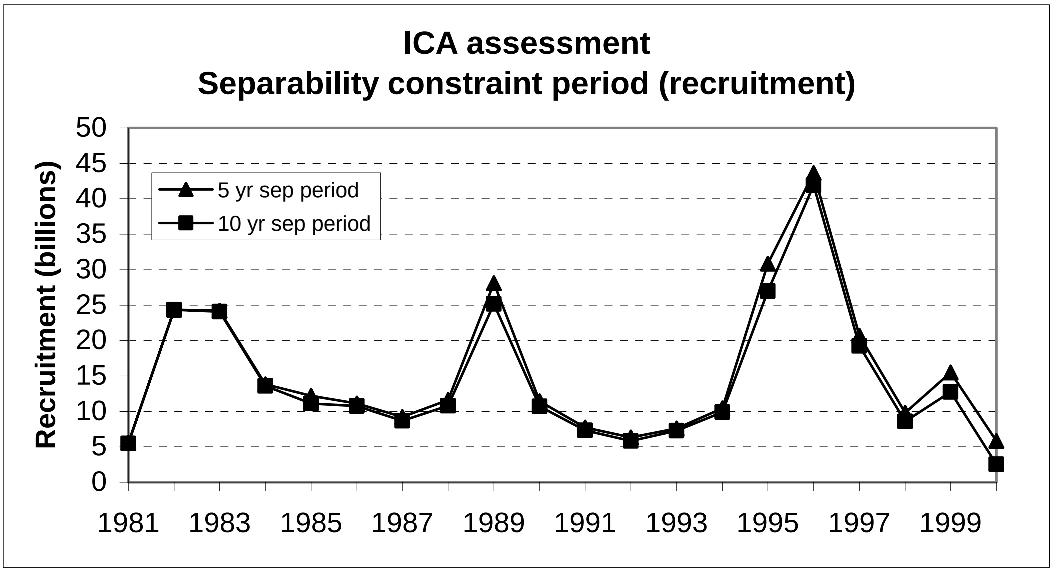


Figure 6.4.4.5. Results of the ICA assessment comparison of period for separability constraint





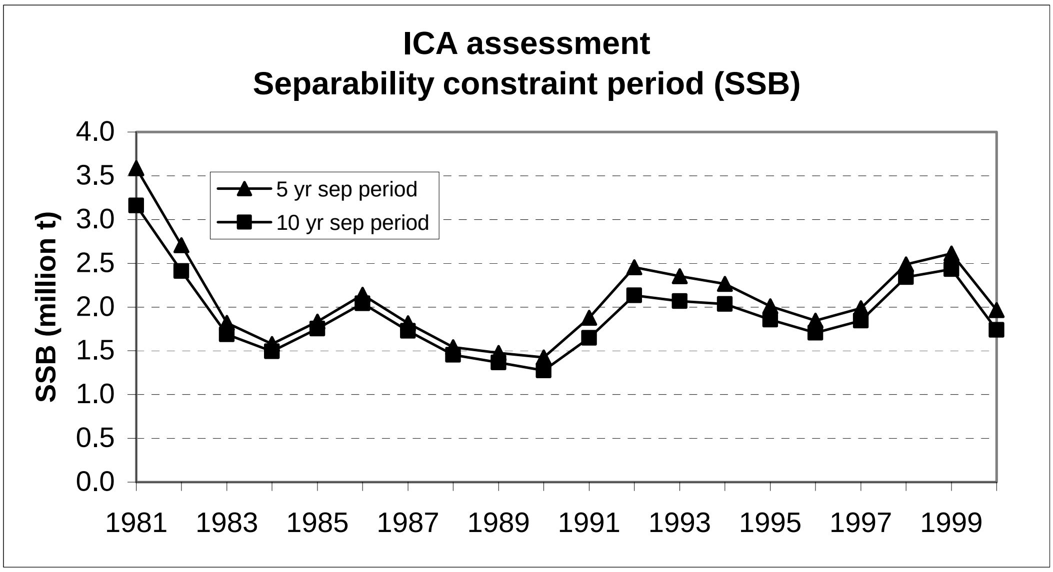


Figure 6.4.5.1. Bootstrapping the AMCI assessment

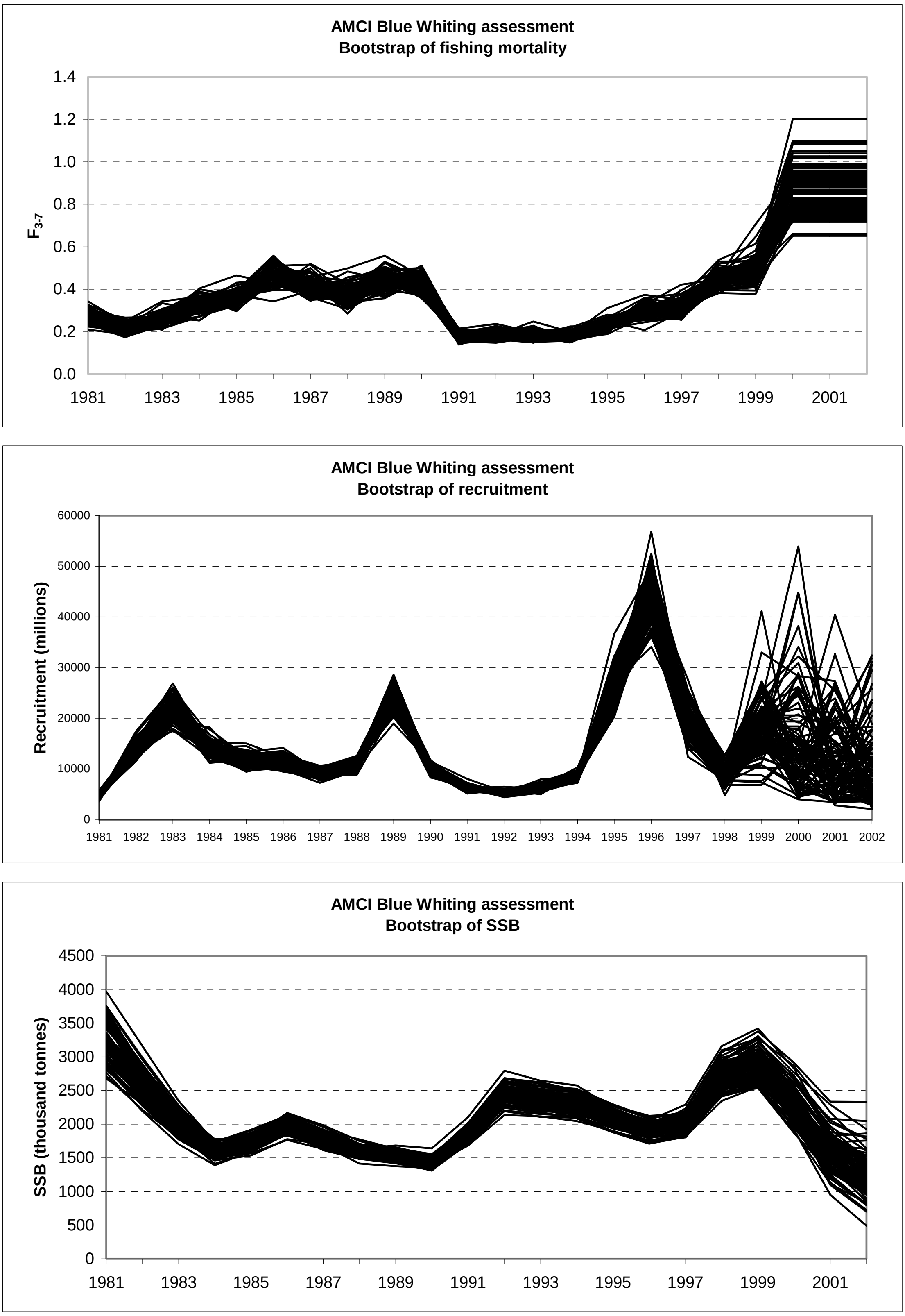


Figure 6.4.5.2 Cumulated frequency distribution of SSB in 2001

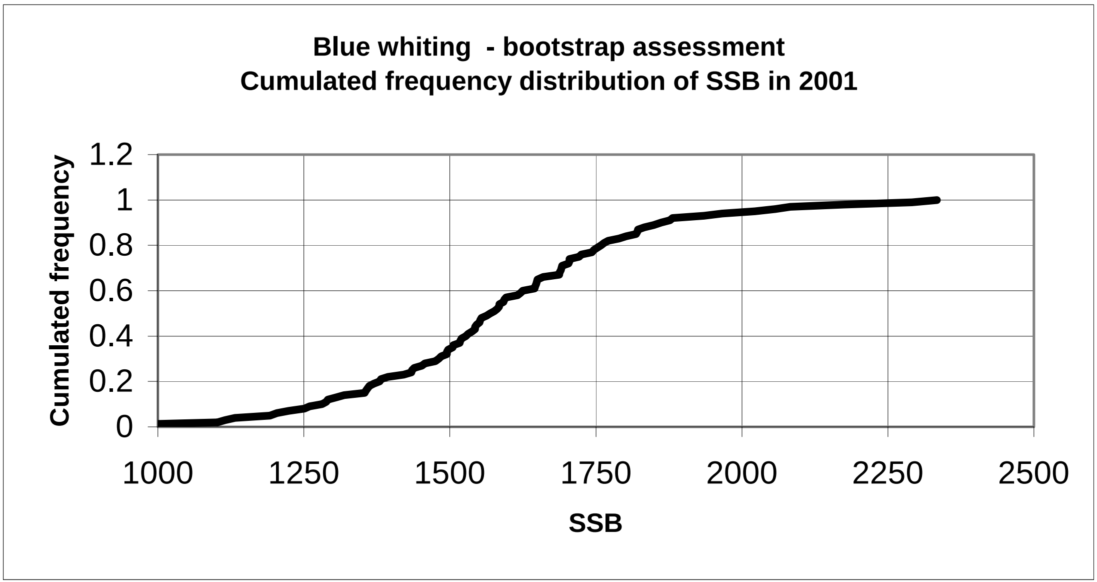
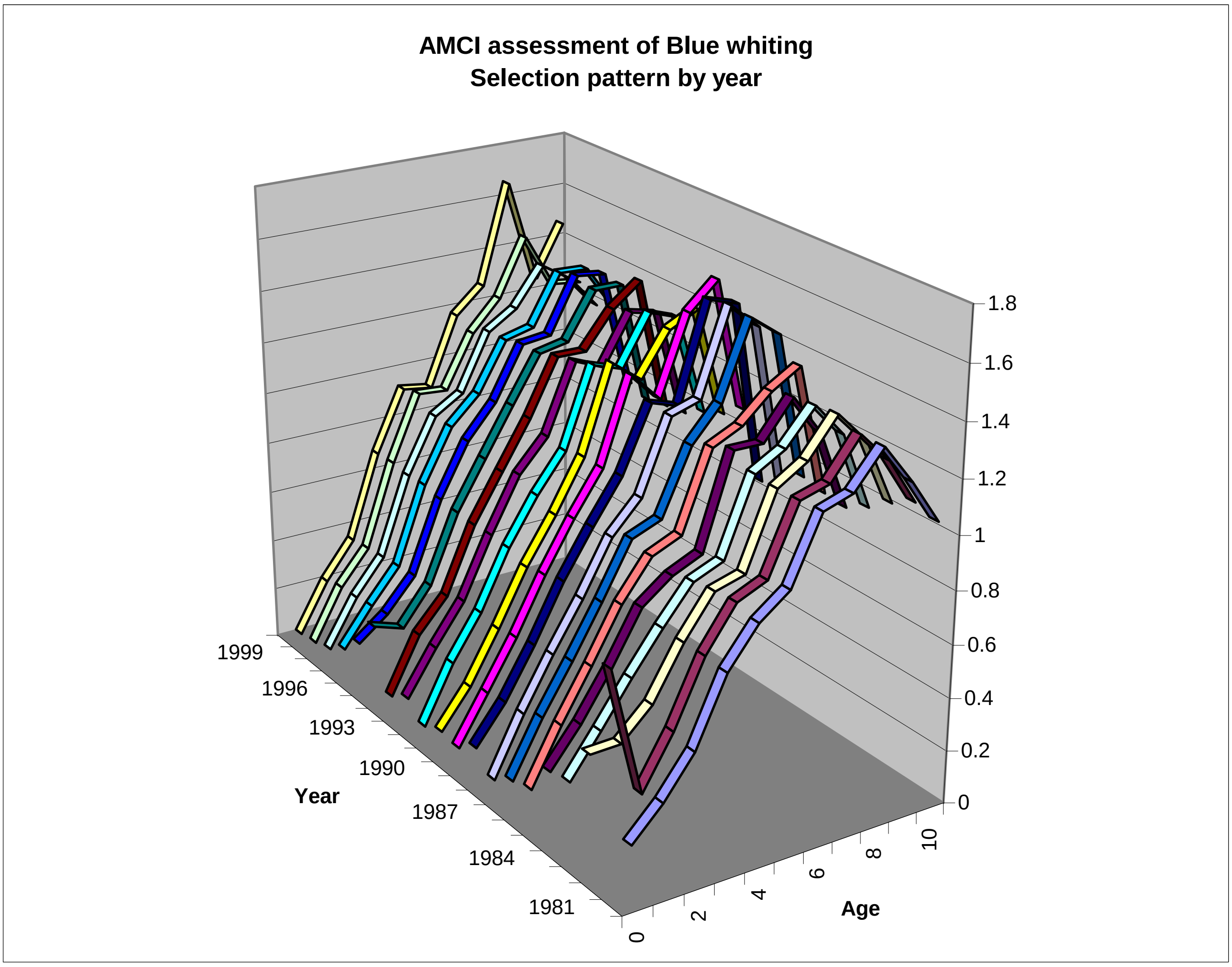


Figure 6.4.5.3. Blue Whiting. Selection pattern by year



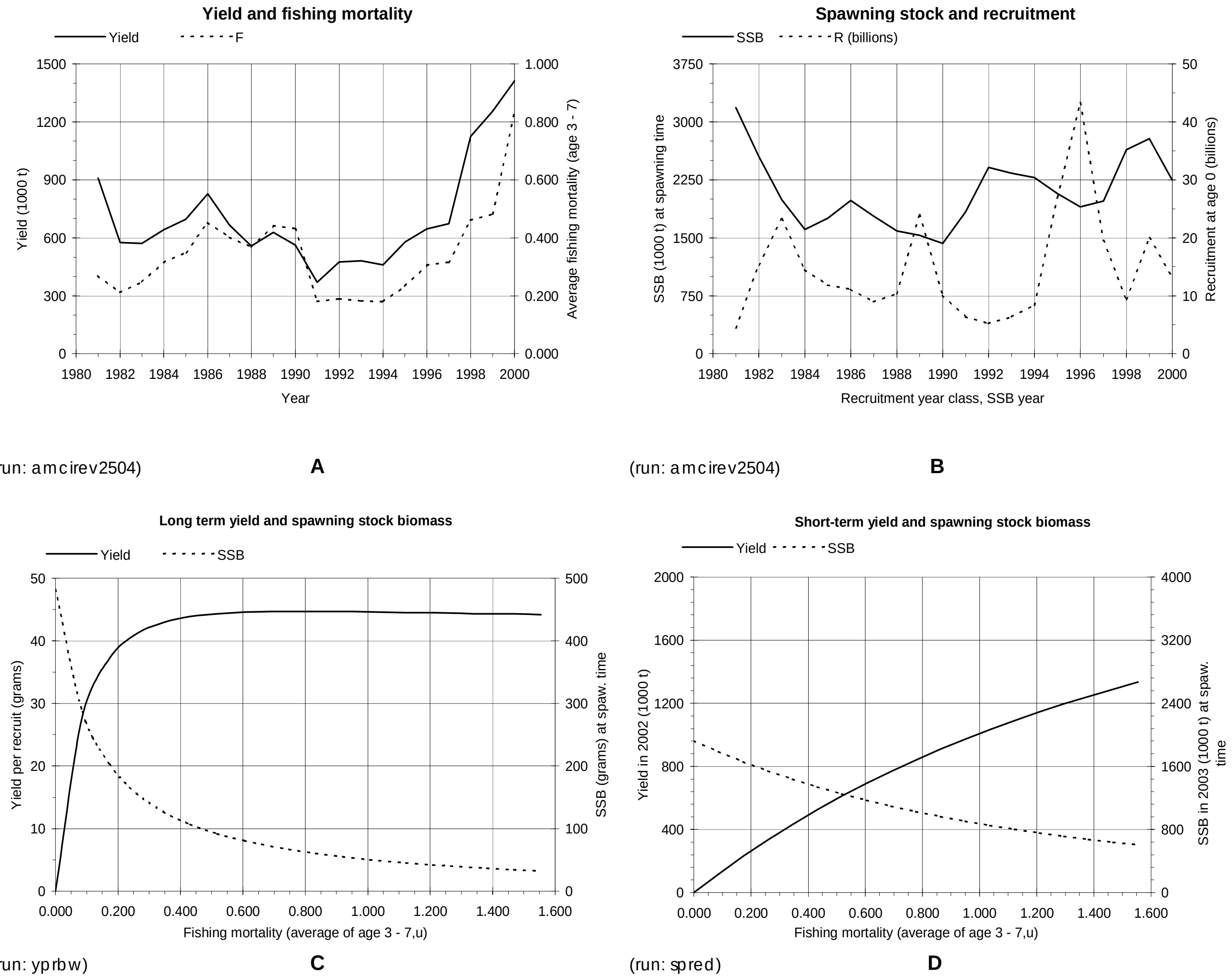
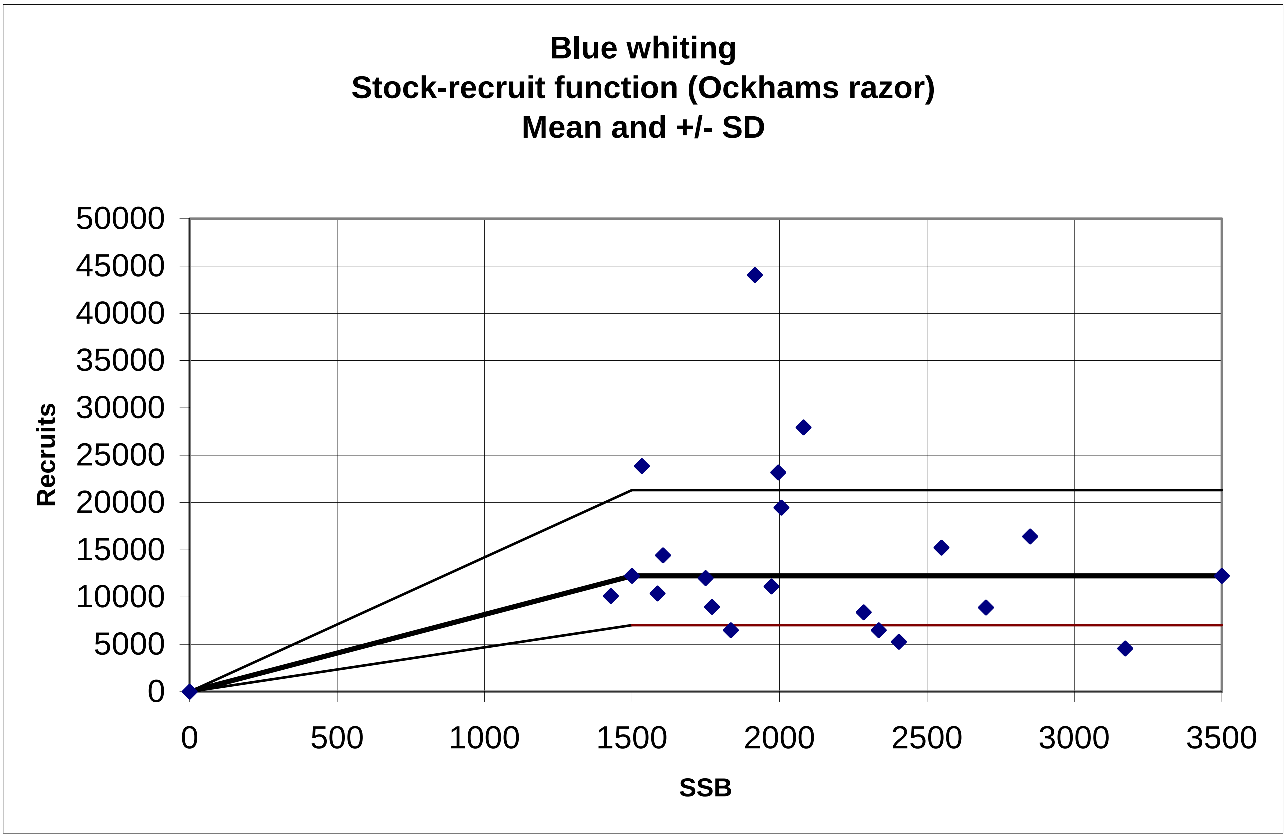
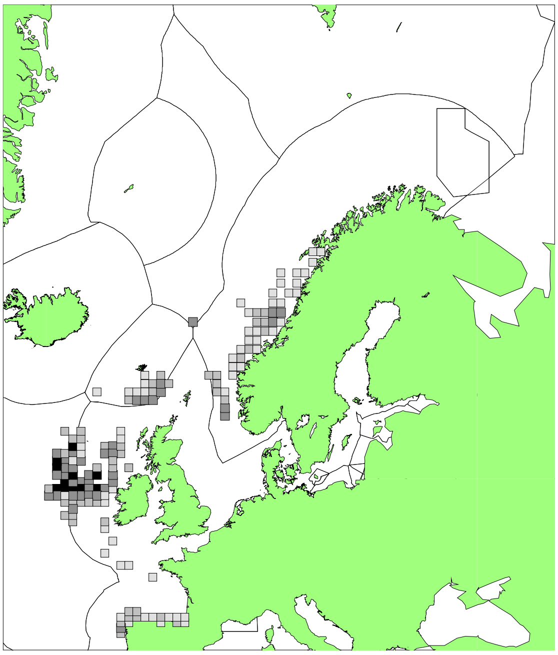


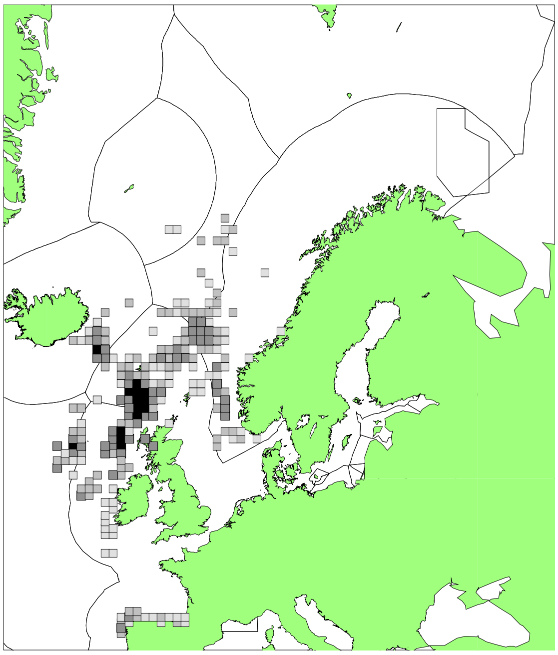
Figure 6.5.1. Blue Whiting. Standard plots from the short-term projection.

Figure 6.6.1. Blue whiting. Stock-recruit function.

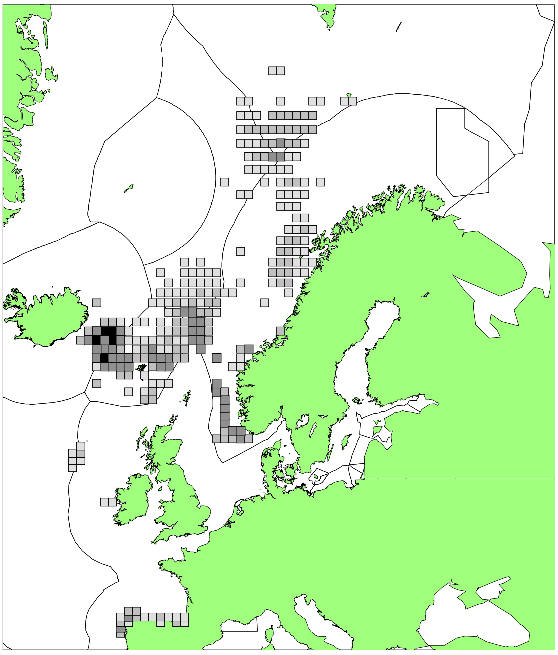




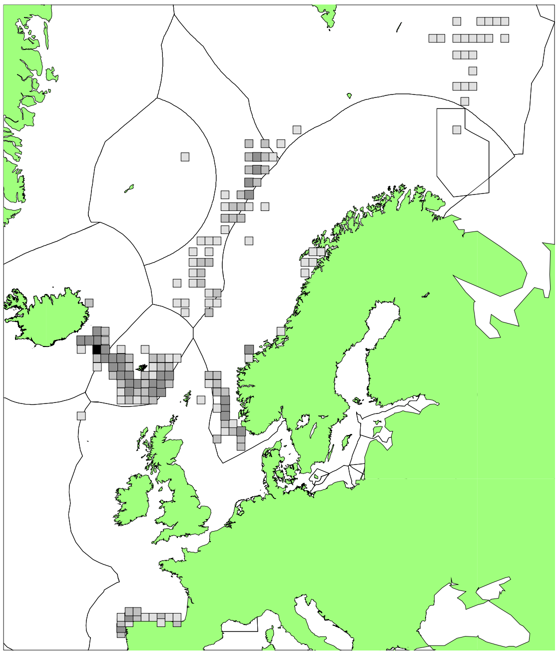
Q1



Q2



Q3



Q4

Figure 6.8.1. Total catches of blue whiting in 2000 by quarter and ICES rectangle. Grading of the symbols: white 0-100 t, light grey 100-1000 t, dark grey 1000 to 10 000 t, and black > 10 000 t. Data from Portugal not included.

7 ICELANDIC SUMMER-SPAWNING HERRING

7.1 The fishery

The catches of summer-spawning herring from 1980 - 2000 are given in Tables 7.1.1, 7.1.2 and 7.1.3. No estimate of discards was made for the 2000/2001 season. The fishery started in September and terminated in January. The catch in September-January was 100 332 t, see Table 7.1.2. The purse-seine fishery took place off the east coast of Iceland in September and October, but west of Iceland in late October-January. The pelagic trawl fishery took place both east and west of Iceland in November-December. In the 1997/98 season 59% of the catch was taken by purse seines, 78% in 1998/99, 61% in 1999/2000 and 72% in 2000/2001. The remainder were taken by pelagic trawl.

The proportion used for reduction to meal and oil was 29% in 1997/98, it increased to 72% in 1998/99. It was 69% in the 1999/2000 and 64% in the 2000/2001 season. The remainder of the catch was either salted or frozen for human consumption.

Until 1990, the herring fishery took place during the last three months of the calendar year, but since 1990 the autumn fishery has continued in January and early February of the following year. In 1994 the fishery started in September. Therefore, all references to the years 1990-1993 imply seasons starting in October of that year, but after that in September. Landings, catches and recommended TACs since 1984 are given in thousand tonnes in Table 7.1.1.

7.2 Catch in numbers, weight at age and maturity

The catches in numbers at age for the Icelandic summer-spawners for the period 1981- 2000 are given in Table 7.1.3. As usual, age is given in rings where age in years equals the number of rings+1.

During the 1995/96 - 1997/98 seasons, the catches were mainly distributed on the 4 year classes from 1988–1991. During the 1998/99 and 1999/2000 seasons the catch was on the other hand dominated by the strong 1994 yearclass. In 2000/2001 the 1994 and the very strong 1996 yearclasses were most abundant in the catch.

The weight at age for each year is given in Table 7.2.1 and the proportion mature at age is given in Table 7.2.2. 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 variables have remained relatively stable over a wide range of stock sizes and fluctuations of environmental conditions of Icelandic waters.

7.3 Acoustic surveys

The Icelandic summer-spawning herring stock has been monitored by annual acoustic surveys since 1973. These surveys have been carried out in October-December or January. During a survey carried out during 25 November – 9 December 2000 an estimate was obtained of the adult stock in open waters east and west of Iceland, and estimates of 1-year-old herring in the coastal waters were also obtained. The estimated size of the adult stock was 564 000 t. of which only 60 000 t. were located on the traditional fising grounds off the east coast.

According to the 1999/2000 acoustic assessment survey, the abundance of the 1992, 1993 and 1995 yearclasses is low. On the other hand, the abundance of the 1994 and 1996-1999 year classes is above average. The acoustic estimate of the 1999 yearclass in the December 2000 survey is the highest recorded in this series (Table 7.3.1).

The sum of results obtained in the winter 2000 acoustic surveys have been used as the basis for the present assessment of 4-ringed (5-ringed on 1 January) and older herring (Table 7.3.1).

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. It was found that a modification of the target strength, from TS=21.7 log(L) - 75.5 dB to TS=20 log(L)-72 dB, gave a much better fit between the two data sets. The resulting target strength TS = 20 log(L) - 72 dB was used to recalculate historic acoustic stock assessments. This TS = 20 log(L) - 72 dB has been the basis of calculations of stock abundance from acoustic survey data since 1993.

7.4 Stock assessment

Using the results from the acoustic survey and the catch in numbers a first estimate of F was made. The results are given in Table 7.4.1 as F_{ac}. In this analysis, 5-ringers (at 1 Jan 2001) and older have been grouped for estimating the fishing mortality for the oldest herring, whereas the fishing mortality on 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.

In comparing the usual ADAPT-type of assessment (see 1.3.4) and the series of acoustic estimates the 1998 acoustic estimate was considered to be an outlier and was therefore discarded from the assessment. The resulting ADAPT-type run gave an F of 0.147, see Figure 7.4.1. The resulting stock trend from VPA is plotted together with the acoustic estimates in Figure 7.4.2 and the relationship between the two estimates is shown in Figure 7.4.3.

Like last year an XSA was run with a result similar to last year, i.e. about 25% lower stock. Retrospective plots (Figure 7.4.4) showed more consistency using the ADAPT-type of assessment than obtained by the XSA. Therefore it was decided to retain the ADAPT-type. However, the retroplot showed that the terminal F values were underestimated in the last 4 years. Therefore the terminal F this year was increased by 20%, which is the mean underestimate of the last 4 years, resulting in a F of 0.18.

In order to test whether the catch data alone gave the same information about F as the ADAPT-type the ISVPA (see 1.3.6) was run and several options tried. Unfortunately no global minimum was found and therefore the results from the ISVPA could not be used.

Using the catch data given in Table 7.1.3 and the fitted values of fishing mortalities given in Table 7.4.1, 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 1980–2000 and stock in numbers at age and spawning stock biomass on 1 July 1980–2000 are given in Tables 7.4.2 and 7.4.3 respectively. The standard stock summary is given in Table 7.4.4 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 7.4.5. In the absence of reliable abundance estimates for the 1997, 1998 and 1999 yearclasses, the RCT3 programme was used. It estimated the sizes of these year classes as 865, 745 and 1508 million respectively (see Tables 7.4.5 and 7.4.6).

According to the present assessment, the spawning stock biomass was about 627 000 t on 1 July 2000 which is similar to the estimate made last year.

7.5 Catch and stock projections

The input data for the MDPF short-term projections are given in Table 7.5.1. 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).

Like in previous years, a regression of increase in weight on mean weight in 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 the period 1990–2000 as starting years. For 1 ringers and 9+ ringers, a simple average of mean weights at age for the period 1996–2000 was used for the prediction. Weights at age for 2–8 ringers in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.191 * W_y + 87.4 \text{ (g)}$$

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

As a selection pattern, the mean selection pattern of 1996–1999 is used, assuming 1 on 4 ringers and older.

Outputs of the prediction, assuming catches corresponding to a fishing mortality rate of $F_{0.1}$=0.22, are given in Table 7.5.2, and projections of spawning stock biomass and catches (tonnes) for a range of values of Fs are given in Table 7.5.3.

In 2001 and 2002, it is expected that by far the largest contribution in numbers at age will be herring of the 1996 yearclass, i.e 4-ringed herring in 2001 and 5-ringed in 2002.

Yield per recruit, spawning stock per recruit and short-term yield and spawning stock biomass are shown in Figure 7.5.1, using the long-term average (1981-2000) values given in Table 7.5.4.

7.6 Management consideration

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 2001/2002 season would result in a catch of about 125 000 t (Table 7.5.2 and 7.5.3). The spawning stock biomass in 2001 is expected to be about 695 000 t and about 725 000 t in the year 2002. This is mainly due to the large contribution of the very strong 1996 yearclass. 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 class 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. Thus the Working Group agreed in 1998 with the SGPAFM on using $F_{pa}=F_{0.1}=0.22$, $B_{pa}=B_{lim}e^{1.645\sigma}$=300 000 t where B_{lim}=200 000 t.

Jakobsson and Stefansson (1999) made a risk analysis and stated that the probability of stock collapse needs no further consideration as long as the target fishing mortality is kept below 0.25 The present F for this stock is estimated to be 0.18 which is well below F_{pa}=0.22. Furthermore, the spawning stock is estimated to be 695 000 t compared to B_{pa}=300 000 t. Therefore, the stock is in a healthy state and well above any “alarm level”.

7.7 Stock recruitment

A stock recruitment plot is shown in Figure 7.7.1.

7.8 Sampling

Investigation	No. of samples	Length measured individuals	Aged individuals
Fishery	79	4149	3876
Acoustic, wintering area	6	1747	600

Table 7.1.1 Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

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
1997/1998	64.7	64.7	100.0
1998/1999	87.0	87.0	90.0
1999/2000	92.9	92.9	100.0
2000/2001	100.3	100.3	110.0

*Preliminary

Table 7.1.2 Icelandic summer spawners. Catch in tonnes by Icelandic squares, ICES rectangles and months.

Icelandic squares	ICES rectangles	September 2000	October 2000	November 2000	December 2000	January 2001
318	55D1		130			
324	55C5			1510	570	
366	56D3			30		
367	56D2			1370		
372	56C7					300
373	56C6			220	6455	5550
374	56C5			3460	930	297
411	57D8					370
413	57D6	3102	7336			
414	57D5	1895	14555			
416	57D3			100		
420	57C9			100		
422	57C7					150
423	57C6					1660
424	57C5					260
425	57C4			2245		620
426	57C3			170		
461	58D8					210
462	58D7		100			100
463	58D6	190	425			
474	58C5		820	720		600
475	58C4		460	430		3580
476	58C3			895		
512	59D7			40	60	
525	59C4			100		
526	59C3			1180	3955	
561	60D8					70
562	60D7			1100	1942	
563	60D6		10928	2496	360	
564	60D5			490		
573	60C6					60
574	60C5		80	300		
575	60C4		20		0	
576	60C3			360	30	
611	61D8					50
612	61D7			3786	680	
613	61D6		70	1575		
614	61D5			100		
663	62D6			40		
674	62C5			1680		
675	62C4			1460		
714	63D5		150			
722	63C7			30		
724	63C5			650		
925	67C4			40		

Table 7.1.3 Icelandic summer spawners. Catch in numbers (millions) and total catch in weight (thous. tonnes). Age in years is number of rings+1.

Rings/Year	1981	1982	1983	1984	1985	1986	1987
1	2.283	0.454	1.475	0.421	0.112	0.100	0.029
2	4.629	19.187	22.499	18.015	12.872	8.172	3.144
3	16.771	28.109	151.718	32.244	24.659	33.938	44.590
4	12.126	38.280	30.285	141.354	21.656	23.452	60.285
5	36.871	16.623	21.599	17.043	85.210	20.681	20.622
6	41.917	38.308	8.667	7.113	11.903	77.629	19.751
7	7.299	43.770	14.065	3.916	5.740	18.252	46.240
8	4.863	6.813	13.713	4.113	2.336	10.986	15.232
9	13.416	6.633	3.728	4.517	4.363	8.594	13.963
10	1.032	10.457	2.381	1.828	4.053	9.675	10.179
11	0.884	2.354	3.436	0.202	2.773	7.183	13.216
12	0.760	0.594	0.554	0.255	0.975	3.682	6.224
13	0.101	0.075	0.100	0.260	0.480	2.918	4.723
14	0.062	0.211	0.003	0.003	0.581	1.788	2.280
Catch	39.544	56.528	58.867	50.304	49.368	65.500	75.439

Rings/year	1988	1989	1990	1991	1992	1993	1994
1	0.879	3.974	11.009	35.869	12.006	0.869	6.225
2	4.757	22.628	14.345	92.758	79.782	35.560	110.079
3	41.331	26.649	57.024	51.047	131.543	170.106	99.377
4	99.366	77.824	34.347	87.606	43.787	87.363	150.310
5	69.331	188.654	77.819	33.436	56.083	25.146	90.824
6	22.955	43.114	152.236	54.840	41.932	28.802	23.926
7	20.131	8.116	32.265	109.418	36.224	18.306	20.809
8	32.201	5.897	8.713	9.251	44.765	24.268	19.164
9	12.349	7.292	4.432	3.796	9.244	14.318	17.973
10	10.250	4.780	4.287	2.634	2.259	3.639	16.222
11	7.378	3.449	2.517	1.826	0.582	0.878	2.955
12	7.284	1.410	1.226	0.516	0.305	0.300	1.433
13	4.807	0.844	1.019	0.262	0.203	0.200	0.345
14	1.957	0.348	0.610	0.298	0.102	0.100	0.345
Catch	92.828	101.000	105.097	109.489	108.504	102.741	134.003

Rings/Year	1995	1996	1997	1998	1999	2000
1	7.411	1.100	9.323	16.161	0.629	7.958
2	26.221	18.723	27.072	37.787	43.537	52.921
3	159.170	45.304	28.397	151.853	65.871	131.153
4	86.940	92.948	29.451	42.833	145.127	44.334
5	105.542	69.878	42.267	19.872	24.653	102.925
6	74.326	86.261	35.285	30.280	20.614	10.962
7	20.076	37.447	28.506	22.572	25.853	9.312
8	13.797	13.207	21.828	32.779	21.163	17.218
9	8.873	6.854	8.160	14.366	14.436	9.471
10	9.140	4.012	3.815	4.802	6.973	7.610
11	7.079	1.672	1.696	2.199	2.164	1.930
12	2.376	4.179	6.570	1.084	2.426	5.199
13	0.927	1.672	1.378	5.081	0.473	0.552
14	0.124	0.100	1.802	3.036	0.961	0.166
Catch	125.851	95.882	64.682	86.998	92.896	100.332

Table 7.2.1 Icelandic summer spawners. Weight at age (g). Age in years is number of rings+1.

Rings/Year	1981	1982	1983	1984	1985	1986	1987
1	61	65	59	49	53	60	60
2	141	141	132	131	146	140	168
3	190	186	180	189	219	200	200
4	246	217	218	217	266	252	240
5	269	274	260	245	285	282	278
6	298	293	309	277	315	298	304
7	330	323	329	315	335	320	325
8	356	354	356	322	365	334	339
9	368	385	370	351	388	373	356
10	405	389	407	334	400	380	378
11	382	400	437	362	453	394	400
12	400	394	459	446	469	408	404
13	400	390	430	417	433	405	424
14	400	420	472	392	447	439	430

Rings/Year	1988	1989	1990	1991	1992	1993	1994
1	75	63	75	74	63	74	67
2	157	130	119	139	144	150	135
3	221	206	198	188	190	212	204
4	239	246	244	228	232	245	249
5	271	261	273	267	276	288	269
6	298	290	286	292	317	330	302
7	319	331	309	303	334	358	336
8	334	338	329	325	346	373	368
9	354	352	351	343	364	387	379
10	352	369	369	348	392	401	398
11	371	389	387	369	444	425	387
12	390	380	422	388	399	387	421
13	408	434	408	404	419	414	402
14	437	409	436	396	428	420	390

Rings/Year	1995	1996	1997	1998	1999	2000	2001*
1	69	78	62	78	64	58	69
2	129	140	137	147	143	158	134
3	178	166	197	184	211	214	215
4	236	208	234	213	236	256	260
5	276	258	270	246	268	284	295
6	292	294	299	286	300	326	317
7	314	312	323	314	318	333	351
8	349	324	342	341	349	366	357
9	374	360	358	351	347	383	363
10	381	349	363	354	377	402	376
11	400	388	373	350	359	405	390
12	409	403	412	372	403	422	403
13	438	385	394	400	408	406	407
14	469	420	429	437	445	444	429

* Predicted

Table 7.2.2 Icelandic summer spawners. Proportion mature at age.
Age in years is number of rings+1.

Rings/Year	1981	1982	1983	1984	1985	1986	1987
1	0.000	0.020	0.000	0.000	0.000	0.000	0.000
2	0.030	0.050	0.000	0.010	0.000	0.030	0.010
3	0.650	0.850	0.640	0.820	0.900	0.890	0.870
4	0.990	1.000	1.000	1.000	1.000	1.000	1.000
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Rings/Year	1988	1989	1990	1991	1992	1993	1994
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.045	0.060	0.000	0.013	0.020	0.049	0.054
3	0.900	0.930	0.780	0.720	0.930	0.999	1.000
4	1.000	1.000	1.000	1.000	1.000	1.000	0.992
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Rings/Year	1995	1996	1997	1998	1999	2000	2001*
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.157	0.049	0.160	0.265	0.074	0.279	0.206
3	0.982	0.990	0.925	0.935	0.879	0.813	0.882
4	0.998	1.000	0.989	0.995	0.977	0.992	0.988
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

* Predicted (mean of 1998-2000)

Table 7.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-2000. The surveys are conducted in October-December or January. The year given is the following year, i.e. if the survey is conducted in the season 1973/1974, then 1974 is given.

Rings/Year	74	75	76	77	78	79	80	81	82	83	84	85	86	87
1	-	-	-	-	-	-	-	625	-	-	-	-	201	-
2	154	5	136	-	212	158	19	361	17	-	171	28	652	-
3	-	137	20	-	424	334	177	462	75	-	310	67	208	-
4	-	19	133	-	46	215	360	85	159	-	724	56	110	-
5	-	21	17	-	19	49	253	170	42	-	80	360	86	-
6	-	2	10	-	139	20	51	182	123	-	39	65	425	-
7	-	2	3	-	18	111	41	33	162	-	15	32	67	-
8	-	-	3	-	18	30	93	29	24	-	27	16	41	-
9	-	-	-	-	10	30	10	58	8	-	26	17	17	-
10	-	-	-	-	-	20	-	10	46	-	10	18	27	-
11	-	-	-	-	-	-	-	-	10	-	5	9	26	-
12	-	-	-	-	-	-	-	-	-	-	12	7	16	-
13	-	-	-	-	-	-	-	-	-	-	-	4	6	-
14	-	-	-	-	-	-	-	-	-	-	-	5	6	-
15	-	-	-	-	-	-	-	-	-	-	-	5	1	-
5+	-	25	33	-	204	260	448	482	415	-	214	538	718	-

Rings/Year	88	89	90	91	92	93	94	95	96	97	98	99	2000	2001
1	406	370	-	710	465	1418	183	-	845	266	1629	-	1069	2832
2	126	725	178	805	745	254	234	-	98	792	237	-	527	101
3	352	181	593	227	850	858	533	-	165	65	716	188	740	560
4	836	249	177	304	353	687	860	-	515	139	100	790	296	1069
5	287	381	302	137	273	160	443	-	316	459	116	240	606	323
6	53	171	538	176	94	99	55	-	361	280	240	101	99	609
7	37	42	185	387	81	87	69	-	166	410	161	73	71	30
8	76	23	-	40	210	44	43	-	110	150	130	47	164	31
9	25	30	-	10	32	92	86	-	52	101	97	77	108	38
10	21	16	-	2	11	39	55	-	29	50	35	47	98	13
11	14	10	18	-	-	-	2	-	16	35	15	10	15	18
12	17	9	-	-	17	-	-	-	27	15	11	10	44	6
13	8	5	-	-	-	-	-	-	19	65	43	-	5	9
14	6	3	-	-	-	-	-	-	8	32	8	22	13	4
15	3	2	-	-	-	-	-	-	2	-	15	-	7	1
5+	547	692	1043	752	718	521	753	-	1105	1597	870	627	1230	1082

Table 7.4.1 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 2000. F_{2000} is the F in 2000. prognosis).

Rings in 2000	Year class	Acoustic estimate Dec. 2000	Catch 2000/2001	F_{ac}	F_{2000}
1	1998	101	7.958	0.008	0.01
2	1997	561	52.921	0.086	0.74
3	1996	1069	131.153	0.110	0.117
4+	1995	1082	209.679	0.169	0.18

Table 7.4.2 Icelandic summer spawners. Fishing mortality at age. Age in years is number of rings+1.

Run title : Herring Summer-spawn, 2nd run in 2001

At 25/04/2001 21:23

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
1,	.0027,	.0020,	.0071,	.0009,	.0001,	.0002,	.0001,	.0019,	.0097,	.0132,
2,	.0217,	.0257,	.1164,	.1009,	.0311,	.0078,	.0058,	.0167,	.0562,	.0397,
3,	.0979,	.1589,	.2576,	.2174,	.1750,	.0964,	.0484,	.0889,	.1102,	.1753,
4,	.1228,	.2999,	.2294,	.3599,	.1988,	.2244,	.2213,	.1301,	.2147,	.1813,
5,	.2478,	.2204,	.2461,	.1748,	.3406,	.2640,	.2801,	.3775,	.3439,	.3071,
6,	.3183,	.3895,	.1533,	.1072,	.1596,	.5243,	.3836,	.5058,	.3786,	.4552,
7,	.1680,	.5649,	.2151,	.0864,	.1064,	.3463,	.6041,	.7449,	.2980,	.4785,
8,	.1689,	.2090,	.3058,	.0808,	.0614,	.2707,	.4801,	1.0116,	.4447,	.5295,
9,	.4048,	.3243,	.1516,	.1397,	.1039,	.2969,	.5721,	.8000,	.5789,	.6245,
10,	.0982,	.5608,	.1651,	.0929,	.1610,	.3116,	.6002,	.9788,	.7433,	.7111,
11,	.7364,	.3006,	.3197,	.0170,	.1781,	.4177,	.7981,	1.0682,	.9620,	1.0229,
12,	2.1779,	1.6231,	.0958,	.0315,	.0959,	.3364,	.6838,	1.3498,	.5196,	1.0077,
13,	.1879,	1.9323,	1.4197,	.0536,	.0688,	.4031,	.8315,	1.7762,	.4595,	.7830,
14,	.4710,	.6450,	.3070,	.1110,	.1460,	.3460,	.5590,	.9010,	.5050,	.6260,
0 FBAR 4-14,	.4638,	.6427,	.3280,	.1141,	.1473,	.3401,	.5467,	.8767,	.4953,	.6115,
W Fbar 4-14	0.245	0.365	0.224	0.255	0.227	0.359	0.38	0.296	0.316	0.371

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**
AGE											
1,	.0333,	.0183,	.0011,	.0212,	.0282,	.0008,	.0190,	.0107,	.0008,	.0110,	.0075,
2,	.1317,	.0868,	.0622,	.1624,	.1051,	.0831,	.0226,	.0900,	.0326,	.0740,	.0656,
3,	.1731,	.2489,	.2400,	.2208,	.3304,	.2375,	.1569,	.1523,	.2000,	.1170,	.1564,
4,	.3927,	.1974,	.2325,	.3076,	.2728,	.2914,	.2139,	.3324,	.1907,	.1800,	.2344,
5,	.2405,	.4158,	.1491,	.3573,	.3277,	.3264,	.1865,	.1959,	.2889,	.1800,	.2216,
6,	.3284,	.4718,	.3464,	.1852,	.4910,	.4308,	.2427,	.1772,	.2849,	.1800,	.2140,
7,	.6113,	.3338,	.3442,	.4011,	.2091,	.4356,	.2194,	.2160,	.2019,	.1800,	.1993,
8,	.2168,	.4805,	.3472,	.6428,	.4486,	.1852,	.4334,	.3731,	.2873,	.1800,	.2801,
9,	.4102,	.3107,	.2465,	.4149,	.6191,	.3725,	.1497,	.5015,	.2489,	.1800,	.3101,
10,	.8409,	.4058,	.1728,	.4300,	.3413,	.5597,	.3254,	.1110,	.4301,	.1800,	.2404,
11,	.6693,	.3903,	.2427,	.1855,	.3003,	.0860,	.4320,	.2812,	.0603,	.1800,	.1738,
12,	.5195,	.1943,	.3177,	.6796,	.1998,	.2595,	.4923,	.4805,	.5028,	.1800,	.3878,
13,	.5316,	.3518,	.1690,	.6425,	1.1808,	.1887,	.1144,	.7817,	.3535,	.1800,	.4384,
14,	.4860,	.3600,	.2610,	.4310,	.4440,	.3160,	.2840,	.3490,	.2860,	.1800,	.2717,
0 FBAR 4-14,	.4770,	.3557,	.2572,	.4252,	.4395,	.3138,	.2813,	.3454,	.2850,	.1800,	
W Fbar 4-14	0.405	0.349	0.245	0.33	0.335	0.334	0.231	0.265	0.215	0.18	

Table 7.4.3 Icelandic summer spawners. VPA stock size (thousands) and SSB (tonnes).
Age in years is number of rings+1.

At 25/04/2001 21:23

Traditional vpa using file input for terminal F

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

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
1	880307	237962	219273	488884	1221030	627117	333067	481689	432423	883851
2	226761	794364	214885	197004	441961	1104727	567344	301344	435014	387494
3	188761	200782	700531	173064	161141	387667	991829	510365	268145	372112
4	110146	154865	154983	489917	125991	122394	318532	855063	422528	217312
5	176138	88146	103820	111493	309292	93445	88490	231004	679315	308453
6	161156	124390	63981	73445	84702	199068	64931	60506	143305	435803
7	49539	106069	76246	49662	59699	65339	106631	40032	33013	88802
8	32839	37894	54551	55641	41216	48565	41816	52737	17198	22173
9	42211	25097	27821	36354	46438	35073	33521	23411	17352	9975
10	11586	25481	16418	21634	28605	37874	23584	17117	9519	8801
11	1772	9503	13159	12595	17838	22034	25094	11709	5820	4096
12	886	768	6366	8649	11205	13507	13130	10222	3641	2012
13	619	91	137	5234	7583	9211	8730	5996	2398	1959
14	173	464	12	30	4489	6405	5569	3439	918	1371
0 TOTAL	1882895	1805875	1652185	1723607	2561190	2772426	2622269	2604635	2470590	2744214
TOTSPBIO	186451	193274	219983	233061	250483	262045	366597	423868	389088	346831

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

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 81-98	AMST 81-98
AGE													
1	1151297	696583	852652	311507	280179	1410802	519236	1590601	861777	764349	0	589238	701026
2	789275	1007641	618881	770684	275945	246471	1275501	460961	1423870	779170	684046	476890	562014
3	336984	626064	835947	526192	592818	224776	205226	1128385	381192	1246986	654734	388956	468377
4	282559	256449	441670	594976	381801	385475	160394	158731	876801	282389	1003736	262755	312988
5	164023	172643	190479	316732	395802	262990	260628	117177	103011	655589	213425	191577	226115
6	205296	116686	103072	148472	200489	258056	171701	195699	87162	69823	495484	135851	156153
7	250125	133758	65867	65956	111629	111025	151772	121879	148327	59314	52771	82646	93725
8	49794	122809	86681	42243	39959	81950	64982	110274	88857	109671	44828	49633	55740
9	11814	36276	68727	55424	20097	23087	61613	38118	68709	60326	82888	30142	34023
10	4834	7093	24057	48600	33119	9791	14393	48001	20888	48473	45594	17869	21695
11	3911	1886	4277	18312	28606	21302	5062	9406	38871	12293	36635	8924	12021
12	1332	1812	1155	3036	13764	19169	17686	2974	6425	33115	9291	4534	7295
13	665	717	1350	761	1392	10199	13380	9781	1664	3516	25028	2100	4456
14	810	353	456	1032	362	387	7641	10798	4050	1057	2657	824	2484
TOTAL	3252720	3180769	3295270	2903927	2375962	3065479	2929214	4002783	4111604	4126072	3351117		
TOT-SPBIO	299632	345083	450592	453267	432139	338555	324143	429163	447980	627167			

Table 7.4.4 Icelandic summer spawners.

Run title : Herring Summer-spawn, 2nd run in 2001
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At 25/04/2001 21:23

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4-14,
1981,	880307,	293501,	186451,	39544,	.2121,	.9988,	.4638,
1982,	237962,	330691,	193274,	56528,	.2925,	1.0003,	.6427,
1983,	219273,	317860,	219983,	58867,	.2676,	.9989,	.3280,
1984,	488884,	300358,	233061,	50304,	.2158,	.9992,	.1141,
1985,	1221030,	396128,	250483,	49368,	.1971,	1.0002,	.1473,
1986,	627117,	471644,	262045,	65500,	.2500,	.9999,	.3401,
1987,	333067,	525509,	366597,	75439,	.2058,	.9999,	.5467,
1988,	481689,	537898,	423868,	92828,	.2190,	.9994,	.8767,
1989,	432423,	493688,	389088,	101000,	.2596,	.9997,	.4953,
1990,	883851,	493188,	346831,	105097,	.3030,	.9991,	.6115,
1991,	1151297,	526451,	299632,	109489,	.3654,	.9996,	.4770,
1992,	696583,	557066,	345083,	108504,	.3144,	.9994,	.3557,
1993,	852652,	624847,	450592,	102741,	.2280,	.9991,	.2572,
1994,	311507,	597731,	453267,	134003,	.2956,	1.0003,	.4252,
1995,	280179,	505672,	432139,	125851,	.2912,	1.0006,	.4395,
1996,	1410802,	499095,	338555,	95882,	.2832,	.9999,	.3138,
1997,	519236,	522957,	324143,	64395,	.1987,	1.0001,	.2813,
1998,	1590601,	637508,	429163,	86999,	.2027,	1.0001,	.3454,
1999,	861777,	730307,	447980,	92896,	.2074,	1.0007,	.2850,
2000,	764349,	838249,	627167,	100332,	.1600,	.9993,	.1800,
Arith. Mean ,	712229,	510017,	350970,	85778,	.2485		.3963,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 7.4.5 Icelandic summer spawners. Input data for the RCT3 program.

Iceland Herring: VPA and acoustic survey data
3 21 2

'Yearcl'	'VPAage2'	'Surv4'	'Surv3'	'Surv2'
1979	880	-11	17	625
1980	237	310	-11	-11
1981	219	67	171	-11
1982	487	208	28	-11
1983	1219	-11	652	-11
1984	627	352	-11	201
1985	333	181	126	-11
1986	482	593	725	406
1987	432	227	178	370
1988	884	850	805	-11
1989	1151	858	745	710
1990	697	533	254	465
1991	853	-11	234	1418
1992	312	165	-11	183
1993	280	65	98	-11
1994	1411	716	792	845
1995	519	188	237	266
1996	1591	740	-11	1629
1997	-11	561	527	-11
1998	-11	-11	101	1069
1999	-11	-11	-11	2832

Table 7.4.6 Icelandic summer spawners. Output from the RCT3 program.

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Analysis by RCT3 ver3.1 of data from file :

 rec13.dat

 Iceland Herring: VPA and acoustic survey data

 Data for    3 surveys over   21 years :  1979 - 1999

 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   0.20
 Minimum of   3 points used for regression

 Forecast/Hindcast variance correction used.

 Yearclass =   1997

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4     0.82   1.64   0.37  0.759     15   6.33    6.85    0.441    0.522
 Surv3     0.85   1.65   0.59  0.507     14   6.27    6.95    0.707    0.203
 Surv2

                                        VPA Mean =    6.47    0.607    0.275


 Yearclass =   1998

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3     0.83   1.73   0.52  0.570     14   4.62    5.56    0.679    0.229
 Surv2     0.84   1.33   0.37  0.737     11   6.98    7.18    0.465    0.488

                                        VPA Mean =    6.49    0.611    0.283


 Yearclass =   1999

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3
 Surv2     0.84   1.35   0.36  0.749     11   7.95    7.99    0.559    0.549

                                        VPA Mean =    6.50    0.617    0.451



 Year     Weighted      Log     Int     Ext      Var      VPA       Log
 Class     Average      WAP     Std     Std     Ratio               VPA
          Prediction           Error   Error

 1997         865      6.76    0.32    0.13     0.17
 1998         745      6.61    0.32    0.45     1.96
 1999        1508      7.32    0.41    0.74     3.19
```

Table 7.5.1

MFDP version 1
Run: FIN2
Time and date: 10:01 27/04/2001
Fbar age range: 4-14

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	1508000	.1	0	0	.5	.069	.006	.069
2	666614	.1	.21	0	.5	.134	.04	.134
3	658242	.1	.882	0	.5	.215	.112	.215
4	1003736	.1	.988	0	.5	.26	.149	.26
5	213425	.1	1	0	.5	.295	.18	.295
6	495484	.1	1	0	.5	.317	.18	.317
7	52771	.1	1	0	.5	.351	.18	.351
8	44828	.1	1	0	.5	.357	.18	.357
9	82888	.1	1	0	.5	.363	.18	.363
10	45594	.1	1	0	.5	.376	.18	.376
11	36635	.1	1	0	.5	.39	.18	.39
12	9291	.1	1	0	.5	.403	.18	.403
13	25028	.1	1	0	.5	.407	.18	.407
14	2657	.1	1	0	.5	.429	.18	.429

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	650000	.1	0	0	.5	.069	.006	.069
2	.	.1	.21	0	.5	.134	.04	.134
3	.	.1	.882	0	.5	.215	.112	.215
4	.	.1	.988	0	.5	.26	.149	.26
5	.	.1	1	0	.5	.295	.18	.295
6	.	.1	1	0	.5	.317	.18	.317
7	.	.1	1	0	.5	.351	.18	.351
8	.	.1	1	0	.5	.357	.18	.357
9	.	.1	1	0	.5	.363	.18	.363
10	.	.1	1	0	.5	.376	.18	.376
11	.	.1	1	0	.5	.39	.18	.39
12	.	.1	1	0	.5	.403	.18	.403
13	.	.1	1	0	.5	.407	.18	.407
14	.	.1	1	0	.5	.429	.18	.429

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	650000	.1	0	0	.5	.069	.006	.069
2	.	.1	.21	0	.5	.134	.04	.134
3	.	.1	.882	0	.5	.215	.112	.215
4	.	.1	.988	0	.5	.26	.149	.26
5	.	.1	1	0	.5	.295	.18	.295
6	.	.1	1	0	.5	.317	.18	.317
7	.	.1	1	0	.5	.351	.18	.351
8	.	.1	1	0	.5	.357	.18	.357
9	.	.1	1	0	.5	.363	.18	.363
10	.	.1	1	0	.5	.376	.18	.376
11	.	.1	1	0	.5	.39	.18	.39
12	.	.1	1	0	.5	.403	.18	.403
13	.	.1	1	0	.5	.407	.18	.407
14	.	.1	1	0	.5	.429	.18	.429

Input units are thousands and kg - output in tonnes

Table 7.5.2

MFDP version 1 , Run: FIN2 , Time and date: 10:01 27/04/2001 , Fbar age range: 4-14

Year: ,2001, F multiplier: , 1.2200 , Fbar: , 0.2162

Age	F	Catch Nos	Yield	StockNos	Biomass	SSNos (Jan)	SSB (Jan)	SSNos (ST)	SSB(ST)
1	0.0073	10467	722	1508000	104052	0	0	0	0
2	0.0488	30226	4050	666614	89326	139989	18759	133162	17844
3	0.1366	80092	17220	658242	141522	580569	124822	552255	118735
4	0.1818	159006	41342	1003736	260971	991691	257840	943326	245265
5	0.2196	40117	11834	213425	62960	213425	62960	203016	59890
6	0.2196	93134	29523	495484	157068	495484	157068	471319	149408
7	0.2196	9919	3482	52771	18523	52771	18523	50197	17619
8	0.2196	8426	3008	44828	16004	44828	16004	42642	15223
9	0.2196	15580	5656	82888	30088	82888	30088	78846	28621
10	0.2196	8570	3222	45594	17143	45594	17143	43370	16307
11	0.2196	6886	2686	36635	14288	36635	14288	34848	13591
12	0.2196	1746	704	9291	3744	9291	3744	8838	3562
13	0.2196	4704	1915	25028	10186	25028	10186	23807	9690
14	0.2196	499	214	2657	1140	2657	1140	2527	1084
Total		469374	125578	4845193	927017	2720851	732566	2588153	696838

Year: ,2002, F multiplier: , 1.5000 , Fbar: , 0.2658

Age	F	Catch Nos	Yield	Stock Nos	Bio-mass	SSNos (Jan)	SSB (Jan)	SSNos (ST)	SSB (ST)
1	0.0090	5542	382	650000	44850	0	0	0	0
2	0.0600	75104	10064	1354543	181509	284454	38117	270581	36258
3	0.1680	84657	18201	574449	123507	506664	108933	481954	103620
4	0.2235	99206	25793	519534	135079	513300	133458	488266	126949
5	0.2700	170898	50415	757258	223391	757258	223391	720326	212496
6	0.2700	34990	11092	155040	49148	155040	49148	147479	46751
7	0.2700	81231	28512	359939	126339	359939	126339	342385	120177
8	0.2700	8651	3089	38335	13686	38335	13686	36465	13018
9	0.2700	7349	2668	32565	11821	32565	11821	30977	11245
10	0.2700	13589	5109	60213	22640	60213	22640	57276	21536
11	0.2700	7475	2915	33121	12917	33121	12917	31506	12287
12	0.2700	6006	2420	26613	10725	26613	10725	25315	10202
13	0.2700	1523	620	6749	2747	6749	2747	6420	2613
14	0.2700	4539	1947	20111	8628	20111	8628	19131	8207
Total		600761	163228	4588472	966986	2794364	762549	2658081	725359

Year: ,2003, F multiplier: , 1.5000 , Fbar: , 0.2658

Age	F	Catch Nos	Yield	Stock Nos	Bio-mass	SSNos (Jan)	SSB (Jan)	SSNos (ST)	SSB (ST)
1	0.0090	5542	382	650000	44850	0	0	0	0
2	0.0600	32318	4331	582875	78105	122404	16402	116434	15602
3	0.1680	170106	36573	1154266	248167	1018062	218883	968411	208208
4	0.2235	83904	21815	439400	114244	434128	112873	412955	107368
5	0.2700	84843	25029	375941	110903	375941	110903	357606	105494
6	0.2700	118045	37420	523064	165811	523064	165811	497554	157725
7	0.2700	24168	8483	107092	37589	107092	37589	101869	35756
8	0.2700	56109	20031	248622	88758	248622	88758	236497	84429
9	0.2700	5976	2169	26479	9612	26479	9612	25188	9143
10	0.2700	5076	1909	22494	8458	22494	8458	21397	8045
11	0.2700	9386	3661	41591	16221	41591	16221	39563	15430
12	0.2700	5163	2081	22878	9220	22878	9220	21762	8770
13	0.2700	4149	1688	18383	7482	18383	7482	17486	7117
14	0.2700	4187	1796	18554	7960	18554	7960	17649	7571
Total		608973	167368	4231639	947379	2979692	810171	2834370	770659

Input units are thousands and kg - output in tonnes

Table 7.5.3

MFDP version 1
Run: FIN2
Second run, future data in 2001.
Time and date: 10:01 27/04/2001
Fbar age range: 4-14

2001				
Biomass	SSB	FMult	FBar	Landings
927017	696838	1.2200	0.2162	125578

2002					2003	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
966986	725359	1.0000	0.1772	112990	1000851	820708
.	725359	1.0500	0.1860	118191	995318	815527
.	725359	1.1000	0.1949	123352	989827	810386
.	725359	1.1500	0.2038	128472	984378	805285
.	725359	1.2000	0.2126	133553	978971	800223
.	725359	1.2500	0.2215	138595	973604	795200
.	725359	1.3000	0.2303	143599	968279	790216
.	725359	1.3500	0.2392	148563	962994	785270
.	725359	1.4000	0.2481	153489	957749	780362
.	725359	1.4500	0.2569	158378	952544	775492
.	725359	1.5000	0.2658	163228	947379	770659
.	725359	1.5500	0.2746	168042	942253	765863
.	725359	1.6000	0.2835	172818	937166	761104
.	725359	1.6500	0.2924	177558	932117	756382
.	725359	1.7000	0.3012	182262	927106	751696
.	725359	1.7500	0.3101	186929	922133	747045
.	725359	1.8000	0.3189	191561	917198	742431
.	725359	1.8500	0.3278	196157	912300	737851
.	725359	1.9000	0.3366	200718	907440	733307
.	725359	1.9500	0.3455	205244	902615	728798
.	725359	2.0000	0.3544	209735	897828	724322

Input units are thousands and kg - output in tonnes

Table 7.5.4 Input data for Yield per recruit.

MFYPR version 1
Run: fin
WG 2001, mean of 1981-2000 used.
Time and date: 13:45 27/04/2001
Fbar age range: 4-14

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	.1	0	0	.5	.065	.006	.065
2	.1	.21	0	.5	.141	.039	.141
3	.1	.882	0	.5	.197	.134	.197
4	.1	.988	0	.5	.236	.22	.236
5	.1	1	0	.5	.27	.22	.27
6	.1	1	0	.5	.3	.22	.3
7	.1	1	0	.5	.324	.22	.324
8	.1	1	0	.5	.346	.22	.346
9	.1	1	0	.5	.365	.22	.365
10	.1	1	0	.5	.377	.22	.377
11	.1	1	0	.5	.394	.22	.394
12	.1	1	0	.5	.409	.22	.409
13	.1	1	0	.5	.411	.22	.411
14	.1	1	0	.5	.428	.22	.428

Weights in kilograms

Figure 7.4.1 Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.

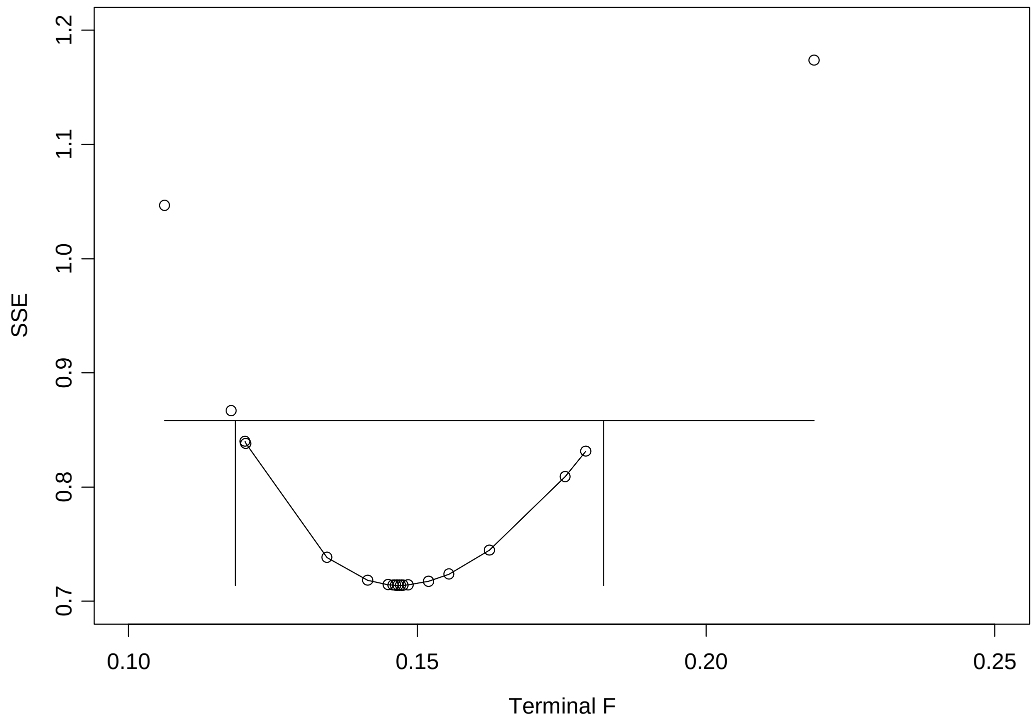
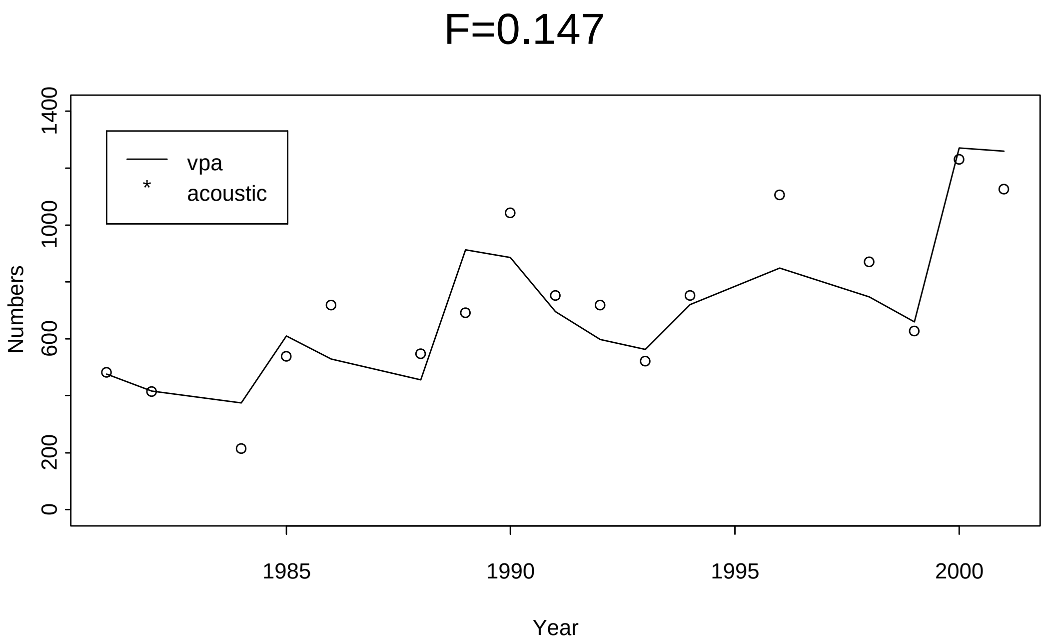


Figure 7.4.2 Icelandic summer spawners. Trend in acoustics and VPA stock numbers.



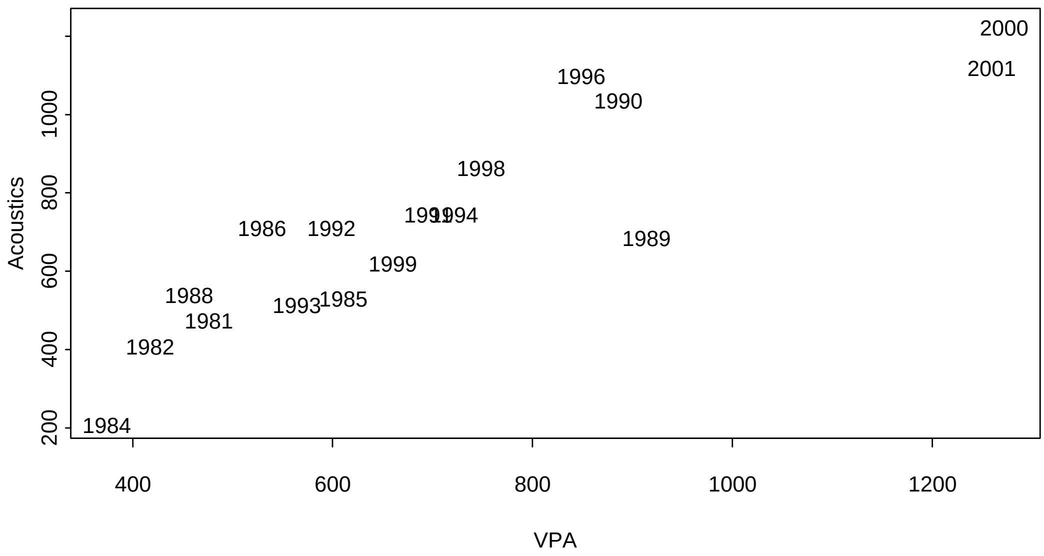
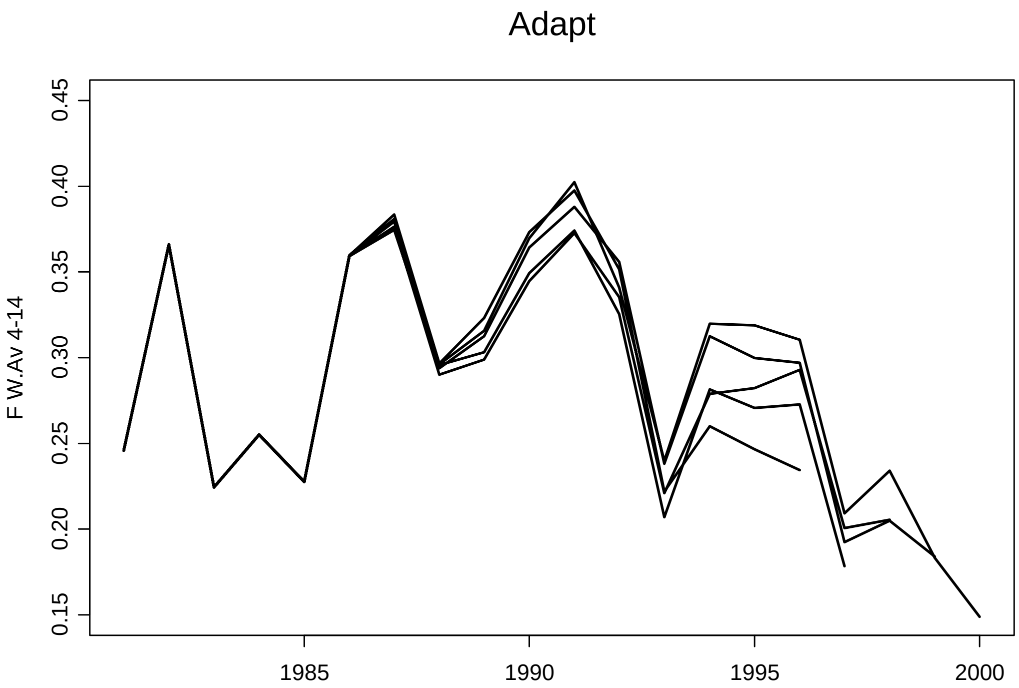
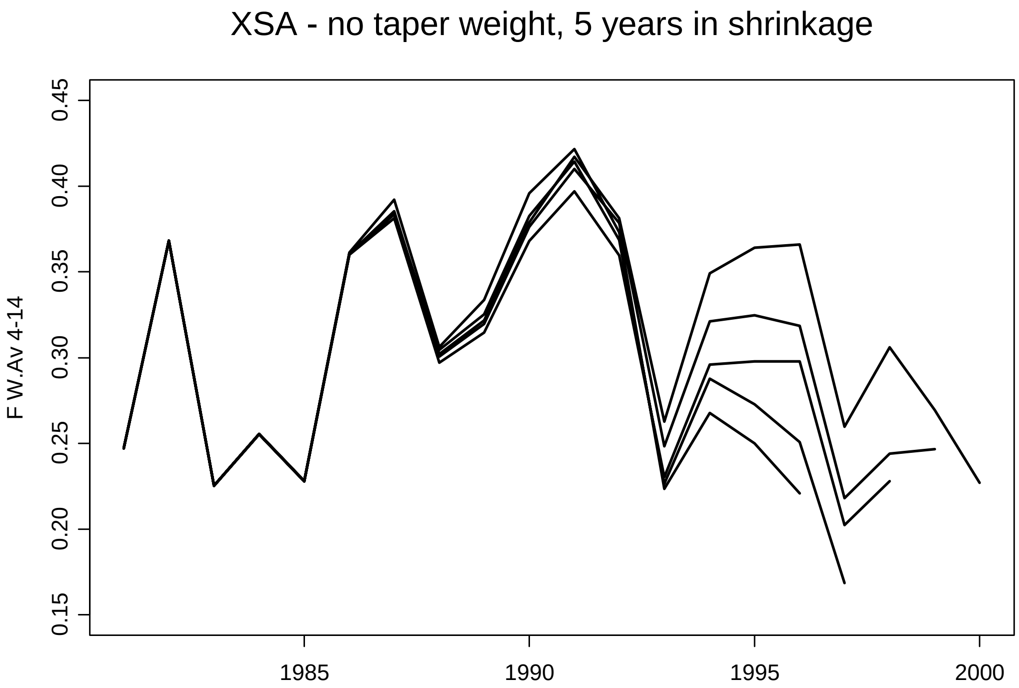


Figure 7.4.3 Icelandic summer spawners. Acoustics estimates vs VPA stock numbers (at the 1st of January)

Figure 7.4.4 Retrospective plots





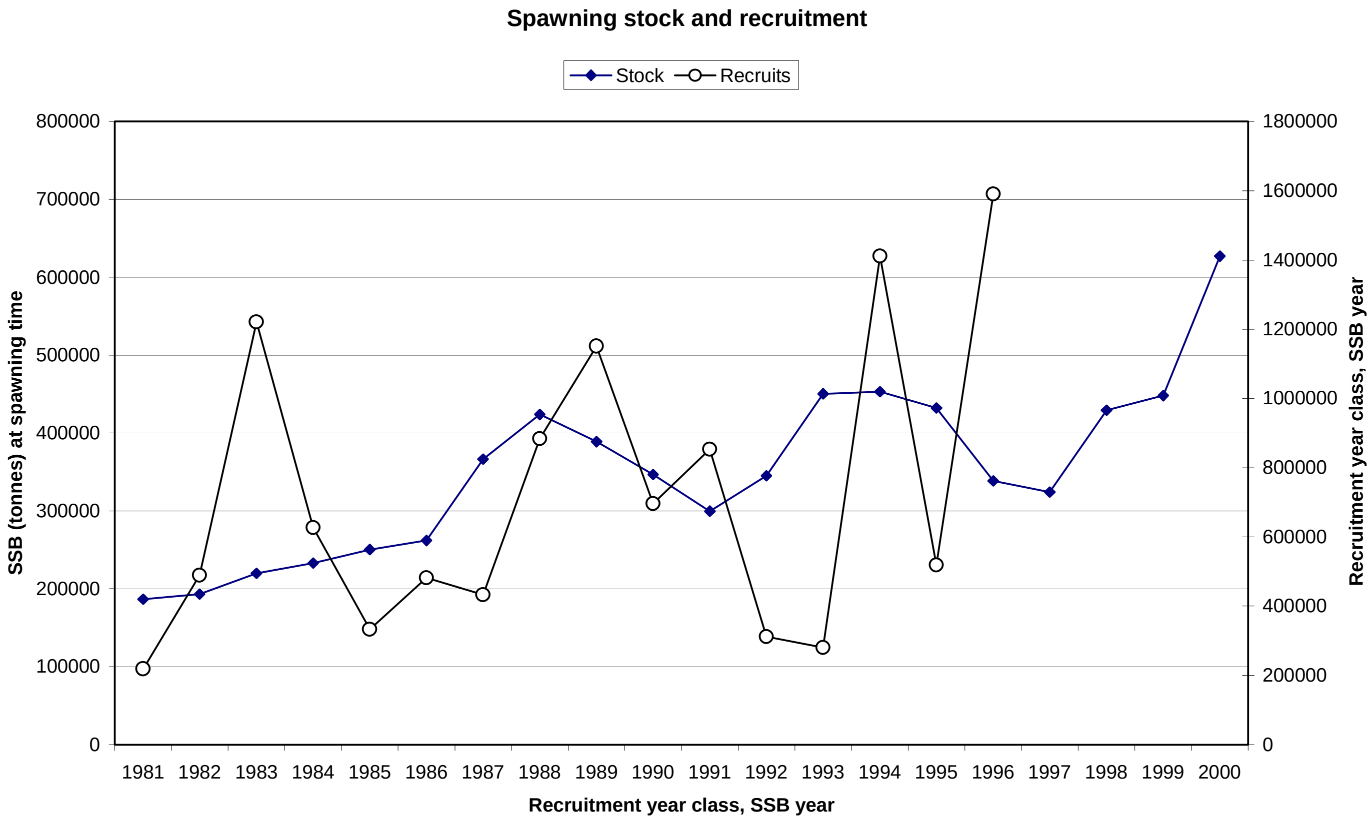


Figure 7.4.5 Fish stock summary. Herring Icelandic Summer-spawning (Fishing Area Va)

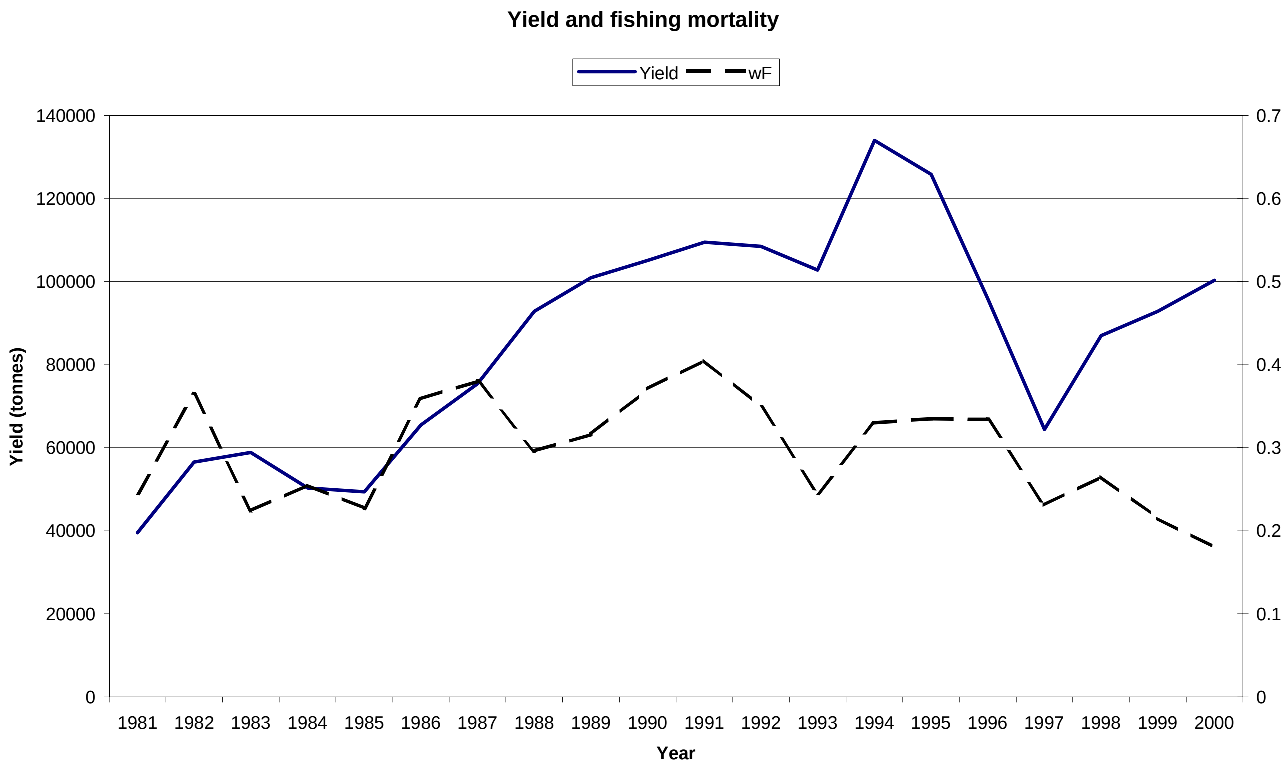
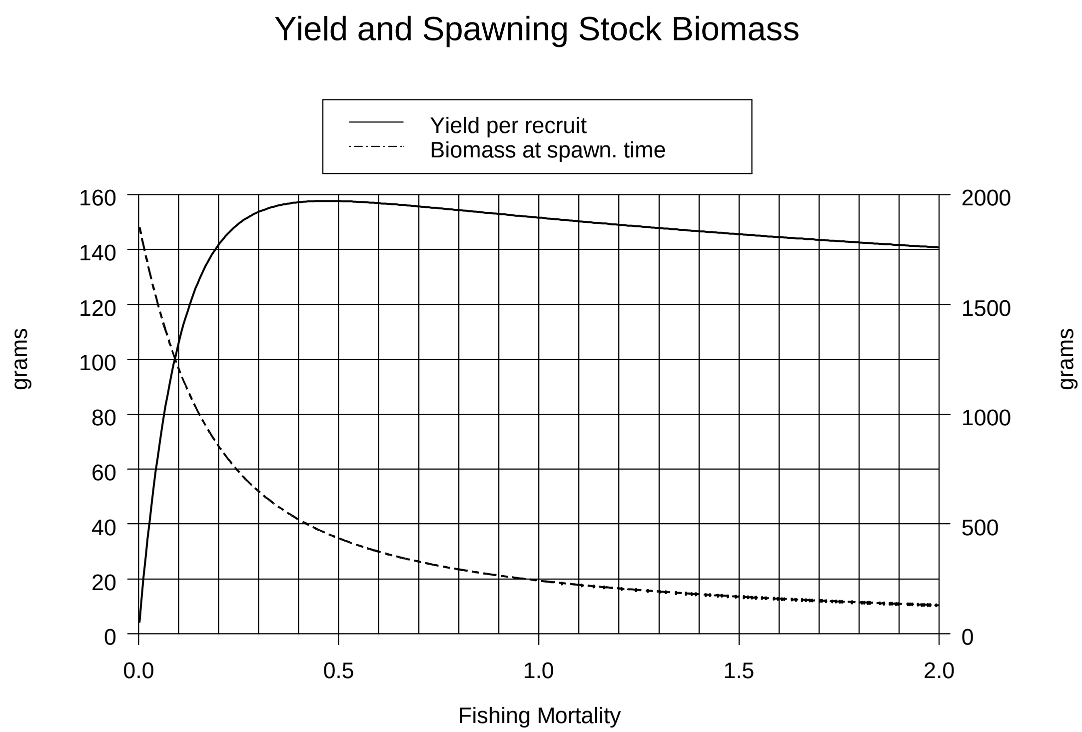
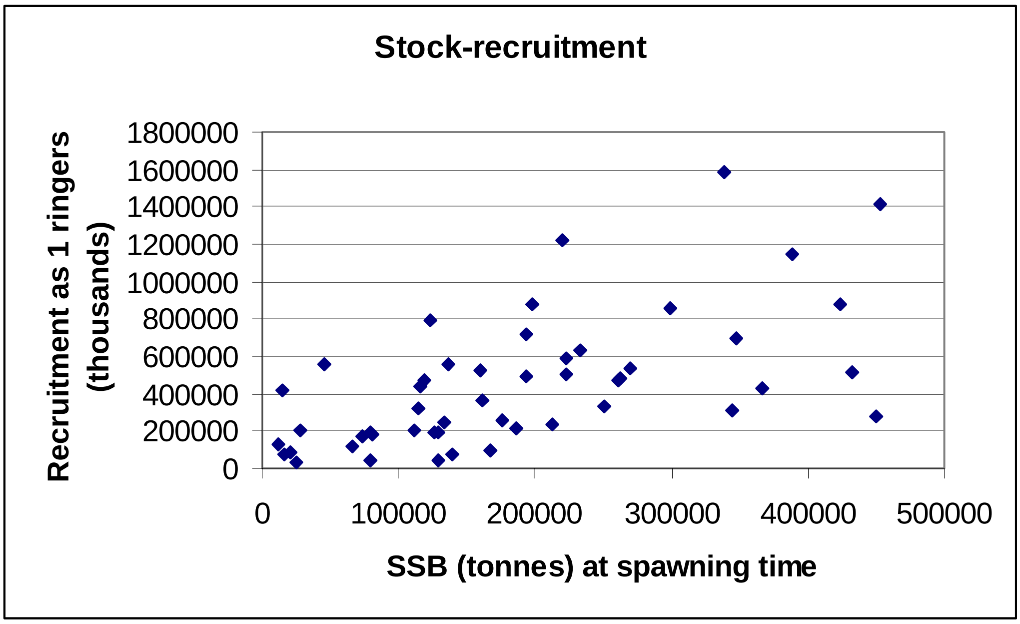


Figure 7.5.1 Fish stock summary. Herring Icelandic summer spawners .



Yield and Spawning Stock Biomass
Yield per recruit
Biomass at spawn. time
grams
grams
160
140
120
100
80
60
40
20
0
2000
1500
1000
500
0
0.0
0.5
1.0
1.5
2.0
Fishing Mortality

Figure 7.7.1



Stock-recruitment
Recruitment as 1 ringers (thousands)
1800000
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
0
100000
200000
300000
400000
500000
SSB (tonnes) at spawning time

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