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Report of the Northern Pelagic and Blue Whiting Fisheries Working Group (WGNPBW)

25 August - 1 September 2005

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Contents

0 Executive Summary

The ICES northern pelagic and blue whiting fisheries working group (WGNPBW) met for 8 days in August 2005 to assess the state of two stocks, blue whiting and Norwegian spring spawning herring. Age-based assessments were carried out for both stocks. The assessment on the blue whithing stock was a full assessment as it is on the observation list while the assessment on the norwegian spring spawning herring stock was an update one. This year the assessments of the Icelandic capelin and the Icelandic summer spawning herring, which in previous year were by done by this working group, were done in spring in the NWWG.

For blue whithing 4 assessment models were used to explore the data. The exploration revealed conflict between catch data and surveys with models relying more on surveys estimating larger spawning stock in recent years. This year a number of recruitment indices were analysed, and the conclusion was that reasonable estimates could be obtained for the most recent yearclasses, in contrast to last year when geometric mean was used for the most recent yearclasses. The assessment was as in many recent years an upward revision of last year assessment.

The group expressed concern about high harvest levels in recent years and also that fishing mortality on the youngest age groups has been increasing in recent years despite the models failing to show this. The harvest levels will be far too high if recruitment will be reduced to earlier levels. Recruitment has been exceptionally good since 1996.

The assessment of Norwegian spring spawning herring was done by the same model as last year. Like last year, two alternating models gave quite different perception of the current stock size. This year's assessment is an upward revision of last year's assessment, but then, the last 5 assessments had been large downward revisions from earlier years. Some problems came up in estimating maturity at age and selection pattern of the big 2002 yearclass that has considerably different spatial distribution from all yearclasses in recent decades.

At ASC last year (2004) there was a proposal to merge the blue whiting and the norwegian spring spawning herring from NPBWWG and the mackerel and the horse mackerel from WGMHSA into one group. The idea behind this is that the fishery is in the same area for mackerel and blue whiting, which are both widely migrating species. The norwegian spring spawning herring is also widely migrating species, even though it does not migrate as south as the other species. All these species feed in the Norwegian Sea. To combine these species into one working group goes along with the regional approach that ICES has taken. The working group discussed this proposal. Mostly the response to this was positive. Some concerns were raised regarding the size of the group though.

The Stock Annexes for the Quality Control Handbook have not been made. They are left for the new working group.

1 Introduction

1.1 Participants

1.2 Terms of Reference

2ACFM07 The **Northern Pelagic and Blue Whiting Fisheries Working Group** [WGNPBW] (Chair: A. Gudmundsdottir, Iceland) will meet at ICES HQ from 25 August to 1 September 2005 to:

a) assess the status of and provide management options for 2006 for the Norwegian spring-spawning herring stock and the blue whiting stock;

b) provide as detailed information as possible on the age/size composition in different segments of the blue whiting fishery;

c) compile existing information on discards and by-catch by the fisheries;

d) enumerate the number, capacity and effort of vessels prosecuting the fishery by country.

e) for the stocks mentioned in a) perform the tasks described in C.Res. 2ACFM01.

WGNPBW will report by 2 September 2005 for the attention of ACFM.

In ToR e) referring to C.Res.2ACFM01 is given below:

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, WGNPBW, AFWG, HAWG, NWWG, and WGPAND will, in addition to the tasks listed by individual group, in 2005:

(1) for stocks where it is considered relevant, review limit reference points (and come forward with new ones where none exist) and develop proposals for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) – following the guidelines from SGMAS (2005) and AMAWGC (2004 and 2005);

(2) comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans;

(3) based on input from WGRED incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem;

(4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;

(5) where misreporting is considered significant provide information on its distribution on fisheries and the methods used to obtain the information

(6) provide for each stock information on discards (its distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessment;

(7) provide on a national basis an overview of the sampling of the basic assessment data for the stocks considered;

(8) provide specific information on possible deficiencies in the 2005 assessments including, at least, any major inadequacies in the data on landings, effort or discards;

any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.

1.3 Methods/software used

Through the years this group has used some softwares for data exploration and assessment of the stocks both separable models and a VPA-type models. These models are: AMCI, ICA, ISVPA, SMS and SeaStar.

1.3.1 AMCI

The assessment model AMCI (Assessment Model Combining Information from various sources), version 2.1, was described in the Working Group report in 2002. For assessments in 2003 AMCI version 2.2 (May 2002) has been used. This version is essentially an updated version of AMCI 2.1 where some known problems have been solved but without important changes in functionality. An updated manual was available for the Working Group. The Working Group on Methods on Fish Stock Assessments explored and evaluated AMCI 2.2, together with ISVPA and an array of other assessment models in their meeting in early 2003 (ICES 2003/D:03). The report of that Working Group can be consulted for more details on AMCI. For the assessment in 2004 a new version was used, AMCI 2.3a. A new version of AMCI, version 2.4 was available for the Working Group and was used.

1.3.2 ICA

ICA (Patterson, 1998) is a separable model over a recent number of years and a conventional VPA over the earlier part of the time series.

1.3.3 ISVPA

ISVPA version is basically the same as was used last year, except that now it can account for surveys in the termina+1 year, and is described in the table below.

Model	**ISVPA**
Version	**2004.3**
Model type	A separable model is applied to one or two periods, determined by the user. The separable model covers the whole assessment period
Selection	The selection at oldest age is equal to that of previous age; selections are normalized by their sum to 1. For the plus group the same mortality as for the oldest true age. No manned inputs.
Estimated parameters	
Catchabilities	The catchabilities by ages and fleets can be estimated or assumed equal to 1. Catchabilities are derived analytically as exponents of the average logarithmic residuals between the catch-derived and the survey-derived estimates of abundance.
Plus group	The plus group is not modelled, but the abundance is derived from the catch assuming the same mortality as for the oldest true age.
SSB surveys	Considered as absolute or relative. If considered as relative, coefficient of proportionality is derived analytically as exponent of the average logarithmic residuals between the catch-derived and the survey estimates of SSB.
Surveys in year	Can be taken into account (in assumption that fishing pattern in the year

(terminal + 1)	(terminal+1) is equal to that of terminal year)
Objective function	The objective function is a weighted sum of terms (weights may be given by user). For the catch-at-age part of the model, the respective term is: • sum of squared residuals in logarithmic catches (SS), or • median of distribution of squared residuals in logarithmic catches MDN(M, fn), or • the median of the distribution of absolute deviations of residuals from their median value - absolute median deviation AMD(M, fn). For SSB surveys it is sum of squared residuals between logarithms of SSB from cohort part and from surveys. For age- structured surveys it is SS, or MDN, or AMD for logarithms of N(a,y) or for logarithms of proportions-at-age, or for logarithms of weighted (by abundance) proportions-at-age.
Variance estimates/ uncertainty	For estimation of uncertainty parametric conditional bootstrap with respect to catch-at-age, (assuming that errors in catch-at-age data are log-normally distributed, standard deviation is estimated in basic run), combined with adding noising to indexes (assuming that errors in indexes are log-normally distributed with specified values of standard deviation) is used.
Other issues	Three error models are available for the catch-at-age part of the model: • errors attributed to the catch-at-age data. This is a strictly separable model (“effort-controlled version”) • errors attributed to the separable model of fishing mortality. This is effectively a VPA but uses the separable model to arrive at terminal fishing mortalities (“catch-controlled version”) • errors attributed to both (“mixed version”). For each age and year, F is calculated from the separable model and from the VPA type approach (using Pope’s approximation). The final estimate is an average between the two where the weighting is decided by the user or by the squared residual in that point. Four options are available for constraining the residuals on the catches: 1. Each row-sum and column-sum of the deviations between fishing mortalities derived from the separable model and derived from the VPA-type model are forced to be zero. This is called “unbiased separabilization” 2. As option 1, but applied to logarithmic catch residuals. 3. As option 1, but the deviations are weighted by the selection-at-age. 4. No constraints on column-sums or row-sums of residuals.
Program language	Visual Basic
References	Kizner Z.I. and D.A.Vasilyev. 1997. Instantaneous Separable VPA (ISVPA). ICES Journal of Marine Science, 54 , N 3: 399-411 Vasilyev, D.A. (2001). Cohort models and analysis of commercial bioresources at information supply deficit. VNIRO Publishing: Moscow. Vasilyev D. 2003. Is it possible to diminish the impact of unaccounted time trends in age structured surveys’ catchability on the results of stock assessment by means of separable cohort models ? ICES CM 2003/X:03. 13 pp. Vasilyev, D. 2004a. Winsorization: does it help in cohort models? ICES CM 2004/K:45. 19 p. Vasilyev, D. 2004. Description of the ISVPA (version 2004.3) WP to ICES WGMHSA (2004), 24 p.

1.3.4 SeaStar

SeaStar 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. Also, a pdf file of the documentation is available from the author and at ICES.

SeaStar is statistically based. All terms in the likelihood function express the probability for the observation, where the expectation value is given by the modelled stock and the variance depends on parameters that are estimated together with the other tuning parameters. This avoids some of the subjectivity often found in assessments, where specific weights must be given to the various time series of data used for tuning. However, subjective choices must be made at various points in the assessment, for instance which tuning data that are to be used or whether outliers should be excluded.

1.3.4.1 Tuning

SeaStar is a traditional back-calculating tuning model using a VPA based on Pope's approximation. If needed, solving the catch equation is implemented in case the model should be used for a stock with high fishing mortality. 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 probability of observing the survey data is calculated and included in 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 used, 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 historic stock is assessed by varying the unknown parameters until the maximum of the likelihood function is reached. The parameters that usually are varied (free parameters, tuning parameters) are:

Catchabilities for the tuning data

Uncertainty parameters for the data

Tagging survival

Terminal F-values

SeaStar provides for basing the likelihood only on the strongest year classes (here referred to as tuned 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 stabilize the tuning by avoiding bias from large relative errors in the catch in the terminal year 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. However, in recent years the practice has been to include all year classes that reside in the Barents Sea in the tuning, so that the latter feature is of no consequence for the assessment. The choice of tuned year classes is subjective. Of importance is to avoid the weakest year classes. The Norwegian spring spawning herring has extremely dynamic recruitment and most often the choice is rather obvious.

In SeaStar it is possible to perform the estimation in separate steps, where during one step the parameters estimated in the previous steps may be used, and new parameters can be estimated.

This feature is used for Norwegian spring spawning herring in order to first fit the adult part of the stock to the main tuning series in the Norwegian Sea and along the Norwegian coast. Keeping this part of the stock fixed the young part of the stock is estimated using survey series from the Barents Sea, which are considered more uncertain. The advantage is that the uncertain data from the Barents Sea then will not influence the estimate of the adult stock, that is of the larger importance in the short term. The adult year classes at ages 1 and 2 enter into the likelihood terms for the Barents Sea data, though, in order to provide a better basis for the estimation of catchabilities for those data.

The most important output variable is the estimated spawning stock in the assessment year, which is calculated on the basis of number at age, weight at age and maturity at age at January 1 in the assessment year. Number at age is taken from the VPA by calculating forward one year using the catch information in the last year. Weight at age and proportion mature at age in the assessment year are input data. However, it is assumed that the spawning occurs timeBeforeSpawning part of a year into the assessment year and in order to calculate the decrease until spawning time the same F as in the last year of catch is assumed also to apply for the assessment year. However, for the short term projection the WG also will assume that a fixed catch of catchAssessmentYear million tonnes will be taken in the assessment year, which may correspond to a somewhat different F.

The number of fish in the plus group is calculated as the sum of the number of fish in the oldest true age group and in the plus group the year before, reduced by natural mortality and catch. By applying the customary natural mortality of 0.15 also for the plus group, the smallest spawning stock biomass in the 1970s was about 0.5 million tonnes, which has been perceived as far to much concerning the collapsed state of the herring at that time. Thus, this year SeaStar was provided with the option of an increased natural mortality in the plus group. By setting this to 0.5 the smallest spawning stock in the 1970s is acceptable small. This did not lead to any appreciable reduction of present spawning stock biomass.

1.3.4.2 Catchabilities

When SeaStar is used for tuning Norwegian spring spawning herring, flat catchabilities (scalars) are used for fish that have recruited to the survey, i.e. fish that are older than a threshold age specified for each survey. However, there are provisions for making the catchabilities dependent on age as well as on cohorts.

1.3.4.3 Calculation of the plus group

In SeaStar, the numbers in the plus group is calculated as the number in the plus group the year before plus the number in the oldest true age group the year before, adjusted for M in the plus group and catch the year before. Thus, no assumption about the F-value in the plus group is needed. However, with low M-value on the plus group, the number of fish in the plus group may accumulate to unrealistic levels.

1.3.4.4 Analysis of assessment uncertainty using bootstrap

The analysis of assessment uncertainty is done using bootstrap. The assessment is run many times, each time new data sets are generated by resampling from the original data set.

1.3.4.5 Surveys

The surveys are resampled from the distribution that is assumed when the likelihood function is constructed, based on the unperturbed surveys.

1.3.4.6 Tagging

The number of tags recovered are sampled from the same distribution as assumed when the likelihood function is evaluated, i.e. Poisson. The number of fish screened for tags is assumed normally distributed with a CV specified in the input data list. The uncertainty in the number of screened fish stems from uncertainty regarding the amount of fish screened and uncertainty in the calculation of number at age screened form biological samples taken from the catch. The number of tagged fish released is also assumed uncertain where a normal distribution with a CV specified in the input data list is assumed.

1.3.4.7 Catch

The catches are considered certain so there is no distribution from which to draw catch data. The best method would be to base the catch data bootstrap on the biological samples used for distributing the catch on age. However, a possibly large source of error in the age distribution of the catch data comes from using biological samples from one space-time domain on catches from another space-time domain. This is necessary because of inadequate biological sampling of the catch from the countries involved in the fishery. The associated error cannot be dealt with however without implementation of the biological samples from all countries and using a time-space model of the fish distribution. This is an important but large project that ideally should be a joint effort of the countries involved.

When SeaStar is used for tuning Norwegian spring spawning herring it is assumed that the error is catch stems from misreading the age by one year. For two neighbouring age groups with number at age of stock1 and stock2 (as based on the unperturbed assessment) the catch to transfer is calculated as:

$$transferred = \max Transfer \frac{Abs(stock1 - stock2)}{stock1 + stock2}$$

where maxTransfer is a setting.

1.3.4.8 Larvae

The larval data are resampled from the assumed distribution.

1.3.5 SMS

SMS (**S**tochastic **M**ulti **S**pecies model; Lewy and Vinther, 2004) is an age-structured multi-species assessment model which includes biological interactions. However, the model can be used with one species only. In “single species mode” the model can be fitted to observations of catch-at-age and survey CPUE. SMS uses maximum likelihood to weight the various data sources assuming a log-normal error distribution for both data sources. The likelihood for the catch observation is then as defined below:

$$L_C = \prod_{a,y,q} \frac{1}{\sigma_{catch}(aa)\sqrt{2\pi}} \exp\left(-\left(\ln(C(a,y,q)) - \ln(\hat{C}(a,y,q))\right)^2 / (2\sigma^2_{catch}(aa))\right)$$

where C is the observed catch-at-age number, $\hat{C}$ is expected catch-at-age number, y is year, q is quarter, a is age group, and aa is one or more age groups.

SMS is a “traditional” forward running assessment model where the expected catch is calculated from the catch equation and F-at-age, which is assumed to be separable into an age selection, a year effect and a season (year, half-year, quarter) effect.

As an example, the F model configuration is shown below for a species where the assessment includes ages 0–3+ and quarterly catch data and quarterly time step are used:

$$F = F(a_a) \times F(y_y) \times F(q_q),$$

with *F*-components defined as follows:

F(*a*):

Age 0	Fa_0
Age 1	Fa_1
Age 2	Fa_2
Age 3	Fa_3

F(*q*):

	q1	q2	q3	q4
Age 0	0.0	0.0	Fq	0.25
Age 1	$Fq_{1,1}$	$Fq_{1,2}$	$Fq_{1,3}$	0.25
Age 2	$Fq_{2,1}$	$Fq_{2,2}$	$Fq_{1,3}$	0.25
Age 3	$Fq_{3,1}$	$Fq_{3,2}$	$Fq_{3,3}$	0.25

F(*y*):

Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	…
1	Fy_2	Fy_3	Fy_4	Fy_5	Fy_6	Fy_7	Fy_8	Fy_9	….

The parameters $F(a_a)$, $F(y_y)$ and $F(q_q)$ are estimated in the model. $F(q_q)$ in the last quarter and $F(y_y)$ Fy in the first year are set to constants to obtain a unique solution. For annual data, the $F(q_q)$ is set to a constant 1and the model uses annual time steps.

One *F*(*a*) vector can be estimated for the whole assessment period, or alternatively, individual *F*(*a*) vectors can be estimated for subsets of the assessment periods. A separate *F*(*q*) matrix is estimated for each *F*(*a*) vector.

For the CPUE time series the expected CPUE numbers are calculated as the product of an assumed age (or age group) dependent catchability and the mean stock number in the survey period.

The likelihood for CPUE observations, L_S, is similar to L_C, as both are assumed lognormal distributed. The total likelihood is the product of the likelihood of the catch and the likelihood for CPUE ($L = L_C * L_{\text{CPUE}}$,). Parameters are estimated from a minimisation of -log(*L*).

The estimated model parameters include stock numbers the first year, recruitment in the remaining years, age selection pattern, and the year and season effect for the separable *F* model, and catchability at age for CPUE time series.

SMS is implemented using the Ad-model builder **(**Otter Research Ltd.), which is a software package to develop non-linear statistical models. The SMS model is still under development, but has extensively been tested in the last year on both simulated and real data.

SMS can estimate the variance of parameters and derived values like average *F* or SSB from the Hessian matrix. Alternatively, variance can be estimated by using the built-in functionality of the AD-Model builder package to carry out Markov Chain Monte Carlo simulations (Gilks et al. 1996), MCMC, to estimate the posterior distributions of the parameters. For the historical assessment, period uniform priors are used. For prediction, an additional stock/recruitment relation including CV can be used.

2 Ecological considerations

2.1 Ecosystem overview

2.1.1 Barents Sea

An overview of the ecological status of the Barents Sea in 2005 is given by the AFWG (ICES 2005).

2.1.2 Norwegian Sea

2.1.2.1 Hydrography and climate

The Nordic Seas (Fig. 2.1.2.1.1) 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 (EIC) and also to some extent by the Jan Mayen Current. 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. From mid 1960's the winter North Atlantic Oscillation index (NAO) has increased to beginning of the 1990s followed by a reduction to the long-term-mean (Fig. 2.1.2.1.2). NAO 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. In winter 2005 the index was about normal. However, a closer look into the monthly values shows that the NAO index for the winter 2005 was relatively high in both December and January but low in February and March. The high values in December-January during winter 2005 can then explain the more eastward displacement of the EIC in 2005 compared to 2004 (see below).

The Institute of Marine Research, Norway, has measured temperature and salinity in three standard sections in the Norwegian Sea almost regularly since 1978. 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.

Figure 2.1.2.1.2 shows the development in temperature and salinity in three different sections from south to north in the Norwegian Sea. During the last 10 years the temperature and salinity in the Svinøy section have increased linearly. The temperature was in 2005 above normal but still less than in 2002-2004 that were the three warmest years in the time series. In 2005 the salinity in the Svinøy section had the largest value in the time series, about 0.09 above normal. Unfortunately some data are missing in the Gimsøy and Sørkapp sections during the last years. In 2004 for both sections the temperature and salinity were above the long-term-means.

The area of Atlantic water (defined with S>35.0) in the Svinøy-section has been calculated. The mean temperature within the limited area has also been calculated, and the results for both spring and summer are shown in Fig. 2.1.2.1.3. There are considerable variations both in the area of Atlantic water distribution and its temperature. The temperature has shown a steady increase and since 1978 the Atlantic water has been about 0.7^{o}C warmer (linearly). During the years 1992-1995 the area was much smaller than average for both seasons, probably due to strong westerly winds. The summer temperature had the three largest values in the time series during 2002-2004 but in 2005 it dropped, close to the long-term-mean. The area of Atlantic water was in 2005 above, but close to, the long-term-mean for both spring and summer.

During research cruises in May with the aim of measuring the stock size of pelagic fishes, hydrographic observations are also taken, covering most of the Norwegian Sea (figures are not shown). In May 2005 there was a larger influence of Arctic water in the southern Norwegian Sea compared to 2004, probably due to stronger westerly winds in December-January compared to last year. In the eastern part of the Norwegian Sea it was reported that the Atlantic Water was about 0.5-1.0^{o}C colder in 2005 than in 2004. A research cruise was also performed in the northern Norwegian Sea during August 2005. Compared to 2003 the Atlantic water in August 2005 was considerable warmer (about 1^{o}C).

Conclusions:

- The winter NAO index in 2005 was close to but still lower than normal. However, the index was relatively large in December-January.
- In 2005, there was an increased influence of Arctic water, from the EIC, in the southern Norwegian Sea compared to 2004.
- In the eastern Norwegian Sea the Atlantic Water was about 0.5-1.0^{o}C colder in May 2005 compared to May 2004.
- In August 2005, the salinity in the core of Atlantic Water (at the slope, near the shelf) in the Svinøy section was record high, about 0,09 above the long-term-mean.
- The summer temperatures of Atlantic Water in the Svinøy section have been the highest ever during 2002-2004 but in 2005 it dropped but was still above the long-term-mean.
- The averaged summer temperature of the Atlantic Water in the Svinøy section has increased linearly with approximately 0.7°C since 1978.

2.1.2.2 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. The Institute of Marine Research, Norway, started in 1990 a long-term study of the mechanisms controlling the development of phytoplankton at Ocean Weather Station Mike situated at 66°N, 2°E. It was not possible to get data from 2004 and 2005 ready for this report.

Figure 2.1.2.2.1 shows the development of the phytoplankton bloom for 2003 expressed as chlorophyll a concentration at the surface. In previous years there has been 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. In all these years a strong peak has characterized the bloom. The situation in 2001 was different to previous years. First, the spring bloom started somewhat later (first week of May) compared to 1998 and 1999 and was followed by relatively moderate chlorophyll concentrations culminating with a major peak in the first week of June. Also a distinct early autumn bloom was observed in the middle of August. In 2002 the springbloom started to develop in the middle of April reaching its maximum at the end of April, resulting in one of the earliest bloom second only to the bloom in 1998. The 2003 bloom also maintained relatively high chlorophyll concentrations for about a month after the first peak on May 8 to decrease rapidly afterwards. After the main spring bloom four other smaller blooms were observed throughout the summer and early autumn.

The 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.

Figure 2.1.2.2.2 shows the extension in time for these two phases and the timing of the spring bloom for the period 1991-2003. 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 but with a trend towards earlier blooms again after 2001.

Conclusions:

- The phytoplankton bloom in 2003 developed earlier than the average since 1991, third only to the 1998 and 2002 blooms.
- Chlorophyll *a* concentrations first peaked in the first week of May 2003 and were maintained at relatively high levels until the first week of June resulting in the longest bloom in the time series. This could, as in 2002, have been the result of a relaxation in the grazing pressure.
- During summer and early autumn of 2003 several peaks of relatively high chlorophyll *a* concentration were observed indicating a strong variability in minor blooms.

2.1.2.3 Zooplankton

Zooplankton biomass distribution in the Norwegian Sea has been mapped annually in May (since 1995) and in July (1994-2002). The sampling in July probably will be resumed in 2006. Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report zooplankton 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 (defined by 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. 2.1.2.3.1). In Atlantic and Arctic water masses zooplankton biomass decreased to a minimum in 1997. Thereafter zooplankton biomass increased again and remained relatively high except for a temporary reduction in 2001. After 2002 there has been a continuous reduction and in 2005 the second lowest biomass during the time series was measured. Due to reduced cruise time the Arctic water mass was not sampled in 2001 and 2004. Zooplankton biomass in Arctic water is generally higher than in Atlantic and coastal water, but in 2002 and 2005 the biomass in Arctic and Atlantic water equalled. In 2005 the highest biomass of the Norwegian Sea was found in coastal water. In the coastal water mass, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the temporal pattern of variation in biomass is different from the other two water masses.

In July the total zooplankton biomass (g dry weight m^{-2}) in the upper 200 m was calculated by integrating biomass at sampling stations within a selected area in the central and eastern Norwegian Sea. There is no obvious trend in the zooplankton biomass in July since 1994 (Figure 2.1.2.3.2).

Conclusions:

- Average zooplankton biomass in Atlantic water masses of the Norwegian Sea in May 2005 was much lower than average and the second lowest for the time series.
- Biomass in coastal water in 2005 was for the first time higher than in Arctic and Atlantic water.

2.1.2.4 Predictions for zooplankton biomass

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 average biomass of zooplankton in Atlantic water in May is fairly well correlated with the average NAO for the March-April period the previous year (Fig. 2.1.2.4.1). However, the model has consistently overestimated the biomass since 2003. This may be related to changes in the processes underlying the relationship, however, changes in for example the area covered by the Norwegian vessel during the international Norwegian Sea survey is another possible reason. March-April is the period when the primary production in the Norwegian Sea is initiated and the major reproductive period for many important zooplankton species such as *Calanus finmarchicus* and krill. The one-year lag in the relationship may be because we in May mainly measure the size of the overwintering stock, i.e. the previous years production and the present years spawning stock. Based on this relationship the biomass for May 2006 is estimated at 10.9 g dry weight m^{-2}. Due to the tendency towards overestimation by the model during the last years, we perceive this as an overestimate as well.

*Biomass (yr2) = 2.23*NAO yr1+10.54* (1)

$R^2=0.47, P=0.02$

Conclusions:

- The average NAO for March-April the previous year is directly related to zooplankton biomass in May and herring condition in the autumn.
- The biomass of zooplankton in 2006 is predicted at 10.9 g dry weight m^{-2} by the model, but is expected to be somewhat lower.

2.1.3 Icelandic waters

2.1.3.1 Hydrography and climate

As Iceland is situated at a meeting place of warm and cold currents its waters are characterised by highly variable conditions especially in the area north and northeast of the country. Heat and salt content in those waters depend on the strength of Atlantic inflow through the Denmark Strait and the variable flow of polar water from the north with the East Icelandic Current. South and west of Iceland fluctuations are smaller.

Climatic conditions in the North Atlantic improved around 1920 and remained rather warm until the mid-1960s, when they deteriorated. 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 off north and east of Iceland improved, but were variable and years have alternated with cold years (Fig. 2.1.3.1.1).

Salinity and temperature increased in 1997 west of Iceland and have remained high. This increase in the Atlantic character of the Irminger Current reached into the northern area and peaked in 1999 and prevailed until winter and spring 2002 when a rather short period of polar influence was observed. In summer 2002 a persistent inflow of Atlantic water started and kept on throughout the year 2003 with little winter cooling which resulted in a record year in temperature and salinity north and east of Iceland. Observations in February 2004 showed continued influence of Atlantic water in the northern and eastern area with stronger winter cooling and high salinities.

Temperature in the warm Atlantic waters south and west of Iceland in 2005 was 5-7˚C and salinity 35.10-35.27, i.e. high values like during the last years. There was a considerable Atlantic inflow eastwards onto the N-Icelandic shelf, reaching to the east of Melrakkasletta. However, there was a fresh and moderately warm surface layer over most of the Atlantic water, north, northeast and east of Iceland – remains of the ice which drifted east off the north coast earlier this spring. Nevertheless, both temperature and salinity in the upper layers were around or higher than the long term average north of Iceland, but somewhat lower than during most recent years.

In the East Icelandic Current outside the shelf edge northeast of Iceland, temperature and salinity were near the long-time average, while the southern limit of the ‘cold tongue’ reached further south than during the last years. East of Iceland, temperature and salinity in the upper layers were 2-3˚C and 34.5-34.9 respectively, which is somewhat colder than in the last years.

2.1.3.2 Zooplankton

In the area north of Iceland, zooplankton biomass tends to be higher in years with strong inflow of Atlantic Water than in years when Atlantic inflow is weak, and lower salinity in the surface layers slows or prevents vertical mixing. A strong inflow of Atlantic water to the north Icelandic area was observed both during November 2002 and February/March 2003. The relatively high zooplankton biomass off the central north coast in spring 2003 is in line with this (Fig. 2.1.3.2.1).

In spring 2003, the zooplankton biomass for the whole Icelandic area was slightly below the long-term average. West of Iceland zooplankton biomass was near average, but slightly below the long term mean south and east of Iceland. The copepod *Calanus finmarchicus* was generally the dominant zooplankton species in the offshore areas, except in the Arctic East Icelandic current northeast of Iceland, where the arctic copepod *C. hyperboreus* dominated the biomass.

As mentioned above, a continued strong inflow of Atlantic water to the north Icelandic area was observed during last years surveys. On the whole, the zooplankton biomass in Icelandic waters in 2005 was above average. South and west of the country the biomass was near average, but considerably higher off the north and east coasts. As compared to 2004 the zooplankton biomass was higher on most stations.

The NSSP herring which migrated west onto the East-Icelandic shelf south of the cold tongue (approx. 64˚50’) in late May-early June 2005 was feeding heavily and could easily have stayed on should she have so wished. According to the fishery these herring, however, backed again to the SE in the 2. week of June, but no systematic search of the area was conducted after that.

2.1.4 Hydrography of the waters west of the British Isles

Hydrographic data have been collected during surveys in the spawning season of blue whiting in spring. The mean temperature and salinity from 50 to 600m of all the stations in deep water (bottom depth>600m) in 2° latitude times 2° longitude boxes have been calculated for each survey. The box with limits 52° to 54°N and 16° to 14°W had few gaps, and the time series of mean temperature and salinity for this box is shown in Figure 2.1.4.1. The pattern seen is that after some years with temperatures around 10.1°C in the 1980s, it dropped to a minimum in 1994 (~9.8°C). After 1994 an increase in temperature is seen, and in 1998 temperature reached a local maximum (~10.5°C) with the three following years a few tenths of a degree colder. 2002 was a warm year with ~10.7°C, and in 2003 the temperature dropped to (~10.5°C). 2004 was the warmest on record (~10.8°C), but 2005 (~10.4°C) is colder than the three preceding years. This is above the long-term average, but about average for the last 10 years. The increase in temperature coincides with the increase in recruitment of blue whiting. However, it is not know whether there is a causal relationship between hydrographic conditions and recruitment of blue whiting.

2.2 Ecosystem impact on the fish stocks

2.2.1 Norwegian spring spawning herring

Feeding and growth

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 2.2.1.1). 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 low level observed during the period 1935 – 1994 (Dr. scient. thesis J.C. Holst 1996, University of Bergen). Following a recovery during 1998 and 1999, the condition of the herring decreased again. During 2001 to 2004 the condition remained at a low level, but slowly increasing.

Since 1995, 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, and the herring condition index obtained after the feeding period in the Norwegian Sea is related to average zooplankton biomass of Atlantic water (Fig. 2.2.1.2). To improve this relationship herring feeding areas should be defined more precisely, because large variations in herring migration routes and in zooplankton distribution have been observed over the years. Extreme changes in migration occurred during the summers 2004 and 2005 when increasing amounts of herring started to feed in the southwestern Norwegian Sea, towards the east coast of Iceland. At the same time we observed that increasing numbers of herring were not overwintering in the fjords of northern Norway, but in the deep waters off the shelf. The herring which are still overwintering inside the fjords had much higher condition than the herring outside, probably due to differences in migration route and feeding conditions between the two groups of overwintering herring. We have used the condition factor of the herring outside the fjord in Fig. 2.2.1.2 (see also 3.9).

A regression of herring condition on the two-months average of the NAO indices showed that the relationship was strongest between herring condition and the NAO during the March-April period (Fig. 2.2.1.3). The prediction for 2005 based on equation (2) is 0.84, and for 2006, 0.82, somewhat above and below average, respectively. The condition factor for 2004 was calculated for the fraction of the stock overwintering outside the fjords, and the predictions for 2005 and 2005 are probably valid only for the same part of the stock (see 3.9).

*Condition (yr2) =0.022*NAO yr1+0.82* (2)

$R^2=0.51, P=0.004$

Recruitment

Predictions of the recruitment in fish stocks are essential for future harvesting of the fish stocks. Traditionally, prediction methods have not included effects of climate variability. Multiple linear regression models can be used to incorporate both climate and fish parameters. Especially interesting are the cases where there exists a time lag between the predictor and response variables as this gives the opportunity to make a prediction. A model for the number of three year old recruits of Norwegian spring spawning herring using the herring 0-group log index and the NCEP skin temperature describes ~80 % of the variation in the recruitment (Figure 2.2.1.4).

The model is:

$$\mathrm{Re}\,c_t = 8.3 \times skin_{t-3} + 16 \times 0group_{t-3} - 44$$

where Rec is the number (in 10^9) of 3 year old recruits of Norwegian spring spawning herring from the WGNPBW 2003 SEASTAR assessment (ICES 2004), skin the NCEP skin (sea surface) temperature in degree C in the Norwegian Sea (64 -70°N, 6°W – 8°E) averaged from January to March 3 years earlier and 0group the 0-group log index of herring larvae from the survey in the autumn 3 years earlier. The subscripts denote the time lag in years. Further details can be found in Stiansen *et al.* (2002).

The dominant variable in the model is the 0-group index, which has a correlation coefficient of 0.84 with the Recruitment (3 years later). When the model was tested on the 0-group index alone it gave an R^2 of 0.71. Still the model explained 9 % more of the variability when adding the skin temperature.

The prognosis shows a steady increase in recruitment for the period 2005-2007, ending at a historic high level in 2007 (Recruits 3 years old: 2005 – $9.9*10^9$, 2006 – $15.8*10^9$, 2007 – $26.8*10^9$).

Conclusions:

- Herring condition was lower than average for the time series in 2005.
- There is a weak relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-2005.
- The March-April NAO index for 2004 and 2005 predicts the herring condition index at 0.84 in the winter 2005 and at 0.82 in the winter 2006.
- Recruitment is predicted to increase during the period from 2005 to 2007.

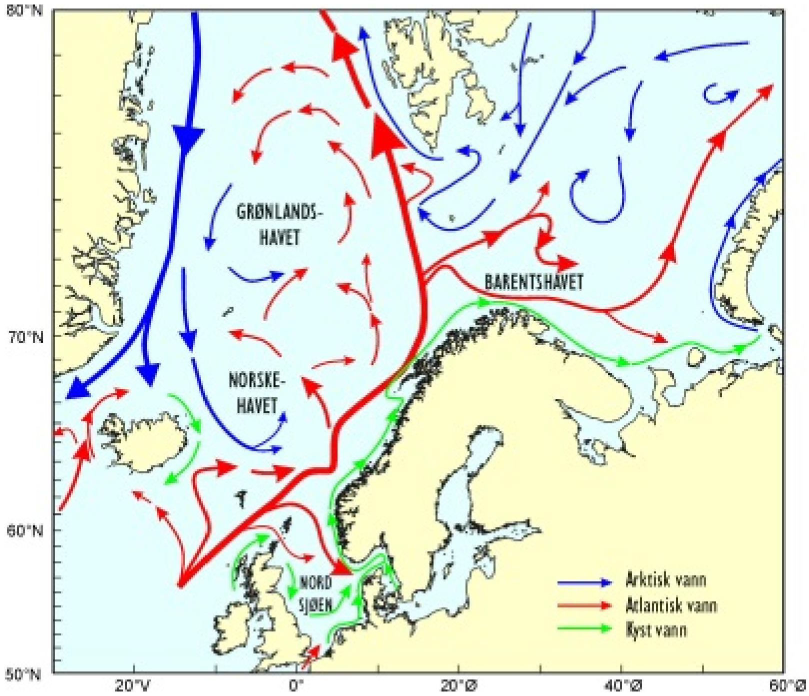

Figure 2.1.2.1.1. Main surface currents of the Nordic Seas.

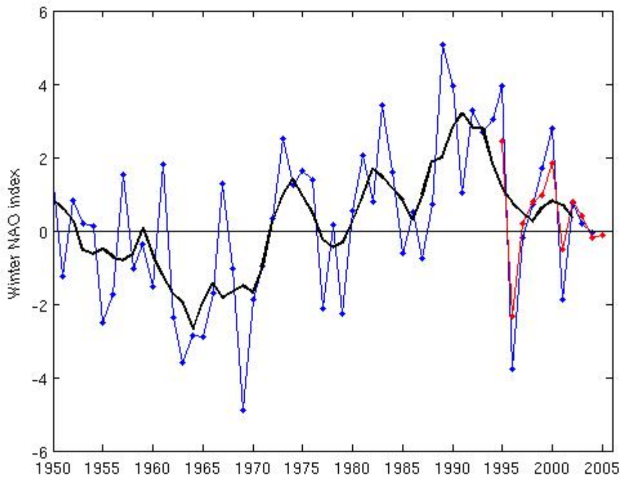

Figure 2.1.2.1.2. Hurrell's winter NAO index (Lisbon-Stykkisholmur/Reykjavik), from 1950 to 2004 (blue line), and Osborn's winter NAO index (Gibraltar-Southwest Iceland) from 1995 to 2005 (red line). Black line is 5 years moving averages.

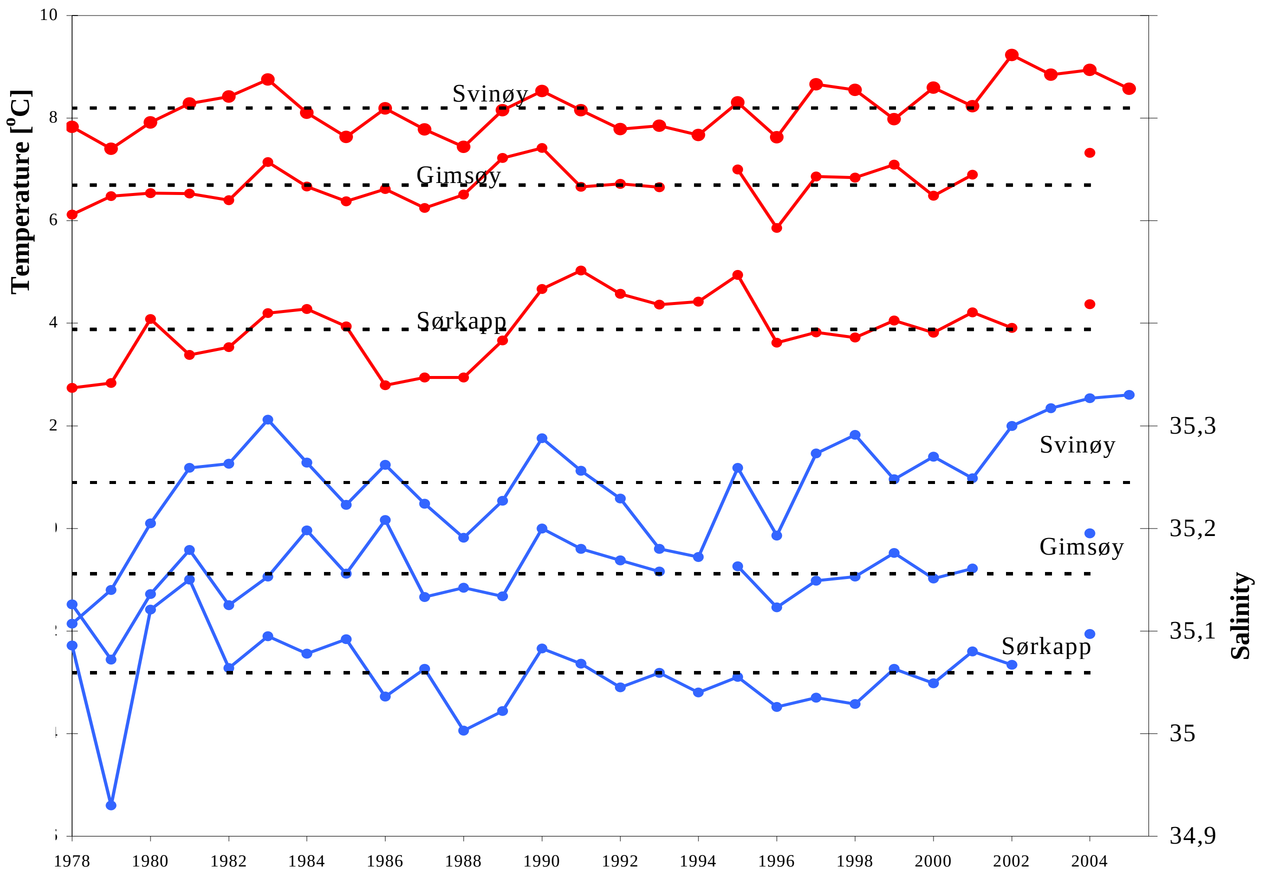

Figure 2.1.2.1.2. Temperature (°C) and salinity observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.

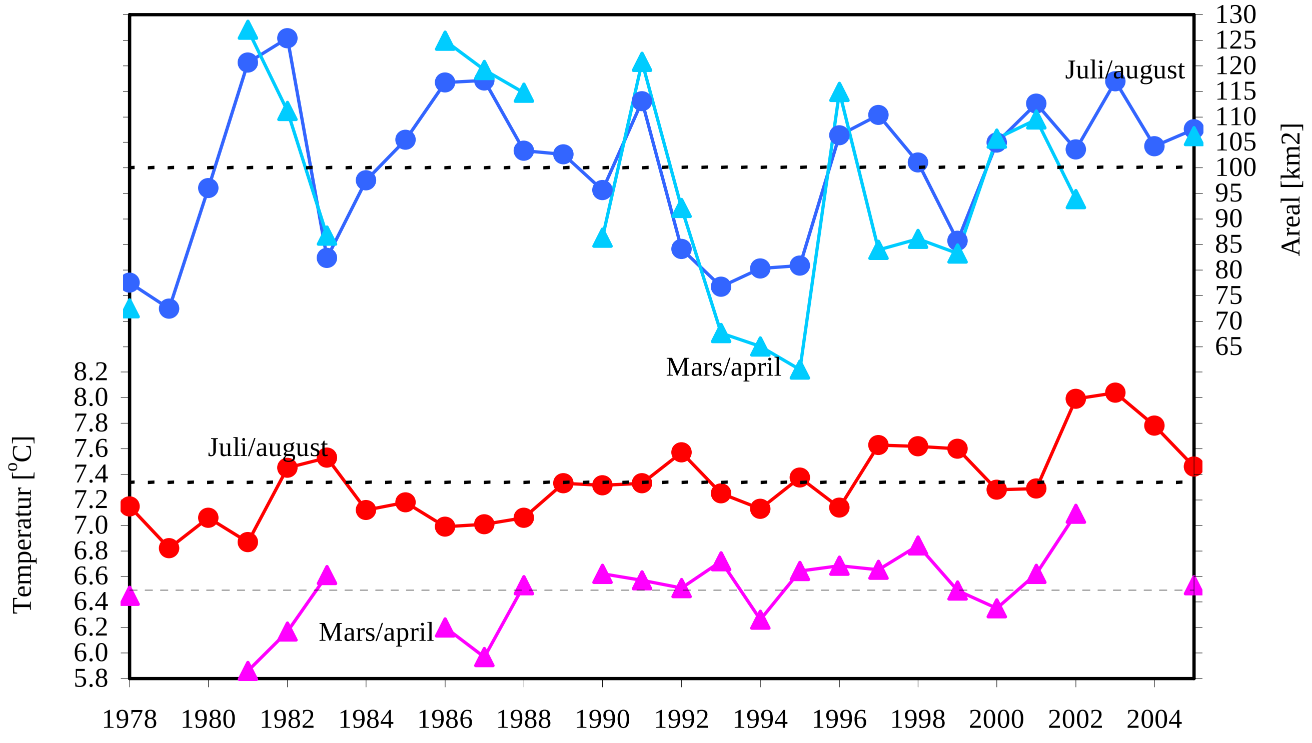

Figure 2.1.2.1.3. Time series of area (blue, in km2) and averaged temperature (red/pink) of Atlantic water in the Svinøy section, observed in March/April (triangles) and July/August (dots) 1978-2005.

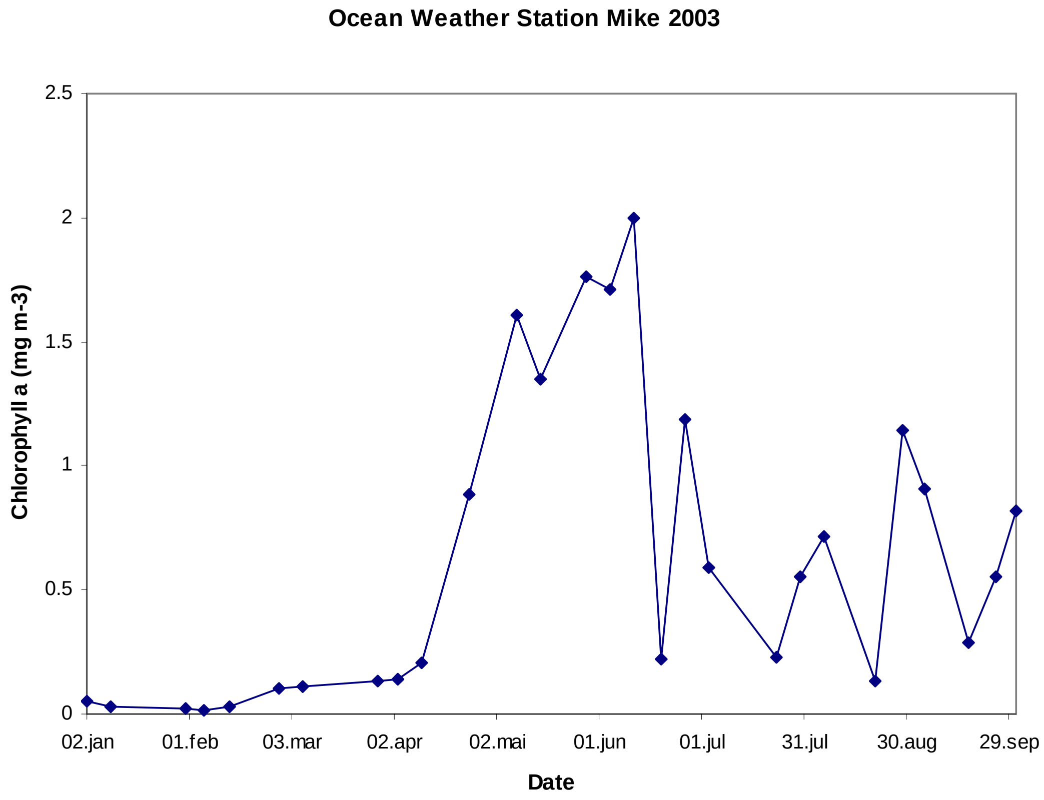

Figure 2.1.2.2.1 Distribution of chlorophyll a at 10 m depth during the year at Weather Station Mike in 2003.

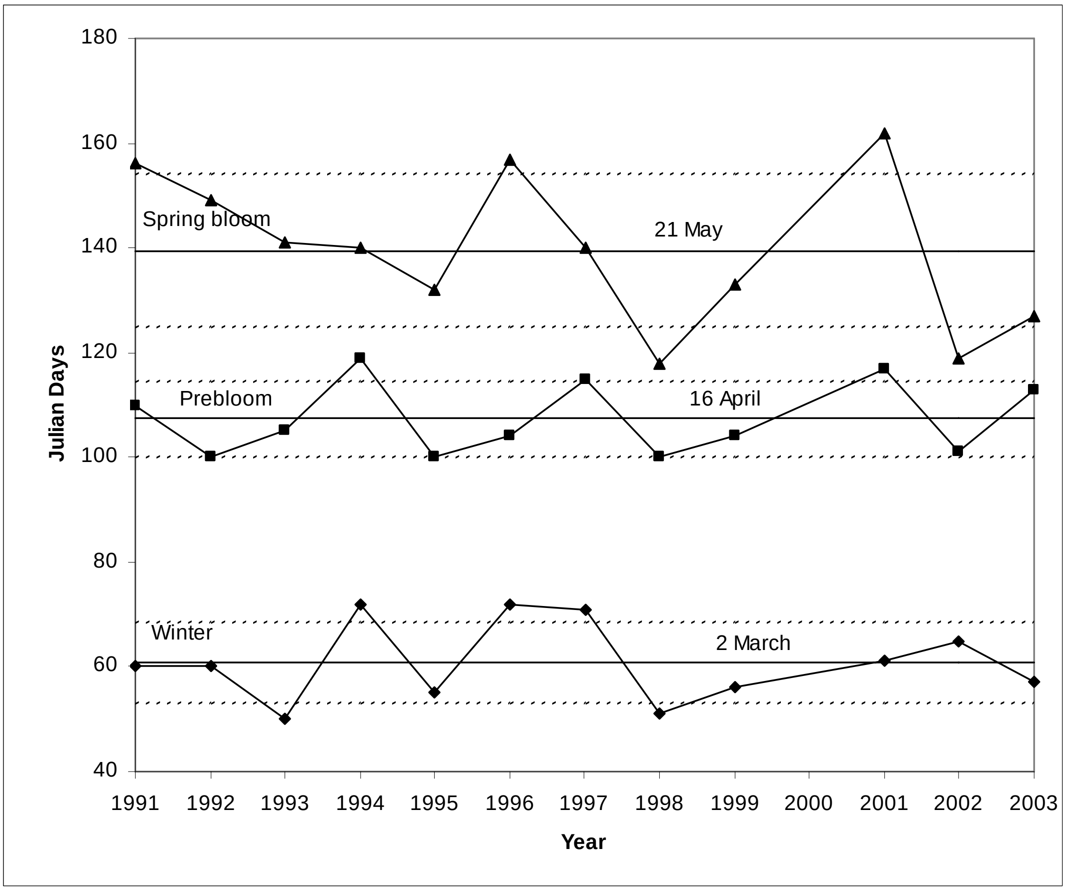

Figure 2.1.2.2.2 Year to year variations in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 2003. Diamonds: winter phase; squares: pre-bloom phase; triangles: spring bloom. Continuous lines represent the average for each phase. Broken lines represent one standard deviation for each phase.

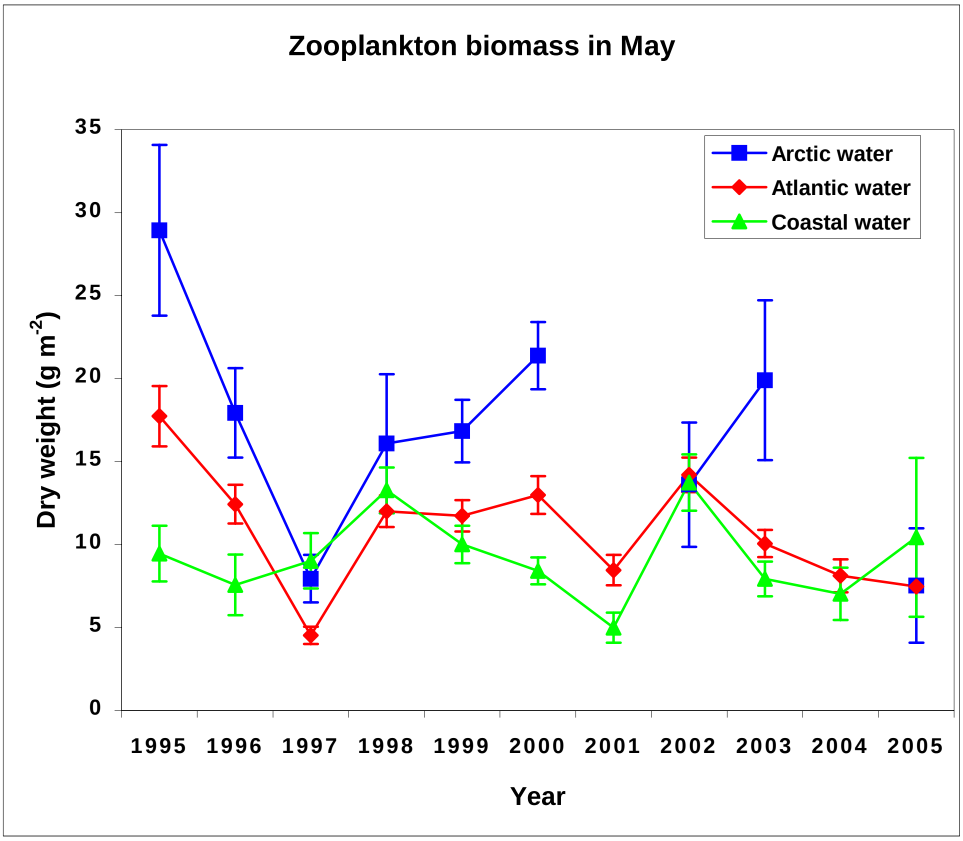

Figure 2.1.2.3.1 Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

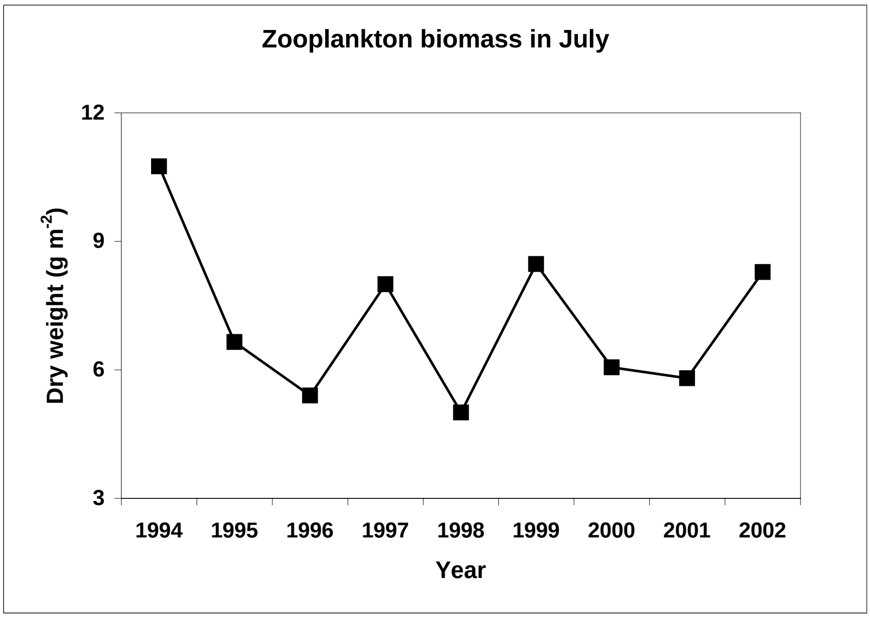

Figure 2.1.2.3.2 Zooplankton biomass in July-August in the eastern Norwegian Sea (0-200 m). Integrated biomass within a fixed geographical region divided by its area.

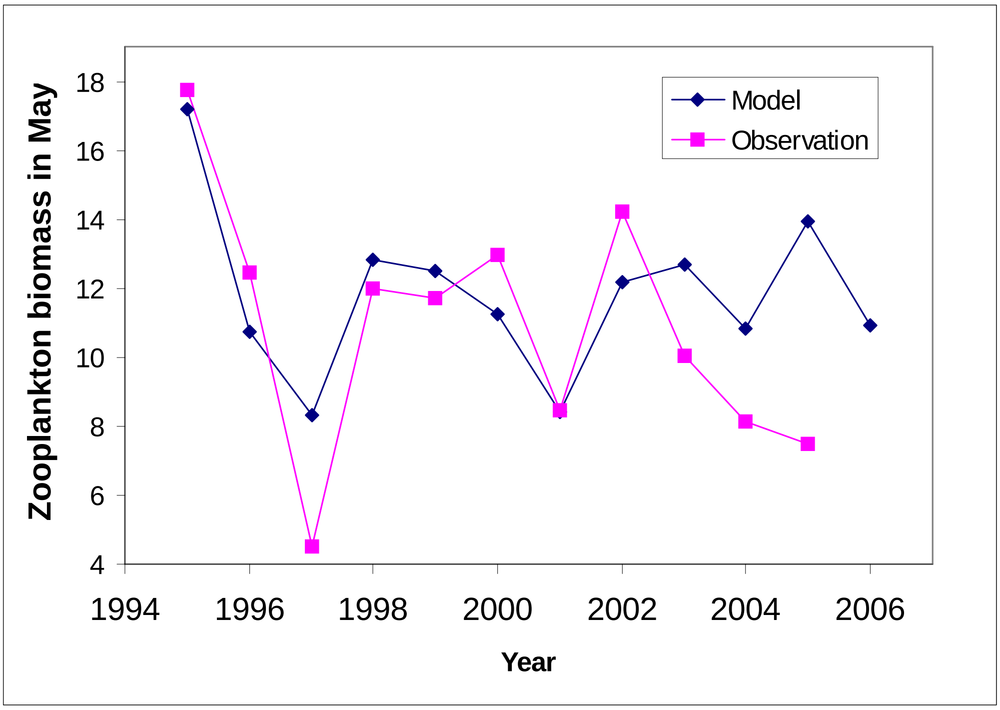

Figure 2.1.2.4.1. Zooplankton biomass in May, observed and modelled. Model: Biomass (yr2) = 2.23*NAO yr1+10.54. R2=0.47, P=0.02. The model predicts a biomass of 10.59 g dry weight m-2 for May 2006.

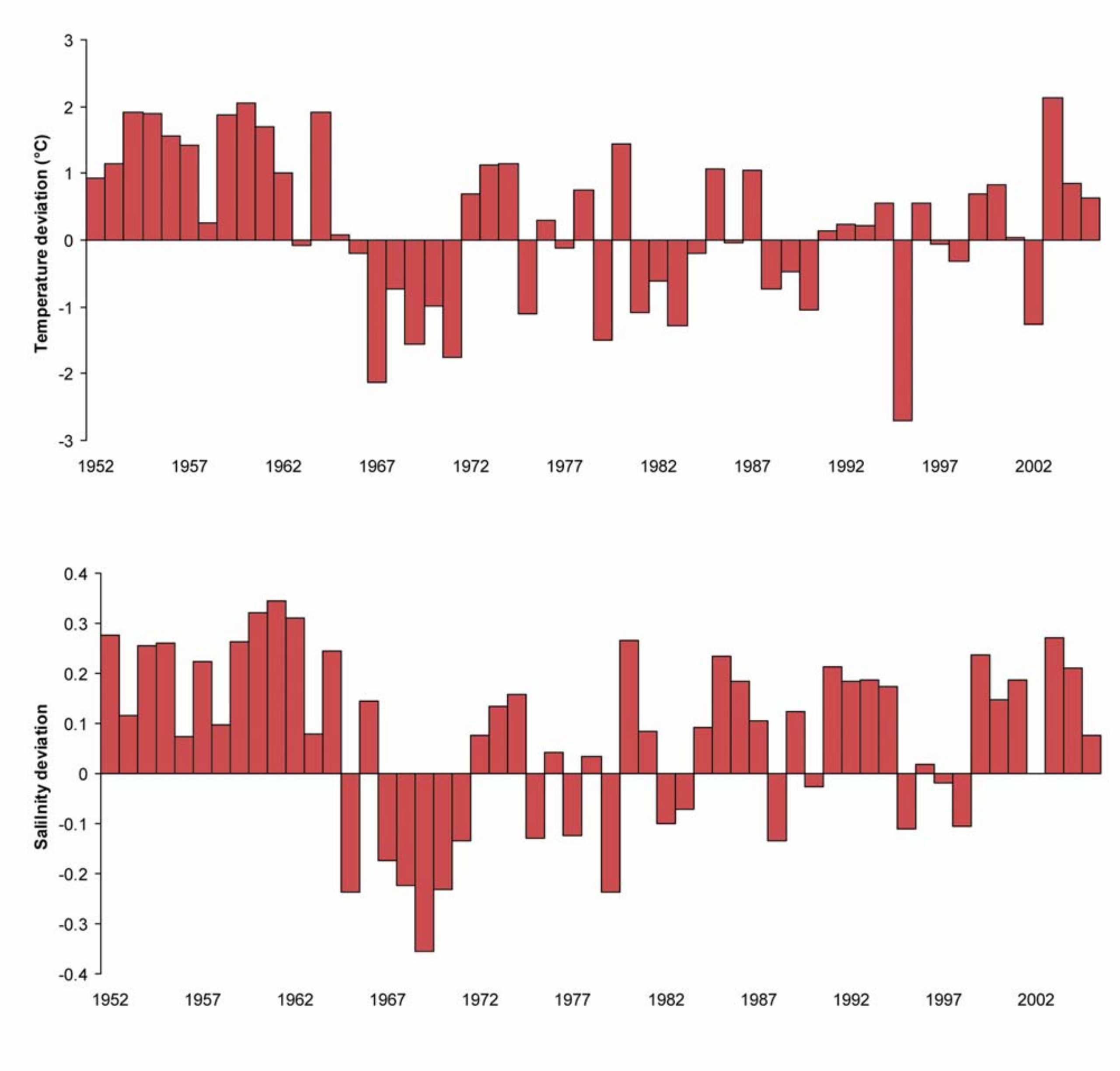

Figure 2.1.3.1.1. Temperature and Salinity deviations on the Siglunes section north of Icleand, mean for stations 1-5 and 0 – 200m, 1952 – 2003.

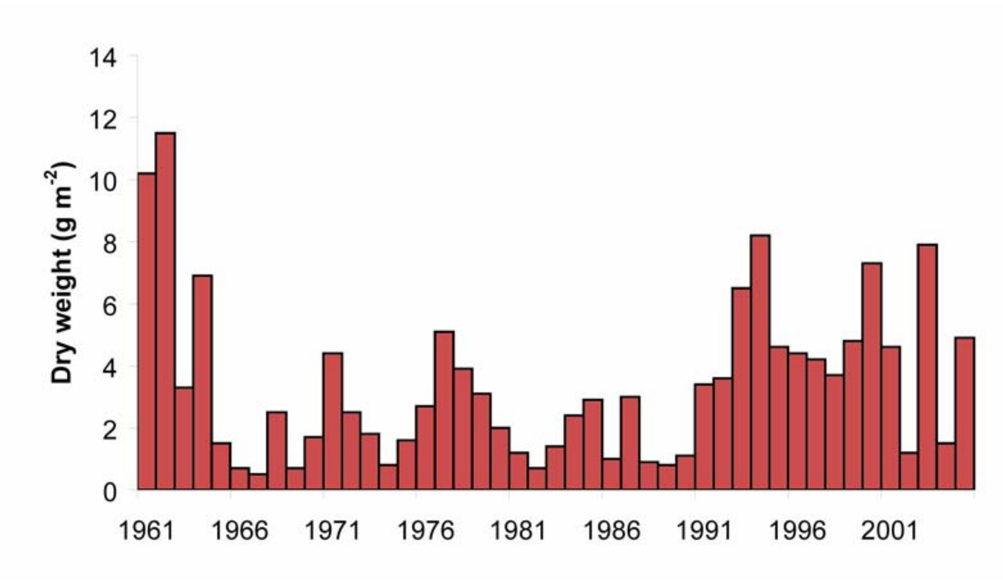

Figure 2.1.3.2.1. Variations in zooplankton biomass (g dry weight m-2, 0-50 m) in spring at Siglunes section. The columns show means for 8 stations.

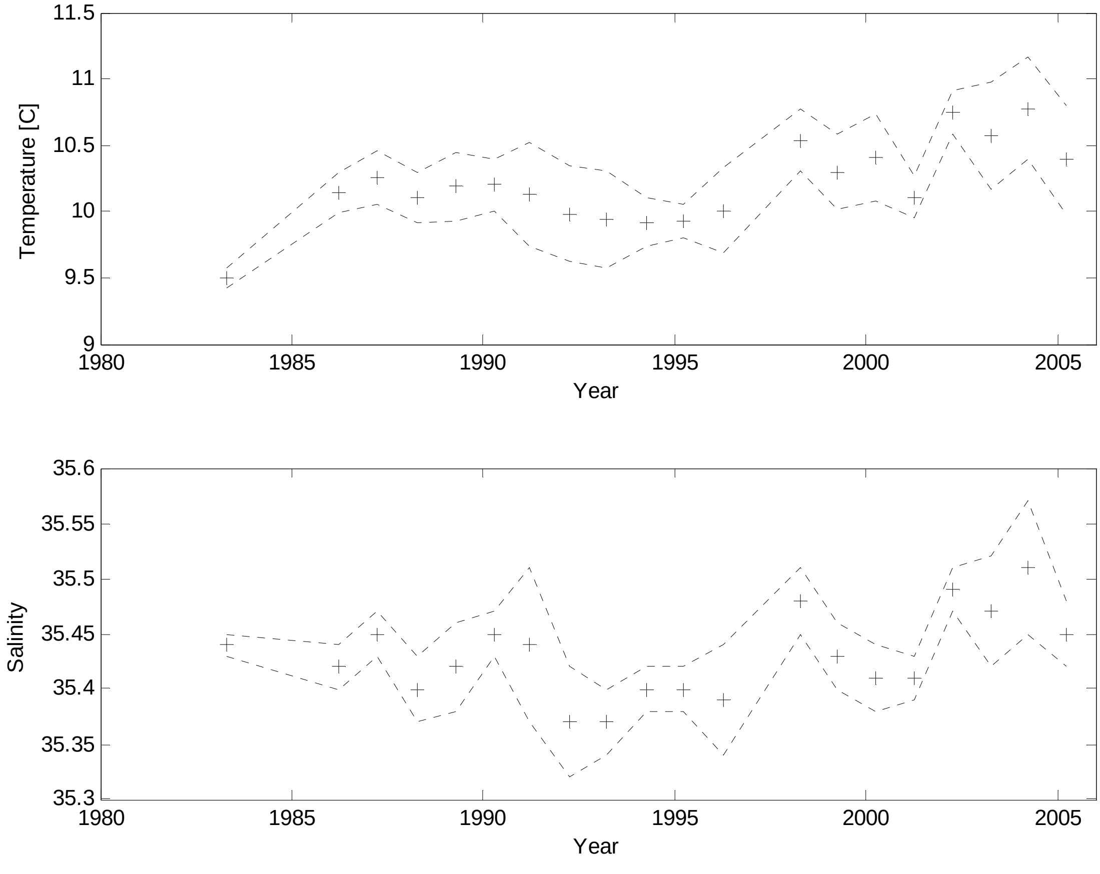

Figure 2.1.4.1. Yearly mean temperature and salinity from 50-600m (crosses) of all stations in a box with bottom depth>600m, west of the Porcupine bank bounded by 52° to 54°N and 16° to 14°W. Dotted lines are drawn at plus-minus one standard deviation of all observations in each box, each year.

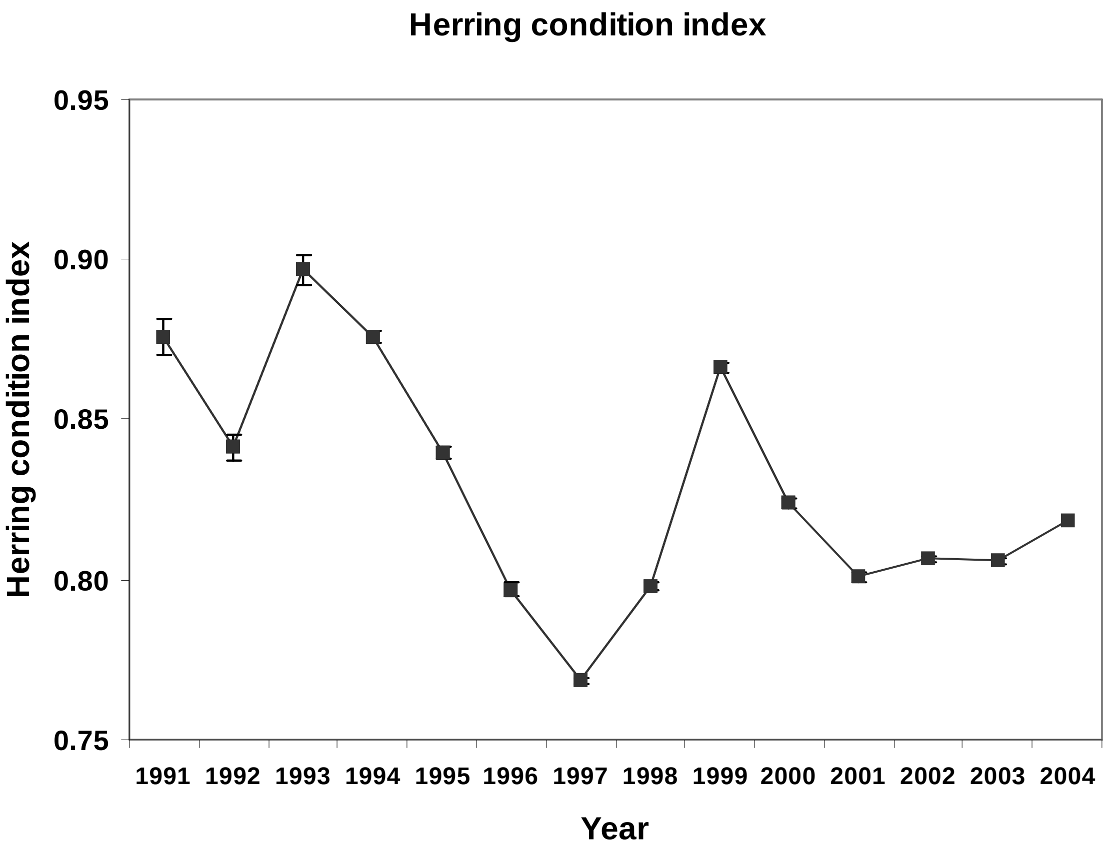

Figure 2.2.1.1 Individual weight to length ratio (herring condition index) for Norwegian spring spawning herring. Data from November and December for herring 30-35 cm body length. Error bars: 95% confidence limits. In 2004 only herring wintering outside the Ofoten-fjord were used.

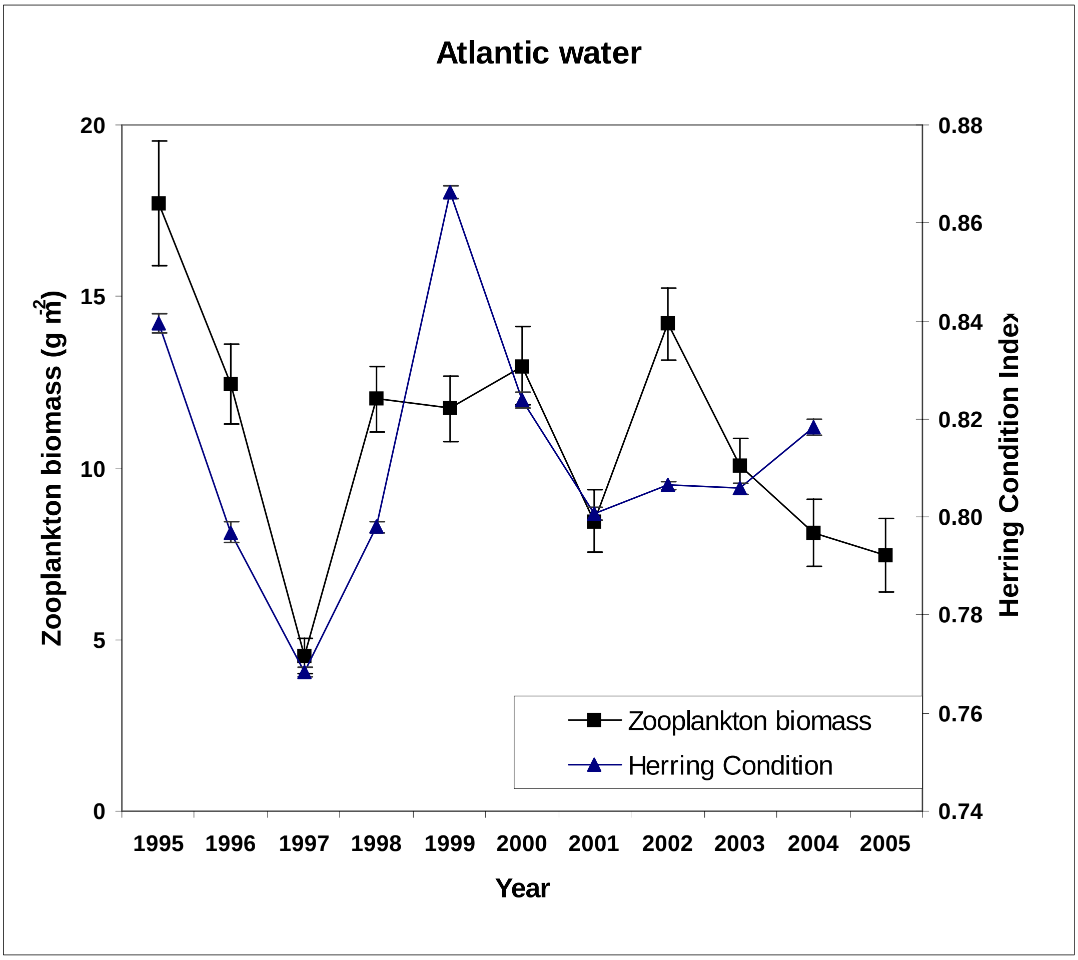

Figure 2.2.1.2 Zooplankton biomass (dry weight) in Atlantic water in the Norwegian Sea in May (0-200 m) and herring condition index (individual weight to length ratio, November and December, 30-35 cm). Error bars: 95% confidence limits. Linear regression: Condition = 0.004 * biomass + 0.766, R2 = 0.32, P = 0.09.

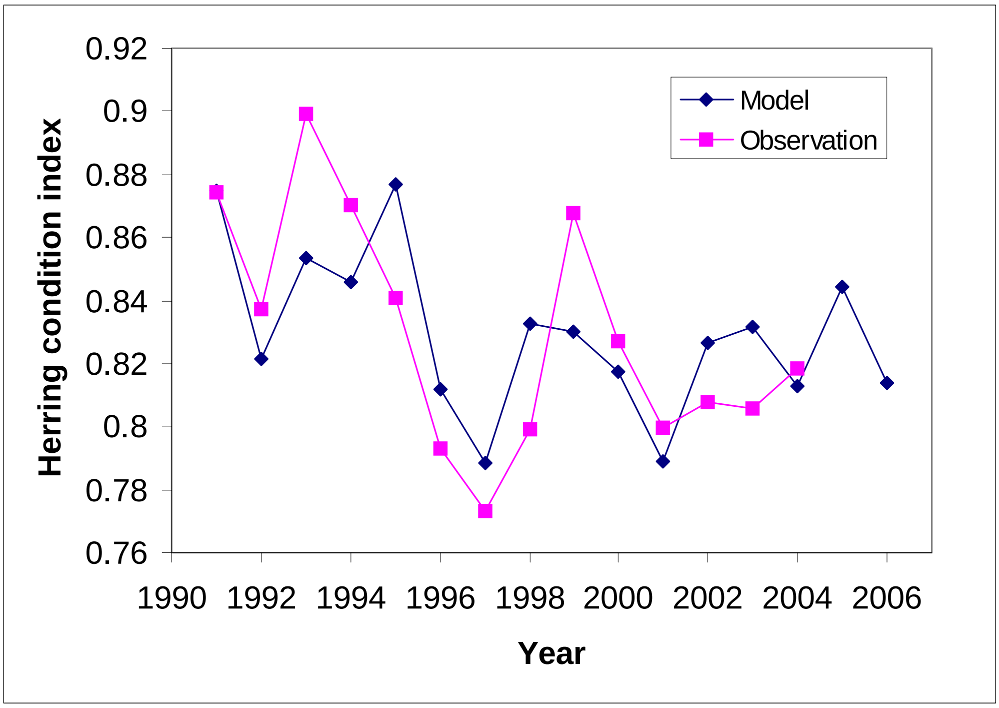

Fig. 2.2.1.3 Herring condition index in December, observed and modelled. Model: Condition (yr2) =0.022*NAO yr1+0.82, R2=0.51, P=0.004.The model predicts herring condition index in December 2005 at 0.844 and in December 2006 at 0.82.

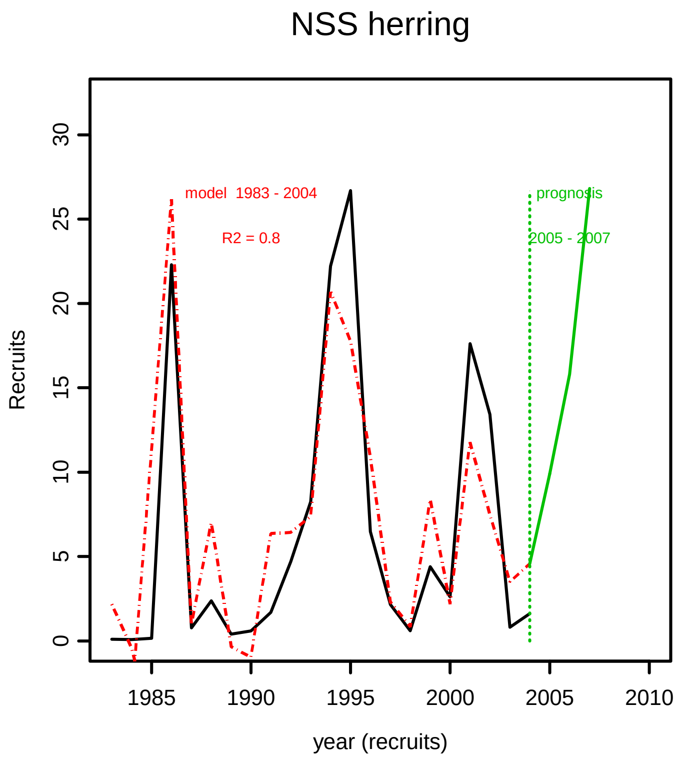

Figure 2.2.1.4. The figure shows the number of recruits (3 year olds) of Norwegian spring spawning herring (black) and the model fit (red), together with prognoses for 2005-2007 (green).

3 Norwegian Spring Spawning Herring

3.1 Stock description

The Norwegian spring spawning herring is a highly migratory stock that is distributed throughout large parts of the NE Atlantic during its lifespan. It is a herring type with high number of vertebrae, large size at age, large maximum size, different scale characteristics from other herring stocks and large variation in year-class strength. The herring spawns along the Norwegian west coast in February - March. The larvae drift north and northeast and distribute as 0-group along the Norwegian coast and in the Barents Sea. The Barents Sea is by far the most important juvenile area for the large yearclasses which forms the basis of the large production potential of the stock. Some yearclasses are in addition distributed into the Norwegian Sea basin as 0-group. Example of this is the 1950 and 2002 yearclasses. Most of the young herring leave the Barents Sea as 3 years old and feed in the northeastern Norwegian Sea for 1-2 years before recruiting to the spawning stock. The adult individuals of the Norwegian spring-spawning herring have a distinct annual migration pattern in the Norwegian Sea. This migration pattern changes over time, at present the herring winters in fjord areas in Northern Norway and off the Vesterålen area from 69^o to 72^{o}N, spawn on the Norwegian coast (mainly between 62^o and 71^{o}N) and feed in the Norwegian Sea. Since 2003 a more southwestern feeding pattern has been observed with increasing amounts of the older herring feeding in the waters north of the Faroes and east of Iceland. As the feeding season progress the herring has a northerly migration along the polar front zone. During the autumn 2004 NSSH were found in smaller concentrations in catches of Icelandic summer spawning herring off the Icelandic east coast. The total catch of NSSH was estimated at approx. 1000 tonnes. This is a new development which is probably coupled to the more southwestern feeding pattern observed in the recent years and should be followed closely.

The Barents Sea component of the large 2002 yearclass migrated out of the Barents Sea during spring of 2005. It is now found in the waters between west to north of the Vesterålen area and has merged with the Norwegian Sea component of the same yearlclass. The Norwegian Sea component is on average more westerly distributed than the Barents Sea component as a consequence of the size dependent migration pattern.

3.2 ICES advice and management applicable to 2004 and 2005

EU, Faroe Islands, Iceland, Norway, and Russia agreed to implement a long-term management plan for Norwegian spring-spawning herring. This plan consists of the following elements (ICES 2002/CRR:255):

1. *Every effort shall be made to maintain a level of Spawning Stock Biomass (SSB) greater than the critical level ($\boldsymbol{B}_{lim}$) of 2 500 000 t.*

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 t ($\boldsymbol{B}_{pa}$), the fishing mortality rate, referred under paragraph 2, shall be adapted in the light of scientific estimates of the conditions to ensure a safe and rapid recovery of the SSB to a level in excess of 5 000 000 t. The basis for such an adaptation should be at least a linear reduction in the fishing mortality rate from 0.125 at $\boldsymbol{B}_{pa}$ (5 000 000 t) to 0.05 $\boldsymbol{B}_{lim}$ (2 500 000 t).*

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

ICES considers that the objectives of this agreement are consistent with the precautionary approach.

In 2003 ACFM stated that "Based on the most recent estimate of SSB and fishing mortality ICES classifies the stock as being inside safe biological limits. The stock is harvested around $\mathbf{F}_{pa}$ = 0.15. The recruitment of the very strong 1992 year class led to an increase in SSB in 1997 to approximately 8 million t, but SSB has since declined to just over 5 million t in 2002. The incoming year classes 1998 and 1999 are estimated to be relatively strong." Further "ICES advises that this fishery should be managed according to the agreed management plan with a fishing mortality of no more than F=0.125, corresponding to landings in 2004 of less than 825 000 t."

At the meeting on Fisheries Consultation on the management of Norwegian spring-spawning herring (Atlanto-Scandian) herring stock in Reykjavik, Iceland in October 2003, the coastal states (European Union, Faroe Islands, Iceland, Norway, and Russia) did not reach any agreement regarding the allocation of the quota.

At a following meeting on Fisheries Consultation on the management of Norwegian spring-spawning herring stock in Copenhagen, Denmark, in mid February 2004, the parties were unable to reach any agreement on quota allocations. However, there seemed to be an unwritten understanding between the parties to accept the TAC proposed by ACFM to limit the total catches to 825 000 t in 2004.

In 2004 ACFM stated that " Based on the most recent estimates of SSB and fishing mortality, ICES classifies the stock as having full reproduction capacity and harvested sustainably. The recruitment of the very strong 1992 year class led to an increase in SSB in 1997 to approximately 8 million t. Thereafter, SSB declined to just below 5 million t in 2001 and increased again to 7 million t in

2004. The year classes 1998 and 1999 are estimated to be relatively strong." Further " The management plan implies catches of 890 000 t in 2005 which is expected to lead to spawning stock of 6.3 million tonnes in 2005."

For 2005 there was no agreement between the Coastal States regarding the allocation of the quota. The Nowegians rose their quota of 14% and following them up so did the Icelanders and the Faroese. The sum of the total revised national quotas for 2005amounts to about 1 million tonnes.

3.3 Description and development of the fisheries

The distribution of the fisheries of Norwegian spring-spawning herring by all countries in 2004 by ICES rectangles are shown in Figure 3.3.1 (total whole year) and in Figure 3.3.2 (by quarter).

Due to limitations by some countries to enter the EEZs of other countries in 2004 the fisheries do not necessarily depict the distribution of herring in the Norwegian Sea and the preferred fishing pattern of the fleets give free access to any zone. However, 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 in 2004 and 2005 during the ICES PGNAPES (Planning Group on Surveys on Pelagic Fish in the Norwegian Sea) investigations (ICES 2004/D:10 and ICES 2005/D:09).

3.3.1 Denmark

5. The Danish fishery of Norwegian spring spawning herring is carried out by purse seiners (18,000 t.) and trawlers (5,000 t.). Most of the landings were landed in Denmark (11,000 t.) and the other landings were landed at the Faroes (10,000 t.) and the remaining part in Iceland (2,000 t.). No landings were landed in Norway do to lack of agreements between EU and Norway. In 2004 the first fishing

period started in the southern part of Division IIa in March (catch 3,600 t) and continued in May – June were app. 17,300 t was caught. Finally the landings from the second part of the year were minor.

3.3.2 Germany

The German fishery for Norwegian spring spawning herring started in Division IIa north of 66°N in late April and continued in May-June in IIa and further north in IIb with the highest catches taken in end of June. Less catches were taken in third quarter in the Svalbard area.

3.3.3 Faroe Islands

The Faroese fishery for Norwegian spring-spawning herring (7 combined purse seiners/trawlers) started in late May 2004 in International waters (ICES Division IIa) close to the Faroese fishing border. The fishery continued in summer gradually moving further northeast in the international area and into the Svalbard area (IIa and IIb). In August the fishery was almost exclusively taken in the Svalbard area (IIb). More than 60% of the catches were taken with pelagic trawls and the rest with purse seines.

3.3.4 Iceland

The Icelandic catch quota for Norwegian spring-spawning herring was set at 128 205 tonnes in 2004. The Icelandic fishery in 2004 began early May in the western part of the international waters in the Norwegian Sea between the Jan Mayen and Faroese zones. Later in the month the fishery continued there as well as in north-eastern part of the international and the eastern part of the Icelandic zone In June the fishery moved into the southern Spitsbergen zone and continued there until the last week of August when it moved into the international waters again. In September the fishery remained in the international waters close to the Spitsbergen zone. When the Icelandic fishery on summer spawners began in autumn some Norwegian spring spawning herring was mixed with the Icelandic summer spawning herring stock off East Iceland. It was estimated that close to 900 t of NSSH were caught in autumn at East Iceland during the fishery of the Icelandic summer spawning herring. In May and June about 4 500 t of NSSH were caught in Icelandic EEZ. The bulk of the catch was caught in May and June (56 thousands tonnes) and in July and August (32 thousands tonnes) and a few tonnes were caught in September. The total catch was 102 787 tonnes of which 68 thousands tonnes were taken in midwater trawl and 34 thousands tonnes in purse-seine.

About 25 purse-seiners/trawlers participated in the herring fishery. The length range of the vessels was 47-79 meters with a mean length of 63 meters. The engine power range of the fleet was 441-5520 kW (599-7500 HP) with a mean of 2751 kW (3738 HP).

3.3.5 Ireland

The Irish catches in 2004 were insignificant.

3.3.6 Netherlands

The Dutch fleet fishing for pelagic species in European waters consists of 14 freezer trawlers and one pair trawler. In addition, a number of flag vessels are operating from the Netherlands. Target species of this fleet are: herring, blue whiting, mackerel, horse mackerel and argentines Some of these trawler also operate in west African waters during part of the year fishing for sardinella and horse mackerel. The fishery for Norwegian spring spawning is conducted using large pelagic trawls. In 2004, 8 vessels have participated in the fishery and reported catches from 17 trips. Most of the herring catches originate from a directed fishery in the second half of the year in the months June-October in ICES Sub-area II (International area in the Norwegian Sea).

3.3.7 Norway

The Norwegian fishery is carried out by many size categories of vessels. Of the total national quota of 470.250 t, approximately 50% is allocated to purse seiners, 10% to trawlers and 40% to smaller coastal purse seiners. Like in previous years the by far larger part of the Norwegian fishery takes place in northern Norwegian coastal waters (Vestfjord area) where the herring winters from September until mid January. In 2004 about 115 000 tonnes were caught in the wintering areas in Northern Norway in January. 80 000 t were taken in the spawning area on the Norwegian coast in February-March. Only negligible quantities (452 tonnes) were caught in the areas south of 62 N in 2004. Much of this herring probably belongs to local fjordic herring stocks but is registered as NSSH in the statistical records. The remaining part of the Norwegian quota (approximately 277 000 t) was taken in the period September-December on the herring migrating to, and wintering in, the wintering areas in northern Norway. The total Norwegian catch in 2003 was 476 624 tonnes.

3.3.8 Russia

In 2004 the Russian fishery started within the shelf region of the Norwegian EEZ, near Trena Bank (approximately 66 ^{o} N) in the beginning of February and Sclinna Bank (approximately 65^{o}N) and Buagrunnen Bank (approximately 63^{o}N) in the end of this month. In March the fishing was in progress in the same regions. In February and March the catch was 17 608 t. In June the commercial vessels conducted fishing in the northern part of the international area in the Norwegian Sea and the zone of Spitsbergen. In June the catch was 11227 t. In July-August vessels caught herring in the international area in the Norwegian Sea in the Polar Front region and the zone of Spitsbergen. In the middle of August 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. In July-September the catch was 70792 t. In November Russian fishery finished in the Norwegian EEZ to north from Lofoten area where was caught 13939 t. The Russian fishery is carried out by many types of vessels, mainly trawls. The entire Russian catch was utilized for human consumption.

3.3.9 Sweden

The Swedish fishery for Norwegian spring-spawning herring was performed by 15 boats using purse seines (60 % of landings) and pelagic trawls (40%). Catches were taken during June and July around the border between IIa and IIb and landed on the Faroes (60%), in Denmark and Sweden.

3.3.10 UK (Scotland)

The Scottish fishery for NSSH takes place at the end of the first quarter, once the mackerel season has finished and also at the end of the third quarter, once the North Sea herring fishery has been completed. Around one half of the pelagic fleet participates in this fishery using either single or pair trawl gear.

3.4 Bycatches in the fishery

No information on bycatches in the fishery was supplied to the working group.

3.5 Fishery dependent data

3.5.1 Sampling intensity

For the direct fisheries of the herring in 2004 samples were provided by Denmark, Iceland, Norway and Russia. The sampled catch accounted for 78,6% of the total catch. Better sampling (85,8%) of catch in ICES area IIa, worse sampling (6,8%) in area IIb and no samples were taken of the catches in areas IVa and Vb.

The Working Group noted that not all nations participating in the international fishery for Norwegian spring spawning herring in 2004 had carried out an adequate sampling of their fishery. The allocation of catches for which no samples were taken and the final catch-at age and weight- at age by ICES areas is given in Table 3.5.1.1. In general Norwegian age distribution and weight were used for un-sampled fishery in the Norwegian Sea in quarter 2 for IIa and 1-4 IVa area ICES, Russian age distribution and weight keys for quarter 3-4 for IIa area ICES for un-sampled fishery in 1 and 3 quarter for for area IIb and Danish data for 2 quarter for area ICES IIb.

3.5.2 Landings

Like in earlier years the fishing pattern in 2004 followed the clockwise migration pattern of the herring (Figure 3.3.3.1). Two main changes in the fishing pattern could be distinguished from 2003: There was no fishing in the Jan Mayen zone in 2004 since no coastal state agreement had been reached allowing non Norwegian vessels to fish in the area. There was also a tendency for more catches being taken in the southwestern areas, in line with the observed increase in concentrations of herring feeding in this area. The herring feeding in these western areas are known to be composed of the largest fish in the stock due to the length dependent migration behaviour of herring. The tonnage taken in the two areas compose a small fraction of the total catch and the changes in fishery pattern have probably not changed the selection pattern appreciably.

The total annual catches of Norwegian spring-spawning herring for the period 1972–2003 (2003 preliminary) are presented in Table 3.5.2.1 (by country). In 2004 the catch provided as catch by rectangle represented approximately 799 236 tonnes, 7 606 tonnes higher than the total catch used in the WG (Figure 3.3.1). Iceland revised their catch upwards 2 036 tonnes at the WG, and the catch from UK (Scotland) was 7 345 tonnes higher in the catch-by-rectangle format than in the reported forms.

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

The Norwegian water content in catches was set at 2 % as of 1 February 2004 by the Norwegian authorities. This came after an international agreement on application of a standard water content in the herring catches. No extra tonnage was consequently added to the official Norwegian catch in 2004 (see last years report for an elaborate description of the water content history).

3.5.3 Discards

In 2004 the part of a young Norwegian spring spawning herring (2002 year-class) was allocated in the eastern part of Norwegian Sea, therefore there is a possibility for by-catch small fish in this area. It is possible that discard of small fish takes place. However the Working Group has no accessible data to estimate possible discards of the herring.

3.5.4 Age and length composition of catches

Age compositions for direct fishery of the herring in the Norwegian Sea were provided by Denmark, Iceland, Norway and Russia, and the sampled catch accounted for 89 % of the total catch. Estimates of catch in numbers for unsampled catches were raised according to the knowledge of how, where, and when the catches were taken. The age compositions in the directed fisheries are given in Table 3.5.1.1 and Table 3.5.4.1. These data were used in the stock assessment. The 1999-1998 year classes were the most numerous in the catches, followed by the 1992-1991 year classes. To calculate the total international catch-at-age, and to document how it was done, the program SALLOC was used (ICES 1998/ACFM:18).

Data on the combined length composition of the 2004 commercial catch by quarter of the year from the directed fisheries in the Norwegian Sea were provided by Iceland, Norway and Russia. Length composition of the herring varied from 13 to 41 cm, with 97% of fish ranging from 28–37 cm. The mean length in this fishery was 32.7 cm (Table 3.5.4.2).

3.5.5 Weight at age

Weight at age in stock for 2005 (January 1st) (Table 3.5.5.1) was taken from the weights at age in the Norwegian samples made in the wintering areas in December 2004. Prognosis of weight at age in stock for 2006 was estimated by adjusting the weights at age for 2005 with the condition prognosis given for December 2005 (sec. 2.2.1). Correspondingly the prognosis of weight at age in stock for 2007 was estimated by adjusting the weights at age for 2005 with the condition prognosis given for December 2006 (sec. 2.2.1).

The weight in catches in 2004 was taken from the total international weight-at-age (Table 3.5.5.2), which were produced using the computer programme SALLOC, standard ICES software.

3.5.6 Length at age

Not used.

3.5.7 Maturity at age

Maturation of the 2002 yearclass: The 2002 yearclass is composed of three components with separate juvenile areas: 1) The Barents Sea 2) The Norwegian Sea 3) Norwegian fjords. The bulk of the yearclass (~97-98%) is made up of the two oceanic components. Of these two the Barents Sea component is the largest, composing about 75-80% of the yearclass. Due to the small fraction made up of the fjordic component only the Norwegian Sea and Barents Sea components were directly included in the calculation of the maturity ogive of the yearclass. The Barents Sea component will start maturing from 4 years of age while the Norwegian Sea component started as 3 years old. The maturity ogive for the yearclass in 2005 was calculated as follows: It was assumed that 0% of the Barents Sea component would mature in 2005. Of the Norwegian Sea component all fishes in the December 2004 survey in stage 3 were supposed to mature (Observations: Stage 2: 67%, Stage 3: 33 %). The maturation of the 2002 yearclass in 2005 thus becomes: 0.75*0+0.25*0.33=0.085. This number was raised to 0.1, taking into account some fish from the coastal component, which matures at a low age (Table 3.5.7.1).

For other ages and yearclasses the maturity ogive were kept like last year for 2005.

3.5.8 Natural Mortality

No changes were done to the applied natural mortalities, 0.9 for 0 to 2 years old, 0.15 for 3 years and older.

3.6 Fisheries independent data

3.6.1 Survey abundance indices

Due to the change of timing of the NPBWWG from spring to autumn 2005, both the May survey 2004 and in 2005 are included in the present description of surveys, as well as the recent summer surveys in the Norwegian Sea and the Barents Sea.

3.6.1.1 Spawning grounds

In 2005 a Norwegian acoustic survey was again undertaken to estimate the abundance of herring in the spawning areas in February-March. During the years 2001-2004 the obtained estimates were either of a bad quality or the survey was not carried out (Table 3.6.1.1.1). The age groups 5-15+ are used in the assessment.

3.6.1.2 Wintering areas

Norwegian acoustic surveys have been carried out in the wintering areas in November/December (1992-present) and in January (1991-1999).

The wintering area of the herring is now split in two areas. This was first observed during the December survey in 2002 when concentrations of herring were observed by the RV Johan Hjort in oceanic waters off Vesterålen and Troms. In December 2004 a survey covering both the fjordic and oceanic wintering area was carried out by the RV G.O.Sars (only fjords) and R/V Johan Hjort. The combined result of the survey (Table 3.6.1.2.1) covers the known wintering area of the mature part of the stock. There was a very distinct difference in age structure between the two areas with most of the 1998 and 1999 yearclasses wintering in the oceanic areas and hardly any of the older yearclasses wintering in these areas. The age groups 4-15+ are used in the assessment.

The results of the survey in the wintering area in January is found in Table 3.6.1.2.2. Although the survey series has ended the data are still used in the assessment. The age groups 5-15+ are used in the assessment.

3.6.1.3 Feeding areas

The feeding areas in the Norwegian Sea were surveyed acoustically by the international ecosystem survey (PGNAPES, former PGPFN) during the period late April to early June in

2004 and 2005 (ICES 2004/D:07 and ICES 2005/D:09). A complete herring data set is found in the PGNAPES reports from the years 1995-2005 at www.imr.no/PGSPFN. The abundance estimate is given in Table 3.6.1.3.1. The age groups 3-15+ are used in the assessment.

3.6.1.4 Nursey areas

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

Results from the Norwegian and Russian acoustic survey in the Barents Sea in May-June 1991-2005 are given in Table 3.6.1.4.1. No surveys were carried out in the years 2003-2004. The age groups 1 and 2 are used in the assessment.

In 2001 the Working Group decided to include data on immature herring obtained during the Russian-Norwegian survey in August-October in estimating the younger year classes in the Barents Sea. The results from these surveys are given in Table 3.6.1.4.2. The age groups 1 and 2 are used in the assessment.

The results from the 0-group herring survey in Norwegian Fjords and Coastal areas are given in Table 3.6.1.4.3, however, the data are not used in the present assessment of herring.

The results from the joint Norwegian-Russian 0-group survey in the Barents Sea are given in Table 3.6.1.4.4. The log index is used in the assessment.

3.6.1.5 Herring larval survey

The Norwegian herring larval survey in 2005 was carried out during March-April. The survey started at Fugløya (70^0N) and continued along the Norwegian shelf south to Stad (62°N). No herring larvae were found in this area. The mean size of the larvae was relatively low, 11.5 mm, which may be due to the early survey period in 2005. The oldest larvae were found in the south indicating an earlier start of the spawning in this area. The larvae had a more northern distribution compared to the historic distribution of this survey. The total number of larvae was estimated to be $73.9*10^{12}$, the highest estimate so far in this series (Table 3.6.1.5.1). The "Index 1" is used in the assessment.

3.6.2 Tagging data

With the exception of 1999, 2001 and 2005, tagging has been carried out annually since 1975 by Norway. The tagging experiments in 2004 were carried out in March along the Norwegian coast from 62°N-67N where a total of 27045 herring were tagged. During the tagging process, the length of each tagged 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 of tagged herring in this batch is then estimated from the age distribution in the sample.

Recovery of tags 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. For stock assessment purposes, tags are only used from supervised detector plants where detector efficiency has been tested, and where it is known that the detectors have been working as intended. Three factories filled these criteria in 2004, and a total of 54 321 million herring were screened in these factories. Magnet efficiency was close to 100% in 2004. All tagged herring recovered were sent to the Institute of Marine Research, Bergen, where they were measured, weighed and aged. In 2004 84 tags from herring that were four years or more when tagged, were recovered from the factories (Table 3.2.4.1).

3.7 Stock Assessment

Stock assessment was carried out with SeaStar and ISVPA.

3.7.1 Catch curve analyses

Not carried out.

3.7.2 Data Exploration with assessment models

Data exploration was carried out with SeaStar and ISVPA.

3.7.2.1 Data Exploration: Sea Star

In SeaStar assessments the catchabilities of the acoustic surveys are assumed to have no age or abundance dependence. The reason for this choice is that the mechanism for the recruiting of herring to the surveys is that of migration, not of growth, where the latter process could be assumed to be more regular and modellable. Instead, for each survey there is set a minimum age for inclusion of each year class. However, one needs to be cautious, since the different year classes may have different recruitment ages to the surveys. An important example is the failure of the 1998 year class to recruit fully to the December survey in 2002, for which reason the WG meeting 2003 considered this data point an outlier. In the coming years special attention should be paid also to the large 2002 year class, where a substantial part grew up in the Norwegian Sea instead of in the Barents Sea.

However, the recruitment to the Norwegian Sea survey by the 1998 and 1999 year classes (see Figure 3.7.2.1.5) may indicate an age dependent catchability for that survey, which should be considered modelled in future assessments.

The input data used are:

Catch data	Updated from Table 3.5.1.1
Acoustic surveys	Table 3.6.1.1-5
Tag data	Table 3.6.2
Larval data	Table 3.6.1.5
0-group data	Table 3.6.1.4.4

The acoustic surveys used are (the numbering is used elsewhere in the text of this section):

1	Spawning grounds along the Norwegian coast	Minimum age: 5
2	Wintering area in Vestfjorden in November-December	Minimum age: 4
3	Wintering area in Vestfjorden in January	Minimum age: 5
4	Young herring in the Barents Sea in May	Ages 1 and 2
5	Feeding areas in the Norwegian Sea in May	Minimum age: 3
6	As part of the joint IMR-PINRO capelin survey in September	Ages 1 and 2

It is assumed that the distribution of the main tuning series of older fish follows a gamma distribution with a common CV, which is estimated, and that the distribution of the acoustic data in the Barents Sea follows a log normal distribution. The tag return data are assumed to follow a Poisson distribution, which is commonly used for rare events, the larval data are assumed to follow a gamma distribution with an estimated CV and the zero group data are assumed to follow a normal distribution with an estimated standard deviation.

It has been experienced that when the fish get old the scales get difficult to read and more scales get discarded. This introduces a bias in the age distribution. An attempt has been made to correct for this bias on an experimental basis in previous WG meetings. This was not done during the present meeting, however.

Previously it has been observed in this WG that as the 1983 and 1985 year classes grew older than about 13 years the age readers tended to transfer fish from the 1983 to the 1985 year class. This problem is part of the general age reading problem for older fish, but is corrected for separately in the SeaStar software. The data used in ISVPA have also this correction.

As has been the case during previous assessments of Norwegian spring spawning herring with SeaStar, a number of exploratory runs were initially performed to see the effect of various options and settings. These runs were:

Label	Explanation
Default	With respect to the 2004 assessment the 2002 year class was included in the tuning
The other runs are deviations from Default:	
NoTags	Tag data were left out
EstimateM	The natural mortality both for adult herring and young herring in the Barents Sea were estimated
IncrMPlus	The natural mortality in the plus group was set to 0.5
TrendLarvae	An attempt to correct for a time trend in the larval data
NoLarv	The larval data were left out
Log	The surveys in the Norwegian Sea and along the Norwegian coast are assumed distributed as normal on log-scale
2002Bar	The measurement of the 2002 year class in the Norwegian Sea is left out , th estimate of this year class is based on Barents Sea data– this run has identical settings to the final SeaStar run in 2004
S2And5NoLNoT	No tags, no larvae, only surveys 2 and 5

The estimated parameters, catchabilities and stock biomass in 2005 are shown in Table 3.7.2.1.1 for the exploratory runs. The catchabilities reflect how well each survey conforms to the modelled stock.

The perceived spawning stock is somewhat increased when the tagging data are removed and decreased when the larval data are removed. If M is estimated there is a decrease in the spawning stock of about one million tonnes. The M-value for adult herring is estimated at 0.103 as opposed to 0.115 in 2004 and 0.128 in 2003, i.e. there has thus been a slightly decreasing trend in the estimated M-value. The M-value for young herring in the Barents Sea is estimated at 1.117, as opposed to 0.188 in 2004 and 0.507 in 2003, i.e a substantial fluctuation from year to year. These fluctuations are probably connected to removing the 1998 and 1999 year classes from the Barents Sea likelihood (stage 2 of the estimation) in 2004 and the 2002 year class in 2005.

Increasing M in the plus group caused only a slight decrease in present spawning stock size, but reduced the spawning stock in the collapsed phase in the 1970s to below 0.1 million tonnes. The WG chose this run as the SeaStar assessment in 2005. Figure 3.7.2.1.1 shows the spawning stock biomass, figure 3.7.2.1.2-7 the survey fits, figure 3.7.2.1.8 the fit to the larval data. Figure 3.7.2.1.9 shows the quantile-quantile plot for the surveys and figure 3.7.2.1.10 the quantile-quantile plot for tags. Figure 3.7.2.1.11 shows the quantile-quantile plot for the surveys when a log-normal distribution is assumed.

The quantile-quantile plots for the tag return data shows a skewed distribution. There are more points with low CDF than expected, i.e. The model expects more tag returns than it gets, so the tag data will tend to move the assessment towards higher tag return rates, i.e. towards a lower stock. This is consistent with a increased stock when the tag data are removed.

The larval data seem to be a reasonably good proxy for the spawning stock, except that since 1997 there seems to be a regime of higher levels. Introducing a linear trend in the data does not improve the fit. These data should be reviewed before the next meeting, looking into possible explanations for the discrepancy between the larval indices before 1997 and since 1997 in relation to modelled spawning stock. Since the WG could not point to any biological reasons for this, the WG decided to keep this survey in the tuning at also at the present assessment. However, these data should be looked closer into with the aim of relating the discrepancy to survey coverage in relation to fluctuating spawning areas, timing of survey with respect to the time of spawning in each year or other reasons.

A gamma distribution seem to fit the acoustic survey data better than a log-normal distribution, but the latter does not seem entirely inappropriate.

Table 3.7.1.2.2 shows a comparison of number by age in 2004 as perceived by the assessment made in 2004 and the present assessment. Of the strong year classes, the 2002 year class has been substantially revised upwards, the perception of the 1998 and 1999 year classes is virtually unchanged and the 1991 and 1992 year classes have been modestly revised downwards.

It may be biologically justifiable that the M-value of the plus group is higher than the M-value for younger fish. The selected value of 0.5 is, however, admittedly speculative. There is strong evidence that the smallest spawning stock biomass in the 1970s could not be as high as 0.5 million tonnes, which is what we get with an M of 0.15 on the plus group. An alternative could be to base the calculation of the numbers in the plus group on the catch and an assumed F-value equal to the F-value of the oldest true age group. This is, however, a very strong assumption.

As the increased M-value of the plus group did not affect the present assessment appreciably, the WG felt that the M-value of 0.5 reflected the stock history better, for which reason this run was chosen.

Figure 3.7.2.1.12 shows the retrospective plot. There has been substantial a downward revisions of the perceived stock history from 1999 until 2004. However, the present assessment increases the perceived stock history. Figure 3.7.2.1.13 shows the estimated catchabilities in the retrospective runs. The catchabilities for the surveys in the Norwegian Sea and along the Norwegian coast show a smooth development, reflecting that the model around 2000 assumed a higher stock relative to the surveys than before or after.

3.7.2.2 Data Exploration: ISVPA

For NSS herring exploratory runs by means of ISVPA the same version of the model and the same settings as in last year stock assessment were used (the catch-controlled version of the ISVPA with constraint of unbiased model approximation of logarithmic catch-at-age, two selection patterns were fitted: first - for 1950-1985, and second - for 1986-2003), except the following two aspects:

Profiles of components of ISVPA loss function for different sources of information are represented on Figure3.7.2.2.1. (It is necessary to mention that the last year report there was a a misspecification in picture 6 of the analogous figure - the median was minimized for survey 6, not the sum of squared errors).

Survey in feeding area in May (N5 on figures) same way as in previously, was used for tuning in form of age proportions, weighted by stock abundance. Weighting by abundance is used in order to make stress on abundant years as probably giving survey information of better quality.

The only marked difference between last year and this year profiles is that now the minimum for survey 1 is shifted towards higher values of fishing mortality.

For the sake of comparison with the SeaStar assessment, where several points in survey data are “masked” (excluded, because by some reasons some of them are treated to be in contradiction to the others), an additional run was made using survey data with the SeaStar “mask” applied. Profiles of the ISVPA loss function components obtained using “masked” survey data are presented on fig.3.7.2.2.2. The only marked influence of this was shift of the minimum for surveys 5, but it did not influence the position of the minimum for the total loss function, and, accordingly, the overall solution (compare curves 7 on Figures3.7.2.2.1 and 3.7.2.2.2).

An attempt to detect outliers in surveys data was also undertaken on the basis of the SPALY ISVPA run results. The so called “X-84” rule by P.Huber was applied. According to this rule the points with residuals higher than 5.2 absolute median deviations are to be excluded (Vasilyev, 2004). Using this rule the following points were detected as outliers and excluded:

Source of information	% of outliers with respect to all points in the data source	age (and years) of outliers
Survey 1 (spawning, Feb)	1.4	9 (1995)
Survey 2 (Wintering, Nov)	0	
Survey 3 (Wintering, Jan)	3.2	9 (1991) 11 (1993)
Survey 4 (Young, Barents Sea, June)	0	
Survey 5 (Feeding, May)	5.6	4 (2005) 9 (1996) 10 (1996) 13 (2000) 14 (2004) 16 (2001, 2005)
Survey 6 (Young, Barents Sea, Sep)	0	

X-84-rule is a very “soft” distribution-free criterion intended to detect apparent outliers; its “softness” helps to avoid false detection and not to worry about the organization of an iterative winsorization-like procedure of correction of outliers, which for more “rigorous” criteria may require many iterations and may move the whole assessment into false direction.

Figure 3.7.2.2.3 illustrates the influence of the outliers’ exclusion on the respective components of the ISVPA loss function. As it can be seen, survey 1 is now less pooling the solution to improper high F; for survey 3 almost no changes are detected (changes are not visible in graphic representation, but very small exist if to look at digits); for survey 5 position of the minimum is not changed, but level of errors is lower and shape of loss function is somewhat more smooth. This may indicate that in general for surveys 1 and 5 exclusion of outliers leads to proper direction, but the median and the absolute median deviation (surveys 3) in this case are already sufficiently robust measures of scale.

If to return to experiments with outliers, detected and coming from Seastrar and from ISVPA, it ought to be reminded that the concept of outliers is intrinsically model-dependent. Convinced classic likelyhoodists, who believe that for any kind of data there exists a “true” distribution, may say that they may detect outliers using only postulated proper model of distribution, correspondingly are dependent on this model; but if even they are working with residuals, they also depend on an observation model which influences on these residuals. But if to believe that anything is possible in a sample of limited size and that dealing with a very limited sample it is hardly possible to detect the best distribution model, to may be preferable to use distribution-free robust statistics and methods for detection of outliers.

Thus, after the above mentioned, being short of time to make other experiments, which were also planned in spirit of merging of the ISVPA and The SeaStar model properties and features, for this year assessment by means of ISVPA it was decided to use the same model settings as in 2004. Results of the ISVPA model (in the same settings as last year) application to herring data in their “default” form are given on Figure 3.7.2.2.4.

Comparison of the results with the result of previous assessment are given on Figure 5. They are very much inline. Current assessment shows further spawning stock biomass stock increase in 2004 and slight decrease in 2005.

Results of retrospective runs are given on Figure. 3.7.2.2.6.

Residuals for all sources of data are collected on Figure 3.7.2.2.7.

Since profiles of components of ISVPA loss function for the SPALY run revealed three sources of information with more distinct minima then the others, it was decided to make an additional run using only these three sources: catch-at-age, survey2 and survey 5. The results of the run are compared to the results of SPALY run on Figure 3.7.2.2.8.

Since in this run the sources of information with weaker signals, which were in contradiction to more clear signals from catch-at-age and surveys 2 and 5 were excluded, this run was chosen as final ISVPA run.

Residuals for ISVPA run with 3 sources of information are given on Fig. 3.7.2.2.9. Fig. 3.7.2.2.10 represents bootstrap results.

3.7.3 Comparison of results of different assessments

The two models used, ISVPA (catch controlled version) and Seastar give somewhat different perception about the state of the stock today with the spawningstock in 2005 estimated to be 11 million tonnes in ISVPA. Historically the models agree reasonably well as expected as both models are VPA type models where age disaggregated catches take over in the past.

In both the models surveys that have been discontinued were used in the tuning. Investigation of the ISVPA SSE profiles indicated that a survey that was discontinued in 1999 (wintering area in January) was having much effect on F in 2004 towards lower F and therefore bigger spawningstock. Tuning only with the December survey on the spawning grounds and the May survey in the Norwegian sea lead to considerable downwards revision of the spawning stock in both models.

An important difference between the two models lies in treatment of the small yearclasses where Seastar does not use those yearclasses in tuning but ISVPA uses all yearclasses. The stock is charaterized by very high contrast in strength of yearclasses which in connection with sampling problems in the surveys leads to very high contrast in numbers in different agegroups in the surveys. Catchabilities are estimated approximately as the mean of log-ratios between survey and number in stock. The observation model used for the large observations may not apply to low observations which may depend on a few age readings. As a consequence, the low observations may lead to wrongly estimated catchabilities which when applied to the large year classes may lead to serious bias in the assessment.

In Seastar estimated catchability is closer to 1 as Seastar does only rely on the large year classes. This is probably the cause for lower estimated catchabilities and lower estimate of recent large year classes (Figure 3.7.3.1). Looking at other catchability related issues like the age after which catchability is independent of age can also matter.

In ISVPA the 1998 and 1999 year classes are stronger than the 1991 and 1992 year classes at the same ages. In SeaStar the 1991 and 1992 year classes are stronger than the 1998 and 1992 year classes, which is in accordance with the survey observations.

The contrast in the age disaggregated survey abundance indices is a problem that has to be taken into account when doing assessment for this stock. Ignoring the small year classes as done in Seastar is not an ideal solution but much better than doing nothing. A quick fix to the problem is to use high detection level in the surveys but the detection level is an indication of how large the survey indices are when sampling errors are no longer the dominant errors and lognormal (or gamma) errors can be assumed. A small check in a VPA model run on this stock showed that changing this detection level by a factor of 20 could change the spawning stock in 2005 by more than 3 million tonnes by estimating higher catchability in the surveys.

As future solution tuning with the total biomass in the survey as lognormal and proportion in each age group as multinomial would also be worth exploring. Also it might be questioned if catchability in the December acoustic survey should be independent of age, but allowing the catchabilities to be estimated for each age group seems to predict decreased catchability with age. Experiments in mackerel very clearly shows that sampling with trawl in an area fished with purse seine gives lower mean lengths in the trawl catches catch than the less selective purse seine catching specific schools. Estimates of catchability are though uncertain for this stock as the survey series are relatively short for a stock with so low fishing and total mortality as estimated for the Norwegian spring spawning herring. Therefore the acoustic surveys need to be scruitinized properly with regard to whether catchability in them could be substantially different from 1 and this belief should possibly be put in the models as a prior.

For more than ten years, tagging data has been used in the assessment of the Norwegian spring spawning herring. SeaStar can handle these data, and therefore when doing the assessment of the stock the tagging data were included as a tuning series. In this assessment, the larvae data are also included. The larvae data is an SSB index, which has also been used for many years in the assessment. Also, the WG considered that the relation between the 1991/1992 and 1998/1999 year classes in the surveys is better reflected in SeaStar than in ISVPA. After an overall evaluation, also including that this assessment is an update from last years the Sea Star assessment was chosen as the final.

3.7.4 Final Assessment

The settings for the final run is described in sec 3.2.1. In order to make the historical biomass during the 1970'ies more in accordance with the observed low stock level at that time the F for the + group was increased from 0.15 to 0.5 in this years assessment.

Table 3.7.1.2.2 shows a comparison of number by age in 2004 as perceived by the assessment made in 2004 and the present assessment. Of the strong year classes, the 2002 year class has been substantially revised upwards, the perception of the 1998 and 1999 year classes is virtually unchanged and the 1991 and 1992 year classes have been modestly revised downwards.

Figure 3.7.2.1.12 shows the retrospective plot. There has been substantial a downward revisions of the perceived stock history from 1999 until 2004. However, the present assessment increases the perceived stock history. Figure 3.7.2.1.13 shows the estimated catchabilities in the retrospective runs. The catchabilities for the surveys in the Norwegian Sea and along the Norwegian coast show a smooth development, reflecting that the model around 2000 assumed a higher stock relative to the surveys than before or after.

The results of the final assessments as stock numbers are given in Table 3.7.4.1. Table 3.7.4.2 shows the stock summary table.

3.8 Recruitment estimates

Recruitment indices are listed in the historic summary table (Tables 3.7.4.2). The mean of the estimated recruits in 1950-2004 is 95 billion as 0 year old fish.

The perception of the strong 2002 year class is based on the measurement in the 2005 survey in the Norwegian Sea. The perception of the 2003 year class is based on the 0-group index and the Barents Sea surveys and the perception of the 2004 year class is based mainly on the 0-group index, which is about the level of the 0-group index for the 1991 year class, and only the 1983 year class ha a higher 0-group index.

3.9 Forecast

Besides the short term forecast two optional runs were made due to special circumstances related to the recruitment of the strong 2002 yearclass. The rationale for this and procedure applied is described in sec 3.9.1.

3.9.1 Short term forecast

Table 3.9.1.1 shows the input data to the short-term prediction. Weight at age used in the forecast is described in sec. 3.5.5. The exploitation pattern was chosen as the population-weighted mean of F by age in the 10 last years of catch data.

The catches calculated for 2006 are sensitive to the selection of 4 year olds because of the strong 2002 year class, and one may get different results depending on how long averaging period is selected. The 2002 year class is special in that a part of it grew up in the Norwegian Sea, in contrast to all other recent strong year classes that grew up in the Barents Sea. The exploitation pattern assumed for 2006 may thus be dubious, as the 2002 year class will recruit earlier than other corresponding year classes. Since the 2002 year class may be more strongly represented in the fishery in 2006 than assumed by the exploitation pattern, the short time forecast will give unrealistic low landings (given the state of the stock) in 2006 with the agreed F = 0.125 (640 000 tonnes). This is a problem, which may typically appear the same year as a strong year class start recruiting heavily. For the 2002 yearclass the problem is even more pertinent because of its early maturation (proportion mature is 0.6 in 2006 as 4 years old). The working group therefore decided to present two additional optional forecasts where alternative selection patterns for the 2002 year class were used in order to arrive at predicted landings in better accordance with the current state of the stock.

Short term: Selection pattern is the population weighted mean of F by age for the last 10 years

Option 1: Selection on 4 year olds as on 5 year olds

Option 2: Regression of catch to historic Fbar

Table 3.9.1.2 shows the short-term prediction tables for the short term, option 1 and option 2 forecast runs.

The upper table shows the standard short term prediction table for the given exploitation pattern. F_{bar} equal to 0.125 gives a catch in 2006 of 640 000 tonnes. It should be noted that with this exploitation pattern there will be virtually no fishing on the 2002 year class in 2006. Also, F_{bar} is based on ages 5-14, and the F-value applied for the 2002 year class in 2006 will not affect F_{bar}.

The middle table shows the short term prediction table corresponding to assuming the selection on 4 year old herring is the same as the selection of 5 year old herring. This is the same as assuming the 2002 year class is recruited earlier to the fishery than normally. In this case an F_{bar} of 0.125 corresponds to a catch in 2006 of about 740.000 tonnes.

The WG has also interpreted the harvesting control rule of F = 0.125 differently from applying an F_{bar} (population weighted) based on ages 5-14 directly. Figure 3.9.1.1 shows a regression of the ratio of total catch to F_{bar} on data from 1990 and later. The regression line was used to calculate the catch for given values of "F_{bar}" and partitioning the catch on age groups accorded to the chosen selection pattern. In this case an "F_{bar}" of 0.125 corresponds to a catch in 2006 of about 800.000 thousand tonnes.

The present harvesting control rule does not devise a higher F-value in cases where a proven strong year class is about to recruit to the fishery. The consequences of such an adaptive strategy should be tested by simulation, which was impossible for the WG to carry out because of time constraints.

3.10 Biological reference points

	ICES considers that:	**ICES proposed that:**
Precautionary Approach reference points	$\mathbf{B}_{lim}$ is 2.5 million t	$\mathbf{B}_{pa}$ be set at 5.0 million t
	$\mathbf{F}_{lim}$ is not considered relevant for this stock	$\mathbf{F}_{pa}$ be set at F = 0.15

Target Reference Points

Management has defined F_y at 0.125

Technical basis:

$\mathbf{B}_{lim}$: MBAL	$\mathbf{B}_{pa}$: =$\mathbf{B}_{lim}$ * exp(0.4*1.645) (ICES Study Group 1998)

F$_{lim}$: -	**F**$_{pa}$: ICES Study Group 1998

3.11 Management considerations

There has been no international agreement on quota allocations the two last years. This has led to an escalation in the F exerted on the stock, with the fisheries in 2005 probably ending close to 1 million tonnes, close to 100.000 tonnes more than the TAC recommended under the long-term management plan. It is of great importance for a high long-term yield in this stock that the intentions of the management plan are not violated.

3.12 Quality of the data and the assessment

For the first time the assessment was carried out after the summer, which means that the May survey result was included in the assessment just after it was carried out and not the year after. It also means that two new May surveys were included in the data set in the present assessment. It is regarded a great advantage with significant effect to the quality of the assessment that the May survey is included shortly after it was carried out and not 11 months after.

The herring is at present moving both its wintering areas and partly its summer feeding area. These dynamics could lead to new factors affecting the survey results. For the wintering area the present coverage is several orders lower in magnitude than it used to be when the entire adult stock wintered in the fjords. In the fjords the extent of the wintering area was fairly well known before the survey started and the surveys could be optimised with regard to the herring distribution. With the oceanic wintering area this is no more the case. Based on the fisheries a rough understanding of the geographic distribution of the herring could still be obtained before the November-December wintering survey, thus helping somewhat in planning the survey transects, but in no way compensating fully.

In can be seen from Figure 3.7.2.12 that there is a strong retrospective pattern in the assessment, in overestimating the spawning stock biomass. This is a negative factor in the assessment indicating an unstable assessment. This tendency has though stopped this year.

In sum there are both positive and negative factors affecting the quality of the present assessment. Probably the inclusion of two May surveys and that the assessment is done shortly after the survey results in an assessment of better quality than last year.

3.13 Recommendations

The present harvesting control rule does not devise a higher F-value in cases where a proven strong year class is about to recruit to the fishery. The consequences of such an adaptive strategy should be tested by simulation, which was impossible for the WG to carry out because of time constraints.

Table 3.5.1.1

Summary of Sampling by Country – Norwegian spring spawning herring
----

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Faroes	0.00	50.00	0	0	0	0.00
Total Vb	0.00	50.00	0	0	0	0.00

Sum of Offical Catches : 50.00
Unallocated Catch : 0.00
Working Group Catch : 50.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	405.00	0	0	0	0.00
Norway	0.00	452.00	0	0	0	0.00
Ireland	0.00	11.00	0	0	0	0.00
Total IVa	0.00	868.00	0	0	0	0.00

Sum of Offical Catches : 868.00
Unallocated Catch : 0.00
Working Group Catch : 868.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Sweden	0.00	5195.00	0	0	0	0.00
Russia	0.00	2310.00	0	0	0	0.00
Iceland	4340.00	37335.00	1	47	50	860.24
Germany	0.00	4152.00	0	0	0	0.00
Faroes	0.00	18165.00	0	0	0	0.00
Denmark	502.00	3947.00	4	477	477	785.40
Total IIb	4842.00	71104.00	5	524	527	852.48

Sum of Offical Catches : 71104.00
Unallocated Catch : 0.00
Working Group Catch : 71104.00

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	1464.00	0	0	0	0.00
Sweden	0.00	2791.00	0	0	0	0.00
Russia	102339.00	113566.00	34	14172	2633	100.05
Norway	476624.00	476624.00	447	33171	8964	100.00
Netherlands	0.00	17369.00	0	0	0	0.00
Iceland	32722.00	63416.00	15	670	798	193.82
Germany	0.00	658.00	0	0	0	0.00
Faroes	0.00	24556.00	0	0	0	0.00
Denmark	5740.00	19164.00	2	247	247	318.54
Total IIa	617425.00	719608.00	498	48260	12642	107.01

Sum of Offical Catches : 719608.00
Unallocated Catch : 0.00
Working Group Catch : 719608.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	17608.00	17608.00	14	5718	1211	100.11
Norway	193209.00	193394.00	160	16939	2427	99.99
Denmark	0.00	7056.00	0	0	0Inf	
Period Total	210817.00	218058.00	174	22657	3638	103.35

Sum of Offical Catches : 218058.00
Unallocated Catch : 0.00
Working Group Catch : 218058.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	1464.00	0	0	0	0.00
Sweden	0.00	5043.00	0	0	0	0.00
Russia	0.00	11227.00	0	0	0	0.00
Norway	4106.00	4175.00	5	150	285	100.01
Iceland	37062.00	55344.00	16	717	848	271.85
Germany	0.00	3934.00	0	0	0	0.00
Faroes	0.00	18411.00	0	0	0	0.00
Denmark	6242.00	15173.00	6	724	724	243.10
Period Total	47410.00	114771.00	27	1591	1857	253.19

Sum of Offical Catches : 114771.00
Unallocated Catch : 0.00
Working Group Catch : 114771.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Sweden	0.00	2943.00	0	0	0	0.00
Russia	70792.00	73102.00	15	6472	1104	100.00
Norway	94303.00	94382.00	120	6989	3569	100.00
Netherlands	0.00	10533.00	0	0	0	0.00
Iceland	0.00	40823.00	0	0	0	0.00
Germany	0.00	876.00	0	0	0	0.00
Faroes	0.00	24310.00	0	0	0	0.00
Denmark	0.00	238.00	0	0	0	0.00
Period Total	165095.00	247207.00	135	13461	4673	100.00

Sum of Offical Catches : 247207.00
Unallocated Catch : 0.00
Working Group Catch : 247207.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	405.00	0	0	0	0.00
Russia	13939.00	13939.00	5	1982	318	100.25
Norway	185006.00	185125.00	162	9093	2683	100.00
Netherlands	0.00	6836.00	0	0	0	0.00
Ireland	0.00	11.00	0	0	0	0.00
Iceland	0.00	4584.00	0	0	0	0.00
Faroes	0.00	50.00	0	0	0	0.00
Denmark	0.00	644.00	0	0	0	0.00
Period Total	198945.00	211594.00	167	11075	3001	100.02

Sum of Offical Catches : 211594.00
Unallocated Catch : 0.00
Working Group Catch : 211594.00

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	1869.00	0	0	0	0.00
Sweden	0.00	7986.00	0	0	0	0.00
Russia	102339.00	115876.00	34	14172	2633	100.05
Norway	476624.00	477076.00	447	33171	8964	100.00
Netherlands	0.00	17369.00	0	0	0	0.00
Ireland	0.00	11.00	0	0	0	0.00
Iceland	37062.00	100751.00	16	717	848	271.85
Germany	0.00	4810.00	0	0	0	0.00
Faroes	0.00	42771.00	0	0	0	0.00
Denmark	6242.00	23111.00	6	724	724	356.09
Total for Stock	622267.00	791630.00	503	48784	13169	112.81

Sum of Offical Catches : 791630.00
Unallocated Catch : 0.00
Working Group Catch : 791630.00

Table 3.5.1.1 continued

```
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
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : (  7)   Norway                 3 IVa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : (  8)   Norway                 4 IVa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : ( 10)   Russia                 2 IIa
Using Only
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 13)   Russia                 3 IIb
Using Only
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 14)   Denmark                1 IIa
Using Only
  >>  (  1)  Norway                 1 IIa

  Filling-in for record : ( 16)   Denmark                3 IIa
Using Only
  >>  (  3)  Norway                 3 IIa

  Filling-in for record : ( 17)   Denmark                4 IIa
Using Only
  >>  ( 12)  Russia                 4 IIa

  Filling-in for record : ( 18)   Denmark                1 IIb
```

Table 3.5.1.1 continued

```
Using Only
  >>  (  9)  Russia                1 IIa

  Filling-in for record : ( 21)   Iceland                3 IIa
Using Only
  >>  ( 20)  Iceland               2 IIa

  Filling-in for record : ( 22)   Iceland                4 IIa
Using Only
  >>  ( 20)  Iceland               2 IIa

  Filling-in for record : ( 24)   Iceland                3 IIb
Using Only
  >>  ( 11)  Russia                3 IIa

  Filling-in for record : ( 25)   Sweden                 2 IIa
Using Only
  >>  (  2)  Norway                2 IIa

  Filling-in for record : ( 26)   Sweden                 3 IIa
Using Only
  >>  ( 11)  Russia                3 IIa

  Filling-in for record : ( 27)   Sweden                 2 IIb
Using Only
  >>  ( 19)  Denmark               2 IIb

  Filling-in for record : ( 28)   Sweden                 3 IIb
Using Only
  >>  ( 11)  Russia                3 IIa

  Filling-in for record : ( 29)   Germany                2 IIa
Using Only
  >>  (  2)  Norway                2 IIa

  Filling-in for record : ( 30)   Germany                2 IIb
Using Only
  >>  ( 19)  Denmark               2 IIb

  Filling-in for record : ( 31)   Germany                3 IIb
Using Only
```

Table 3.5.1.1 continued

```
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 32)   UK(Scot)              2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 33)   UK(Scot)              4 IVa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 34)   Faroes                2 IIa
Using Only
  >>  (  2)  Norway                 2 IIa

  Filling-in for record : ( 35)   Faroes                3 IIa
Using Only
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 36)   Faroes                2 IIb
Using Only
  >>  ( 19)  Denmark                2 IIb

  Filling-in for record : ( 37)   Faroes                3 IIb
Using Only
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 38)   Faroes                4 Vb
Using Only
  >>  ( 20)  Iceland                2 IIa

  Filling-in for record : ( 39)   Ireland               4 IVa
Using Only
  >>  ( 20)  Iceland                2 IIa

  Filling-in for record : ( 40)   Netherlands           3 IIa
Using Only
  >>  ( 11)  Russia                 3 IIa

  Filling-in for record : ( 41)   Netherlands           4 IIa
Using Only
  >>  ( 13)  Russia                 3 IIb
```

Table 3.5.1.1 continued

Catch Numbers at Age by Area

Ages	Vb	IVa	IIb	IIa	Total
0	0.00	0.00	0.00	125.00	125.00
1	0.00	0.00	0.00	1814.40	1814.40
2	1.92	3.67	2189.10	40940.26	43134.95
3	4.61	6.70	5421.85	25453.09	30886.26
4	35.04	48.72	32805.59	110003.00	142892.36
5	165.04	275.96	325479.09	551713.31	877633.44
6	172.87	709.95	425810.75	772300.88	1198994.63
7	18.10	153.46	66510.80	128939.09	195621.44
8	5.85	230.59	28530.12	133842.73	162609.33
9	0.45	23.46	5046.79	28113.38	33184.07
10	2.38	57.43	14532.73	52615.46	67208.01
11	5.53	179.78	24823.88	159865.53	184874.72
12	9.09	665.48	32472.07	378488.78	411635.41
13	4.19	357.28	12217.76	196579.25	209158.47
14	1.49	24.96	2594.90	24975.90	27597.25
15	0.32	31.98	548.78	10584.00	11165.08

Mean Weight at Age by Area (Kg)

Ages	Vb	IVa	IIb	IIa	Total
0	0.0000	0.0000	0.0000	0.0224	0.0224
1	0.0000	0.0000	0.0000	0.0655	0.0655
2	0.1084	0.0733	0.1360	0.1416	0.1413
3	0.1764	0.1304	0.1983	0.1801	0.1833
4	0.1853	0.1711	0.2124	0.2111	0.2114
5	0.2127	0.2132	0.2264	0.2423	0.2364
6	0.2308	0.2630	0.2394	0.2762	0.2631
7	0.2641	0.2964	0.2761	0.3078	0.2970
8	0.3004	0.3292	0.3116	0.3496	0.3429
9	0.3082	0.3320	0.3510	0.3600	0.3586
10	0.3189	0.3562	0.3253	0.3719	0.3618
11	0.3273	0.3648	0.3459	0.3887	0.3829
12	0.3324	0.3726	0.3418	0.3931	0.3890
13	0.3447	0.3825	0.3659	0.4011	0.3990
14	0.3629	0.4056	0.3677	0.4251	0.4197
15	0.4303	0.4171	0.4620	0.4383	0.4394

Table 3.5.2.1 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	Greenl and	UK	Germany	France	Poland	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	-	15,97119,	7,003	605	-	14,863	1,223,131
1999	740,640	157,328	37,010	55,527	203,381	2,412	5,871	-	207	-	-	-	14,057	1,235,433
2000	713,500	163,261	34,968	68,625	186,035	8,939	-	-	14,096	3,298	-	-	14,749	1,207,201
2001	495,036	109,054	24,038	34,170	77,693	6,070	6,439	-	12,230	1,588	-	-	9,818	766,136
2002	487,233	113,763	18,998	32,302	127,197	1,699	9,392	-	3,482	3,017	-	1,226	9,486	807,795
2003	438,140	122,846	14,144	27,943	117,910	1,400	8,678	-	9,214	3,371	-	-	6,431	750,077
2004[1]	477,076	115,876	23,111	42,771	102,787	11	17,369	-	1,869	4,810		-	7,986	793,666

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

Table 3.5.4.1. Catch data for Norwegian spring spawning herring, billion individuals.

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	5.113	2.000	0.600	0.276	0.185	0.186	0.547	0.629	0.080	0.089	0.110	0.087	0.195	0.368	0.066	0.107	0.237
1951	1.636	7.608	0.400	0.007	0.384	0.172	0.164	0.516	0.602	0.077	0.083	0.103	0.108	0.254	0.348	0.047	0.305
1952	13.720	9.150	1.233	0.039	0.061	0.602	0.136	0.205	0.380	0.378	0.079	0.086	0.108	0.107	0.187	0.256	0.308
1953	5.697	5.055	0.581	0.740	0.047	0.101	0.356	0.082	0.111	0.314	0.395	0.062	0.091	0.094	0.099	0.216	0.515
1954	10.680	7.071	0.855	0.266	1.436	0.143	0.236	0.490	0.128	0.200	0.440	0.461	0.088	0.101	0.133	0.127	0.676
1955	5.176	2.871	0.510	0.093	0.276	2.045	0.114	0.190	0.275	0.085	0.193	0.296	0.203	0.059	0.085	0.104	0.477
1956	5.364	2.024	0.627	0.117	0.252	0.314	2.555	0.110	0.204	0.264	0.131	0.198	0.273	0.163	0.063	0.089	0.476
1957	5.002	3.291	0.220	0.023	0.373	0.154	0.229	1.985	0.072	0.127	0.183	0.088	0.121	0.149	0.132	0.034	0.248
1958	9.667	2.798	0.666	0.018	0.018	0.111	0.089	0.194	0.973	0.071	0.123	0.201	0.099	0.077	0.071	0.069	0.186
1959	17.900	0.199	0.326	0.015	0.027	0.026	0.147	0.115	0.241	1.104	0.089	0.124	0.198	0.089	0.077	0.085	0.151
1960	12.880	13.580	0.393	0.122	0.018	0.028	0.024	0.096	0.073	0.204	1.163	0.085	0.130	0.154	0.057	0.047	0.122
1961	6.208	16.080	2.885	0.031	0.008	0.004	0.015	0.019	0.062	0.049	0.136	0.728	0.050	0.045	0.063	0.022	0.038
1962	3.693	4.081	1.041	1.844	0.008	0.003	0.007	0.020	0.012	0.059	0.053	0.117	0.814	0.044	0.055	0.066	0.087
1963	4.807	2.119	2.045	0.760	0.836	0.005	0.002	0.004	0.018	0.009	0.108	0.093	0.174	0.924	0.080	0.060	0.125
1964	3.613	2.728	0.220	0.115	0.399	2.046	0.014	0.002	0.003	0.025	0.029	0.096	0.082	0.153	0.773	0.046	0.291
1965	2.303	3.781	2.854	0.090	0.256	0.571	2.200	0.020	0.015	0.007	0.019	0.040	0.101	0.108	0.139	0.704	0.179
1966	3.927	0.663	1.678	2.049	0.027	0.467	1.306	2.885	0.038	0.014	0.017	0.026	0.011	0.069	0.072	0.097	0.460
1967	0.427	9.877	0.070	1.392	3.254	0.027	0.421	1.132	1.721	0.009	0.006	0.004	0.008	0.009	0.018	0.014	0.090
1968	1.784	0.437	0.388	0.099	1.881	1.387	0.014	0.094	0.134	0.345	0.002	0.001	0.000	0.003	0.003	0.002	0.015
1969	0.561	0.507	0.142	0.188	0.000	0.009	0.005	0.000	0.012	0.034	0.036	0.000	0.000	0.000	0.000	0.000	0.002
1970	0.119	0.529	0.033	0.006	0.019	0.000	0.003	0.003	0.001	0.013	0.026	0.028	0.000	0.000	0.000	0.000	0.002
1971	0.031	0.043	0.085	0.002	0.001	0.001	0.000	0.001	0.001	0.000	0.004	0.007	0.005	0.000	0.000	0.000	0.000
1972	0.347	0.041	0.020	0.035	0.003	0.004	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1973	0.029	0.004	0.002	0.002	0.025	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1974	0.066	0.008	0.004	0.000	0.000	0.025	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1975	0.031	0.004	0.002	0.003	0.000	0.000	0.031	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1976	0.020	0.002	0.001	0.023	0.005	0.000	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1977	0.043	0.006	0.003	0.022	0.024	0.000	0.000	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1978	0.020	0.002	0.001	0.003	0.012	0.020	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1979	0.033	0.004	0.002	0.006	0.002	0.007	0.011	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
1980	0.007	0.000	0.000	0.006	0.006	0.002	0.008	0.016	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000
1981	0.008	0.001	0.012	0.004	0.005	0.009	0.002	0.005	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1982	0.023	0.001	0.000	0.014	0.008	0.005	0.006	0.002	0.005	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1983	0.127	0.005	0.002	0.003	0.021	0.010	0.006	0.007	0.001	0.005	0.007	0.000	0.000	0.000	0.000	0.000	0.000
1984	0.034	0.002	0.002	0.004	0.005	0.062	0.018	0.013	0.016	0.007	0.016	0.006	0.000	0.000	0.000	0.002	0.000
1985	0.029	0.013	0.207	0.022	0.016	0.017	0.130	0.059	0.055	0.063	0.010	0.031	0.050	0.000	0.000	0.000	0.003
1986	0.014	0.001	0.003	0.540	0.018	0.015	0.016	0.105	0.075	0.042	0.077	0.019	0.066	0.080	0.000	0.000	0.002
1987	0.014	0.006	0.036	0.020	0.501	0.019	0.004	0.007	0.028	0.012	0.010	0.005	0.008	0.007	0.007	0.000	0.000

Table 3.5.4.1. Catch data for Norwegian spring spawning herring, billion individuals. (con't)

1988	0.015	0.003	0.009	0.063	0.025	0.550	0.009	0.004	0.006	0.015	0.009	0.003	0.003	0.003	0.002	0.000	0.000
1989	0.007	0.002	0.025	0.003	0.004	0.006	0.324	0.003	0.000	0.000	0.003	0.001	0.000	0.000	0.000	0.000	0.000
1990	0.001	0.000	0.016	0.019	0.003	0.012	0.011	0.226	0.001	0.002	0.002	0.002	0.000	0.000	0.000	0.000	0.000
1991	0.000	0.003	0.003	0.008	0.003	0.001	0.015	0.009	0.219	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1992	0.002	0.000	0.001	0.013	0.033	0.005	0.001	0.012	0.006	0.226	0.002	0.000	0.000	0.001	0.000	0.000	0.000
1993	0.007	0.000	0.007	0.028	0.107	0.087	0.009	0.004	0.030	0.019	0.410	0.000	0.000	0.000	0.000	0.000	0.000
1994	0.000	0.000	0.008	0.033	0.110	0.364	0.165	0.016	0.008	0.037	0.036	0.645	0.003	0.000	0.000	0.002	0.000
1995	0.000	0.000	0.001	0.058	0.346	0.623	0.638	0.231	0.016	0.016	0.070	0.084	0.912	0.004	0.000	0.000	0.000
1996	0.000	0.000	0.030	0.034	0.714	1.571	0.941	0.406	0.103	0.006	0.007	0.066	0.018	0.837	0.000	0.000	0.000
1997	0.000	0.000	0.022	0.130	0.271	1.796	1.994	0.761	0.326	0.061	0.020	0.032	0.091	0.019	0.370	0.000	0.000
1998	0.000	0.000	0.083	0.070	0.242	0.368	1.760	1.264	0.381	0.130	0.043	0.025	0.003	0.113	0.006	0.109	0.000
1999	0.000	0.000	0.005	0.138	0.036	0.135	0.429	1.605	1.164	0.291	0.106	0.015	0.040	0.007	0.089	0.000	0.064
2000	0.000	0.000	0.014	0.084	0.560	0.035	0.111	0.404	1.299	1.045	0.217	0.072	0.016	0.023	0.023	0.005	0.067
2001	0.000	0.000	0.002	0.102	0.161	0.427	0.039	0.096	0.296	0.839	0.507	0.074	0.024	0.004	0.003	0.000	0.022
2002	0.000	0.000	0.062	0.198	0.643	0.256	0.326	0.030	0.094	0.265	0.663	0.339	0.053	0.012	0.007	0.000	0.010
2003	0.000	0.003	0.005	0.075	0.326	0.750	0.182	0.173	0.024	0.077	0.222	0.578	0.223	0.044	0.009	0.002	0.003
2004	0.000	0.002	0.043	0.030	0.143	0.878	1.198	0.196	0.163	0.033	0.067	0.185	0.412	0.210	0.026	0.005	0.006

Table 3.5.4.2 Norwegian Spring Spawning Herring Landings in numbers ('000) by length group and quarters in the Norwegian Sea 2004.

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4	All year
13				59	59
14					
15				59	59
16				59	59
17				59	59
18	349	1		118	468
19			36	176	212
20			71	176	247
21			36	59	95
22	217		71	411	699
23	1037	1257	1177	705	4175
24	369	838	0	1116	2323
25	574	843	944	2350	4711
26	703	3360	4171	5170	13403
27	2108	10505	3207	6992	22812
28	6090	55895	7538	6405	75928
29	16713	126468	14828	6698	164707
30	40044	129206	41312	14924	225486
31	97087	54552	60581	32844	245064
32	91173	21166	57897	66803	237039
33	80183	18351	50843	73912	223289
34	88380	15496	55894	73735	233505
35	130428	5773	83817	110869	330887
36	83426	3047	68533	93714	248720
37	19342	1029	25114	37427	82912
38	4342	77	5202	6110	15731
39	932	8	1158	1058	3157
40	245	2		59	306
41				59	59
TOTAL numbers	663743	447874	482428	542126	2136171
Official Catch (t)	210817	104857	167405	187507	670586

Table 3.5.5.1 Weight at age in the stock for Norwegian spring spawning herring, gram

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	1	8	47	100	204	230	255	275	290	305	315	325	330	340	345	362	365
1951	1	8	47	100	204	230	255	275	290	305	315	325	330	340	345	362	365
1952	1	8	47	100	204	230	255	275	290	305	315	325	330	340	345	362	365
1953	1	8	47	100	204	230	255	275	290	305	315	325	330	340	345	362	365
1954	1	8	47	100	204	230	255	275	290	305	315	325	330	340	345	362	365
1955	1	8	47	100	195	213	260	275	290	305	315	325	330	340	345	362	365
1956	1	8	47	100	205	230	249	275	290	305	315	325	330	340	345	362	365
1957	1	8	47	100	136	228	255	262	290	305	315	325	330	340	345	362	365
1958	1	8	47	100	204	242	292	295	293	305	315	330	340	345	352	360	365
1959	1	8	47	100	204	252	260	290	300	305	315	325	330	340	345	355	360
1960	1	8	47	100	204	270	291	293	321	318	320	344	349	370	379	375	380
1961	1	8	47	100	232	250	292	302	304	323	322	321	344	357	363	365	370
1962	1	8	47	100	219	291	300	316	324	326	335	338	334	347	354	358	358
1963	1	8	47	100	185	253	294	312	329	327	334	341	349	341	358	375	375
1964	1	8	47	100	194	213	264	317	363	353	349	354	357	359	365	402	402
1965	1	8	47	100	186	199	236	260	363	350	370	360	378	387	390	394	394
1966	1	8	47	100	185	219	222	249	306	354	377	391	379	378	361	383	383
1967	1	8	47	100	180	228	269	270	294	324	420	430	366	368	433	414	414
1968	1	8	47	100	115	206	266	275	274	285	350	325	363	408	388	378	378
1969	1	8	47	100	115	145	270	300	306	308	318	340	368	360	393	397	397
1970	1	8	47	100	209	272	230	295	317	323	325	329	380	370	380	391	391
1971	1	15	80	100	190	225	250	275	290	310	325	335	345	355	365	390	390
1972	1	10	70	150	150	140	210	240	270	300	325	335	345	355	365	390	390
1973	1	10	85	170	259	342	384	409	404	461	520	534	500	500	500	500	500
1974	1	10	85	170	259	342	384	409	444	461	520	543	482	482	482	482	482
1975	1	10	85	181	259	342	384	409	444	461	520	543	482	482	482	482	482
1976	1	10	85	181	259	342	384	409	444	461	520	543	482	482	482	482	482
1977	1	10	85	181	259	343	384	409	444	461	520	543	482	482	482	482	482
1978	1	10	85	180	294	326	371	409	461	476	520	543	500	500	500	500	500
1979	1	10	85	178	232	359	385	420	444	505	520	551	500	500	500	500	500
1980	1	10	85	175	283	347	402	421	465	465	520	534	500	500	500	500	500
1981	1	10	85	170	224	336	378	387	408	397	520	543	512	512	512	512	512
1982	1	10	85	170	204	303	355	383	395	413	453	468	506	506	506	506	506
1983	1	10	85	155	249	304	368	404	424	437	436	493	495	495	495	495	495
1984	1	10	85	140	204	295	338	376	395	407	413	422	437	437	437	437	437
1985	1	10	85	148	234	265	312	346	370	395	397	428	428	428	428	428	428
1986	1	10	85	54	206	265	289	339	368	391	382	388	395	395	395	395	395
1987	1	10	55	90	143	241	279	299	316	342	343	362	376	376	376	376	376

1988	1	15	50	98	135	197	277	315	339	343	359	365	376	376	376	376	376
1989	1	15	100	154	175	209	252	305	367	377	359	395	396	396	396	396	396
1990	1	8	48	219	198	258	288	309	428	370	403	387	440	440	440	440	440
1991	1	11	37	147	210	244	300	324	336	343	382	366	425	425	425	425	425
1992	1	7	30	128	224	296	327	355	345	367	341	361	430	470	470	470	450
1993	1	8	25	81	201	265	323	354	358	381	369	396	393	374	403	400	400
1994	1	10	25	75	151	254	318	371	347	412	382	407	410	410	410	410	410
1995	1	18	25	66	138	230	296	346	388	363	409	414	422	410	410	405	447
1996	1	18	25	76	118	188	261	316	346	374	390	390	384	398	398	398	398
1997	1	18	25	96	118	174	229	286	323	370	378	386	360	393	391	391	391
1998	1	18	25	74	147	174	217	242	278	304	310	359	340	344	385	363	375
1999	1	18	25	102	150	223	240	264	283	315	345	386	386	386	382	382	407
2000	1	18	25	102	150	223	240	264	283	315	345	386	386	386	382	382	407
2001	1	18	25	75	178	238	247	296	307	314	328	351	376	406	414	425	425
2002	1	10	23	57	177	241	275	302	311	314	328	341	372	405	415	467	409
2003	1	10	55	98	159	211	272	305	292	331	337	347	356	381	414	425	441
2004	1	10	55	106	149	212	241	279	302	337	354	355	360	371	400	412	445
2005	1	10	46	112	156	234	267	295	330	363	377	414	406	308	420	452	452

Table 3.5.5.2 Norwegian spring spawning herring. Catch weight at age (in kg).

year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1950	0.007	0.025	0.058	0.11	0.188	0.211	0.234	0.253	0.266	0.28	0.294	0.303	0.312	0.32	0.323	0.331	0.335
1951	0.009	0.029	0.068	0.13	0.222	0.249	0.276	0.298	0.314	0.33	0.346	0.357	0.368	0.377	0.381	0.39	0.395
1952	0.008	0.026	0.061	0.115	0.197	0.221	0.245	0.265	0.279	0.293	0.308	0.317	0.327	0.335	0.339	0.346	0.351
1953	0.008	0.027	0.063	0.12	0.205	0.23	0.255	0.275	0.29	0.305	0.32	0.33	0.34	0.347	0.351	0.359	0.364
1954	0.008	0.026	0.062	0.117	0.201	0.225	0.25	0.269	0.284	0.299	0.313	0.323	0.333	0.341	0.345	0.352	0.357
1955	0.008	0.027	0.063	0.119	0.204	0.229	0.254	0.274	0.289	0.304	0.318	0.328	0.338	0.346	0.35	0.358	0.363
1956	0.008	0.028	0.066	0.126	0.215	0.241	0.268	0.289	0.304	0.32	0.336	0.346	0.357	0.365	0.369	0.378	0.383
1957	0.008	0.028	0.066	0.127	0.216	0.243	0.269	0.29	0.306	0.322	0.338	0.348	0.359	0.367	0.371	0.38	0.385
1958	0.009	0.03	0.07	0.133	0.227	0.255	0.283	0.305	0.321	0.338	0.355	0.366	0.377	0.386	0.39	0.399	0.404
1959	0.009	0.03	0.071	0.135	0.231	0.259	0.287	0.31	0.327	0.344	0.36	0.372	0.383	0.392	0.397	0.406	0.411
1960	0.006	0.011	0.074	0.119	0.188	0.277	0.337	0.318	0.363	0.379	0.36	0.42	0.411	0.439	0.45	0.444	0.448
1961	0.006	0.01	0.045	0.087	0.159	0.276	0.322	0.372	0.363	0.393	0.407	0.397	0.422	0.447	0.465	0.452	0.452
1962	0.009	0.023	0.055	0.085	0.148	0.288	0.333	0.36	0.352	0.35	0.374	0.384	0.374	0.394	0.399	0.411	0.416
1963	0.008	0.026	0.047	0.098	0.171	0.275	0.268	0.323	0.329	0.336	0.341	0.358	0.385	0.353	0.381	0.386	0.386
1964	0.009	0.024	0.059	0.139	0.219	0.239	0.298	0.295	0.339	0.35	0.358	0.351	0.367	0.375	0.372	0.427	0.434
1965	0.009	0.016	0.048	0.089	0.217	0.234	0.262	0.331	0.36	0.367	0.386	0.395	0.393	0.404	0.401	0.429	0.437
1966	0.008	0.017	0.04	0.063	0.246	0.26	0.265	0.301	0.41	0.425	0.456	0.46	0.467	0.446	0.459	0.465	0.474
1967	0.009	0.015	0.036	0.066	0.093	0.305	0.305	0.31	0.333	0.359	0.413	0.446	0.401	0.408	0.439	0.427	0.431
1968	0.01	0.027	0.049	0.075	0.108	0.158	0.375	0.383	0.364	0.382	0.441	0.41	0.442	0.517	0.491	0.464	0.487
1969	0.009	0.021	0.047	0.072	0.105	0.152	0.296	0.376	0.329	0.329	0.341	0.363	0.385	0.377	0.451	0.423	0.429
1970	0.008	0.058	0.085	0.105	0.171	0.256	0.216	0.277	0.298	0.304	0.305	0.309	0.357	0.348	0.357	0.367	0.376
1971	0.011	0.053	0.121	0.177	0.216	0.25	0.277	0.305	0.333	0.353	0.366	0.377	0.388	0.399	0.419	0.444	0.444
1972	0.011	0.029	0.062	0.103	0.154	0.215	0.258	0.295	0.322	0.341	0.354	0.365	0.376	0.387	0.406	0.43	0.43
1973	0.006	0.053	0.106	0.161	0.213	0.239	0.255	0.277	0.287	0.324	0.338	0.257	0.257	0.257	0.257	0.257	0.257
1974	0.006	0.055	0.117	0.168	0.222	0.249	0.265	0.288	0.299	0.337	0.352	0.267	0.324	0.324	0.324	0.324	0.324
1975	0.009	0.079	0.169	0.241	0.318	0.358	0.381	0.413	0.429	0.484	0.506	0.384	0.466	0.466	0.466	0.466	0.466
1976	0.007	0.062	0.132	0.189	0.25	0.28	0.298	0.323	0.336	0.379	0.396	0.3	0.364	0.364	0.364	0.364	0.364
1977	0.011	0.091	0.193	0.316	0.35	0.398	0.439	0.495	0.511	0.558	0.583	0.537	0.537	0.537	0.537	0.537	0.537
1978	0.012	0.1	0.21	0.274	0.424	0.454	0.495	0.524	0.596	0.613	0.65	0.59	0.59	0.59	0.59	0.59	0.59
1979	0.01	0.088	0.181	0.293	0.359	0.416	0.436	0.482	0.482	0.539	0.553	0.518	0.518	0.518	0.518	0.518	0.518
1980	0.012	0.101	0.202	0.266	0.399	0.449	0.46	0.485	0.472	0.618	0.645	0.608	0.594	0.594	0.594	0.594	0.594

Table 3.5.5.2 Norwegian spring spawning herring. Catch weight at age (in kg) (con't).

1981	0.01	0.082	0.163	0.196	0.291	0.341	0.368	0.38	0.397	0.436	0.45	0.492	0.481	0.481	0.481	0.481	0.481
1982	0.01	0.087	0.159	0.256	0.312	0.378	0.415	0.435	0.449	0.448	0.506	0.493	0.499	0.499	0.499	0.499	0.499
1983	0.011	0.09	0.165	0.217	0.265	0.337	0.378	0.41	0.426	0.435	0.444	0.468	0.461	0.461	0.461	0.461	0.461
1984	0.009	0.047	0.145	0.218	0.262	0.325	0.346	0.381	0.4	0.413	0.405	0.426	0.415	0.415	0.415	0.415	0.415
1985	0.009	0.022	0.022	0.214	0.277	0.295	0.338	0.36	0.381	0.397	0.409	0.417	0.435	0.435	0.435	0.435	0.435
1986	0.007	0.077	0.097	0.055	0.249	0.294	0.312	0.352	0.374	0.398	0.402	0.401	0.41	0.41	0.41	0.41	0.41
1987	0.01	0.075	0.091	0.124	0.173	0.253	0.232	0.312	0.328	0.349	0.353	0.37	0.385	0.385	0.385	0.385	0.385
1988	0.008	0.062	0.075	0.124	0.154	0.194	0.241	0.265	0.304	0.305	0.317	0.308	0.334	0.334	0.334	0.334	0.334
1989	0.01	0.06	0.204	0.188	0.264	0.26	0.282	0.306	0.309	0.391	0.422	0.364	0.429	0.429	0.429	0.429	0.429
1990	0.007	0.078	0.102	0.23	0.239	0.266	0.305	0.308	0.376	0.407	0.412	0.424	0.428	0.428	0.428	0.428	0.428
1991	0.007	0.015	0.104	0.208	0.25	0.288	0.312	0.316	0.33	0.344	0.372	0.354	0.398	0.398	0.398	0.398	0.398
1992	0.007	0.075	0.103	0.191	0.233	0.304	0.337	0.365	0.361	0.371	0.403	0.365	0.394	0.404	0.406	0.408	0.41
1993	0.007	0.03	0.106	0.153	0.243	0.282	0.32	0.33	0.365	0.373	0.379	0.38	0.385	0.39	0.395	0.4	0.405
1994	0.007	0.063	0.102	0.194	0.239	0.28	0.317	0.328	0.356	0.372	0.39	0.379	0.399	0.403	0.405	0.407	0.405
1995	0.007	0.063	0.102	0.153	0.192	0.234	0.283	0.328	0.349	0.356	0.374	0.366	0.393	0.387	0.4	0.4	0.4
1996	0.007	0.063	0.136	0.136	0.168	0.206	0.262	0.309	0.337	0.366	0.36	0.361	0.367	0.379	0.379	0.379	0.379
1997	0.007	0.063	0.089	0.167	0.184	0.207	0.232	0.277	0.305	0.331	0.328	0.344	0.343	0.397	0.357	0.51	0.51
1998	0.007	0.063	0.111	0.15	0.216	0.221	0.249	0.277	0.316	0.338	0.374	0.372	0.366	0.396	0.377	0.406	0.406
1999	0.007	0.063	0.096	0.173	0.228	0.262	0.274	0.292	0.307	0.335	0.362	0.371	0.399	0.396	0.4	0.4	0.404
2000	0.007	0.063	0.124	0.175	0.222	0.242	0.289	0.303	0.31	0.328	0.349	0.383	0.411	0.41	0.419	0.409	0.409
2001	0.007	0.063	0.105	0.166	0.214	0.252	0.268	0.305	0.308	0.322	0.337	0.363	0.353	0.378	0.4	0.427	0.427
2002	0.007	0.063	0.056	0.128	0.198	0.255	0.281	0.303	0.322	0.323	0.334	0.345	0.369	0.407	0.41	0.435	0.435
2003	0.007	0.062	0.068	0.17	0.216	0.255	0.286	0.317	0.325	0.351	0.36	0.358	0.378	0.394	0.399	0.447	0.447
2004	0.007	0.065	0.143	0.183	0.211	0.236	0.263	0.297	0.342	0.358	0.361	0.382	0.389	0.399	0.42	0.439	0.439

Table 3.5.7.1 Proportion mature at age - Norwegian spring spawning herring.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0.00	0.00	0.00	0.00	0.10	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1951	0.00	0.00	0.00	0.00	0.10	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1952	0.00	0.00	0.00	0.00	0.10	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1953	0.00	0.00	0.00	0.00	0.10	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1954	0.00	0.00	0.00	0.00	0.10	0.30	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1955	0.00	0.00	0.00	0.08	0.22	0.37	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1956	0.00	0.00	0.00	0.08	0.22	0.37	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1957	0.00	0.00	0.00	0.00	0.00	0.50	0.60	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1958	0.00	0.00	0.00	0.08	0.22	0.37	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1959	0.00	0.00	0.00	0.08	0.22	0.37	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1960	0.00	0.00	0.00	0.08	0.22	0.37	0.85	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1961	0.00	0.00	0.00	0.04	0.35	0.68	0.94	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1962	0.00	0.00	0.00	0.00	0.11	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1963	0.00	0.00	0.00	0.04	0.03	0.32	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1964	0.00	0.00	0.00	0.02	0.06	0.28	0.32	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1965	0.00	0.00	0.00	0.00	0.34	0.35	0.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1966	0.00	0.00	0.00	0.01	0.15	1.00	0.96	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1967	0.00	0.00	0.00	0.00	0.01	0.23	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1968	0.00	0.00	0.00	0.00	0.00	0.01	0.76	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1969	0.00	0.00	0.00	0.62	0.89	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1970	0.00	0.00	0.00	0.06	0.13	0.31	0.17	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1971	0.00	0.00	0.00	0.10	0.25	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1972	0.00	0.00	0.00	0.00	0.10	0.25	0.60	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1973	0.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1974	0.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1975	0.00	0.00	0.00	0.50	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1976	0.00	0.00	0.00	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1977	0.00	0.00	0.00	0.73	0.89	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1978	0.00	0.00	0.00	0.13	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1979	0.00	0.00	0.00	0.10	0.62	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1980	0.00	0.00	0.00	0.25	0.50	0.97	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1981	0.00	0.00	0.00	0.30	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1982	0.00	0.00	0.00	0.10	0.48	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1983	0.00	0.00	0.00	0.10	0.50	0.69	0.71	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1984	0.00	0.00	0.00	0.10	0.50	0.90	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1985	0.00	0.00	0.00	0.10	0.50	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.00	0.00	0.10	0.20	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1987	0.00	0.00	0.00	0.10	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.5.7.1 Proportion mature at age - Norwegian spring spawning herring (con't).

1988	0.00	0.00	0.00	0.10	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1989	0.00	0.00	0.00	0.10	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1990	0.00	0.00	0.00	0.40	0.80	0.90	0.90	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1991	0.00	0.00	0.00	0.10	0.70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1992	0.00	0.00	0.00	0.10	0.20	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1993	0.00	0.00	0.00	0.01	0.30	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1994	0.00	0.00	0.00	0.01	0.30	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1995	0.00	0.00	0.00	0.00	0.30	0.80	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1998	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1999	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2001	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2002	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2003	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2004	0.00	0.00	0.00	0.00	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2005	0.00	0.00	0.00	0.10	0.30	0.90	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.6.1.1.1 Norwegian Spring-spawning herring. Estimates from the acoustic surveys on the spawning stock in February-March. Numbers in millions.

Year Age	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2005***
2		101	183	44			16		407			106	1516	103
3	255	5	187	59			128	1792	231			1366	690	281
4	146	373	0	54			676	7621	7638		381	337	1996	811
5	6805	103	345	12			1375	3807	11243		1905	1286	164	3310
6	202	5402	112	354			476	2151	2586		10640	2979	592	7545
7		182	4489	122			63	322	957		6708	11791	1997	10453
8			146	4148			13	20	471		1280	7534	7714	887
9				102			140	1	0		434	1912	4240	563
10							35	124	0		130	568	553	159
11							1820	63	165		39	132	71	122
12								2573	0		0	0	3	610
13									2024		175	0	0	1100
14											0	392	6	686
15+											804	437	361	17
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496	28840	19903	26649

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

* No surveys in 2001-2004.

Table 3.6.1.2.1 Norwegian Spring-spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in November-December. Numbers in millions.

Year Age	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002***
1		72		380		9	65	74	56	362	7
2	36	1518	16	183	1465	73	1207	159	322	522	50
3	1247	2389	3708	5133	3008	661	441	2425	1522	3916	276
4	1317	3287	4124	5274	13180	1480	1833	296	5260	1528	1659
5	173	1267	2593	1839	5637	6110	3869	837	165	2615	624
6	16	13	1096	1040	994	4458	12052	2066	497	82	1029
7	208	13	34	308	552	1843	8242	6601	1869	338	32
8	139	158	25	19	92	743	2068	4168	4785	864	188
9	3742	26	196	13	0	66	629	755	3635	3160	516
10	69	4435	29	111	7	0	111	212	668	2216	1831
11			3239	39	41	0	14	0	205	384	911
12				907	15	126	0	15	0	127	184
13					393	0	392	0	0	0	0
14+						842	221	146	168	18	0
Total	6947	13178	15209	15246	25384	16411	31144	17754	19152	16132	7345

Year Age	**2003****	**2004****
1	586	257
2	406	6814
3	2167	1123
4	10670	1596
5	13237	5334
6	1047	6731
7	678	363
8	41	280
9	134	37
10	301	42
11	1214	187
12	502	761
13	10	392
14+	37	83
Total	31030	24000

* Much of the youngest yearclasses (-98,-99) wintered outside the fjords this winter and are not included in the estimate

** In 2003-2004 a combined estimate from the Tysfjord, Ofotfjord and oceanic areas off Vesterålen/Troms.

Table 3.6.1.2.2 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in January. Numbers in millions. No surveys carried out since 1999.

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.

Table 3.6.1.3.1 Norwegian spring-spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions.

Year Age	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	0	0	24	0	0	0	0
2	0	0	1404	215	157	1540	677
3	4114	1169	367	2191	1353	8312	6343
4	22461	3599	1099	322	2783	1430	9619
5	13244	18867	4410	965	92	1463	1418
6	4916	13546	16378	3067	384	179	779
7	2045	2473	10160	11763	1302	204	375
8	424	1771	2059	6077	7194	3215	847
9	14	178	804	853	5344	5433	1941
10	7	77	183	258	1689	1220	2500
11	155	288	0	5	271	94	1423
12	0	415	0	14	0	178	61
13	3134	60	112	0	114	0	78
14		2472	0	158	0	0	28
15+			415	128	1135	85	26
Total	50514	44915	37415	26016	21857	23353	26142

Year Age	**2003**	**2004**	**2005**
1	32073	0	0
2	8115	13735	1293
3	6561	1543	19679
4	9985	5227	1353
5	9961	12571	1765
6	1499	10710	6205
7	732	1075	5371
8	146	580	651
9	228	76	388
10	1865	313	139
11	2359	362	262
12	1769	1294	526
13		1120	1003
14	287	10	364
15+	45	88	115
Total	75625	48704	39114

Table 3.6.1.4.1. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in May/June. No survey in 2003, 1990-2002. See footnotes.

Year	1991	1992	1993	1994	1995	1996[1]	1997[2]	1998	1999	2000	2001	2002	2005*
Age													
1	24.3	32.6	102.7	6.6	0.5	0.1	2.6	9.5	49.5	105.4	0.3	0.5	23.3
2	5.2	14.0	25.8	59.2	7.7	0.25	0.04	4.7	4.9	27.9	7.6	3.9	4.5
3		5.7	1.5	18.0	8.0	1.8	0.4	0.01	0.00	0.00	8.8	0.0	2.5
4				1.7	1.1	0.6	0.35	0.01	0.00	0.00	0.00	0.0	0.4
5						0.03	0.05	0.00	0.00	0.00	0.00	0.0	0.3

[1] Average of Norwegian and Russian estimates[2] Combination of Norwegian and Russian estimates as described in 1998 WG report, since then only Russian estimates

* No surveys in 2003 and 2004.

Table 3.6.1.4.2. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in August-October. 0-group in separate table (Table 3.6.1.4.4).

Year	2000	2001	2002	2003	2004
Age					
1	14.7	0.5	1,3	99.9	14.3
2	11.5	10.5	0.0	4.3	36.5
3	0.0	1.7	0.0	2.5	0.9

Table 3.6.1.4.3 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–2004 (numbers in millions).

Year		**Area**			**Total**
	South of 62°N	62°N-65°N	65°N -68°N	North of 68°30'N	
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	204	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
2001	89	324	134	1421	1968
2002	67	1227	284	3573	5151
*	South of 62°N	62°N-64°N	64°N -67°N	North of 67°N	
2003	9	44	6647	21417	28117
2004	19	884	1306	11950	14159

* A new survey design was introduced in 2003, which resulted in changed areas and wider and denser coverage of the fjords. Thus the estimates from 2003 and onwards are likely to be higher and not directly comparable to the former estimates.

** Data not supplied.

Table 3.6.1.4.4 Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1974-2004.

Year	Log index	Year	Log index
1974	0.01	1989	0.59
1975	0.00	1990	0.31
1976	0.00	1991	1.19
1977	0.01	1992	1.06
1978	0.02	1993	0.75
1979	0.09	1994	0.28
1980	-	1995	0.16
1981	0.00	1996	0.65
1982	0.00	1997	0.39
1983	1.77	1998	0.59
1984	0.34	1999	0.41
1985	0.23	2000	0.30
1986	0.00	2001	0.13
1987	0.00	2002	0.53
1988	0.32	2003	0.51
		2004	1.20

Table revised since 2004.

Table 3.6.1.5.1 Norwegian Spring-spawning herring. The indices for herring larvae on the Norwegian shelf for the period 1981-2003 ($N*10^{-12}$)

Year	Index1	Index 2	Year	Index 1	Index 2
1981	0.3		1993	24.7	78.0
1982	0.7		1994	19.5	48.6
1983	2.5		1995	18.2	36.3
1984	1.4		1996	27.7	81.7
1985	2.3		1997	66.6	147.5
1986	1.0		1998	42.4	138.6
1987	1.3	4.0	1999	19.9	73.0
1988	9.2	25.5	2000	19.8	127.5
1989	13.4	28.7	2001	40.7	131.9
1990	18.3	29.2	2002	27.1	113.9
1991	8.6	23.5	2003	3.7	18.9
1992	6.3	27.8	2004	56.4	175.7
			2005	73.9	*

Index 1. The total number of herring larvae found during the cruise.
Index 2. Back-calculated number of newly hatched larvae with 10% daily moratlity. The larval age is estimated from the duration of the yolksac stages and the size of the larvae.
* Not calculated in 2004.

Table 3.2.4.1 Tagging data used in the SeaStar runs. Please note that the tagging data for 2002 was considered an outlier and thus not included in the analysis - Norwegian spring spawning herring.

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Tagging data for the 1983 year class

Year of Recovery	Number Tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release	1988 release	1987 release
1987	33067														
1988	38152														
1989	20620	10695													12
1990	24585	5489												10	4
1991	12558	5545											5	7	1
1992	15262	1737										2	2	0	4
1993	15839	9372									9	12	6	13	6
1994	5364	9474								11	4	8	7	10	2
1995	859	11554							7	9	6	15	5	10	6
1996	2879	4038						3	4	1	2	10	6	2	3
1997	2266	3867					0	0	0	3	2	3	2	3	0
1998	648	509				1	0	0	0	2	2	1	1	3	1
1999		379			1	0	0	0	1	0	0	1	1	0	0
2000		413		0	0	0	0	0	0	1	0	3	0	1	0
2001		35		0	0	0	0	0	0	0	0	0	0	1	0
2002		221	0	0	0	0	0	0	0	0	0	0	0	1	0
2003		0	0	0	0	0	0	0	0	0	0	0	0	0	0
2004		0	0	0	0	0	0	0	0	0	0	0	0	0	0

Tagging data for the 1984 year class

Year of Recovery	Number Tagged	Number screened in thousands	Recovered											
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release	1988 release
1988	1342													
1989	1175													
1990	1097	157												0
1991	257	138											0	0
1992	767	30										0	0	0
1993	479	287									0	1	1	2
1994	160	267								1	2	0	0	0
1995	56	264							0	0	0	0	0	0
1996	113	281						0	0	0	0	0	0	0
1997	0	0					0	0	0	0	0	0	0	0
1998	0	1				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
2001		0		0	0	0	0	0	0	0	0	0	0	0
2002		0	0	0	0	0	0	0	0	0	0	0	0	0
2003		0	0	0	0	0	0	0	0	0	0	0	0	0

Will not be updated after 2003.

Table 3.2.4.1 continued. Tagging data for the 1985 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered										
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release	1989 release
1989	2982												
1990	1081												
1991	1154	355											0
1992	851	114										0	0
1993	1465	573									1	1	1
1994	368	345								1	0	0	2
1995	167	735							1	2	0	0	0
1996	564	427						0	0	0	0	0	1
1997	555	888					1	1	1	3	0	2	0
1998	778	497				0	0	0	1	0	0	1	0
1999		623			1	0	0	0	0	0	0	0	1
2000	299*	703		2	0	0	0	0	1	0	0	0	0
2001		139		1	0	0	0	0	0	0	0	0	1
2002		194	0	2	0	0	0	0	0	0	0	0	1
2003		105	0	0	0	0	0	0	0	1	0	0	0
2004		0	0	0	0	0	0	0	0	0	0	0	0

*1985+ group

Tagging data for the 1986 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered												
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release	1990 release			
1990	381														
1991	165														
1992	210	17										0			
1993	52	19									0	0			
1994	256	65								0	0	0			
1995	0	104							0	0	0	1			
1996	213	92						0	0	1	0	0			
1997	15	166					0	0	0	0	0	0			
1998	84	0				0	0	0	0	0	0	0			
1999		0			0	0	0	0	0	0	0	0			
2000	0	3		0	0	0	0	0	0	0	0	0			
2001		0		0	0	0	0	0	0	0	0	0			
2002		10	0	0	0	0	0	0	0	0	0	0			
2003		0	0	0	0	0	0	0	0	0	0	0			

Will not be updated after 2003.

Table 3.2.4.1 continued Tagging data for the 1987 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered								
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release	1991 release
1991	634										
1992	1146										
1993	1569	329									0
1994	315	259								0	0
1995	27	90							1	0	1
1996	0	43						0	1	0	0
1997	135	224					0	0	0	0	0
1998	0	8				0	0	0	0	1	0
1999		81			0	0	0	0	0	0	0
2000	0	0		0	0	0	0	0	0	0	0
2001		22		0	0	0	0	0	0	0	0
2002	606*	29	0	0	0	0	0	0	0	0	0
2003		0	0	0	0	0	0	1	0	0	0
2004		0	0	0	0	0	0	0	0	1	0

*1987+group

Tagging data for the 1988 year class

Year of Recovery	Number tagged	Number screened in thousands	Recovered							
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release	1992 release
1992	5827									
1993	5267									
1994	4473	3506								3
1995	1041	3729							0	4
1996	2109	1176						2	3	3
1997	1940	811					0	0	0	0
1998	215	148				0	0	1	0	1
1999		12			0	0	0	0	0	0
2000	118	75		0	0	0	0	0	0	0
2001		0		0	0	0	0	0	1	0
2002	37	77	1	0	1	0	0	0	0	0
2003	22	2	0	0	0	0	0	0	0	0
2004		0	0	0	0	0	0	0	0	0

Table 3.2.4.1 continued Tagging data for the 1989 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1993	7584								
1994	11873								
1995	2348	9463							4
1996	5170	4636						5	1
1997	4103	3346					0	7	2
1998	1176	1183				1	0	0	0
1999		1179			1	1	0	0	1
2000	470	790		1	0	0	0	2	0
2001		841		0	0	2	0	1	1
2002	319	286	0	1	0	0	0	0	0
2003	59	460	0	0	0	1	0	0	0
2004		758	0	0	0	0	0	0	0

Tagging data for the 1990 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1994	10784							0	
1995	3868						0	3	
1996	6171	9009				3	3	9	
1997	4057	9830			2	3	3	7	
1998	2381	2828		2	3	1	1	1	
1999		3402		3	1	2	2	1	
2000	1219	3146		1	0	2	2	0	
2001		1052		0	0	0	0	2	
2002	1605	1348	0	1	0	1	0	0	
2003	56	1129	0	0	0	1	0	1	
2004		1176	0	0	1	1	1	0	

Table 3.2.4.1 continued Tagging data for the 1991 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered						
			2000 release	1998 release	1997 release	1996 release	1995 release	1994 release	1993 release
1995	21528								
1996	25683								
1997	7129	30952					21		
1998	6002	12459				6	8		
1999		14968			4	14	7		
2000	3802	18461		9	1	10	7		
2001		10032		1	2	5	3		
2002	5878	8937	10	9	1	1	1		
2003	1243	9522	4	7	3	7	4		
2004		14288	1	1	4	6	1		

Tagging data for the 1992 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
1996	8417					
1997	8353					
1998	22320	20695				7
1999		23790		7	9	4
2000	16798	31430		20	7	15
2001		14668		8	0	4
2002	9995	17305	12	23	2	1
2003	2829	27306	11	11	4	9
2004		28022	19	17	2	7

Tagging data for the 1993 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	
1997	976					
1998	2015					
1999		8046			0	
2000	2673	9049		3	0	
2001		3994		0	0	
2002	2832	5577	4	2	5	
2003	1020	6612	11	5	1	
2004		7315	6	8	2	

Table 3.2.4.1 continued Tagging data for the 1994 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
1998	3752					
1999						
2000	2278	2450		1		
2001		1104		1		
2002	1143	1588	1	2		
2003	442	2154	3	0		
2004		1933	3	3		

Tagging data for the 1995 year class

Year of Recovery	Number tagged	Number Screened in thousands	Recovered			
			2000 release	1998 release	1997 release	1996 release
2000	505					
2001		276				
2002	197	250	1			
2003	263	747	2			
2004		829	0			

Table 3.7.2.1.1. Summary of SeaStar exploratory runs - Norwegian Spring-spawning herring..

SeaStar summary table

	Default	EstimateM	IncMPlus	TrendLarv	NoLarv	Log	2002Bar	NoTags	S2And5NoLNoT
Spawning stock	6.632	5.495	6.575	6.091	5.873	6.642	6.642	6.905	4.739
Juvenile stock	4.657	4.188	4.593	4.304	4.231	4.729	4.729	4.775	3.820
terminalF83	0.192	0.210	0.193	0.203	0.202	0.213		0.163	0.222
terminalF90	0.315	0.434	0.316	0.347	0.354	0.598		0.321	0.437
terminalF91	0.304	0.382	0.304	0.331	0.335	0.324		0.289	0.465
terminalF92	0.323	0.413	0.323	0.353	0.357	0.321		0.332	0.442
terminalF93	0.448	0.522	0.448	0.472	0.478	0.531		0.366	0.682
terminalF96	0.280	0.348	0.280	0.299	0.304	0.300		0.268	0.391
terminalF97	0.265	0.317	0.265	0.278	0.282	0.266		0.255	0.359
terminalF98	0.137	0.165	0.136	0.149	0.154	0.137		0.132	0.193
terminalF99	0.104	0.127	0.104	0.113	0.118	0.102		0.101	0.138
terminalF02	0.001	0.002	0.001	0.001	0.001	0.001		0.001	0.002
terminalF03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
terminalF04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
cat1	1.042	1.255	1.047	1.083	1.102	1.010		1.003	
cat2	0.820	0.990	0.820	0.852	0.858	0.744		0.797	0.958
cat3	0.930	1.111	0.931	0.946	0.947	0.917		0.907	
cat5	1.113	1.353	1.113	1.164	1.176	1.045		1.071	1.374
catLarvae2	4.632	5.332	4.785	5.108		4.705		4.533	
cat4	0.343	0.354	0.339	0.366	0.361	0.352	0.352	0.335	
cat6	0.486	0.536	0.486	0.529	0.534	0.488	0.488	0.472	
catZero	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003
distPar1	0.485	0.477	0.486	0.481	0.485	0.518		0.483	0.518
distParLarvae	0.657	0.743	0.620	0.430		0.659		0.652	
disPar2	1.914	1.797	1.209	1.211	1.919	1.197	1.197	1.917	113.989
distParZero	0.255	0.259	0.257	0.247	0.241	0.266	0.266	0.257	0.231
Log-lik pt, S1	-1.511	-1.501	-1.511	-1.538	-1.548	-1.561		-1.479	
Log-lik pt, S2	-1.228	-1.221	-1.228	-1.220	-1.216	-1.236		-1.249	-1.157
Log-lik pt, S3	-1.818	-1.809	-1.817	-1.812	-1.818	-1.842		-1.832	
Log-lik pt, S4	-3.438	-3.422	-3.267	-3.265	-3.438	-3.264	-3.264	-3.442	
Log-lik pt, S5	-1.526	-1.490	-1.527	-1.521	-1.517	-1.554		-1.504	-1.553
Log-lik pt, S6	-3.787	-3.761	-3.641	-3.654	-3.797	-3.627	-3.627	-3.788	
Num data, S1	27	27	27	27	27	27	0	27	0
Num data, S2	58	58	58	58	58	58	0	58	58
Num data, S3	18	18	18	18	18	18	0	18	0
Num data, S4	20	20	20	20	20	20	40	20	0
Num data, S5	65	65	65	65	65	65	0	65	65

Table 3.7.2.1.1. Summary of SeaStar exploratory runs (con't)

Num data, S6	11	11	11	11	11	11	22	11	0
vpaM	0.150	0.103	0.150	0.150	0.150	0.150	0.150	0.150	0.150
vpaMYoung	0.900	1.117	0.900	0.900	0.900	0.900	0.900	0.900	0.900
survLogLik1	-243.917	-240.733	-243.981	-243.723	-243.662	-248.002	-105.169	-243.099	-168.020
survLogLik2	-110.421	-109.812	-105.397	-105.487	-110.528	-105.169	-105.169	-110.514	0.000
tagLogLik1	-370.238	-366.024	-370.199	-370.085	-370.088	-369.623	0.000	0.000	-422.105
larvLogLik1	-79.873	-83.251	-78.296	-68.741	0.000	-79.955	0.000	-79.671	0.000
zeroLogLik1	0.000	0.000	0.000	0.000	0.000	0.000	-1.236	0.000	0.000
zeroLogLik2	-0.704	-0.352	-0.772	-0.278	0.065	-1.236	-1.236	-0.798	0.606

Some abbreviations:

cat<n> Catchability for survey n

Log-lik pt, S<n> Log-likelihood per term, survey n

distPar Distribution parameters (CV for gamma distributions and standard deviation for log normal distributions)

Table 3.7.2.1.2. Comparison of number by age in 2004 between the SeaStar assessments in 2005 and 2004. Norwegian Spring-spawning herring.

Age in 2004	*Year class*	*Present assessment*	*Assessment 2004*
0	2004	411.694	
1	2003	66.272	63.392
2	2002	50.903	33.527
3	2001	0.954	1.621
4	2000	2.284	0.632
5	1999	9.568	9.601
6	1998	9.124	10.069
7	1997	0.903	0.902
8	1996	0.714	0.964
9	1995	0.125	0.100
10	1994	0.222	0.255
11	1993	0.548	0.600
12	1992	1.601	2.006
13	1991	0.856	1.006
14	1990	0.109	0.210
15	1989	0.015	0.044
16+	1988 and older	0.020	0.284

Table 3.7.4.1 Norwegian Spring-spawning herring.. Stock numbers final assessment.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2005	0.000	165.952	26.803	19.801	0.797	1.847	7.476	7.661	0.596	0.464	0.077	0.129	0.301	0.998	0.543	0.069	0.019
2004	408.177	65.928	48.770	0.959	2.299	9.632	10.194	0.904	0.715	0.125	0.222	0.549	1.603	0.857	0.110	0.016	0.020
2003	162.158	119.960	2.367	2.752	11.543	12.652	1.246	1.017	0.171	0.342	0.877	2.486	1.236	0.175	0.028	0.009	0.030
2002	295.054	5.821	6.866	13.625	15.393	1.723	1.533	0.231	0.498	1.304	3.604	1.802	0.260	0.046	0.018	0.001	0.051
2001	14.317	16.887	33.515	17.994	2.175	2.242	0.310	0.682	1.835	5.091	2.640	0.382	0.079	0.024	0.005	0.000	0.097
2000	41.536	82.432	44.281	2.618	3.208	0.397	0.911	2.567	7.316	4.194	0.677	0.169	0.046	0.031	0.025	0.025	0.163
1999	202.751	108.915	6.446	3.876	0.500	1.204	3.446	10.229	6.127	1.101	0.310	0.069	0.079	0.037	0.124	0.000	0.355
1998	267.887	15.855	9.663	0.657	1.660	4.401	13.782	8.481	1.690	0.500	0.126	0.119	0.047	0.266	0.006	0.663	0.005
1997	38.997	23.768	1.651	2.070	5.405	17.948	12.002	2.784	0.933	0.212	0.159	0.089	0.407	0.028	1.170	0.001	0.006
1996	58.460	4.060	5.138	6.316	21.622	15.638	4.249	1.522	0.357	0.191	0.112	0.544	0.051	2.261	0.002	0.000	0.011
1995	9.986	12.637	15.538	25.184	18.542	5.608	2.456	0.664	0.239	0.147	0.707	0.150	3.610	0.006	0.000	0.000	0.017
1994	31.083	38.217	61.954	21.578	6.634	3.246	0.949	0.295	0.179	0.861	0.212	4.890	0.010	0.000	0.000	0.023	0.006
1993	94.008	152.383	53.085	7.738	3.887	1.197	0.352	0.212	1.033	0.267	6.123	0.012	0.000	0.000	0.027	0.000	0.010
1992	374.804	130.568	19.035	4.529	1.426	0.414	0.248	1.213	0.316	7.357	0.017	0.002	0.000	0.033	0.000	0.000	0.016
1991	321.146	46.823	11.145	1.666	0.484	0.289	1.425	0.377	8.784	0.022	0.003	0.000	0.039	0.000	0.000	0.024	0.002
1990	115.167	27.413	4.122	0.582	0.339	1.668	0.449	10.449	0.027	0.005	0.003	0.048	0.000	0.000	0.029	0.001	0.002
1989	67.436	10.143	1.472	0.397	1.942	0.528	12.490	0.035	0.006	0.004	0.059	0.002	0.001	0.034	0.002	0.000	0.003
1988	24.971	3.624	0.991	2.324	0.641	15.104	0.051	0.011	0.011	0.085	0.012	0.005	0.043	0.005	0.002	0.002	0.003
1987	8.935	2.447	5.772	0.766	18.089	0.079	0.017	0.021	0.128	0.027	0.016	0.055	0.014	0.009	0.010	0.001	0.004
1986	6.041	14.200	1.888	21.598	0.111	0.035	0.041	0.262	0.113	0.063	0.147	0.037	0.082	0.097	0.002	0.000	0.007
1985	34.970	4.665	53.449	0.152	0.058	0.065	0.445	0.194	0.133	0.238	0.054	0.128	0.167	0.002	0.000	0.000	0.014
1984	11.528	131.465	0.378	0.072	0.081	0.583	0.246	0.168	0.294	0.071	0.167	0.201	0.002	0.000	0.000	0.026	0.000
1983	323.552	0.938	0.179	0.098	0.700	0.296	0.202	0.348	0.084	0.198	0.242	0.003	0.000	0.000	0.032	0.000	0.000
1982	2.343	0.442	0.241	0.829	0.352	0.240	0.412	0.099	0.236	0.287	0.003	0.000	0.000	0.037	0.000	0.000	0.000
1981	1.100	0.595	2.057	0.413	0.283	0.487	0.118	0.279	0.343	0.004	0.000	0.000	0.044	0.000	0.000	0.000	0.000
1980	1.474	5.060	1.017	0.336	0.573	0.139	0.333	0.415	0.005	0.000	0.000	0.054	0.000	0.000	0.000	0.000	0.000
1979	12.498	2.508	0.830	0.672	0.164	0.394	0.494	0.007	0.000	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.001
1978	6.201	2.044	1.655	0.194	0.471	0.596	0.009	0.000	0.001	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.002
1977	5.095	4.080	0.482	0.571	0.718	0.010	0.000	0.002	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
1976	10.068	1.188	1.407	0.860	0.018	0.000	0.002	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
1975	2.971	3.467	2.117	0.024	0.000	0.004	0.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
1974	8.631	5.220	0.066	0.000	0.004	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
1973	12.884	0.168	0.005	0.008	0.317	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023
1972	0.957	0.077	0.051	0.407	0.005	0.006	0.003	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037
1971	0.236	0.193	1.134	0.008	0.008	0.005	0.002	0.003	0.002	0.000	0.006	0.008	0.007	0.000	0.000	0.000	0.061
1970	0.661	3.620	0.072	0.017	0.026	0.003	0.007	0.005	0.002	0.021	0.038	0.038	0.000	0.000	0.000	0.000	0.101
1969	9.785	0.972	0.263	0.233	0.004	0.018	0.011	0.003	0.037	0.080	0.083	0.000	0.000	0.000	0.000	0.000	0.168
1968	5.187	1.333	1.182	0.111	2.048	1.509	0.018	0.144	0.238	0.469	0.003	0.002	0.002	0.003	0.004	0.003	0.276
1967	3.947	18.398	0.384	3.880	5.260	0.050	0.622	1.496	2.400	0.013	0.008	0.006	0.013	0.014	0.022	0.020	0.455
1966	51.409	1.984	12.175	8.320	0.087	1.225	3.146	5.897	0.056	0.025	0.025	0.043	0.028	0.100	0.100	0.148	0.719
1965	8.491	35.874	24.938	0.198	1.700	4.271	9.222	0.086	0.045	0.037	0.071	0.076	0.224	0.233	0.321	1.627	0.148
1964	93.903	65.617	0.833	2.098	5.392	12.920	0.115	0.054	0.047	0.109	0.120	0.364	0.359	0.538	2.724	0.180	0.295
1963	168.931	5.371	8.368	7.085	15.912	0.139	0.064	0.058	0.146	0.149	0.539	0.517	0.813	4.160	0.294	0.286	0.573
1962	19.003	26.983	19.058	20.474	0.170	0.078	0.075	0.192	0.186	0.690	0.658	1.070	5.710	0.390	0.391	0.517	0.589
1961	76.103	72.088	54.883	0.231	0.099	0.092	0.239	0.237	0.868	0.817	1.390	7.419	0.506	0.503	0.669	0.233	0.849
1960	197.514	156.290	1.185	0.247	0.127	0.308	0.302	1.112	1.029	1.835	9.874	0.680	0.725	0.942	0.331	0.392	1.057

Table 3.7.4.1 Norwegian Spring-spawning herring. Stock numbers final assessment (con't)

1959	412.478	3.225	1.117	0.163	0.387	0.379	1.449	1.319	2.391	12.661	0.886	0.976	1.308	0.480	0.539	0.860	1.040
1958	23.094	7.136	1.447	0.468	0.460	1.804	1.628	2.988	15.760	1.105	1.266	1.737	0.665	0.709	1.075	0.948	0.959
1957	25.397	8.719	1.496	0.559	2.498	2.058	3.718	20.450	1.362	1.608	2.214	0.867	0.955	1.410	1.244	0.381	1.440
1956	29.858	6.852	2.358	3.028	2.662	4.658	26.514	1.701	2.089	2.857	1.149	1.323	1.932	1.621	0.510	0.787	1.905
1955	24.971	10.303	8.247	3.193	5.710	33.009	2.099	2.631	3.616	1.427	1.745	2.564	2.102	0.656	1.005	1.124	2.629
1954	42.086	31.374	9.195	6.921	39.898	2.593	3.311	4.730	1.795	2.243	3.453	2.939	0.858	1.277	1.449	1.115	3.831
1953	86.102	30.543	17.934	47.153	3.063	3.956	5.878	2.174	2.726	4.351	3.840	1.063	1.581	1.785	1.402	3.082	4.103
1952	96.644	58.460	117.910	3.601	4.661	7.479	2.673	3.387	5.465	4.869	1.321	1.930	2.190	1.744	3.782	3.938	3.488
1951	146.355	301.944	9.484	5.422	9.103	3.292	4.113	6.905	6.306	1.617	2.331	2.656	2.142	4.667	4.950	0.757	5.388
1950	750.680	26.465	14.278	10.874	4.023	4.978	8.612	8.004	1.965	2.804	3.203	2.583	5.632	6.148	0.952	2.567	6.709

Table 3.7.4.2 Norwegian Spring-spawning herring. Summary table SeaStar. Biomass in million tonnes.

Summary table SeaStar. Biomass in million tonnes.

	Recruits Age 0	Total biomass	Spawning stock biomass	Fbar 5-14
1950	750.680	20.013	14.359	0.058
1951	146.355	19.274	12.635	0.070
1952	96.644	20.182	11.042	0.073
1953	86.102	17.419	9.457	0.066
1954	42.086	18.565	8.703	0.113
1955	24.971	15.725	9.324	0.078
1956	29.858	13.799	10.934	0.110
1957	25.397	11.088	9.661	0.103
1958	23.094	9.549	8.731	0.079
1959	412.478	8.076	7.200	0.113
1960	197.514	7.634	5.853	0.136
1961	76.103	7.796	4.403	0.104
1962	19.003	6.765	3.443	0.146
1963	168.931	6.913	2.641	0.253
1964	93.903	6.446	2.479	0.226
1965	8.491	5.935	2.996	0.278
1966	51.409	4.392	2.658	0.696
1967	3.947	3.018	1.304	1.519
1968	5.187	0.982	0.318	3.493
1969	9.785	0.190	0.142	0.590
1970	0.661	0.116	0.069	1.320
1971	0.236	0.130	0.032	1.525
1972	0.957	0.085	0.016	1.497
1973	12.884	0.112	0.086	1.173
1974	8.631	0.160	0.091	0.114
1975	2.971	0.302	0.079	0.190
1976	10.068	0.362	0.139	0.106
1977	5.095	0.429	0.288	0.111
1978	6.201	0.579	0.360	0.043
1979	12.498	0.635	0.391	0.024
1980	1.474	0.748	0.475	0.034
1981	1.100	0.796	0.509	0.022
1982	2.343	0.729	0.507	0.020
1983	323.552	1.087	0.579	0.029
1984	11.528	2.014	0.603	0.090
1985	34.970	5.182	0.502	0.379
1986	6.041	1.819	0.402	1.074
1987	8.935	3.126	0.880	0.404
1988	24.971	3.496	2.749	0.045
1989	67.436	4.078	3.347	0.028
1990	115.167	4.563	3.501	0.022
1991	321.146	5.203	3.640	0.025
1992	374.804	6.231	3.506	0.029
1993	94.008	7.305	3.361	0.068
1994	31.083	8.323	3.785	0.139
1995	9.986	9.124	4.611	0.239
1996	58.460	9.196	6.151	0.195
1997	38.997	9.105	7.370	0.185
1998	267.887	7.952	6.642	0.166
1999	202.751	9.042	6.021	0.208
2000	41.536	8.171	4.725	0.256
2001	14.317	6.949	3.976	0.208
2002	295.054	7.424	4.047	0.224
2003	162.158	8.772	5.299	0.134
2004	408.177	10.411	6.692	0.160

Table 3.9.1.1 Norwegian Spring-spawning herring. Input to the short term prediction

Landings in 2005 1. million tonnes
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Total biomass in 2005 11.0877 million tonnes
Spawning stock biomass in 2005 6.0438 million tonnes
Fbar in 2005 0.178015
Part of year before spawning: 0.1

	Numbers (billion) 2005	Weight stock 2005	Weight stock 2006	Weight stock 2007	Weight catch (kg)	Fraction mature 2005	Fraction mature 2006	Fraction mature 2007	Exploitation pattern
0	0.000	0.001	0.001	0.001	0.007	0.000	0.000	0.000	0.000
1	165.952	0.010	0.010	0.010	0.065	0.000	0.000	0.000	0.000
2	26.803	0.047	0.050	0.050	0.143	0.000	0.000	0.000	0.002
3	19.801	0.112	0.110	0.110	0.183	0.150	0.100	0.100	0.013
4	0.797	0.154	0.160	0.160	0.211	0.450	0.600	0.600	0.047
5	1.847	0.233	0.249	0.246	0.236	0.900	0.900	0.900	0.109
6	7.476	0.265	0.282	0.279	0.263	1.000	1.000	1.000	0.180
7	7.661	0.289	0.310	0.306	0.297	1.000	1.000	1.000	0.215
8	0.596	0.317	0.339	0.335	0.342	1.000	1.000	1.000	0.237
9	0.464	0.354	0.367	0.362	0.358	1.000	1.000	1.000	0.258
10	0.077	0.362	0.379	0.375	0.361	1.000	1.000	1.000	0.252
11	0.129	0.411	0.416	0.411	0.382	1.000	1.000	1.000	0.295
12	0.301	0.394	0.406	0.401	0.389	1.000	1.000	1.000	0.303
13	0.998	0.398	0.409	0.405	0.399	1.000	1.000	1.000	0.470
14	0.543	0.413	0.423	0.418	0.420	1.000	1.000	1.000	0.663
15	0.069	0.442	0.470	0.464	0.439	1.000	1.000	1.000	0.198
16	0.019	0.445	0.470	0.464	0.439	1.000	1.000	1.000	0.276

Table 3.9.1.2 Norwegian spring spawning herring. Short term prediction and two optional runs.

Short term:

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.511	0.115	0.592	12.046	8.194
6.509	0.120	0.616	12.021	8.168
6.506	0.125	0.640	11.997	8.142
6.504	0.130	0.664	11.973	8.117
6.501	0.135	0.688	11.949	8.091
6.498	0.140	0.712	11.925	8.066
6.496	0.145	0.736	11.901	8.040
6.493	0.150	0.759	11.877	8.015
6.490	0.155	0.783	11.854	7.990
6.488	0.160	0.806	11.830	7.965

Optional 1. Short term, selection on age 4 as on age 5

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.505	0.115	0.687	11.941	8.099
6.503	0.120	0.715	11.912	8.069
6.500	0.125	0.744	11.883	8.039
6.497	0.130	0.771	11.855	8.010
6.494	0.135	0.799	11.827	7.980
6.491	0.140	0.827	11.799	7.951
6.488	0.145	0.855	11.770	7.922
6.486	0.150	0.882	11.743	7.893
6.483	0.155	0.909	11.715	7.864
6.480	0.160	0.937	11.687	7.836

Optional 2. Catches in 2006 and SSB in 2007 when a regression of catch to historic Fbar was used.

Fbar	Catch 2006	SSB 2007
0.115	0.741	8.027
0.120	0.772	7.990
0.125	0.803	7.954
0.130	0.834	7.917
0.135	0.865	7.881
0.140	0.895	7.845
0.145	0.926	7.810
0.150	0.957	7.774

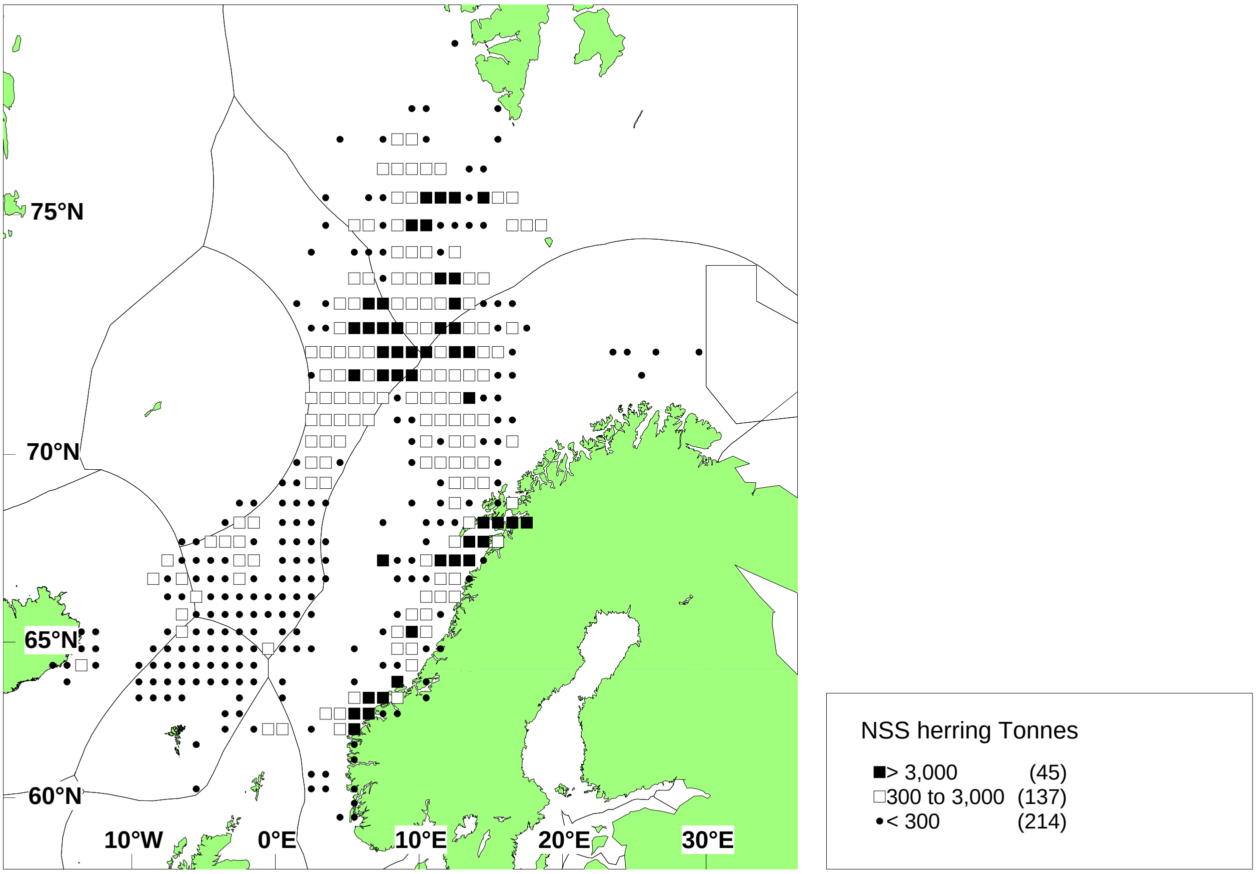


Figure 3.3.1. Total reported of Norwegian spring-spawning herring in 2004 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t.

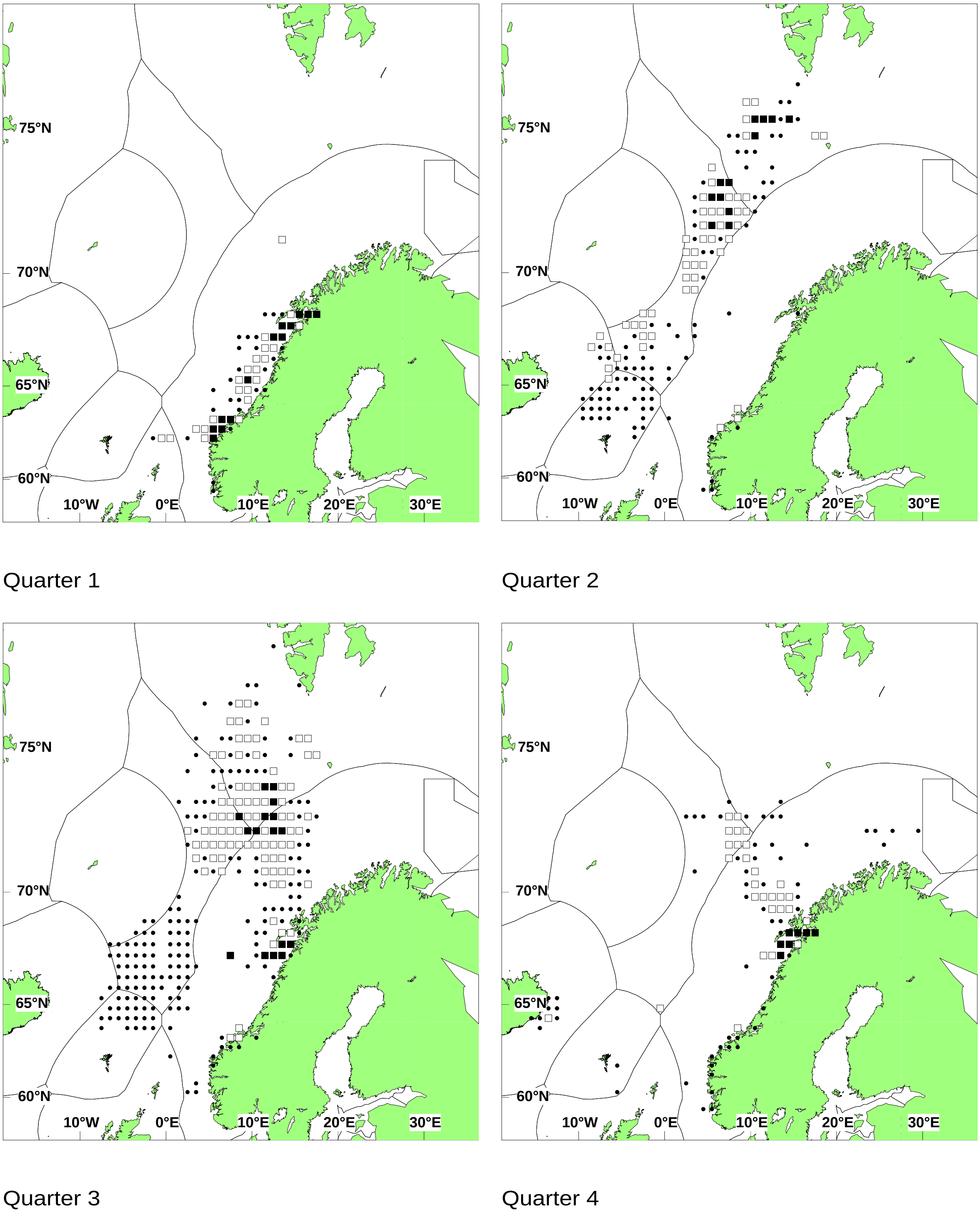


Figure 3.3.2. Total catches of Norwegian spring-spawning herring in 2004 by quarter and ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t. Some catches reported in the northern part of the North Sea in first quarter are considered to be of autumn-spawning origin.

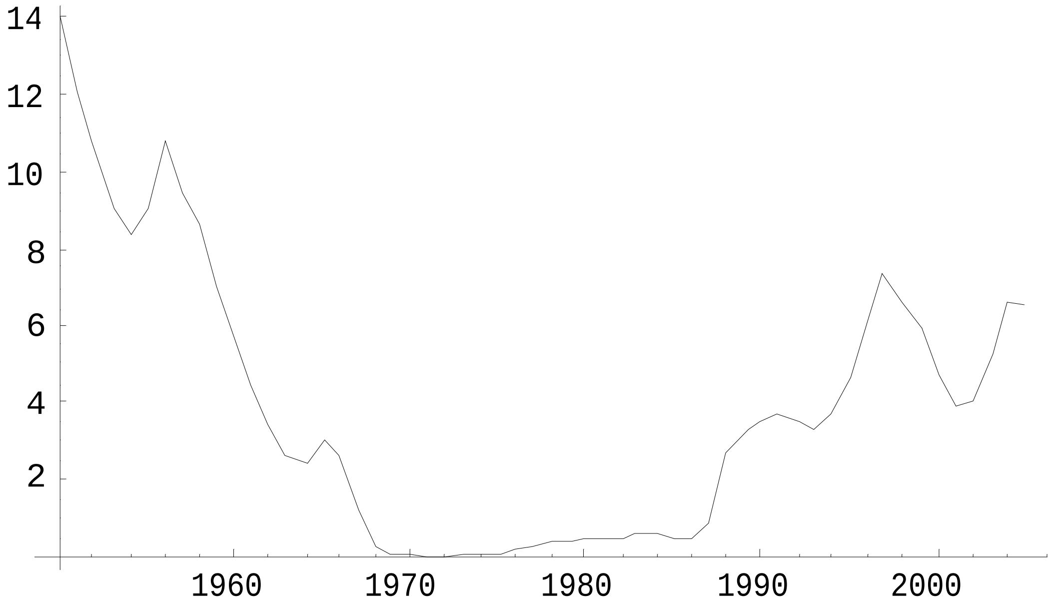


Figure 3.7.2.1.1. Spawning stock history (million tonnes) of Norwegian spring spawning herring as estimated by SeaStar.

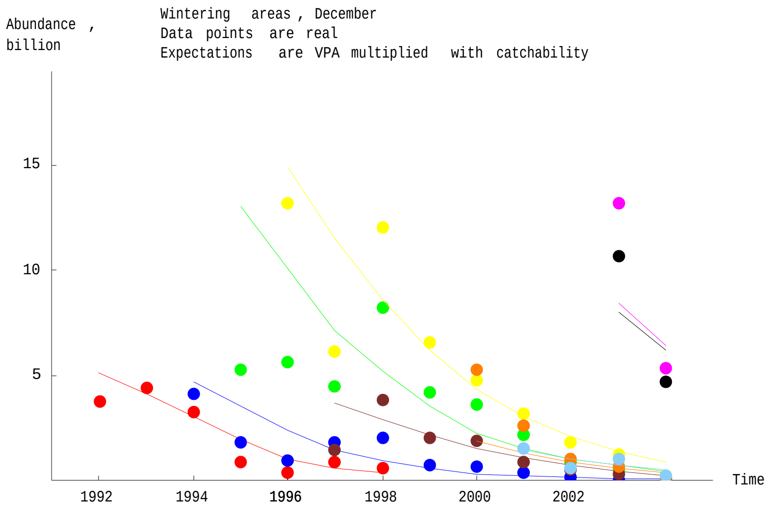


Figure 3.7.2.1.2. Estimated year classes and fit to the December survey in Vestfjorden, SeaStar assessment.

Spawning grounds

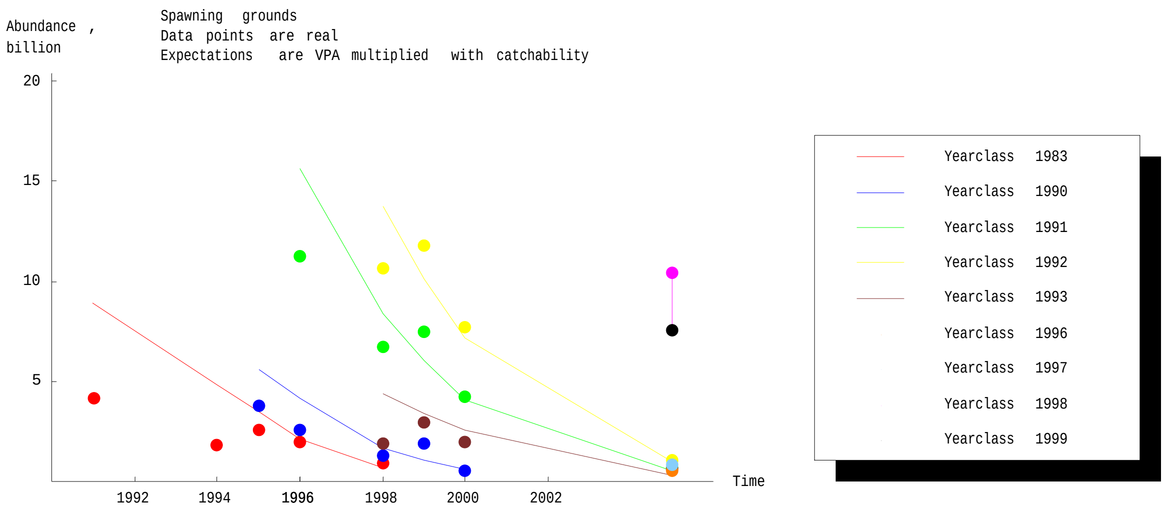


Figure 3.7.2.1.3. Estimated year classes and fit to the spawning stock survey along the Norwegian coast, SeaStar assessment.

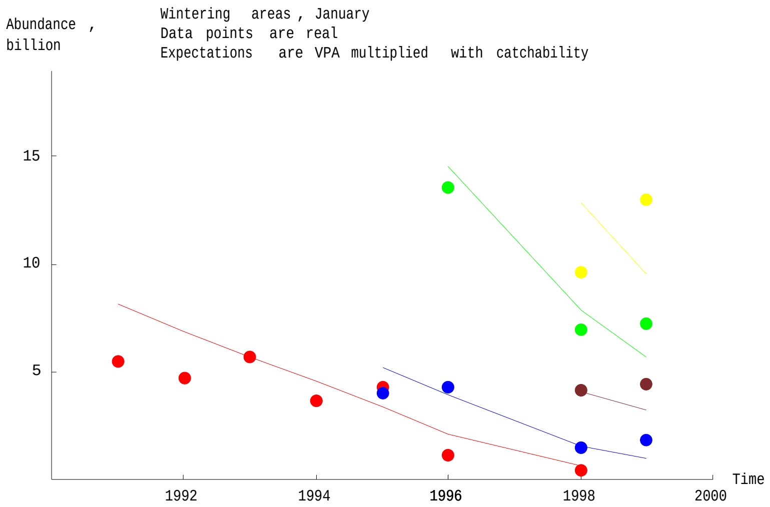


Figure 3.7.2.1.4. Estimated year classes and fit to the January survey in Vestfjorden, SeaStar assessment.

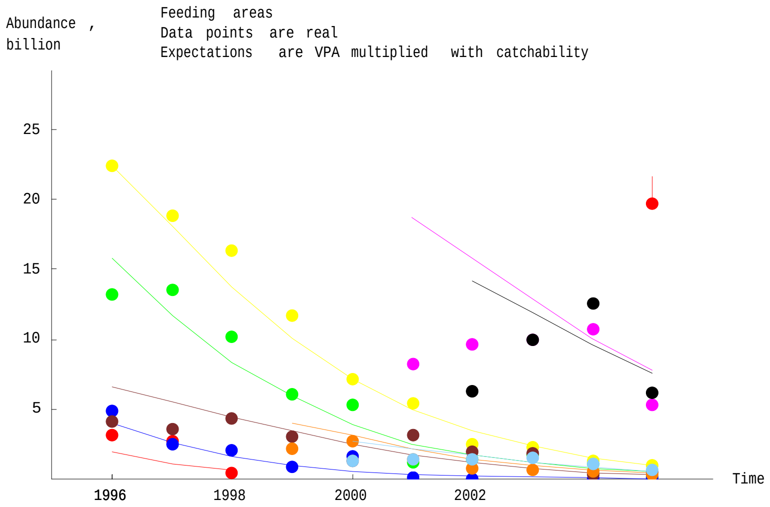


Figure 3.7.2.1.5. Estimated year classes and fit to the May survey on feeding grounds in the Norwegian Sea, SeaStar assessment.

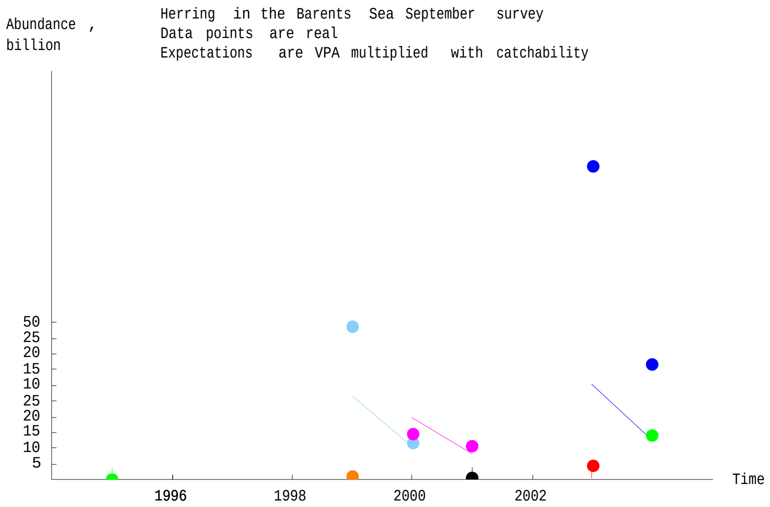


Figure 3.7.2.1.6. Estimated year classes and fit to the September survey in the Barents Sea, SeaStar assessment.

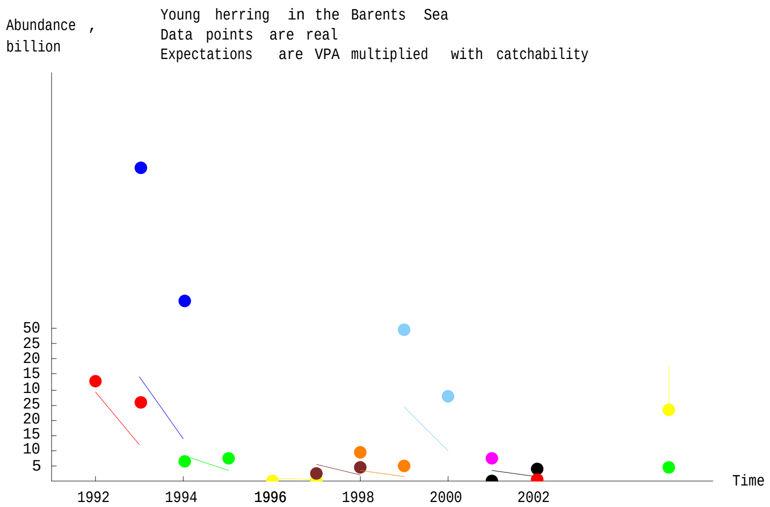


Figure 3.7.2.1.7. Estimated year classes and fit to the May survey in the Barents Sea, SeaStar assessment.

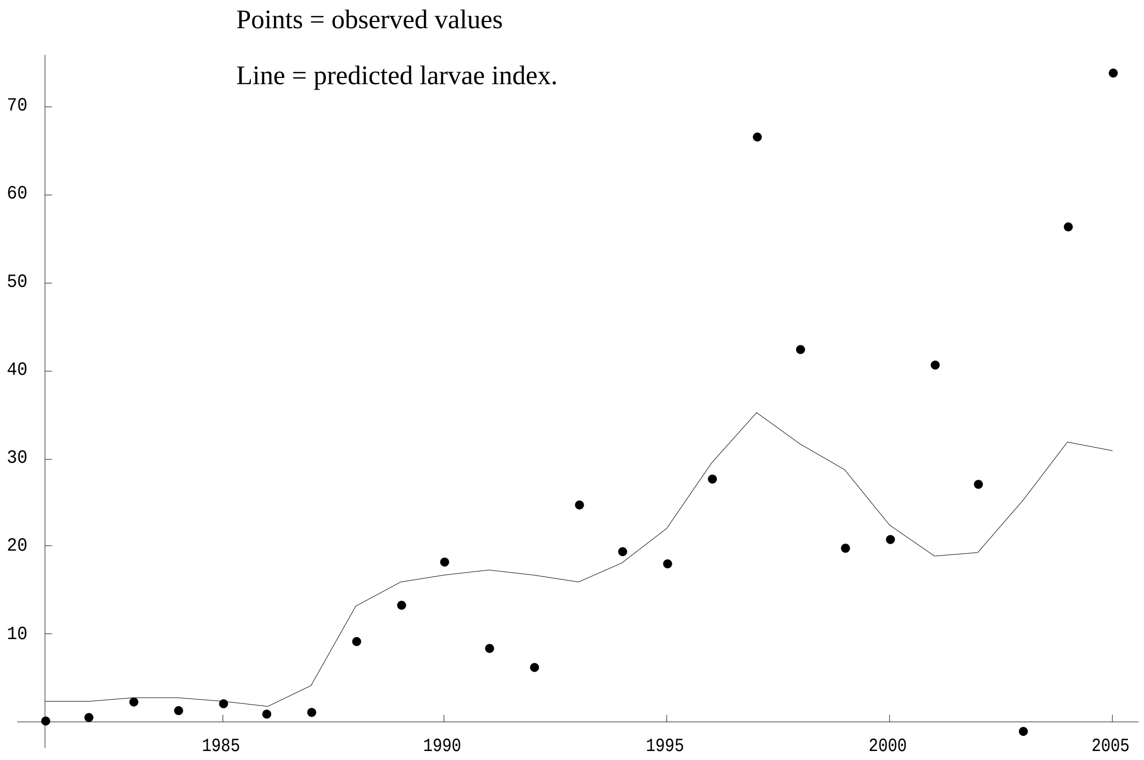


Figure 3.7.2.1.8. SSB for Norwegian spring spawning herring estimated by SeaStar and fit to larval data. 2003 point below X-axis marks deletion.

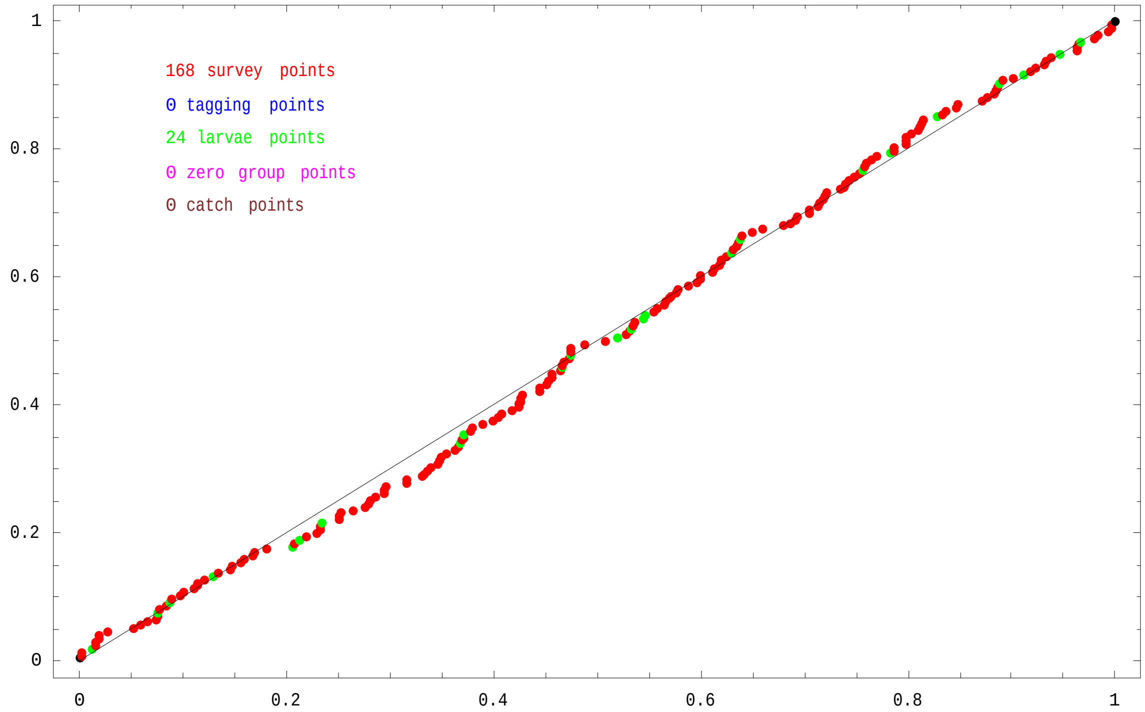


Figure 3.7.2.1.9. Quantile-quantile plot for survey and larval data for the SeaStar assessment of Norwegian spring spawning herring.

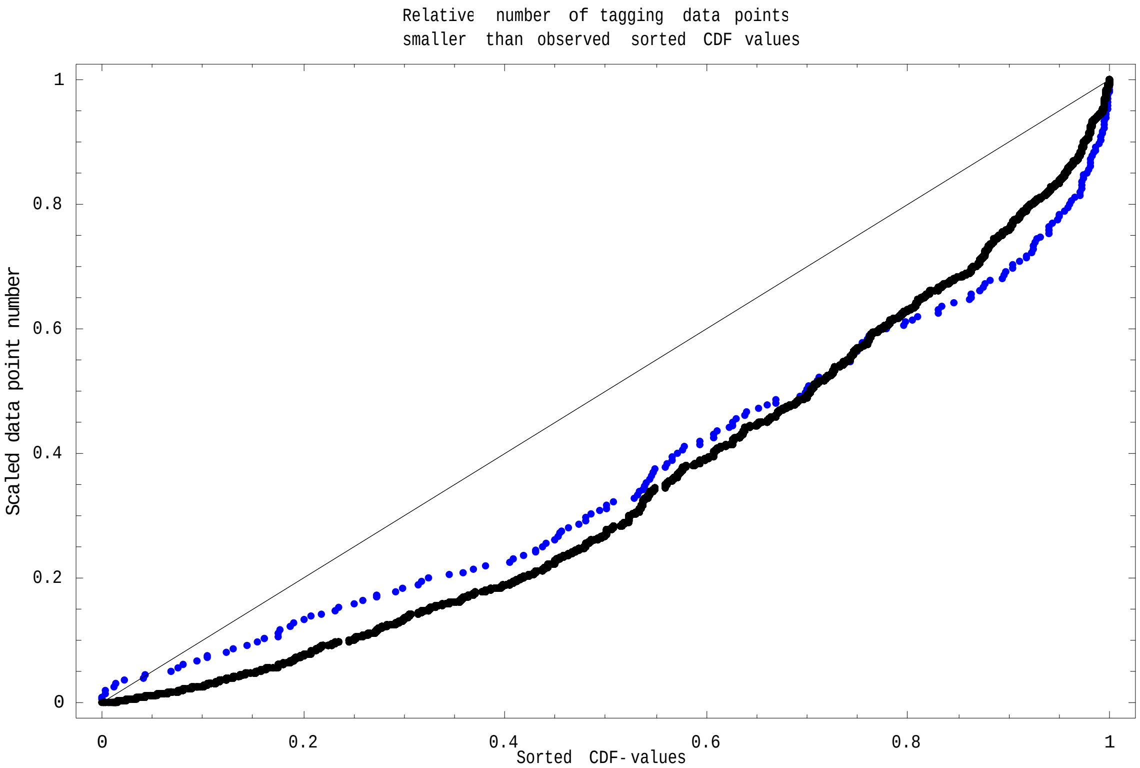


Figure 3.7.2.1.10. Quantile-quantile plot (blue points) for tag return data for the SeaStar assessment of Norwegian spring spawning herring. The black line shows the simulated theoretical curve for a perfect fit.

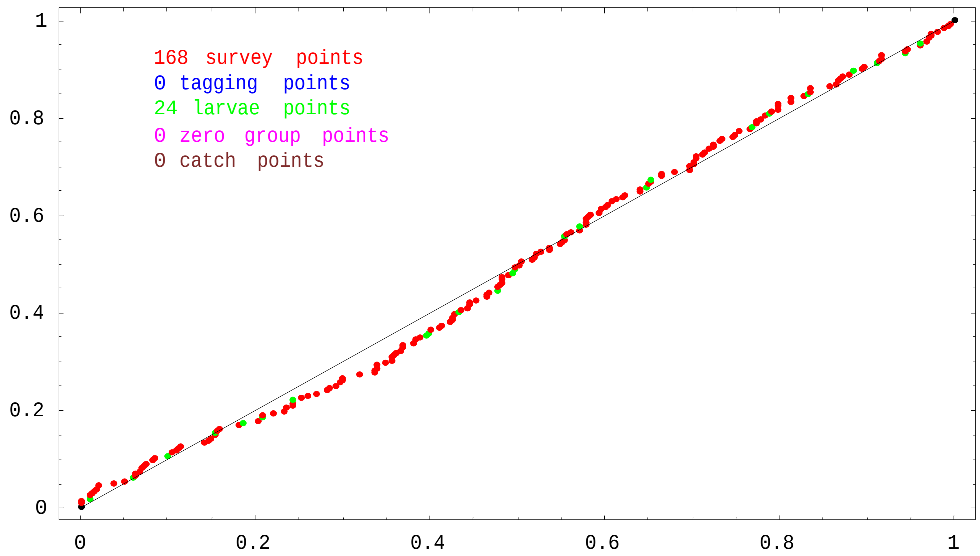


Figure 3.7.2.1.11. Quantile-quantile plot (blue points) for tag return data for the SeaStar assessment of Norwegian spring spawning herring when the log normal distribution is assumed for surveys in the Norwegian Sea and along the Norwegian coast.

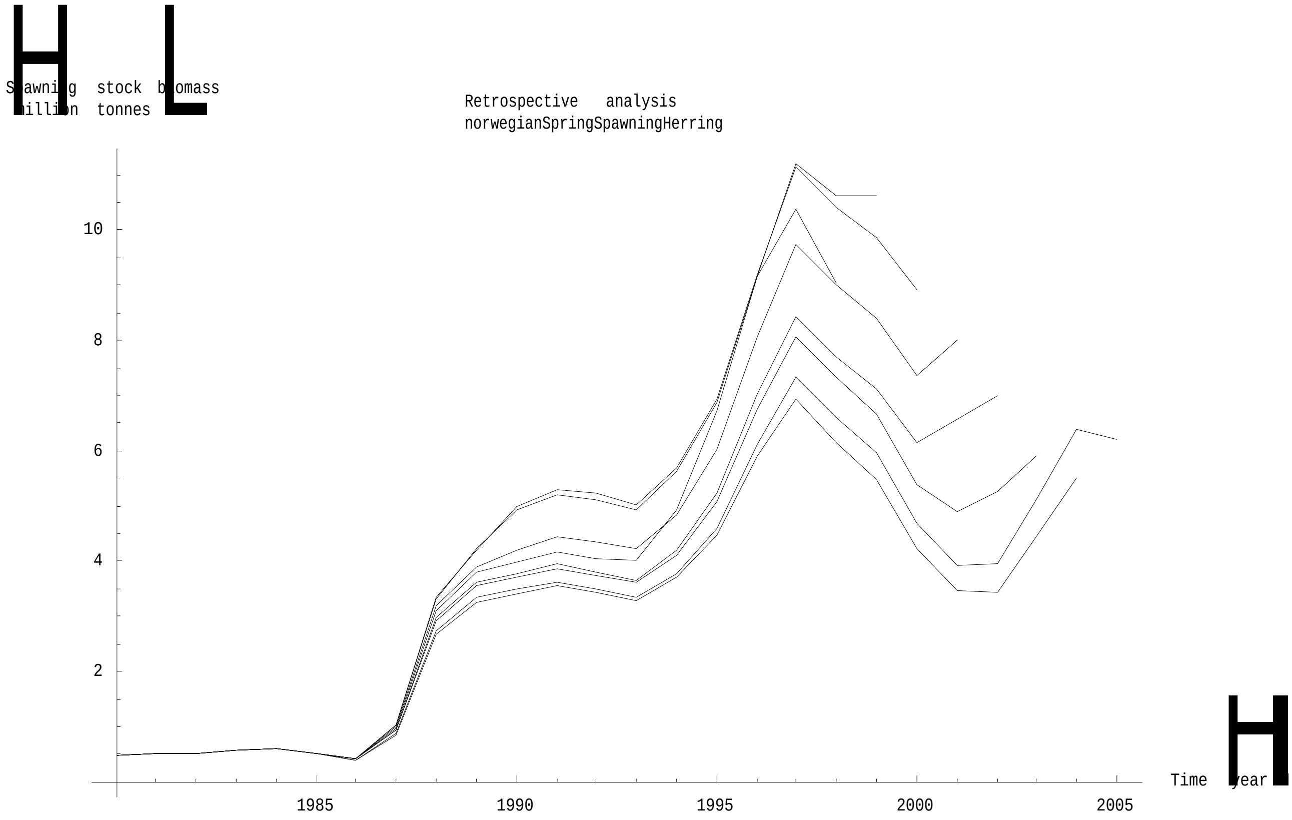


Figure 3.7.2.1.12. Retrospective plot for the SeaStar assessment of Norwegian spring spawning herring.

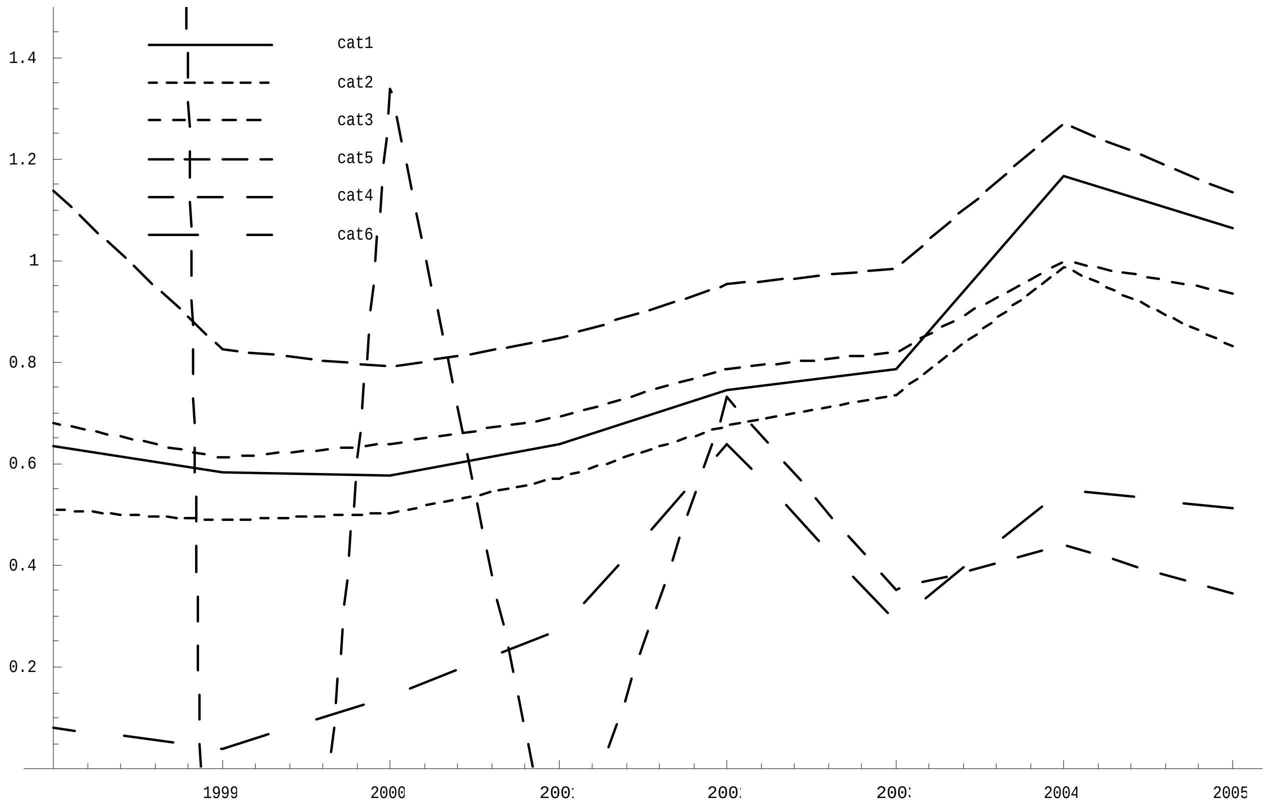
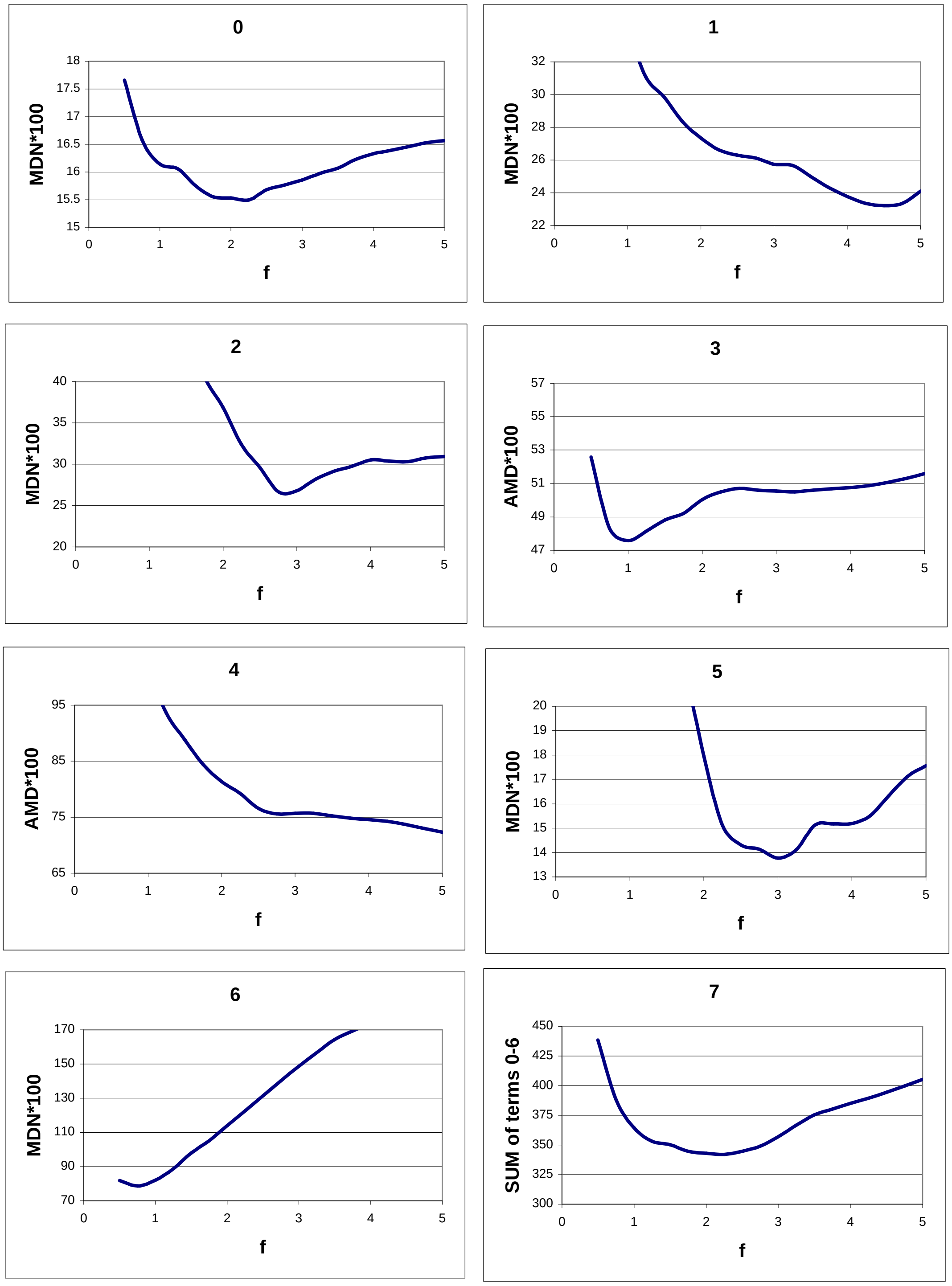
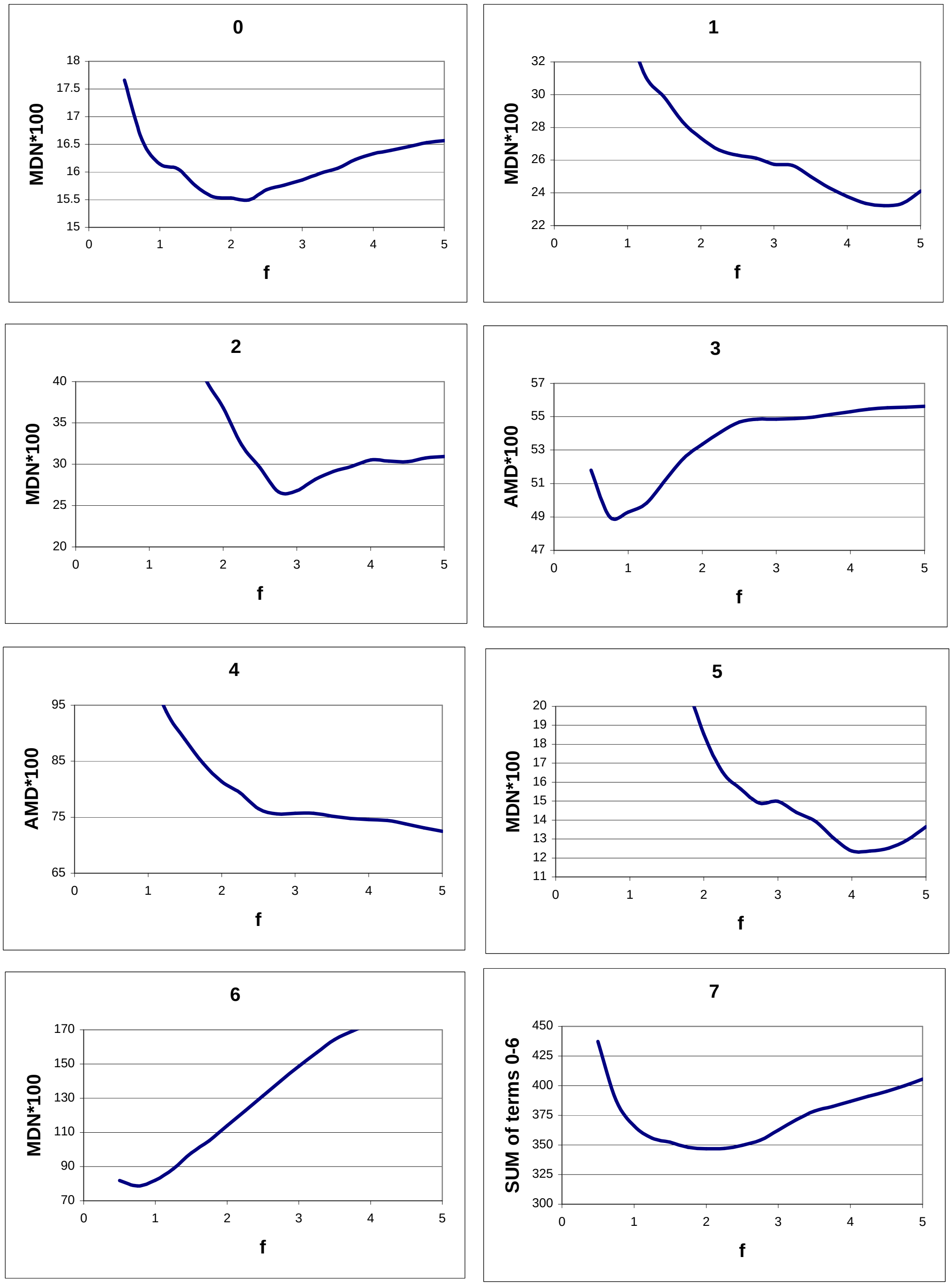


Figure 3.7.2.1.13. Retrospective trend in the estimation of catchabilities of acoustic surveys in the SeaStar assessment of Norwegian spring spawning herring.



0- catch-at-age
1- spawning grounds acoustic in Febr.-March
2-acoust. surv. in wint. area Nov.-December
3- acust. in wintering areas, January
4- Young herring in the Barents Sea (June)
5- Feeding areas, May
6-Young herring in the Barents Sea, September survey

Figure 3.7.2.2.1. Profiles of components of ISVPA loss function for different sources of data (SPALY run).



0- catch-at-age
1- spawning grounds acoustic in Febr.-March
2-acoust. surv. in wint. area Nov.-December
3- acust. in wintering areas, January
4- Young herring in the Barents Sea (June)
5- Feeding areas, May
6-Young herring in the Barents Sea, September survey
(in thel ast year report there was a missspecification in pictire 6 - it was MDN!!!).

Fig. 3.7.2.2.2 Profiles of components of the ISVPA loss function for “masked” surveys data (masking - from SeaStar)

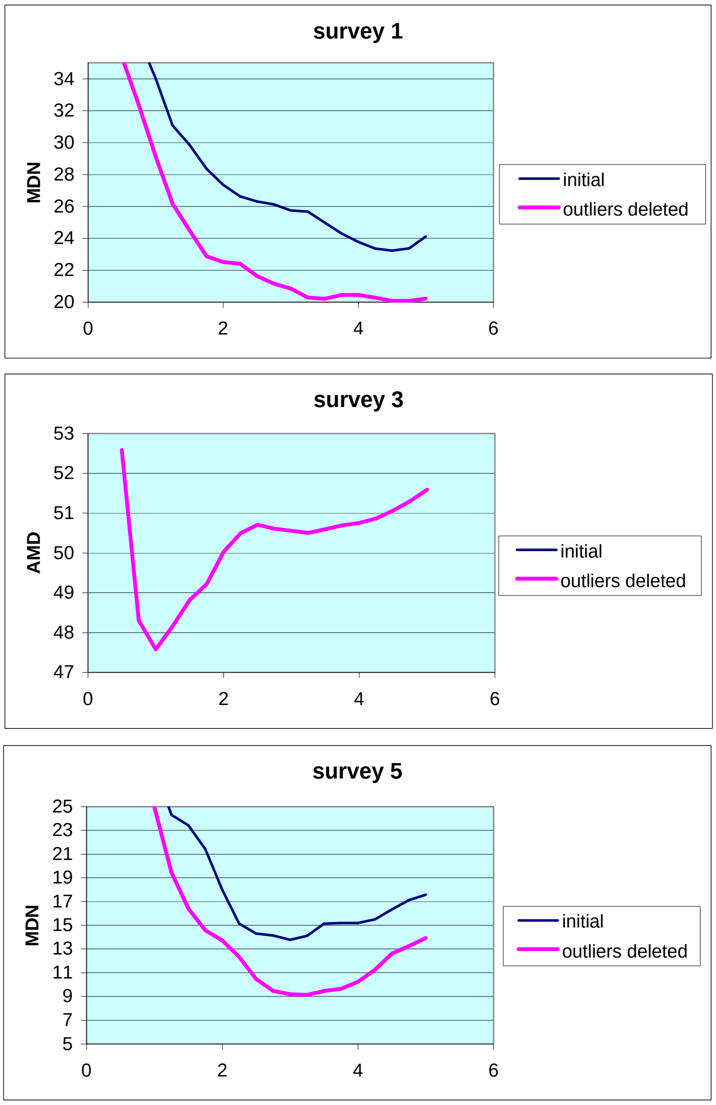


Figure 3.7.2.2.3 Influence of the outliers' exclusion (using "X-84" rule) on the respective components of the ISVPA loss function.

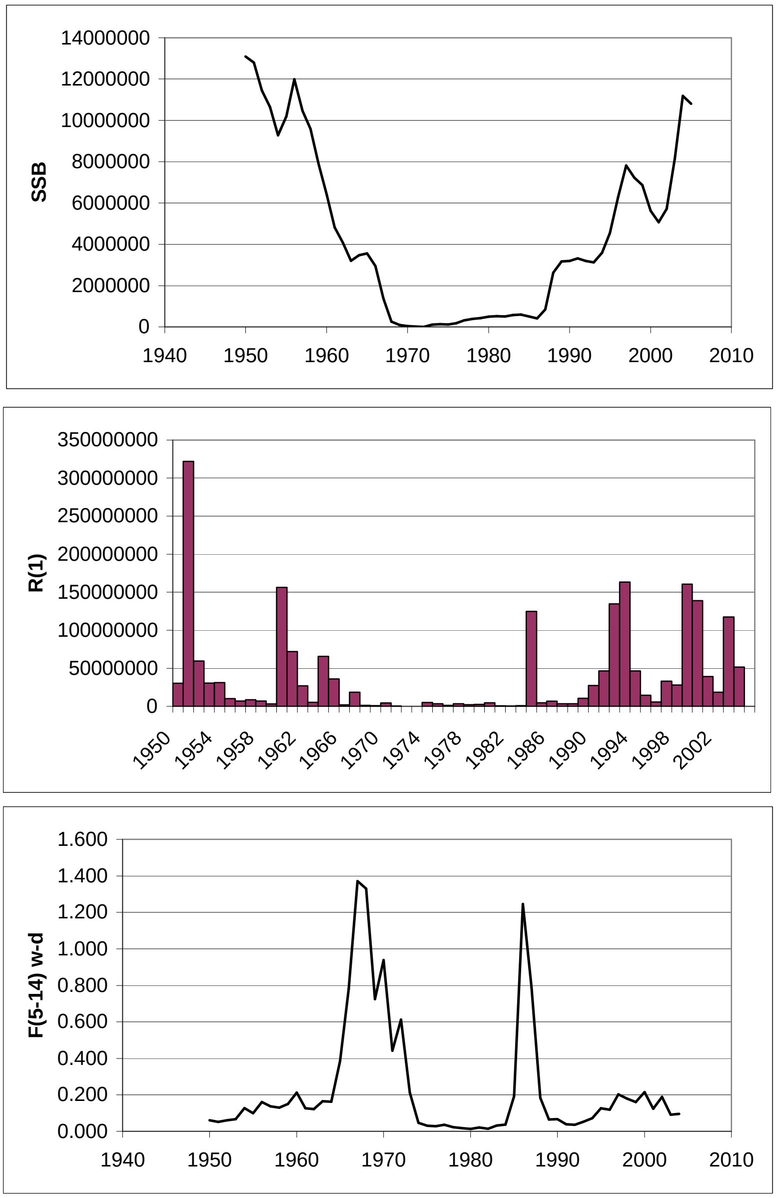


Figure. 3.7.2.2.4 . Results of NSS herring stock assessment by ISVPA

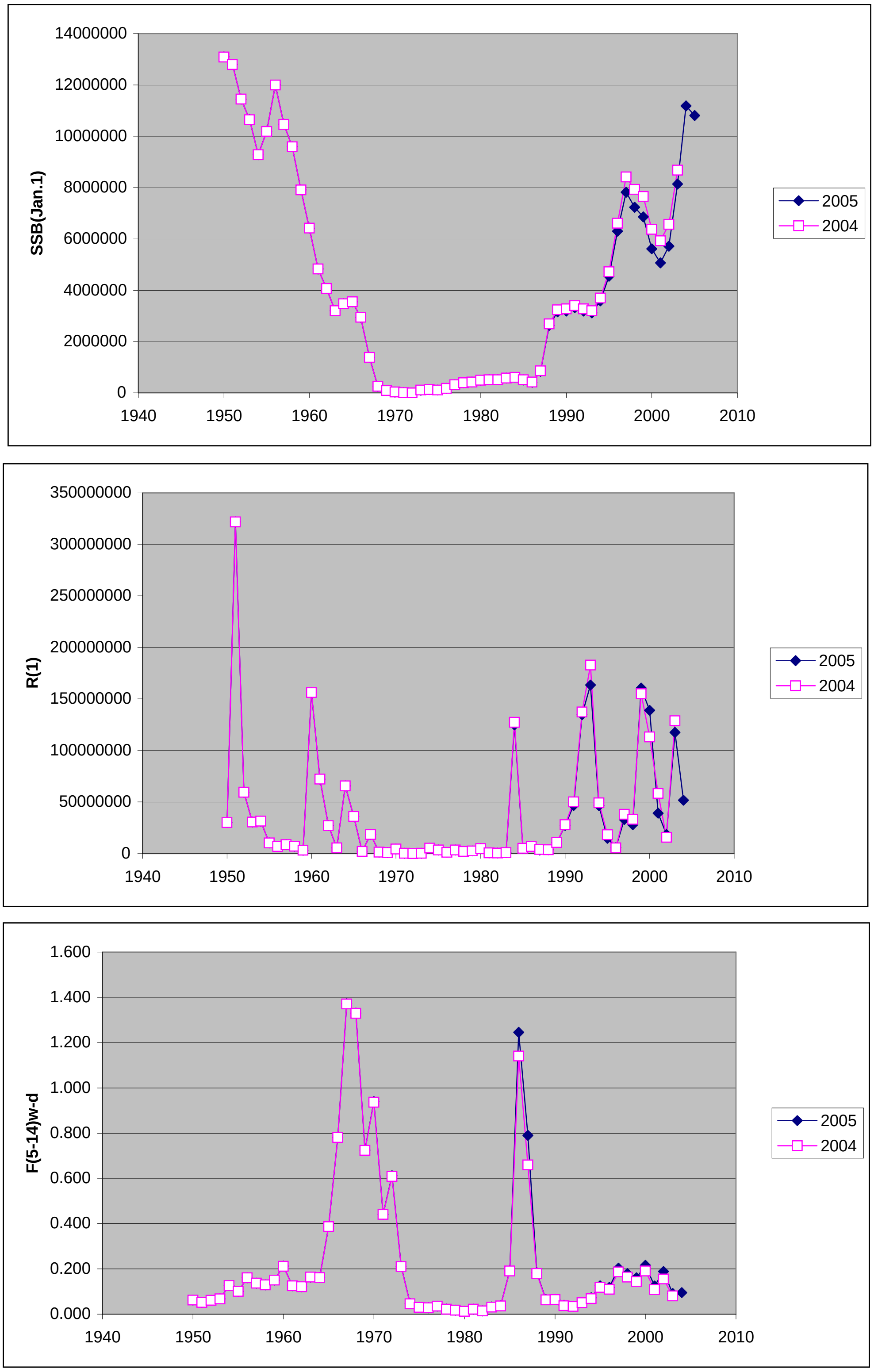


Figure. 3.7.2.2.5. NSS herring. ISVPA. Comparison to previous assessment

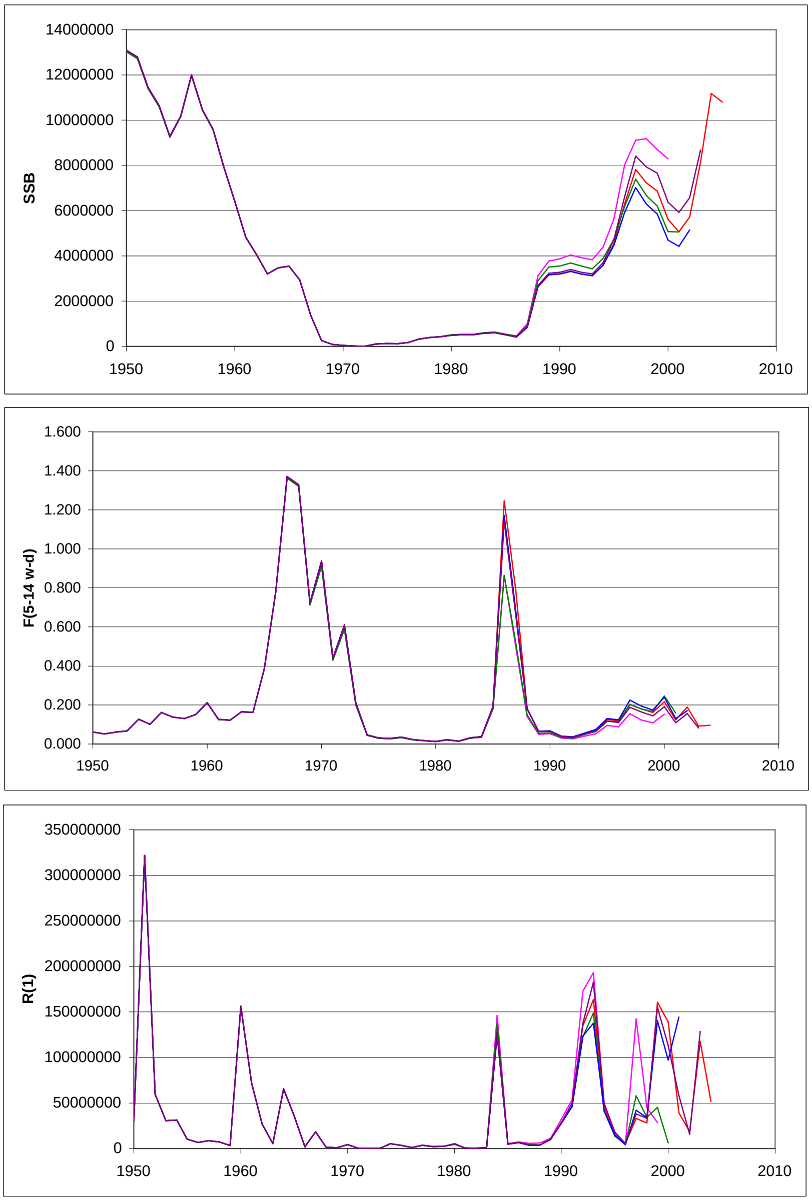
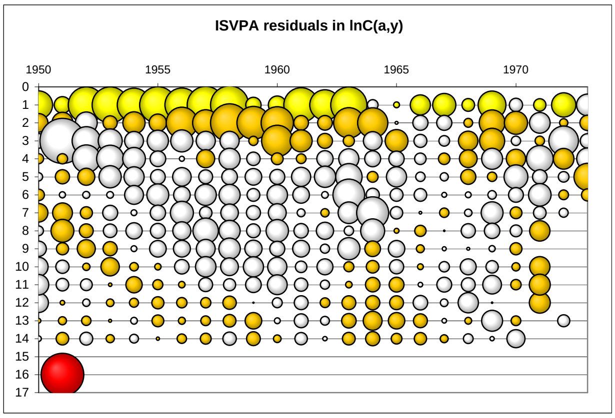
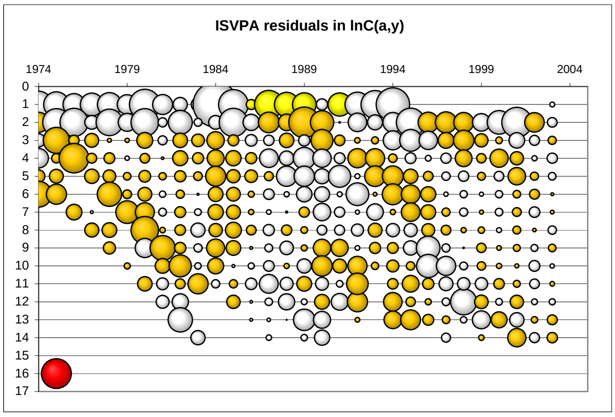
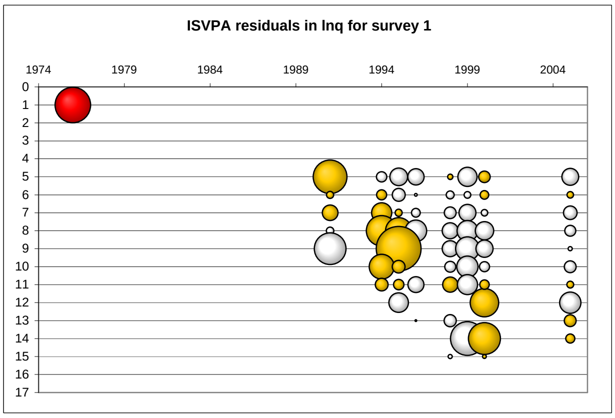
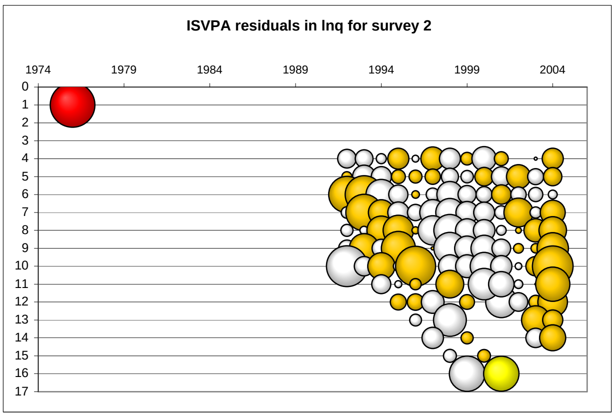


Figure 3.7.2.2.6 NSS herring, ISVPA, retrospective runs.


ISVPA residuals in lnC(a,y)
1950
1955
1960
1965
1970
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17


ISVPA residuals in lnC(a,y)
1974
1979
1984
1989
1994
1999
2004
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17


ISVPA residuals in lnq for survey 1
1974
1979
1984
1989
1994
1999
2004
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17


ISVPA residuals in lnq for survey 2
1974
1979
1984
1989
1994
1999
2004
0
1
2
3
4
5
6
7
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9
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11
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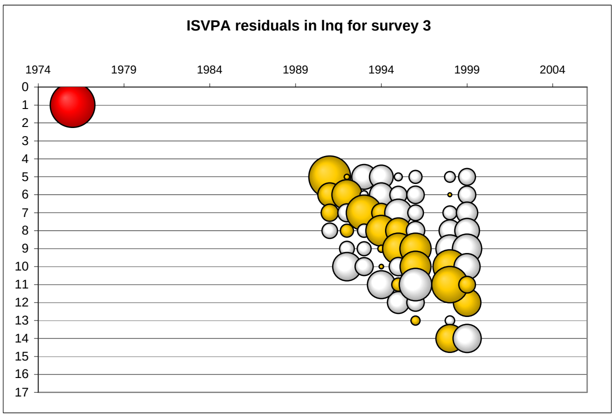
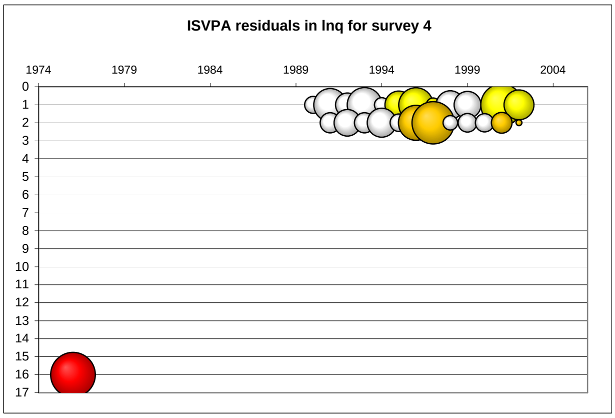
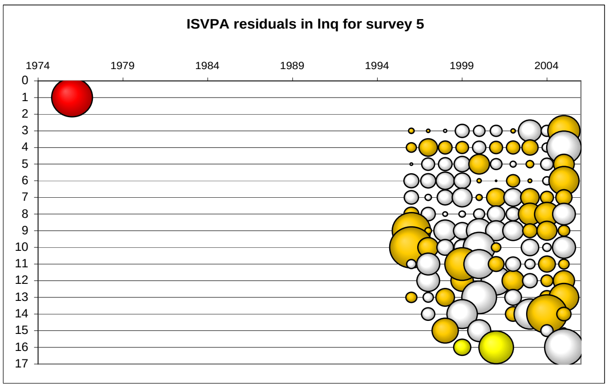
13
14
15
16
17







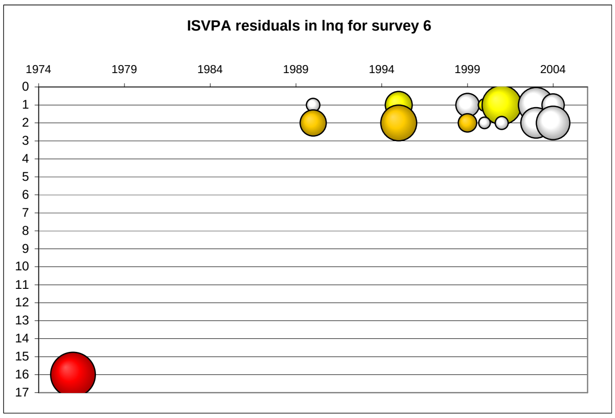
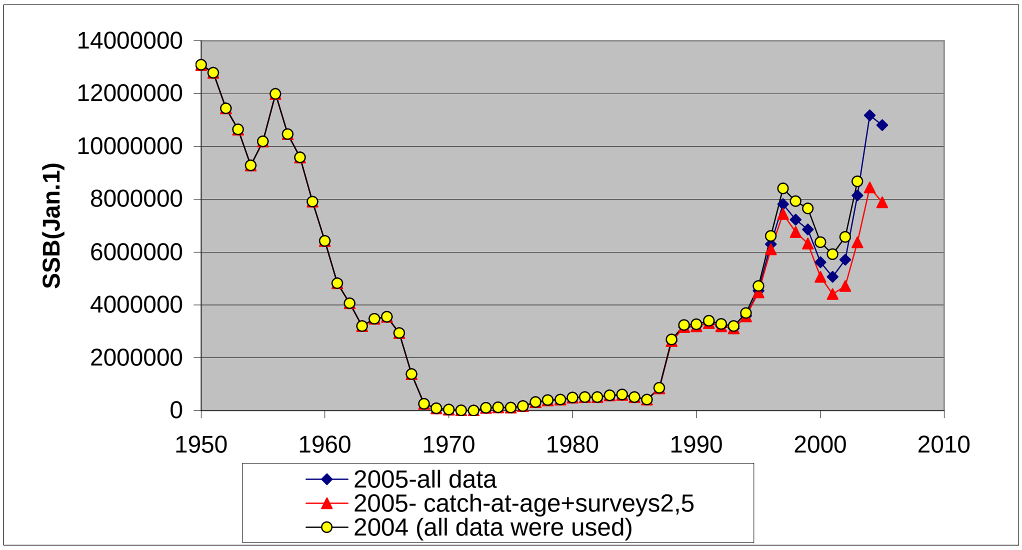
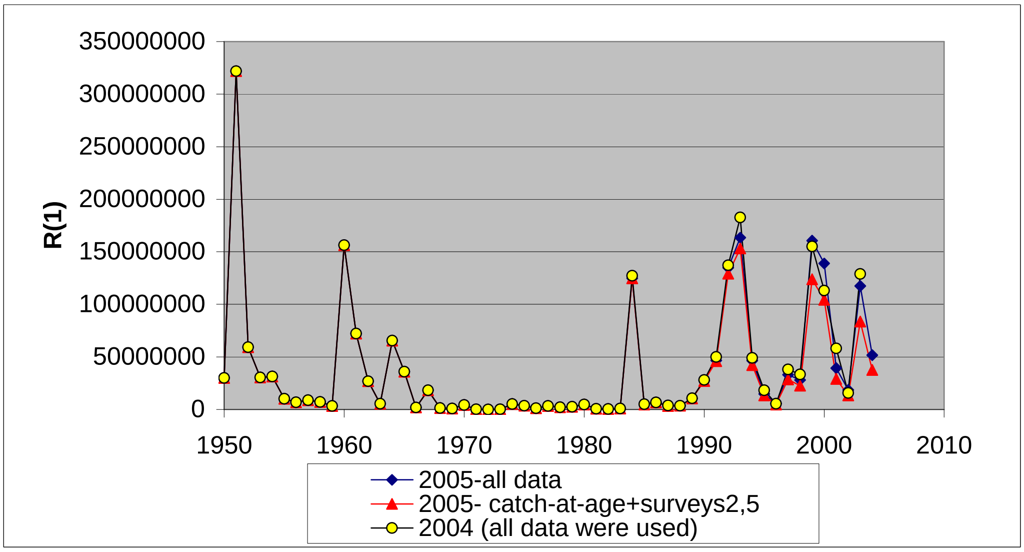


Figure 3.7.2.2.7. NSS herring. ISVPA residuals. Red ball corresponds to 3





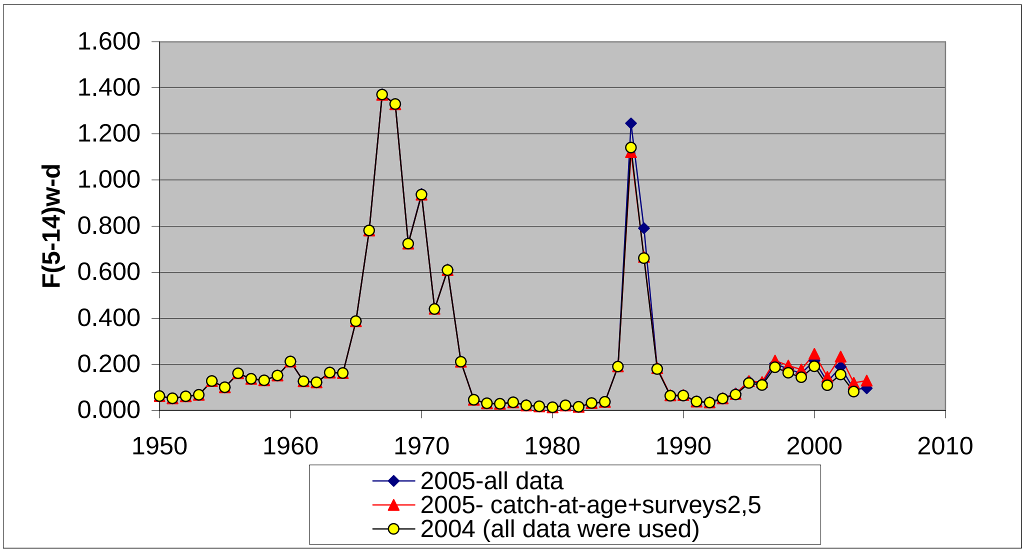
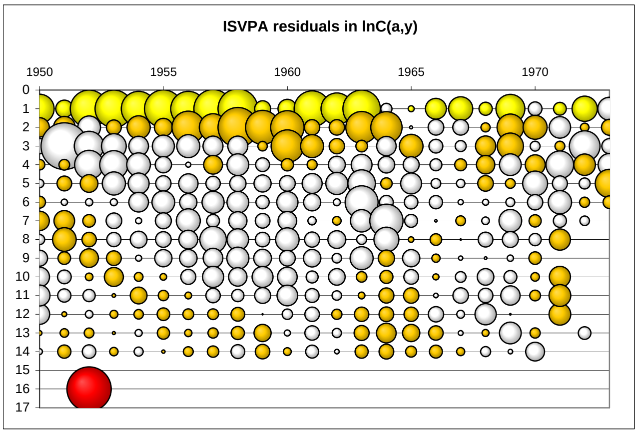
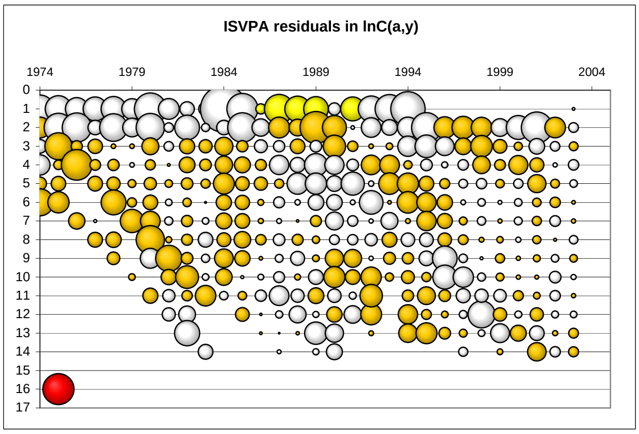
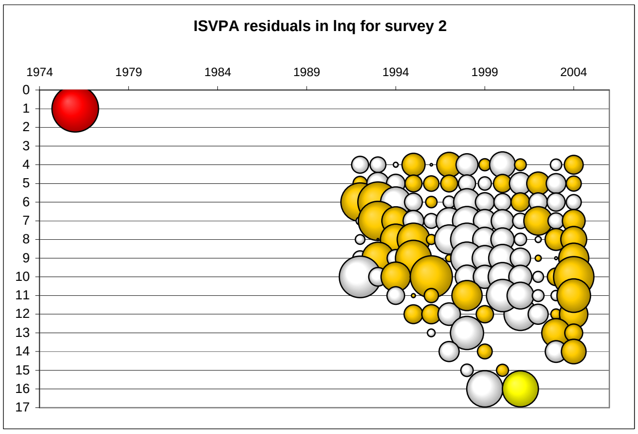


Figure 3.7.2.2.8. NSS herrng. ISVPA. Comparison of results when signal from catch-at-age + surveys 2 and 5 were used to assessments using all data sources







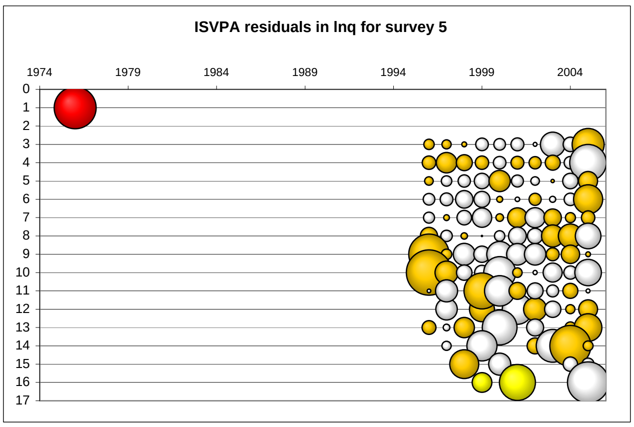


Figure 3.7.2.2.9. Residuals for ISVPA run with 3 sources of information

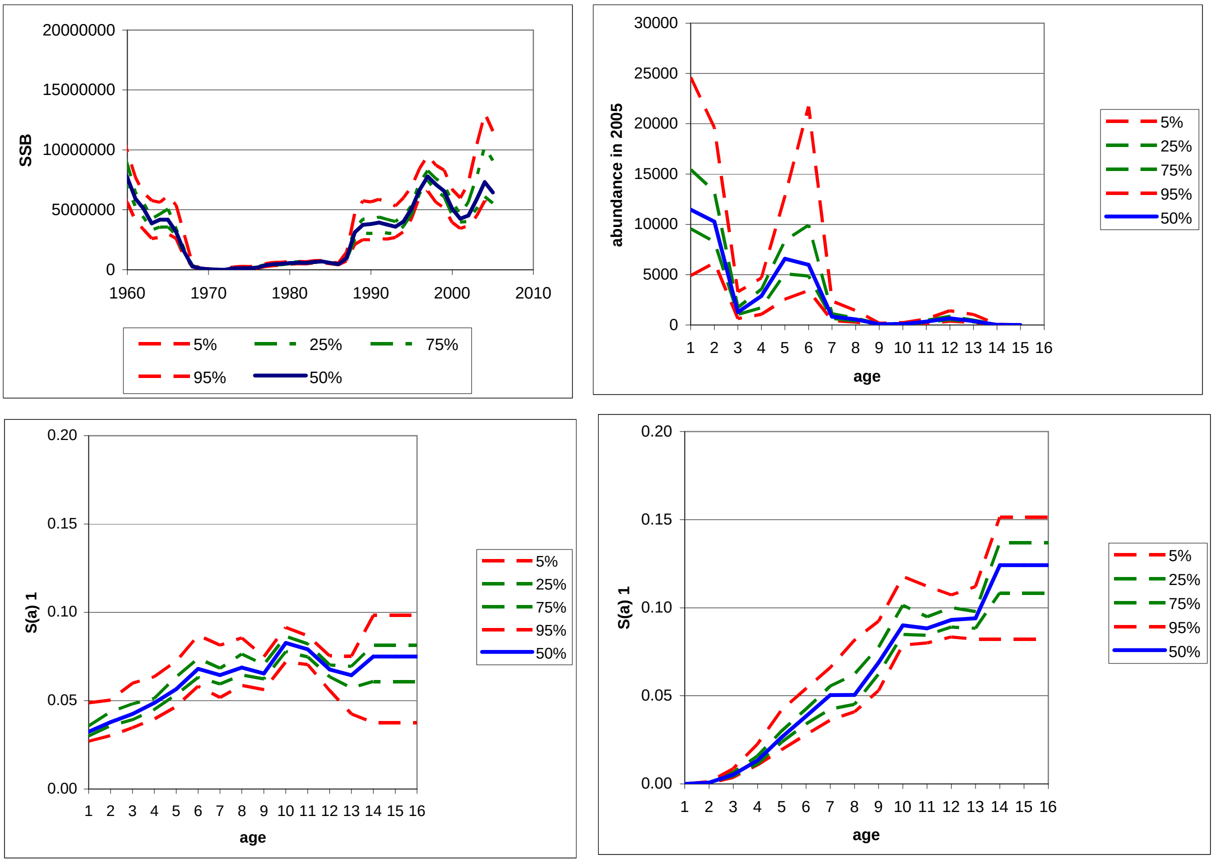


Figure 3.7.2.2.10. ISVPA. NSS herring. Bootstrap.

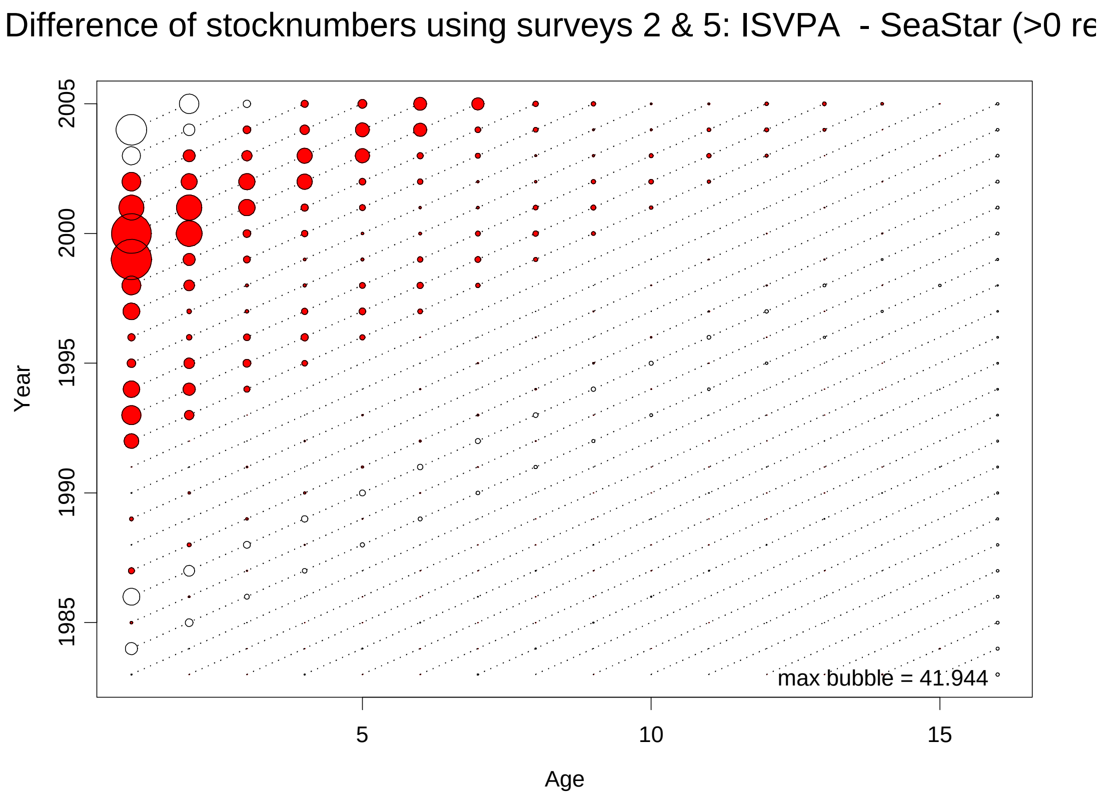


Figure 3.7.3.1 Difference of stocknumbers using surveys 2 and 5: ISVPA-SeaStar.

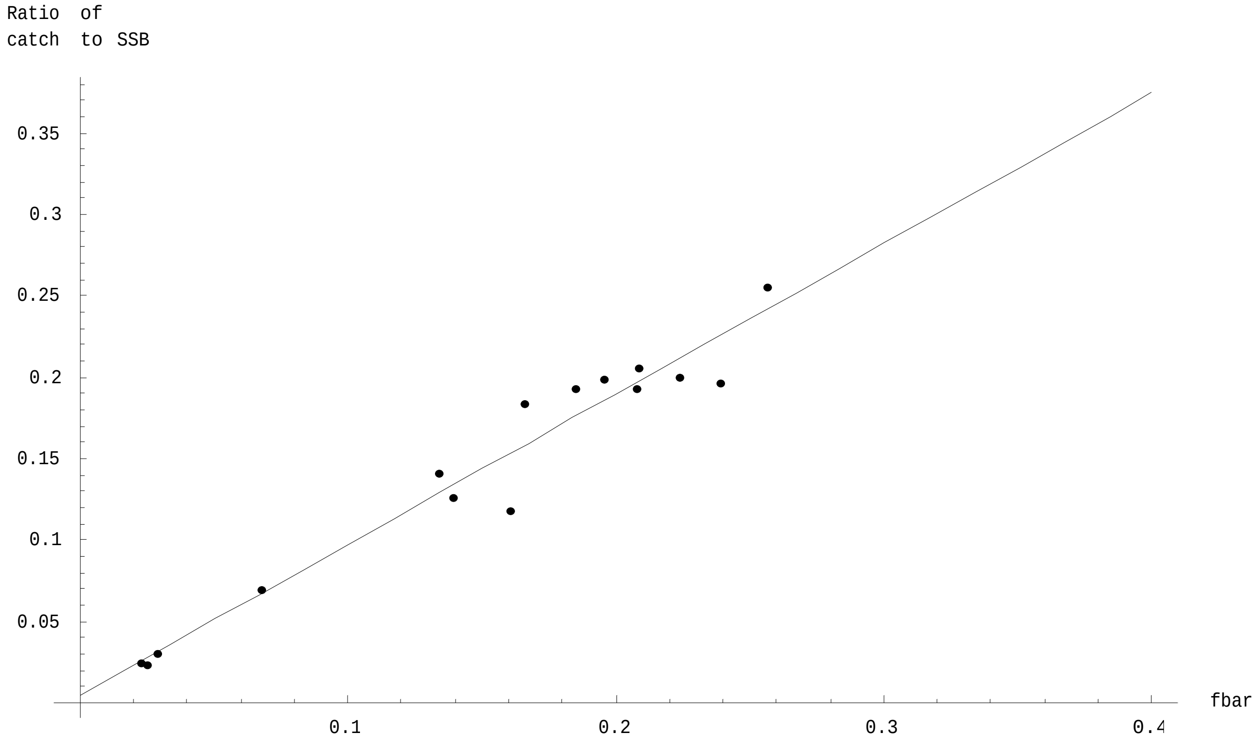


Figure 3.9.1.1 Ratio of catch to SSB regressed to Fbar. The fitted line has an intercept of 0.005 and a steepness of 0.93.

4 Blue whiting

4.1 Stock description

Blue whiting is a pelagic gadoid which is widely distributed in the eastern part of the North Atlantic. The highest concentrations are found along the edge of the continental shelf in areas II, V, VI where it occurs in large schools at depths ranging between 300 and 600 meter but is also present in almost all other management areas between the Barents Sea and the Strait of Gibraltar. The major spawning takes place in February and March, along the edge west of the British Isles. Juveniles are abundant in the Norwegian Sea and Barents Sea. Morphological, physiological, and genetic research has suggested that there may be several components of the stock which mix in the spawning area west of the British Isles (ICES C.M. 2000/ACFM:16;). For assessment purposes blue whiting in these areas is treated as a single stock since it has so far not been possible to define an unambiguous border between populations.

4.2 ICES advice and management applicable to 2004 and 2005

In 1998 ICES defined limit and precautionary reference points for this stock: $\mathbf{B}_{lim}$ (1.5 mill.t.), $\mathbf{B}_{pa}$ (2.25 mill.t.), $\mathbf{F}_{lim}$ (0.51) and $\mathbf{F}_{pa}$ (0.32). The advice of ICES in following years has been given within a framework defined by these reference points.

In December 2002 EU, Faroe Islands, Iceland, and Norway agreed to implement a long-term management plan for the fisheries of the blue whiting stock, which is consistent with a precautionary approach, aimed at constraining the harvest within safe biological limits and designed to provide for sustainable fisheries and a greater potential yield. The plan should consist of the following:

1. *Every effort shall be made to prevent the stock from falling below the minimum level of Spawning Stock Biomass (SSB) of 1 500 000 tonnes.*
2. *For 2003 and subsequent years, the Parties agreed to restrict their fishing on the basis of a TAC consistent with a fishing mortality less than 0.32 for appropriate age groups as defined by ICES, unless future scientific advice requires modification of the fishing mortality rate.*
3. *Should the SSB fall below a reference point of 2 250 000 tonnes ($\mathbf{B}_{pa}$) the fishing mortality rate, referred to under paragraph 1, shall be adapted in the light of scientific estimates of the conditions then prevailing. Such adaptation shall ensure a safe and rapid recovery of the SSB to a level in excess of 2 250 000 tonnes.*
4. *In order to enhance the potential yield, the Parties shall implement appropriate measures, which will reduce catches of juvenile blue whiting.*
5. *The Parties shall, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.*

This management plan as a whole has never been implemented. In the absence of agreements on a TAC for 2002, 2003 2004 and 2005, the Coastal States and the Russian Federation each unilateral implemented catch limits for these years. The combined total of the catch limits greatly exceed the provisions of the agreed management plans and has not lead to a restriction of a further expansion of the fishery on blue whiting. ICES has not evaluated the management plan in relation to the precautionary approach.

In addition to the combined catch limits, agreements are made between countries which regulate access to each others waters. Also technical measures may apply to national fleets or national zones.

In 2003, ICES stated that both estimates of SSB and fishing mortality were high but uncertain. Nevertheless, the spawning stock biomass in 2003 was likely to be above $\mathbf{B}_{pa}$. Therefore, based on the most recent estimates of fishing mortality and SSB, ICES classified the stock as likely to be harvested outside safe biological limits (F>$\mathbf{F}_{lim}$). The incoming year classes seemed to be strong. ICES recommended that catches should be less than 925 000 tonnes in 2004 in order to achieve a 50% probability that the fishing mortality in 2004 is less than $\mathbf{F}_{pa}$ (=0.32). This would also assure a high probability that the spawning stock biomass in 2005 to be above $\mathbf{B}_{pa}$.

In 2004 ICES concluded from the most recent estimates of fishing mortality and SSB, that the stock had full reproduction capacity, but was harvested unsustainably (cat. 2b). Although the estimates of SSB and fishing mortality were not considered precise, it was certain that SSB was above $\mathbf{B}_{pa}$ and the estimated fishing mortality well above $\mathbf{F}_{lim}$. Recruitments in the last decade appeared to be at a much higher level than earlier. The (not implemented) management plan implied catches of less than 1.075 million t in 2005 which is expected to keep fishing mortality less than 0.32 with 50% probability. This would also assure a high probability that the spawning stock biomass in 2006 to be above $\mathbf{B}_{pa}$. The management plan point 4 calls for a reduction of the catch of juvenile blue whiting which have not been taken place. ICES recommended that measures be taken to protect juveniles.

4.3 Description and development of the fisheries in 2004

Total catches figures in 2004 were provided by members of the WG. They were estimated to be 2.4 million tonnes, about the same as last year. Time series with catches by nations and area are given in Tables 4.3.1-4.3.7. No catches from France were reported to ICES for 2004. The Working Group noted that France reported about 19 000 tonnes in 2004 to the EU. The information came to late to be included in the assessment.

The spatial and temporal distribution of the catches of blue whiting in 2004 is given by quarter and ICES rectangles in Figure 4.3.2. The distribution of the catch by ICES rectangles for the whole year is given in Figure 4.3.1. In 2004 the catch provided as catch by rectangle represented approximately 100% of the total WG catch.

4.3.1 Denmark

The Danish directed fishery blue whiting fishery is mainly conducted by trawlers using a minimum mesh size of 40mm. Blue whiting was also taken as by-catch using trawl with mesh sizes between 16 and 36 mm for Norway pout, however in 2004 this fishery was very limited. The directed fishery caught 89 500 t mainly in Divisions VIa, IIa, IVa, and Vb. Some blue whiting by-catches are also taken during the human consumption consumption herring fishery in the Skagerak.

4.3.2 Germany

The main fleet fishing pelagic species is based at Bremerhaven and Rostock, Dutch owned and operating under German flag. It consists of 3 large pelagic freezer trawlers of sizes greater than 90m up to more than 120m with horse power between 4200 and 11000. Crew consists of about 35 to 40 men. They are specially designed for pelagic fisheries. The catch is pumped into large storage tanks filled with cool water to keep the catch fresh until it is processed.

The Blue Whiting fishery is seasonal in the first and second quarter. The fishery starts in divisions VIIb, c and XII in March and continues in April along divisions VIa and b to divisions Vb1 and 2 in May. Occasionally there is blue whiting by-catch in the herring directed fishery in IIa and b in August. In 2004 the Atlanto-Scandian Herring directed fishery started in Division IIa in May and continued in IIa and b in June until it ended in IIb in July.

4.3.3 Faroe Islands

The Faroese fishery for blue whiting (7 combined purse seiners/trawlers and one large factory vessel) started in January 2004 in the south-western part of the Faroese EEZ (ICES Division Vb) and on Porcupine Bank area west of Ireland (Division VIIc,k and VIb) in the EU zone. In February the fishery continued in the Porcupine area. Later in February and March the fishery continued in international waters Div. VIb and XII outside the EU zone. In April the fishery had moved northwards towards the Faroese zone (northern VIb and southern Vb). In May the fishery continued in the southern part of the Faroese area and on the slope vest off the Faroe plateau, indicating that the fish migrated west of the Faroes on their way northwards. Later in May the fishery had moved northwest towards the Icelandic border and into the Icelandic zone (Divisions Va and Vb). In June the fishery operated in the Faroese and Icelandic zones (Va and IIa) and continued in this area in August, also including the northern part of IIa (International waters). The fishery continued on the Faroe-Iceland ridge in September and October, as well as in the northern part of the International waters (IIa). In November till the end of 2004 the catches were taken in Icelandic and Faroese waters (Va, Vb and IIa), moving closer to the Faroes in December. Over 90% of the catches were taken with pelagic trawl (44 mm # in cod end).

The industrial fleet (5 trawlers) operated mainly in Norwegian waters (ICES Division IVa) with catches of blue whiting scattered throughout the year.

4.3.4 France

No information was available to the WG. France did not report any catches to ICES for 2004. The WG was informed that France reported 19 467 tonnes to EU in 2004.

4.3.5 Iceland

Iceland and Faroes have a bilateral agreement of mutual fishing rights for blue whiting within each other´s EEZs. Iceland set a total blue whiting catch quota of 428 000 tonnes in 2004 for Icelandic-Faroese and International waters.

The Icelandic directed fishery started in the third week of March in International waters west of the British Isles and a few days later some catches were also taken at southeast Iceland. In April only very few catches were taken in International waters at the beginning of the month and the fishery moved totally into Faroese waters. In May the fishery gradually moved north and by the middle of the monthhad completely shifted into the Icelandic area. In June-October the fishery was almost entirely conducted in the Icelandic zone. The total Icelandic catch was 422 079 tonnes compared to 501 000 tonnes in 2003. Almost all catches are landed for fish meal.

About 20 purse-seiners/trawlers participated in the Icelandic fishery, using large pelagic trawls with a 40 mm mesh size in the cod end. The length range of the vessels was 51-86m with a mean length of 66m. The engine power range of the fleet was 1943-5520 kW (2640-7500 HP) with a mean of 3593 kW (4882 HP).

Iceland has set size limitations on landings of blue whiting. If the catch consists of 30% or more fish smaller than 25 cm, a temporary area closure is imposed.

4.3.6 Ireland

The Irish fishery for blue whiting is prosecuted by the pelagic RSW (refrigerated seawater) fleet. Involvement in the fishery began with exploratory fishings in the late 1980s and intensified in the following decade in response to restrictive quotas for mackerel and herring.

Landings peaked in 2004 with around 76,000 t landed from divisions, VIa,b, VIIb, XII and VIIj,k.

Fishing begins in February on the spawning aggregations on the shelf edge west of Ireland and develops northwards towards the Faeroes until the end of the season in April. In 2005 landings were made from 17 trawlers ranging from 40m to 70m in length and using trawls up to 1700m circumferences with a brailler mesh of 35-40mm. The majority of the catch is landed for reduction to meal but an increasingly important proportion is now processed for human consumption. This is facilitated by the proximity of the fishing grounds to the major Irish pelagic port and processing centre at Killybegs.

4.3.7 Netherlands

The Dutch fleet fishing for pelagic species in European waters consists of 14 freezer trawlers and one pair trawler. In addition, a number of flag vessels are operating from the Netherlands. Target species of this fleet are: herring, blue whiting, mackerel, horse mackerel and argentines. Some of these trawlers are also fishing for sardinella and horse mackerel in west African waters during part of the year. The fishery for blue whiting is carried out with large pelagic trawls and is a directed fishery with almost no bycatch of other species. Catches increased in 2004 compared to 2003. Most of the catches in 2004 originated from ICES Division VIa and VIIc and were taken in the first half of the year. All catches are landed frozen for human consumption.

4.3.8 Norway

Norway did not set a blue whiting quota for the directed fisheries in the Norwegian EEZ, Jan Mayen zone and international waters for 2004. Likewise, there was no quota regulation for the mixed industrial fishery in the Norwegian EEZ in the North and Norwegian Seas (areas east of 4ºW). Through international agreements, 120 000 t in the EEZ of EU (of which up to 40 000 t could be taken by the mixed industrial fishery in the ICES area IVa) and 36 200 t in the Faroese zone were made available to the Norwegian fleet.

The main Norwegian fishery is a directed pelagic trawl fishery, regulated by vessel quotas (in 2004, these were only in effect in the EU and Faroese zone), and is carried out on and west of the spawning areas west of the British Isles and in the Norwegian Sea using pelagic trawls with minimum mesh size of 35 mm. A total of 46 large combined purse seiners/trawlers took part in the fishery in 2004. Blue whiting were also fished in the North Sea and in the southern Norwegian Sea (areas east of 4ºW) in the mixed industrial fishery targeting blue whiting and Norway pout. Notice that before 2004 these vessels were only allowed to fish blue whiting south of 64ºN. These vessels use small-meshed trawls operated close to the bottom (minimum mesh size 16 mm) or pelagic trawls with minimum mesh size of 35 mm.

In 2004, as usual, there was a seasonal progression of the fishery from the international waters off Porcupine Bank and Rockall in the beginning of the season (January-March) towards the shelf edge in EU zone and the banks in the Faroese waters in the end of the spawning season. The fishery in EEZ of EU was stopped 26 April and that in the Faroese zone 16 June after the quotas in the respective zones were taken. The fishery in the Norwegian EEZ, Jan Mayen zone and international waters was stopped for the period 29 April-23 May; this was at least partly a reaction to large proportions of juvenile blue whiting in the catches in the southern Norwegian Sea. For the rest of the season, no regulation took place, although significant proportions of young blue whiting, particularly of age 1 year, occurred in the catches. There were also reports of non-negligible numbers of saithe and redfish being caught as by-catch, but no attempts to estimate the actual quantities.

According to the official statistics, the catch in the directed fishery was 828 000 tonnes, which is a new record. In the industrial mixed fishery, 129 000 tonnes were taken – a new record as well. Notice than in area IVa, where 106 000 t was landed as blue whiting, sampling indicates that about 16 000 t represents other species. In contrast to the most previous years, this correction was not reported to the Working Group.

4.3.9 Portugal

In 2004 Portuguese landings of blue whiting amounted to 3 937 tonnes, increasing by around 50%. Most of the landings were taken by a trawl fishery (82.9%) The remaining landings were taken by polyvalent (16.9%) and purse seine (0.2%) fisheries.

The two main harbours (Portimão and Matosinhos), with tradition of blue whiting landings, have reach 49.2% of total landings. This last year two other main harbour had importance for blue whiting landings, they were: Sines (in southwest coast) and Vila Real de Santo António (in South coast) with 17.9% and 16.8% respectively.

4.3.10 Russia

The directed blue whiting fishery started at the beginning of the year in the Faroese fishing zone. The fishery in international waters west of Porcupine Bank began on the 8th of February and moved gradually northwards following the spawning migrations. Primo March the fleet left Division VIIc and moved to the Rockall area. (Division VIb) where a successful fishery took place. This fishery ended earlier than in 2003 on 15th of April. This early conclusion of the fishery was due to a more easterly distribution of spawning fish than observed in 2003. Only few catches were taken west of 18ºW in Division XII where catch rates were somewhat lower than in 2003. Nevertheless, the total catch increased. The number of vessels that participated in this fishery was higher than in 2003, at times the number of vessels were as high as 35. In April the pelagic trawlers returned to the Faroese EEZ (Division Vb1). In summer the vessels moved to the Norwegian EEZs and to international waters (Divisions Vb1 and IIa). From October to December a Russian fleet operated mostly in international waters and in the Faroese fishing zone (IIa, Vb1).

Some blue whiting were caught at Rockall by bottom trawls in the haddock fishery in March-September. Blue whiting on Rockall Bank was mostly taken as by-catch, predominantly in July and August.

4.3.11 Spain

The Spanish blue whiting fishery was carried out mainly by bottom pair trawlers in a directed fishery and by single bottom trawlers in a by-catch fishery, and small quantities (10 t) were also caught by long-liners. These coastal fisheries have trip durations of 1 or 2 days and catches are for human consumption. Thus, coastal landings are rather stable due mainly to market forces.

Pair Bottom Trawl Fishery: The Pair bottom trawl is a traditional fleet that fish mainly blue whiting (above 80%) and other pelagic species in Div. VIIIc and North IXa. In the middle of 90’s, VHVO gear (with 25 m of vertical opening) was gradually substituting the traditional one. From 2001 the cod end mesh size was increased to 55 mm. This fleet is composed of 68 pairs (136 vessels) with an average of 25 m length, 472 HP, and 145 GRT. The pair trawler fleet landed 13 840 t, taken mainly on the border between Divisions VIIIc and IXa.

Bottom Trawl Mixed Fishery: This metier operates in Divisions VIIIc and IXa North, using a cod end mesh size of 65 mm and a vertical opening of 1.2-1.5 m. It targets a wide range of species including horse mackerel, blue whiting, mackerel, hake, anglerfish, megrims, and

Nephrops (the first three species contributes around 70% of the landings). At present it is composed of around 235 vessels, with an average of 27 m length, 561 HP, and 177 GRT. By-catches of blue whiting in this fishery were (1 762 t).

Spanish landings increased around 13 % in 2004 after the low value observed in 2003, partly explained by the closure of the fishery in some fishing grounds and ports, due to the sinking of the oil tanker "Prestige" in Galician waters in December 2002. These closures took place in the first semester of 2003.

4.3.12 Sweden

The total Swedish catch was 19 000t. About 95% of the catches were caught in the directed Norwegian Sea fishery (ICES Divisions IIa and IIIa) in the 3rd quarter of the year. All the Swedish catches were taken with pelagic trawl, most by single vessels and about 5 000t by pair-trawlers.

4.3.13 UK (Scotland)

The total Scottish catch was 58 000t. About 98% of the catch was caught in the directed spawning fishery (ICES Divisions VIa, Vb, VIb and VIIb) in the first and second quarters of the year. A pelagic fleet of 24 vessels, ranging in length from 45-76 m with an engine power range of 2149-10720 HP., took part in the fishery. The catch was stored in RSW tanks and mainly landed for fish meal.

4.4 Bycatches in the fishery

In last two years, reports were available from Faroes and Iceland on the by-catch of other species, particular cod and saithe, in the pelagic fishery for blue whiting. The knowledge on by-catch is generally very sparse in this fishery, but have recently been investigated by both countries.

4.4.1 Icelandic investigations (land based sampling)

During May-December 2004 by-catch in the Icelandic blue whiting fishery in Icelandic and Faroese waters was analysed. From 42 trips (10.0% of all trips) 411 samples were collected in a randomised manner. By-catch species in the samples were quantified and length measured. In general, by-catch was a relatively rare occurrence, but associated with rather wide confidence limits.

The by-catch of saithe and cod were recorded in 35.3% and 21.7% of samples, and their total by-catch was 0.69% (2900 tonnes) and 0.26% (1080 tonnes), respectively. by-catch per haul ranging from 0-25% for saithe and 0-10% for cod. By-catch of saithe more than doubled since 2003 and that of cod was sevenfold by weight and ninefold as a proportion of total catch (Pálsson et al. 2004).

Spatial distributions indicate that cod is mainly caught as by-catch in Icelandic waters, while by-catch of saithe is found in both Icelandic and Faroese waters, on the Faroe-Iceland Ridge (Figs 4.4.1.1-2). The length distributions indicate that the by-catch mainly constitutes the catchable component (large fish) of the stocks in question (Fig. 4.4.1.3). For saithe especially high by-catch rates on the Faroe-Iceland Ridge, in May-Jul in Icelandic zone and in Nov-Dec in Faroese zone. By-catch rates of cod resulted in highest rates in June-July in Icelandic waters.

An analysis of by-catch in 2003 has been analysed by Pálsson (2005).

4.4.2 Faroese investigations at sea

Faroes initiated screenings on board a large factory trawler (M/T Næraberg) in November-December 2004 (Lamhauge 2004). Relatively high by-catch rates were observed on the Faroe-Iceland Ridge off the northwestern edge of the Faroe plateau (Fig. 4.4.2.1). Average by-catch rate of saithe was 3.5% (68.2 t), ranging from 0-20% on a by-haul basis. The size of the saithe was large, on average 77 cm and 4.7 kg (Fig. 4.4.2.2).

4.4.3 Summary

Results from by-catch screenings of saithe and cod in the blue whiting fishery on the Faroe-Iceland Ridge so far:

- Faroese screening at sea Nov-Dec 2004: saithe 3.5% (68.2 t), ranging from 0-20%. Large saithe on average 77 cm and 4.7 kg feeding on blue whiting.
- Icelandic screenings on land 2004: saithe 0.69% (2900 t) and cod 0.26% (1080 t) in 420.000 t of blue whiting caught. Screening of 42 trips or 10%, ranging from 0-25% by-catch of saithe per haul.
- Especially high by-catch rates on the Faroe-Iceland Ridge in May-July in the Icelandic zone and in Nov-Dec in the Faroese zone.
- Icelandic screenings on land 2003: saithe 0.32% (1600 t) and cod 0.03% (160 t).

The blue whiting fishery in May in the Faroese area has not been screened, and the likelihood of by-catches of saithe might be high.

In general screenings on land might be considered to yield minimum estimates of true by-catch, as some by-catch will be lost or avoided during pumping, as well as some fish will be taken for food on board. This can be seen from the higher by-catch ratio estimates of saithe from the sea based screenings in November 2004 as compared to the Icelandic land based screenings (fished in the approximately same area), where the by-catch of 3.5% compared to around 2% in the Icelandic material (estimate from Iceland based on visual inspection of Fig. 4, Pálsson et al. 2004).

In order to minimise by-catch in the pelagic fishery it could be recommended to use a sorting grid in the mid-section of the trawl. This would prevent large fish, such as saithe and cod, to enter the cod-end. However such a method has not been tested properly yet.

4.5 Fishery dependent data

4.5.1 Sampling intensity

In total 1774 samples were collected from the fisheries in 2004. 181235 fish were measured and 27835 were fish aged. Sampled fish were not evenly distributed throughout the fisheries (see text table below).

Quarter	Fisheries	Directed	Mixed	Southern	Total
1	No. of samples	356	33	148	537
	WG Catch	754678	17900	4902	777480
2	No. of samples	234	70	159	463
	WG Catch	835121	40450	4520	880092
3	No. of samples	211	55	152	418
	WG Catch	422096	45763	4368	472227
4	No. of samples	147	51	158	356
	WG Catch	216646	25365	5759	247770
Total No. of samples		948	209	617	1774
Total WG Catch		2228542	129478	19549	2377569

Considering the proportion between catches and sampling, the most intensive sampling took place in the southern fishery of Spain and Portugal. Here one sample was taken for every 32 tonnes, followed by the mixed fishery with one sample for every 620 tonnes, and lastly the directed fishery where there was one sample for every 2351 tonnes caught. In this context it should be noted that implementation of the EU Collection of Fisheries Data, Fisheries Regulation 1639/2001, requires a minimum of one sample to be taken for every 1000 t landed. Detailed information on the number of samples, number of fish measured, and number of fish aged by country and quarter is given in Table 4.5.1.1 and 4.5.1.2. As can be seen, no sampling was carried out by Germany, Sweden and France.

The WG requires the samples to estimate catch in numbers and mean length and mean weight. Therefore, the WG urges all countries that exploit this stock to develop appropriate sampling schemes.

4.5.2 Landings

Most of the catches are taken in the directed pelagic trawl fishery in the spawning and post-spawning areas (Divisions Vb, VIa,b, and VIIb,c). Catches are also taken in the directed and mixed fishery in Subarea IV and Division IIIa, and in the pelagic trawl fishery in the Subareas I and II, in Divisions Va, and XIVa,b. These fisheries in the northern areas have taken 340 000–2 300 000 t per year in the last decade, while catches in the southern areas (Subarea VIII, IX, Divisions VIId,e and g-k) have been stable in the range of 20 000–85 000 t. In Division IXa blue whiting is mainly taken as by-catch in mixed trawl fisheries.

In the last few year the proportion of landings originating from the Norwegian Sea has increased from 5% in the mid-1990's to 40% in 2003 and 2004 (Figure 4.5.2.1). This has implications for the stock assessment as much larger proportions of juvenile fish occur in catches from the Norwegian Sea, thus probably changing the exploitation pattern of the fishery as whole.

4.5.3 Discards

Discarding of blue whiting is thought to be small. Most of the blue whiting is caught in directed fisheries for reduction purposes. However, some discarding occurs in the fisheries for human consumption and as bycatch in fisheries directed to other species. Reports on discarding and bycatches in fisheries which catch blue whiting were available from Iceland and the Netherlands for the year 2004. Also information on discarding of blue whiting was available from Spain. It was reported to the WG that no discarding of blue whiting occurs in Icelandic, Russian, Faroese and Danish fisheries. No data were available from Ireland and Norway and for all other countries no information was available.

The Netherlands reported discarding of blue whiting in 2004 (<4% in weight) from observations carried out in the EU data collection framework. Most of these discards were reported to be associated with net damage. An annual estimate of discarding of the Dutch fleet is included in the assessment.

Also information of discards was available for some Spanish fleets. Blue whiting is a bycatch in several bottom trawl fisheries directed to a mixture of species. In general the catch rates of blue whiting in these fisheries are low and most of the catch is discarded and only last day catch may be retained for marketing fresh. The estimates of discard in these fisheries in 2004 ranged between 85 and 100% (In weight). In the directed fishery for blue whiting for human consumption with pair trawls, discards were estimate to be 35% (in weight) in 2004. No attempt was made to calculate an annual estimate of discarding because of insufficient information of the fleets concerned.

4.5.4 Age and length composition of catches

Data on the combined length composition of the 2004 commercial catch by quarter of the year from the directed fisheries in the Norwegian Sea and from the stock's main spawning area were provided by the Faroes, Iceland, Ireland, the Netherlands, Norway, Russia and Scotland. Length composition of blue whiting varied from 9 to 49 cm, with 70% of fish ranging from 23–28 cm in length and 98% from 18-33 cm. The mean length in this fishery was 25.9 cm (Table 4.5.4.1). Length compositions of the blue whiting catch and by-catch from "other fisheries" in the Norwegian Sea and the North Sea and Skagerrak were presented by Norway (Table 4.5.4.2). The catches of blue whiting from the mixed industrial fisheries consisted of fish with lengths of 8–43 cm and a mean of 14.6 cm. Norway, the Netherlands, Spain and Portugal caught blue whiting in the Southern area. The Spanish and Portugese data used for length distribution of catches showed a length range from 15 - 40 cm with a mean length of 21.9 cm (Table 4.5.4.3).

For the directed fisheries in the northern area in 2004, age compositions were provided by Denmark, the Faroe Islands, Iceland, Ireland, Norway, the Netherlands, Russia and Scotland and the sampled catch accounted for 95 % of the total catch. Estimates of catch in numbers for unsampled catches were raised according to the knowledge of how, where, and when the catches were taken. The age compositions in the directed fisheries are given in Table 4.5.4.4.

Age compositions for blue whiting by-catches from "other fisheries" in the North Sea and Skagerrak were provided by Norway and Denmark and sampled catch accounted for 94% of catches. These data were used for allocation of the remaining part of the total in that area. The age compositions are given in Table 4.5.4.5.

For the fisheries in the Southern area, age composition representing 100% of the catch were presented by Spain and Portugal. The age compositions in the southern fishery data are given in Table 4.5.4.6.

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 by-catch of blue whiting in "other fisheries" and for landings in the Southern area, were assumed to represent the overall age composition of the total landings for the blue whiting stock. The catch numbers-at-age used in the stock assessment are given in Table 4.5.4.7. The 2000 and 2001 year classes were the most numerous in the catches, followed by the 2002, year class. 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 allocations are shown in the Annex II.

4.5.5 Weight at age

Mean weight-at-age data were available from Denmark, the Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. Mean weight-at-age for other countries was based on the allocations shown in the Annex II ("ALLOC" files) and was estimated by the SALLOC program for the total international catch. Table 4.5.5.1 shows the mean weight-at-age for the total catch during 1981–2004 used in the stock assessment. There is a general trend towards lower weight-at-age, except for age-group 10+ years in 2004 that is likely an error. The weight-at-age for the stock was assumed to be the same as the weight-at-age for the catch.

4.5.6 Length at age

Mean length-at-age data were available from Denmark, the Faroes, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, Scotland and Spain. Mean length-at-age for other countries was based on the allocations shown in the Annex II ("ALLOC" files) and was estimated by the SALLOC program for the total international catch. Table 4.5.6.1 shows the mean length-at-age for the 4 main fisheries and the total catch in 2004.

4.5.7 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 4.5.7.1). Although the values of maturity-at-age probably are too low, sufficient information for estimating new ogives is not available.

4.5.8 Natural Mortality

The possible need for revising the current estimate of instantaneous natural mortality rate M for blue whiting was discussed in detail by the 2002 WG. Although it was admitted that the current estimate M=0.2 yr^{-1} might be too low, the factual basis for revision was ambiguous. More recent methodological work by WGMG (ICES 2003/D:03) emphasises that natural mortality rate cannot be estimated reliably with information normally available for stock assessment models. WG therefore considers that there is no new information that would justify a revision of the current estimate of M.

4.5.9 CPUE data

4.5.9.1 Spanish pair trawl CPUE

The Spanish pair trawls CPUE series (Table 4.5.9.1.1) has been used for several years as a tuning fleet in the blue whiting assessment. This fleet represents only a small part of the landings caught in a small part of the distribution area. Due to this fact, and following a recommendation of the Methods working group (ICES 2003/D:03), this tuning series is not used in the assessments anymore. This year there is not new data about this series so last year’s data are presented. Data show a slight decreasing trend in CPUE (Figure 4.5.9.1.1).

4.5.9.2 Norwegian CPUE

CPUE data in the spawning area has been collected from the Norwegian commercial fleet 1982-2003; the time series is shown in Figure 6.4.3.2 in the WG report from 2004. No data from 2004 are available to update this time series. The data are not considered to be respresentative for the development of the stock and are not used in the assessment.

4.5.10 Effort data

No effort data are available as a measure of activity of the fisheries directed towards the blue whiting stock. The absense of quantitative data demonstrating changes in the fishery is considered to be a handicap in interpreting differences in the results of different assessments.

4.6 Fishery independent data

4.6.1 Survey abundance indices

4.6.1.1 International Blue Whiting survey on the spawning grounds

An international blue whiting spawning stock acoustic survey is carried out on the spawning grounds west of the British Isles in March-April. The survey started in 2004 and is an extension of the Norwegian survey described in section 4.6.1.2. The survey is carried out by Norway, Russia, EU (Ireland and Netherlands), and in 2005 the Faroes joined the survey. This international survey with broad international participation allowed for broad spatial coverage of the distribution of the stock as well as a relatively dense net of trawl and hydrographical stations. A description of the survey is given in the reference. The survey is coordinated by PGNAPES.

The highest concentrations were recorded in the area between the Hebrides, Rockall and Bill Bailey/Faroes Banks. In comparison to 2004, the bulk of the biomass was observed further offshore in relation to the Hebrides shelf break. The distribution of acoustic backscattering densities for blue whiting as recorded by the six vessels are shown in Figure 4.6.1.1.1

The blue whiting spawning stock estimates based on the international survey are given in the table below. The 2005 estimate of SSB is about 30% lower than in 2004. An age-disaggregated total stock estimate is presented in Table 4.6.1.1.1, showing that the SSB was dominated by blue whiting of 4 and 5 year olds (year class 2000 and 2001) which contributed about 60% to the SSB. As in last year, the contribution of juveniles to the stock estimate is low; the survey may not give a good signal of expected recruitment.

International Survey	Abundance, 10^9 individuals		Biomass, mill. tonnes		Mean weight,	Mean length,
	total	spawning	total	spawning	g	cm
2004	137	128	11.4	10.9	85.5	26.4
2005	90	83	8.0	7.6	88.6	26.3

Results from the individual vessels are reported in more detail in respective survey reports (O'Donnell et al., WD; Heino et al. b; Ybema; Jacobsen et al.). Of these only the Norwegian time series is long enough to be used in tuning the assessment. For this reason, it was decided to keep the spatial coverage of this survey similar to earlier years. The estimated total biomass and SSB of the international survey and Norwegian time series in 2004 and 2005 are very close.

4.6.1.2 Norwegian surveys on the spawning grounds

Norwegian survey on the spawning grounds of blue whiting, west of the British Isles, provides the longest time series covering a significant part of the blue whiting stock, and thereby an important time series for tuning the assessment. While from 2004 onwards this survey has been run as a part of the PGNAPES coordinated international survey (see 4.6.1.1 above), this survey has been run such that the integrity of the existing time series is maintained. The results from both the international and Norwegian survey are very much in agreement.

The estimated total abundance of blue whiting for the 2005 Norwegian survey was 8.5 million tonnes, representing an abundance of $95x10^9$ individuals (Table 4.6.1.2.1). The stock estimate obtained in 2005 is significantly smaller than in 2002–2004, both in terms of numbers and biomass (Table 4.6.1.2.2). Virtually all fish were estimated to be mature, and the spawning stock is thus only marginally smaller than the total stock in the area. However, sampling in the areas where juveniles have usually been observed was jeopardized by bad weather, exaggerating the paucity of juveniles in the stock estimate.

A potential caveat in interpreting the results from this survey is the decrease in survey coverage, which in 2005 was about 20% less than in 2004. To make the numbers more comparable, only those survey strata that were covered in both years are compared and adjusted for relative coverage within each stratum. In 2005, the total stock biomass estimate in those strata that were covered in 2004 is 8.4 million tonnes. Adjusting for slightly smaller coverage within each stratum in 2005 than in 2004, the corrected estimate is 8.7 million tonnes. This estimate has to be compared with the estimate obtained in 2004 for the same strata, 10.9 million tonnes. The coverage-corrected decrease in total stock biomass is thus about 20% – a slightly less pessimistic result.

Year class 2000 (age 5 years) continues, albeit with a narrow margin, to be the most abundant year class in the stock, both in terms of biomass and numbers (Fig. 4.6.1.2.1). This was also the dominant year class in 2002–2004, and appears for fourth year in row as the strongest one in record for its age. Abundance of this year class has been reduced by some 37% from 2004, the year when it presumably was fully recruited to the spawning stock. Year class 2001 is currently almost as abundant as year class 2000, although much less abundant than that year class at the same age. Blue whiting of age 3 years makes also a significant contribution (~17%) although it is relatively weak for its age. Year classes 1999 and before lumped together make a similar contribution.

Mean length and weight of blue whiting in the survey area continue to increase (Table 4.6.1.2.2), largely reflecting the increase in the average age and the continued dominance of year class 2000. Condition of young blue whiting was somewhat lower and that of old fish somewhat better compared to 2004; these changes are mostly driven by changes in weight-at-age.

4.6.1.3 Russian surveys on the spawning grounds

The Russian research vessels surveyed the blue whiting spawning stock since 1980. The area was firstly located between 57ºN and 69ºN, and the works conducted in April-May. Since 1984 area was shifted to 50º- 62ºN, and March-April become to be as new period. Mean area covered yearly in 1981-96 amounts 53 thousands miles^2. The highest abundance of blue whiting was observed in 1986. The vessels operated using pelagic and partly a bottom trawls with cod-end mesh 16 mm based on a distance of 30-miles between the latitudinal transects. After 1990 the surveys fulfilled in coordination with Norwegian research vessels. The time series used in exploratory runs is shown in Table 4.6.1.3.1.

In 2005 two research vessels operated west of British Isles in spring. "Fridtjof Nansen" carried out an acoustic survey mostly inside of the EEZ zone from 53º to 61º40'N on 18.3 - 14.4 based on a distance of 30-miles between the latitudinal transects. "Atlantniro" fulfilled the same work outside of EEZ zone from 54º33' to 60º07'N on 15.3 - 08.4 based on 15-miles distance between the transects. The total blue whiting biomass in the international waters was estimated as 1 million tones. This is similar to the equivalent result in 2002 and almost three times lower than in 2003. Environmental conditions are suggested as reasons for the fluctuations. Mean temperature in the depth layer 400-600 m on Rockall was 9.56ºC during the survey in 2002 and 9.64º C in 2005 while in 2003 the temperature reached 9.76º. In both years the east directed transport of water predominated putting obstacles in the western migration of spawners.

4.6.1.4 International ecosystem survey in the Norwegian Sea

The international ecosystem survey in the Nordic Seas is aimed at observing the pelagic ecosystem in the area, with particular focus on herring, blue whiting, mackerel, zooplankton and hydrography. In addition the Norwegian Sea was covered during June-July and in August 2005 on a national basis. The observations on herring and blue whiting are done by acoustic observation with main focus on Norwegian spring-spawning herring (ASH) and blue whiting in the Norwegian Sea. The survey is carried out in May since 1995 by the Faroes, Iceland, Norway, and Russia, and since 1997 (except 2002 and 2003) also the EU. The survey is used in the final assessment for the first time.

In 2005, blue whiting were observed in most of the survey area, with the highest densities off the north-western Norway and in the south, between the Faroes and Norway and the Faroes and Iceland (Figure 4.6.1.4.1). There is a tendency of mean length to increase away from the Norwegian coast towards northeast. Both distribution and size structure of the stock are broadly similar compared to the survey in previous year.

Stock estimate for the total survey area is given in Table 4.6.1.4.1. Blue whiting of age 1 year dominate the stock both in terms of numbers and biomass. The stock biomass estimate, 6.6 million tones, is 36% lower than in 2004, 10.4 million tonnes. Also stock numbers are decreased, from $152{\cdot}10^9$ in 2004 to $120{\cdot}10^9$ in 2005. These rather dramatic decreases are largely due to the more restricted coverage in the south-western part of the survey area where post-spawning fish aggregate at the time of the survey. For the standard survey area that has been covered each year (between 8°W-20°E and north of 63°N) the estimate is 4.7 million tonnes, down 14% from 5.4 million tonnes measured in 2004. The stock estimate in numbers at $95{\cdot}10^9$ is virtually unchanged from 2004. The proportions of large and old blue whiting are slightly lower in the standard survey area than in the total survey area; this is expected as the post-spawner aggregations in the southwest are largely excluded from the standard area. Time series of stock estimates for the standard area are given in Table 4.6.1.4.2.

4.6.1.5 Iceland acoustic summer survey

Iceland has carried out an acoustic survey in summer in the Icelandic EEZ since 1998. No survey was carried out in 2005. Age-disaggregated results are available from 1999 onwards until and including 2004 (Table 4.6.1.5.1). The survey in 2003 gave stock estimate that was well above the one from the previous years. However, this survey had a wider coverage than those before. This reflects wider distribution of blue whiting in the Icelandic waters. It can be argued that the increase reflects genuine increase of blue whiting in the area (see the discussion in Heino et al., WD 2004). Table 4.6.1.5.1 gives nevertheless also an estimate that is calculated for the more restricted area covered all years. The survey in 2004 confirms the results from 2003 that year class 2003 is weak in Icelandic waters. Year class 2004 is average in stregth. The mean age is the highest observed in this survey.

4.6.1.6 Icelandic Groundfish survey 2005

The Icelandic Groundfish survey has been conducted in every March month since 1985. The survey covers the Icelandic continental shelf down to 400m and in the period 1985 - 1995 and since 2004 the Icelandic part of the Icelandic-Faeroes ridge was covered. The number of stations hys been variable or between 500 and 600. The survey is conducted by 4-5 trawlers all identical trawlers built in Japan in the early 1970.

Blue withing is caught in the survey near the edges of continental shelf in the southern part of the survey area. In recent years blue withing has been found at 70 - 100 in the survey. Blue withing was not measured regularly in the survey until 1996. The length distributions and age readings from the same month indicate that smaller than 21cm fish can be considered a proxy of age 1 fish. The indices of age 1 fish are calculated as the mean number of age 1 blue withing per station in the areae covered by the survey in all years (Table 4.6.1.6.1). The survey is not used for prediction of recruitment.

4.6.1.7 Norwegian sea summer survey

In 1981-2001 Norway ran an acoustic survey in the Norwegian Sea in order to follow the migration of Norwegian spring spawning herring and to measure blue whiting in its feeding areas. The stock estimates in numbers at age are given in Table 4.6.1.7.1. This survey used to give the first indication of the incoming year class measured at age 1; in 2004 SGAMHBW recommended using indices from this survey at ages 1-4 years. However, as the survey is terminated it provides little information for the latest years in the assessment, and it was decided not to use the survey in the final assessment.

4.6.1.8 Russian survey in the Barents Sea

A blue whiting stock survey was carried out in the Barents Sea and adjacent waters in October-December 2004. This is the continuation of survey series started in 2000. Two vessels participated in the survey: “Smolensk” and “Fridtjof Nansen”. As the work mentioned was a part of multi-species trawl-acoustic survey, both bottom and pelagic trawls were applied to the schools identification. The area investigated makes 236637 square miles. Estimated biomass of blue whiting over the whole surveyed area constituted 524 thousand tones whereas in 2003 only 350 thousand tones were found. Almost whole biomass was distributed in the ICES divisions IIa and IIb (Fig. 4.6.1.8.1). The survey is not used in the assessment.

4.6.1.9 Spanish bottom trawl survey

Bottom trawl surveys have been conducted off the Galician (NW Spain) coast since 1980, following a stratified random sampling design and covering depths down to 500 m. The survey directed to a misxture of species. Since 1983, the area covered in the Spanish survey was extended to completely cover Spanish waters in Division VIIIc. A new stratification has been established since 1997. Stratified mean catches and standard errors are shown in Table 4.6.1.9.1 . 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 (124 kg/haul). The 2004 estimate is 25 kg/haul . (Figure 4.6.1.9.1). The survey is not used in the assessments.

4.6.1.10 Portuguese bottom trawl survey

Bottom trawl surveys have been conducted off the Portuguese coast since 1979, following a stratified random sampling design and covering depths down to 500 m. The area covered in the Portuguese survey was extended in 1989 to the 750 m contour. Stratified mean catches and standard errors from the Portuguese survey are shown in Table 4.6.1.10.1. Larger mean catch rates are observed in the 100 - 500 m depth range. The 2004 estimate is around average in the Portuguese autumn survey (84 kg/haul) . The Portuguese autumn surveys generally give higher values than in the summer surveys, and a better correlation with the Spanish surveys (Figure 4.6.1.10.1). The survey is not used in the assessments

4.6.1.11 Faroes plateau spring bottom trawl survey

On the Faroe plateau an annual demersal bottom trawl surveys is carried out during spring (March 1996-2005). The survey is not used in the assessments. The survey is aimed at cod, haddock and saithe, but varying amounts of blue whiting are caught as by-catch each year. The size of the blue whiting ranges between 11-45 cm during spring, including 1-group and older fish.

After the spawning west of the British Isles and Ireland in spring the larvae drift northwards with the currents passing the Faroes and young of the year are found in the deeper regions of the shelf in August. One group blue whiting are also found on the shelf in the deeper regions and are caught in both the autumn and spring groundfish surveys.

Unfortunately no otoliths are available from these groundfish surveys prior to 2004, making the separation of the 1- and 2-group blue whiting inaccurate. The 1-group blue whiting were visually separated from the length distribution from the spring surveys (Table 4.6.1.11.1). In the spring surveys the 1-group is usually well separated in the length distribution (Table 4.6.1.11.2). In 2004 the 1-group was separated from otolith samples during the survey.

4.6.1.12 Faroes plateau autumn bottom trawl survey

On the Faroe plateau an annual demersal bottom trawl survey is carried out in autumn (August-September 1994-2004). The surveys is aimed at cod, haddock and saithe, but varying amounts of blue whiting are caught as by-catch each year. The size of the blue whiting ranges between 9-45 cm during autumn, including 0-group and older blue whiting.

Unfortunately no otoliths are available from these groundfish surveys, making the separation of the 0- and 1-group blue whiting inaccurate. For the summer survey Icelandic age-length keys (from June-August) were used to split the length into age groups (Table 4.6.1.12.1). Since the Icelandic age-length keys were from the June-August period, they could not be used to split the spring data (see previous section).

The consistency in the time series in representing the 0- and 1-group can be checked by a comparison of the abundance of the 0-group caught in summer with the abundance of 1-group the following spring. Figure 4.6.1.12.1 shows the bottom trawl 0-group index (number of blue whiting caught 10^{-3}) from autumn 1996-2004 compared to the corresponding 1-group spring index lagged one year to match the 0-group index, the correlation is relatively low, the r^2 is around 0.41. The survey is not used in the assessments.

4.6.1.13 Norwegian shrimp survey in the North Sea

Norway has conducted a bottom trawl survey on shrimp in the northern parts of the North Sea annually in October 1984-2002 (Tveite 2000). Blue whiting is caught in >95% of trawl hauls, with individual lengths ranging between 9 and 52 cm. Blue whiting have not been aged, but based on sampling of the commercial catches in the area by Norway, a reasonably good separation of 0-group blue whiting can be achieved by assuming that all individuals less than 19 cm in body length are of age 0 years. Separation of other age groups has not been attempted. The results are summarized in Table 6.4.2.6 of the WG report from 2004, showing that 0-group blue whiting are occasionally very abundant, but that the years of great abundance show only weak correspondence with large year classes seen in the analytic assessment. This applies in particular to the recent strong year classes that have not occurred in large numbers in the North Sea. The survey is not used in the assessments.

4.6.1.14 Norwegian bottom trawl survey in the Barents Sea

Norway has conducted bottom trawl surveys targeting cod and other demersal fish in the Barents Sea since late 1970s. From 1981 onwards there have been systematically designed surveys carried out during the winter months (usually late January-early March) by at least two Norwegian vessels; in some years the survey has been conducted in co-operation with Russia. Blue whiting is a regular by-catch species in these surveys, and is in some years one of the most abundant species. Most of the blue whiting catches (or samples thereof) have been measured for body length, but very few age readings are available (from 2004 onwards otoliths are systematically collected). The existing age readings suggest that virtually all blue whiting less than 20 cm in length belong to 1-group and that while some 1-group blue whiting are larger, the resulting underestimation is not very large. An abundance index of all blue whiting and putative 1-group blue whiting from 1981 onwards is given in Table 4.6.1.14.1 and follows methods described in Heino et al. (2003) except that all blue whiting <20 cm in length are taken as 1-group blue whiting (threshold 21 cm was used in 2004). 1-group indices for both 2004 and 2005 are relatively high, ranking as fifth and third highest in this 25-year time series, although well below the record from 2001. Also the total indices are at a historically high level.

4.6.1.15 Russian Egg survey

Ichthyoplankton samples were collected during the spring cruises of R/V "Atlantniro" and "Fritdjof Nansen" in 2005. A vertical plankton net lowered to 600 meter depth. Altogether more than 70 samples were fixed, 50 of them were treated before the WG meeting. The egg development stages were determined according to scale of Seaton & Bailey (1971). Stage V predominated in the samples (Table 4.6.1.15.1). Survey started near the Porcupine bank a few days after the main spawning finished there. The number of eggs in the catches in that part of area was not large for the given reasons. The vessels arrived at the next spawning ground located between 55º and 56º30'N after peak spawning activity but a lot of eggs were still available. The greatest catches were derived at Rockall where the survey and intensive spawning were falling at the same time (Figure 4.6.1.15.1). Following the traditional approach (Hensen, 1887; English, 1964) the data on the duration of spawning period and on the incubation time were used to convert egg number to the SSB. Seasonal egg production was calculated by equation:

$P = \frac{N_i t_i}{T_i(1-y)}$; where

P - seasonal production; N_i - number of eggs in the area surveyed; T_i - duration of egg development; y - daily loss of eggs.

T_i assumed as 4.8 days and t_i as 59 days to obtain comparable results with Coombs (1979) estimation. Daily loss assumed as 5% (Bailey, 1974). Surfer-8 software applied to count total number of eggs in the volume investigated. Egg production in the area from which the samples are elaborated amounts to $1{,}8 \times 10^{14}$ eggs. Using the actual data on fecundity (38000), mean weight of fish (0,99 kg) and sex ratio (1:1) the spawning stock biomass on the area investigated was estimated as $1{,}8 \times 10^{14} \times 0.099 \times 2/38000 = 0.94$ mln.tones. That number is corrected for a relation between the biomasses inside and outside of area surveyed according to results of international acoustic survey in 2005. The area from which the samples were treated contains 1.8 of the total 8 mln. tones. Hence, total SSB have to be 4.2 mln. tonnes.

The main uncertainties in this calculation are related with mortality rate and development time of eggs. Cautious levels of those parameters are used above. Present-day temperatures should determine more fast incubation. Mortality had to grow as well (Coombs, 1977). Daily loss rates are usually especially high on the 3-rd stage of development. One attempt to avoid those gaps was undertaken by use the 1-st and 2-nd stages only. In this case development time may be assumed as 1 day, and the impact of mortality ignored. N_i may be suggested as equal to the one at the most numerous stages. Those is a stage V. Fish at stage V were some days ago at the stages I and II while their number were at least same as at the stage V. If samples were collected several days earlier, this number would be correspondingly more. However in this case the spawning duration should be estimated in different way. Instead of the whole period when the spawning indications are available, the time of active spawning should be used when large schools of spawning fish are observed - 45 days. The mentioned corrections are included into the estimation. By given data the SSB is counted as 5.6 mln. tones.

The approach used is stochastic as is the case with other ways of stock assessment. Increasing the number of samples and improving the coincidence of yhe survey with peak spawning could improve results. Still despite the rare net of tows and patched egg distribution, the preliminary figures obtained are not far from results of acoustic and analytical estimates. Therefore the egg surveys continuation seems to be a reasonable. The survey resuls cannot be used to tune the assessment at present.

4.7 Stock Assessment

The catch at age data were explored using a number of assessment tools. Apart from catch curve analyses, exploratory assessments were carried out using AMCI, ICA, ISVPA and SMS.

4.7.1 Evaluation of data underlying the assessment

Catches

Figure 4.7.1.1 show the number of blue withing caught plotted on log scale and curves corresponding to Z = 0.6 drawn for comparison. The picture seems to indicate that yearclasses 1995 and 1996 have been disappearing from the catches at a rate corresponding to Z higher than 0.6 (around 0.7) but yearclass 1996 at a rate around 0.7. This interpretation of the graphs is dependent on the fishing effort being reasonably constant in recent years but gradually increasing fishing effort makes the slopes lower than the real value of Z. The catch curves also indicated that the smaller year classes may be exploited at a slightly lower rate. The curves are on the other hand difficult to interpret for agegroups that have not been fully recruited to the fishery for more than 2 years, which applies to most of the agegroups that are relevant today.

Figure 4.7.1.2 shows log of the abundance indices from the Norwegian survey on the spawning grounds in February. According to the figures the yearclasses 1998 and 1999 have been disappearing at a rate corresponding to Z = 0.6, but yearclass 1996 at higher rate of approximately Z = 0.7. For younger year classes interpretation of the curves is difficult.

Surveys

Acoustic survey on the spawning grounds in February.

Figure Figure 4.7.1.2 shows the internal consistency of the survey by comparing the abundance indices of a yearclass in the survey to the abundance indices of the same yearclass the year before. The consistency is best between age 3 and 4 but detoriates after that, most likely due to increasing fishing mortality which is variable through the period. For the oldest ages sampling in the survey is most likely a problem. Only a small part of each yearclass is mature at age 2. This part is variable from year to year leading to variability in the indices for age 2 which are therefore not as good indicators of stock size as the abundance indices of older fish. Figure 4.7.1.3 shows the abundance indices from the spawning survey plotted on log scale. The figure indicates that in recent year Z > 0.6 for the oldest age groups.

Survey in the Norwegian sea in May.

Figure 4.7.1.2 indicates that the use of indices for age 2 from the spawning fish acoustic survey might be questionable and the survey does not at all cover age 1. The May acoustic survey in the Norwegian sea and adjacent areas is covering large part of the immature part of the stock and might therefore give better indices of recruitment. The survey is on the other hand not considered as an reliable indicator of the mature part of the stock which migrates much more than the immature part.

Figure 4.7.1.4 shows that the internal consistency of the May survey is reasonably good but there are some exceptions like for yearclass 2001 between ages 1 and 2 and the 1996 yearclass between ages 4 and 5. The figures as tables from the survey do also indicate that the abundance indices decrease rapidly with age.

4.7.2 Data Exploration with AMCI

Explorations were carried out with the latest version of AMCI, version 2.4. In comparison to version 2.3a that was used in 2004, the new version contains some new functionality (not used) and bug fixes. Repeating the final AMCI assessment from 2004 with the new version of AMCI yielded essentially identical results.

The final WG assessment from 2004 updated with the new data available (catch in 2004 and Norwegian spawning stock survey in 2005) – so-called SPALY run – shows an overall increase in SSB (and a corresponding decrease in F) since about year 2000 in comparison to the 2004 assessment (Figure 4.7.2.1). Recruitment estimates from about year 1999 onwards are also slightly increased. However, the overall patterns remain very similar.

In tuning the assessment, three time series are traditionally used: Norwegian and Russian acoustic spawning stock surveys and the Norwegian Sea summer acoustic survey. However, Russian spawning stock and Norwegian Sea summer surveys were terminated respectively in 1996 and 2001. Furthermore, Norwegian spawning stock survey is split in two because of changes in instrumentation (the same is true for the other two surveys). It has been asserted that the surveys that do not extend to the most recent years contribute very little information to the assessment and can be dropped. Indeed, AMCI run with the modern part of the Norwegian spawning stock survey (1991-2005) as the only tuning time series yields results that are very similar to the results from the SPALY run. All further AMCI explorations were therefore tuned without the terminated time series.

Two recruitment surveys were tested: international acoustic survey in the Norwegian Sea in May, and winter bottom trawl survey in the Barents Sea. Age range 1-2 years from the international May survey was used, while at the same time the lower age for the Norwegian spawning stock survey was increased by 1 year; the age range then is 3-8 years. With these changes, SSB in the most recent years is somewhat increased, and the recruitment in 2001 is somewhat higher. However, observed and modelled yield do not fit well in 2002-2003.

It was also tried to use the Barents Sea data. However, because of the strong non-linearity between modelled recruitment (final AMCI run in 2004 WG) and 1-group index from the Barents Sea, the data cannot be directly included in AMCI. A two-tier procedure was then employed: a linear model on log-log scale was used to estimate the power linking these two time series in 1994-2002 (in earlier years, larger meshes were used), and then using this relationship to construct a time series of modelled recruitments from the Barents Sea data that best fit the 2004 assessment. This time series was then used as an additional tuning time series. The resulting assessment shows slightly lower SSB and recruitment than the corresponding run without the Barents Sea data. However, the residuals from the fitted values do not add up to zero, raising some concerns about lack of convergence or other technical problems.

To increase the fit between observed and modelled yield in 2002-2003, the weight of the yield partial objective was increase from 1 to 2. This was presented as the final AMCI run and is shown in Figure 4.7.6.1. Model residuals are shown in Figure 4.7.2.2. Retrospective analysis is illustrated in Figure 4.7.2.3 and the results from bootstrapping catches and survey time series in Figure 4.7.2.4 and Figure 4.7.2.5. Furthermore, the results turned out to be rather robust with respect to changes in relative weighting of different ages in the catch and survey data.

The residuals show no worrisome features, and the retrospective analysis suggests that the assessment is not prone to bias. As always, there is increasing uncertainty towards the end of the assessment period. Bootstrapping suggests that a range of combinations of F in the final year and SSB in the end of the final year ranging from low F and high SSB to high F and low SSB are possible given the uncertainty in the data. Among other things, the uncertainty in recruitment in 2001 (probably the strongest year class in record) is manifested in the estimate of SSB in the end of the final year.

Judging the assessment against external information reveals some worrisome features. The estimated exploitation pattern (not shown) does not show increase in fishing mortality of young fish (ages 1-2 years) that would be expected from the increase of the fishery in the Norwegian Sea with different selectivity. Also the decrease in SSB from 2004 to 2005 is much less than suggested by the Norwegian and international spawning stock surveys. Also the SSB estimate is very high in comparison to the levels prior to 2001 and not in accordance with the sentiment and purported lower catch rates from the fishery in the spawning grounds in 2005 and in the Norwegian Sea in summer. Recruitment from 2000 onwards is estimated to be considerably higher than the Barents Sea recruitment index suggests.

All in all, the final AMCI assessment is acceptable when judged with conventional model diagnostics, but does not quite match the external information available. It is quite likely that this is related to the model assuming roughly constant exploitation pattern from year to year, an assumption that is likely grossly violated. Although AMCI allows for some changes in exploitation pattern, the changes may have been stronger than the model can deal with. The assessment is therefore to be judged as particularly uncertain.

4.7.3 Data Exploration with ISVPA

If to retain the same model settings as were taken in 2004 stock assessment by ISVPA (SPALY run), i.e., effort-controlled version of the model with unbiased separable representation of fishing mortalities and single selection pattern for the whole period, profiles of components of the loss function, corresponding to different sources of information, reveal minima only for catch-at-age and the second period of Norway spawning acoustic (Figure 4.7.3.1), the minimum for the second period of Norwegian Sea acoustic survey, which was present in last year assessment, now has deteriorated. This survey was not undertaken after 2001and changes in fishing mortality in 2004 cannot now influence sufficiently and clearly (in presence of all kinds of noise) the goodness of fit to these data which are now rather distant from terminal year.

What is also can be seen in Figure 4.7.3.1 is that now minimum for catch-at-age is somewhat shifted with respect to the minimum of survey 2 (in the last year assessment they were closer to each other).

If compare the results of the catch-controlled version with the last year results for this version of the model (Figure 4.7.3.2), it can be seen that positions of minima for catch-at-age and survey 2 in this year assessment are almost coincide, analogously to what was observed in last year assessment. From this point of view the catch-controlled version may looks preferable for this year stock assessment. Signal from survey 6 has deteriorated this year analogously to the results of the effort-controlled version.

But comparison of ISVPA-derived results from stock assessments in 2004 and 2005 years (Figure 4.7.3.3) shows that results of the effort-controlled version are more in line with the previous assessment. Besides, results for this version less dependable on exclusion of survey 6 (compare families of F controlled and catch controlled curves on Figure 4.7.3.3, corresponding to effort- and catch-controlled versions). Bearing in mind also that in the previous assessment the effort-controlled version was shown to be more retrospective stable, it look reasonable not to change the model settings this year, but only to exclude survey 6, which now gives no signal along with other auxiliary information, except second part of Norwegian spawning stock acoustic surveys.

Also it is interesting to note that the estimates of R(1) for 2004 are very close to each other for both versions of the model.

Results of stock assessment by the effort-controlled version of the ISVPA, where signals only from catch-at-age and second part of Norwegian spawning stock acoustic surveys are shown, in Figure 4.7.3.4. The estimated abundance of age group 1 for 2004 (21 469 millions) is almost equal to 1981-2003 historical arithmetic mean for estimates of R(1) (21 569 millions) and is not far from the median (16 153 millions) and the geometric mean value (16 178 millions).

Results of retrospective runs are presented on Figure 4.7.3.5.

Comparison of theoretical catches with reported values for are presented on Figure 4.7.3.6. As in last year assessment, theoretical catches in 2002 are higher than reported ones. In agreement with its ideology, the effort-controlled version does not consider catch-at-age data as true and theoretical analogues of catch-at-age may deviate from reported values.

Bootstrap estimates of uncertainty in the results are presented on Figure 4.7.3.7.

Figure 4.7.3.8.represents residuals in catch-at-age and surveys. Residuals in catch-at-age have cohort effect what indicates that estimates of abundance for some cohorts are less based on reported catch-at-age and more based on theoretical values, derived from estimated selection pattern. If estimation of abundances are more based on theoretical catch-at-age (through estimates selection pattern), cohort effect in catch residuals may outline cohorts with problems in catch-at-age data and shows that overall estimate for cohorts with higher residuals is less based on reported catch-at-age data.

4.7.4 Data Exploration with ICA

The data was explored with a number of different scenarios to try and obtain the best fit to the model. Explorations began with a same procedure as last year (SPALY) run (run 1) on updated fishery and survey data. The analysis planned to investigate the effect of:

- The different tuning fleets on model fit and stability
- Different length for the separable period
- Different levels of selection (S)
- Different relative weights of age groups 1 and 2
- Different reference age for separable period

The results of these different runs are presented Figure 4.7.4.1.

In exploring the contribution of the different tuning fleets the WG began by removing all tuning fleet data except the most recent series, i.e., the Norwegian spawning ground acoustic survey. Values for SSB and F appeared unchanged from the SPALY run. There was no indication of increased uncertainty in the run results indicating that inclusion of the old tuning fleet data is unnecessary. This run (run 2) was taken as the departure point for further exploration.

The effect of using a reduced separable period of 3 years was investigated in run three with all other parameters from Run 2 retained. An additional run (run 4) with the same separable period but with altered values for relative weights at age 1 and 2 and an increased value for fixed selection on the last age was conducted. The thinking behind reducing the separable period to three years was to see if better resolution for SSB and F could be achieved during a period when there had been a change in exploitation pattern due to expansion of the fishery into the Norwegian sea in the second quarter. By down weighting the value for relative weights at ages 1 and 2 it was hoped to reduce noise in the results. This noise may be a spawning ground fishery effect where the youngest year classes are not fully recruited. The result of the reduced separable period (run 3) was to raise the estimated SSB substantially and lower the value for F. Noise in the model output increased and the model fit deteriorated. This was indicated by changes in the residual pattern. Compared with a longer separable period of 8 years used in runs 1 and 2 the results of these runs appeared less stable. Down weighting the relative weights of ages 1 and 2 (run 4) and increasing the S value had no discernible effect on the output.

In Run 5 the separable period was raised to 4 years and the reference age increased from 3 to 5. The value for selection was raised to the maximum. and relative weights for ages 1 and 2 down n weighted to 0.5. This produced similar values and model fit for SSB and F to runs 1 and 2 though with a slight deterioration in the quality of the diagnostics.

Run 2 showed the best-defined minimum value for SSQ and offered a high level of consistency with the previous years assessment. Taking this as the final ICA run shows that SSB continues at a high level. F is also comparatively high. Recruitment is well below the very high values of recent years though still at or above the best values estimated for the earlier part of the time series.

The stock summary and diagnostics from final run 2 are presented in Figures 4.7.4.2. to 3. Comparisons of the different ICA runs are presented in Figure 4.7.4.4;

Retrospective analysis (Figure 4.7.4.4) shows that the final runs for ICA have been developing consistency over the last four years. Running the same settings with 2001 and2000 as the final year show a quite different stock characterised by much lower SSB and raised F values.

Settings used for ICA final run	**2004**	**2005**
Number of age structured tuning series	3, each split	1
Number of biomass tuning series	0	0
Number of years for separable constraint	8	8
Reference age for separable constraint	3	3
Constant exploitation pattern	Yes	Yes
S to be fixed on last age	1.5	1.5
Age range for mean F	3-7	3-7
Catchability model for tuning fleets	Linear	Linear
Age range for the analysis	1-10	1-10
Survey weights for all fleets	100%	100%
Shrinkage	No	No
Manual down weighting	Yes	Yes
Tuning series split	Yes	Yes
Weighting of age 1 catch numbers	100%	50%

4.7.5 Data Exploration with SMS

SMS (Stochastic Multi Species model) (Lewy and Vinther, 2004) is an age structured assessment model to handle biological interaction, however, it can be reduced to operate with one species only. In "single species mode" an objective functions for catch at age numbers and survey indices at age time series are minimized assuming a log-normal error distribution for both data sources. SMS uses maximum likelihood to weight the various data sources. For more details see section (XX).

Since the last WG meeting, SMS has been modified slightly. Now, it is possible to give a starting and an ending date for surveys and observed indices are compared with the mean stock number within that period. Previously, the mean stock numbers within the calendar year was used. In addition, it is now possible to use survey indices for the year following the last assessment year. In such cases, it is assumed that the survey is conducted the 1. January in all years. By using this assumption there is no need to guess on the mortalities in the year following the assessment year.’

SPALY run

A SMS run was made using the same settings as last year and the updated data series.

Catch data

Catch data for the period 1981-2004, age 1 to age 10+ were used. The age selection pattern was assumed constant within two periods, 1981-1992 and 1993-2004. Selection at age was estimated by individual age group for age 1 to 7 and combined for age 8-10. Variance of catch observation was estimated separately for age 1, age 2, age 3-6 combined and age 7-10 combined.

Tuning data

Survey data and settings used in the last year's SMS run are presented in the table below. Last year, it was not possible to use survey data sampled after the assessment period and for this first run the "Acoustic survey on spawning grounds" used data for the period 1981-2004.

Survey	Year range	Catchability at age	Variance at age of survey observation
Acoustic survey on spawning grounds	1981-1990 1991-2005	By age-group: age 2-6. Combined: age 7-8	By age: age 2, Combined: 3-5 and 6-8
Russian acoustic survey	1982-1991 1992-1996	By age-group: age 3-6. Combined: age 7-8	Combined: 3-5 and 6-8
Norwegian Sea	1981-1990 1991-2001	By age-group: age 1-5. Combined: age 6-7	By age: 1-2 and 5 Combined: 3-4

The results of a model run with the same settings as last year and the updated input data are given in Figure 4.7.5.1. Compared with last year's assessment the 2003 SSB is now estimated one million tonnes higher and the 2003 fishing mortality is reduced by 25%.

SPALY settings with use of the 2005 survey data

SMS is now able to use survey data from the year after the last assessment year. Using this feature and the 2005 data from the acoustic survey on the spawning grounds gives a slightly higher F and lower SSB (Figure 4.7.5.1) for the most recent years compared to the SPALY run. Recruitment is estimated lower for the 2000-2003 year-classes when the 2005 survey data are used, which results in an almost one million tonnes lower SSB in 2005The extension of the assessment time series up to 2004 seems to be the main cause for the upward revision of the 2003 SSB. The additional use of 2005 survey data does not affect the stock estimate up to 2004 much, but the estimate for the SSB in 2005 is reduced by 15%.

SMS estimates relative low CV for catch observations and a rather high CV for survey indices (Table 4.7.5.1). The Russian acoustic and the Norwegian Sea acoustic surveys have in general the highest survey CV and the two surveys do not cover the most recent assessment years. The overall contribution to assessment model from these two surveys is therefore limited.

SMS using only the spawning grounds acoustic survey.

The results from a SMS run where data from the acoustic survey on the spawning ground were the only survey data are included in Figure 4.7.5.1. The difference from the results using 3 surveys fleets is less than 1-2% for the main output values and the CV of SSB and estimated stock numbers at age in the terminal year is not affected by more than a fraction of a percent. Moreover the number of model parameters is reduced from 109 to 87. It was therefore decided not to use the Russian and the Norwegian Sea acoustic surveys in the next SMS exploratory runs.

SMS using spawning ground and juvenile surveys

The acoustic survey conducted in the Norwegian Sea in May, 2000-2005 may give information on the juveniles, even though the time series is short. Data for the 1 and 2-groups were used in a new run.

The effects of including the survey is an increase in the estimate on juveniles in the terminal assessment years and the SSB estimated for 2005 (Figure 4.7.5.1)

Diagnostics

The SMS diagnostics (Table 4.7.5.2) show that the log-likelihood contributions are highest from catch data. For the surveys the likelihood contributions are highest from the Norwegian Sea May survey and for the most recent survey period of the survey on the spawning grounds. The same information can be found in the estimated CV for catch and survey observations, where the catch observations have the lowest CV. The estimated selection pattern (labelled F, age effect) indicates a shift towards the age group 3-5 in the most recent separable period (Figure 4.7.5.2). Survey catchabilities at age from the spawning area are fairly constant for the younger ages for the two periods, but considerably lower in the most recent period for the older age-groups (Table 4.7.5.2). This confirms the decision to split of the survey into time periods.

There is no consistent pattern in the residuals plot for catch observations (Figure 4.7.5.3) even though the plot indicates a possible shift in the exploitation pattern for the oldest ages in the last four years. Survey residuals (Figure 4.7.5.4) have a very clear year effect, often seen for acoustic time series. The residuals for the 2-group in 2005 are rather large with higher than expected survey CPUE from “juvenile survey” and much lower than expected for the spawning grounds survey. The spawning ground survey might not be a good survey for the 2-group, and the CPUE of 2-groups in 2005 should maybe have been seen as an extreme outlier and deleted. Observed and predicted yield are fairly overlapping, however with some discrepancy for the most recent years (Figure 4.7.5.5)

The retrospective pattern for 1998-2004 (Figure 4.7.5.6), excluding the very short “Norwegian Sea, May 2000-2005” survey shows a tendency for overestimation of F and underestimation of SSB. There was no survey data for 1997, which may cause the very unstable estimation of F in the period 1998-2000. After that period the estimated of F and SSB are rather stable from year to year. SMS uses maximum likelihood to estimate the parameters and put as default an equal *a priori* weighting factor (=1.0) on both catch at age and survey at age information. To investigate the sensitivity of this default settings, different *a priori* weights were applied to the survey observations ranging from a low weight (weighting factor 0.1) to a high weighting factor (3.0). Weighting on catch observation was kept constant at 1.0. The results (Figure 4.7.5.7) show that the estimated SSB are sensitive to the *a priori* weighting factors on surveys. That shows that the overall signal in the two data sources, catch and survey, is the same, however the details differs slightly. From Figure 4.7.5.7, it is clear that an increasing *a priory* weight on survey observations gives an increase in the estimated SSB in the terminal year. Said in another way, survey observations indicate a higher SSB than the catch data.

When the default a priori weighting factors are applied, catch observation get the lowest CV (Table 4.7.5.2) which shows that the maximum likelihood method see catch data as more precise than survey data. Increasing *a priori* weight on surveys gives increasing CV on catch observation, and *a priori* weight on surveys higher than 3.0, result in CV on catches higher than 100-150%. This means that there is almost no information in catch data which results in highly variable estimated SSB based purely on surveys. Results for *a priori* weight on surveys higher than 3.0 are not shown on Figure 4.7.5.7.

Results

Estimated fishing mortality in Table 4.7.5.3, stock numbers are presented in Table 4.7.5.4, stock summary in Table 4.7.5.5 and Figure 4.7.5.8 and stock recruit plot in Figure 4.7.5.9. The uncertainty of estimated stock numbers in 2004, SSB and F are presented in Figure 4.7.5.10 and 4.7.5.11. A CV at 35% for the estimated 1-group stock number and 22% CV for the 2-group emphasize that rather little is known about the abundance of the recruiting ages to the fishery. However, compared with the estimated CV in last year's SMS assessment the inclusion of the May survey for juveniles has reduced the uncertainties on the juveniles considerably, as the uncertainties last year were estimated to 45% and 30%. The use of the 2005 survey on the spawning grounds has reduced the CV on SSB in the last assessment years. CV of SSB in 2003-2004 are now 10% and 12%, a clear reduction from last years assessment with CV at SSB at 14% and 22%.

The uncertainties presented above have been calculated from the Hessian matrix. Assessment uncertainties estimated by the used of Markov Chain Monte Carlo (MCMC) simulations, with 200 000 chains thinned by a factor 500 is presented on Figure 4.7.5.12 and 4.7.5.13. The median of average F (0.57) in 2004 is higher than the F (0.51) estimated from SMS using maximum likelihood.

4.7.6 Comparison of results of different assessments

The results of the preferred assessments, carried out with each assessment model (AMCI, ICA, ISVPA and SMS), are compared in Figure 4.7.6.1. The different assessments give basically the same results as last year with the exception of the most recent years. In general the results of the models are in good agreement with each other. All models use the assumption of separability. Differences between the results may to a large extent originate from the differences in external data sources used in the assessment or the capability of the model to use certain kind of data. Also different weighting of the various input sources (example: see Figure 4.7.5.7) may have contributed to differences in the results.

SSB: All models show the same development of the SSB in the historical time series. They indicate a significant increase in SSB in the late 1990's to a historic high in 2003. At its maximum size the stock is estimated by the different models between 5.7 and 6.9 million t. In 2004 and 2005 the SBB declined. The high SSB are in line with the results from the acoustic survey on the spawning grounds although there is a difference in trend between the survey and the assessments in 2001-2003. The decline in SSB in 2005 indicated by the assessment corresponds to the survey. The stock in 2005 is estimated between 4.8 and 5.5 million t.

Fishing mortality: Trends in fishing mortality estimated by the different models are show the same trend but are noisier than SSB estimates. ISVPA estimates of F between 1986 and 1990 are consistently higher than those estimated by the other models. All models indicate a sharp decrease in F from 1990 to 1991. The reasons for this decrease are unclear and may reflect a shift in the fishery to other components of the stock. Also, all models indicate F has increased after 1994. Between 2000 and 2003 trends in F become unclear. In 2004, F is estimated to increase by all assessments and is well above $\mathbf{F}_{pa}$ and close to $\mathbf{F}_{lim}$.

Recruitment: All models indicate a significant increase in the level of recruitment after 1995. The 1996 year class was estimated as the strongest in the time series. The estimate of this year class is almost the same by all models. The trends in the time series by ISVPA differ somewhat from the other assessment models. The estimates of recruitment in 2002 and 2003 estimated by ICA are higher than for the other models. The recruitment is 2004 is not estimated well by any model or has been assumed. Recruitment for this year will be estimated separately.

Catches: All models estimate catches in those periods where separability of the fishing pattern has been assumed. Figure 4.7.6.1. shows that there is in general good agreement between observed and modelled catches in the historical period. However, there are differences are in the most recent period. All models estimate a higher catch in 2002 than the reported one and a lower catch than reported in 2003 and 2004. ISVPA also show noticeable discrepancies between observed and modelled catches in some earlier years.

Comparision with last year's assessment: Compared to last year all tuning methods estimate somewhat lower F and higher biomasses in recent years (Figure 4.7.6.2 and 4.7.6.3). SMS and AMCI show the largest differences. The ICA assessment is the most consistent. The change in levels has also been a problem in previous years and contribute to fluctuations in prognoses and the stability of the advice which is based on absolute reference points.

The WG felt it difficult to make a choice between the models. There is little information supporting a specific choice between them. Nevertheless, it was necessary to make a choice as a basis for the predictions. None of the models investigated showed a possible shift in exploitation by the expansion of the fishery into the Norwegian Sea in the most recent 4 years. All models appear to be sensitive for the inclusion of a new year's data and show in some cases large residuals between observed and estimated parameter values. There still appear to be very strong year effects in all surveys and similar in all models whereas ISVPA also show clear cohort effects exist.

The WG selected SMS as the preferred assessment. This choice of the WG differs from last year where AMCI was selected. The choice for SMS was based on the fact that is could demonstrate the sensitivity of the model to the weight given to the survey and the catch data. Also the historical and recent estimates were always close to those estimated by most other models.

4.7.7 Final Assessment

The key settings and data for the final blue whiting assessment in 2005 are shown in the table below. The key settings of the final assessment in 2002-2004 are also shown for comparison. Some of the settings are described in more detail after the table.

Settings/options for the AMCI run	2002	2003	2004	2005
Software	AMCI 2.1	AMCI 2.2	AMCI 2.3a	SMS
Age range for the analysis	0-10+	1-10+	1-10+	1-10+
Last age a plus-group?	Yes	Yes	Yes	Yes
Age at recruitment (from Jan 1 in the year of spawning)	0.5	1	1	1
Recruitment in the terminal year	Fixed	Fixed	Fixed	Estimated
Recruitment in the terminal year-1	Estimated	Fixed	Estimated	Estimated
Catch data				
Weights for the partial objective functions for the catch fleet				
Log sum of squares of catches-at-age	1	1	1	Estimated
Log sum of squares of yearly yields	1	1	1	0
Weights of catch-at-age, age 0 and 1 years	0.1, 0.5	n.a., 0.5	n.a., 0.5	n.a., estimated
Constant selection pattern for the catch fleet?	Almost	Almost	Almost	2 periods
Selectivity for age 10 equals average of selectivity at age 8-9?	No	Yes	Yes	Yes
Age-structured tuning time series				
Norwegian acoustic survey on the spawning grounds, ages 2-8	1981-2002	1981-2003	1981-2004	1981-2005
Flat selectivity for ages 6-8?	Yes	No	No	No, 7-8
Weight in tuning for the partial objective function	1	1	1	Estimated
Russian acoustic survey on the spawning grounds, ages 3-8,	1982-1996	1982-1996	1982-1996	not used
Flat selectivity for ages 7-8?	Yes	No	No	n.a.
Weight in tuning for the partial objective function	1	1	1	n.a.
Norwegian Sea summer acoustic survey, ages 1-7	1981-2001	1981-2001	1981-2001	not used
Flat selectivity for ages 5-7?	Yes	No	No	n.a.
Weight in tuning for the partial objective function	1	1	1	n.a.
Norwegian Sea international ecosystem survey, ages 1-2	not used	not used	not used	2000-2005
Weight in tuning for the partial objective function	n.a.	n.a.	n.a.	Estimated
Biomass tuning time series	0	0	0	0

Survey data used in tuning are shown in Table 4.7.7.1. As in previous years, the Norwegian acoustic survey on the spawning grounds was split into two time periods reflecting a likely change in catchability caused by a change in acoustic equipment (from Simrad EK-400 to EK-500). Survey indices are treated as relative abundance indices.

Fishing mortality was modelled as strictly separable within two periods, 1981-1992 and 1993-2004, in contrast to earlier years when small gradual changes in selection were allowed.

Recruitment in 2004 was estimated. Recruitment in 2005 was set to 43.7×10^9 on the basis of the Barents Sea 1-group index from winter 2005 calibrated with the SMS-estimated recruitment in 1981-2003 (see Section 4.8). In earlier years, recruitment in the final assessment year has not been estimated but set to a mean value calculated from earlier recruitments (usually 10-year geometric mean).

Catch-at-age data are input at yearly resolution (Table 4.5.4.7). The spawning stock is derived from the stock numbers January 1st (was the first quarter in the 2004 assessment), and the survey indices are related to the mean values in the survey period (Table 4.7.7.1). The yearly fishing mortality is assumed constant over a year (in the 2004 assessment, was split on quarters assuming that the proportion 0.35 of the total annual fishing mortality occurs in the first and in the second quarter, 0.2 in the third quarter, and 0.1 in the fourth quarter).

The model was run until 2005. The SSB in 2005 is a predicted value based on assumed recruitment in 2005 (43.7×10^9, see above). The key results are presented in Tables 4.7.5.4–4.7.5.6 and summarized in Figure 4.7.5.9. Residuals of the model fit are shown in Figures 4.7.5.3–4.7.5.4. Some modest cohort effects are visible in the catch residuals for the early cohorts. More importantly, there are age-specific blocks of positive and negative residuals for the latest years (i.e., systematic differences in modelled and observed catches), suggesting changes in selection pattern. Year effects occur throughout the spawning stock survey time series.

The assessment (Tables 4.7.5.6, Figure 4.7.5.9) indicates that fishing mortality first steadily increased since mid-1990s and has then been fluctuating between $\mathbf{F}_{pa}$ and $\mathbf{F}_{lim}$; the most recent value is similar to $\mathbf{F}_{lim}$. The exploitation pattern (Figure 4.7.5.2) indicates only a modest change between the two periods. SSB has been at a historically high level since 1998 and is only marginally less than the record in 2003. Year class 2000 (recruits in 2001) is the highest in the time series by a large margin. All year classes 1995-2004 are strong in comparison to recruitment before 1995: even the weakest year class born after 1996, that of 1998, is much stronger than was typical before 1995.

Retrospective analysis (Figure 4.7.5.6) shows a small but consistent bias towards under-estimation of SSB and over-estimation of fishing mortality. Marko Chain Monte Carlo (MCMC) simulations (Figure 4.7.5.12) give an indication of the uncertainty in the assessment. Temporal patterns in recruitment, spawning stock biomass and fishing mortality are reproduced, but uncertainty in the absolute level of these metrics during the recent years is clearly visible. Nevertheless, the qualitative development of fishing mortality (marked increase) and spawning stock biomass (marked decrease) from 2003 to 2005 appear to be robustly estimated. The 95 % confidence intervals for SSB in 2004-2005 are wide but do not overlap with $\mathbf{B}_{pa}$, whereas fishing mortality in 2004 is with >95 % probability larger than $\mathbf{F}_{pa}$, with modal F close to $\mathbf{F}_{lim}$. The estimates of terminal F (2004) and SSB (2005) are negatively correlated (Figure 4.7.5.13). The two-topped density distribution of SSB in 2004 indicates uncertainty in assessment.

4.8 Recruitment estimates

Information on recruitment (age 1 year) in particular and young blue whiting (ages 0-2 years) in general is provided by a number of surveys, none of these covering the whole distribution of juvenile blue whiting. Only one of these, international Norwegian Sea ecosystem survey in May, is used in the current assessment. The shortcoming of this time series is its shortness, a problem that applies to most other time series as well. Here we discuss this and other surveys from the viewpoint of recruitment in the latest years.

Figure 4.8.1 shows an overview of normalized survey time series in the northern areas (the Faroes and northwards). Information on age 0 is scanty (only two time series) and does not provide a consistent signal. Information on age 1 year is provided by several surveys. These all tend to suggest that recruitment in all years between 2000-2005 has been close to (2002-2003) or above (2000-2001, 2004-2005) average of the respective time series. At age 2 years the data are scanty but suggest a decreasing trend.

Figure 4.8.2 shows that the internal consistency of the Norwegian Sea ecosystem survey in May is reasonably good but there are some exceptions like for year-class 2001 between ages 1 and 2 years and the 1996 year-class between ages 4 and 5 years. The graphs also indicate that the abundance indices decrease rapidly with age (slope <1).

Another potential problem with the Norwegian Sea ecosystem survey (other than short time series) is that it does not cover the whole nursery area of blue whiting. Acoustic measurements in Icelandic water from July 2000-2004 indicate that part of the nursery areas are near Iceland (section 4.6.1.5). The part that grows up in Icelandic waters is variable but the Icelandic indices of age 1 year are between 10 and 50% of the indices for the same age group in the Norwegian Sea (highest for year-class 2001). If blue whiting of age group 1 year is considered reasonably stationary in its behaviour, adding the Icelandic July data to the Norwegian Sea May data could be possible. Acoustic measurement of blue whiting in Icelandic waters was not conducted in 2005. The data from the May survey for the area west of 18°W were used as proxy for age 1 but in this survey little 1-group blue whiting was measured (section 4.6.1.6). For age 2 years the Icelandic survey was not used.

Use of bottom trawl surveys as a measure of recruitment is another possibility that could be investigated. Data on blue whiting are available from the winter bottom trawl survey in the Barents Sea since 1981 (section 4.6.1.14). Figure 4.6.3 shows those indices from the survey plotted against the recruitment estimate from 2004 WG on both log and ordinary scales. The relationship can be modelled by a power curve (estimated power 2.8) or it can be argued that year-classes smaller than about 30 000 million at age 1 year are not properly detected in the survey. Although the Barents Sea is not considered a major nursery area for blue whiting (in summer 2004, estimate at age 1 year was about $5.8x10^9$, about 20% of the estimates in the Norwegian Sea surveys in May but of similar to the estimates in the Icelandic July surveys), the survey could be measuring the component drifting into the Norwegian Sea. This is supported by figure 4.6.4 that shows the index of age 1 year in the Barents Sea vs. the acoustic abundance of age 1 year in the Norwegian Sea.

The Icelandic groundfish survey in March (section 4.6.1.15) commenced in 1985 but length measurements of blue whiting started in 1996 so indices of age 1 year blue whiting can only be calculated since 1996. In figure 4.6.4 it can be seen how the indices fit with other indices of recruitment and with the assessment. The immediate answer is that they do not fit well with the assessment nor with the other surveys. They are on the other hand representative for another area and should possibly be added to the other indices as suggested for the Icelandic acoustic measurement. Figure 4.6.5 shows the result from that kind of model with the estimated model combining Icelandic and Barents Sea bottom trawl surveys as $N_1 = 0.76 I_{ice} + 0.124 I_{bar}$. The figure indicates a reasonable prediction of recruitment except for year-class 1997 that is missing in both surveys.

The longest time series for predicting recruitment is the Barents Sea winter survey. A possible complication is the change in mesh size from 35-40 to 18 mm in 1994. We make recruitment predictions by fitting model log(WGrecruitment)~a_0+$a_1$log(Index) with data from 1994 onwards, or model log(WGrecruitment)~a_0+$a_1$log(Index)+a_2Mesh where Mesh is an indicator variable having value 1 in 1981-1993 and 0 later on. As the WG recruitment estimates we use final assessments from 2004 and 2005. These models are illustrated in Figure 4.8.6.

To summarize no good recruitment survey is yet available but a number of surveys can be used to predict the size of year-classes 2003 and 2004 at age 1. The following table shows recruitment estimates for those year-classes using the different surveys. All these are well above the long term average and close to or higher than the average during the recent “high productivity” period.

Survey data	Calibration data	Time period	Recruitment 2004 (10^9)	Recruitment 2005 (10^9)
Barents Sea	WG04	1994-2002	33	35
Barents Sea	WG05	1994-2003	41	44
Barents Sea	WG04	1981-2002	32	34
Barents Sea	WG05	1981-2003	40	42
Norwegian Sea ecosystem	WG05*	2000-2005	42	48
Norwegian Sea May+Icelandic acoustic	WG05*	2000-2005	41	45
Barents Sea+Icelandic groundfish	WG05*	1996-2005	32	32

* AMCI assessment

4.9 Forecast

4.9.1 Short term forecast

Last year short term projection was carried out using the STPR3 (Skagen, 2002), using bootstrap output from the final AMCI assessment as input. This year SMS was used to produce the final assessment, and this program cannot provide bootstrap data. Therefore, the previous STPR3 approach could not be continued. Instead, it was decided to make a deterministic short term forecast based on the SMS maximum likelihood estimate and in addition a stochastic projection based on MCMC functionality build in to SMS (SMS is using the ad-Model builder software, which provides MCMC).

By using the MCMC a number of sets of SMS model parameters are produced, where the correlation between the parameters are maintained. 200 sets were produced from 100000 MCMC chains thinned by a factor of 500. This parameter set (the posterior distribution) was used as basis for 200 replicate short term projections, which due to the different parameter values, will produce variable initial stock size for the projection and variable exploitation pattern and F *status quo*. SMS has no model for mean weight in the sea, catch mean weight or proportion mature, and these values were kept constant in the projections. The mean and confidence limits of the predicted SSB, and Yield were calculated from the output of the 200 MCMC projections.

Input

Mean weight at age in the sea, mean weight in the catch, natural mortality and proportion mature were derived from the average of the values for the period 2001-2004. The SMS assessment assumes a constant exploitation pattern for the period 1991-2005, and this was used in the projection. Recruitment at age 1 in 2005 was assumed at 43.7 *10^6 (see Section 4.8). A geometric mean recruitment and its variance in 1996-2003 was used for recruitment in 2006. Table 4.9.1.1 gives an overview of the input data.

For the fishery in 2005 it was assumed that
the catch will reach 2 million tonnes;
the F *status quo* F will applied.

Ouput

The predicted catch and SSB for two options are presented in Table 4.9.1.2.

When *status quo* F is applied for 2005 the catch in 2005 is predicted to be 2.38 and 2.30 million tonnes for respectively the deterministic and MCMC projections. These values are quite close to the best guess (2 million tonnes) of the WG on the catch level for 2005.

The deterministic projections (based on the SMS maximum likelihood estimate) have a higher initial SSB and lower F compared to the stochastic projections (based on the SMS MCMC estimate). This difference is maintained in the projections such that deterministic projections predict a higher SSB in 2007 for a given TAC in 2006.

Ideally, the two methods should give the same (mean) values for SSB and F. The assessment was made with a lower limit (0.25) on the CV on catch observations. If this restriction is removed the assessment model give a higher weight on catch observations. This will, as indicated at Figure 4.7.5.7, give a lower SSB and a higher F. The effect of an unbound CV on both types of projections is a relative decrease in predicted SSB. As an example for option a) with a TAC of 2 million tonnes in 2006: SSB in 2007 will in the deterministic projection decrease from 6.0 to 5.7 million tons, whereas the MCMC projection has a decrease from 5.3

to 5.2 million tonnes. Therefore, the difference in the two model outputs is not due to the applied minimum CV.

The confidence limits are likely to be underestimated, because the recruitment estimate for 2005 has been assumed to be without uncertainty. Likewise, the mean weight at age and proportion mature are assumed to be constant.

4.9.2 Harvest Control Rules

Presently short term ICES catch advice for blue whiting is based on stochastic predictions which are sensitive to the size of the stock estimated by the most recent assessment. Several assessments methods are carried out on the blue whiting stock. In general they show agreement in the development of the stock and the exploitation but give different estimates of the actual level of stock size and fishing mortality. Often, it is impossible to discriminate that one is better than the other. The difference between the assessments indicates the range where the true situation of the stock and the exploitation of it may be (even though there is no guarantee that the “true” value lies within this range). Short term catch prognoses, therefore, may be very dependent on the choice of a preferred assessment. Also, for a particular assessment method, the results may show large differences from year to year, indicating that it is very sensitive to the weight given to the different data sources used and the addition of new data year.

This may lead to large variation in the short term catch advice which are not only related to variations in the projected fishing mortality and stock size but to a large extent to the variations of the assessment. In such situation the assessment is a poor basis for providing catch options and an alternative procedure should be considered which is less sensitive to the performance of the assessment.

For the credibility of the advice, (large) changes in the catch advice and management measures induced by assessment error are highly undesirable. In such cased it may be preferable to introduce more stability in the annual catch opportunities. HCRs based on a fixed target fishing mortality would not achieve this when this parameter is poorly estimated. Also applying a fixed target F or effort would lead to fluctuations in TACs closely following projections of the projected stock.

In such situations, it could be considered to base management strategy (Harvest Control Rule) on a more robust estimators of the state and the productivity of the stock. This indicator could, for instance, be an index of exploitable biomass obtained from surveys or cpue time series, which are considered to be sufficiently representative indicators for the development of the stock.

As an example, a HCR could be based on a stable (fixed) TAC. In the case of blue whiting, different levels of TAC could be considered associated with observed differences in productivity of the stock. All assessments indicate that between 1995 and 2002 the blue whiting stock has shown a significant increased productivity (high recruitment). This has lead to a large increase of the stock after 1997. Such a situation may justify higher TAC in the period of high stock size caused by increased productivity.

This simple Harvest Control Rule requires only the adoption of a few entities. Firstly a time series should be adopted as relative indicator of exploitable biomass which is the basis for a management decision. It is essential that each year the time series will expanded with a new data point (index). This index is required to decide whether or not to change the management. Secondly, the HCR requires the adoption of a trigger point in the range of the time series. If the index is above the trigger point then an agreed management procedure would be applied. If it is below the trigger point, a different agreed management procedure would be applied. Thirdly it should be agreed what the management procedure would be. In the most simple situation the management procedure would be a pre-agreed TAC. In principle the rule could be expanded with more trigger points defining ranges within different management procedures would be applied.

Before adopting the HCR, the proposed procedures should be evaluated, with respect to its performance in terms of maintaining the stock within precautionary limits (more here?).

In the case of blue whiting it could be explored whether the acoustic surveys on the spawning grounds could be adopted as representative indicators of the stock size. These surveys have recently been coordinated internationally and expanded by participation of the EU and Far Oer. The survey aims to cover the entire distribution area of blue whiting on the spawning grounds. The surveys are, however, not reliable estimators of expected recruitment. The HCR could be expanded if time series of recruitment became available indicating productivity in the most recent years.

4.10 Biological reference points

The present precautionary reference points have been introduced in the advice of ACFM in 1998. The values and their technical basis are:

Reference point	$\mathbf{B}_{lim}$	$\mathbf{B}_{pa}$	$\mathbf{F}_{lim}$	$\mathbf{F}_{pa}$
value	1.5 mill t	2.25 mill. t	0.51	0.32
basis	$\mathbf{B}_{loss}$	$\mathbf{B}_{lim}$*1.5	$\mathbf{F}_{loss}$	$\mathbf{F}_{med}$

Although problems have been identified with these reference points they have remained unchanged since then. A major problem is that fishing at $\mathbf{F}_{pa}$ implies a high probability of bringing the stock below $\mathbf{B}_{pa}$, in other words the present combination of $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ is inconsistent.

It should be noted that the PA reference points presently applied in the ICES advice are based on an ICA assessment in 1998 and are based on a relatively short time series. Since then regular changes have been made in the assessment by selecting other assessment methods or different assessment configurations. Also major changes have been observed in the stock and in the fishery. The assessments have frequently lead to different perceptions of the history of the development of the stock and the fishing mortality. PA reference points derived from these assessments would vary considerable between years. Since the introduction of the PA reference points the stock has moved into a period of high productivity. In such situations it may be inappropriate to adopt fixed reference points. Therefore, given the uncertaintly in the assessment process, the WG was requested to develop management strategies which are less sensitive to the assessment results.

No attemp was made to recalculate the reference points in 2005. However the value of $\mathbf{B}_{lim}$ was reconsidered since all management stategies would have to comply with a low probability of bringing the SSB below $\mathbf{B}_{lim}$.

SGPRP revisited the $\mathbf{B}_{lim}$ reference point for blue whiting in February 2003 (ICES 2003/ACFM:15). The current $\mathbf{B}_{lim}$ a value of 1.5 million t was based on an estimate of $\mathbf{B}_{loss}$ from an assessment in 1998. Since a segmented regression on the stock recruitment data was not significant, $\mathbf{B}_{loss}$ remains the obvious candidate for $\mathbf{B}_{lim}$. Within the range of observed SSB there is no indication of reduced recruitment at low SSB. In the assessment carried out in 2002 $\mathbf{B}_{loss}$ was estimated to be 1.2 million t and SGPRP proposed this value for $\mathbf{B}_{lim}$.

Based on assessments carried out in 2005 by WGNPBW, the $\mathbf{B}_{loss}$ is estimated between 1.4 million t (AMCI), 1.7 million t (ISVPA) and 1.6 million t (ICA and SMS), the same values as last year. If the value of $\mathbf{B}_{lim}$ is to be revised, it is likely to be around the region of the present value of 1.5 million tonnes.

4.11 Management considerations

Countries participating in the fishery on blue whiting have not been able to agree on measures to regulate the fishery. TACs have been set unilateral and increased during the year. Some countries have not set a TAC at all. In the last two years international catches of blue whiting have increased to record high levels. The stock has been able to support these catches because of an increased production since 1995.

No updated, official information on the fishery in 2005 was available. Anectodical information from Working Group members suggest that catches in 2005 may be lower than in 2003 and 2004. It was considered that input into the blue whiting fishery in the second part of the year was somewhat lower than in previous years. The reduced interest in the fishery is likely caused by economic considerations such as an increase in fuel prices and reduced densities of blue whiting in the second part of the year. The Working Group assumed in its forecast that a total catch of 2 million tonnes would be taken in 2005. This is about 400 thousand tonnes lower than in the previous two years

Should the production change back to the previously observed low-production regime, the current catch levels would be unsustainable., The causes of change in productivity are unknown and need investigation. Maintaining the high catch levels could lead to a rapid decrease or even collapse of the stock in the case of a change to a low productivity regime.

In order to allow optimal harvesting of the stock and to take adequate management measures, monitoring of the productivity of the system should be carried out.

In recent years the fishery has expanded to areas where large amounts of juvenile blue whiting occur. In particular the fishery in the Norwegian Sea has expanded and now contributes about 40% to the total catches. In order to improve the exploitation, measures should be considered to reduce the exploitation on juveniles.

4.12 Quality of the data and the assessment

A new fishery-independent data source, the international ecosystem survey in the Norwegian Sea. was included in this year’s assessment. At the same time, the structural uncertainty in the blue whiting assessment has likely increased: while most assessment models assume constant exploitation pattern, the expansion of the fishery in the Norwegian Sea has possibly resulted in increased exploitation of juveniles. This change is not captured in results of any of the assessments. If the change in exploitation pattern has indeed taken place, all assessments are probably too optimistic.

The assessment of blue whiting has been very uncertain in recent years with upwards revision of the stock size with every new assessment. This trend has been driven by exceptionally good recruitment compared to earlier period, while at the same time little information has been available on the recruitment.

Compared to earlier assessments the 2005 assessment shows some upwards revision of the stock from last year; the actual change varies between models (Figure 4.7.6.3), least for ICA and ISVPA but most for AMCI.

The resulting spawning stock in 2004 for the selected models ranges from 5 (AMCI) to 6.6 millions (ISVPA) tonnes and SSB in 2005 from 4.8 to 5.8 million tonnes (Figure 4.7.6.1). As 11% of age group 1 is mature, estimate of the 2004 yearclass can affect the SSB in 2005. This relatively narrow range of results is however not not indicative of the precision of the assessement as all the models are somewhat similar (mostly seperable models for fishing mortality). The SMS run where a priori weights on survey relative to catch are varied (figure 4.7.5.4) gives SSB in 2004 in the range from 4 to 7 million tonnes, with a higher number obtained with more weight on surveys. This tendency for the surveys to indicate higher biomass than the catches can also be seen in the ISVPA profiles (4.7.3.1) where the minimum for the catches occur at higher F than the minimum for the Norwegian spawning stock survey that is the most important surveys. Looking at the numbers in figure 4.7.3.1 for the median of the catches and the SSE for the Norwegian spawning stock survey (that are added) shows that the survey will get more weight. Thus, ISVPA is weighting the survey relative to the catch more than the other models with the default settings. An ADAPT model that was run gave spawning stock of 6.8 million tonnes in 2004 but that model has not model for fishing mortality and its fit to the most recent survey is only limited by results from earlier surveys. The perception of the stock today is therefore a question of our confidence in the survey data versus the catch data.

With regard to catch data, fisheries for blue whiting in the eastern Norwegian Sea have expanded. These fisheries are catching also large proportions of young immature fish. This change will violate the assumption of seperability used by most of the assessment models and could affect the assessment results in unpredictable ways.

With regards to the spawning ground survey, figures 4.7.2.2 and 4.7.5.4 show positive residuals for age 5 years and older in the last year, but large negative residuals for ages 2 and 3 years. In Section 4.6.1.2 it was argued that the lack of ages 2 and 3 in the survey 2005 was caused by inadequate sampling as more of those age groups was found in the international survey. The SMS assessment uses age 2 in 2005 from the spawning ground survey for tuning, which is questionable as manifested by the large residual in figure 4.7.5.4; this residual is most likely a sampling problem. Looking at older surveys, negative block is seen in 2001 but the surveyed biomass dropped then by more than 50% from the years 1999-2000, increasing again after that. Figure 4.12.1 shows that the survey has generally been a reasonable measure of stock size. Age 5 in 2005 seems to be considerably larger than estimated by the survey and this residual seen there means well over 1.2 million tonnes in spawning stock biomass. Comparing observed and modelled survey biomass seems to indicate that in many of the surveys they fit reasonably together but the age composition in the surveys and the models does not match, indicating sampling problems.

Another measure of the quality of the assessment can be obtained from the estimates of uncertainity from the assesssment models (figures 4.7.2.4, 4.7.2.5, 4.7.3.4 , 4.7.5.11, and 4.7.5.13). The uncertainity estimated by ISVPA seems to be considerably more than by AMCI with SMS falling in between. This is caused by ISVPA putting relatively more weight on the noisier survey data but does not have to mean the the ISVPA results are worse. Surveys are often more noisy than data from catches but give the correct main trends ("It is better to be roughly right than to be precisely wrong" – Maynard Keynes). It is known that uncertainty estimated by assessment models is an underestimate of the "real uncertainty" but here the estimated uncertainty seems to explain the difference between assessments.

The selection of a "final run" in an uncertain situation is always a problem but as seen in figures 4.7.5.7 and 4.7.6.1 the selected "final run" is somewhere in the middle of plausible outcomes.

Recruitment estimates have been a problem for this stock with age 1 contributing both to the spawning stock and to the fisheries. Analyses done at this meeting indicated that information from the acoustic surveys in the Norwegian Sea and south of Iceland as well as the bottom trawl surveys in the Barents Sea and Iceland could be used to estimate the size of yearclasses 2003 and 2004, with reasonable confidence (see Section 4.8) .

With regards to yearclasses 2005 and later the question is whether to assume that recruitment has been as in the high production period since 1995 or if to use the whole period since 1981. The geometric mean for the latter period is 35 000 million fishes while it is 18 000 million fishes for the whole period. Yield per recruit is about 50g so recruitment as in recent years can sustain a yield close to 1.7 million tonnes while recruitment according to the long term mean can sustain 0.9 million tonnes. Increasing exploitation on age 1 and 2 fish as done in recent years will reduce yield per recruit unless M is considerably higher than 0.2 yr^{-1}.

To summarize, the quality of the assessement and recruitment estimates have improved considerably from last year, mostly due to more data on recruitment. As the Norwegian spawning stock and the international ecosystem surveys will likely continue, the assessment might improve further in the coming years. Expansion of the international ecosystem survey in May to include all important nursery areas and better sampling in the spawning stock survey would, however, be beneficial.

4.13 Recommendations

- The Working Group recommends merging the data from the international blue whiting spawning stock survey (carried out in 2004 and 2005, and in the future years) with the Norwegian times series in a way that would allow benefiting from the length of the Norwegian time series and from the increased survey effort on the spawning grounds through the international survey. The data should be prepared and evaluated by PGNAPES before the next year.
- The Working Group recognises that more time, tools and expertise is required for developing and evaluating Harvest Control Rules
- The Working Group recognises that several surveys are being carried out in different countries which provide information on blue whiting. Some of the surveys are directed to a mixture of species. The WG request PGNAPES to consider investigating the feasibility of improved coordination between these surveys.
- The Working Group felt that improvement was made in 2005 in getting information on recruitment from blue whiting from existing data sources (surveys). Further work on evaluating existing information sources should be encouraged.
- The Working Group recommends that surveys, which provide information on recruitment of blue whiting should be continued in the same way as in the past. Better coordination of the surveys carried out in different areas is required.
- The Working Group asks ICES to remind member countries that reliable catch statistics are required to enable proper analyses. All countries which have catches of blue whiting should timely report these to ICES. (France did not report catches to ICES in 2004 although catches were reported to the EU. Informal information of Frensh landing came too late to the WG to be included in the assessment.)
- Comparisons of age distributions from landings investigated by different laboratories indicate that there are differences in the age interpretations. Many hardships in the stock assessments may be caused by those uncertainties. The situation is likely ameliorated through the age reading workshop arranged in June 2005. WG recommends that the coordination between the institutes in this line should be continued.
- The Working Group recommends to its members to recompile the time series of catch at age data on an area basis, which allows to analyse the effect of changing

behaviour of the distribution of the fleet. In particular, separate catch at age data for the Norwegian Sea are required.

- The Working Group recommends to the institutes participating in the Norwegian Sea Ecosystem Survey (coordinated by PGNAPES) to make survey data of blue whiting available to PGNAPES in the agreed format to allow for extension of the time series to the years before 2000.

Table 4.3.1 Landings (tonnes) of BLUE WHITING from the directed fisheries (Sub-areas I and II, Division Va, XIVa and XIVb) 1987–2004, as estimated by the Working Group.

Country	1987	1988	1989 3)	1990	1991	1992	1993	1994 2)	1995 3)	1996	1997	1998	1999	2000	2001	2002	2003	2004
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	15	7,721	5,723	13,608	38,226	23,437
Estonia	-	-	-	-	-	-	-	-	-	377	161	904	-	-	-	-	-	
Faroes	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594	11,507	17,980	64,496	82,977	115,755	109,380
Germany	1,010	3	1,341	-	-	-	-	2	3	32	-	78	-	-	3117	1,072	813	488
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Iceland	-	-	4,977	-	-	-	-	-	369	302	10,464	68,681 4)	96,295	155,024	245,814	195,483	312,334	322,247
Latvia	-	-	-	-	-	-	-	422	-	-	-	-	-	-	-	-		
Netherlands	-	-	-	-	-	-	-	-	72	25	-	63	435	-	5180	906	592	1,365
Norway 5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64,581	100,922	215,075	302,166
Norway 6)	-	-	-	566	100	912	240	-	-	58	1,386	12,132	5,455	-	28,812	-	-	22167
Poland	56	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Scotland																		64
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	850	57,206	15,794
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	173,860	145,649	191,507	166,677
Total	123,042	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570	177,494	179,639	284,666	591,583	541,467	931,508	963,785

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.

5) Directed fishery

6) By-catches of

Table 4.3.2 Landings (tonnes) of BLUE WHITING from directed fisheries (Division Vb,VIa,b, VIIa,b,c and Sub-area XII) 1987–2004, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998 1)	1999	2000	2001	2002	2003	2004
Denmark	2,655	797	25	-	-	3,167	-	770	-	269	-	5051	19,625	11,856	18,110	2,141	17,813	44,992
Estonia	-	-	-	-	-	6,156	1,033	4,342	7754	10,605	5,517	5,416	-	-	-	-	-	4)
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	188,464	115,127	208,427	206,078
France	-	-	2,190	-	-	-	1,195	-	720	6,442	12,446	7,984	6,662	13,481	13,480	14,688	13,365	-
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	15,862	15,378	21,866	13,813
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	64,135	105,833	119,287	91,853	189,159	99,832
Ireland	3,706	4,646	2,014	-	-	781	-	3	222	1,709	25,785	45635	35,240	25,200	29,854	17,723	22,484	62,730
Japan	-	-	-	-	-	918	1,742	2,574	-	-	-	-	-	-	-	-	-	-
Latvia	-	-	-	-	-	10,742	10,626	2,160	-	-	-	-	-	-	-	-	-	-
Lithauen	-	-	-	-	-	-	2,046	-	-	-	-	-	-	-	-	-	-	-
Netherlands2)	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	68,415	33,365	45,239	82,520
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	399,932	385,495	502,320	486,843
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	50,147	26,403	27,136	56,326
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-
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	141,549	144,419	163,812	179,400
Total	446,287	426,037	475,179	463,495	218,946	318,018	347,101	378,704	423,504	478,077	514,654	827,194	943,578	989,131	1,045,100	846,602	1,211,621	1,232,534

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

4) Reported to the EU but not to the ICES WGNPBW. (Landings of 19,467 tonnes)

Table 4.3.3 Landings (tonnes) of BLUE WHITING from directed fisheries and by-catches caught in other fisheries (Divisions IIIa, IV) 1987–2004, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993 [3]	1994	1995	1996	1997	1998 [2]	1999	2000	2001	2002	2003	2004
Denmark [4]	28,541	18,144	3,632	10,972	5,961	4,438	25,003	5,108	4,848	29,137	9,552	40,143	36,492	30,360	21,995			
Denmark [5]			22,973	16,080	9,577	26,751	16,050	14,578	7,591	22,695	16,718	16,329	8,521	7,749	7,505	35,530	26,896	21,071
Faroes [4] [6]	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	-	-	-	60	7,317	5,712	6,864
Faroes [5] [6]												296	265	42	6,741			
Germany [1]	115	280	3	-	-	25	9	-	-	-	-			-	81	-	36	19
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4		4
Netherlands	-	-	-	20	-	2	46	-	-	-	793			-	-	50	0	0
Norway [4]	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	21,804	85,062	117,145	107,311
Norway [5]															58,182			
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	69	-	-	
Scotland																		35
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	2,086	17,689	8,326	3,289
UK	-	100	7	-	335	18	252	-	-	1	-	-	-	-	-	-	65	
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	114,476	118,523	145,652	158,180	138,593

[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.

[4] Directed fishery

[5] By-catches of blue whiting in other fisheries.

[6] For the periode 1987-2000 landings figures also include landings from mixed fisheries in Division Vb.

Table 4.3.4 Landings (tonnes) of BLUE WHITING from the Southern areas (Sub-areas VIII and IX and Divisions VIIg-k and VIId,e) 1987–2004, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600 [2]	88 [2]	973
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98 [2]	96 [2]	12,659
Netherlands	-	-	-	450	10	-	-	-	-	-	-	10 [1]	-	-	-	3208 [2]	2471,8 [2]	11,426
Norway	4	-	-	-	-	-	-	-	-	-	-			-	-	-	-	39197
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	1,746	1,659	2,651	3,937
Russia																		685
Scotland																		603
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	23,218	17,506	13,825	15,612
UK	23	12	29	13	-	-	-	5	-	-	-	-	-	-	-	-	181	
France	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	784	
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	24,964	23,071	20,097	85,093

[1] Directed fisheries in VIIIa

[2] Landings reported as Directed fisheries and included in the Catch-at-Age calculations of that fisheries

Table 4.3.5 Total landings of blue whiting by country and area for 2004 in tonnes. Landing figures provided by Working Group members and these figures may not be official catch statistics and therefore can not be used for management purposes.

Area	Denmark	Faroe Islands	France	Germany	Iceland	Ireland	Norway	Portugal	Russia	Scotland	Spain	Sweden	Netherlands	Grand Total
I							63							63
IIa	23,437	95,868		386	183,322		314,690		137,430	64		15,794	1,365	772,355
IIb				103	392		591		28,976					30,062
IIIa	4,274	53					383					2,730		7,440
IVa	16,368	6,627		19		4	106,344			35		532	0	129,929
IVb	429	184					584					27	0	1,224
IXa							0	3,937						3,937
Va		13,512			138,533		8,989							161,034
Vb	12,935	111,036		395	95,090	1,653	18,790		104,371	1,364			3,143	348,777
VIa	31,935	44,632		13,196		42,506	67,890			53,587			62,944	316,690
VIb					4,742		320,364		69,096					394,202
VIIa						0	0							0
VIIb				2		1,524	0			1,376			140	3,042
VIIc	122	47,247		220		15,538	69,616		871				16,293	149,906
VIIg						4	0							4
VIIIabd							0						131	131
VIIIc+IXa							0				15,612			15,612
VIIj				31		925	0			603			895	2,454
VIIk				942		11,730	39,197		685				10,400	62,955
XII		3,163				1,509	10,183		5,062					19,917
XIVb							0		271					271
Grand Total	89,500	322,322	[1)]	15,293	422,079	75,393	957,684	3,937	346,762	57,028	15,612	19,083	95,311	2,420,005

[1)] Reported to the EU but not to the ICES WGNPBW. (Landings of 19,467 tonnes)

Table 4.3.6 Landings (tonnes) of BLUE WHITING from the main fisheries, 1987–2004, as estimated by the Working Group.

Area	Norwegian Sea fishery (Sub-areas 1+2 and Divisions Va, XIVa-b)	Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	Directed- and mixed fisheries (Divisions IIIa and IV)	**Total northern areas**	Total southern areas (Subareas VIII and IX and Divisions VIId, e, g-k)	**Grand total**
1987	123,042	446,287	62,689	**632,018**	32,819	**664,837**
1988	55,829	426,037	45,143	**527,009**	30,838	**557,847**
1989	42,615	475,179	75,958	**593,752**	33,695	**627,447**
1990	2,106	463,495	63,192	**528,793**	32,817	**561,610**
1991	78,703	218,946	39,872	**337,521**	32,003	**369,524**
1992	62,312	318,081	65,974	**446,367**	28,722	**475,089**
1993	43,240	347,101	58,082	**448,423**	32,256	**480,679**
1994	22,674	378,704	28,563	**429,941**	29,473	**459,414**
1995	23,733	423,504	104,004	**551,241**	27,664	**578,905**
1996	23,447	478,077	119,359	**620,883**	25,099	**645,982**
1997	62,570	514,654	65,091	**642,315**	30,122	**672,437**
1998	177,494	827,194	94,881	**1,099,569**	29,400	**1,128,969**
1999	179,639	943,578	106,609	**1,229,826**	26,402	**1,256,228**
2000	284,666	989,131	114,477	**1,388,274**	24,654	**1,412,928**
2001	591,583	1,045,100	118,523	**1,755,206**	24,964	**1,780,170**
2002	541,467	846,602	145,652	**1,533,721**	23,071	**1,556,792**
2003	931,508	1,211,621	158,180	**2,301,309**	20,097	**2,321,406**
2004	963,785	1,232,534	138,593	**2,334,912**	85,093	**2,420,005** [1)]

[1)] Preliminary data, not including France. Iceland revised their data after the meeting of 42 436. In the assessment was used 2,377,569.

Table 4.3.7 Total landings of blue whiting by quarter and area for 2004 in tonnes. Landing figures provided by Working Group members.

Area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total
I			63		63
IIa	13,776	294,494	355,895	108,190	772,355
IIb		455	1,512	28,095	30,062
IIIa	13	528	6,816	83	7,440
IVa	26,917	37,229	40,785	24,998	129,929
IVb	3	20	1,138	63	1,224
IXa	606	920	768	1,643	3,937
Va	682	56,669	55,745	47,938	161,034
Vb	20,863	250,079	3,401	74,434	348,777
VIa	136,186	178,310	1,621	574	316,690
VIb	338,240	55,215	747		394,202
VIIa				0	0
VIIb	2,475	567	0		3,042
VIIc	149,342	564			149,906
VIIg		4	0	0	4
VIIIabd		-	131		131
VIIIc+IXa	4,295	3,600	3,599	4,117	15,612
VIIj	1,209	1,166	6	72	2,454
VIIk	62,955				62,955
XII	19,917				19,917
XIVb		271			271
Grand Total	777,480	880,092	472,227	290,206	2,420,005

Table 4.5.1.1. Blue whiting. Total landings, No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2004.

Country	Quarter	Landings (t)	No. Samples	No. Fish measured	No. Fish aged
Denmark	1	21842	10	805	778
	2	40973	8	495	454
	3	22236	14	819	817
	4	4449	1	100	50
	Total	89500	33	2219	2099
Faroe Islands	1	96047	12	2417	1200
	2	146734	10	2309	1000
	3	37915	5	1146	500
	4	41626	4	750	400
	Total	322322	31	6622	3100
Germany	1	5696	0	0	0
	2	9538	0	0	0
	3	59	0	0	0
	4	0	0	0	0
	Total	15293	0	0	0
Iceland	1	4599	1	100	50
	2	223594	47	3629	2310
	3	94881	17	1143	843
	4	56569	11	690	518
	Total	379643	76	5562	3721
Ireland	1	52885	13	2246	1248
	2	21914	0	0	0
	3	517.576	0	0	0
	4	76	0	0	0
	Total	75393	13	2246	1248
Norway	1	442937	176	6783	3855
	2	256421	205	8745	5925
	3	232108	125	6345	1483
	4	26218	51	1953	151
	Total	957684	557	23826	11414
Portugal	1	606	79	8960	321
	2	920	85	10781	262
	3	768	74	8105	162
	4	1643	75	9268	162
	Total	3937	313	37114	907
Russia	1	66065	108	27407	1066
	2	107466	27	5031	555
	3	61172	105	17512	813
	4	112059	131	23294	655
	Total	346762	371	73244	3089
Scotland	1	31252	1	151	135
	2	25472	3	662	186
	3	0	0	0	0
	4	305	0	0	0
	Total	57028	4	813	321
Spain	1	4295	69	6850	40
	2	3600	74	6559	45
	3	3599	78	6605	22
	4	4117	83	7776	30
	Total	15612	304	27790	137
Sweden	1	0	0	0	0
	2	379	0	0	0
	3	18682	0	0	0
	4	22	0	0	0
	Total	19083	0	0	0
The Netherlands	1	51254	68	1699	1699
	2	43081	4	100	100
	3	289	0	0	0
	4	687	0	0	0
	Total	95311	72	1799	1799
Grand Total		2377569	1774	181235	27835

Table 4.5.1.2 Blue Whiting. Sampling levels in 2004 per area.

Area	landings	nos samples	nos measured	nos aged
I	63	0	0	0
IIa	772,355	410	41,835	8,239
IIb	30,062	95	15,471	642
IIIa	7,440	9	548	496
IVa	129,929	186	8,691	2,014
IVb	1,224	2	149	49
IXa	3,937	313	37,114	907
Va	118,598	33	3,208	1,815
Vb	348,777	55	6,019	2,052
VIa	316,690	101	5,101	4,589
VIb	394,202	168	27,449	2,942
VIIa	0	0	0	0
VIIb	3,042	3	305	255
VIIc	149,906	48	2,870	2,413
VIIg	4	0	0	0
VIIIabd	131	0	0	0
VIIIc+IXa	15,612	304	27,790	137
VIIj	2,454	0	0	0
VIIk	62,955	35	2,413	710
XII	19,917	12	2,272	575
XIVb	271	0	0	0
total	2,377,569	1,774	181,235	27,835

Table 4.5.4.1 Blue whiting. Landing in numbers ('000) by length group (cm) and quarters for the Nothern area in 2004.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9		2 256			2 256
10			146		146
11			3 342		3 342
12			2 664		2 664
13	13	783	1 747		2 543
14	466	391	1 529	34	2 420
15	2 948	329	1 857	578	5 712
16	8 671	2 349	1 201	306	12 527
17	15 394	10 906	6 318	952	33 570
18	12 900	35 810	30 874	12 541	92 125
19	9 057	101 520	139 518	36 966	287 060
20	27 842	111 267	164 576	114 534	418 218
21	36 487	127 270	189 820	110 739	464 316
22	70 790	304 988	360 062	100 157	835 998
23	213 974	616 330	518 325	116 331	1464 960
24	502 694	918 476	593 181	139 884	2154 235
25	767 692	1040 007	594 793	224 068	2626 560
26	784 481	949 343	478 809	233 577	2446 210
27	723 627	822 375	367 655	247 984	2161 642
28	595 500	580 860	239 297	168 652	1584 308
29	450 614	433 268	147 004	86 406	1117 291
30	335 525	317 997	107 085	88 275	848 882
31	230 597	171 218	68 989	53 090	523 895
32	148 296	126 876	24 880	40 579	340 632
33	114 727	81 950	9 797	18 490	224 964
34	56 576	21 116	6 082	6 651	90 425
35	33 223	20 483	1 663	2 552	57 920
36	17 603	23 688	918	1 224	43 432
37	11 554	8 791	1 410	1 960	23 715
38	4 873	3 084		986	8 942
39	3 961			306	4 267
40	2 779	263	36	102	3 181
41	1 633			68	1 701
42	1 080			34	1 114
43	377			34	411
44	38				38
45	38			34	72
46					
47	170				170
48					
49	170				170
50					
TOTAL numbers	5186 371	6833 993	4063 578	1808 090	17892 031

Table 4.5.4.2 Blue whiting. Landings in numbers ('000) by length group (cm) and quarters for the North Sea and Skagerrak in 2004.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8			356		356
9	281				281
10	281				281
11	281			455	736
12				303	303
13	281	380		303	964
14	5 414	1 902		4 704	12 020
15	34 466	6 032	6 400	6 373	53 271
16	66 878	25 165	9 955	6 980	108 978
17	81 653	44 530	2 848	6 980	136 011
18	45 747	61 196	17 150	4 552	128 645
19	22 453	84 637	46 399	7 586	161 075
20	18 985	73 711	75 846	32 318	200 860
21	35 082	63 459	73 151	42 332	214 024
22	33 398	85 882	101 506	32 925	253 711
23	26 382	76 172	108 674	29 435	240 663
24	13 091	61 919	86 063	24 580	185 653
25	10 384	46 219	67 787	23 821	148 211
26	10 946	28 751	40 205	19 725	99 627
27	5 794	18 343	22 143	14 111	60 391
28	8 221	8 696	16 664	9 407	42 988
29	5 595	6 139	8 848	7 435	28 017
30	2 707	3 381	4 858	5 766	16 712
31	1 403	2 620	3 286	3 186	10 495
32		792	1 410	2 731	4 933
33	1 123	517	783	1 062	3 485
34	561	137	39	759	1 496
35		137	14	607	758
36			721	152	873
37	281	275	719		1 275
38			362		362
39					
40			2		2
41			711		711
42					
43				152	152
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	431 688	700 992	696 900	288 740	2118 320

Table 4.5.4.3 Blue whiting. Landings in numbers ('000) by length group (cm) and quarters for the Southern area in 2004.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15	122	1	20		143
16	1 399	22	72	28	1 521
17	2 569	504	391	81	3 546
18	3 744	2 804	2 433	1 424	10 406
19	7 344	6 785	4 891	6 847	25 866
20	8 520	12 460	8 547	12 215	41 742
21	8 442	12 713	15 368	13 461	49 983
22	8 373	11 324	14 244	12 156	46 097
23	7 128	6 664	8 559	9 851	32 202
24	6 428	5 681	4 551	6 561	23 222
25	4 129	3 247	1 774	3 614	12 764
26	2 755	1 855	1 757	2 339	8 706
27	1 746	784	635	1 274	4 440
28	1 715	722	436	686	3 558
29	1 059	275	163	324	1 821
30	792	232	106	248	1 377
31	805	100	58	147	1 110
32	333	85	38	69	525
33	215	20	20	56	311
34	61	8	7	19	95
35	36	9	4	11	60
36	32	4	1	7	43
37	7	2		5	14
38				7	7
39				2	3
40		1		2	3
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	67 756	66 300	64 076	71 434	269 566

Table 4.5.4.4 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 1993-2004.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	-	-	1	4	167	15	61	41	119	16	58	6
1	37	44	99	497	1352	984	544	912	3459	1111	2464	1132
2	130	31	143	327	1079	3535	1180	752	3924	2439	3626	3481
3	335	190	338	451	751	3211	5257	3119	2728	2939	7964	6220
4	1348	362	416	425	526	929	3235	4834	3644	2114	4726	6524
5	376	1242	566	248	268	346	362	1517	2474	1804	2006	2972
6	196	294	769	430	238	311	186	500	555	1602	1090	1252
7	108	201	246	619	270	298	143	210	160	336	398	633
8	60	103	154	214	391	257	146	144	91	165	119	246
9	38	88	58	88	101	209	66	57	69	100	18	74
10+	14	32	40	70	164	85	138	139	55	142	27	36
Total	2,641	2,588	2,829	3,373	5,307	10,180	11,318	12,225	17,281	12,768	22,495	22,575
Tonnes	389,010	401,378	447,015	493,373	545,058	1,000,870	1,123,317	1,273,123	1,636,683	1,399,659	2,177,047	2,219,296

Table 4.5.4.5 BLUE WHITING. Catch in number (million) by age group in the directed fishery and by-catches from mixed fisheries (Divisions IIIa and IV) for 1993-2004.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	132	95	3303	812	29	11	60	56	9	190	222	52
1	167	33	101	1334	621	576	188	822	770	621	1191	925
2	39	21	88	71	269	524	286	317	416	685	369	784
3	91	18	29	58	50	259	434	253	174	274	368	405
4	97	37	11	71	14	47	168	143	149	105	73	116
5	15	6	6	39	14	6	16	22	109	17	18	46
6	7	3	11	45	5	4	5	3	29	45	23	12
7	8	1	2	33	4	3	5	0	9	8	1	11
8	-	1	2	14	6	4	6	7	6	3	1	1
9	-	0	1	9	1	4	1	1	8	2	1	1
10+	-	-	1	11	2	12	3	1	11	1	1	1
Total	556	214	3,555	2,499	1,015	1,450	1,172	1,627	1,689	1,951	2,269	2,355
Tonnes	55,215	28,563	104,004	119,359	65,091	94,881	106,609	114,477	118,523	136,171	153,697	138,593

Table 4.5.4.6 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1993-2004.

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	25	13	3	9	11	18	18	32	33	17	7	4
1	41	12	96	43	118	97	57	80	134	88	88	84
2	146	56	123	131	143	122	82	123	146	108	79	130
3	181	149	55	117	86	71	130	93	60	79	47	50
4	62	72	38	36	26	69	57	35	14	24	26	10
5	12	27	44	33	8	32	35	9	10	4	12	5
6	7	9	20	17	4	7	15	10	1	1	4	3
7	2	5	6	5	3	2	3	3	0	0	1	1
8+	1	4	5	3	3	4	2	0	0	0	1	0
Total	477	347	390	394	402	422	399	384	398	321	264	286
Tonnes	32,256	29,468	27,664	25,099	30,122	29,400	26,402	24,654	24,964	19,165	16,476	19,680

Table 4.5.4.7. Blue Whiting: Catch in numbers (thousands) of the total stock in 1981-2004.

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	258,000	148,000	2,283,000	2,291,000	1,305,000	650,000	838,000	425,000
2	348,000	274,000	567,000	2,331,000	2,044,000	816,000	578,000	721,000
3	681,000	326,000	270,000	455,000	1,933,000	1,862,000	728,000	614,000
4	334,000	548,000	286,000	260,000	303,000	1,717,000	1,897,000	683,000
5	548,000	264,000	299,000	285,000	188,000	393,000	726,000	1,303,000
6	559,000	276,000	304,000	445,000	321,000	187,000	137,000	618,000
7	466,000	266,000	287,000	262,000	257,000	201,000	105,000	84,000
8	634,000	272,000	286,000	193,000	174,000	198,000	123,000	53,000
9	578,000	284,000	225,000	154,000	93,000	174,000	103,000	33,000
10+	1,460,000	673,000	334,000	255,000	259,000	398,000	195,000	50,000

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	865,000	1,611,000	266,686	407,730	263,184	306,951	296,100	1,893,453
2	718,000	703,000	1,024,468	653,838	305,180	107,935	353,949	534,221
3	1,340,000	672,000	513,959	1,641,714	621,085	367,962	421,560	632,361
4	791,000	753,000	301,627	569,094	1,571,236	389,264	465,358	537,280
5	837,000	520,000	363,204	217,386	411,367	1,221,919	615,994	323,324
6	708,000	577,000	258,038	154,044	191,241	281,120	800,201	497,458
7	139,000	299,000	159,153	109,580	107,005	174,256	253,818	663,133
8	50,000	78,000	49,431	79,663	64,769	90,429	159,797	232,420
9	25,000	27,000	5,060	31,987	38,118	79,014	59,670	98,415
10+	38,000	95,000	9,570	11,706	17,476	30,614	41,811	82,521

Age	1997	1998	1999	2000	2001	2002	2003	2004
1	2,131,494	1,656,926	788,200	1,814,851	4,363,690	1,821,053	3,742,841	2,140,731
2	1,519,327	4,181,175	1,549,100	1,192,657	4,486,315	3,232,244	4,073,497	4,394,444
3	904,074	3,541,231	5,820,800	3,465,739	2,962,163	3,291,844	8,378,955	6,675,323
4	577,676	1,044,897	3,460,600	5,014,862	3,806,520	2,242,722	4,824,590	6,649,684
5	295,671	383,658	412,800	1,550,063	2,592,933	1,824,047	2,035,096	3,023,013
6	251,642	322,777	207,200	513,663	585,666	1,647,122	1,117,179	1,267,219
7	282,056	303,058	151,200	213,057	170,020	344,403	400,022	645,205
8	406,910	264,105	153,100	151,429	97,032	168,848	121,280	247,303
9	104,320	212,452	68,800	58,277	76,624	102,576	19,701	74,872
10+	169,235	85,513	140,500	139,791	66,410	142,743	27,493	36,540

Note: Age 0 catches should be include next year.

Table 4.5.5.1. Blue Whiting: Mean weights-at-age in the total catch and stock in 1981-2004.

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

Age	1989	1990	1991	1992	1993	1994	1995	1996
0	0.014	0.034	0.036	0.024	0.028	0.033	0.022	0.018
1	0.059	0.045	0.055	0.057	0.066	0.061	0.064	0.041
2	0.079	0.070	0.091	0.083	0.082	0.087	0.091	0.080
3	0.103	0.106	0.107	0.119	0.109	0.108	0.118	0.102
4	0.126	0.123	0.136	0.140	0.137	0.137	0.143	0.116
5	0.148	0.147	0.174	0.167	0.163	0.164	0.154	0.147
6	0.158	0.168	0.190	0.193	0.177	0.189	0.167	0.170
7	0.171	0.175	0.206	0.226	0.200	0.207	0.203	0.214
8	0.203	0.214	0.230	0.235	0.217	0.217	0.206	0.230
9	0.224	0.217	0.232	0.284	0.225	0.247	0.236	0.238
10+	0.253	0.256	0.266	0.294	0.281	0.254	0.256	0.279

Age	1997	1998	1999	2000	2001	2002	2003	2004
0	0.031	0.033	0.035	0.031	0.038	0.021	0.019	0.026
1	0.047	0.048	0.063	0.057	0.050	0.054	0.049	0.042
2	0.072	0.072	0.078	0.075	0.078	0.074	0.075	0.066
3	0.102	0.094	0.088	0.086	0.094	0.093	0.098	0.089
4	0.121	0.125	0.109	0.104	0.108	0.115	0.108	0.102
5	0.140	0.149	0.142	0.133	0.129	0.132	0.131	0.123
6	0.166	0.178	0.170	0.156	0.163	0.155	0.148	0.146
7	0.177	0.183	0.199	0.179	0.186	0.173	0.168	0.160
8	0.183	0.188	0.193	0.187	0.193	0.233	0.193	0.173
9	0.203	0.221	0.192	0.232	0.231	0.224	0.232	0.209
10+	0.232	0.248	0.245	0.241	0.243	0.262	0.258	0.347

Table 4.5.6.1 Blue whiting. Length at age composition (cm) of the landings from the main fisheries in 200

Age	Norwegian Sea fishery (Subareas I, II and Divisions Va, XIVa,b)	Spawning area fishery (Divisions Vb, VIa,b, VIIb,c)	Directed and mixed fisheries (Division IIIa and Subarea IV)	Southern areas fishery (Subareas VIII and IX, and Divisions VIId,e,g-k)
0	13.4		16.3	19.5
1	20.0	20.6	18.6	20.4
2	22.7	23.6	22.1	22.4
3	25.1	25.7	24.9	25.3
4	26.4	26.9	27.3	27.1
5	28.0	28.9	29.1	29.2
6	29.5	30.5	29.6	31.5
7	30.2	31.4	29.7	34.3
8	31.3	32.0	35.5	35.6
9	33.3	34.1	36.0	37.3
10+	37.8	38.5	40.9	34.5

Table 4.5.7.1. Blue Whiting: natural mortality and proportion of maturation at age. Natural mortality is assumed to be the same in all years. The values for the maturity-ogive were estimated by the 1994 WG (ICES 1995/Assess:7).

Age	0	1	2	3	4	5	6	7	8	9	10+
Proportion of mature	0.00	0.11	0.40	0.82	0.86	0.91	0.94	1.00	1.00	1.00	1.00
Natural mortality	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20

Table 4.5.9.1.1. Blue whiting. Age stratified Spanish cpue (not used in the assessment).

Numbers	age							
	1	2	3	4	5	6	7	total
1982								
1983		7196	16392	9311	7476	6326	1718	48419
1984		13710	27286	14845	4836	1755	1750	64182
1985		14573	23823	14126	6256	1232	217	60227
1986		3721	14131	14745	7113	1278	505	41493
1987		25328	13153	6664	2938	1029	166	49278
1988		7778	21473	18436	6391	1300	781	56159
1989		15272	18486	17160	8374	3760	1003	64055
1990		21444	19407	5194	1803	1357	451	49656
1991		15924	15370	4989	2329	1045	440	40097
1992		10007	24235	9671	4316	1194	462	49885
1993		4036	13991	22493	7979	1354	658	50511
1994		543	6066	15917	7474	2990	1055	34045
1995		9090	14409	6833	4551	1990	623	37496
1996		3905	14557	14449	3931	3639	1834	42315
1997		8742	15875	11134	3698	1046	450	40945
1998		5884	13236	9803	10844	5229	1153	46149
1999		2048	10268	20242	9833	6287	3047	51725
2000		6207	15518	13987	5375	1264	1414	43765
2001		16223	16488	6830	1620	1148	162	42471
2002		10520	13725	10265	3385	336	69	38300
2003		9069	10461	6517	3983	1932	737	32699

Table 4.6.1.1.1 Blue Whiting: Age and length distribution of blue whiting in the international surveys by R/Vs "Atlantniro", "Celtic Explorer", "Fridtjof Nansen", "G. O. Sars", "Magnus Heinason", and "Tridens"

Length	Age in years (year class)											Num-	Bio-	Mean	Prop. mature *
	1	2	3	4	5	6	7	8	9	10	11	bers	mass	weight	
(cm)	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994	(10^6)	(10^6 kg)	(g)	(%)
13.0 – 14.0	2	0	0	0	0	0	0	0	0	0	0	2	0	13.1	8
14.0 – 15.0	46	0	0	0	0	0	0	0	0	0	0	46	0.6	14.1	7
15.0 – 16.0	451	34	0	0	0	0	0	0	0	0	0	485	9	17.8	11
16.0 – 17.0	985	28	0	0	0	0	0	0	0	0	0	1013	21	21.1	13
17.0 – 18.0	861	90	0	0	0	0	0	0	0	0	0	952	24	25.4	17
18.0 – 19.0	756	91	0	0	0	0	0	0	0	0	0	847	26	30.7	21
19.0 – 20.0	272	541	0	0	0	0	0	0	0	0	0	813	30	37.4	54
20.0 – 21.0	119	1125	25	0	0	10	0	0	0	0	0	1279	52	40.4	79
21.0 – 22.0	36	703	395	0	0	0	0	0	0	0	0	1134	54	47.2	85
22.0 – 23.0	33	419	1342	148	0	0	0	0	0	0	0	1941	111	57.2	85
23.0 – 24.0	0	823	3034	620	199	0	0	0	0	0	0	4676	294	62.9	86
24.0 – 25.0	49	262	4526	3507	1891	0	0	0	0	0	0	10236	711	69.5	91
25.0 – 26.0	0	204	5243	6608	3628	472	0	0	0	0	0	16155	1246	77.1	95
26.0 – 27.0	20	0	2645	6827	6516	579	16	0	0	0	0	16603	1404	84.6	97
27.0 – 28.0	0	0	1240	4270	5719	759	71	5	0	0	0	12063	1140	94.5	98
28.0 – 29.0	0	0	235	2348	3352	1282	254	85	0	0	0	7555	805	107	99
29.0 – 30.0	0	0	74	908	3285	1095	249	24	0	0	0	5635	663	118	99
30.0 – 31.0	0	0	9	238	1177	1484	68	129	37	0	0	3143	419	133	100
31.0 – 32.0	0	0	8	19	833	1480	311	18	5	0	0	2673	397	148	100
32.0 – 33.0	0	0	0	86	11	601	302	62	47	0	0	1108	183	165	100
33.0 – 34.0	0	0	0	0	11	347	295	146	0	0	0	799	146	183	100
34.0 – 35.0	0	0	0	0	0	142	295	81	79	2	4	602	121	201	100
35.0 – 36.0	0	0	0	0	7	9	61	8	43	0	0	128	27	209	100
36.0 – 37.0	0	0	0	0	31	37	47	140	0	0	0	254	63	247	100
37.0 – 38.0	0	0	0	0	0	0	44	3	14	0	0	62	15	241	100
38.0 – 39.0	0	0	0	0	0	0	0	13	14	0	0	28	8	282	100
39.0 – 40.0	0	0	0	0	0	1	3	10	43	0	0	58	18	311	100
40.0 – 41.0	0	0	0	0	0	0	0	5	39	0	0	45	17	382	100
41.0 – 42.0	0	0	0	0	0	0	0	0	2	0	0	2	0.5	343	100
TSN (10^6)	3631	4320	18774	25579	26660	8298	2016	728	323	2	4	90336			
TSB (10^6 kg)	99	217	1377	2194	2546	1046	320	128	76	0.5	0.7	8005			
Avg. length (cm)	17.6	21.6	25.0	26.4	27.4	29.8	31.9	33.0	35.6	34.9	34.5	26.3			
Avg. weight (g)	27.3	50.2	73.3	85.8	95.5	126	159	176	236	212	183	88.6			
Cond. (g/dm^3)	5.0	5.0	4.7	4.7	4.6	4.8	4.9	4.9	5.2	5.0	4.5	4.9			
% mature*	13	79	93	93	100	100	100	100	100	100	100	92			
% of SSB	0	2	17	27	33	14	4	2	1	0	0				

Table 4.6.1.2.1. Age and length distribution of blue whiting in the survey by R/V "G. O. Sars" west of the British Isles, March-April 2005.

Length	Age in years (year class)										Num- bers	Bio- mass	Mean weight	Ma- ture
	1	2	3	4	5	6	7	8	9	10				
(cm)	2004	2003	2002	2001	2000	1999	1998	1997	1996	1995	(10^6)	(10^6 kg)	(g)	(%)
14.0–15.0	16	0	0	0	0	0	0	0	0	0	16	0.2	14	0
15.0–16.0	48	0	0	0	0	0	0	0	0	0	48	0.8	16.8	0
16.0–17.0	41	0	0	0	0	0	0	0	0	0	41	0.8	19.0	0
17.0–18.0	11	0	0	0	0	0	0	0	0	0	11	0.3	24.2	0
18.0–19.0	98	26	0	0	0	0	0	0	0	0	124	3.4	27.1	0
19.0–20.0	95	109	0	0	0	0	0	0	0	0	203	6.4	31.6	11
20.0–21.0	23	602	0	0	0	0	0	0	0	0	624	21	34.1	14
21.0–22.0	23	78	103	0	0	0	0	0	0	0	204	9.4	46.0	54
22.0–23.0	15	0	534	0	0	0	0	0	0	0	549	28	50.7	94
23.0–24.0	0	409	2822	384	13	0	0	0	0	0	3627	215	59.3	98
24.0–25.0	0	124	4918	2439	1876	0	0	0	0	0	9356	618	66.1	99
25.0–26.0	0	110	6309	7595	3801	734	0	0	0	0	18549	1385	74.7	100
26.0–27.0	0	0	2764	8872	8126	344	0	0	0	0	20105	1664	82.8	100
27.0–28.0	0	0	1798	5806	6301	976	26	0	0	0	14907	1384	92.8	100
28.0–29.0	0	0	571	3367	4246	1254	425	165	0	0	10028	1052	105	100
29.0–30.0	0	0	150	1657	4325	1560	372	36	0	0	8100	938	116	100
30.0–31.0	0	0	0	206	1613	907	37	343	0	0	3106	401	129	100
31.0–32.0	0	0	0	29	1318	979	286	16	29	0	2658	384	144	100
32.0–33.0	0	0	0	103	39	233	413	0	25	0	813	131	162	100
33.0–34.0	0	0	0	0	37	230	113	132	0	0	512	92	179	100
34.0–35.0	0	0	0	0	0	16	295	2	189	15	516	99	191	100
35.0–36.0	0	0	0	0	0	12	3	0	91	0	106	23	216	100
36.0–37.0	0	0	0	0	14	175	14	13	0	0	215	48	221	100
37.0–38.0	0	0	0	0	0	0	0	0	0	0	0	0	.	
38.0–39.0	0	0	0	0	0	27	7	38	0	0	71	20	285	100
39.0–40.0	0	0	0	0	0	8	2	2	0	0	12	3.1	263	100
40.0–41.0	0	0	0	0	0	1	0	0	0	0	1	0.4	410	100
TSN (10^6)	370	1456	19968	30459	31708	7455	1993	747	333	15	94503			
TSB (10^6 kg)	11	69	1469	2608	3025	882	287	107	64	2.9	8527			
Avg. length (cm)	18.4	22.0	25.3	26.7	27.6	29.4	31.3	31.1	34.4	34.5	27.0			
Avg. weight (g)	29.4	47.5	73.6	85.6	95.4	118	144	143	194	192	90.2			
Condition	4.7	4.5	4.5	4.5	4.5	4.7	4.7	4.8	4.8	4.7	4.6			
% mature	10	50	99	100	100	100	100	100	100	100	99.5			
% of SSB	0	0	17	31	36	10	3	1	1	0				

Table 4.6.1.2.2. Stock estimates of blue whiting in the Norwegian spawning stock surveys west of the British Isles.

Year	Abundance, 10^9 individuals		Biomass, mill. tonnes		Mean weight,	Mean length,
	total	spawning	total	spawning	g	cm
1990	63	56	6.3	5.7	101	27.1
1991	42	41	5.1	4.8	116	27.8
1992	38	37	4.3	4.2	111	27.5
1993	42	40	5.2	5.0	125	28.6
1994	27	26	4.1	4.1	153	31.1
1995	62	45	6.7	6.1	108	26.9
1996	52	36	5.1	4.5	94.9	25.5
1997						
1998	80	57	5.5	4.7	68.3	23.2
1999	120	110	8.9	8.5	74.4	25.0
2000	102	90	8.3	7.8	80.7	25.5
2001	97	72	6.7	5.6	69.0	24.1
2002	176	147	12.2	10.9	69.3	24.2
2003	160	132	11.4	10.4	71.6	24.6
2004	137	128	11.4	10.9	83.2	26.1
2005	95	93	8.5	8.5	90.2	27.0

Table 4.6.1.3.1 Age stratified acoustic survey estimates of blue whiting in the spawning area by Russian vessels
Number in millions, biomass in thousand t, mean length in cm, mean weight in grams

Numbers	age									
	1	2	3	4	5	6	7	8	9	10	total
1981											
1982			540	2750	1340	1380	1570	2350	1730	1290	12950
1983			2330	2930	9390	3880	1970	1370	780	660	23310
1984			2900	800	1100	4200	2200	1200	1700	1200	15300
1985			13220	930	580	1780	860	610	580	540	19100
1986			18750	23180	2540	610	620	750	640	710	47800
1987			4480	19170	5860	1070	500	810	860	670	33420
1988			3710	4550	8610	4130	1270	480	250	260	23260
1989			11910	7120	6670	6970	4580	2750	1880	810	42690
1990			9740	12140	5740	2580	1470	220	80	10	31980
1991			10300	5350	5130	2630	1770	870	300	220	26570
1992			20010	6700	1350	440	390	170	0	0	29060
1993			4728	12337	5304	2249	1316	621	386	150	27091
1994			no survey								
1995			12657	10028	8942	2651	1093	408	131	14	35924
1996			15285	10629	4897	6940	1482	653	85	0	39971
1997			no survey								
1998			no survey								
1999			no survey								
2000			no survey								
2001			no comparable survey								
2002			no comparable survey								
2003			no comparable survey								
2004			no comparable survey								

used in the assessment

Table 4.6.1.4.1. Blue Whiting: Age- and length-stratified abundance estimate of blue whiting in the Norwegian Sea in May-June 2005. Data from R/Vs “Dana”, “Magnus Heinason”, “Arni Fridriksson”, “Johan Hjort” and “G. O. Sars”. Target strength used for blue whiting: 21.8 log L – 72.8 dB.

ength (cm)	Age in years (year class) 1 2004	2 2003	3 2002	4 2001	5 2000	6 1999	7 1998	8 1997	9 1996	10 1995	11 1994	Numbers (10^6)	Biomass (10^6	Mean weight (g)
14.0 -	186											186	2.8	14.8
15.0 -	2416											2416	41.6	17.3
16.0 -	1057											10571	223	21.3
17.0 -	1946	87										19552	499	25.7
18.0 -	1675											16751	516	31.0
19.0 -	8741	331										9073	338	37.6
20.0 -	2351	2938	321									5610	260	46.6
21.0 -	703	6916	1133									8752	469	54.6
22.0 -	497	7772	1916	35								10221	631	62.9
23.0 -	91	4720	4085	212								9107	648	72.6
24.0 -		1332	4684	712	46							6774	570	84.4
25.0 -	18	350	3976	1509	387							6240	584	94.6
26.0 -		56	2266	2225	584	28						5158	527	104
27.0 -		13	672	1863	811	63	25					3447	388	114
28.0 -			245	1289	908	110	37					2590	320	124
29.0 -			26	764	817	105	13					1727	231	134
30.0 -				148	557	272	74	25		12		1089	161	148
31.0 -				14	252	196	56	28	14			559	86.2	157
32.0 -					37	135	25	37				233	40.2	173
33.0 -					46	46	46	15				153	26.8	184
34.0 -					27		27	27	27			108	21.5	200
35.0 -							11					11	2.6	238
36.0 -								10				10	2.0	199
37.0 -												0	0	
38.0 -											11	11	2.4	222
N	6179	2451	1932	8772	4471	956	314	142	41	12	11	12034		
B (10^6	1792	1489	1591	941	553	139	49.0	24.4	7.5	1.8	2.4	6590		
an length	18	22.3	24.5	26.9	28.5	30.5	31.3	32.7	33.5	30.5	38.5	21.1		
an weight	29.2	61.7	83.4	108	125	147	158	173	185	148	222	55.3		
nditio	5.0	5.6	5.7	5.6	5.4	5.2	5.2	5.0	4.9	5.2	3.9	5.9		

Table 4.6.1.4.2. Blue whiting: Estimated stock biomass, numbers, length and weight at age for blue whiting in the standard survey area (between 8°W-20°E and north of 63°N) in the international surveys 2000-2005.

Age	1	2	3	4	5	6	7	8	9	10	11	Total
Numbers (10^6)												
2000	48927	3133	3580	1668	201	5						57514
2001	85772	25110	7533	3020	2066							123501
2002	15251	46656	14672	4357	513	445		15		6		81915
2003	35688	21487	35372	4354	639	201	43	3				97787
2004	49254	22086	13292	8290	1495	533	83	39				95072
2005	54660	19904	13828	4714	1886	326	103	43	8	3	11	95486
Biomass (10^6 kg)												
2000	1795	260	335	193	25	1						2608
2001	2735	1776	763	418	322							6014
2002	651	2640	1289	526	76	64		3		2		5250
2003	1475	1539	2897	497	88	31	11	1				6538
2004	1643	1437	1188	886	193	77	13	6				5442
2005	1558	1204	1124	502	233	49	16	8	2	1	2	4699
Length (cm)												
2000	19.2	24.7	25.6	27.3	27.7	33.2						20.2
2001	18.2	23.4	26.3	28.8	29.8							20.2
2002	20.1	21.9	25.1	27.9	30.1	30.2		34.5		37.5		22.5
2003	20.1	23.5	24.5	27	28.9	29.9	34.5	33.5				22.8
2004	18.7	22.5	24.8	26.5	28.6	30.1	31.4	30.9				21.4
2005	17.9	22.3	24.3	26.5	28	30.3	31	32.7	32.7	30.5	38.5	20.4
Weight (g)												
2000	36.7	83	93.5	116	122	225						45.3
2001	31.9	70.7	101	138	156							48.7
2002	42.7	56.6	87.8	121	147	145		210		269		64.1
2003	41.3	71.6	81.9	114	138	153	256	219				66.9
2004	33.4	65	89.4	107	129	144	162	160				57.2
2005	28.8	61.7	82.7	108	126	155	164	197.3	189.5	157.7	222	49.9

Table 4.6.1.5.1 Blue whiting. Age stratified acoustic survey estimates in the Icelandic EEZ in July (not used in the assessment)

Year	Age (yrs)									
	0	1	2	3	4	5	6	7	8	9+	Total
Numbers (millions)											
1999	14869	2100	1357	1772	5790	1344	316	50	15	42	27655
2000	10683	8594	934	523	1218	468	106	25	1	1	22553
2001	27305	4090	5215	1657	1614	398	132	37	6	2	40456
2002	3815	10785	3107	1436	1724	1430	727	178	47	5	23254
2003	5011	9363	6054	7430	3888	1350	852	581	91	33	34653
2004	10437	989	3970	3983	4854	2048	817	507	157	33	27795
2003*	5011	9158	4899	4645	1918	646	218	227	91	6	26819

* An estimate calculated for an area that is comparable with the area covered by surveys in 1999-2002

Biomass (tonnes*10^-3)											
1999	265	163	127	201	764	212	55	13	4	14	1818
2000	186	624	85	63	167	78	22	5	0	0	1230
2001	661	295	568	211	231	66	22	8	1	0	2063
2002	77	746	297	160	217	203	114	31	13	1	1859
2003	68	555	600	853	503	200	147	102	19	9	3055
2004	169	59	354	429	620	305	153	100	33	8	2229

Mean length (cm)											
1999	13.5	23.5	25.6	26.3	27.6	29.0	30.3	33.7	35.5	36.8	19.7
2000	13.5	22.3	24.1	26.1	27.6	29.4	32.3	32.0	36.0	28.0	18.0
2001	15.1	22.4	25.3	26.4	28.1	29.9	31.8	32.6	33.0	37.0	18.3
2002	14.8	22.8	24.9	26.2	27.6	29.3	30.6	30.9	36.9	35.0	23.1
2003	13.2	21.3	25.1	26.4	27.9	29.2	31.0	31.1	33.9	31.0	23.4
2004	13.5	22.3	24.1	26.1	27.6	29.4	32.3	32.0	36.0	28.0	18.0

Mean weight (gr)											
1999	17.8	77.4	93.8	113	132	158	174	254	248	307	66
2000	17.5	72.4	88.5	117	137	164	211	188	245	322	50
2001	24.0	72.0	109.0	127	143	165	190	218	194	234	51
2002	20.3	69.2	95.5	111	126	142	157	173	267	205	80
2003	13.6	59.3	99.1	115	129	148	172	175	212	257	88
2004	16	59	89	108	128	149	188	197	208	242	95

Table 4.6.1.6.1. Blue Whiting. 1-group index from the Islandic Groundfish survey

year	age1
1996	6.055
1997	2.803
1998	0.903
1999	5.308
2000	9.139
2001	4.902
2002	12.243
2003	14.142
2004	7.423
2005	6.326

Table 4.6.1.7.1 Age stratified acoustic survey estimates of blue whiting in the Norwegian Sea in July-August. Numbers in millions.

Year\Age	1	2	3	4	5	6	7	8	9	Total
1981	182	728	4542	3874	2678	2834	2964	2756	2054	22612
1982	184	460	1242	4715	3611	3128	2323	1679	874	18216
1983	22356	396	468	756	1404	576	468	432	324	27180
1984	30380	13916	833	392	539	539	343	49	49	47040
1985	5969	23876	12502	658	423	188	235	141	376	44368
1986	2324	2380	7224	6944	1876	952	336	308	140	22484
1987	8204	4032	5180	5572	1204	224	168	56	84	24724
1988	4992	2880	2640	3480	912	120	96	24	48	15192
1989	1172	1125	812	379	410	212	22	32		4164
1990	no survey									
1991	no survey									
1992	792	1134	6939	766	247	172	90	11	18	10169
1993	830	125	1070	6392	1222	489	248	58	88	10522
1994	no survey									
1995	6974	2811	1999	1209	1622	775	173	61		15624
1996	23464	1057	899	649	436	505	755	69	41	27875
1997	30227	25638	1524	779	300	407	260	137	123	59395
1998	24244	47815	16282	556	212	100	64	10	255	89538
1999	14367	9750	23701	9754	1733	466	79	48	91	59989
2000	25813	3298	2721	3078	23	46	6			34985
2001	61470	22051	7883	3225	1824	156	12		68	96689
2002	no survey									

Table 4.6.1.9.1 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	
Year	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	17.87	7.35	44.68	10.52	57.14	16.60	42.62	7.29
1998	14.13	4.17	42.78	8.13	78.88	22.01	47.14	7.58
1999	93.01	14.60	112.39	19.92	169.21	50.26	124.66	17.85
2000	62.39	12.00	91.99	14.75	58.72	24.94	76.19	10.61
2001	8.35	3.31	50.18	10.09	52.41	16.71	42.02	7.02
2002	31.40	5.02	69.00	13.41	36.75	12.07	51.80	7.64
2003	42.52	12.22	71.40	11.01	46.43	11.42	58.13	6.92
2004	2.80	2.11	14.05	7.79	59.51	21.41	24.76	7.31

Number/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
Year	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	552	235.60	1443	361.89	1183	323.14	1180	209.94
1998	351	105.96	1463	320.26	2012	590.04	1387	234.82
1999	2508	427.20	4388	849.80	6119	2026.40	4490	727.90
2000	2267	414.97	3930	604.11	2009	859.71	3027	400.87
2001	171	77.34	1310	263.84	1232	381.49	1048	172.74
2002	771	90.34	2526	499.30	1075	331.09	1739	268.70
2003	1320	384.25	2791	554.16	1513	454.02	2114	317.68
2004	31	22.77	336	154.33	1472	736.78	599	225.74

Table 4.6.1.10.1 BLUE WHITING. Stratified mean catch (Kg/haul) and standard error of bottom trawl surveys in Portuguese waters (Division IXa).

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy
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**	0	**60**	21	**66**	19	**25**	2	**37**	9
	October	**0**	0	**69**	16	**80**	20	**18**	8	**41**	7
2000	July	**23**	13	**109**	34	**116**	10	**63**	6	**75**	13
	October	**11**	4	**155**	53	**196**	22	**54**	4	**99**	19
2001	July	**18**	7	**238**	37	**305**	116	**57**	14	**152**	23
	October	**106**	6	**474**	224	**294**	66		0	**295**	97
2002	October	**19**	12	**176**	81	**180**	24		0	**116**	34
2003	October	**24**	10	**114**	14	**119**	30	**34**	6	**76**	8
2004	October	**0**	0	**44**	10	**380**	27			**84**	15

Table 4.6.1.11.1 Catch in number of 1-group (age 1) blue whiting from the spring (March) bottom trawl surveys on the Faroe plateau 1996-2005. The number of 1-group in 2004 was taken out by age readings while for other years they were taken out from a visual inspection of the length distributions. There was a clear separation of the 1 and 2-group in the data (see Table 6.4.2.3).

Year	1-group
1994	1388
1995	1171
1996	4442
1997	1239
1998	262
1999	1108
2000	782
2001	2058
2002	3885
2003	873
2004	13016
2005	22653

Table 4.6.1.11.2 Length distribution (cm) of blue whiting from the spring (March) bottom trawl surveys on the Faroe plateau 1994-2005. Shaded areas in the years 1994-2005 indicate 1-group fish separated from visual inspection of the length distributions (in lack of otolith samples from the catch). In 2004 the 1-group was separated by age readings from the survey.

					Year							
Length	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	18	12	0	0	0	0	0	0	0	0
14	0	0	107	149	0	0	0	11	0	0	159	512
15	0	0	702	347	0	5	1	68	0	0	1285	2402
16	1	8	865	207	6	92	51	289	0	16	3508	5617
17	25	0	585	303	31	178	126	356	124	303	3106	5212
18	198	53	669	141	72	263	133	398	262	249	2035	4498
19	442	146	567	79	64	317	200	439	553	162	1932	2244
20	399	111	539	132	45	200	137	230	1050	46	1005	1302
21	271	446	250	130	44	53	88	267	843	97	589	866
22	46	341	140	263	98	222	46	1299	1053	56	1544	1097
23	6	66	164	331	157	386	105	2235	1120	377	1471	853
24	0	112	793	356	183	623	221	2348	1047	472	2401	1536
25	0	224	1051	139	179	1022	312	2664	1859	856	2462	2512
26	0	291	1456	94	136	1259	668	2687	2670	602	3909	3394
27	8	194	841	82	93	789	1049	2493	4125	691	3100	2140
28	4	89	548	61	57	529	1148	2954	4564	240	2659	1698
29	5	49	195	93	48	314	1105	1774	5014	184	2080	1530
30	23	27	159	16	28	105	939	731	4852	229	965	1862
31	36	28	108	38	43	140	549	526	2924	126	1311	998
32	43	176	65	30	63	114	434	94	1899	90	754	417
33	48	79	112	32	12	96	361	201	1812	18	452	610
34	15	154	159	40	26	61	196	140	928	32	233	555
35	24	252	74	14	33	63	172	158	341	9	282	118
36	40	134	134	45	20	2	149	101	418	0	22	284
37	40	201	127	58	14	50	126	40	253	0	52	16
38	31	230	27	41	6	33	47	2	61	0	9	0
39	31	107	19	0	8	12	16	0	126	0	0	0
40	16	93	29	3	0	0	17	0	0	0	0	0
41	7	12	12	0	0	12	15	0	0	0	0	0
42	2	0	0	0	0	16	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0
Sum	1761	3623	10515	3237	1466	6956	8411	22505	37898	4855	37325	42273
1-group	1388	1171	4442	1239	262	1108	782	2058	3885	873	13016	22653

Table 4.6.1.12.1 Catch in number by age of blue whiting from the summer (August/September) bottom trawl surveys on the Faroe plateau 1996-2004. Icelandic age readings from June-August) were used to split the numbers by age.

						Age								
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
1996	12513	18586	4576	5392	6754	2755	1610	768	352	337	121	2	34	53802
1997	4139	20745	13710	8345	5748	2488	1376	619	242	179	95	2	14	57701
1998	2359	21202	28278	19217	12289	4143	2330	1057	358	301	126	4	27	91690
1999	7322	4189	4468	12725	19609	6041	791	524	344	284	139	0	18	56452
2000	11120	85876	18307	18875	42059	10892	2557	584	270	400	316	0	0	191254
2001	17431	65857	49449	16099	25119	9486	3362	1295	420	134	0	0	0	188652
2002	1113	12348	10026	7112	5623	5724	3616	1577	448	508	0	0	0	48095
2003	60646	18043	17338	21706	12578	4791	3701	1424	357	49	0	9	0	140641
2004	35744	18243	10222	16912	20938	6887	823	550	287	315	137	0	76	111133

Table 4.6.1.14.1. Abundance index on blue whiting in the Norwegian winter survey (late January-early March) in the Barents Sea. Blue whiting <20cm in total body length most likely belong to 1-group.

Year		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Catch rate	All	0.10	0.24	5.41	7.66	38.3	24.2	11.8	6.57	1.88	18.4	56.1	34.2	8.22
(ind./nm)	<20cm	0.00	0.01	4.47	6.63	1.08	1.00	0.01	0.06	0.45	12.1	12.1	0.44	0.04

Year		1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Catch rate	All	3.7	1.9	23.3	220.7	20.2	8.1	106.3	396.0	119.6	70.4	171.1	225.2
(ind./nm)	<20cm	0.00	0.17	21.07	208.05	8.76	1.71	66.54	313.79	38.07	4.46	65.02	87.02

Table 4.6.1.15.1 Blue whiting egg number and development stages in the samples west of British Isles in March-April 2005.

Longitude	Latitude	nos. egg/m^2	Egg development stages					
			1	2	3	4	5	6
17.51	54.62	0						
16.00	55.38	0						
18.00	55.37	0						
18.34	55.87	0						
16.50	55.88	76	4	3	16	6	20	20
17.09	56.13	166	56	20	44	14	20	12
16.00	56.37	94	10	2	8	16	20	38
18.68	56.37	0						
17.92	56.63	26	2	6	12	6		
17.00	57.12	94	6	8	34	38	6	2
17.67	57.12	2						
15.49	57.38	14				4	6	4
16.03	57.64	40	2	4	2	8	18	6
17.03	57.65	2						
15.00	58.13	4					4	
16.03	58.13	280		7	7		95	171
17.03	58.13	32	2			2	10	18
17.76	58.38	2				2		
15.00	58.64	0						
16.00	58.63	1582	37	38	217	198	993	99
17.00	58.64	34	2	2	4	18	4	
17.85	58.87	2		2				
14.66	59.14	224	62	18	85	28	18	13
16.00	59.12	160	2	2		12	44	8
16.50	59.50	0						
14.14	59.63	220	128	18	13	5	4	9
14.94	59.62	0						
15.97	59.62	0						
15.33	59.87	2						
13.48	60.12	84		6	8	24	32	14
16.00	53.00	0						
15.52	53.00	4				2	2	
15.00	53.00	2					2	
14.25	53.77	0						
15.13	53.76	0						
15.50	54.23	2					2	
15.50	54.75	0						
14.49	54.74	0						
11.75	54.75	8			8			
11.33	55.25	2	2					
14.00	55.25	6				2	4	
14.98	55.25	0						
15.00	55.76	32	4		2	2	14	10
13.83	55.75	2					2	
12.67	55.75	0						
11.48	55.75	0						
11.50	56.25	74	8	2	2	28	30	4
12.84	56.34	4			2	2		
13.83	56.33	8			2	4	2	
13.51	58.24	100		2	12	32	32	22
		Total	327	140	478	453	1384	450

Table 4.7.4.1. Blue whiting. Description of ICA runs performed at the WG in 2005. Mean values of SSB and F are presented for comparison.

Run	parable peri	Ages removed	ɔwn weighti	No. fleets	Ref. age	loitation pat	Age 1 weigh	F	Mean F	SSB	SSB Mean
3	3	No	Manual	1	3	1 period	1	0.4	0.29	7.4	3.3
4	3	No	Manual	1	3	1 period	0.5	0.4	0.3	7.3	3.2
5	4	No	Manual	6	5	1 period	0.5	0.46	0.43	6.3	2.9
1	8	No	Manual	6	3	1 period	0.5	0.46	0.33	5.9	2.3
2*	8	No	Manual	1	3	1 period	0.5	0.46	0.33	5.8	2.9
Final 2004	8	No	Manual	6	3	1 period	0.5	0.37	0.3	6.1	2.8

* Final 2005

Table 4.7.5.1 Blue Whiting, SMS exploratory run. Estimated coefficient of variation for catch and survey observations using the same setting as for last year's WG, input data for 2004 and additional survey observations for 2005.

```
estimated CV:
                                  age 1  age 2  age 3  age 4  age 5   age 6   age
7-10
--------------------------------------------------------------------------------
----
Catch                                  0.40   0.34   0.25   0.25   0.25    0.25
0.50
Surveys:
  Spawning grounds 1981-1990                 1.09   0.61   0.61   0.61    0.69
0.69
  Spawning grounds 1991-2005                 0.74   0.41   0.41   0.41    0.71
0.71
  Rus. acoustics 1982-1991                          0.67   0.67   0.67    0.65
0.65
  Rus. acoustics 1992-1996                          0.57   0.57   0.57    0.67
0.67
  Norw. Sea acoustics 1981-1989     1.26   0.84   0.73   0.73   1.04    1.04
1.04
  Norw. Sea acoustics 1992-2001     0.72   1.18   0.60   0.60   1.11    1.11
1.11
```

Table 4.7.5.2 Blue Whiting, SMS exploratory run. Diagnostics

```
objective function, negative log likelihood:  -146.552

objective function weight:
catch    survey   Stock/recruit
     1     1        0.01

objective function contributions (total):
              Catch   CPUE     S/R
             -148.9     2.3     7.6

objective function contributions (per observation):
              Catch    CPUE     S/R
              -0.62    0.01    0.31

contribution by fleets:
-----------------------
Spawning grounds 1981-1990  total: 8.502   mean: 0.152
Spawning grounds 1991-2005  total:-4.850   mean:-0.049
Norw. Sea May 2000-2005     total:-1.371   mean:-0.125

F, Year effect:
---------------

1981:    1.000
1982:    0.803
1983:    1.014
1984:    1.275
1985:    1.398
1986:    1.708
1987:    1.360
1988:    1.296
1989:    1.688
1990:    1.655
1991:    0.741
1992:    0.723
1993:    1.000
1994:    0.892
1995:    1.195
1996:    1.649
1997:    1.631
1998:    2.212
1999:    1.847
2000:    2.332
2001:    2.139
2002:    2.019
2003:    2.135
2004:    2.477


F, age effect:
--------------
                  1     2     3     4     5     6     7     8     9    10
1981-1992:   0.074 0.114 0.169 0.217 0.265 0.356 0.414 0.430 0.430 0.430
1993-2004:   0.036 0.055 0.135 0.200 0.214 0.244 0.242 0.269 0.269 0.269
```

Table 4.7.5.2 (continued) Blue Whiting, SMS exploratory run. Diagnostics

sqrt(catch variance) ~ CV:

age	
1	0.377
2	0.339
3	0.250
4	0.250
5	0.250
6	0.250
7	0.493
8	0.493
9	0.493
10	0.493

Survey catchability:

	age 1	age 2	age 3	age 4	age 5	age 6	age 7- 10
Spawning grounds 1981-1990		0.72	1.81	2.36	2.70	2.49	2.66
Spawning grounds 1991-2005		0.63	1.63	2.23	1.56	1.24	1.14
Norw. Sea May 2000-2005	0.96	0.63					

sqrt(CPUE variance) ~ CV:

	age 1	age 2	age 3	age 4	age 5	age 6	age 7- 10
Spawning grounds 1981-1990		1.09	0.62	0.62	0.62	0.70	0.70
Spawning grounds 1991-2005		0.85	0.42	0.42	0.42	0.71	0.71
Norw. Sea May 2000-2005	0.52	0.55					

Table 4.7.5.3 Blue Whiting, SMS run. Estimated fishing mortality using the survey on the spawning grounds and the surveys for juveniles (Norwegian Sea May 2000-2005).

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0745	0.0598	0.0756	0.0950	0.1041	0.1272	0.1013	0.0965
2	0.1140	0.0916	0.1156	0.1454	0.1594	0.1947	0.1551	0.1477
3	0.1688	0.1356	0.1712	0.2153	0.2360	0.2884	0.2296	0.2187
4	0.2174	0.1747	0.2205	0.2772	0.3039	0.3714	0.2957	0.2817
5	0.2646	0.2125	0.2683	0.3373	0.3698	0.4519	0.3598	0.3428
6	0.3557	0.2858	0.3608	0.4536	0.4972	0.6076	0.4838	0.4609
7	0.4143	0.3328	0.4202	0.5282	0.5790	0.7076	0.5635	0.5367
8	0.4299	0.3454	0.4360	0.5481	0.6008	0.7342	0.5847	0.5569
9	0.4299	0.3454	0.4360	0.5481	0.6008	0.7342	0.5847	0.5569
10	0.4299	0.3454	0.4360	0.5481	0.6008	0.7342	0.5847	0.5569
Avg. F 3-7	0.284	0.228	0.288	0.362	0.397	0.485	0.386	0.368

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	0.1257	0.1233	0.0552	0.0539	0.0359	0.0320	0.0429	0.0592
2	0.1924	0.1887	0.0845	0.0824	0.0554	0.0494	0.0662	0.0913
3	0.2850	0.2794	0.1251	0.1221	0.1352	0.1205	0.1615	0.2228
4	0.3670	0.3598	0.1611	0.1572	0.2004	0.1787	0.2394	0.3303
5	0.4465	0.4379	0.1961	0.1913	0.2139	0.1908	0.2555	0.3526
6	0.6004	0.5888	0.2637	0.2572	0.2442	0.2178	0.2917	0.4026
7	0.6992	0.6857	0.3071	0.2995	0.2424	0.2162	0.2896	0.3997
8	0.7255	0.7115	0.3186	0.3108	0.2686	0.2396	0.3209	0.4428
9	0.7255	0.7115	0.3186	0.3108	0.2686	0.2396	0.3209	0.4428
10	0.7255	0.7115	0.3186	0.3108	0.2686	0.2396	0.3209	0.4428
Avg. F 3-7	0.480	0.470	0.211	0.205	0.207	0.185	0.248	0.342

Age	1997	1998	1999	2000	2001	2002	2003	2004
1	0.0585	0.0794	0.0663	0.0837	0.0768	0.0725	0.0767	0.0889
2	0.0903	0.1225	0.1023	0.1291	0.1185	0.1118	0.1183	0.1372
3	0.2204	0.2990	0.2496	0.3151	0.2892	0.2729	0.2886	0.3347
4	0.3267	0.4432	0.3700	0.4672	0.4287	0.4046	0.4279	0.4962
5	0.3487	0.4731	0.3950	0.4987	0.4576	0.4318	0.4567	0.5297
6	0.3982	0.5402	0.4510	0.5694	0.5224	0.4930	0.5214	0.6048
7	0.3953	0.5363	0.4477	0.5653	0.5187	0.4895	0.5177	0.6004
8	0.4380	0.5942	0.4961	0.6263	0.5747	0.5424	0.5736	0.6653
9	0.4380	0.5942	0.4961	0.6263	0.5747	0.5424	0.5736	0.6653
10	0.4380	0.5942	0.4961	0.6263	0.5747	0.5424	0.5736	0.6653
Avg. F 3-7	0.338	0.458	0.383	0.483	0.443	0.418	0.442	0.513

Table 4.7.5.4 Blue Whiting, SMS run. Estimated stock numbers and biomass using the survey on the spawning grounds and the surveys for juveniles (Norwegian Sea May 2000-2005).

Age		1981	1982	1983	1984	1985	1986	1987	1988
	1	3342387	3858693	14117028	18885537	11256144	8916707	9852958	7195757
	2	3629317	2540067	2975701	10716999	14061105	8304474	6428173	7289620
	3	4445215	2651242	1897600	2170261	7587147	9816400	5596020	4506933
	4	2511825	3074039	1895316	1309128	1432720	4906090	6023593	3641595
	5	2277662	1654651	2113441	1244687	812322	865620	2770771	3669191
	6	2251836	1431309	1095315	1323139	727282	459494	451051	1582961
	7	1852758	1291769	880551	625169	688274	362169	204903	227635
	8	1754642	1002395	758188	473614	301808	315813	146133	95494
	9	1503333	934636	581025	401407	224146	135501	124083	66677
	10	3109902	2457308	1966097	1348520	828184	472459	238867	165605
TSB		3248753	2638905	2115739	2156721	2640955	2845648	2543199	2344468
SSB		2930993	2376228	1865496	1566284	1842102	2183449	1958717	1806309

Age		1989	1990	1991	1992	1993	1994	1995	1996
	1	9233757	23931786	8249899	5784619	5412704	6115437	8017621	23367810
	2	5349369	6666769	17320888	6391610	4487726	4275274	4849107	6288699
	3	5148656	3613021	4519629	13031968	4818957	3476296	3331601	3715964
	4	2965004	3170147	2236938	3265100	9443669	3446658	2522922	2320999
	5	2249572	1681896	1811095	1558866	2284405	6328001	2360074	1625904
	6	2132331	1178474	888744	1218770	1054106	1510180	4281128	1496595
	7	817438	957734	535504	558996	771562	676046	994440	2618248
	8	108964	332605	395005	322514	339215	495703	445864	609450
	9	44797	43185	133687	235165	193519	212305	319382	264840
	10	108966	60941	41852	104506	203814	248679	297012	366134
TSB		2195852	1948557	3091330	3333611	3074713	2905910	2718704	2510451
SSB		1744354	1510896	1977477	2634625	2533532	2438528	2257063	2065900

Age		1997	1998	1999	2000	2001	2002	2003	2004
	1	43837166	28490055	21897867	42477405	67311890	40554444	41523647	28931287
	2	18032437	33850197	21544895	16778342	31984836	51035921	30881507	31487779
	3	4699493	13489011	24518818	15924628	12072871	23261102	37364203	22463676
	4	2434693	3086643	8189913	15640206	9513661	7402448	14496293	22922145
	5	1365712	1437818	1622333	4631511	8025792	5073701	4044098	7737172
	6	935624	788947	733453	894835	2302930	4158211	2697235	2097064
	7	819234	514429	376353	382529	414578	1118241	2079316	1310985
	8	1437361	451720	246350	196919	177949	202062	561154	1014425
	9	320446	759442	204152	122816	86183	82008	96179	258887
	10	331763	344600	498965	350534	207163	135189	103384	92068
TSB		2968856	4878040	5369800	5228329	6249552	8399799	8978987	8144671
SSB		2035801	3105755	3819928	3935254	4288840	5526287	6639399	6106538

Table 4.7.5.5 Blue Whiting, SMS run. Results using the survey on the spawning grounds and the surveys for juveniles (Norwegian Sea May 2000-2005). For the calculation of SSB in 2005, a recruitment of 43700 millions is assumed.

Year	Recruits (1000)	SSB (tonnes)	TSB (tonnes)	SOP (tonnes)	mean-F age 3-7
1981	3342387	2930993	3248753	922980	0.284
1982	3858693	2376228	2638905	550643	0.228
1983	14117028	1865496	2115739	553344	0.288
1984	18885537	1566284	2156721	615569	0.362
1985	11256144	1842102	2640955	678214	0.397
1986	8916707	2183449	2845648	847145	0.485
1987	9852958	1958717	2543199	654718	0.386
1988	7195757	1806309	2344468	552264	0.368
1989	9233757	1744354	2195852	630316	0.480
1990	23931786	1510896	1948557	558128	0.470
1991	8249899	1977477	3091330	364008	0.211
1992	5784619	2634625	3333611	474592	0.205
1993	5412704	2533532	3074713	475198	0.207
1994	6115437	2438528	2905910	457696	0.185
1995	8017621	2257063	2718704	505176	0.248
1996	23367810	2065900	2510451	621104	0.342
1997	43837166	2035801	2968856	639681	0.338
1998	28490055	3105755	4878040	1131955	0.458
1999	21897867	3819928	5369800	1261033	0.383
2000	42477405	3935254	5228329	1412449	0.483
2001	67311890	4288840	6249552	1771805	0.443
2002	40554444	5526287	8399799	1556955	0.418
2003	41523647	6639399	8978987	2365319	0.442
2004	28931287	6106538	8144671	2383504	0.513
2005		6107000			

Table 4.7.7.1 Tuning data for the blue whiting assessment. Inside the framed areas constant selection pattern is assumed. -1=missing data.

Norwegian acoustic spawning stock survey, ages 2-8

Year	Month	Min.obs.num	2	3	4	5	6	7	8
1981	3	1	2372	7583	3253	3647	4611	4638	3654
1982	3	1	-1	-1	-1	-1	-1	-1	-1
1983	3	1	297	2108	2723	6511	3735	3650	3153
1984	3	1	15767	1721	1616	1719	1858	1128	567
1985	3	1	-1	-1	-1	-1	-1	-1	-1
1986	3	1	1003	5829	4122	624	228	203	250
1987	3	1	4960	8417	22589	4735	282	417	385
1988	3	1	9712	9090	12367	20392	7355	723	599
1989	3	1	6787	22270	9973	10504	7803	933	293
1990	3	1	14169	12670	11228	5587	6556	3273	516
1991	3	1	11147	6340	8497	7407	4558	2019	545
1992	3	1	1232	26123	4719	1574	1386	810	616
1993	3	1	4489	3321	26771	2643	1270	557	426
1994	3	1	1603	2950	4476	11354	1742	1687	908
1995	3	1	8538	9874	7906	6861	9467	1795	1083
1996	3	1	8781	7433	8371	2399	4455	4111	1202
1997	3	1	-1	-1	-1	-1	-1	-1	-1
1998	3	1	18218	34991	4697	1674	279	407	381
1999	3	1	19034	60309	26103	1481	316	72	153
2000	3	1	8613	31011	41382	6843	898	427	228
2001	3	1	44162	12843	13805	8292	718	175	51
2002	3	1	71996	54740	12757	5266	8404	1450	305
2003	3	1	23992	70303	28756	5735	2430	1708	260
2004	3	1	18569	40669	50137	15649	4454	2218	1313
2005	3	1	1456	19968	30459	31708	7455	1993	747

Norwegian Sea ecosystem survey, ages 1-2

Year	Month	Min.obs.num	1	2
2000	5	1	182	728
2001	5	1	184	460
2002	5	1	22356	396
2003	5	1	30380	13916
2004	5	1	5969	23876
2005	5	1	2324	2380

Table 4.9.1.1 Blue Whiting. Input to short term projection.

Age	Weight in the stock	Weight in the catch	Proportion mature	Natural mortality	F *status quo*	Stock numbers 2005
	(kg)	(kg)				(millions)
1	0.0488	0.0488	0.11	0.2	0.089	43700.0
2	0.0732	0.0732	0.40	0.2	0.137	21671.8
3	0.0935	0.0935	0.82	0.2	0.335	22476.0
4	0.1083	0.1083	0.86	0.2	0.496	13159.9
5	0.1288	0.1288	0.91	0.2	0.530	11425.9
6	0.1530	0.1530	0.94	0.2	0.605	3729.8
7	0.1718	0.1718	1.00	0.2	0.600	937.8
8	0.1980	0.1980	1.00	0.2	0.665	588.8
9	0.2240	0.2240	1.00	0.2	0.665	427.0
10+	0.2775	0.2775	1.00	0.2	0.665	147.7

Recruitment in 2006: Geometric mean 1996-2003. 36400 millions, CV=37%.

Table 4.9.1.2 Blue Whiting. Short term projection results.

Option a) Catch in 2005 is assumed at 2 million tonnes

Deterministic projection

F 2005: 0.417
Yield 2005: 2000000 tonnes
SSB 2005: 6107000 tonnes

TAC in 2006 (1000 tonnes)	F in 2006	SSB in 2006 (1000 tonnes)	SSB in 2007 (1000 tonnes)
500	0.094	6002	7453
1000	0.195	6002	6978
1500	0.306	6002	6506
1558	0.32=F_{pa}	6002	6452
2000	0.429	6002	6038
2307	0.51=F_{lim}	6002	5752
2500	0.564	6002	5573
3000	0.715	6002	5113
3500	0.886	6002	4658

MCMC projection

F 2005: 0.469
Yield 2005: 2000000 tonnes
SSB 2005: 5489000 tonnes

TAC 2006	F 2006 median	F 2006 confidence intv.	SSB 2006 (1000 tonnes) median	SSB 2006 (1000 tonnes) confidence intv.	SSB 2007 (1000 tonnes) median	SSB 2007 (1000 tonnes) confidence intv.
500	0.106	(0.094-0.129)	5233	(4471-6055)	6734	(5910-7472)
1000	0.223	(0.195-0.273)	5233	(4471-6055)	6265	(5435-6998)
1500	0.352	(0.306-0.434)	5233	(4471-6055)	5799	(4965-6527)
2000	0.497	(0.428-0.616)	5233	(4471-6055)	5336	(4500-6059)
2500	0.661	(0.562-0.828)	5233	(4471-6055)	4877	(4046-5595)
3000	0.848	(0.713-1.076)	5233	(4471-6055)	4424	(3598-5135)
3500	1.061	(0.882-1.367)	5233	(4471-6055)	3978	(3160-4680)

F 2006	TAC 2006 (1000 tonnes) median	TAC 2006 (1000 tonnes) confidence intv.	SSB 2006 (1000 tonnes) median	SSB 2006 (1000 tonnes) confidence intv.	SSB 2007 (1000 tonnes) median	SSB 2007 (1000 tonnes) confidence intv.
0.32	1336	(1144-1554)	5136	(4402-5943)	5823	(5239-6517)
0.51	1984	(1696-2306)	5136	(4402-5943)	5208	(4718-5817)

Confidence intv. corresponds to the 25 - 75 percentiles

Option b) Catch in 2005 from F *status quo*

Deterministic projection

F 2005: 0.513
Yield 2005: 2373000 tonnes
SSB 2005: 6107000 tonnes

TAC in 2006 (1000 tonnes)	F in 2006	SSB in 2006 (1000 tonnes)	SSB in 2007 (1000 tonnes)
500	0.100	5659	7095
1000	0.210	5659	6622
1462	0.32=F_{pa}	5659	6188
1500	0.330	5659	6152
2000	0.462	5659	5686
2168	0.51=F_{lim}	5659	5531
2500	0.610	5659	5225
3000	0.777	5659	4767
3500	0.968	5659	4315

MCMC projection

F 2005: 0.567
Yield 2005: 2294000 tonnes
SSB 2005: 5489000 tonnes

TAC 2006	F 2006 median	F 2006 confidence intv.	SSB 2006 (1000 tonnes) median	SSB 2006 (1000 tonnes) confidence intv.	SSB 2007 (1000 tonnes) median	SSB 2007 (1000 tonnes) confidence intv.
500	0.115	(0.099-0.136)	4954	(4214-5664)	6361	(5693-7128)
1000	0.241	(0.207-0.289)	4954	(4214-5664)	5890	(5228-6651)
1500	0.381	(0.325-0.461)	4954	(4214-5664)	5424	(4764-6180)
2000	0.538	(0.457-0.659)	4954	(4214-5664)	4953	(4303-5713)
2500	0.718	(0.606-0.890)	4954	(4214-5664)	4489	(3849-5248)
3000	0.923	(0.775-1.162)	4954	(4214-5664)	4038	(3403-4786)
3500	1.163	(0.966-1.492)	4954	(4214-5664)	3598	(2967-4329)

F 2006	TAC 2006 (1000 tonnes) median	TAC 2006 (1000 tonnes) confidence intv.	SSB 2006 (1000 tonnes) median	SSB 2006 (1000 tonnes) confidence intv.	SSB 2007 (1000 tonnes) median	SSB 2007 (1000 tonnes) confidence intv.
0.32	1256	(1088-1441)	4803	(4178-5601)	5579	(5064-6230)
0.51	1868	(1618-2136)	4803	(4178-5601)	5023	(4565-5573)

Confidence intv. corresponds to the 25 - 75 percentiles

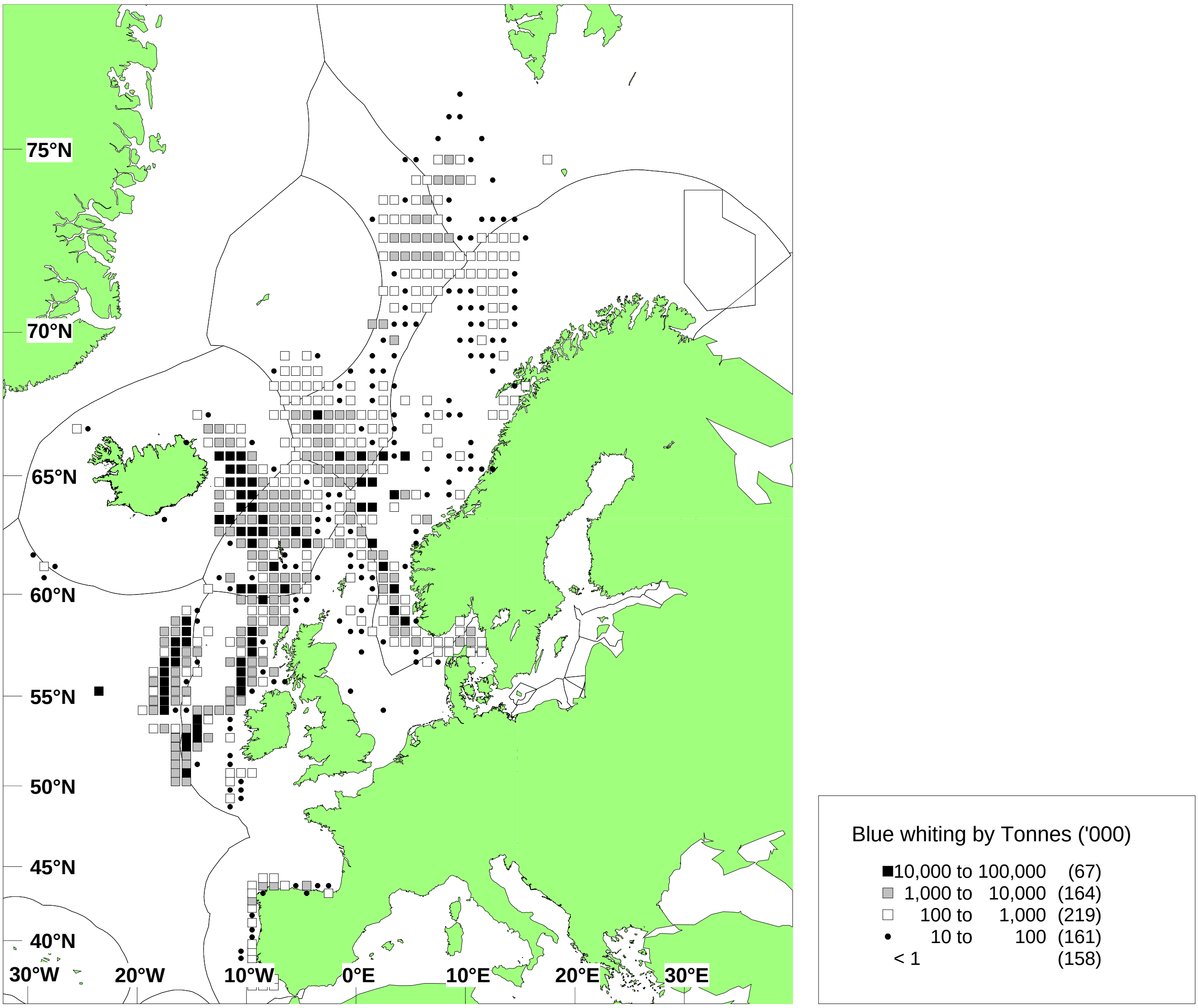


Figure 4.3.1. Total catches of blue whiting in 2004 by ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t.

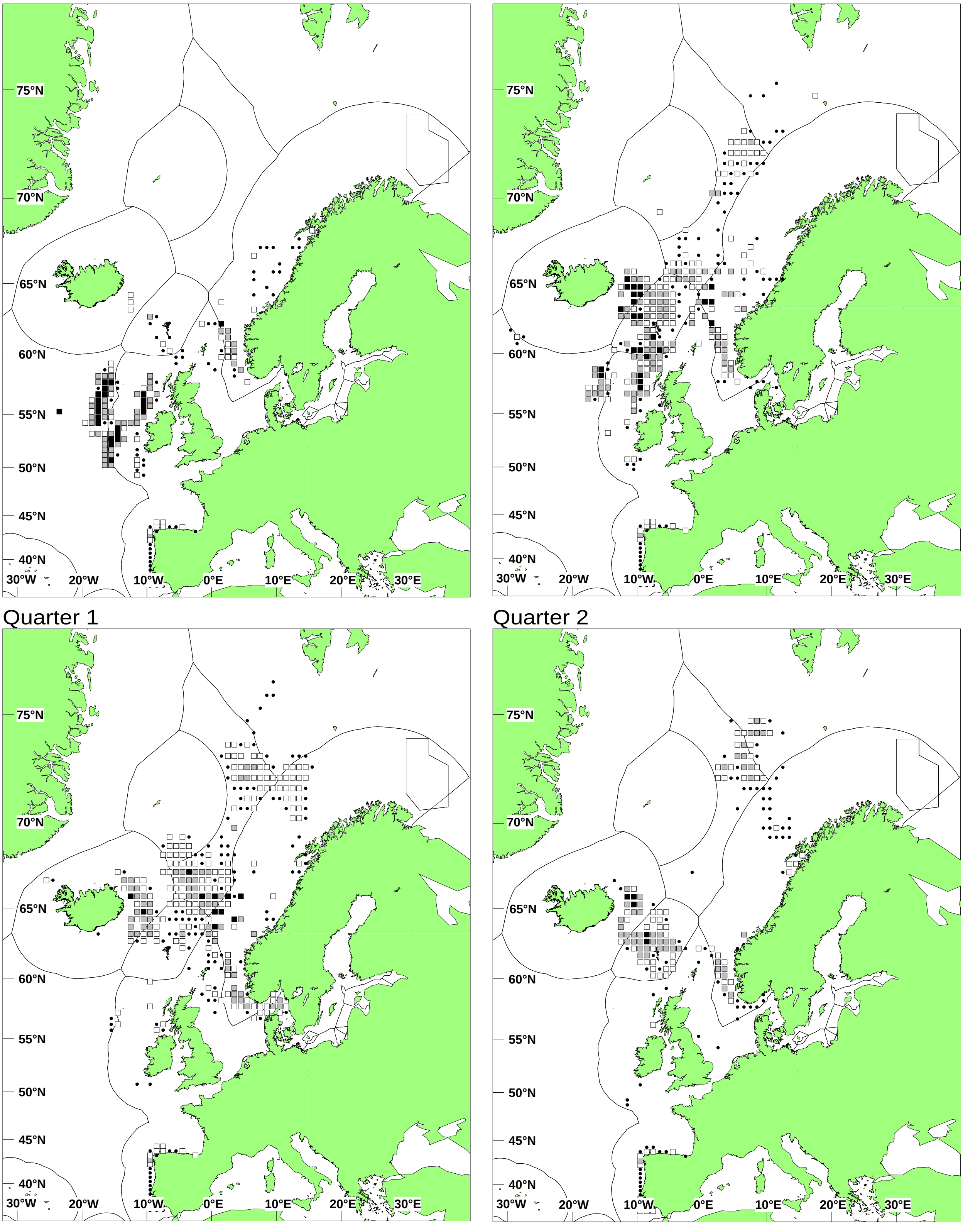


Figure 4.3.2. Total catches of blue whiting in 2004 by quarter and ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t.

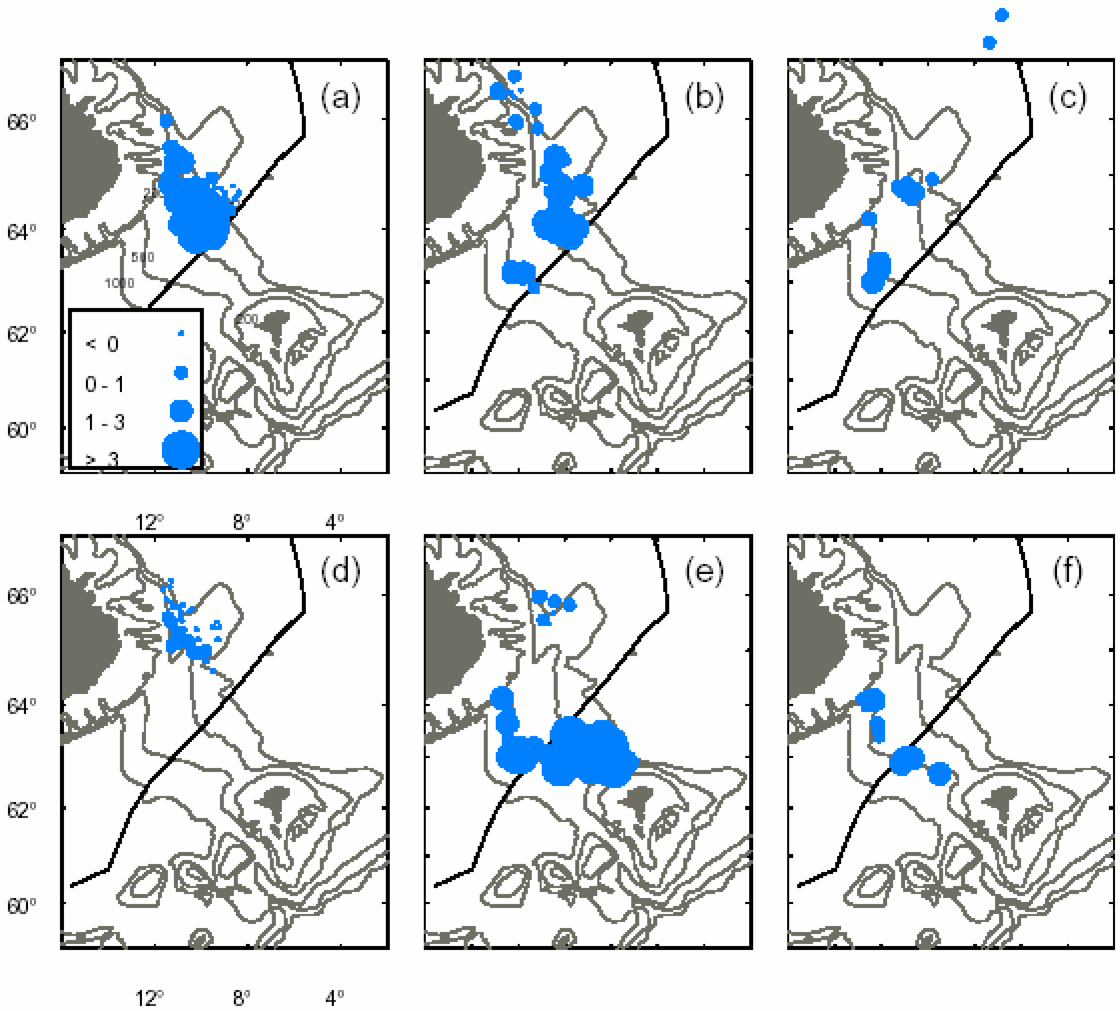


Fig. 4.4.1.1. Geographic distribution of saithe (*Pollachius virens*) by-catch rates (% weight) in sampled hauls 2004. (a) May-June, (b) July, (c) August-September, (d) October, (e) November, (f) December (Pálsson et al. 2004).

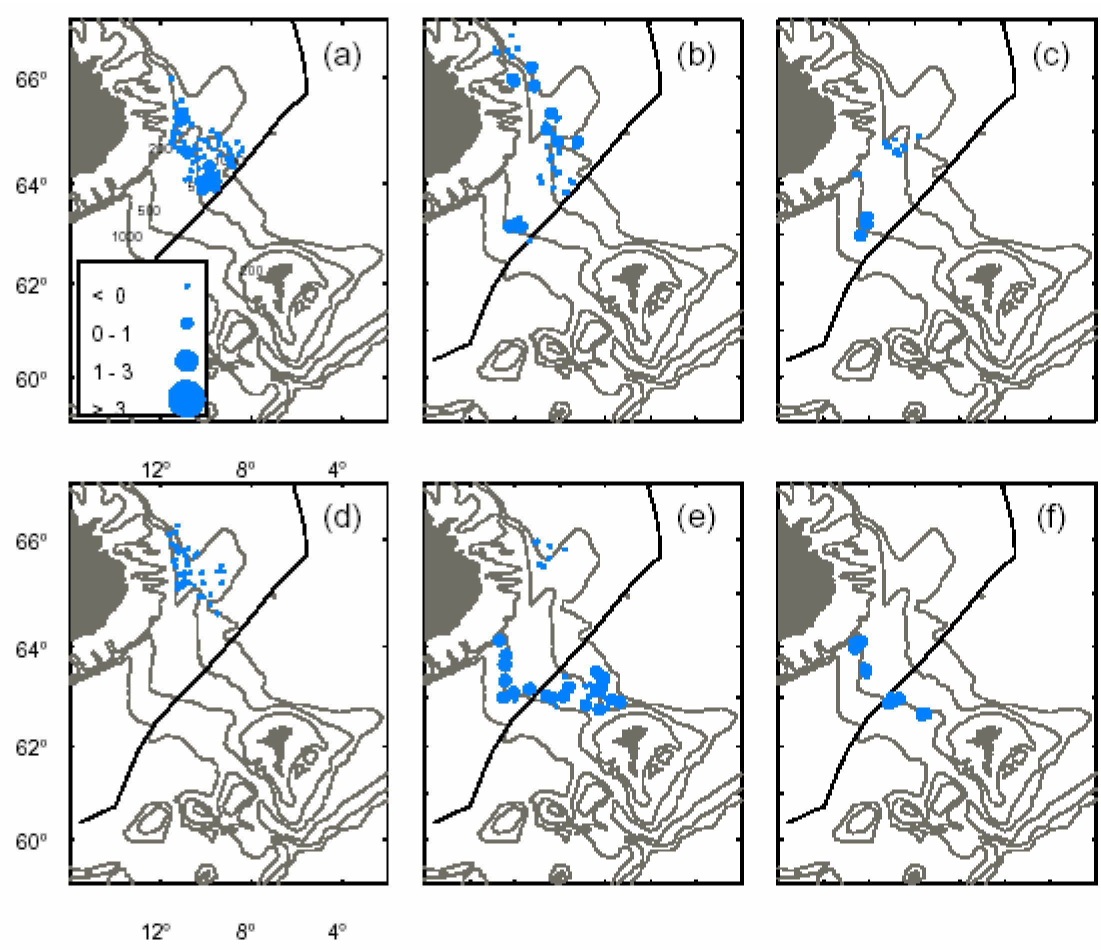


Fig. 4.4.1.2. Geographic distribution of cod (*Gadus morhua*) by-catch rates (% weight) in sampled hauls by months 2004. (a) May-June, (b) July, (c) August-September, (d) October, (e) November, (f) December (Pálsson et al. 2004).

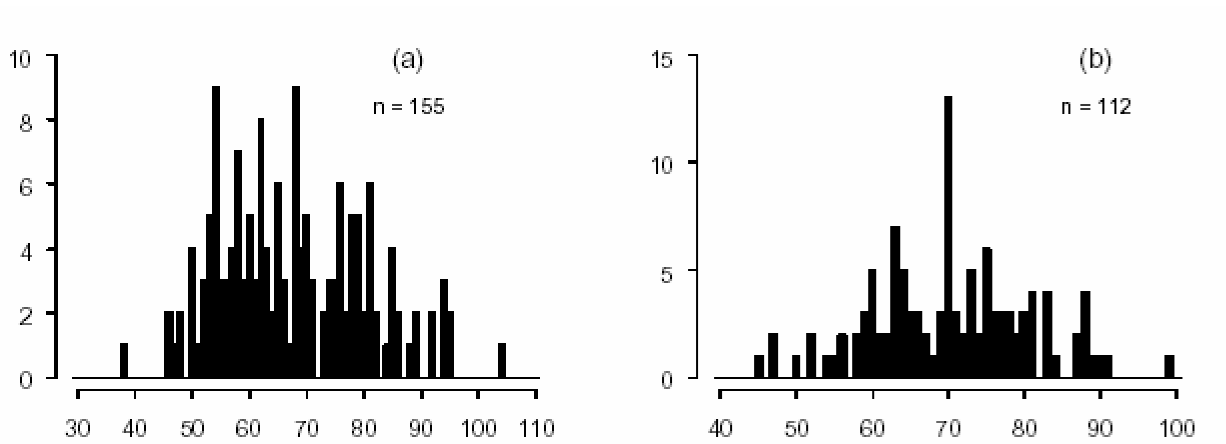


Fig. 4.4.1.3. Length distributions (numbers) of by-catch of (a) cod and (b) saithe in the Icelandic blue whiting fishery 2004 (Pálsson et al. 2004).

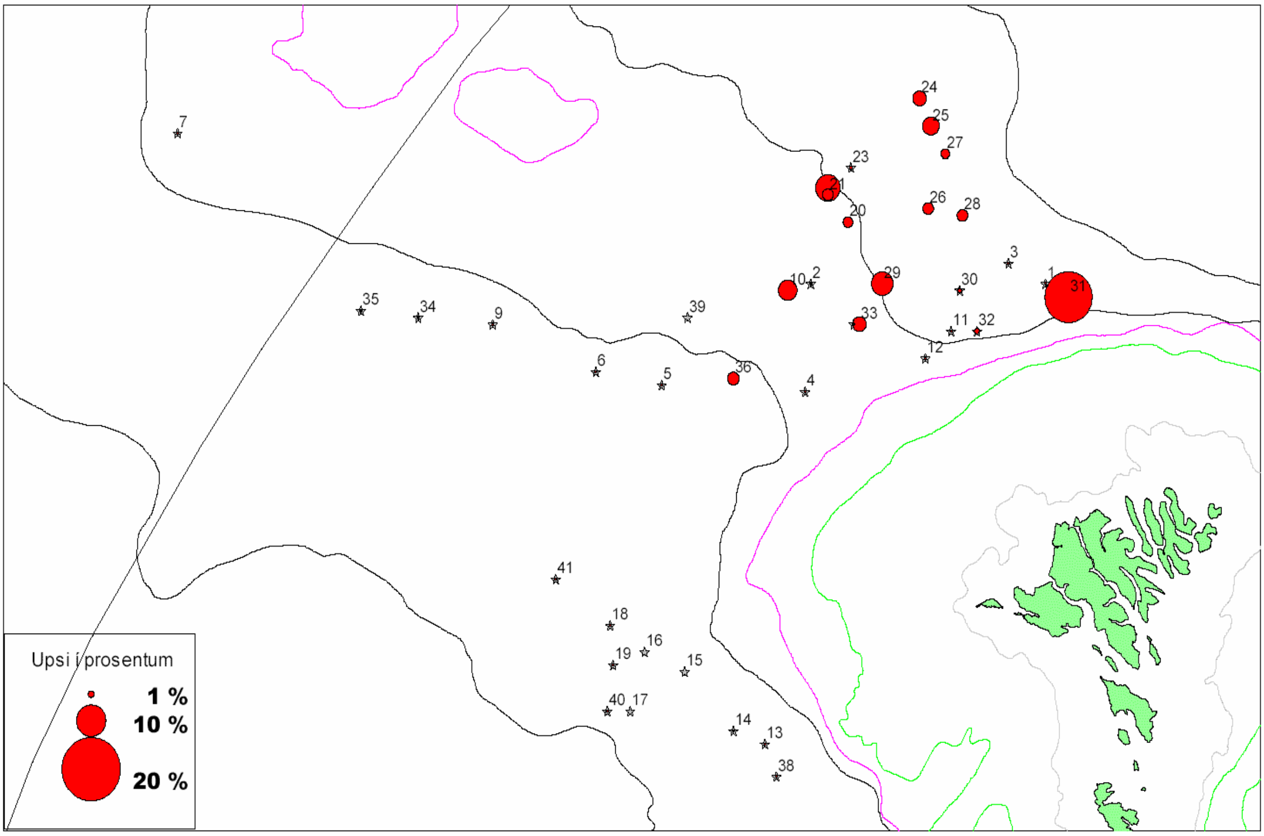


Figure 4.4.2.1. Faroese screenings on board the factory trawler M/T Næraberg in November-December 2004 (Lamhauge 2004).

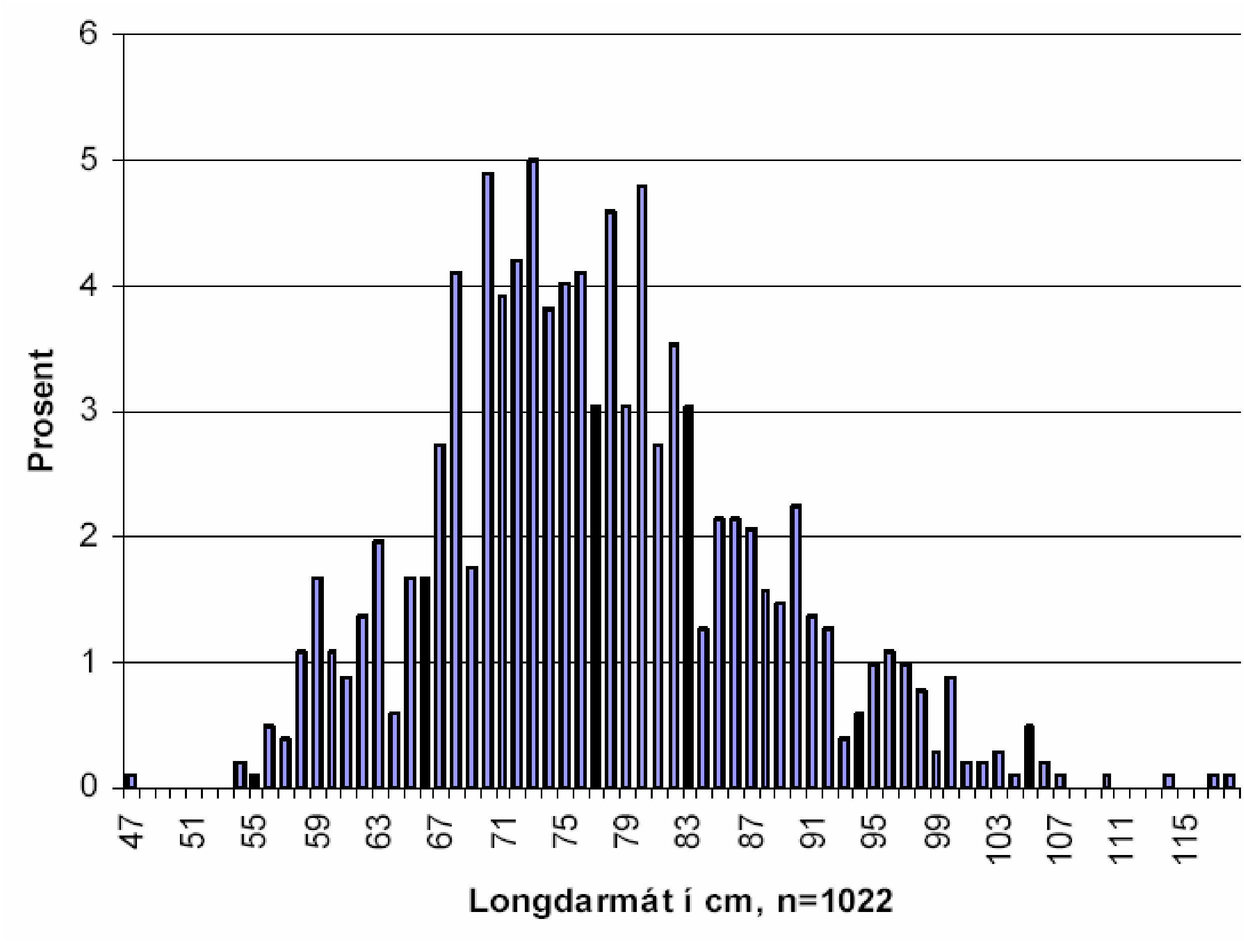


Figure 4.4.2.2. Length distribution (percentage) in cm of by-catch of saithe caught in the screenings on board the factory trawler M/T Næraberg in November-December 2004 (Lamhauge 2004).

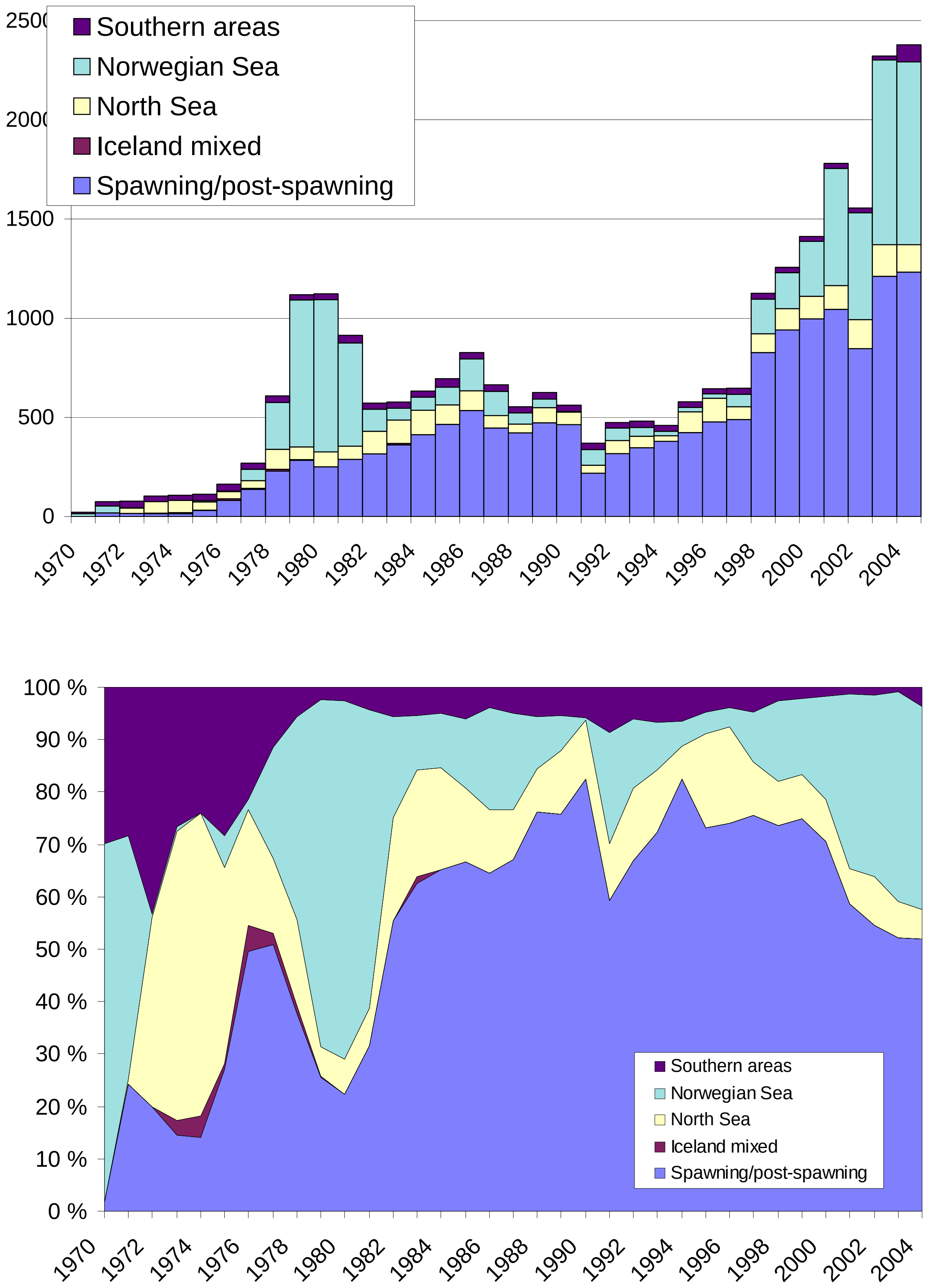


Figure 4.5.2.1. Development of blue whiting fisheries in different sub-areas in terms of absolute (top) and relative catches (bottom).

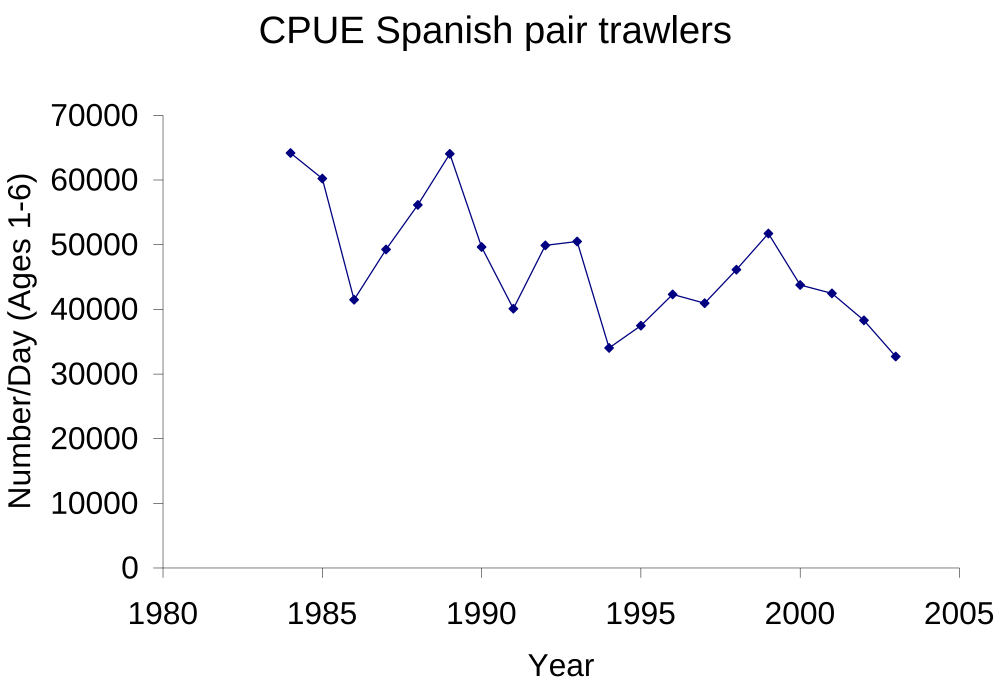


Figure 4.5.9.1.1. Blue whiting CPUE from Spanish Pair trawlers in ICES Div VIIIc and IXa (North).

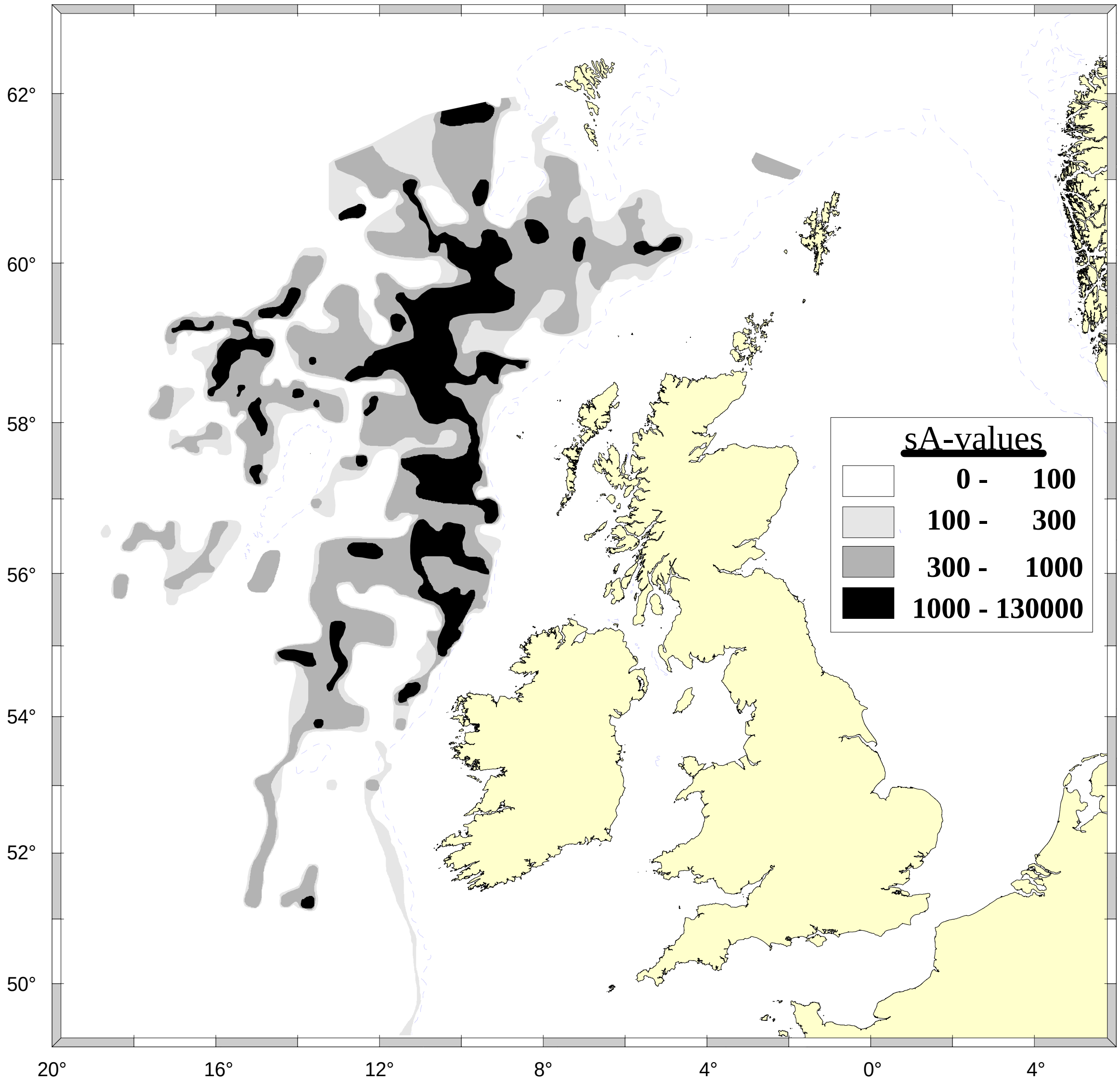


Figure 4.6.1.1.1. Blue Whiting: Schematic map of blue whiting acoustic density (s_A, m^2/nm^2) in the international spring survey in 2005.

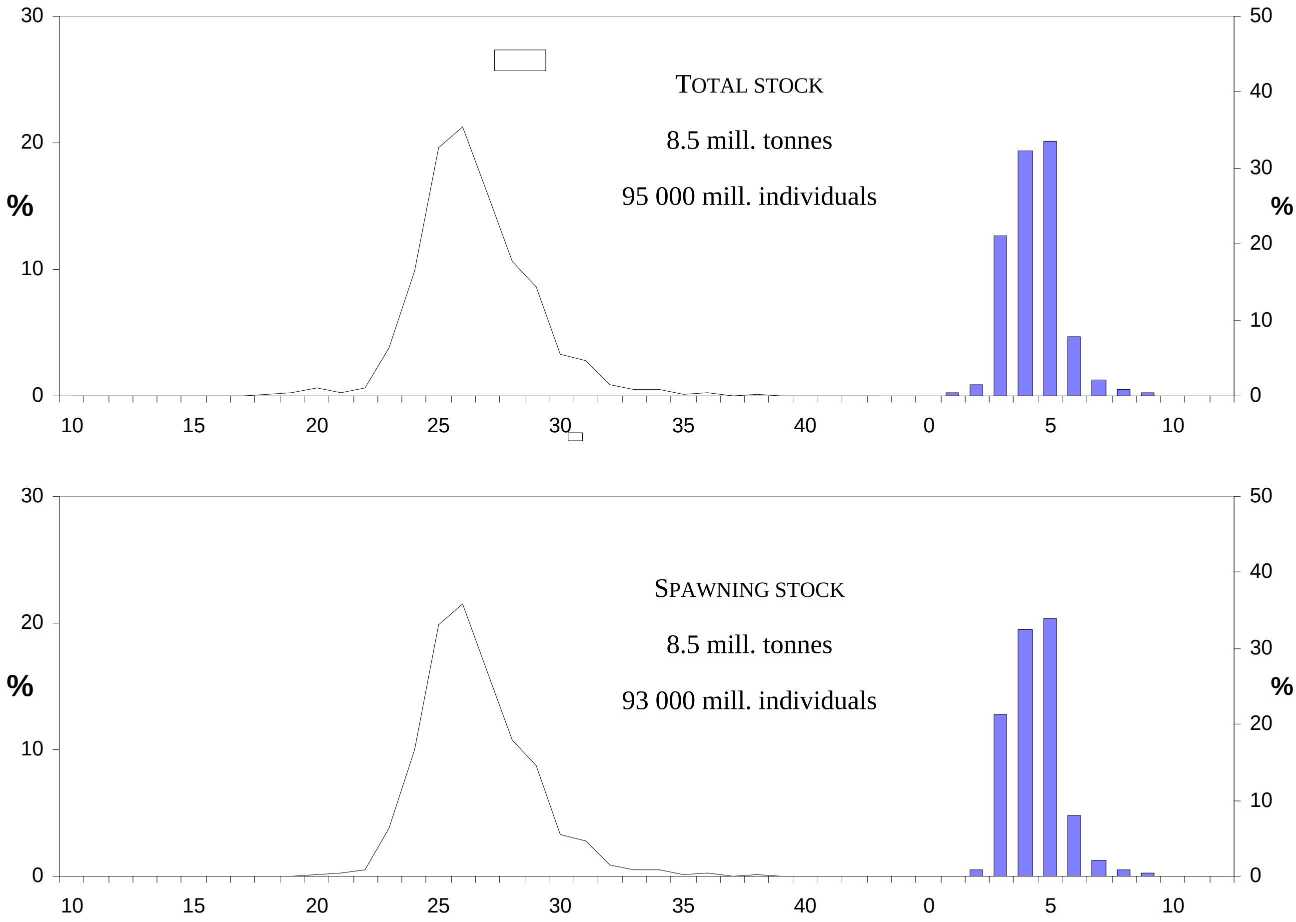


Figure 4.6.1.2.1. Length and age distribution of blue whiting estimated from the Norwegian blue whiting spawning stock survey with R/V "G. O. Sars" in March-April 2005.

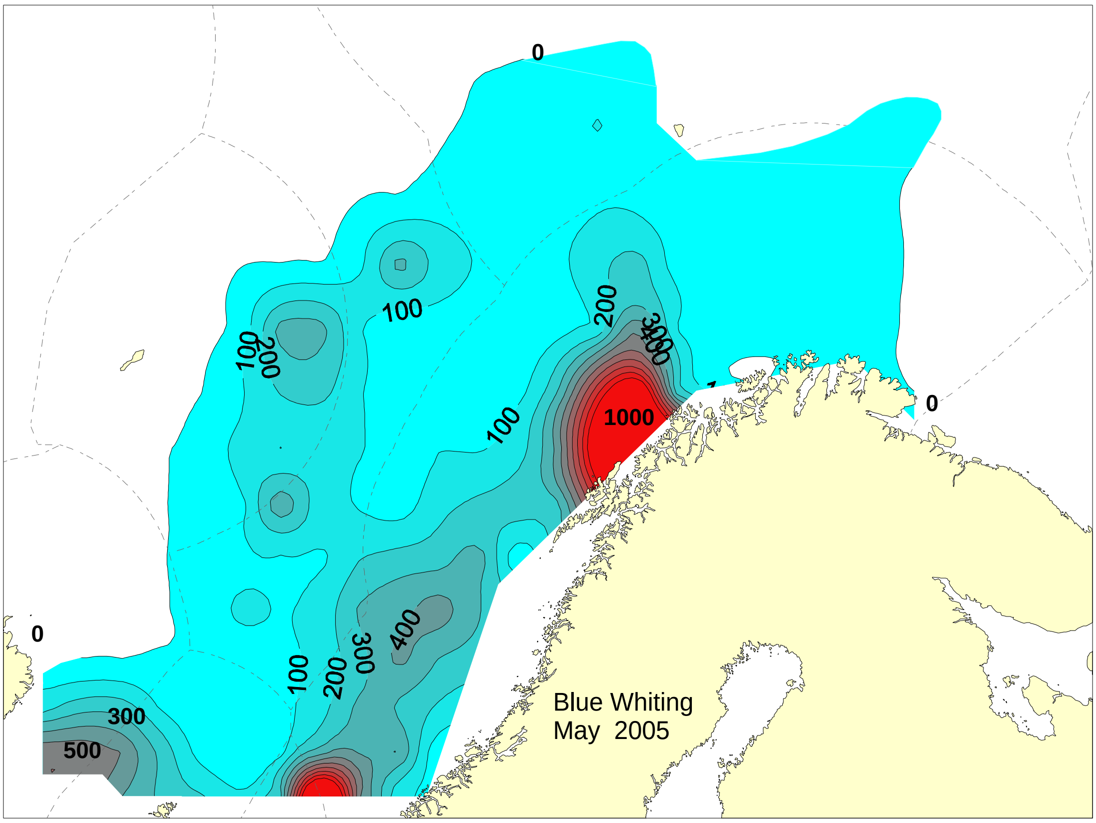


Figure 4.6.1.4.1. Density of blue whiting in terms of s_A-values (m^2/nm^2) based on combined 5 nm values reported by each of the research vessels “Dana”, “Magnus Heinason”, “Arni Fridriksson”, “Johan Hjort” and “G. O. Sars” in the Norwegian Sea–Faroese EEZ in May 2005.

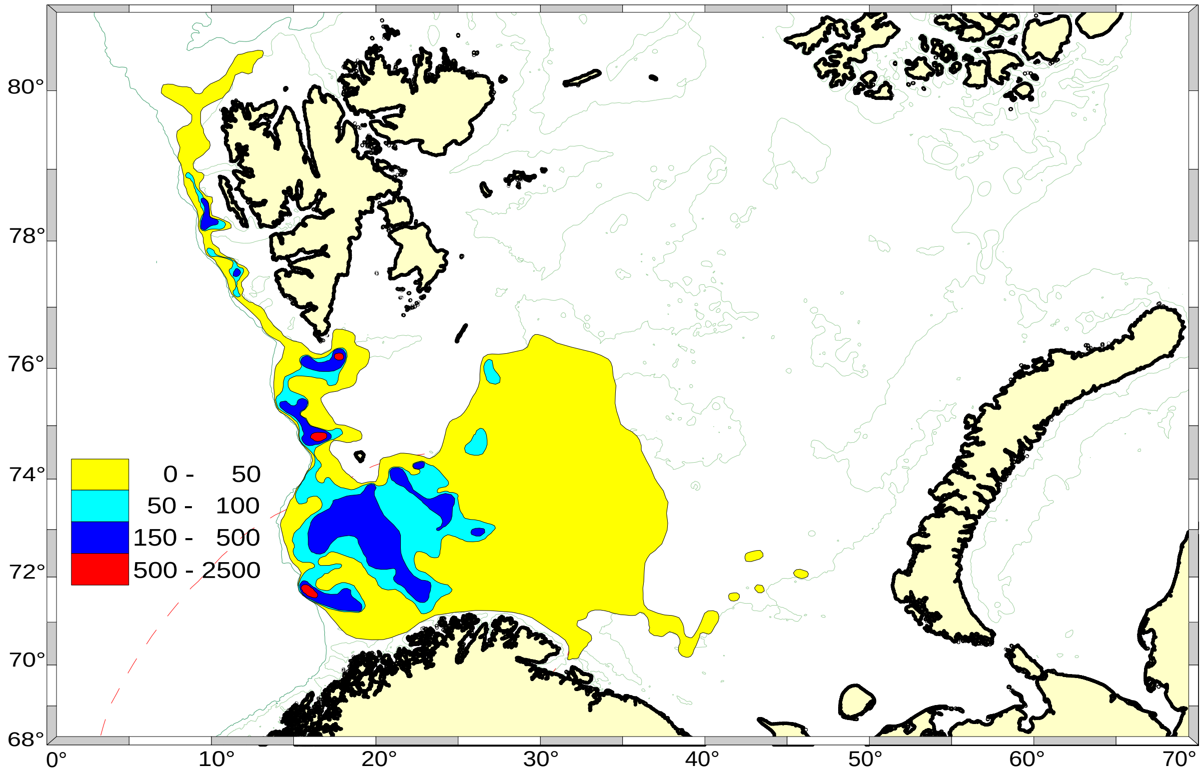


Fig. 4.6.1.8.1 Blue whiting distribution in October-December 2004 (s_A, $m^2/mile^2$).

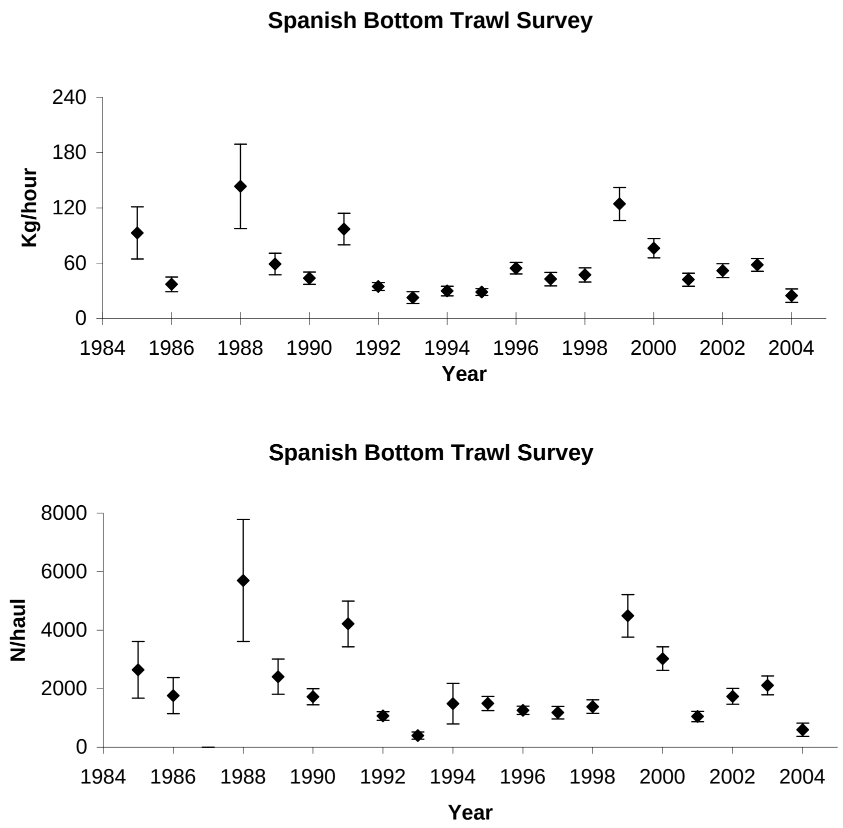
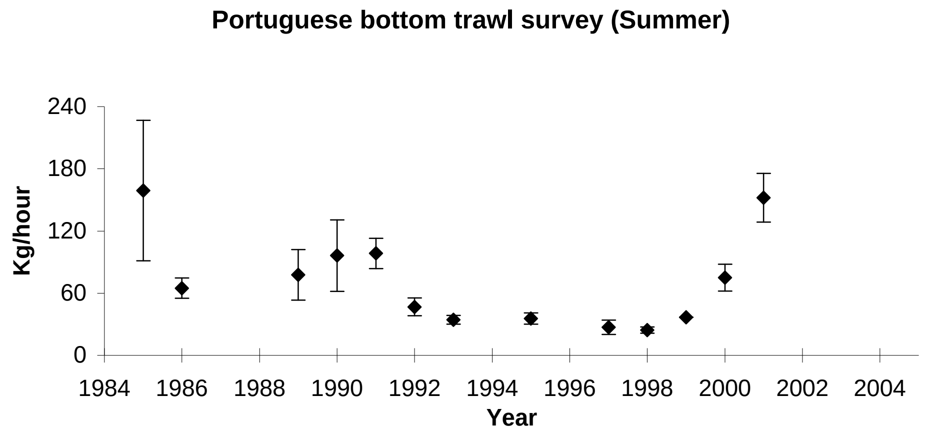


Figure 4.6.1.9.1 Blue whiting. Mean catch rates (Kg/haul and Number/haul) in Spanish bottom trawl survey.



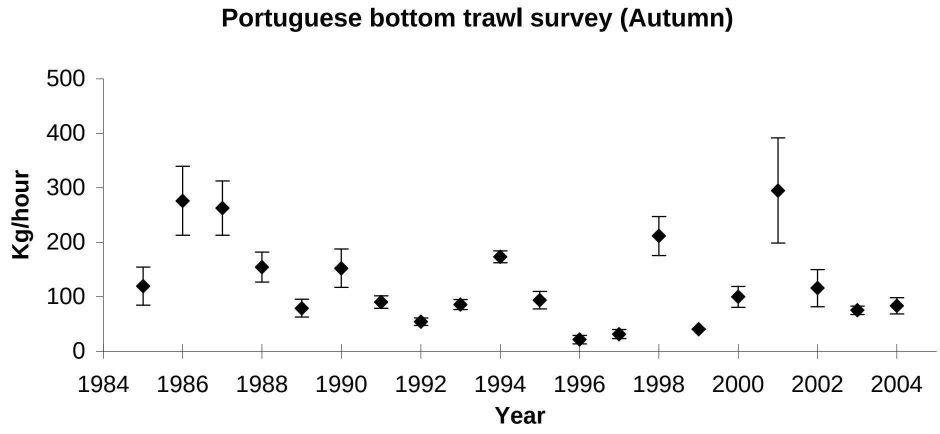


Figure 4.6.1.10.1 Blue whiting. Mean catch rates in the Portuguese bottom trawl surveys.

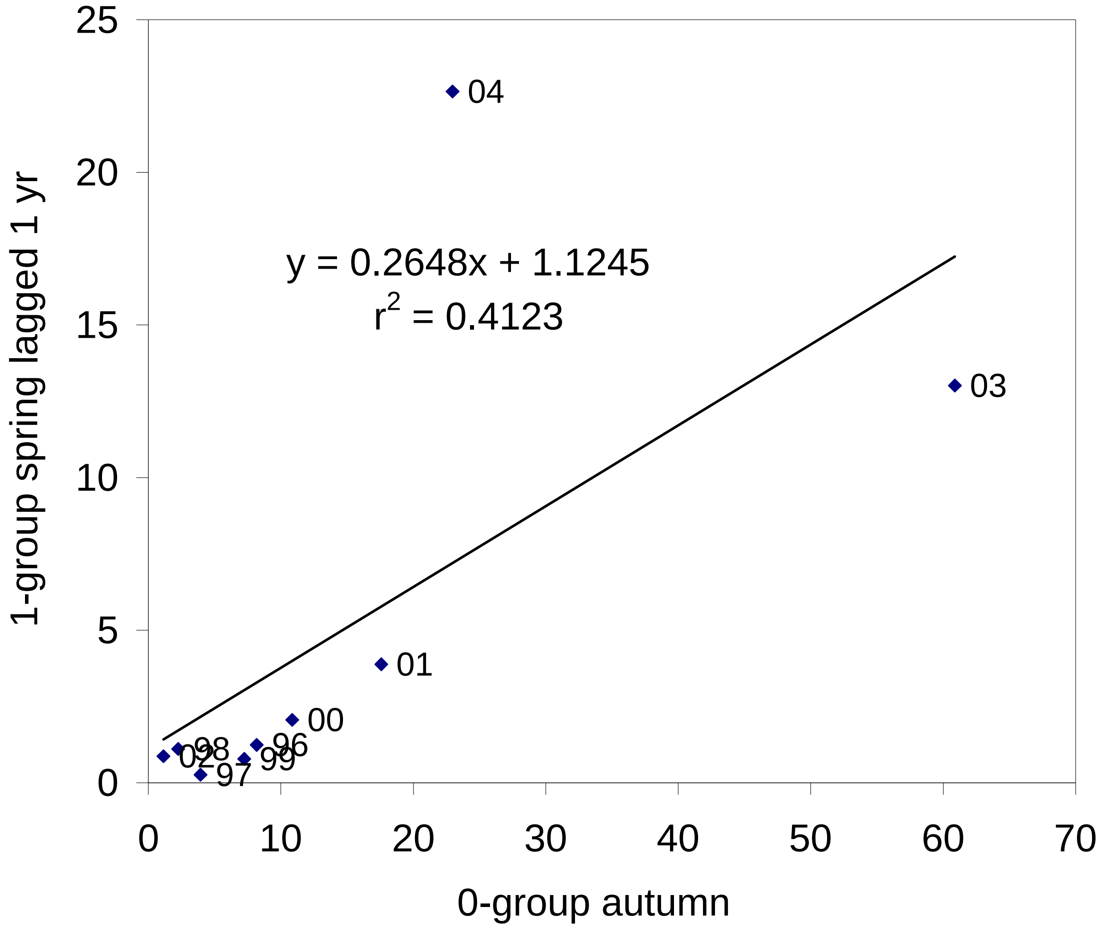


Figure 4.6.1.12.1 Bottom trawl 0-group index (number of blue whiting caught 10^{-3}) of Faroes plateau bottom trawl survey from autumn 1996-2004 compared to the following 1-group spring index lagged one year to match the 0-group index. Year is indicated on the points.

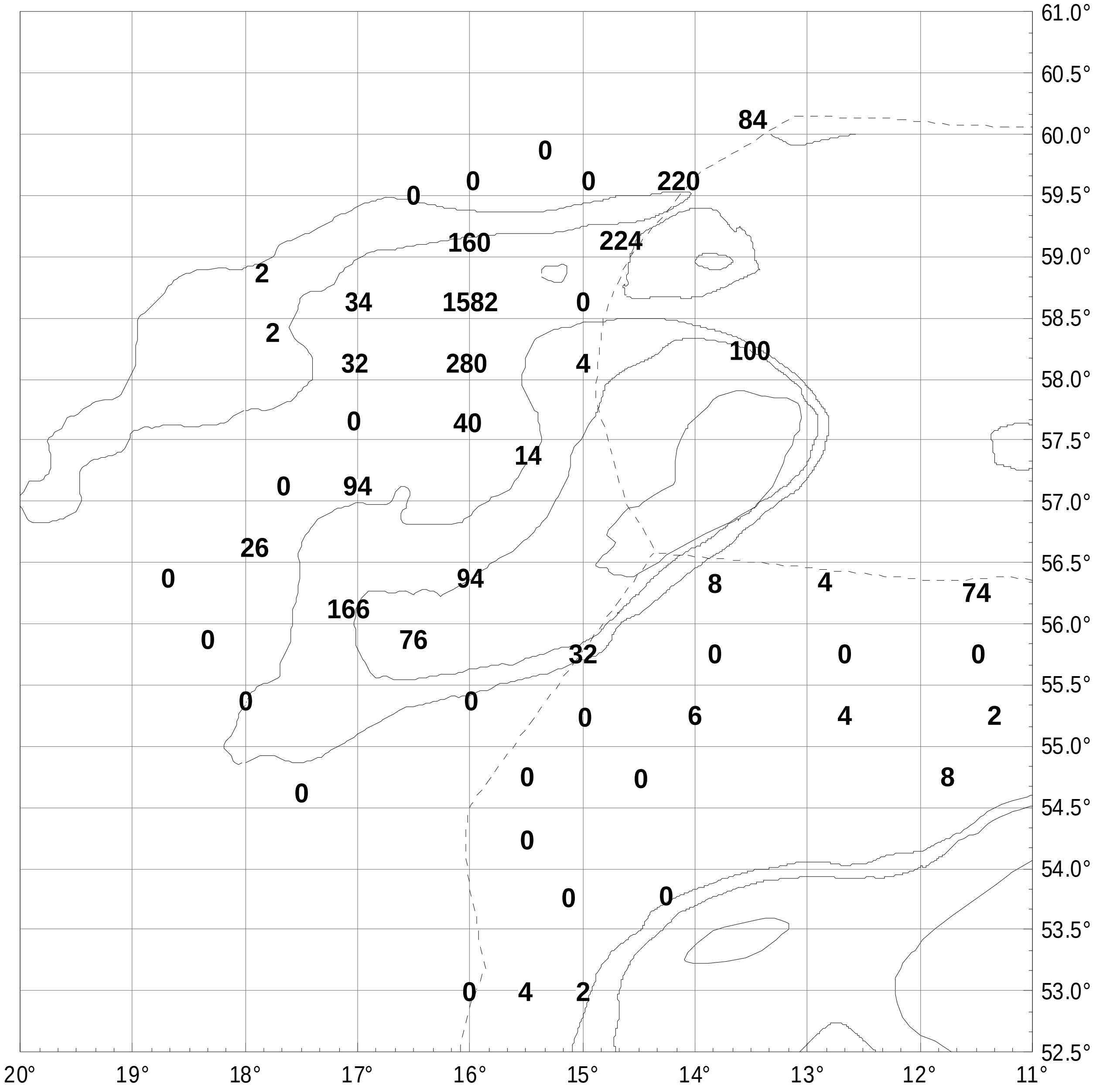


Fig. 4.6.1.15.1. Number of blue whiting eggs above 1 m^2 of the area investigated by R/V ATLANTNIRO 16.03 - 08.04.2005 and R/V FRIDTJOF NANSEN 18-29.03.2005

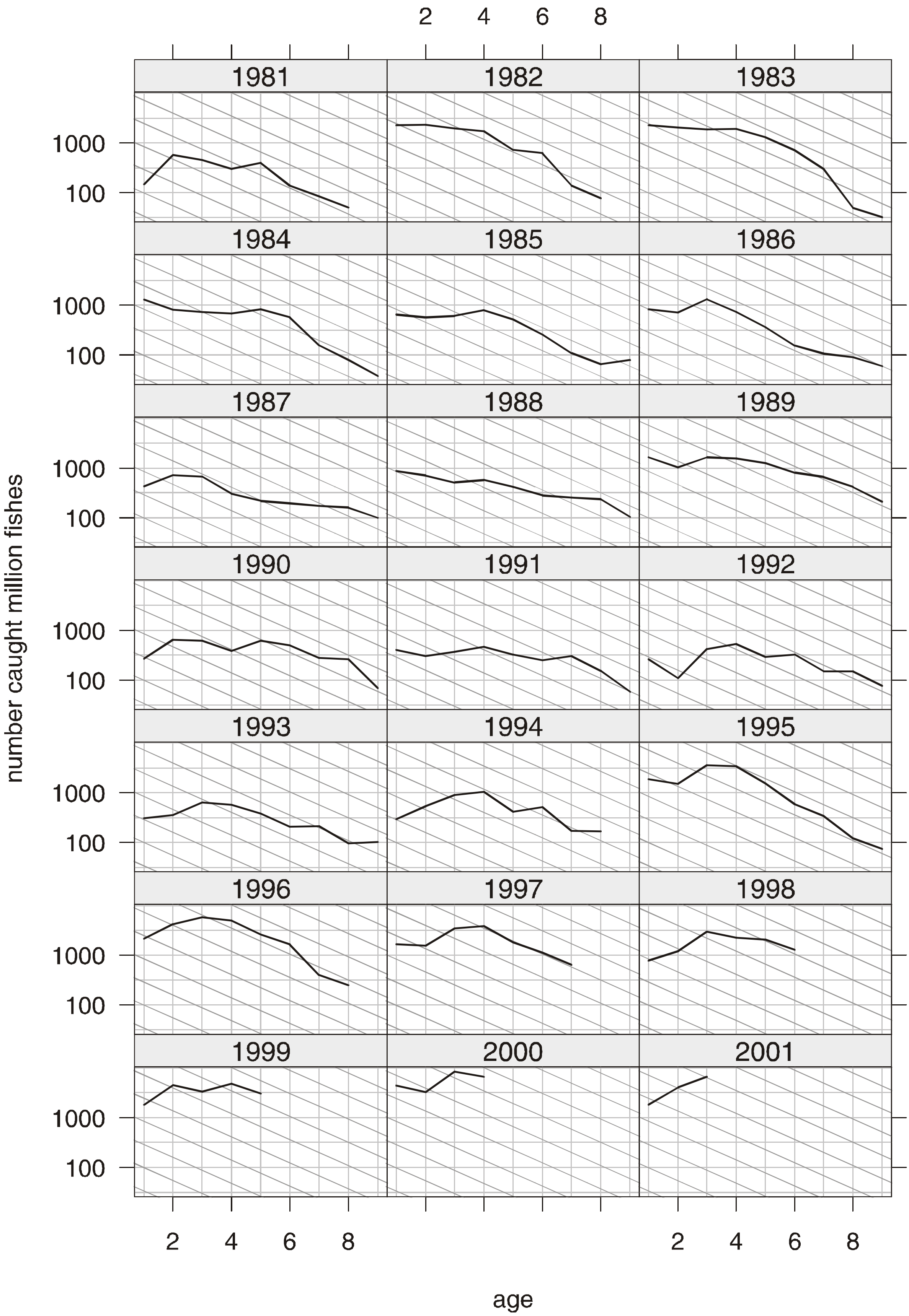


Figure 4.7.1.1 Age disaggregated catch in numbers of blue whiting plotted on log scale. The labels above each figure indicate yearclasses. The grey lines correspond to Z=0.6.

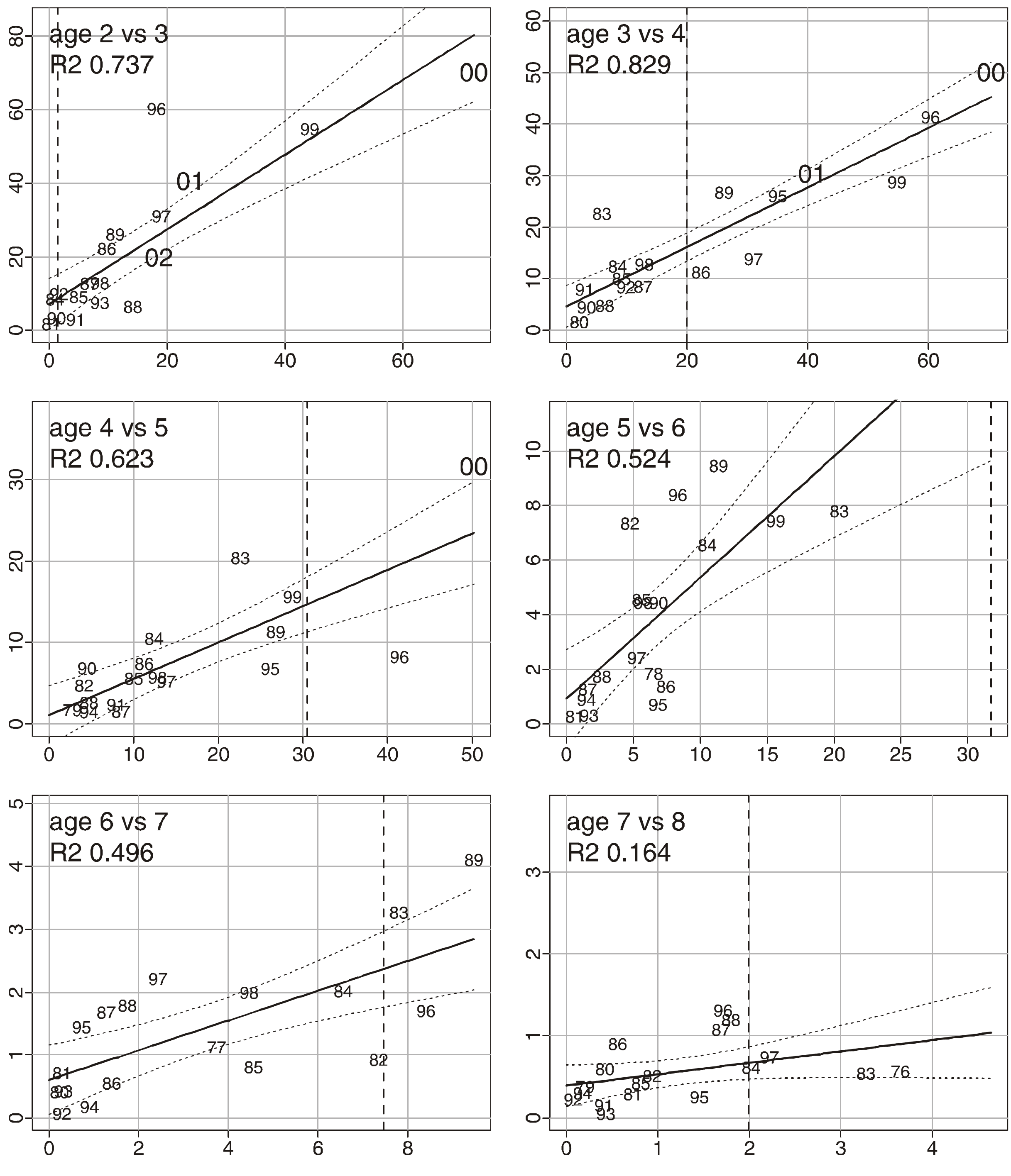


Figure 4.7.1.2. Abundance index of blue whiting in the spawning fish survey plotted against the abundance index of the same yearclass the following year. The dashed line shows the most recent estimate. The labels in the picture indicate yearclass.

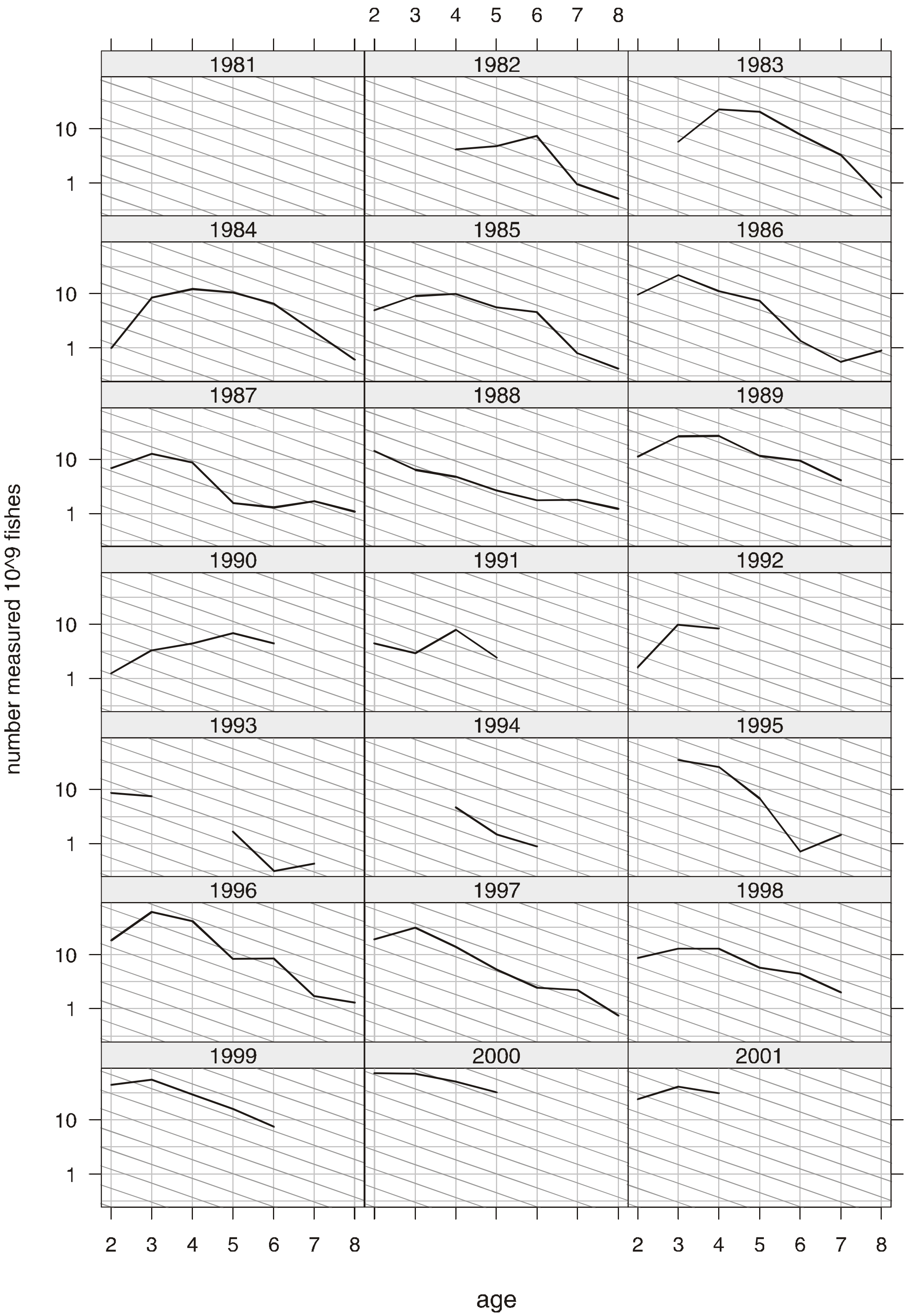


Figure 4.7.1.3 Age disaggregated abundance indices of blue whiting from the spawning survey plotted on log scale. The labels above each figure indicate yearclasses. The grey lines correspond to Z=0.6.

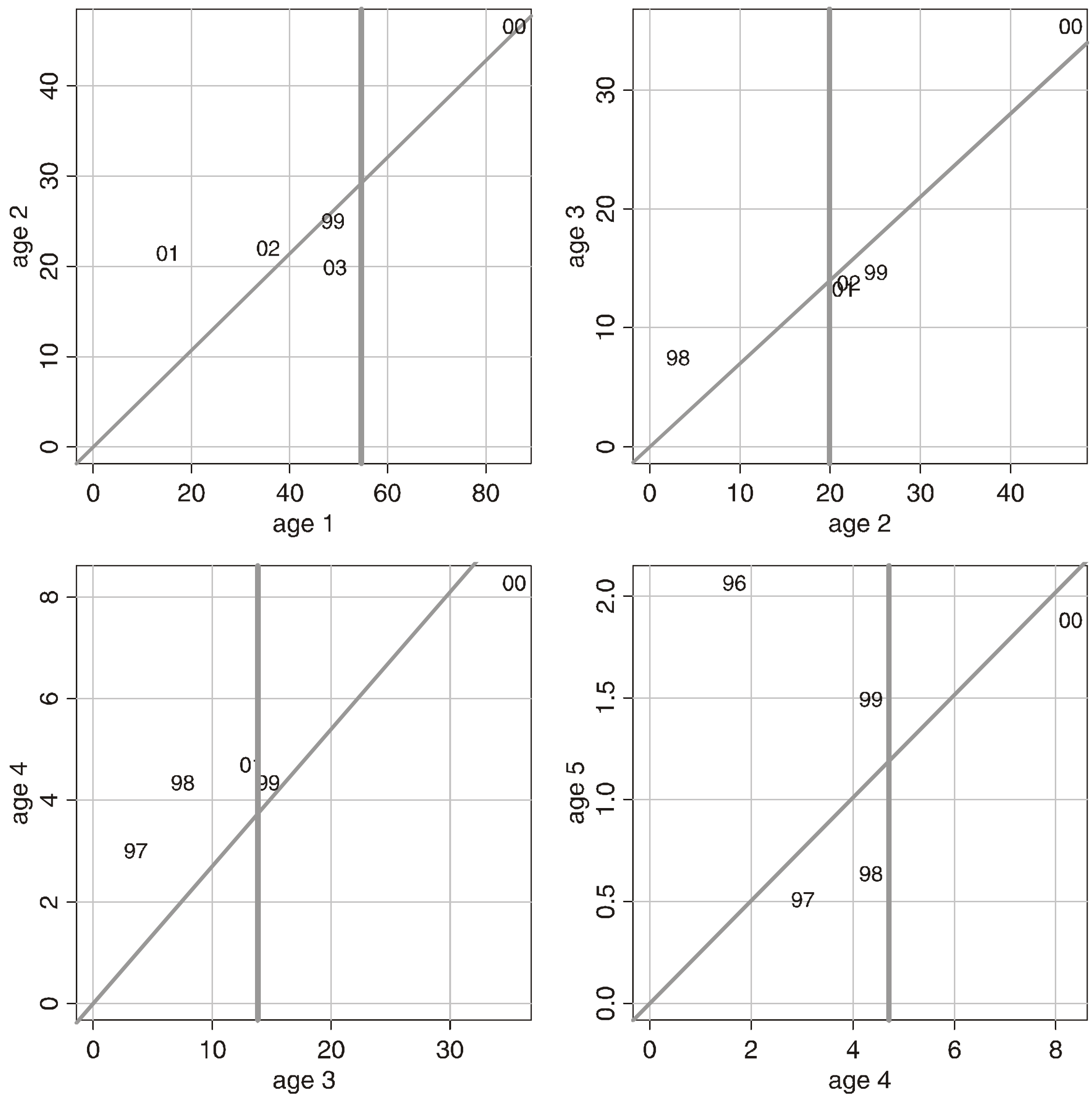


Figure 4.7.1.4. Abundance index of blue whiting in Norwegian sea survey plotted against the abundance index of the same yearclass the following year. The wide line shows the most recent estimate. The labels in the picture indicate yearclass

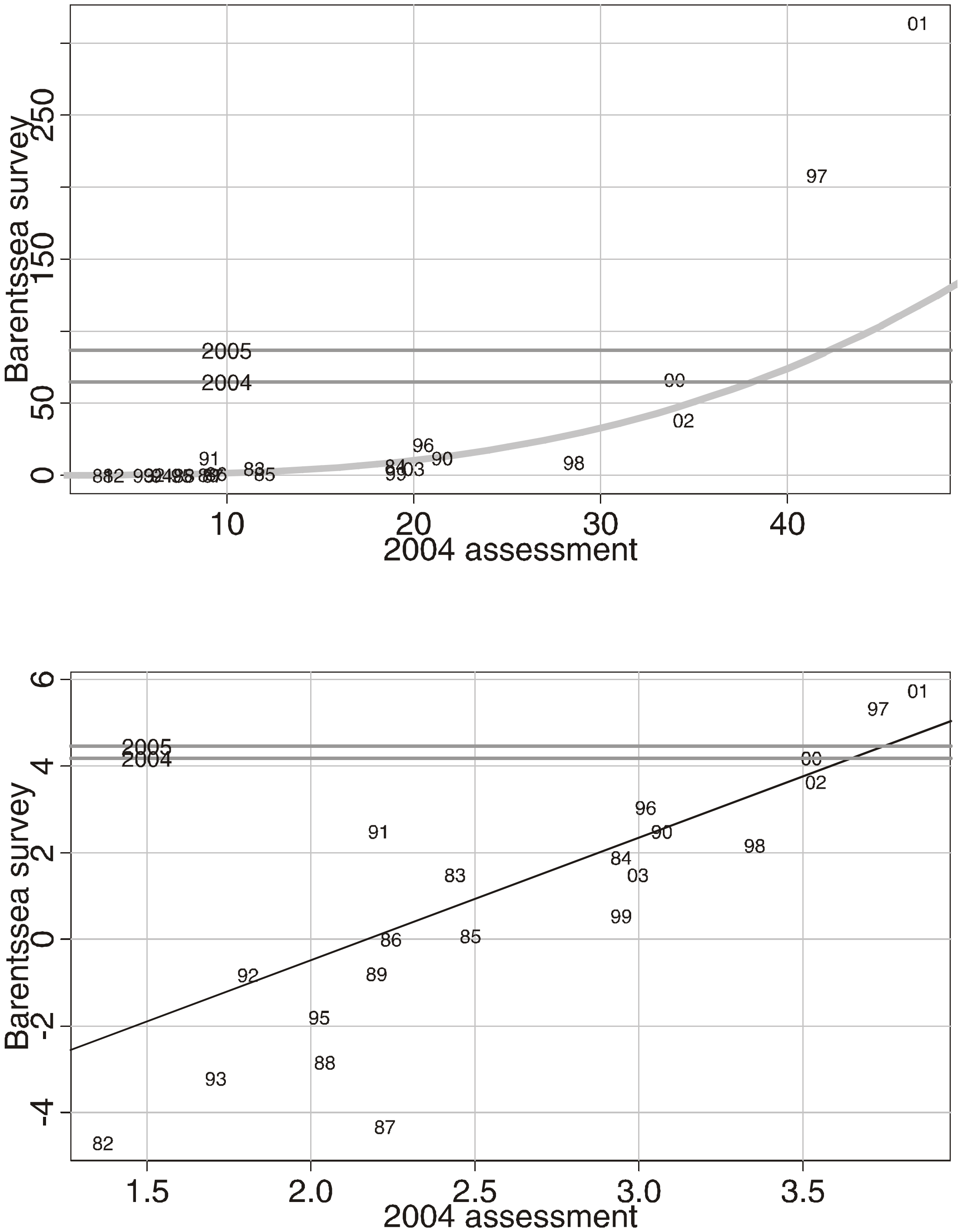


Figure 4.7.1.5 Number of age 1 blue whiting in the Barents sea survey plotted against estimate from assessment . The lines show curve fitted to the data and the horizontal lines the most recent points.

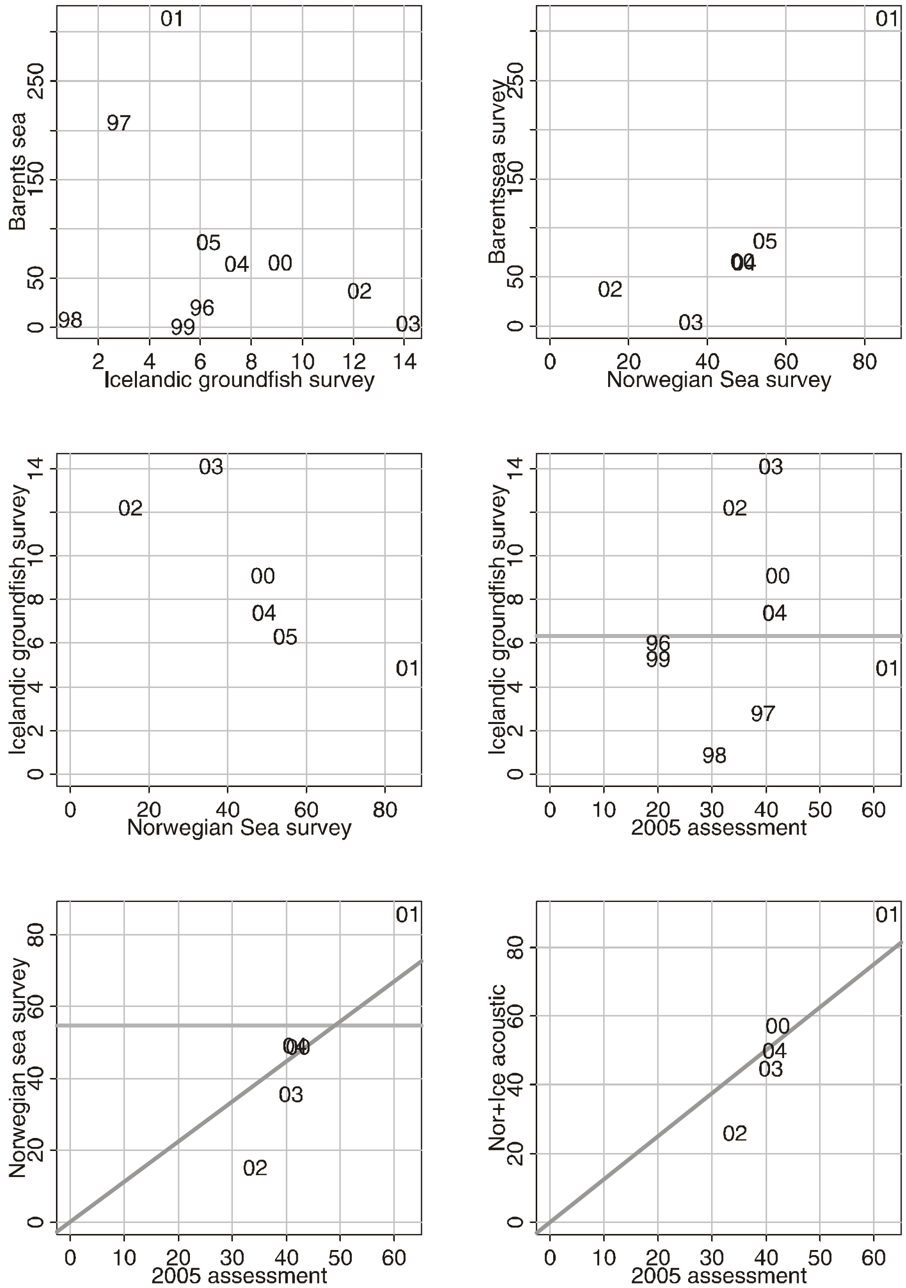


Figure 4.7.1.6 Some recruitment indices of blue whiting plotted against each other. In the upper 2 figures the label indicates year but yearclass in the lower 2.

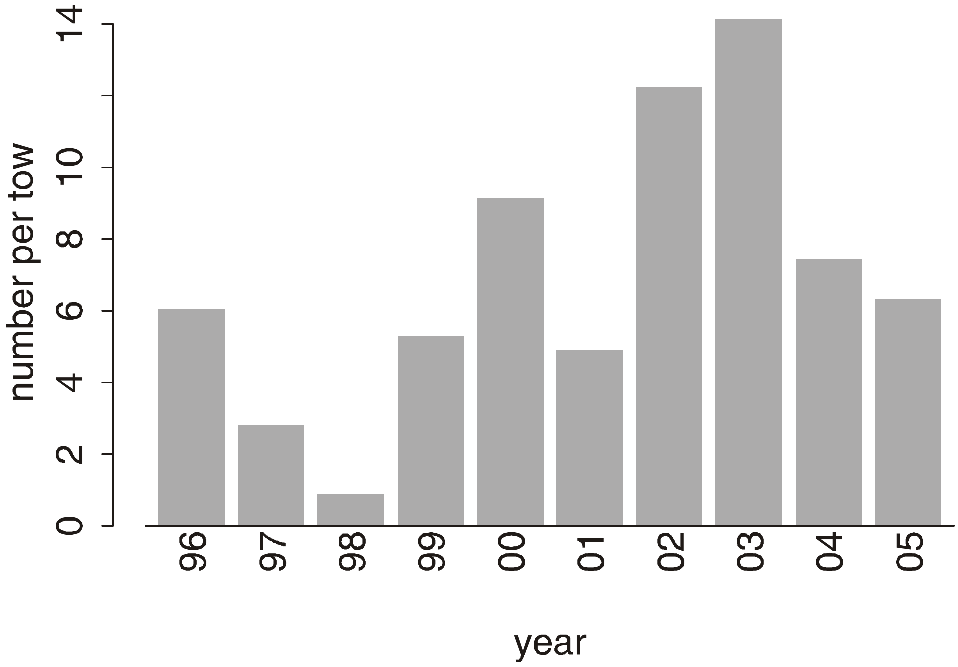


Figure 4.7.1.7 Indices of age 1 blue whiting from the Icelandic groundfish survey in March. The indices are calculated as the mean number of fish smaller than 21 cm in each tow using the area covered by the survey in all years.

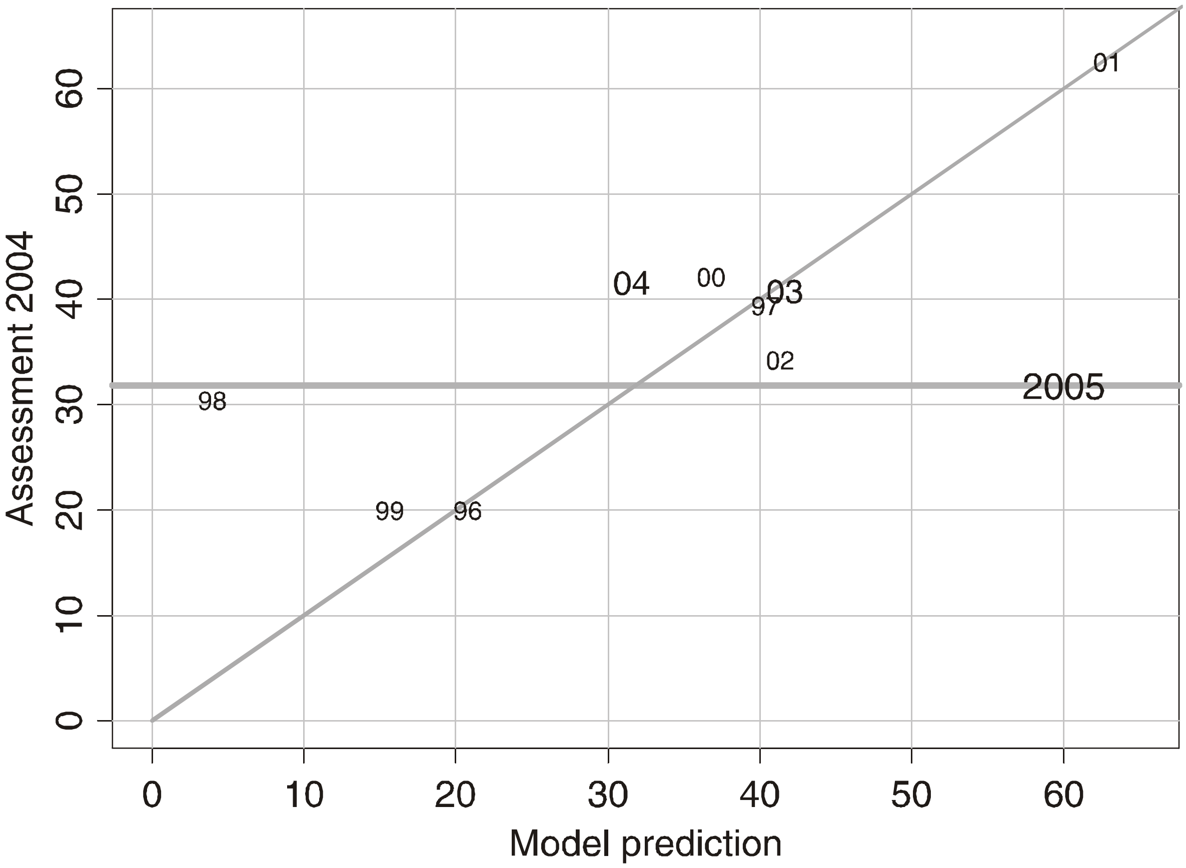


Figure 4.7.1.8 Blue whiting. Prediction of recruitment from a model $N_1 = \alpha I_{ice} + \beta I_{bar}$. Labels in the figure indicate year. The horizontal line shows the estimate for the 2005 yearclass and the slope line 1-1 relationship so points on that line fit perfectly.

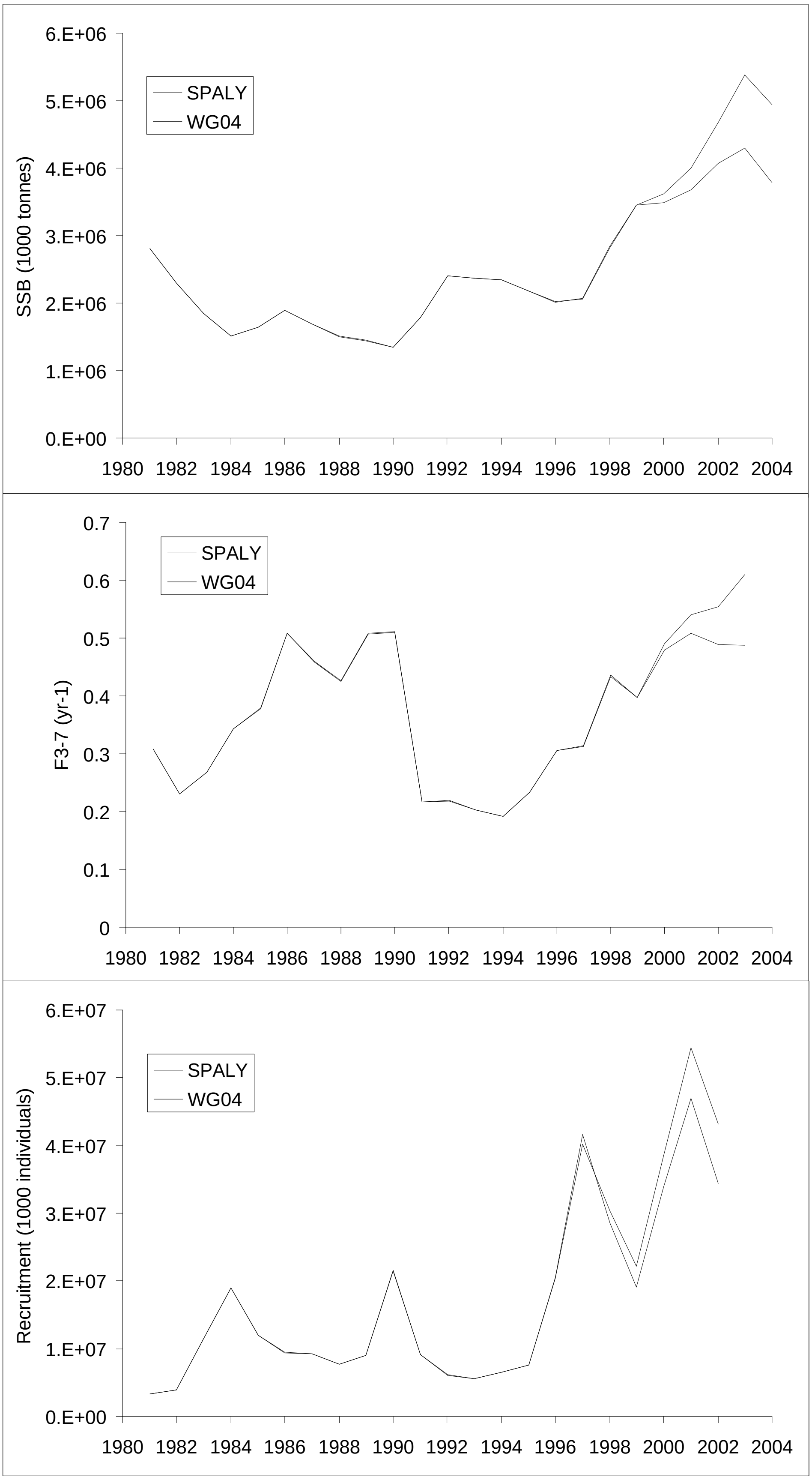


Figure 4.7.2.1. Blue whiting. Comparison of the final AMCI assessment in 2004 and new assessment with the same settings but updated data (SPALY: the same procedure as the last year).

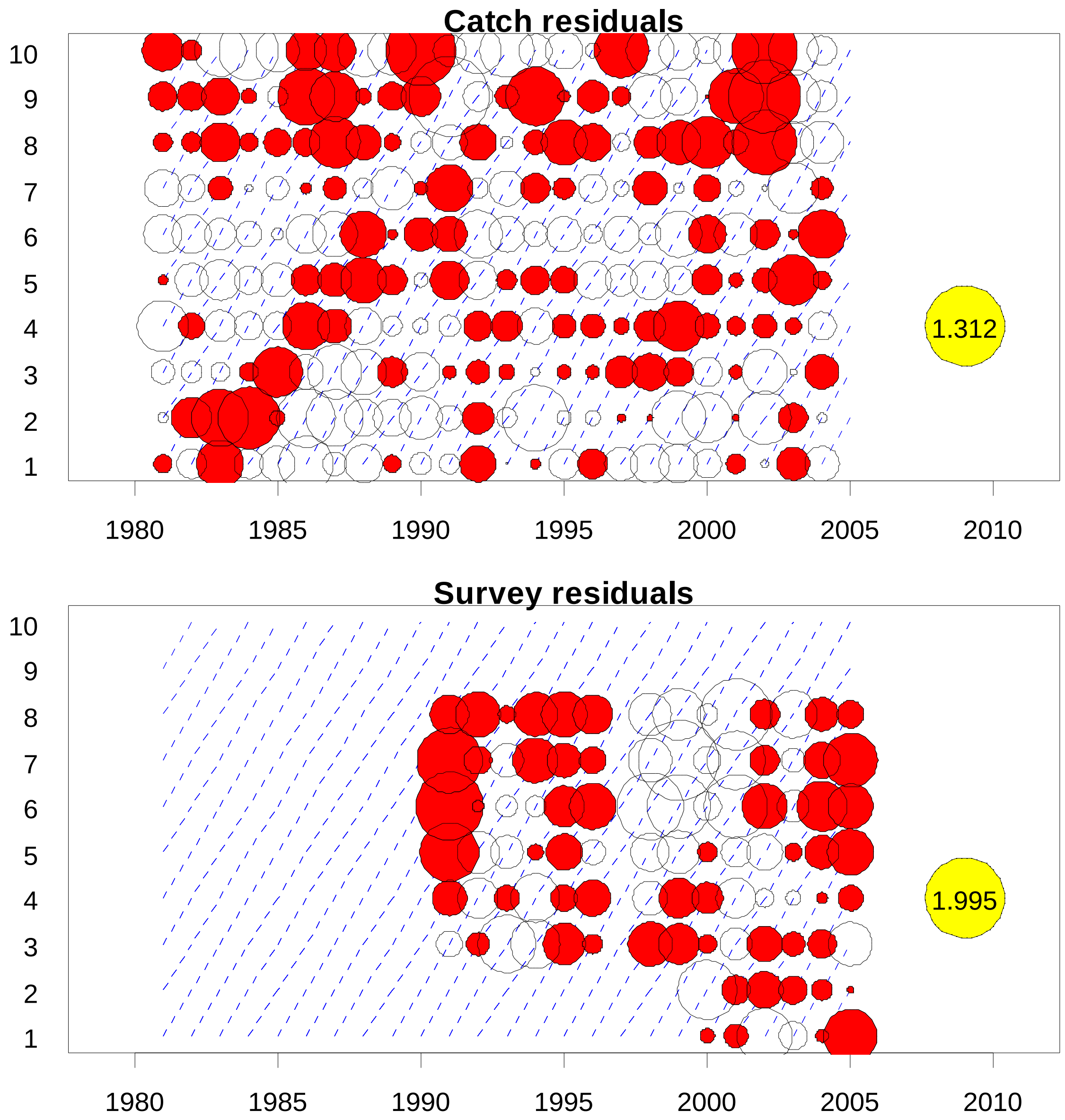


Figure 4.7.2.2. Blue whiting. Residuals from the final AMCI run. In the lower panel, residuals from two surveys are plotted in the same figure: Norwegian spawning stock survey (ages 3- 8 years) and international May survey (ages 1- 2 years).

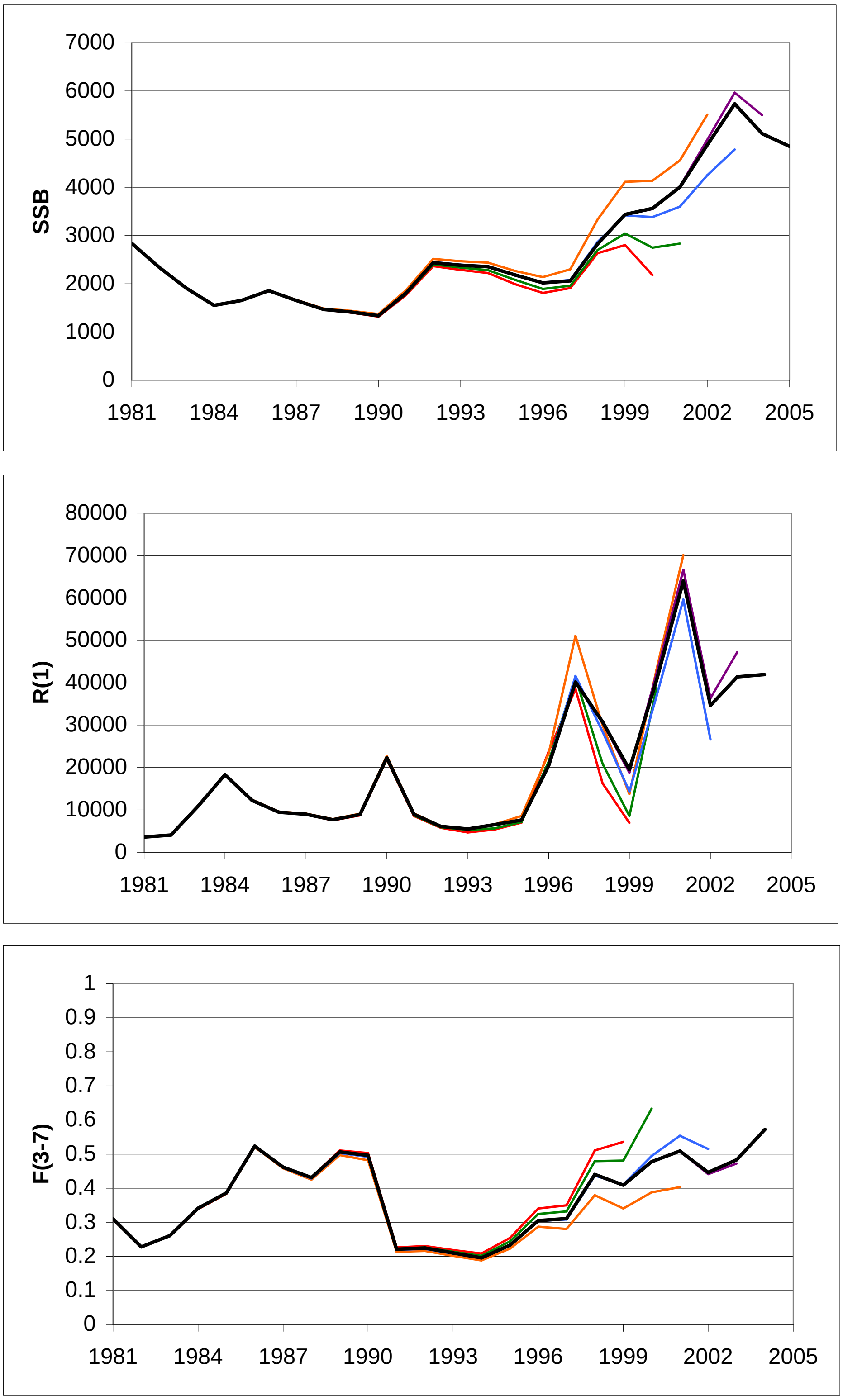


Figure 4.7.2.3. Blue whiting. Retrospective analysis on the final AMCI assessment. The terminal year is varied from 2000 to 2005.

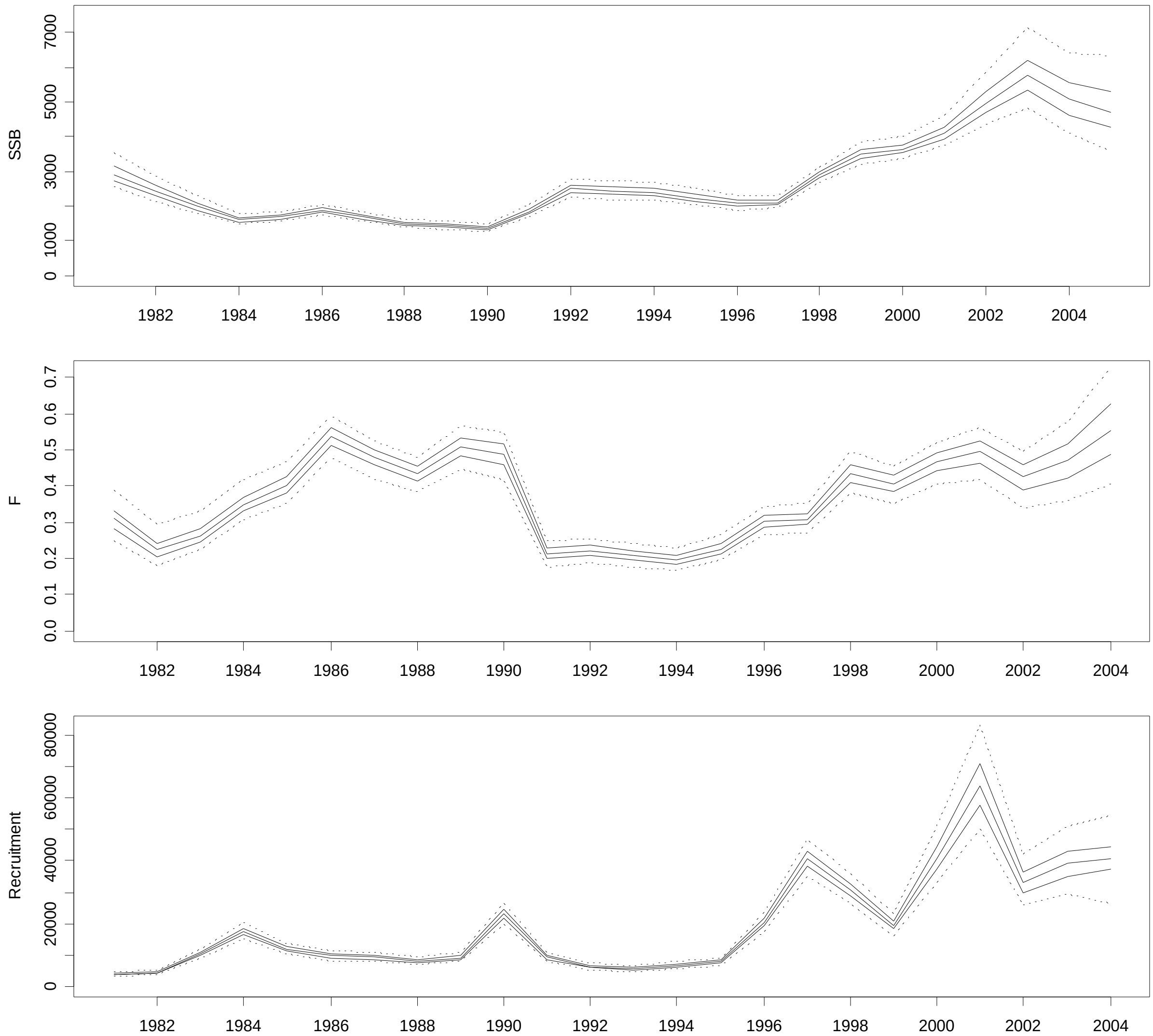


Figure 4.7.2.4. Blue whiting. Results from bootstrapping the final AMCI assessment (1000 replicates).

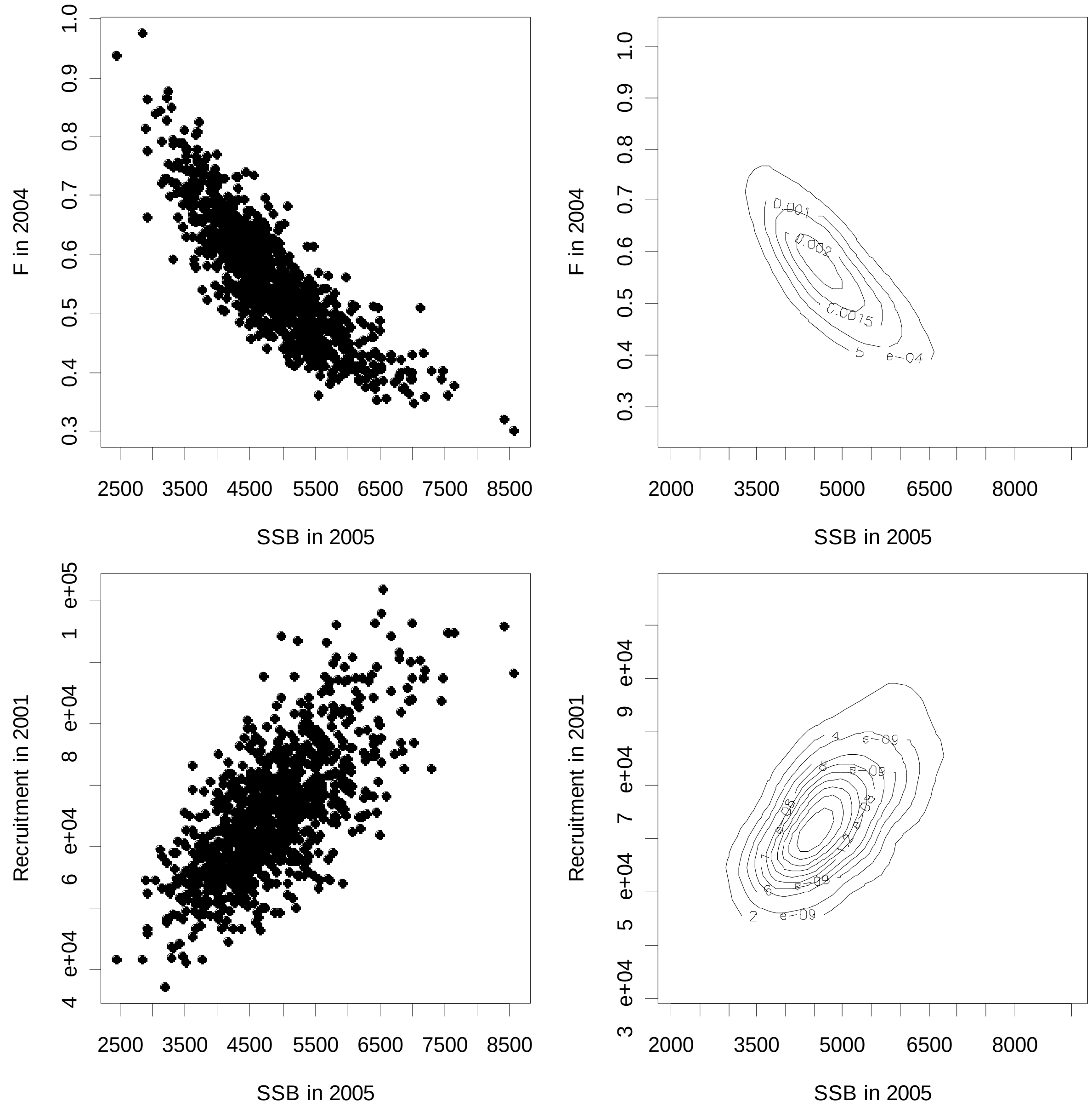


Figure 4.7.2.5. Blue whiting. Results from bootstrapping the final AMCI assessment (1000 replicates). These graphs show interdependence between the estimate of fishing mortality in the final year and SSB in the end of the final year. SSB in the end of the final year is also strongly correlated with recruitment in 2001.

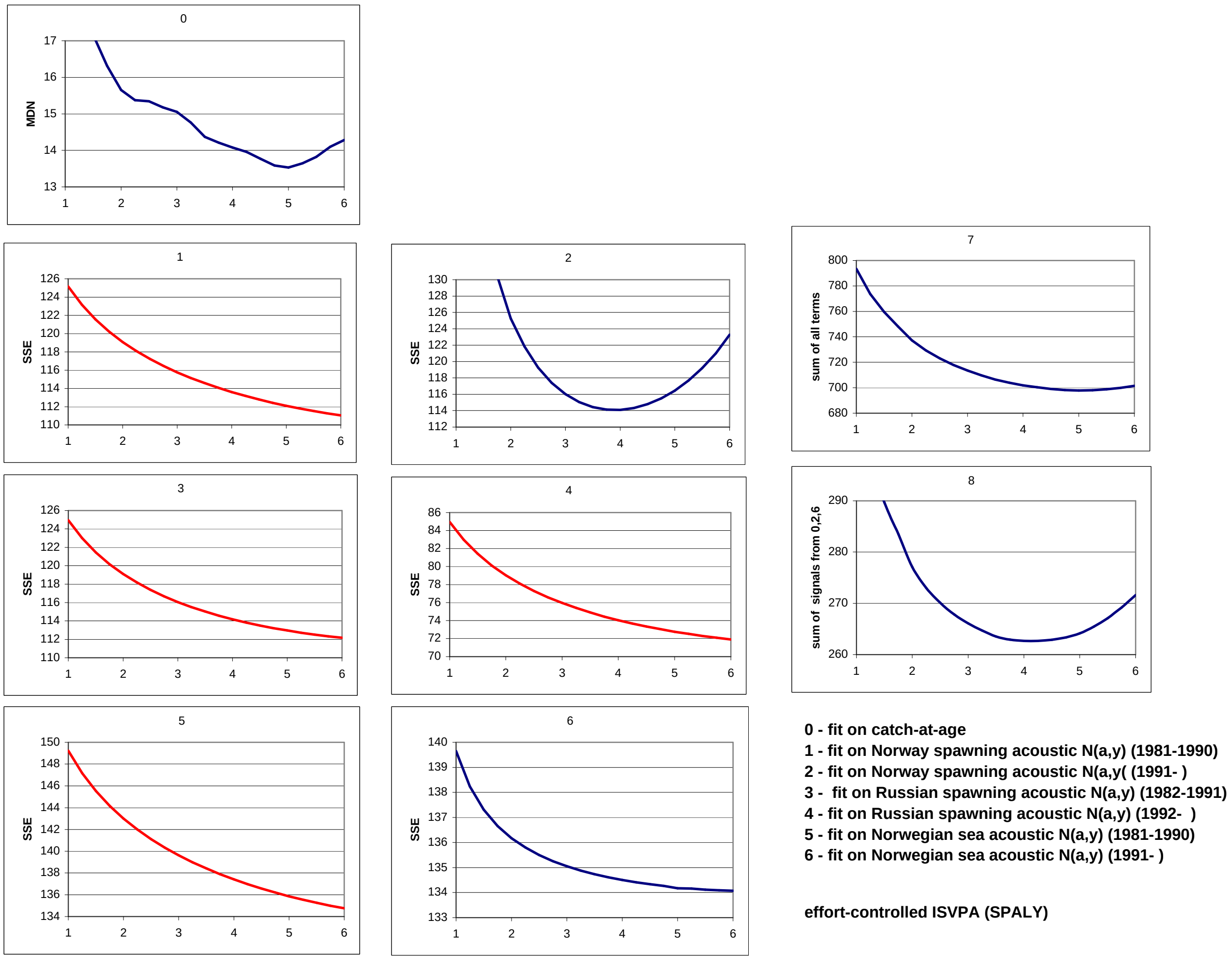


Figure 4.7.3.1 Blue whiting. ISVPA effort-controlled version.

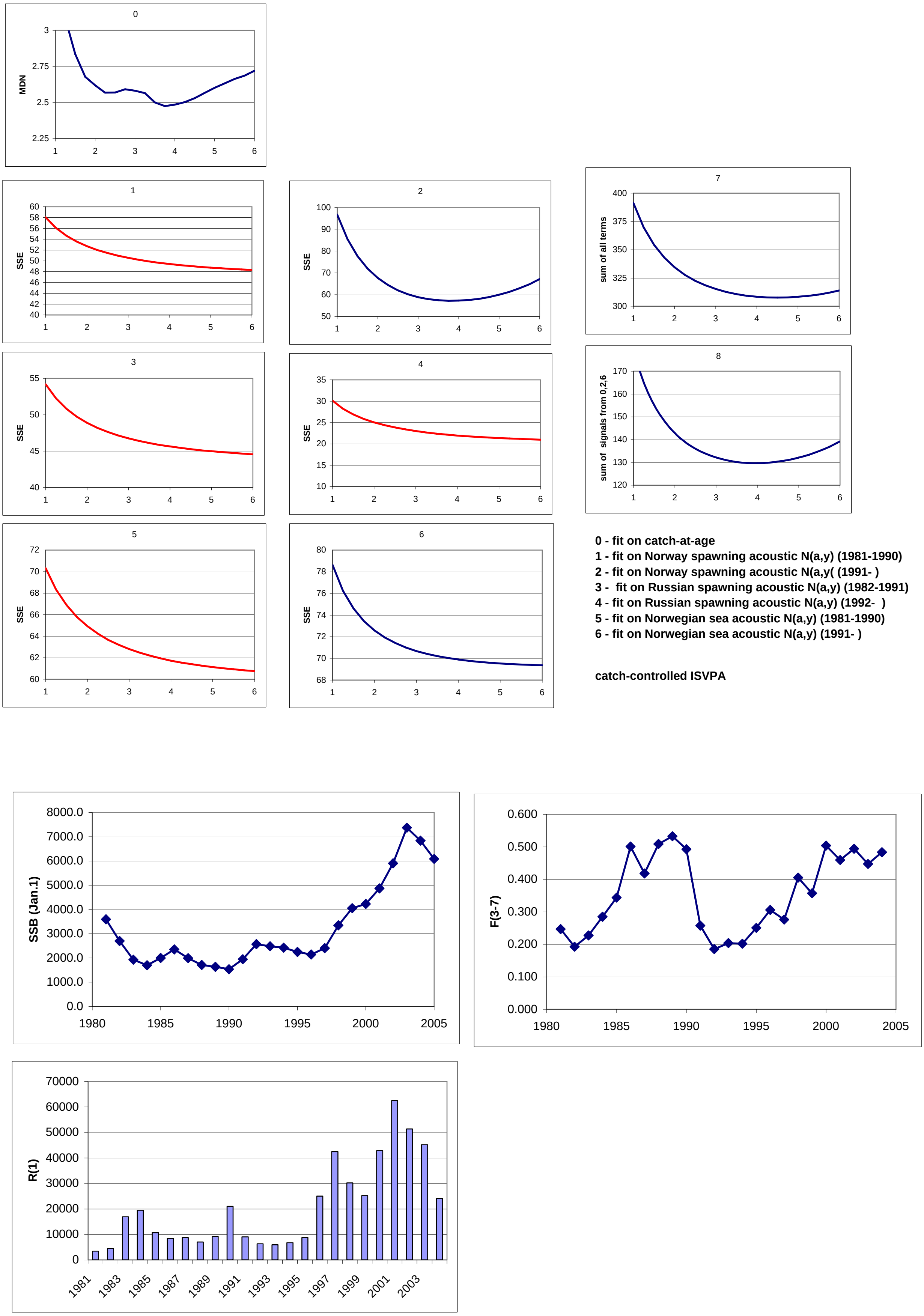
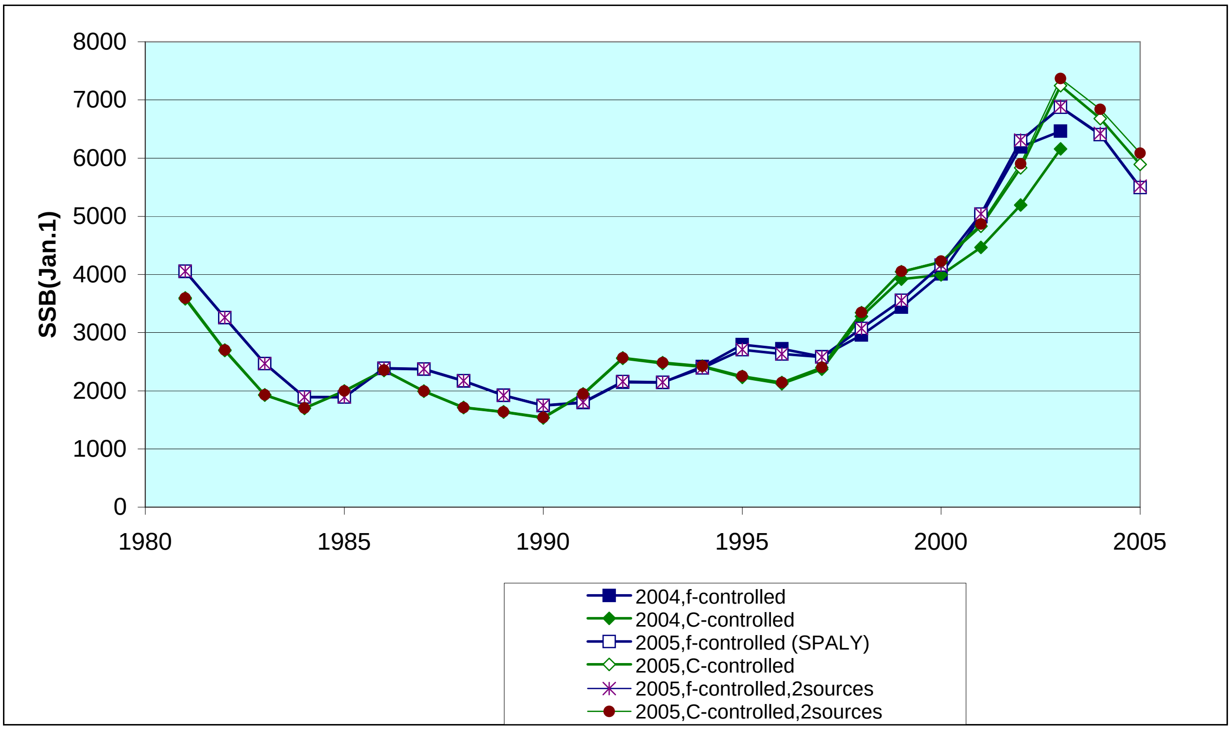


Figure 4.7.3.2 Blue whiting. ISVPA, catch-controlled version, 2 sources of information.



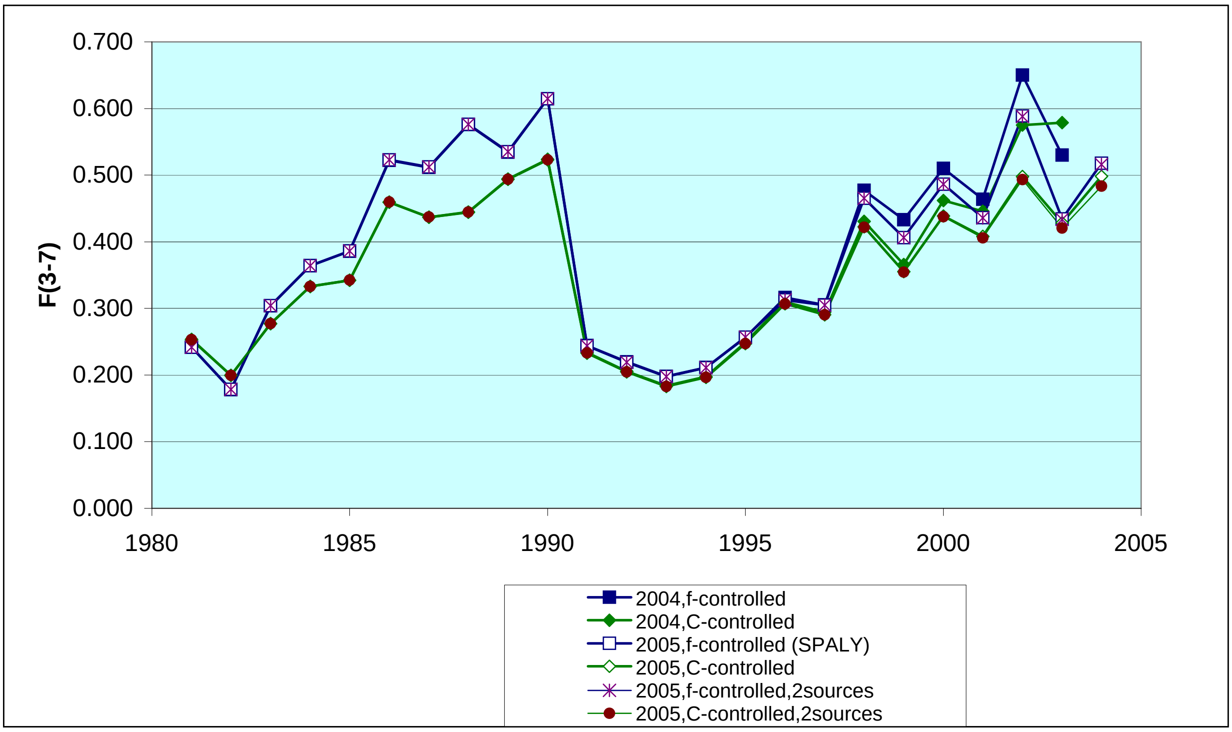


Figure 4.7.3.3 Blue whiting. Comparison of ISVPA-derived estimates in 2004 and 2005 assessments.

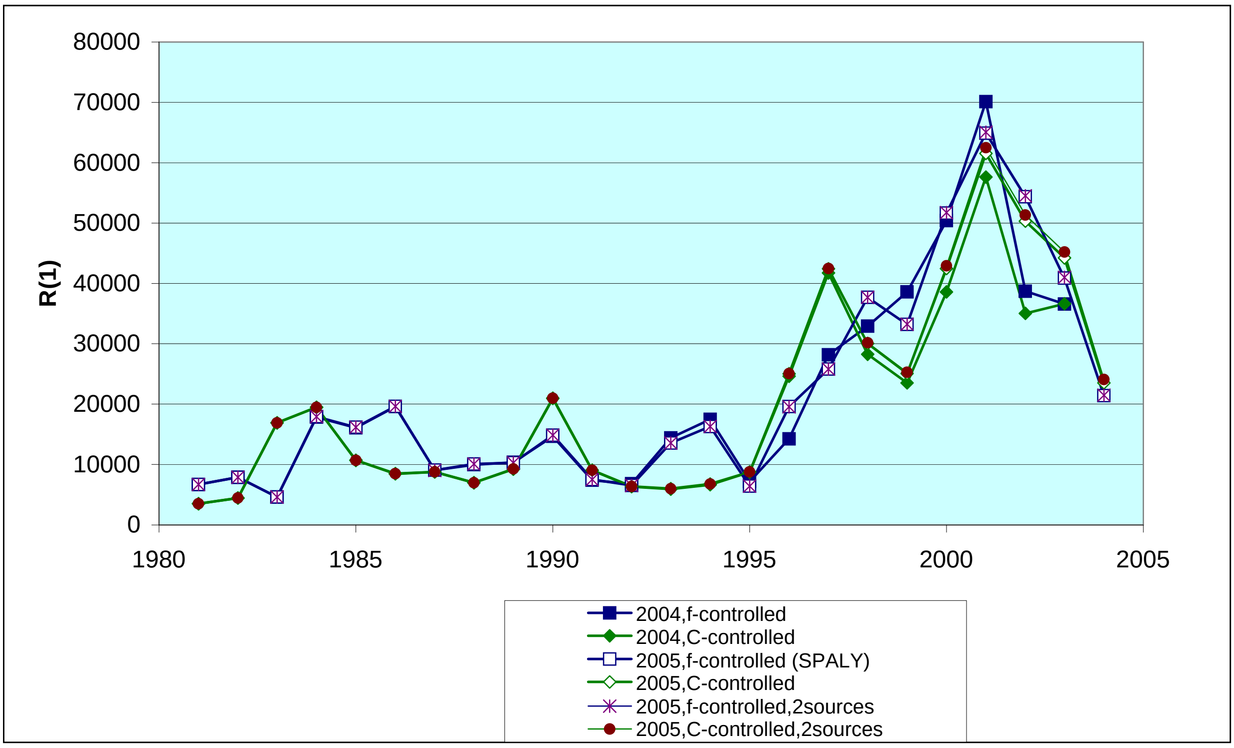
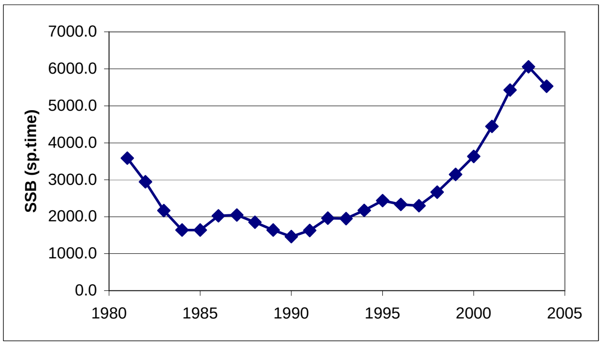
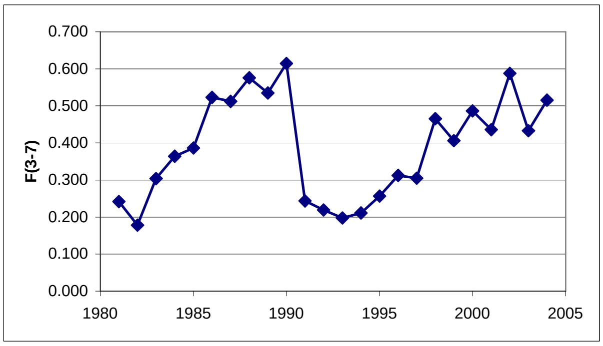
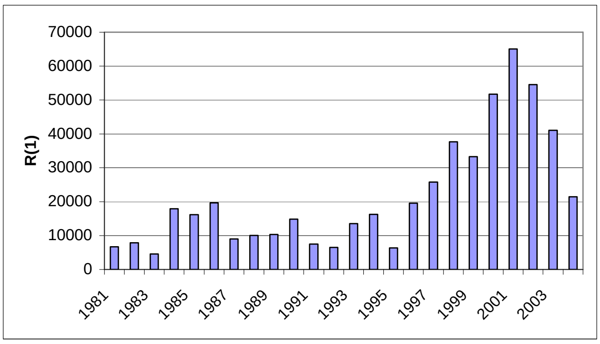


Figure 4.7.3.4 Blue whiting. Results of ISVPA stock assessment (effort-controlled version, 2 sources of information (catch-at-age and second part of Norwegian spawning acoustic surveys)







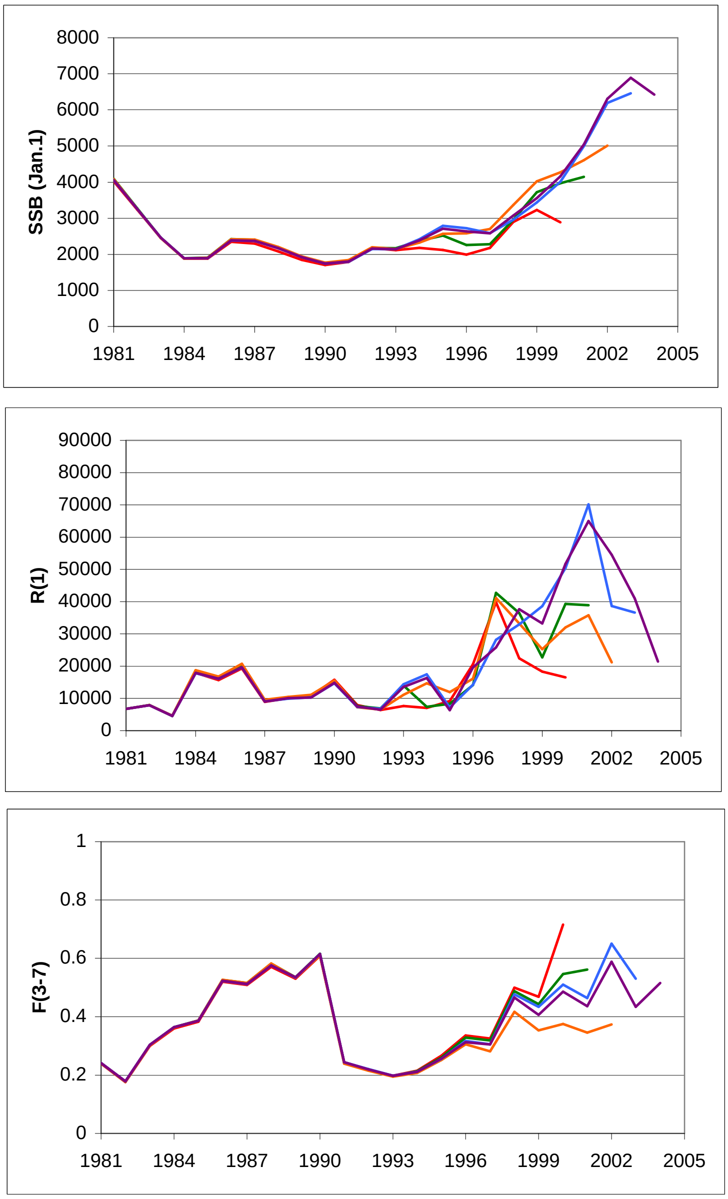


Figure 4.7.3.5 Blue whiting, ISVPA, retrospective runs

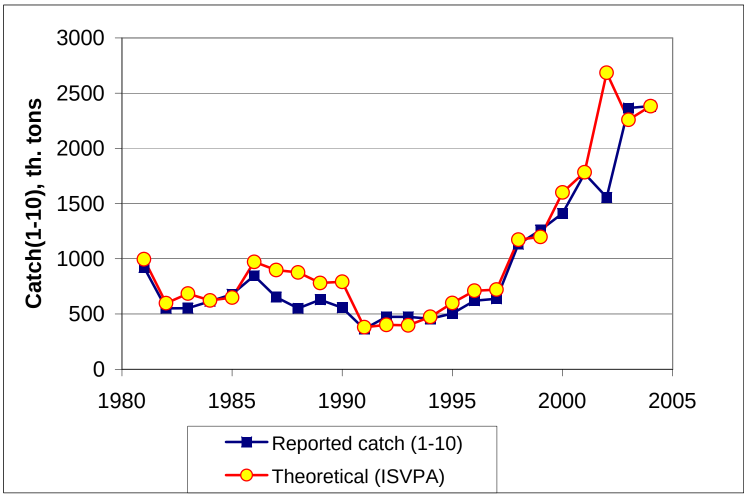


Figure 4.7.3.6 Blue whiting. Comparison of reported and theoretical (ISVPA-derived) catches in weight for age groups 1-10+.

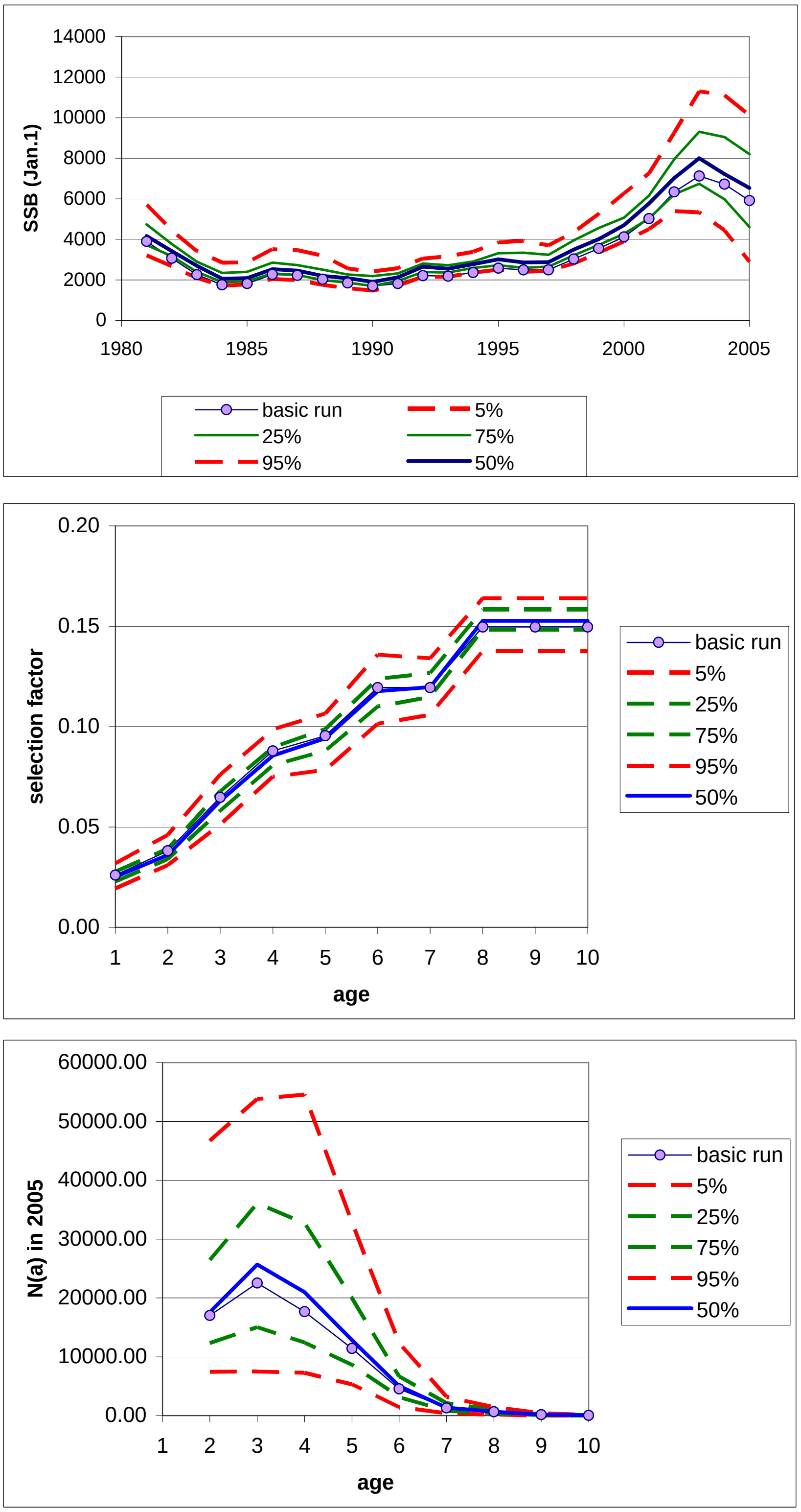
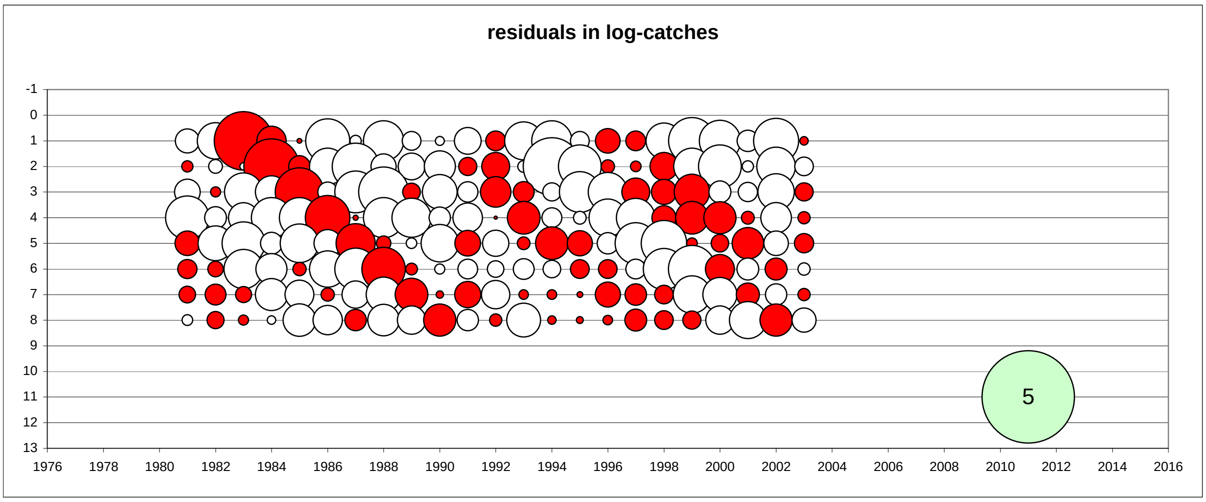


Figure 4.7.3.7 Blue whiting, ISVPA, bootstrap



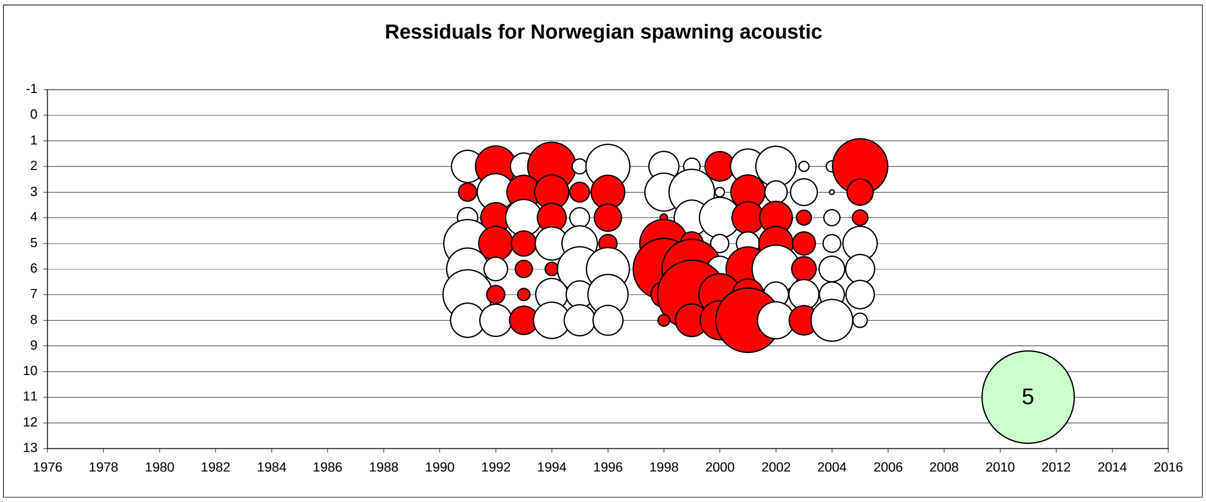


Figure 4.7.3.8 Blue whiting. Residuals in catch-at-age and surveys (ISVPA derived)

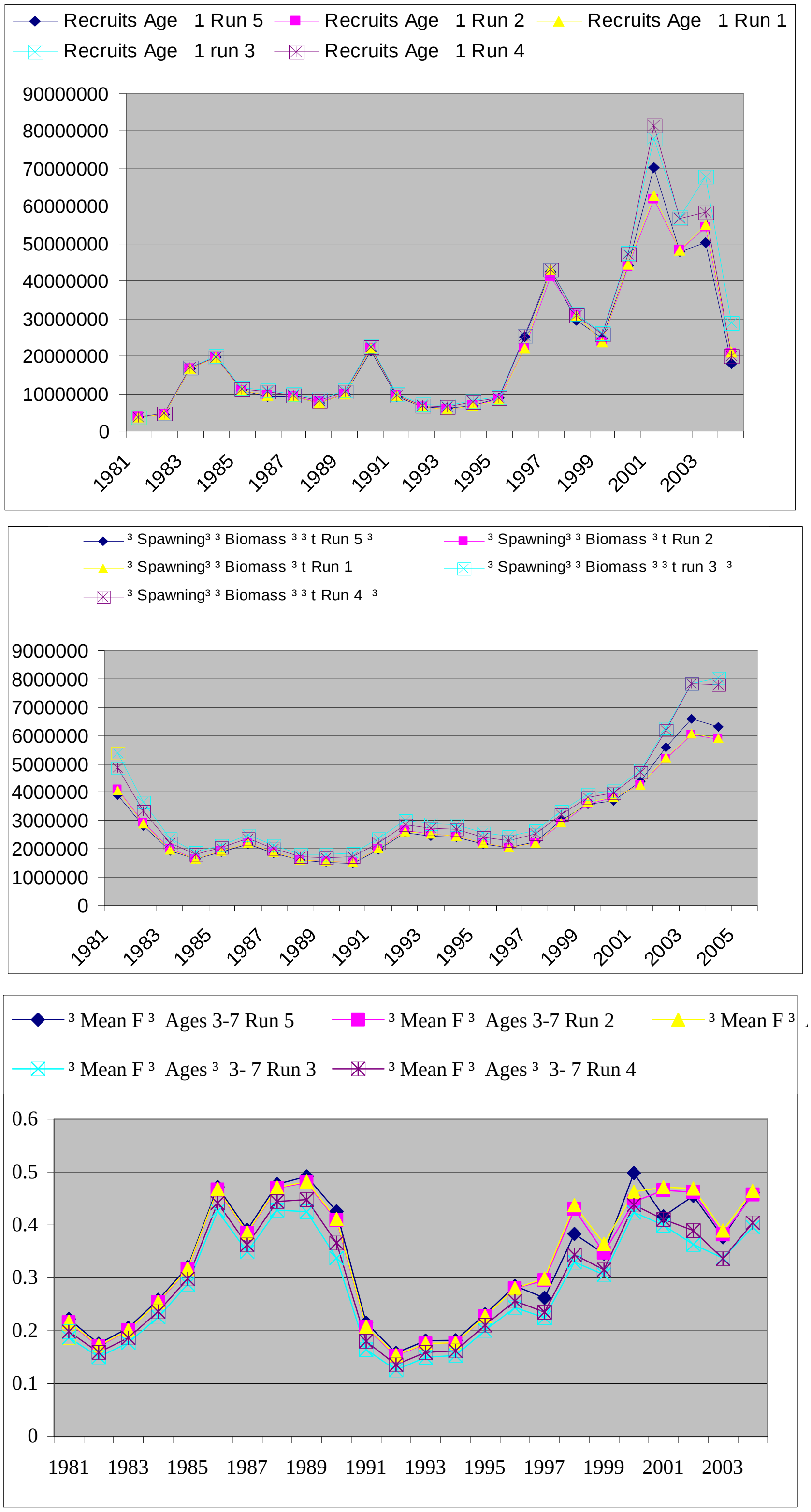


Figure 4.7.4.1 Blue whiting. Comparison of 5 runs of ICA by WG in 2005. Run 2 is the final run.

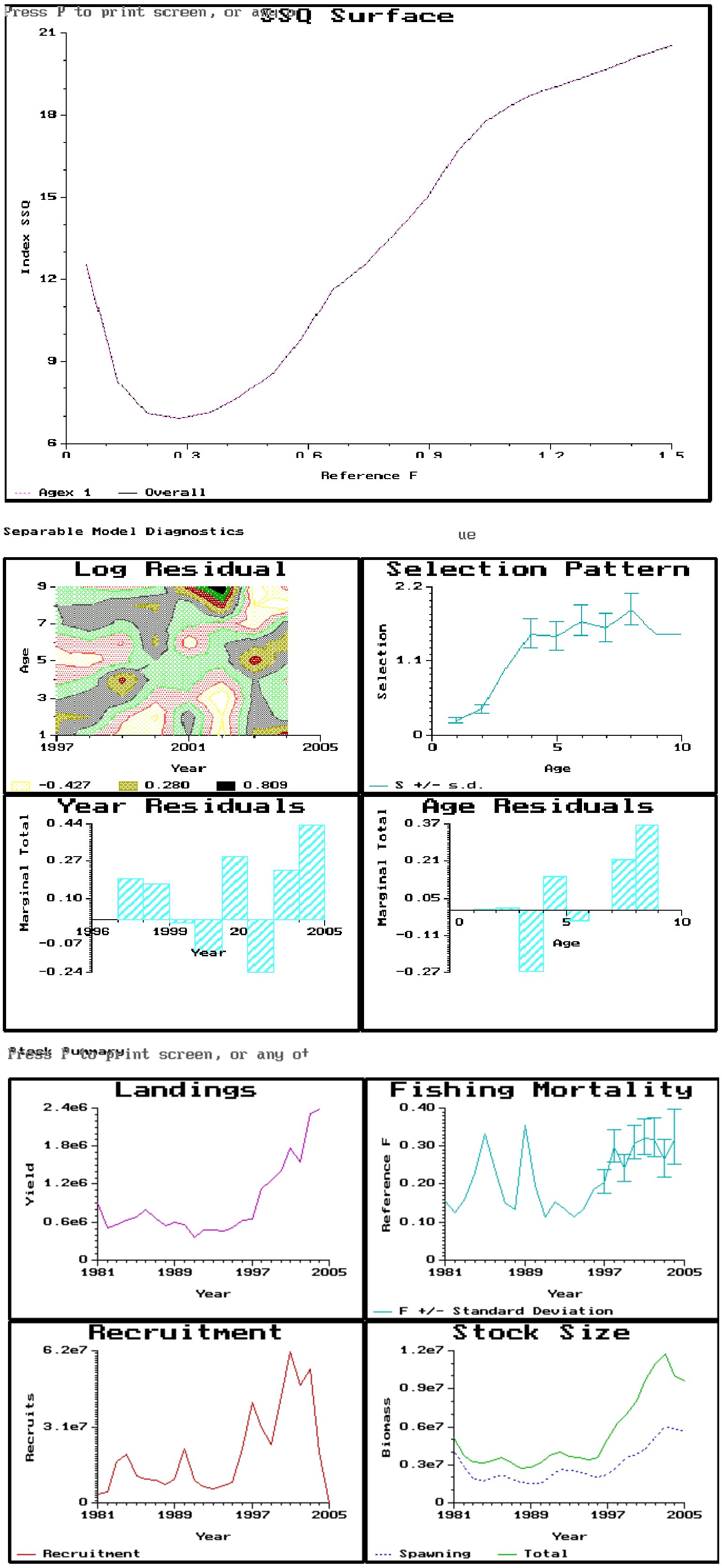


Figure 4.7.4.2. SSq surface plot, catch residuals and selection pattern, and standard plots for final ICA run for blue whiting in 2004.

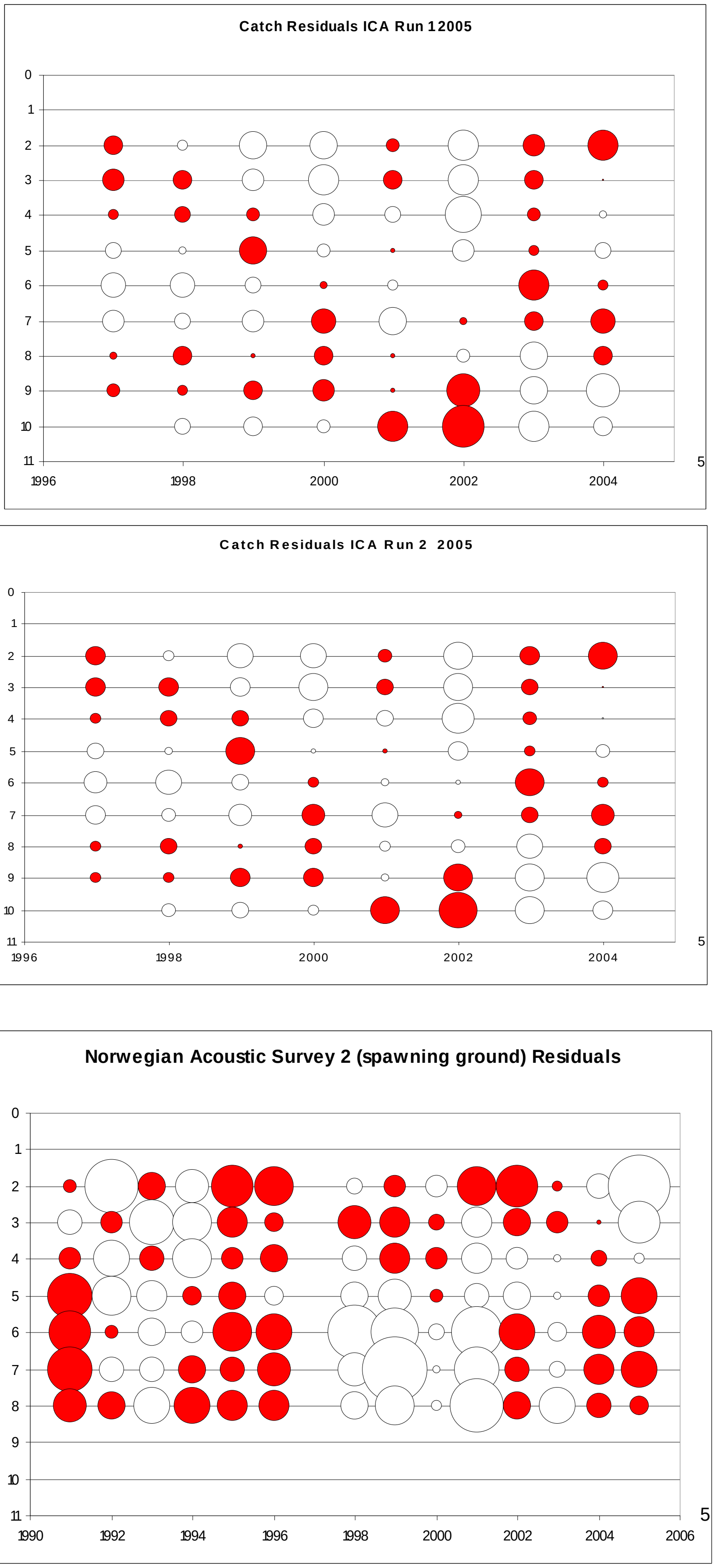


Figure 4.7.4.3. Residual plots for catches and survey for blue whiting, final run 2 WG 2005.

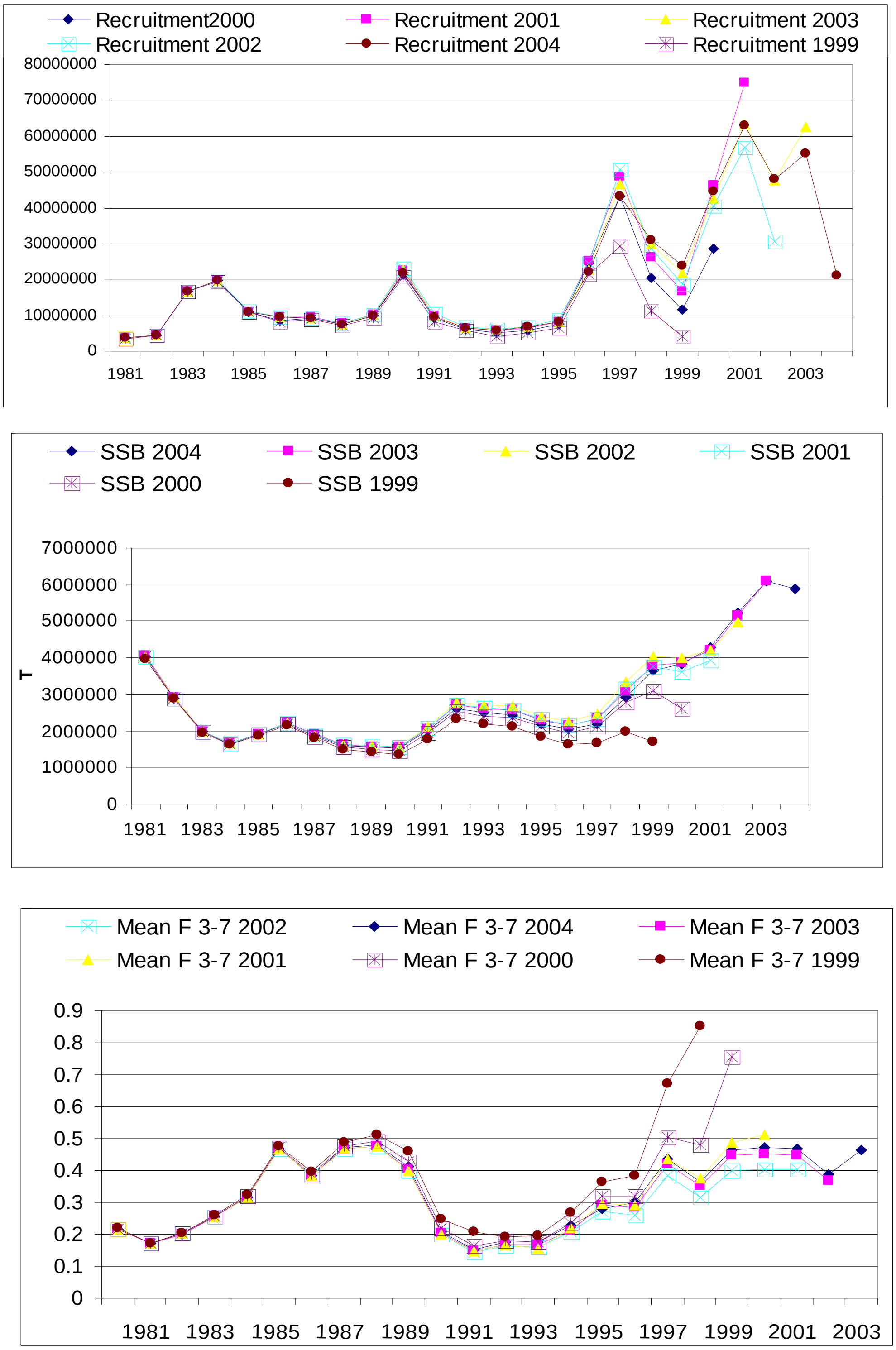
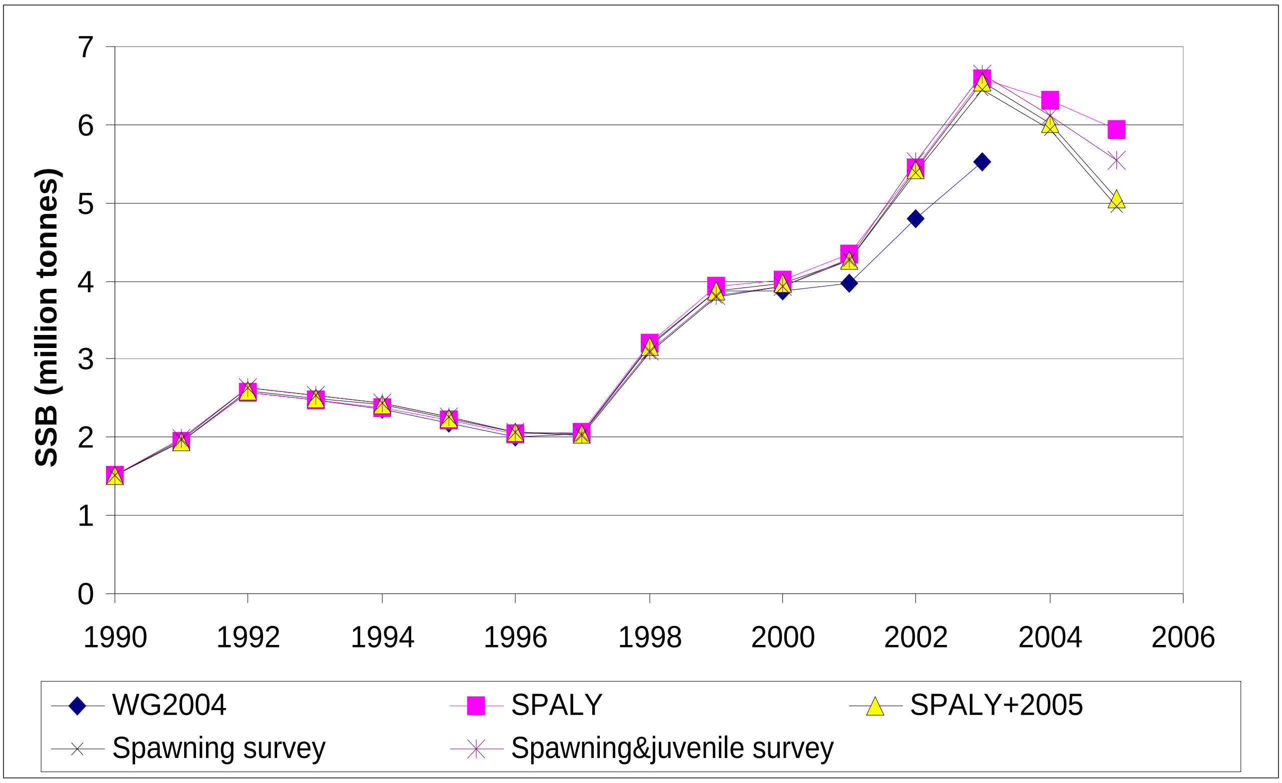


Figure 4.7.4.4. Blue whiting. Retrospective ICA runs to 2000 using settings for final run 2005



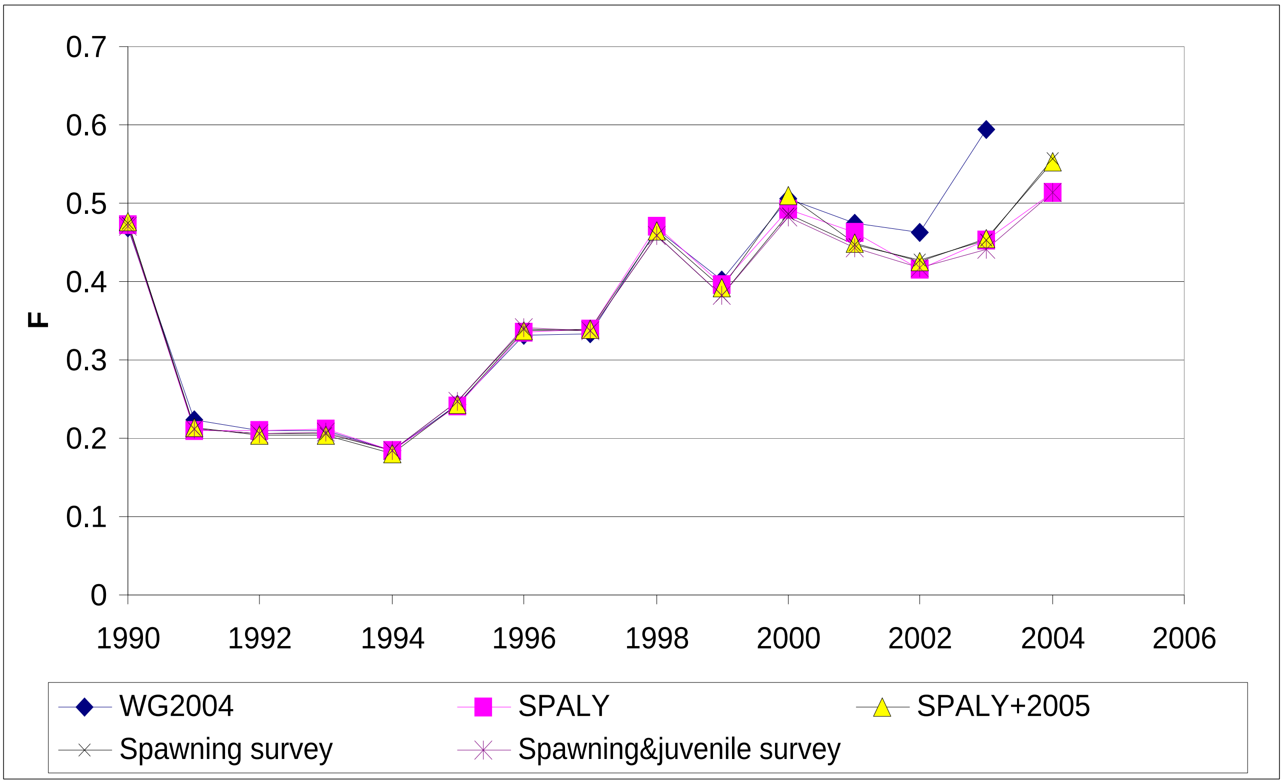


Figure 4.7.5.1 Blue Whiting, SMS exploratory run. Model comparison, SSB and fishing mortality. SSB for 2005 does not include contributions from age 1.

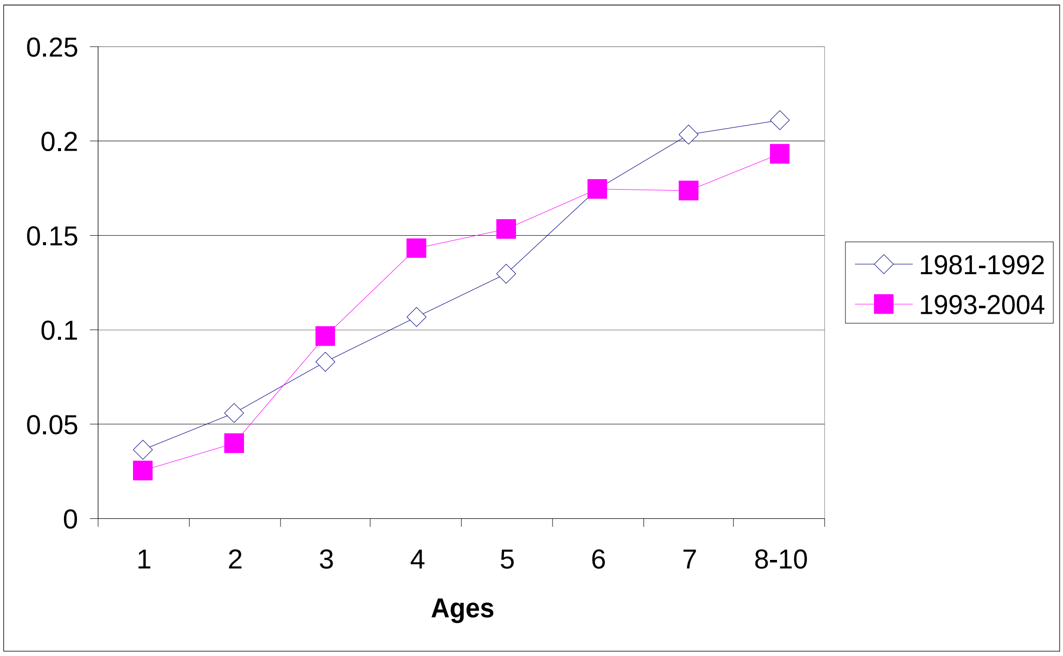


Figure 4.7.5.2 **Blue Whiting, SMS exploratory run, Selection pattern for blue whiting (each series is normalized to 1)**

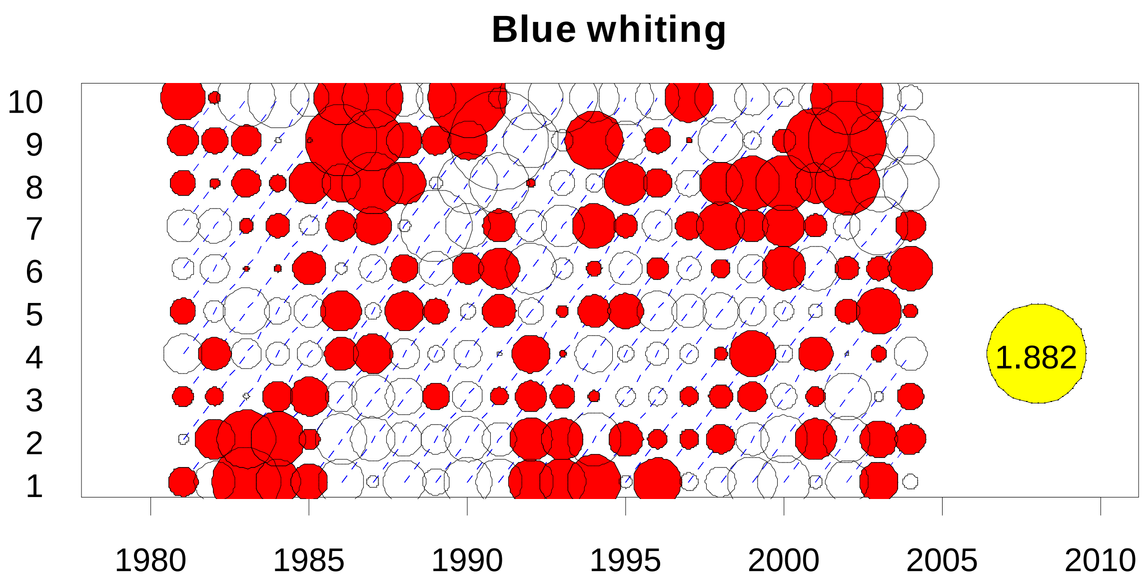


Figure 4.7.5.3 **Blue Whiting, SMS exploratory run, Residuals for catch observations. Red (dark) bubbles show that the observed value is bigger than the expected value.**

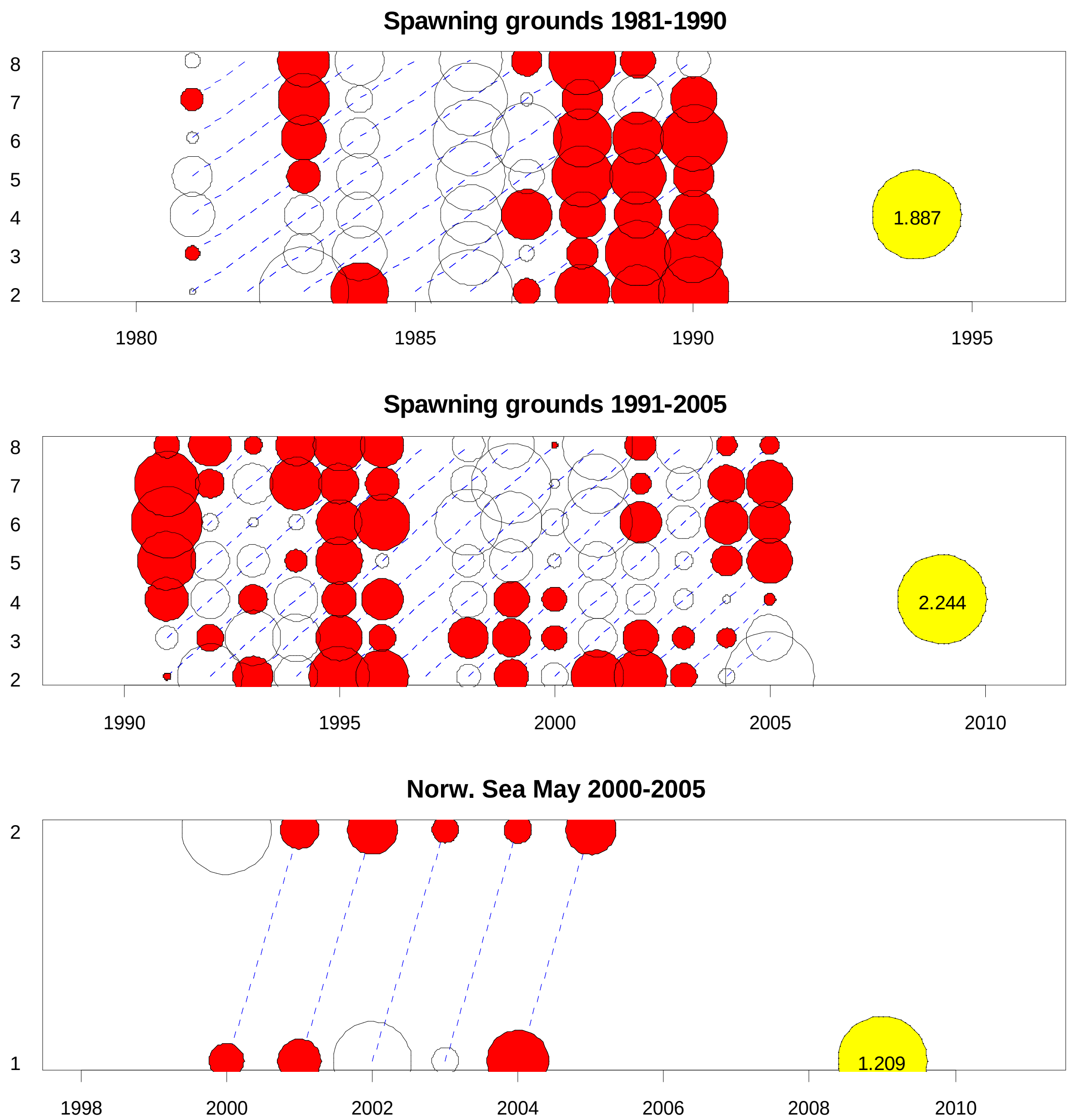


Figure 4.7.5.4 Blue Whiting, SMS exploratory run, Residuals for survey observations. Red (dark) bubbles show that the observed value is bigger than the expected value

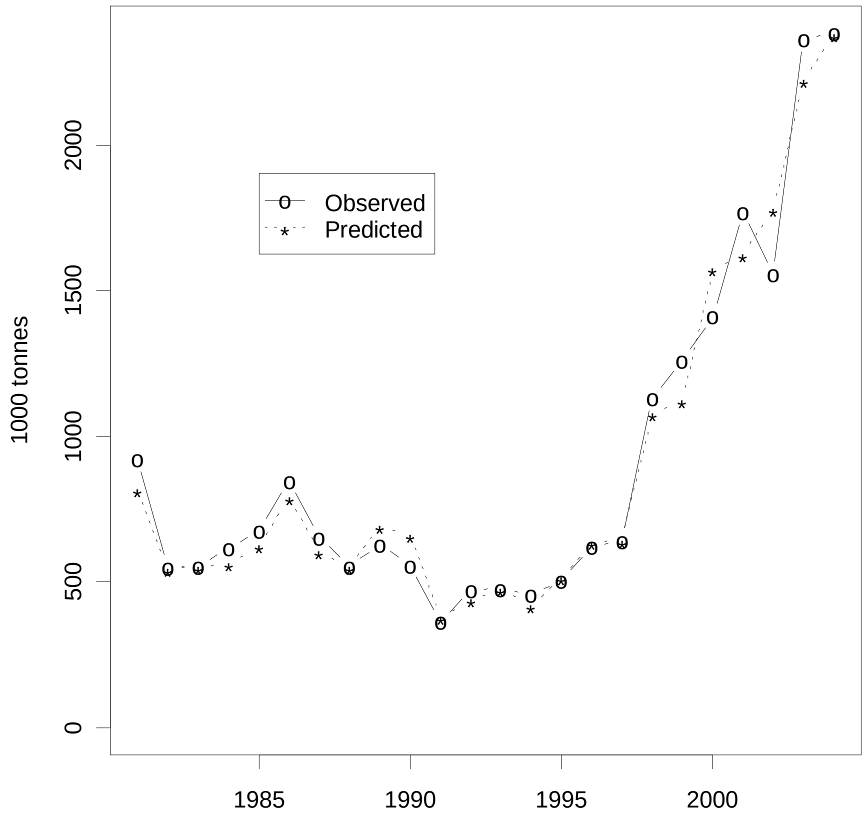
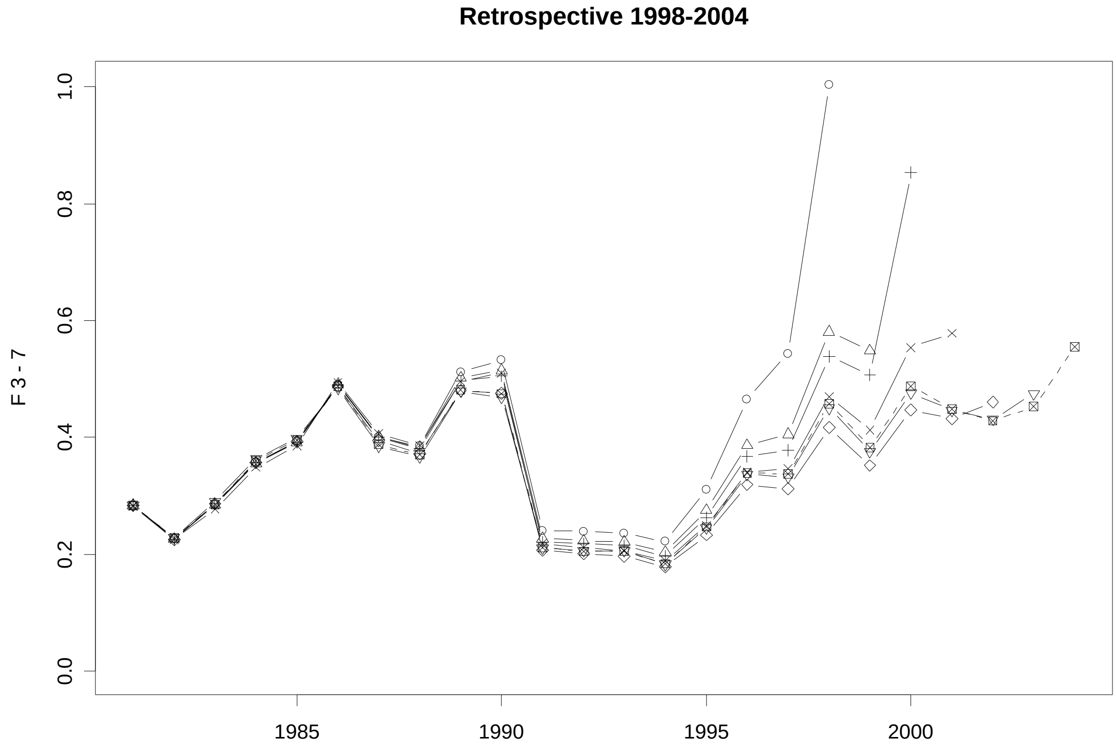


Figure 4.7.5.5 Blue Whiting, SMS exploratory run, Observed and predicted Yield



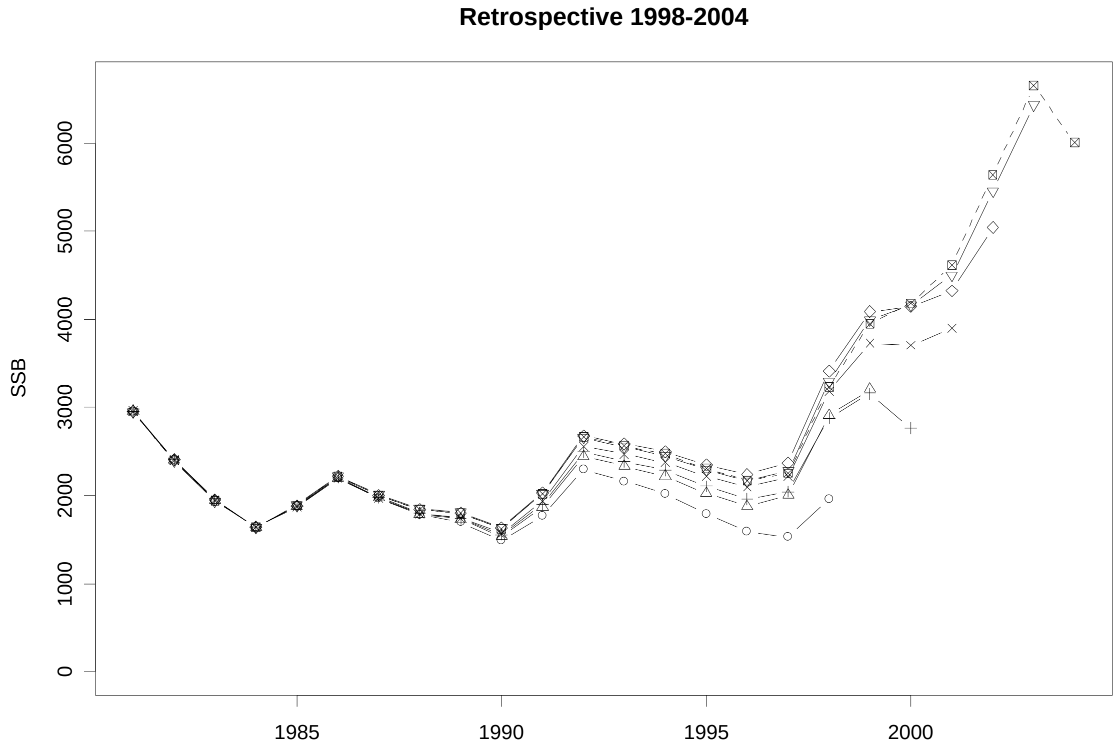


Figure 4.7.5.6 Blue Whiting, SMS exploratory run, Retrospective pattern of F and SSB

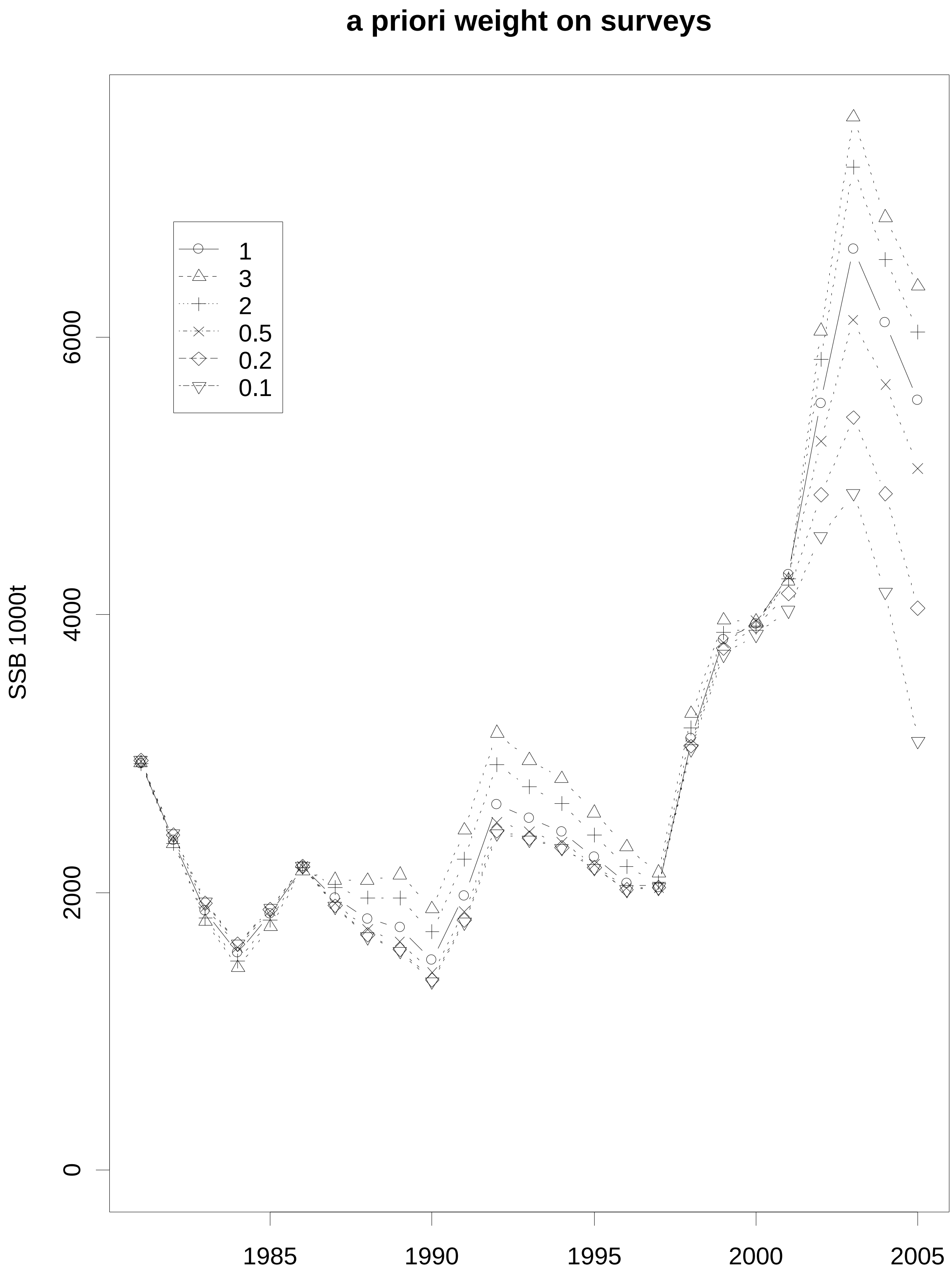


Figure 4.7.5.7 Blue Whiting, SMS exploratory run. Effect on estimated SSB of varying a priori weight on survey observations. A priori weight on catch observations are kept constant at 1.0. SSB in 2005 does not include contributions from the age 1.

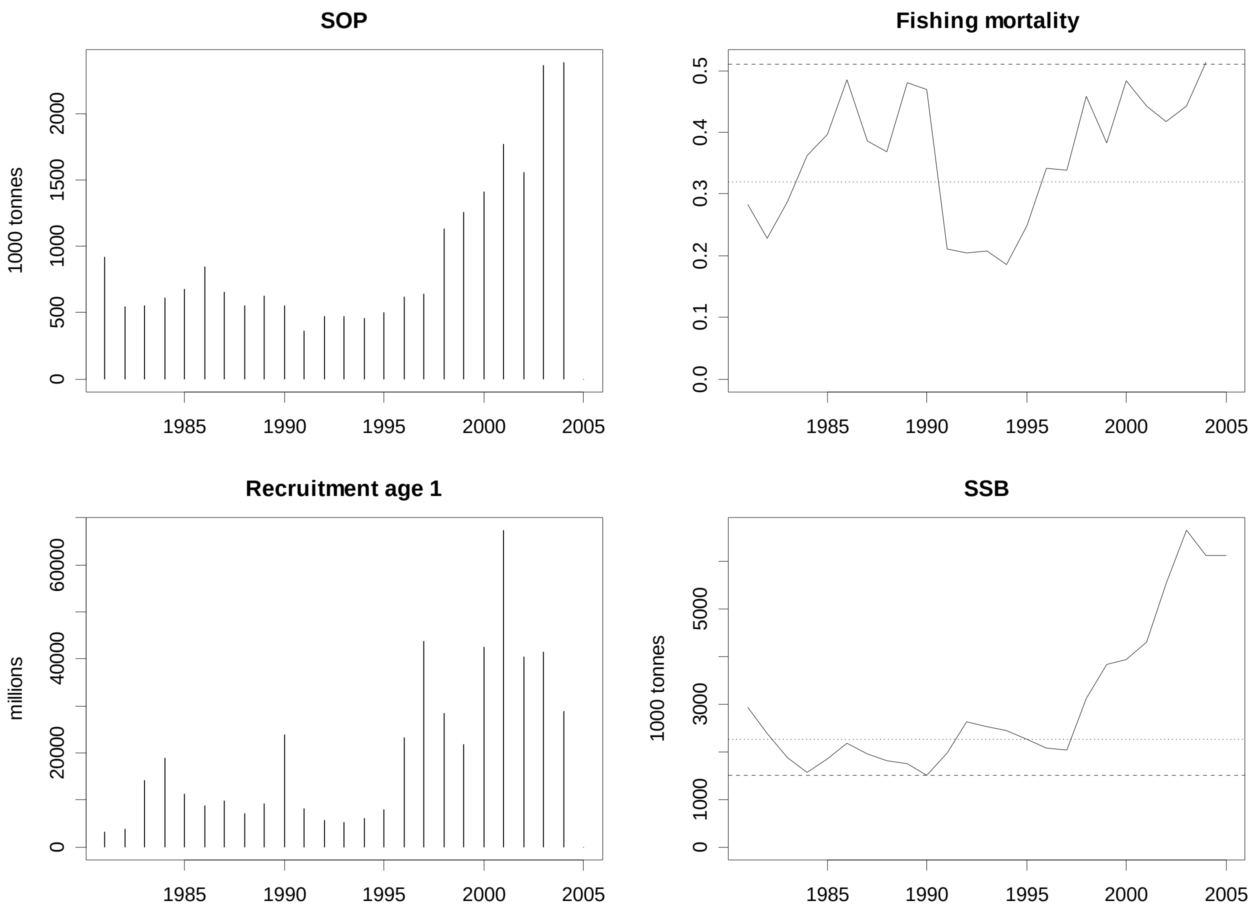


Figure 4.7.5.8 Blue Whiting, SMS. Stock summary, 1981-2005. For the calculation of SSB in 2005 an recruitment at 43.7*10^9 is assumed.

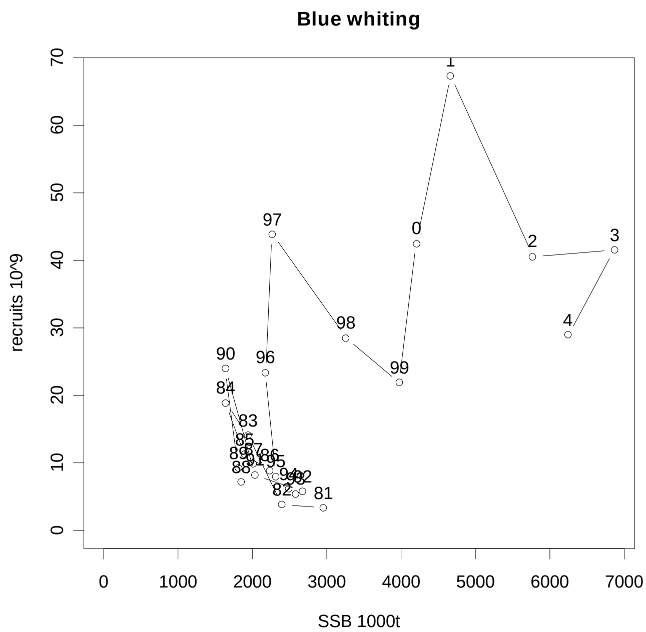


Figure 4.7.5.9 Blue Whiting, SMS. SSB-recruit plot

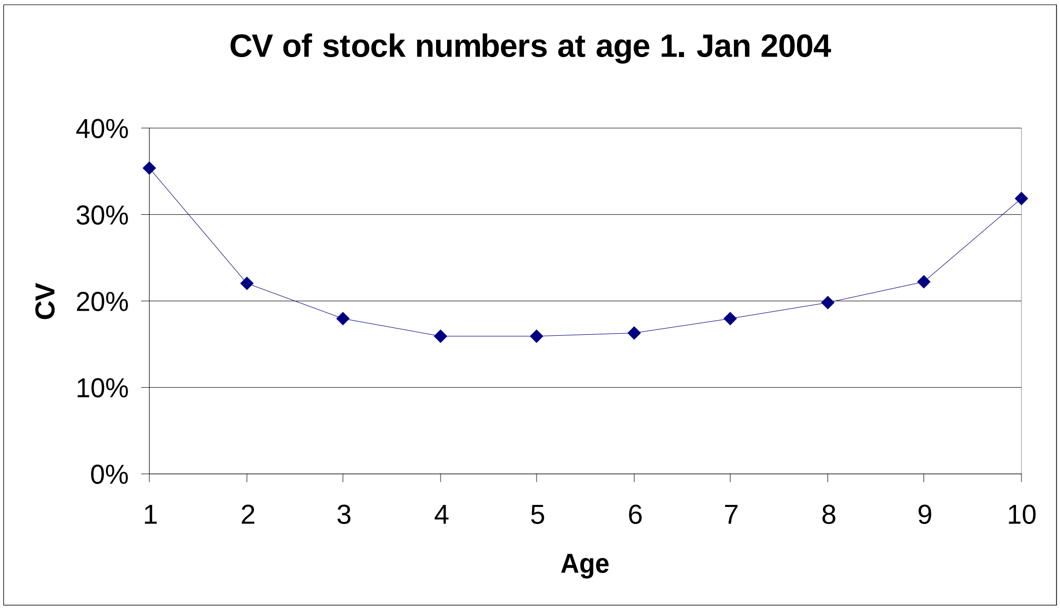


Figure 4.7.5.10 Blue Whiting, SMS. Estimated uncertainties on stock numbers.

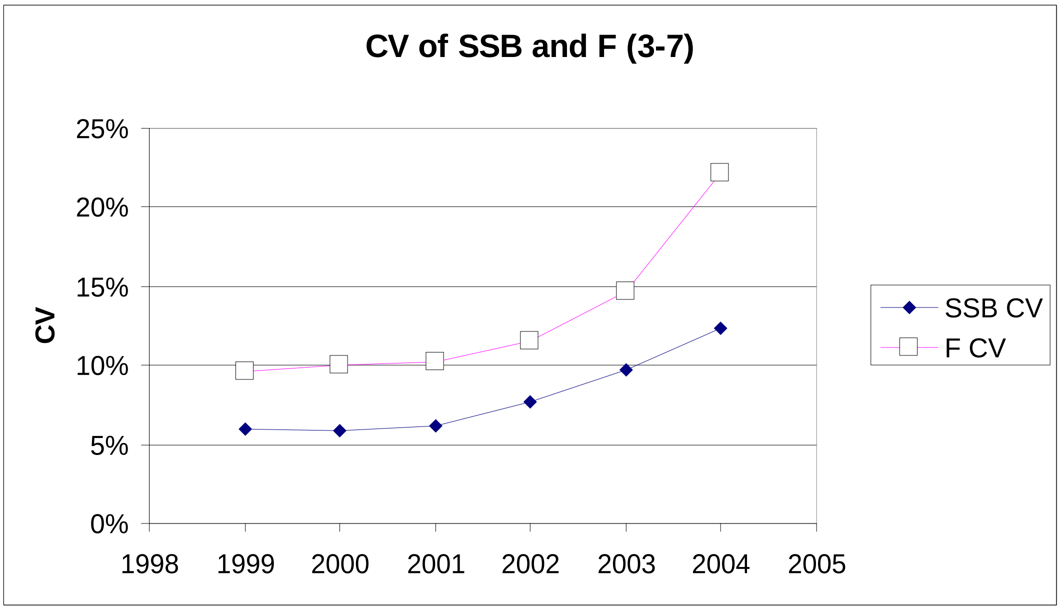


Figure 4.7.5.11 Blue Whiting, SMS. Estimated uncertainties on F and SSB.

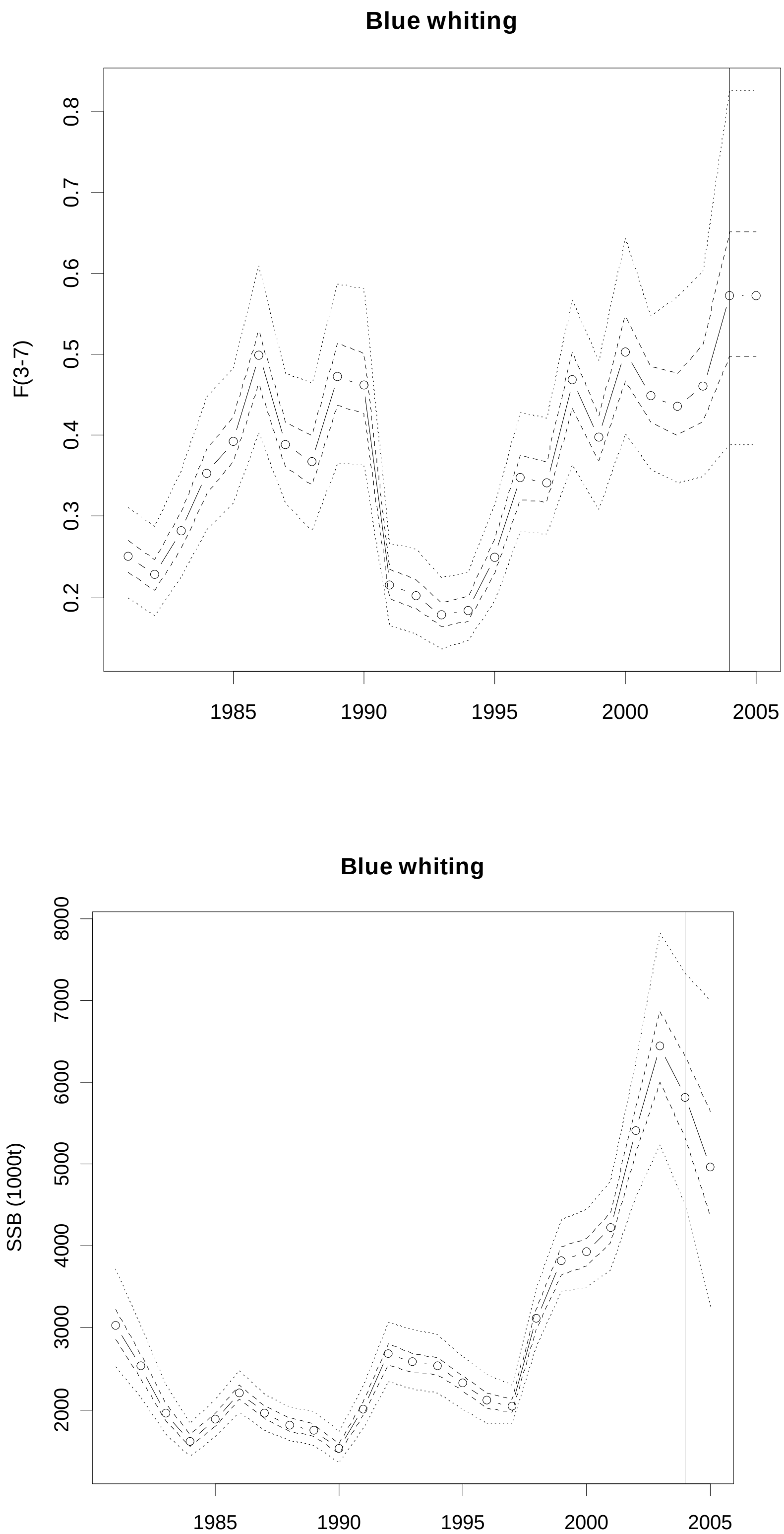


Figure 4.7.5.12 Blue Whiting, SMS. Posterior density (2.5, 25, 50, 75 and 97.5 percentiles) of average F and SSB estimated from 200000 Markov Chain Monte Carlo simulations. Recruitment in 2005 is assumed as the GM of the full time series.

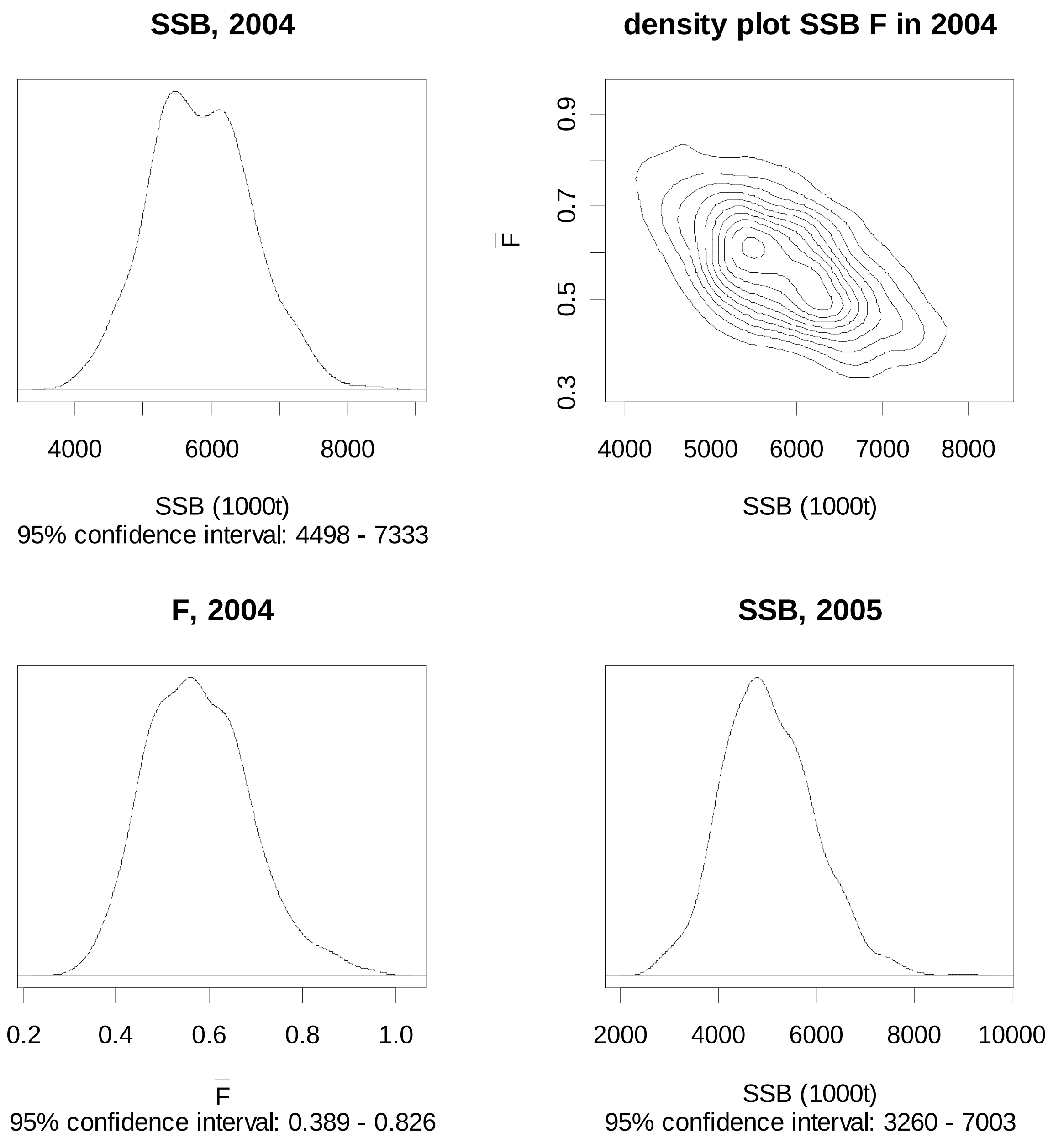


Figure 4.7.5.13 Blue Whiting, SMS. Posterior density of SSB, average F and their simultaneous distribution in the 2004 estimated from 200000 Markov Chain Monte Carlo simulations.

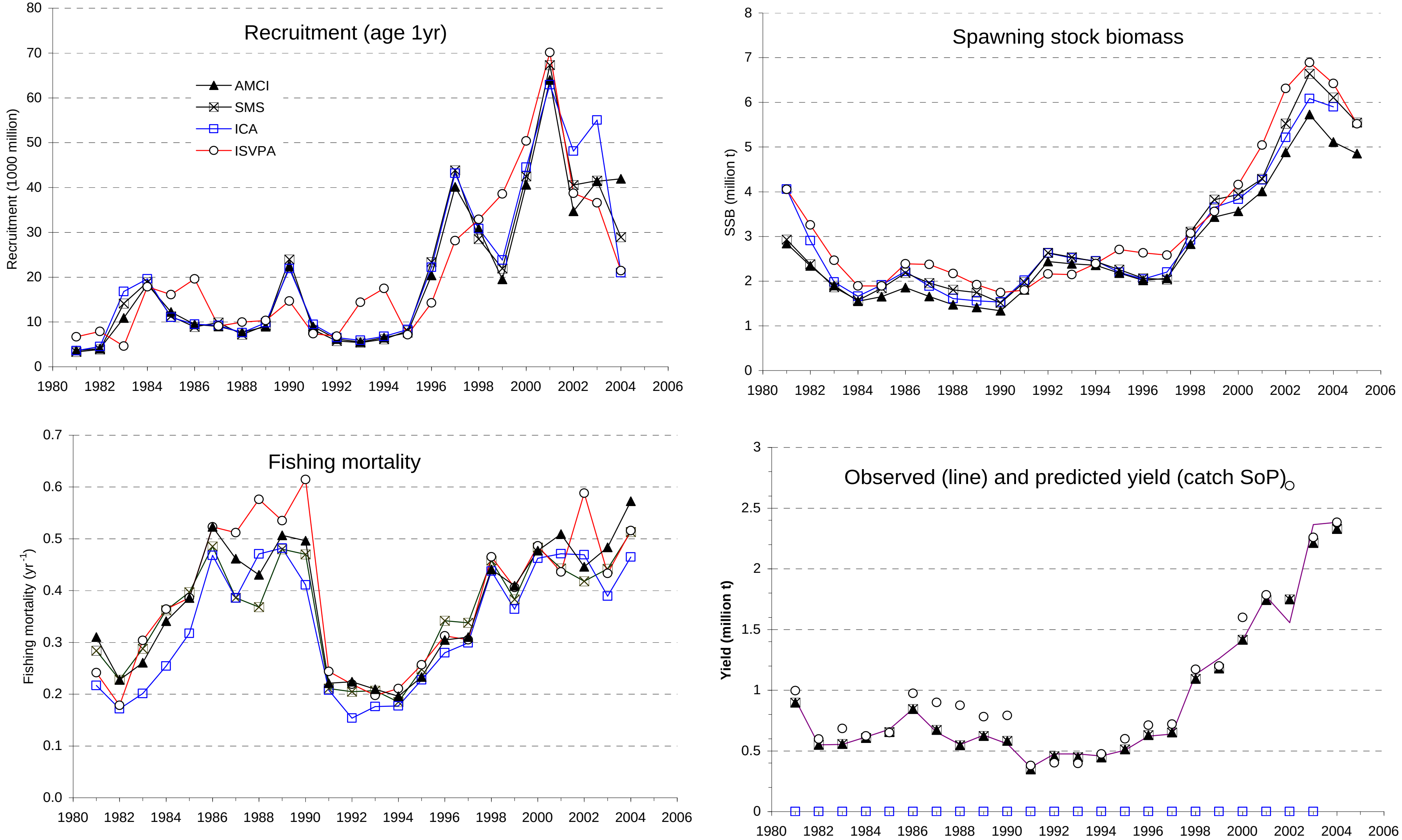


Figure 4.7.6.1. Blue Whiting: Comparisons between final AMCI, ISVPA ICA and SMS assessments.

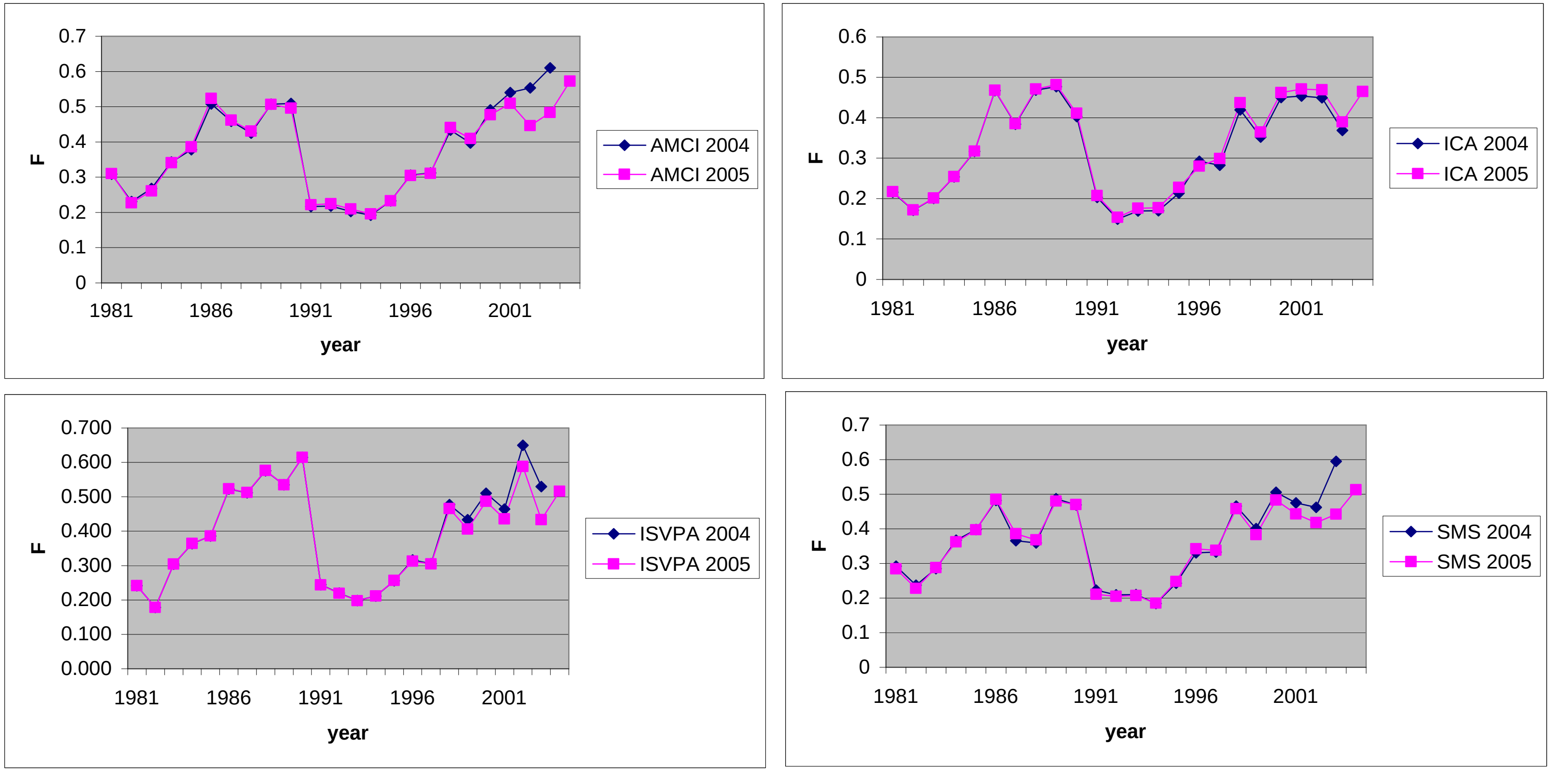


Figure 4.7.6.2 Blue whiting Comparison of F estimated by different tuning methods in WG 2004 and WG 2005

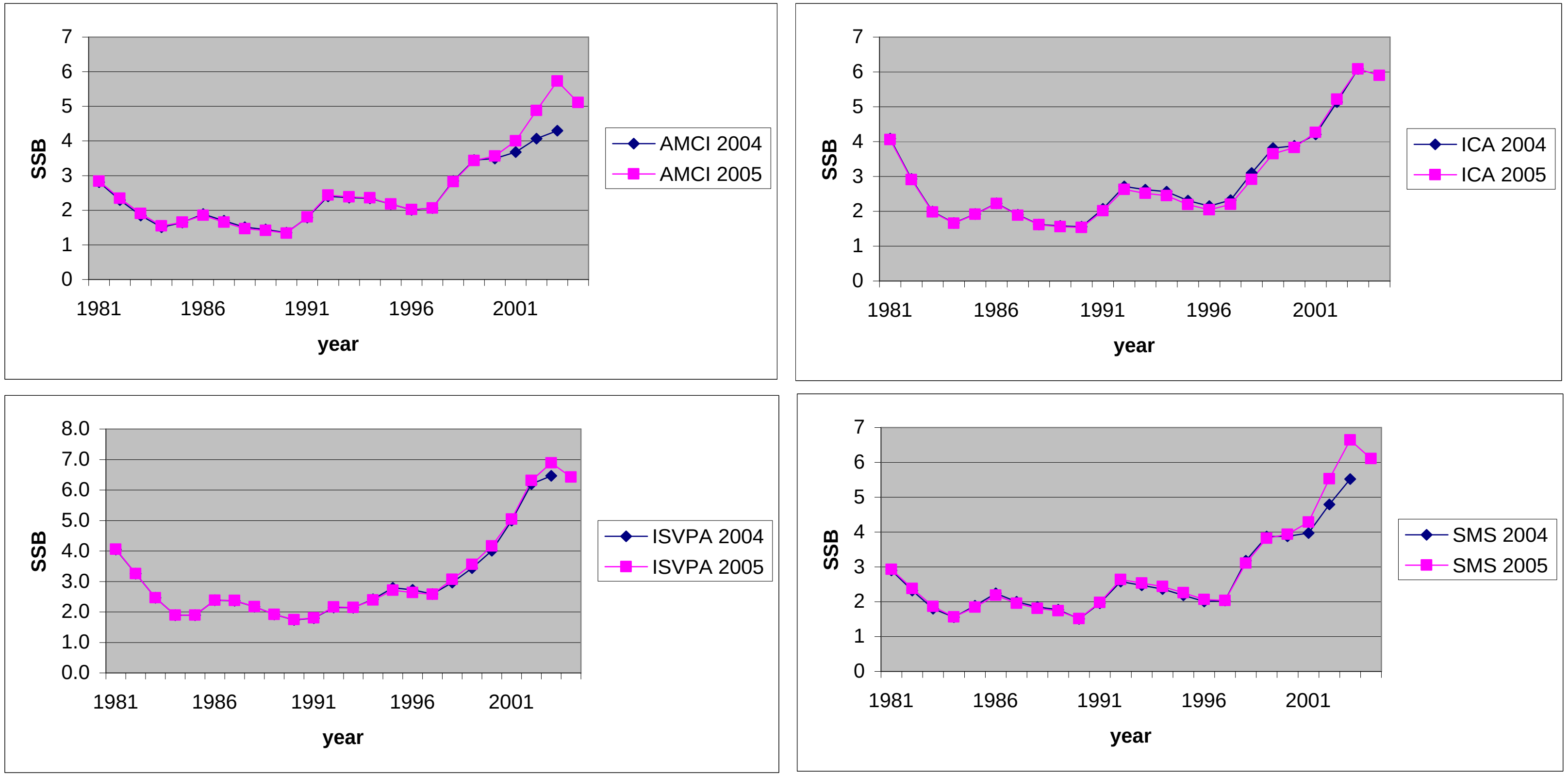


Figure 4.7.6.3 Blue whiting Comparison of SSB estimated by different tuning methods in WG 2004 and WG 2005

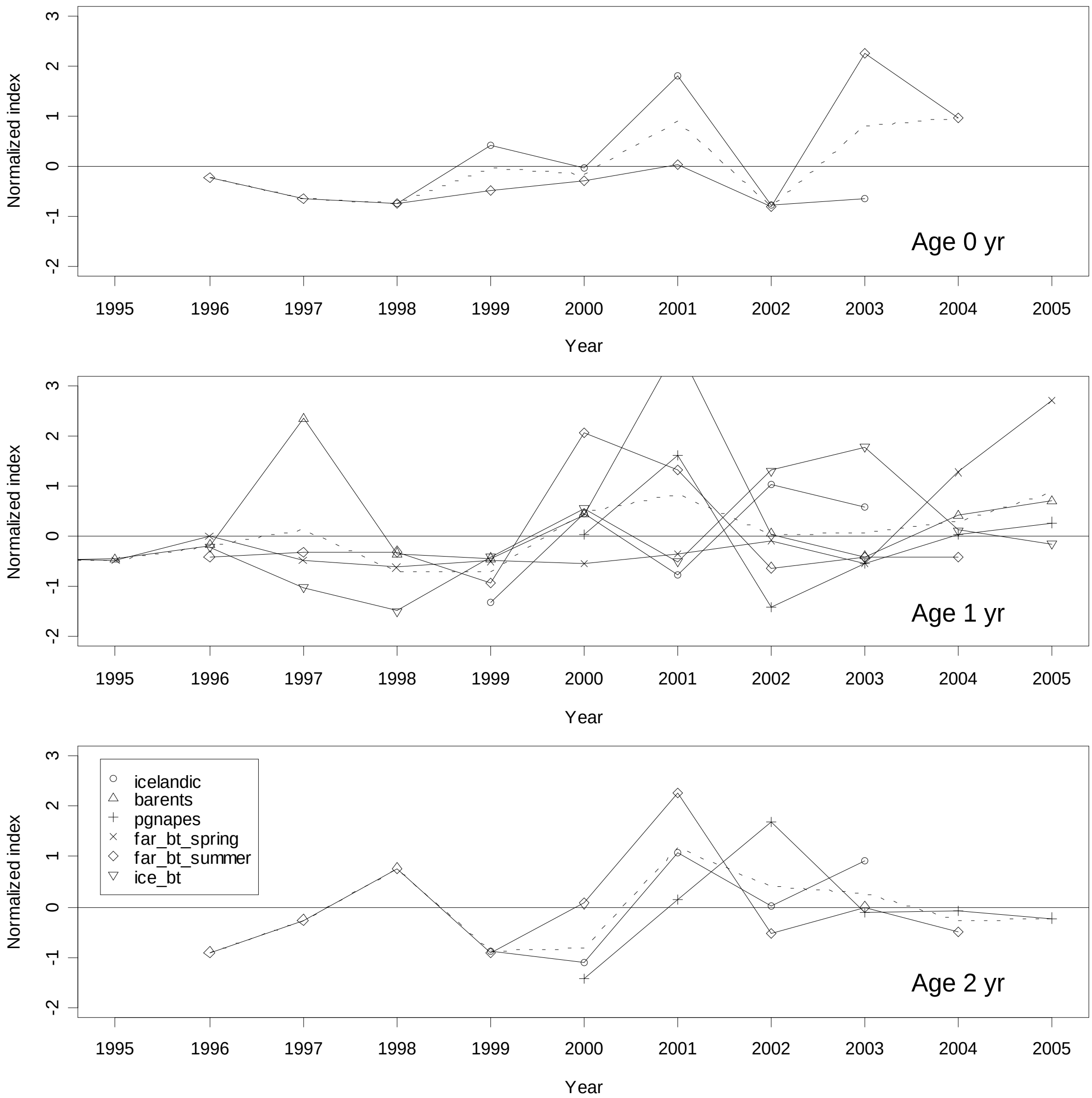


Figure 4.8.1. Overview of survey indices for young blue whiting (Icelandic July acoustic, Barents Sea winter bottom trawl, PGNAPES-coordinated Norwegian Sea May, Faroese bottom trawl spring and summer, and Icelandic winter bottom trawl surveys). Each time series is normalized to zero mean and unity variance. The dotted line shows arithmetic mean of the data – please note that ignores the unequal areal coverage of the surveys.

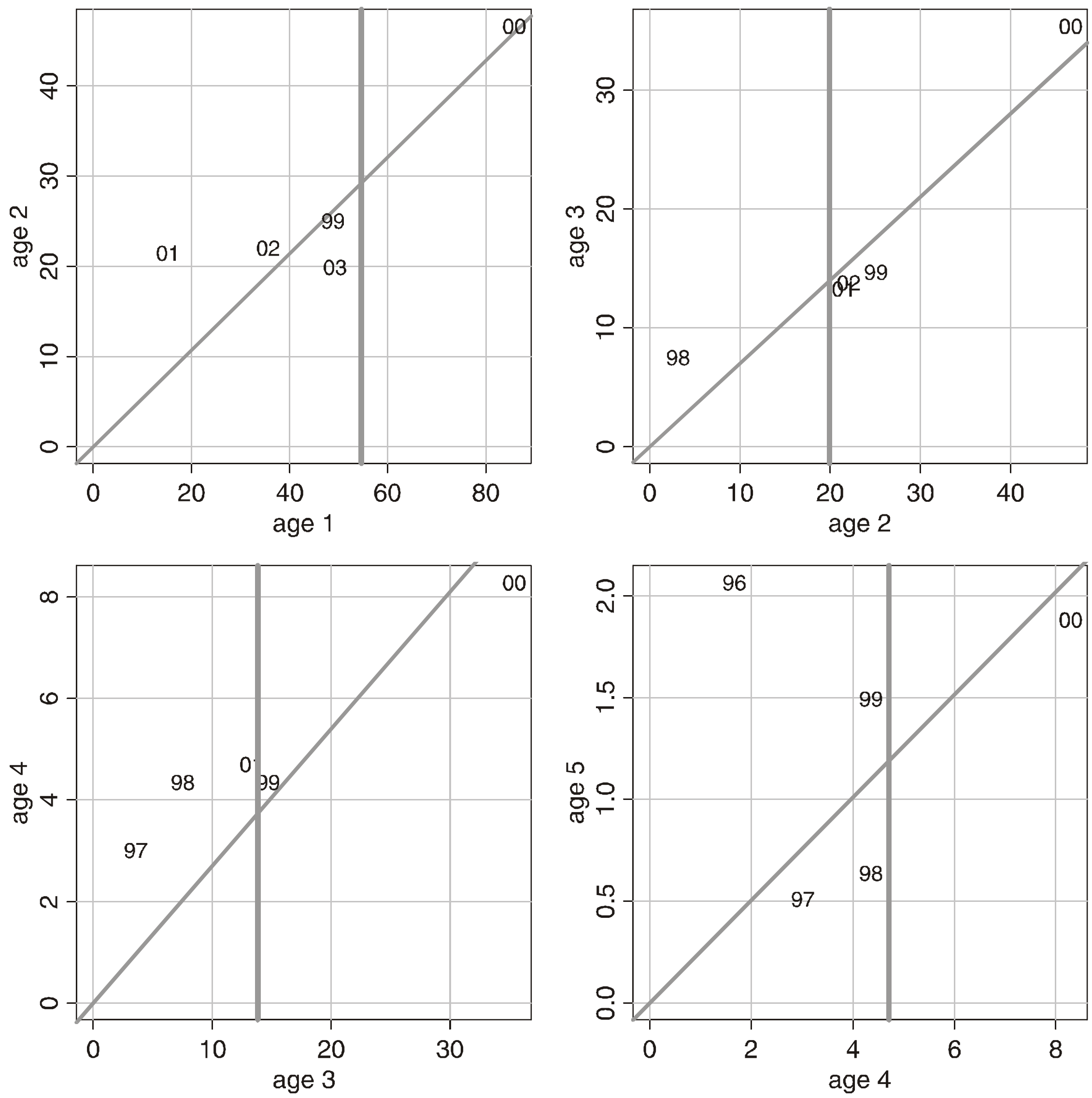


Figure 4.8.2. Abundance index of blue whiting in Norwegian Sea ecosystem survey in May plotted against the abundance index of the same year-class the following year. The wide line shows the most recent estimate (i.e., 2005). The labels show year-class.

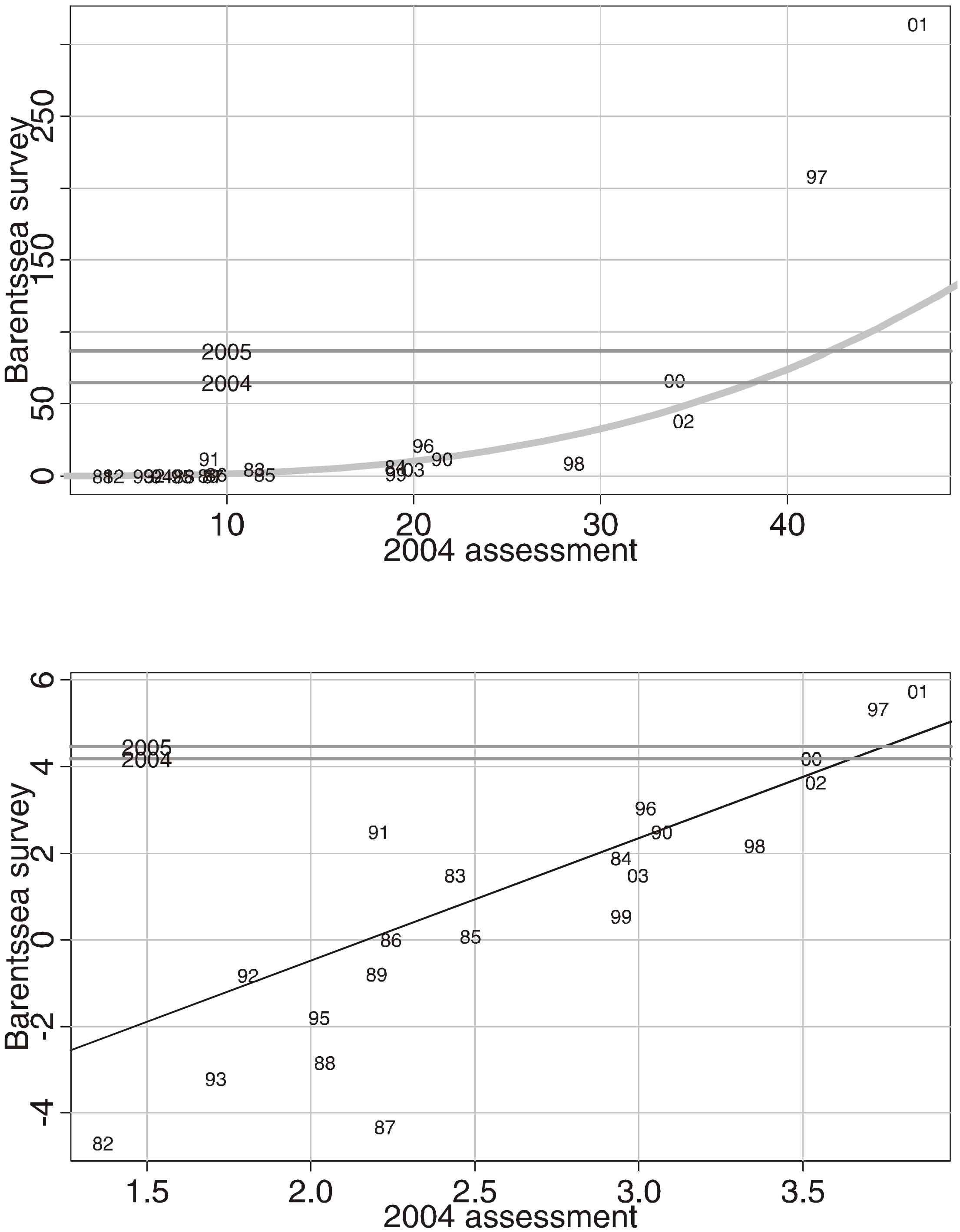


Figure 4.8.3. Number of age 1 year blue whiting in the Barents Sea survey plotted against estimate from the WG assessment in 2004. The lines show curve fitted to the data and the horizontal lines the most recent points (2004-2005).

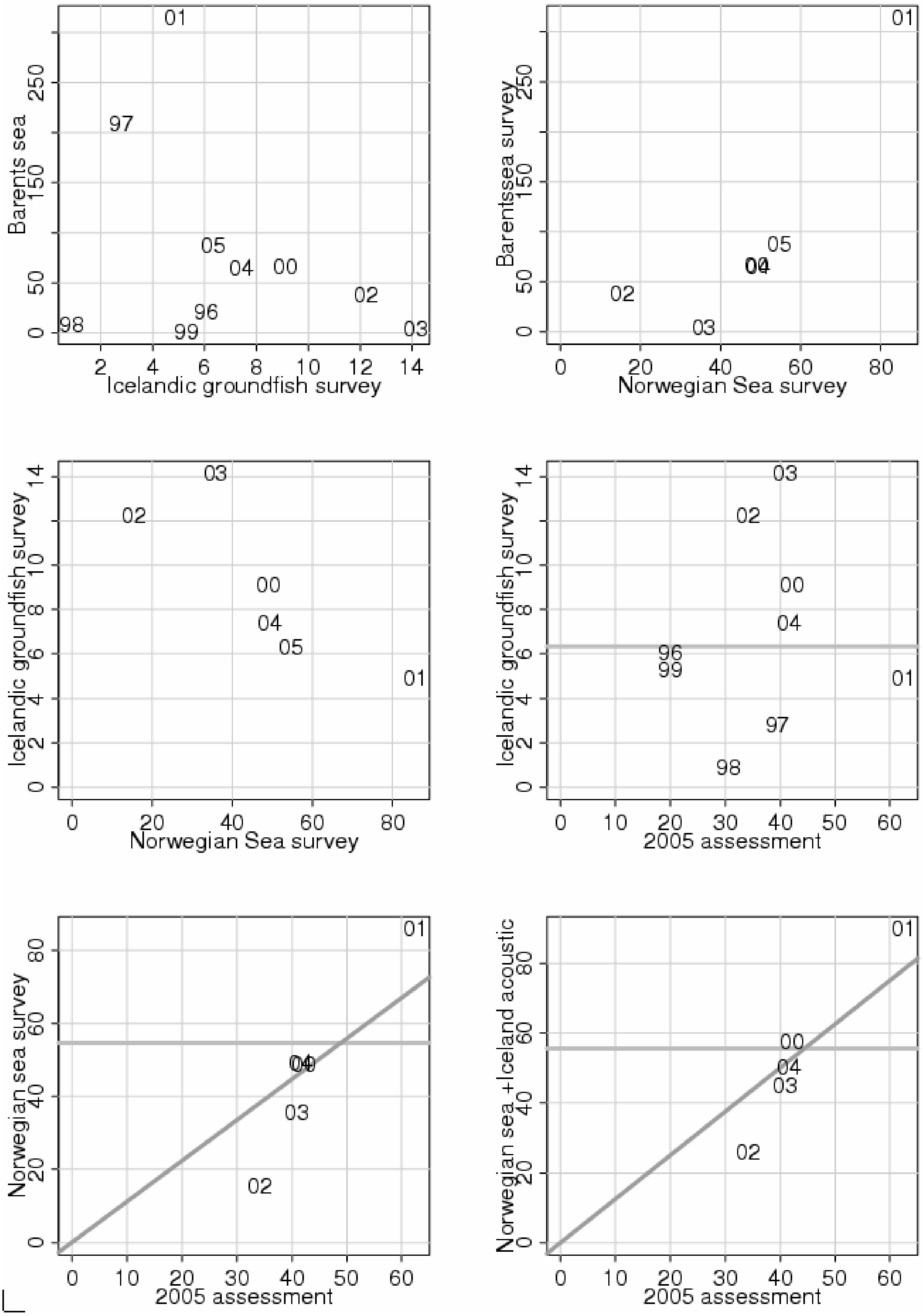


Figure 4.8.4. Some recruitment indices of blue whiting plotted against each other. The label shows the year of observation.

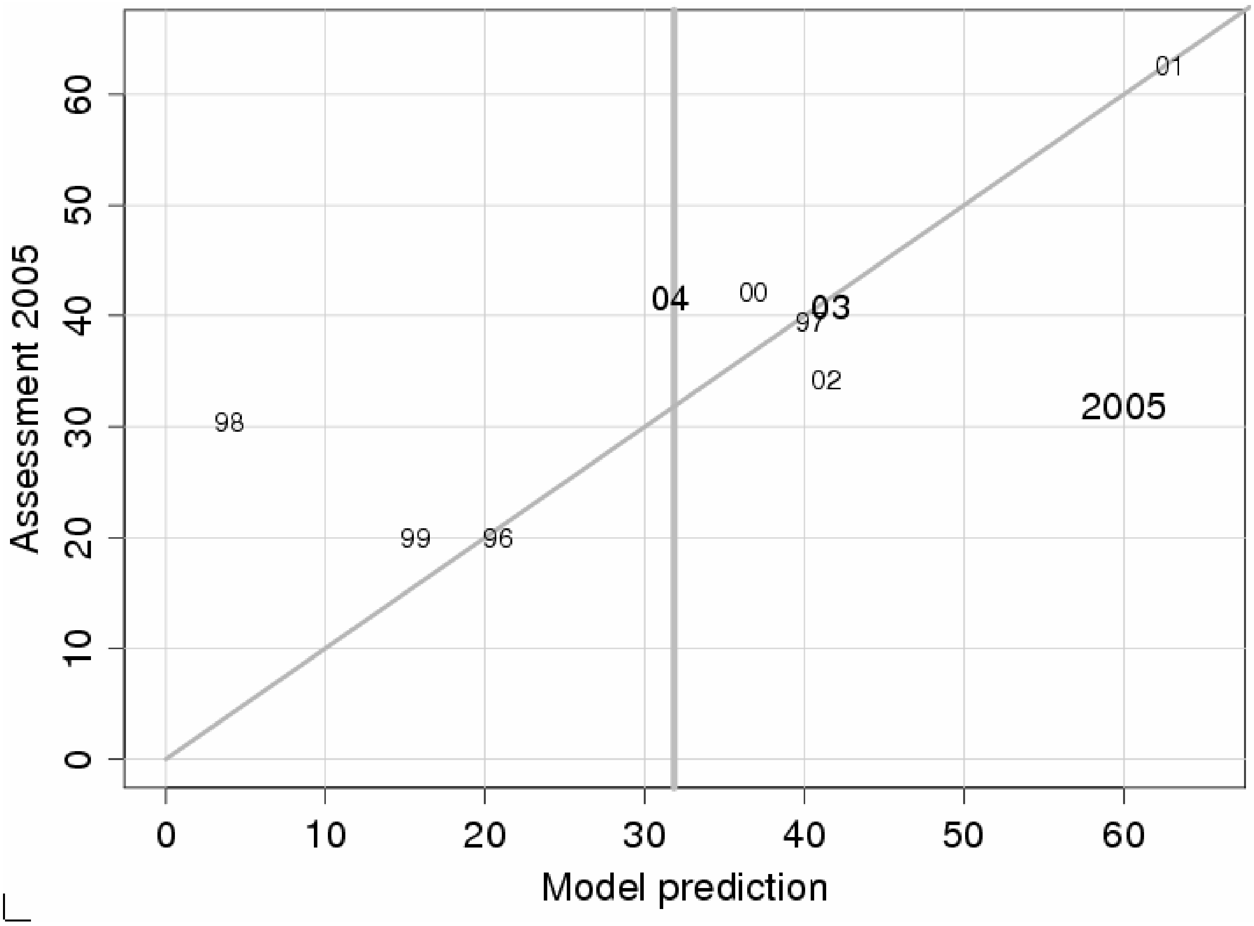


Figure 4.8.5. Blue whiting. Prediction of recruitment from a model $N_1 = \alpha I_{ice} + \beta I_{bar}$ (i.e., forced through the origin). Labels show the year of observation. The horizontal line shows the estimate for the 2005 year-class and the diagonal 1:1 relationship (points on that line fit perfectly).

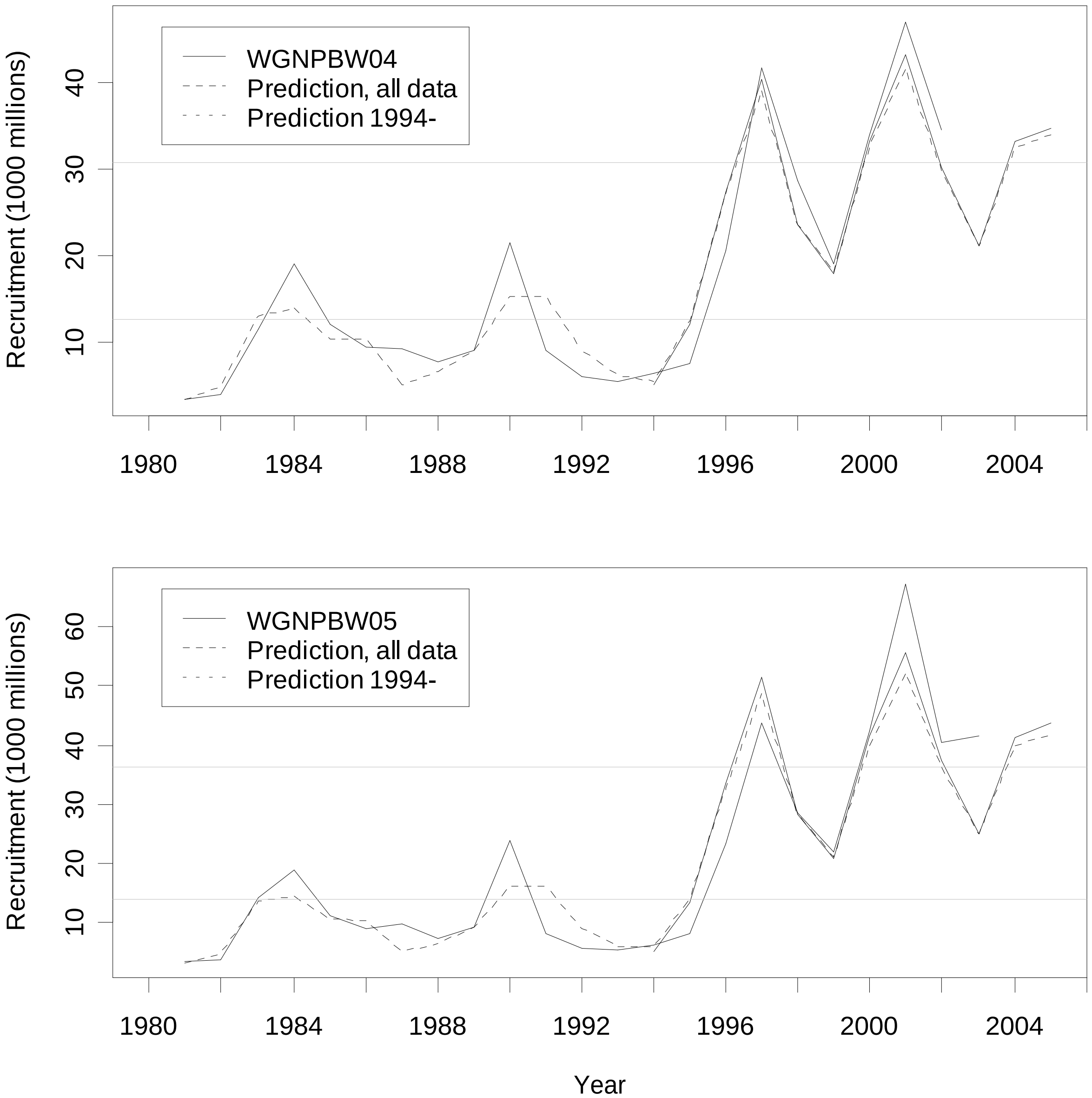


Figure 4.8.6. Blue whiting. Prediction of recruitment from the Barents Sea data calibrated with the assessment estimate from 2004 (upper panel) and 2005 (lower panel). The thin curves show fitted values based on either the whole period and taking into account the change in mesh size in 1994, or on data from 1994 onwards only. Grey horizontal lines show geometric mean WG recruitment for the whole period and for the "high productivity" period from 1996 onwards.

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Mikko Heino, Henrik Søiland, Martin Dahl, Jaime Alvarez, Valentine Anthonypillai, Øyvind Tangen, Vladimir Shnar, Alexander Malyshko, Mikhail Sokolov, Ciaran O'Donnell, Eugene Mullins, Gavin Power, Jan Arge Jacobsen, Leon Smith, Ivan Oganin, Sergey Ratushny, Aleksey Astakhov, Vladimir Guzenko, Sytse Ybema, Ronald Bol, Martien Warmerdam, Mark Dickey-Collas. INTERNATIONAL BLUE WHITING SPAWNING STOCK SURVEY SPRING 2005

Annex 1 - List of participants

Northern Pelagic and Blue Whiting Fisheries Working Group

ICES, Headquarters, 25 August – 1 September 2005

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NPBW Review Group

28 – 29 September, 2005

Jan Horbowy	Poland (Chair)
Asta Gudmundsdottir	Iceland (Chair of WGNPBW)
Mika Kurkilahti	Finland
John Simmonds	UK Scotland

Technical Minutes

Norwegian Spring Spawning Herring

Catch at age numbers and weights used in the assessment and presented in the report were different from official catch, this was detected by the WG after the meeting. These were corrected in an *ad hoc* way to remove SOP differences. None of the SALLOC files for NSSH were on the report directory so it was not possible to trace the cause, the files were obtained late in the meeting and two problems identified, the corrections applied are unlikely to be significant..

The fraction mature in the assessment tables for 2005 differ from those in the projections. During the review group it was confirmed that the fraction mature in the projections was the correct version.

Historic maturity at age looks that it may be incorrect data on 1963 - 1966 year-classes at some of the ages 3 - 6 (very low maturity of 1963 year-class at age 5, in next year-classes maturity at some older ages are lower than at younger ages). Can these be checked and either an explanation or a correction provided

Assessment.

The WG has run the assessment with settings similar to those from last year which is correct (the update assessment was planed this year) and the assessment is accepted.

A separate assessment and projection was presented by the Russian delegation. It was based on an ISVPA model fit which has poor residual patterns (large year-class effects) and although good retrospective pattern with last year assessment, it had poorer performance in earlier assessment years. In addition, it was noted that in the loss function of ISVPA functionally different terms were used for some of the surveys and statistical effects of such usage are not clear. The ISVPA assessment was not supported by the WG and is not accepted by the review group.

There are number of issues regarding the use of data in the assessment. These issues are not sufficient to make the assessment unacceptable but it would be helpful if they could be resolved. It is therefore recommended that these points should be considered as part of a benchmark assessment in 2006. The assessments should be run as far as possible (if the model can converge) with each survey independently thus illustrating the influence of each source of data on the main assessment results and diagnostic. Survey time series that have ceased more than 5 years before terminal year should be investigated for utility. In particular survey 2, the January over-wintering survey, should be considered for exclusion as it has no longer been carried out since 1999. Survey 6, the Barents Sea in autumn survey for ages 1 and 2, has very strong influence on the terminal F in ISVPA. The use of a survey on 1 and 2 age herring too strongly influenced F and the abundance for 4 years and older is particularly of concern. While these are useful to make estimates of incoming year-classes they perhaps should not used to dominate the assessment of older ages. This influence of individual surveys on the Seastar results is not specifically documented and more information would be helpful. The choice of whether a survey should be included and the a priori weight it is given should be based on the precision of the assessment and the restrospective bias resulting from its use.

Catch prediction

The WG presented three options for catch prediction, differing with assumptions on exploitation pattern of strong 2002 year class in 2006. The Review Group supported option 1 of the WG, i.e. assumption that exploitation of 2002 year class in 2006 (4 years old) will be the same as exploitation of 5 years old in that year. The basis for the choice of F on 4 year olds in 2006 is that the 2002 year-class is expected to be distributed spatially along with the older ages and therefore subject to higher F than previous year-classes at age 4. To obtain a TAC that represents the F correctly for older ages (i.e. one that matches the management plan) the selection on this age needs to be increased, the increase is uncertain but the use of F at age 5 is the best estimate available. This option is recommended for use in the projections for ACFM. In addition, it was unclear why 60% maturity in 2006 was assumed for strong 2002 year class in prediction, this was not well documented in the report. As the year-class is strong this assumption may matter for estimate of SSB in prediction.

Report information

The historical estimates of fishing mortality at age were missing. Residual plots of the fit for Seastar fitted cohorts should be provided for comparison with plots from ISVPA. Major cohort plots similar to those from Seastar should be provided from ISVPA. A table of the main parameters for ISVPA runs (SSB, Juveniles, terminal Fs, catchabilities of surveys, like table 3.7.2.1.1) should be provided for comparison with Seastar. Many of the graphs are provided without axes labels (particularly from Seastar graphs)

Blue Whiting

The documentation standards for the blue whiting assessments are much better than those for NSSH. The exploratory analysis was very helpful. However, the discussion of the 4 different assessment models fits depended more on the individual author than a concerted review. Thus some aspects were ignored in some discussion but the same issues were raised as major concerns with a different model. The major issue is that the description of the fishery is one with substantial changes in fishing pattern over the last 15 years. Despite this the models were all set with long separable model periods. Only AMCI allowed for inclusion of some limited variations in exploitation patterns from year to year but these could be to low when compared with probable variations resulting from diverse fisheries on the stock.

The recently enhanced international spawning area survey used in the assessment excluded the more recent data, despite indications that this was consistent. The WG or (PGNAPES) should now combine this data into a single series.

There are two areas of concern.

The major adult tuning series (spawning area survey) shows a distinctly different selection pattern between the early (EK400) period and the later (EK500) period. The earlier section shows a flatter selection at old age compared with the later period which shows a distinct decline at age. This difference is not discussed or explained, and it may result in incorrect elevation of numbers at older ages.

The spawning survey time-series expressed as a biomass index shows around a factor of two rise in SSB from the early 90s to the last four years. When fitted most strongly in the SMS model the rise in biomass in nearer a factor of four. The final assessment shows a factor of three. This suggests a distinct conflict between catch data and survey data. The separable constraint that all the models use to try to smooth the data may be resulting in a false impression. The WG should consider a less constrained model, representing the observed changes in the fishery better, possibly by allowing more change in recent years in AMCI, or evaluating the use of XSA, with some flexibility in the selection in recent years.

The WG accepted the assessment with SMS model as a final assessment opposite to previous years assessments which were based on AMCI. No compelling argument was provided by the WG for changing the model and given the above reasons the review group did not support the change in assessment method to the newer more constrained model and decided to recommend the previous method as the assessment. Given concerns about the modelling, the stochastic element was ignored as it was thought to under-represent the uncertainty in the assessment. A deterministic short term projection was run and is provided.

The results of corrected herring assessment and projections and results of blue whiting assessment and projections with AMCI are provided below.

Norwegian spring spawning herring.

Rescaled catch in numbers for 2004.

Age	Numbers	Mean weight
0	0.000	0.022
1	0.002	0.065
2	0.037	0.141
3	0.024	0.181
4	0.108	0.211
5	0.591	0.240
6	0.818	0.271
7	0.135	0.303
8	0.129	0.347
9	0.027	0.359
10	0.052	0.368
11	0.151	0.387
12	0.350	0.392
13	0.180	0.400
14	0.023	0.423
15+	0.010	0.438

Table. 3.7.2.1.1 NSSH. Summary of SeaStar exploratory runs.

	Default	EstimateM	IncreasedMPlusgroup	TimeTrendLarvae	NoLarvae	Log	2002InBarents	NoTags	CompatibleISVPA	CorrectingAgeBias
Spawning stock	6.102	5.141	6.133	5.678	5.411	6.120	6.120	6.329	4.564	6.102
Juvenile stock	5.006	4.364	4.983	4.701	4.633	5.111	5.111	5.125	4.318	5.006
terminalF83	0.198	0.217	0.198	0.209	0.208	0.220		0.167	0.174	0.198
terminalF90	0.280	0.381	0.273	0.300	0.312	0.530		0.285	0.392	0.280
terminalF91	0.268	0.334	0.264	0.288	0.295	0.285		0.257	0.367	0.268
terminalF92	0.278	0.353	0.273	0.300	0.308	0.274		0.290	0.417	0.278
terminalF93	0.377	0.439	0.374	0.398	0.404	0.448		0.307	0.437	0.377
terminalF96	0.226	0.279	0.223	0.238	0.246	0.242		0.217	0.292	0.226
terminalF97	0.187	0.223	0.185	0.195	0.200	0.187		0.181	0.237	0.187
terminalF98	0.095	0.115	0.094	0.103	0.108	0.095		0.093	0.127	0.095
terminalF99	0.072	0.087	0.070	0.077	0.081	0.070		0.070	0.090	0.072
terminalF02	0.001	0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001
terminalF03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
terminalF04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
cat1	1.053	1.257	1.057	1.104	1.113	1.036		1.009		1.053
cat2	0.846	1.012	0.831	0.861	0.885	0.755		0.828	0.951	0.846
cat3	0.943	1.119	0.944	0.957	0.960	0.933		0.909		0.943
cat5	1.143	1.379	1.133	1.187	1.208	1.072		1.102	1.326	1.143
catLarvae2	4.699	5.349	4.841	5.173		4.748		4.603		4.699
cat4	0.345	0.367	0.340	0.374	0.364	0.348	0.348	0.338		0.345
cat6	0.494	0.571	0.485	0.543	0.540	0.487	0.487	0.481		0.494
catZero	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
distributionParameter1	0.486	0.478	0.491	0.494	0.485	0.525		0.482	0.514	0.486
distributionParameterLarvae	0.674	0.764	0.627	0.430		0.674		0.670		0.674
distributionParameter2	1.945	1.822	1.210	1.227	1.948	1.205	1.205	1.948	113.989	1.945
distParZero	0.249	0.250	0.251	0.243	0.238	0.259	0.259	0.250	0.230	0.249
Log-likelihood per term, survey 1	-1.506	-1.494	-1.505	-1.536	-1.541	-1.560		-1.475		-1.506
Log-likelihood per term, survey 2	-1.238	-1.234	-1.237	-1.224	-1.228	-1.246		-1.260	-1.191	-1.238
Log-likelihood per term, survey 3	-1.823	-1.813	-1.827	-1.832	-1.822	-1.853		-1.835		-1.823
Log-likelihood per term, survey 4	-3.453	-3.432	-3.280	-3.277	-3.452	-3.276	-3.276	-3.457		-3.453
Log-likelihood per term, survey 5	-1.523	-1.487	-1.526	-1.520	-1.513	-1.546		-1.499	-1.507	-1.523
Log-likelihood per term, survey 6	-3.797	-3.766	-3.643	-3.652	-3.804	-3.629	-3.629	-3.799		-3.797
Number of data points, survey 1	27	27	27	27	27	27	0	27	0	27
Number of data points, survey 2	58	58	58	58	58	58	0	58	58	58
Number of data points,										

survey 3	18	18	18	18	18	18	0	18	0	18
Number of data points, survey 4	20	20	20	20	20	20	40	20	0	20
Number of data points, survey 5	65	65	65	65	65	65	0	65	65	65
Number of data points, survey 6	11	11	11	11	11	11	22	11	0	11
vpaM	0.150	0.104	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
vpaMYoung	0.900	1.077	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
survLogLik1	-244.240	-241.169	-244.424	-244.198	-243.987	-248.199	-105.438	-243.357	-167.040	-244.240
survLogLik2	-110.823	-110.061	-105.663	-105.716	-110.879	-105.438	-105.438	-110.919	0.000	-110.823
tagLogLik1	-369.756	-365.624	-369.722	-369.545	-369.620	-369.093	0.000	0.000	0.000	-369.756
tagLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
larvLogLik1	-80.560	-84.084	-78.634	-68.730	0.000	-80.624	0.000	-80.387	0.000	-80.560
larvLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
zeroLogLik1	0.000	0.000	0.000	0.000	0.000	0.000	-0.870	0.000	0.000	0.000
zeroLogLik2	-0.362	-0.104	-0.460	-0.075	0.215	-0.870	-0.870	-0.432	0.678	-0.362
predLogLik1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
predLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.7.4.1. NSSH. Stock in numbers.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2005	0.000	163.151	26.549	19.391	0.921	2.070	7.492	7.709	0.614	0.476	0.078	0.124	0.306	1.027	0.551	0.068	0.020
2004	401.287	65.302	47.753	1.097	2.521	9.341	9.839	0.859	0.692	0.120	0.200	0.518	1.571	0.835	0.104	0.015	0.021
2003	160.617	117.458	2.705	3.006	11.189	12.203	1.185	0.981	0.164	0.312	0.831	2.418	1.199	0.166	0.027	0.009	0.029
2002	288.899	6.652	7.492	13.214	14.871	1.652	1.492	0.223	0.463	1.250	3.524	1.758	0.250	0.045	0.018	0.002	0.050
2001	16.362	18.427	32.504	17.387	2.093	2.193	0.301	0.642	1.772	4.999	2.589	0.370	0.077	0.025	0.005	0.000	0.094
2000	45.323	79.946	42.789	2.522	3.152	0.387	0.865	2.495	7.208	4.135	0.664	0.167	0.046	0.031	0.025	0.026	0.158
1999	196.635	105.244	6.211	3.810	0.488	1.150	3.362	10.105	6.059	1.085	0.308	0.069	0.079	0.037	0.125	0.000	0.347
1998	258.857	15.276	9.502	0.643	1.597	4.303	13.637	8.402	1.672	0.498	0.126	0.119	0.047	0.267	0.006	0.650	0.005
1997	37.573	23.372	1.616	1.996	5.291	17.780	11.910	2.763	0.931	0.213	0.160	0.089	0.408	0.028	1.155	0.001	0.006
1996	57.485	3.974	4.958	6.184	21.427	15.531	4.224	1.519	0.358	0.192	0.112	0.545	0.051	2.243	0.002	0.000	0.011
1995	9.773	12.194	15.213	24.956	18.418	5.579	2.453	0.665	0.239	0.147	0.709	0.150	3.589	0.006	0.000	0.000	0.017
1994	29.993	37.417	61.395	21.434	6.601	3.242	0.951	0.295	0.179	0.863	0.212	4.866	0.010	0.000	0.000	0.023	0.006
1993	92.042	151.007	52.729	7.700	3.882	1.199	0.352	0.212	1.035	0.267	6.095	0.012	0.000	0.000	0.027	0.000	0.010
1992	371.421	129.694	18.941	4.524	1.428	0.414	0.248	1.216	0.316	7.325	0.017	0.002	0.000	0.033	0.000	0.000	0.016
1991	318.995	46.592	11.132	1.669	0.484	0.289	1.428	0.377	8.746	0.022	0.003	0.000	0.039	0.000	0.000	0.024	0.002
1990	114.598	27.381	4.129	0.583	0.339	1.672	0.449	10.405	0.027	0.005	0.003	0.048	0.000	0.000	0.029	0.001	0.002
1989	67.357	10.158	1.473	0.397	1.947	0.528	12.439	0.035	0.006	0.004	0.059	0.002	0.001	0.034	0.002	0.000	0.003
1988	25.009	3.628	0.991	2.329	0.641	15.045	0.051	0.011	0.011	0.085	0.012	0.005	0.043	0.005	0.002	0.002	0.003
1987	8.945	2.447	5.786	0.766	18.020	0.079	0.017	0.021	0.128	0.027	0.016	0.055	0.014	0.009	0.010	0.001	0.004
1986	6.041	14.232	1.888	21.519	0.111	0.035	0.041	0.262	0.113	0.063	0.147	0.037	0.082	0.097	0.002	0.000	0.007
1985	35.051	4.665	53.252	0.152	0.058	0.065	0.445	0.194	0.133	0.238	0.054	0.128	0.167	0.002	0.000	0.000	0.014
1984	11.528	130.982	0.378	0.072	0.081	0.583	0.246	0.168	0.294	0.071	0.167	0.201	0.002	0.000	0.000	0.026	0.000
1983	322.362	0.938	0.179	0.098	0.700	0.296	0.202	0.348	0.084	0.198	0.242	0.003	0.000	0.000	0.032	0.000	0.000
1982	2.343	0.442	0.241	0.829	0.352	0.240	0.412	0.099	0.236	0.287	0.003	0.000	0.000	0.037	0.000	0.000	0.000
1981	1.100	0.595	2.057	0.413	0.283	0.487	0.118	0.279	0.343	0.004	0.000	0.000	0.044	0.000	0.000	0.000	0.000
1980	1.474	5.060	1.017	0.336	0.573	0.139	0.333	0.415	0.005	0.000	0.000	0.054	0.000	0.000	0.000	0.000	0.000
1979	12.498	2.508	0.830	0.672	0.164	0.394	0.494	0.007	0.000	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.001
1978	6.201	2.044	1.655	0.194	0.471	0.596	0.009	0.000	0.001	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.002
1977	5.095	4.080	0.482	0.571	0.718	0.010	0.000	0.002	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
1976	10.068	1.188	1.407	0.860	0.018	0.000	0.002	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
1975	2.971	3.467	2.117	0.024	0.000	0.004	0.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
1974	8.631	5.220	0.066	0.000	0.004	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
1973	12.884	0.168	0.005	0.008	0.317	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023
1972	0.957	0.077	0.051	0.407	0.005	0.006	0.003	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037
1971	0.236	0.193	1.134	0.008	0.008	0.005	0.002	0.003	0.002	0.000	0.006	0.008	0.007	0.000	0.000	0.000	0.061
1970	0.661	3.620	0.072	0.017	0.026	0.003	0.007	0.005	0.002	0.021	0.038	0.038	0.000	0.000	0.000	0.000	0.101
1969	9.785	0.972	0.263	0.233	0.004	0.018	0.011	0.003	0.037	0.080	0.083	0.000	0.000	0.000	0.000	0.000	0.168
1968	5.187	1.333	1.182	0.111	2.048	1.509	0.018	0.144	0.238	0.469	0.003	0.002	0.002	0.003	0.004	0.003	0.276
1967	3.947	18.398	0.384	3.880	5.260	0.050	0.622	1.496	2.400	0.013	0.008	0.006	0.013	0.014	0.022	0.020	0.455
1966	51.409	1.984	12.175	8.320	0.087	1.225	3.146	5.897	0.056	0.025	0.025	0.043	0.028	0.100	0.100	0.148	0.719
1965	8.491	35.874	24.938	0.198	1.700	4.271	9.222	0.086	0.045	0.037	0.071	0.076	0.224	0.233	0.321	1.627	0.148
1964	93.903	65.617	0.833	2.098	5.392	12.920	0.115	0.054	0.047	0.109	0.120	0.364	0.359	0.538	2.724	0.180	0.295
1963	168.931	5.371	8.368	7.085	15.912	0.139	0.064	0.058	0.146	0.149	0.539	0.517	0.813	4.160	0.294	0.286	0.573

1962	19.003	26.983	19.058	20.474	0.170	0.078	0.075	0.192	0.186	0.690	0.658	1.070	5.710	0.390	0.391	0.517	0.589
1961	76.103	72.088	54.883	0.231	0.099	0.092	0.239	0.237	0.868	0.817	1.390	7.419	0.506	0.503	0.669	0.233	0.849
1960	197.514	156.290	1.185	0.247	0.127	0.308	0.302	1.112	1.029	1.835	9.874	0.680	0.725	0.942	0.331	0.392	1.057
1959	412.478	3.225	1.117	0.163	0.387	0.379	1.449	1.319	2.391	12.661	0.886	0.976	1.308	0.480	0.539	0.860	1.040
1958	23.094	7.136	1.447	0.468	0.460	1.804	1.628	2.988	15.760	1.105	1.266	1.737	0.665	0.709	1.075	0.948	0.959
1957	25.397	8.719	1.496	0.559	2.498	2.058	3.718	20.450	1.362	1.608	2.214	0.867	0.955	1.410	1.244	0.381	1.440
1956	29.858	6.852	2.358	3.028	2.662	4.658	26.514	1.701	2.089	2.857	1.149	1.323	1.932	1.621	0.510	0.787	1.905
1955	24.971	10.303	8.247	3.193	5.710	33.009	2.099	2.631	3.616	1.427	1.745	2.564	2.102	0.656	1.005	1.124	2.629
1954	42.086	31.374	9.195	6.921	39.898	2.593	3.311	4.730	1.795	2.243	3.453	2.939	0.858	1.277	1.449	1.115	3.831
1953	86.102	30.543	17.934	47.153	3.063	3.956	5.878	2.174	2.726	4.351	3.840	1.063	1.581	1.785	1.402	3.082	4.103
1952	96.644	58.460	117.910	3.601	4.661	7.479	2.673	3.387	5.465	4.869	1.321	1.930	2.190	1.744	3.782	3.938	3.488
1951	146.355	301.944	9.484	5.422	9.103	3.292	4.113	6.905	6.306	1.617	2.331	2.656	2.142	4.667	4.950	0.757	5.388
1950	750.680	26.465	14.278	10.874	4.023	4.978	8.612	8.004	1.965	2.804	3.203	2.583	5.632	6.148	0.952	2.567	6.709

Table. NSSH. Modelled historic F-values.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2005	0.000	0.000	0.001	0.010	0.025	0.048	0.067	0.084	0.092	0.108	0.138	0.110	0.092	0.093	0.093	0.093	0.093
2004	0.000	0.000	0.001	0.024	0.047	0.071	0.094	0.185	0.223	0.273	0.324	0.374	0.273	0.264	0.273	0.262	1.340
2003	0.000	0.000	0.002	0.026	0.031	0.065	0.171	0.199	0.163	0.295	0.322	0.282	0.212	0.317	0.429	0.252	0.118
2002	0.000	0.000	0.013	0.016	0.048	0.182	0.269	0.156	0.245	0.259	0.227	0.233	0.259	0.358	0.542	0.241	0.281
2001	0.000	0.000	0.000	0.006	0.086	0.235	0.150	0.176	0.199	0.200	0.237	0.242	0.401	0.166	1.120	0.230	0.261
2000	0.000	0.000	0.001	0.037	0.213	0.102	0.149	0.192	0.216	0.318	0.434	0.620	0.476	1.590	8.330	0.219	0.687
1999	0.000	0.000	0.001	0.040	0.082	0.135	0.148	0.188	0.232	0.342	0.463	0.256	0.793	0.236	1.430	0.208	0.085
1998	0.000	0.000	0.014	0.125	0.179	0.097	0.150	0.177	0.282	0.330	0.450	0.261	0.084	0.606	6.820	0.198	0.000
1997	0.000	0.000	0.021	0.073	0.057	0.115	0.199	0.352	0.475	0.369	0.145	0.497	0.273	1.370	0.424	0.262	0.000
1996	0.000	0.000	0.010	0.006	0.037	0.115	0.274	0.340	0.373	0.033	0.074	0.140	0.463	0.514	0.001	0.303	0.000
1995	0.000	0.000	0.000	0.002	0.021	0.128	0.329	0.469	0.072	0.124	0.112	0.925	0.320	1.200	4.050	0.100	0.014
1994	0.000	0.000	0.000	0.002	0.018	0.129	0.207	0.059	0.050	0.048	0.200	0.154	0.349	0.939	2.220	0.100	0.000
1993	0.000	0.000	0.000	0.004	0.030	0.082	0.027	0.019	0.031	0.078	0.075	0.000	0.001	0.008	0.000	0.059	0.000
1992	0.000	0.000	0.000	0.003	0.025	0.013	0.005	0.011	0.020	0.034	0.175	0.486	0.963	0.041	0.048	0.029	0.000
1991	0.000	0.000	0.000	0.005	0.006	0.005	0.011	0.026	0.027	0.130	0.214	0.172	0.019	1.650	1.990	0.024	0.004
1990	0.000	0.000	0.006	0.035	0.008	0.008	0.026	0.024	0.053	0.436	1.430	0.056	1.680	0.413	0.022	0.153	0.266
1989	0.000	0.000	0.027	0.008	0.002	0.012	0.029	0.113	0.149	0.198	0.062	0.912	0.744	0.010	0.171	0.090	0.000
1988	0.001	0.001	0.015	0.030	0.043	0.040	0.223	0.436	0.857	0.206	1.460	1.060	0.088	0.875	4.760	0.381	0.000
1987	0.002	0.004	0.010	0.028	0.030	0.293	0.254	0.461	0.268	0.639	1.060	0.093	0.903	1.520	1.520	0.417	0.000
1986	0.004	0.000	0.003	0.027	0.187	0.588	0.530	0.565	1.260	1.250	0.835	0.820	2.060	2.160	0.001	1.400	0.594
1985	0.001	0.004	0.006	0.165	0.343	0.320	0.378	0.396	0.590	0.336	0.221	0.302	0.389	0.001	0.506	0.379	0.087
1984	0.005	0.000	0.010	0.070	0.074	0.121	0.083	0.085	0.059	0.116	0.112	0.035	0.000	0.294	0.242	0.070	0.000
1983	0.001	0.008	0.015	0.036	0.033	0.035	0.034	0.021	0.017	0.025	0.033	0.058	2.280	3.310	0.030	0.029	0.000
1982	0.015	0.004	0.001	0.018	0.025	0.021	0.017	0.022	0.023	0.023	0.040	0.539	0.194	0.004	0.024	0.022	0.000
1981	0.012	0.003	0.009	0.011	0.018	0.019	0.020	0.018	0.026	0.092	0.692	0.384	0.024	0.021	0.019	0.028	0.000
1980	0.007	0.000	0.001	0.021	0.011	0.018	0.027	0.042	0.093	0.033	0.002	0.055	0.017	0.016	0.023	0.058	0.000
1979	0.004	0.002	0.004	0.010	0.012	0.019	0.025	0.055	0.003	0.002	0.043	0.015	0.013	0.020	0.048	0.042	0.000
1978	0.005	0.002	0.001	0.017	0.028	0.037	0.115	0.003	0.743	0.069	0.012	0.011	0.017	0.039	0.035	0.079	0.000
1977	0.013	0.002	0.010	0.043	0.036	0.036	0.003	0.266	0.116	0.011	0.010	0.014	0.033	0.029	0.064	0.116	0.000
1976	0.003	0.003	0.001	0.030	0.397	0.002	0.000	0.109	0.009	0.008	0.012	0.027	0.024	0.052	0.090	0.015	0.000
1975	0.016	0.002	0.001	0.157	0.222	0.319	0.189	0.038	0.014	0.010	0.023	0.021	0.043	0.072	0.012	0.019	0.000
1974	0.012	0.002	0.097	0.122	0.060	0.112	0.973	0.779	0.009	0.019	0.017	0.035	0.058	0.011	0.016	0.017	0.000
1973	0.004	0.033	0.769	0.405	0.090	0.857	1.520	1.120	1.370	0.015	0.029	0.047	0.009	0.014	1.260	0.603	0.000
1972	0.842	1.830	0.987	0.098	1.290	0.956	1.820	1.250	2.980	1.780	0.039	1.570	2.070	1.110	0.332	2.110	0.000
1971	0.226	0.429	0.125	0.283	0.140	0.308	0.277	0.476	1.630	2.550	1.960	2.280	1.840	0.217	2.800	2.030	0.000
1970	0.333	0.261	1.300	0.529	1.490	0.298	0.678	1.100	1.160	1.180	1.370	1.550	3.940	1.620	0.823	1.410	0.024
1969	0.094	1.710	1.870	2.050	0.259	0.756	0.599	0.347	0.419	0.600	0.626	0.612	0.867	0.394	0.843	0.578	0.015
1968	0.775	0.722	0.724	3.230	4.590	4.750	1.810	1.210	0.936	1.580	1.290	1.320	0.771	1.960	1.250	1.360	0.067
1967	0.186	1.850	0.339	0.489	1.100	0.853	1.310	1.690	1.480	1.330	1.450	1.080	1.260	1.130	1.990	1.480	0.208
1966	0.128	0.742	0.244	0.308	0.405	0.529	0.593	0.749	1.310	0.976	1.340	1.060	0.543	1.370	1.480	1.190	0.280
1965	0.554	0.181	0.198	0.672	0.177	0.156	0.297	0.280	0.444	0.239	0.344	0.838	0.659	0.691	0.627	0.620	0.948
1964	0.062	0.067	0.536	0.061	0.083	0.187	0.138	0.031	0.072	0.283	0.306	0.333	0.284	0.366	0.365	0.320	0.849

1963	0.046	0.964	0.483	0.123	0.058	0.042	0.031	0.069	0.145	0.070	0.243	0.214	0.263	0.274	0.344	0.257	0.156
1962	0.364	0.271	0.090	0.102	0.052	0.044	0.109	0.121	0.071	0.097	0.090	0.125	0.167	0.130	0.163	0.147	0.143
1961	0.137	0.430	0.086	0.157	0.092	0.049	0.070	0.092	0.080	0.067	0.112	0.112	0.112	0.101	0.107	0.106	0.040
1960	0.108	0.147	0.733	0.759	0.168	0.104	0.091	0.098	0.080	0.128	0.136	0.145	0.214	0.193	0.204	0.139	0.084
1959	0.071	0.102	0.611	0.105	0.078	0.077	0.115	0.099	0.115	0.099	0.114	0.148	0.178	0.221	0.168	0.113	0.101
1958	1.070	0.954	1.280	0.041	0.043	0.069	0.061	0.073	0.069	0.071	0.111	0.133	0.174	0.125	0.074	0.082	0.192
1957	0.369	0.896	0.262	0.046	0.176	0.084	0.069	0.111	0.059	0.089	0.093	0.116	0.147	0.121	0.121	0.100	0.151
1956	0.331	0.622	0.540	0.042	0.107	0.076	0.110	0.072	0.111	0.105	0.131	0.176	0.165	0.115	0.143	0.130	0.219
1955	0.393	0.575	0.102	0.032	0.054	0.069	0.061	0.081	0.085	0.067	0.127	0.133	0.110	0.101	0.095	0.104	0.175
1954	0.507	0.436	0.158	0.042	0.040	0.061	0.080	0.118	0.080	0.101	0.148	0.185	0.118	0.089	0.104	0.130	0.132
1953	0.110	0.301	0.052	0.017	0.017	0.028	0.067	0.041	0.045	0.081	0.117	0.065	0.064	0.059	0.079	0.078	0.085
1952	0.252	0.282	0.017	0.012	0.014	0.091	0.057	0.067	0.078	0.087	0.067	0.049	0.055	0.068	0.055	0.073	0.096
1951	0.018	0.040	0.068	0.001	0.047	0.058	0.044	0.084	0.109	0.053	0.039	0.043	0.056	0.060	0.079	0.070	0.050
1950	0.011	0.126	0.068	0.028	0.051	0.041	0.071	0.088	0.045	0.035	0.038	0.037	0.038	0.067	0.078	0.046	0.033

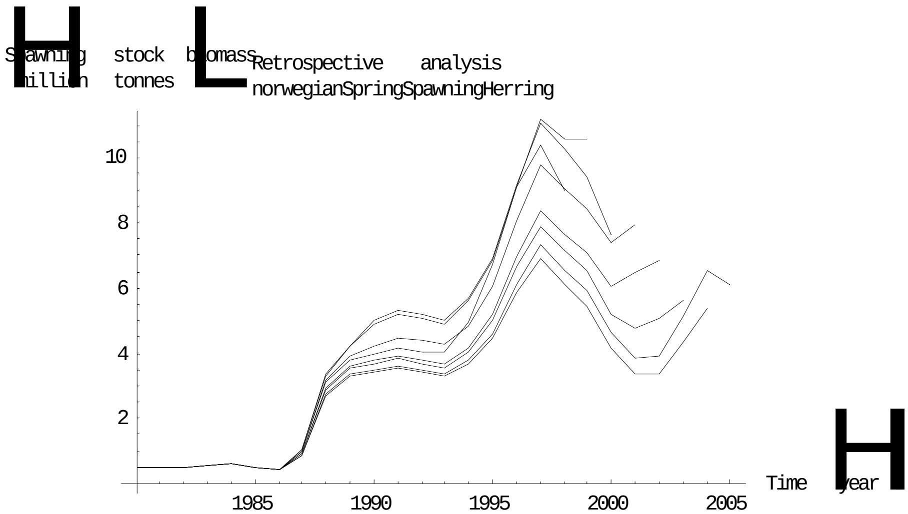

Figure 3.7.2.1.12. NSSH. Retrospective plot for the assessment in 2004.

Table 3.7.4.2 NSSH. Stock summary table. Biomass in million tonnes.

	Recruits Age 0	Total biomass	Spawning stock biomass	Fbar 5-14
1950	750.680	20.013	14.359	0.058
1951	146.355	19.274	12.635	0.070
1952	96.644	20.182	11.042	0.073
1953	86.102	17.419	9.457	0.066
1954	42.086	18.565	8.703	0.113
1955	24.971	15.725	9.324	0.078
1956	29.858	13.799	10.934	0.110
1957	25.397	11.088	9.661	0.103
1958	23.094	9.549	8.731	0.079
1959	412.478	8.076	7.200	0.113
1960	197.514	7.634	5.853	0.136
1961	76.103	7.796	4.403	0.104
1962	19.003	6.765	3.443	0.146
1963	168.931	6.913	2.641	0.253
1964	93.903	6.446	2.479	0.226
1965	8.491	5.935	2.996	0.278
1966	51.409	4.392	2.658	0.696
1967	3.947	3.018	1.304	1.519
1968	5.187	0.982	0.318	3.493
1969	9.785	0.190	0.142	0.590
1970	0.661	0.116	0.069	1.320
1971	0.236	0.130	0.032	1.525
1972	0.957	0.085	0.016	1.497
1973	12.884	0.112	0.086	1.173
1974	8.631	0.160	0.091	0.114
1975	2.971	0.302	0.079	0.190
1976	10.068	0.362	0.139	0.106
1977	5.095	0.429	0.288	0.111
1978	6.201	0.579	0.360	0.043
1979	12.498	0.635	0.391	0.024
1980	1.474	0.748	0.475	0.034
1981	1.100	0.796	0.509	0.022
1982	2.343	0.729	0.507	0.020
1983	322.362	1.086	0.579	0.029
1984	11.528	2.009	0.603	0.090
1985	35.051	5.166	0.502	0.379
1986	6.041	1.815	0.401	1.074
1987	8.945	3.117	0.877	0.404
1988	25.009	3.485	2.738	0.045
1989	67.357	4.067	3.335	0.029
1990	114.598	4.550	3.490	0.022
1991	318.995	5.187	3.628	0.025
1992	371.421	6.208	3.496	0.029
1993	92.042	7.270	3.352	0.068
1994	29.993	8.275	3.775	0.139
1995	9.773	9.061	4.592	0.240
1996	57.485	9.123	6.113	0.197
1997	37.573	9.012	7.308	0.187
1998	258.857	7.841	6.564	0.168
1999	196.635	8.863	5.930	0.212
2000	45.323	7.986	4.635	0.262
2001	16.362	6.798	3.878	0.213
2002	288.899	7.220	3.918	0.232
2003	160.617	8.542	5.107	0.132
2004	401.287	10.180	6.513	0.119

Table 3.9.1.1 NSSH. Input to the short term prediction.

Landings in 2005 1. million tonnes
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Total biomass in 2005 11.1161 million tonnes
Spawning stock biomass in 2005 6.13347 million tonnes
Fbar in 2005 0.1846
Part of year before spawning: 0.1

	Numbers (billion) 2005	Weight stock 2005	Weight stock 2006	Weight stock 2007	Weight catch (kg)	Fraction mature 2005	Fraction mature 2006	Fraction mature 2007	Exploitation pattern
0	0.000	0.001	0.001	0.001	0.007	0.000	0.000	0.000	0.000
1	163.151	0.010	0.010	0.010	0.065	0.000	0.000	0.000	0.000
2	26.549	0.047	0.050	0.050	0.143	0.000	0.000	0.000	0.002
3	19.391	0.112	0.110	0.110	0.183	0.150	0.100	0.100	0.013
4	0.921	0.154	0.160	0.160	0.211	0.450	0.600	0.450	0.047
5	2.070	0.233	0.249	0.246	0.236	0.900	0.900	0.900	0.106
6	7.492	0.265	0.282	0.279	0.263	1.000	1.000	1.000	0.174
7	7.709	0.289	0.310	0.306	0.297	1.000	1.000	1.000	0.215
8	0.614	0.317	0.339	0.335	0.342	1.000	1.000	1.000	0.239
9	0.476	0.354	0.367	0.362	0.358	1.000	1.000	1.000	0.262
10	0.078	0.362	0.379	0.375	0.361	1.000	1.000	1.000	0.254
11	0.124	0.411	0.416	0.411	0.382	1.000	1.000	1.000	0.288
12	0.306	0.394	0.406	0.401	0.389	1.000	1.000	1.000	0.294
13	1.027	0.398	0.409	0.405	0.399	1.000	1.000	1.000	0.465
14	0.551	0.413	0.423	0.418	0.420	1.000	1.000	1.000	0.666
15	0.068	0.442	0.470	0.464	0.439	1.000	1.000	1.000	0.201
16	0.020	0.445	0.470	0.464	0.439	1.000	1.000	1.000	0.282

Table 3.9.1.2 NSSH. Short term prediction and two optional runs.

Short term prediction. Averaging period 10 Averaged

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.498	0.000	0.000	12.467	8.500
6.437	0.115	0.588	11.873	7.866
6.435	0.120	0.613	11.848	7.840
6.432	0.125	0.636	11.824	7.815
6.430	0.130	0.660	11.800	7.789
6.427	0.135	0.684	11.776	7.764
6.424	0.140	0.708	11.753	7.739
6.422	0.145	0.731	11.729	7.714
6.419	0.150	0.755	11.705	7.689
6.417	0.155	0.778	11.682	7.664
6.414	0.160	0.801	11.659	7.640

Optional 1. Short term prediction Averaging period 10 Averaged **-** Increase 1 year on 4 year olds

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.489	0.000	0.000	12.457	8.490
6.424	0.115	0.676	11.767	7.771
6.421	0.120	0.704	11.739	7.741
6.418	0.125	0.732	11.711	7.712
6.415	0.130	0.759	11.683	7.683
6.412	0.135	0.786	11.655	7.654
6.410	0.140	0.814	11.628	7.626
6.407	0.145	0.841	11.600	7.597
6.404	0.150	0.868	11.573	7.569
6.401	0.155	0.895	11.545	7.541
6.398	0.160	0.921	11.518	7.513

Optional 2. Catches in 2006 and SSB in 2007 if the fishing mortality is applied to spawning stock biomass

	Catch 2006	SSB 2007
0.000	0.000	7.380
0.115	0.758	7.296
0.120	0.791	7.292
0.125	0.823	7.288
0.130	0.856	7.285
0.135	0.889	7.281
0.140	0.922	7.277
0.145	0.955	7.274
0.150	0.988	7.270
0.155	1.021	7.267
0.160	1.054	7.263

Blue Whiting.

Table. Blue whiting. Stock numbers at age derived by AMCI.

Age	1981	1982	1983	1984	1985	1986	1987	1988
0								
1	3,634,926	4,074,635	10,886,489	18,346,768	12,241,432	9,473,498	8,982,704	7,684,033
2	3,994,375	2,763,744	3,179,573	7,637,886	12,598,817	8,534,761	6,686,965	6,520,681
3	4,787,469	2,956,782	2,090,780	2,345,821	5,324,109	8,596,914	5,530,846	4,489,524
4	3,032,825	3,246,249	2,105,565	1,455,627	1,547,086	3,343,590	4,952,787	3,357,315
5	2,421,173	1,978,893	2,236,277	1,414,218	921,378	952,453	1,798,949	2,745,985
6	2,309,452	1,509,387	1,327,705	1,461,018	863,349	546,013	496,258	968,288
7	1,878,814	1,228,032	903,621	759,007	748,554	417,017	222,861	222,973
8	1,799,023	999,044	735,182	516,571	388,878	361,568	170,210	100,133
9	1,487,675	956,615	598,095	420,281	264,666	187,837	147,578	76,477
10+	3,149,132	2,465,584	2,048,759	1,513,122	990,581	606,312	324,140	211,947

Age	1989	1990	1991	1992	1993	1994	1995	1996
0								
1	8,938,636	22,336,700	9,008,614	6,160,529	5,525,904	6,505,224	7,617,300	20,406,428
2	5,786,361	6,601,063	16,718,297	7,119,122	4,769,354	4,291,179	5,060,322	5,919,291
3	4,492,794	3,896,371	4,504,638	12,659,255	5,362,474	3,612,442	3,279,957	3,817,265
4	2,841,816	2,704,454	2,391,453	3,252,181	9,078,501	3,872,129	2,628,043	2,329,541
5	1,958,331	1,572,766	1,520,596	1,665,696	2,242,592	6,296,292	2,722,504	1,788,218
6	1,505,873	992,705	812,496	1,010,437	1,105,252	1,503,193	4,251,225	1,761,823
7	444,766	626,251	412,484	490,239	610,836	685,201	950,396	2,574,480
8	102,419	184,966	260,217	248,883	296,363	378,688	433,219	575,546
9	45,994	42,593	76,856	157,008	150,456	183,730	239,426	262,351
10+	132,482	74,224	48,539	75,660	140,654	180,474	230,268	284,440

Age	1997	1998	1999	2000	2001	2002	2003	2004
0								
1	40,137,768	30,806,560	19,527,742	40,592,636	64,009,280	34,671,620	41,366,872	41,950,092
2	15,314,992	30,492,660	23,208,058	15,039,314	31,336,016	48,849,068	26,757,696	31,224,204
3	4,353,480	11,222,027	21,317,802	16,517,499	10,575,065	21,754,324	34,914,972	18,904,828
4	2,589,741	2,919,289	6,837,649	13,164,899	9,881,424	6,154,365	13,411,988	21,161,342
5	1,489,306	1,639,443	1,640,733	3,810,114	6,916,746	4,981,085	3,292,873	6,970,656
6	1,083,852	899,824	882,762	915,044	1,995,481	3,480,721	2,660,460	1,639,702
7	972,908	597,449	422,277	439,253	414,796	881,843	1,649,291	1,216,932
8	1,421,670	536,294	280,376	210,121	199,116	183,306	417,849	754,409
9	317,826	783,664	251,677	139,512	95,249	87,993	86,857	191,130
10+	301,947	341,636	528,091	388,004	239,127	147,767	111,712	90,828

Table. Blue whiting. Fishing mortality derived by AMCI.

Age	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0								
1	0.074	0.048	0.154	0.176	0.161	0.148	0.120	0.084
2	0.101	0.079	0.104	0.161	0.182	0.234	0.198	0.173
3	0.189	0.140	0.162	0.216	0.265	0.351	0.299	0.257
4	0.227	0.173	0.198	0.257	0.285	0.420	0.390	0.339
5	0.273	0.199	0.226	0.294	0.323	0.452	0.419	0.401
6	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
7	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
8	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
9	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
10+	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
F(3-7)	0.310	0.227	0.261	0.341	0.386	0.523	0.462	0.431

Age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
0								
1	0.103	0.090	0.035	0.056	0.053	0.051	0.052	0.087
2	0.195	0.182	0.078	0.083	0.078	0.069	0.082	0.107
3	0.308	0.288	0.126	0.132	0.126	0.118	0.142	0.188
4	0.392	0.376	0.162	0.172	0.166	0.152	0.185	0.247
5	0.479	0.460	0.209	0.210	0.200	0.193	0.235	0.301
6	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
7	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
8	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
9	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
10+	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
F(3-7)	0.507	0.496	0.221	0.224	0.210	0.196	0.233	0.305

Age	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
0								
1	0.075	0.083	0.061	0.059	0.070	0.059	0.081	0.073
2	0.111	0.158	0.140	0.152	0.165	0.136	0.147	0.167
3	0.200	0.295	0.282	0.314	0.341	0.284	0.301	0.352
4	0.257	0.376	0.385	0.444	0.485	0.425	0.454	0.505
5	0.304	0.419	0.384	0.447	0.487	0.427	0.497	0.568
6	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
7	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
8	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
9	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
10+	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
F(3-7)	0.310	0.441	0.409	0.477	0.509	0.446	0.483	0.572

Table. Blue whiting. Summary table by AMCI.
Run id 20050829 194934.741

SUMMARY TABLE

Year	Recruits age 1	SSB 3 - 7	F SOP	Catch
1981	3634925	2840186	0.3102	922980
1982	4074635	2340060	0.2275	550643
1983	10886489	1903785	0.2608	553344
1984	18346767	1548446	0.3409	615569
1985	12241432	1651896	0.3858	678214
1986	9473497	1855547	0.5231	847145
1987	8982703	1655472	0.4617	654718
1988	7684032	1469257	0.4306	552264
1989	8938635	1412695	0.5067	630316
1990	22336699	1335867	0.4962	558128
1991	9008614	1803269	0.2213	364008
1992	6160528	2437900	0.2242	474592
1993	5525903	2385790	0.2096	475198
1994	6505223	2354832	0.1960	457696
1995	7617300	2180177	0.2331	505175
1996	20406428	2019352	0.3047	621104
1997	40137767	2062619	0.3104	639680
1998	30806559	2827013	0.4408	1131954
1999	19527741	3434783	0.4093	1261033
2000	40592635	3562036	0.4773	1412449
2001	64009279	4005004	0.5093	1771805
2002	34671620	4881275	0.4460	1556954
2003	41366871	5729501	0.4834	2365319
2004	41950091	5113236	0.5725	2383503

Table. Blue Whiting. Input data for short term prediction.

MFDP version 1

Run: AMCI run 2

Time and date: 15:33 29/09/2005

Fbar age range: 3-7

Recruitment, geometric mean of 1996-2003.

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	31918788	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	21639784	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	10888237	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	10452690	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	3234738	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	654252.9	0.2	1	0.25	0.25	0.172	0.702	0.172
8	485564.7	0.2	1	0.25	0.25	0.198	0.702	0.198
9	301014.8	0.2	1	0.25	0.25	0.224	0.702	0.224
10	112503.5	0.2	1	0.25	0.25	0.278	0.702	0.278

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	.	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	.	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	.	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	.	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	.	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	.	0.2	1	0.25	0.25	0.172	0.702	0.172
8	.	0.2	1	0.25	0.25	0.198	0.702	0.198
9	.	0.2	1	0.25	0.25	0.224	0.702	0.224
10	.	0.2	1	0.25	0.25	0.278	0.702	0.278

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	.	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	.	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	.	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	.	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	.	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	.	0.2	1	0.25	0.25	0.172	0.702	0.172
8	.	0.2	1	0.25	0.25	0.198	0.702	0.198
9	.	0.2	1	0.25	0.25	0.224	0.702	0.224
10	.	0.2	1	0.25	0.25	0.278	0.702	0.278

Input units are thousands and kg - output in tonnes

Table. Blue Whiting. Short term prediction.

2005				
Biomass	SSB	FMult	FBar	Landings
9351161	4935621	1	0.5725	2366726

2006					2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
8723133	5183464	0	0	0	10609585	6771015
.	5150761	0.056	0.0321	154401	10443755	6586761
.	5118297	0.112	0.0641	304857	10282225	6408829
.	5086070	0.168	0.0962	451485	10124864	6236976
.	5054078	0.224	0.1282	594399	9971550	6070970
.	5022320	0.28	0.1603	733709	9822159	5910590
.	4990793	0.336	0.1924	869522	9676575	5755620
.	4959497	0.392	0.2244	1001940	9534685	5605857
.	4928428	0.448	0.2565	1131064	9396379	5461104
.	4897585	0.504	0.2885	1256991	9261550	5321172
.	4866967	0.56	0.3206	1379813	9130096	5185880
.	4836571	0.616	0.3526	1499622	9001916	5055055
.	4806396	0.672	0.3847	1616505	8876915	4928529
.	4776440	0.728	0.4168	1730547	8755000	4806142
.	4746701	0.784	0.4488	1841831	8636080	4687740
.	4717178	0.84	0.4809	1950436	8520067	4573176
.	4687869	0.896	0.5129	2056440	8406877	4462308
.	4658772	0.952	0.545	2159916	8296427	4355000
.	4629885	1.008	0.5771	2260939	8188639	4251122
.	4601208	1.064	0.6091	2359576	8083436	4150546
.	4572738	1.12	0.6412	2455898	7980743	4053154

Input units are thousands and kg - output units are tonnes.

Appendix

Norwegian spring spawning herring.

Rescaled catch in numbers for 2004.

Age	Numbers	Mean weight
0	0.000	0.022
1	0.002	0.065
2	0.037	0.141
3	0.024	0.181
4	0.108	0.211
5	0.591	0.240
6	0.818	0.271
7	0.135	0.303
8	0.129	0.347
9	0.027	0.359
10	0.052	0.368
11	0.151	0.387
12	0.350	0.392
13	0.180	0.400
14	0.023	0.423
15+	0.010	0.438

Table. 3.7.2.1.1 NSSH. Summary of SeaStar exploratory runs.

	Default	EstimateM	IncreasedMPlusgroup	TimeTrendLarvae	NoLarvae	Log	2002InBarents	NoTags	CompatibleISVPA	CorrectingAgeBias
Spawning stock	6.102	5.141	6.133	5.678	5.411	6.120	6.120	6.329	4.564	6.102
Juvenile stock	5.006	4.364	4.983	4.701	4.633	5.111	5.111	5.125	4.318	5.006
terminalF83	0.198	0.217	0.198	0.209	0.208	0.220		0.167	0.174	0.198
terminalF90	0.280	0.381	0.273	0.300	0.312	0.530		0.285	0.392	0.280
terminalF91	0.268	0.334	0.264	0.288	0.295	0.285		0.257	0.367	0.268
terminalF92	0.278	0.353	0.273	0.300	0.308	0.274		0.290	0.417	0.278
terminalF93	0.377	0.439	0.374	0.398	0.404	0.448		0.307	0.437	0.377
terminalF96	0.226	0.279	0.223	0.238	0.246	0.242		0.217	0.292	0.226
terminalF97	0.187	0.223	0.185	0.195	0.200	0.187		0.181	0.237	0.187
terminalF98	0.095	0.115	0.094	0.103	0.108	0.095		0.093	0.127	0.095
terminalF99	0.072	0.087	0.070	0.077	0.081	0.070		0.070	0.090	0.072
terminalF02	0.001	0.001	0.001	0.001	0.001	0.001		0.001	0.001	0.001
terminalF03	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
terminalF04	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
cat1	1.053	1.257	1.057	1.104	1.113	1.036		1.009		1.053
cat2	0.846	1.012	0.831	0.861	0.885	0.755		0.828	0.951	0.846
cat3	0.943	1.119	0.944	0.957	0.960	0.933		0.909		0.943
cat5	1.143	1.379	1.133	1.187	1.208	1.072		1.102	1.326	1.143
catLarvae2	4.699	5.349	4.841	5.173		4.748		4.603		4.699
cat4	0.345	0.367	0.340	0.374	0.364	0.348	0.348	0.338		0.345
cat6	0.494	0.571	0.485	0.543	0.540	0.487	0.487	0.481		0.494
catZero	0.003	0.002	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
distributionParameter1	0.486	0.478	0.491	0.494	0.485	0.525		0.482	0.514	0.486
distributionParameterLarvae	0.674	0.764	0.627	0.430		0.674		0.670		0.674
distributionParameter2	1.945	1.822	1.210	1.227	1.948	1.205	1.205	1.948	113.989	1.945
distParZero	0.249	0.250	0.251	0.243	0.238	0.259	0.259	0.250	0.230	0.249
Log-likelihood per term, survey 1	-1.506	-1.494	-1.505	-1.536	-1.541	-1.560		-1.475		-1.506
Log-likelihood per term, survey 2	-1.238	-1.234	-1.237	-1.224	-1.228	-1.246		-1.260	-1.191	-1.238
Log-likelihood per term, survey 3	-1.823	-1.813	-1.827	-1.832	-1.822	-1.853		-1.835		-1.823
Log-likelihood per term, survey 4	-3.453	-3.432	-3.280	-3.277	-3.452	-3.276	-3.276	-3.457		-3.453
Log-likelihood per term, survey 5	-1.523	-1.487	-1.526	-1.520	-1.513	-1.546		-1.499	-1.507	-1.523
Log-likelihood per term, survey 6	-3.797	-3.766	-3.643	-3.652	-3.804	-3.629	-3.629	-3.799		-3.797
Number of data points, survey 1	27	27	27	27	27	27	0	27	0	27
Number of data points, survey 2	58	58	58	58	58	58	0	58	58	58
Number of data points,										

survey 3	18	18	18	18	18	18	0	18	0	18
Number of data points, survey 4	20	20	20	20	20	20	40	20	0	20
Number of data points, survey 5	65	65	65	65	65	65	0	65	65	65
Number of data points, survey 6	11	11	11	11	11	11	22	11	0	11
vpaM	0.150	0.104	0.150	0.150	0.150	0.150	0.150	0.150	0.150	0.150
vpaMYoung	0.900	1.077	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
survLogLik1	-244.240	-241.169	-244.424	-244.198	-243.987	-248.199	-105.438	-243.357	-167.040	-244.240
survLogLik2	-110.823	-110.061	-105.663	-105.716	-110.879	-105.438	-105.438	-110.919	0.000	-110.823
tagLogLik1	-369.756	-365.624	-369.722	-369.545	-369.620	-369.093	0.000	0.000	0.000	-369.756
tagLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
larvLogLik1	-80.560	-84.084	-78.634	-68.730	0.000	-80.624	0.000	-80.387	0.000	-80.560
larvLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
zeroLogLik1	0.000	0.000	0.000	0.000	0.000	0.000	-0.870	0.000	0.000	0.000
zeroLogLik2	-0.362	-0.104	-0.460	-0.075	0.215	-0.870	-0.870	-0.432	0.678	-0.362
predLogLik1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
predLogLik2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 3.7.4.1. NSSH. Stock in numbers.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2005	0.000	163.151	26.549	19.391	0.921	2.070	7.492	7.709	0.614	0.476	0.078	0.124	0.306	1.027	0.551	0.068	0.020
2004	401.287	65.302	47.753	1.097	2.521	9.341	9.839	0.859	0.692	0.120	0.200	0.518	1.571	0.835	0.104	0.015	0.021
2003	160.617	117.458	2.705	3.006	11.189	12.203	1.185	0.981	0.164	0.312	0.831	2.418	1.199	0.166	0.027	0.009	0.029
2002	288.899	6.652	7.492	13.214	14.871	1.652	1.492	0.223	0.463	1.250	3.524	1.758	0.250	0.045	0.018	0.002	0.050
2001	16.362	18.427	32.504	17.387	2.093	2.193	0.301	0.642	1.772	4.999	2.589	0.370	0.077	0.025	0.005	0.000	0.094
2000	45.323	79.946	42.789	2.522	3.152	0.387	0.865	2.495	7.208	4.135	0.664	0.167	0.046	0.031	0.025	0.026	0.158
1999	196.635	105.244	6.211	3.810	0.488	1.150	3.362	10.105	6.059	1.085	0.308	0.069	0.079	0.037	0.125	0.000	0.347
1998	258.857	15.276	9.502	0.643	1.597	4.303	13.637	8.402	1.672	0.498	0.126	0.119	0.047	0.267	0.006	0.650	0.005
1997	37.573	23.372	1.616	1.996	5.291	17.780	11.910	2.763	0.931	0.213	0.160	0.089	0.408	0.028	1.155	0.001	0.006
1996	57.485	3.974	4.958	6.184	21.427	15.531	4.224	1.519	0.358	0.192	0.112	0.545	0.051	2.243	0.002	0.000	0.011
1995	9.773	12.194	15.213	24.956	18.418	5.579	2.453	0.665	0.239	0.147	0.709	0.150	3.589	0.006	0.000	0.000	0.017
1994	29.993	37.417	61.395	21.434	6.601	3.242	0.951	0.295	0.179	0.863	0.212	4.866	0.010	0.000	0.000	0.023	0.006
1993	92.042	151.007	52.729	7.700	3.882	1.199	0.352	0.212	1.035	0.267	6.095	0.012	0.000	0.000	0.027	0.000	0.010
1992	371.421	129.694	18.941	4.524	1.428	0.414	0.248	1.216	0.316	7.325	0.017	0.002	0.000	0.033	0.000	0.000	0.016
1991	318.995	46.592	11.132	1.669	0.484	0.289	1.428	0.377	8.746	0.022	0.003	0.000	0.039	0.000	0.000	0.024	0.002
1990	114.598	27.381	4.129	0.583	0.339	1.672	0.449	10.405	0.027	0.005	0.003	0.048	0.000	0.000	0.029	0.001	0.002
1989	67.357	10.158	1.473	0.397	1.947	0.528	12.439	0.035	0.006	0.004	0.059	0.002	0.001	0.034	0.002	0.000	0.003
1988	25.009	3.628	0.991	2.329	0.641	15.045	0.051	0.011	0.011	0.085	0.012	0.005	0.043	0.005	0.002	0.002	0.003
1987	8.945	2.447	5.786	0.766	18.020	0.079	0.017	0.021	0.128	0.027	0.016	0.055	0.014	0.009	0.010	0.001	0.004
1986	6.041	14.232	1.888	21.519	0.111	0.035	0.041	0.262	0.113	0.063	0.147	0.037	0.082	0.097	0.002	0.000	0.007
1985	35.051	4.665	53.252	0.152	0.058	0.065	0.445	0.194	0.133	0.238	0.054	0.128	0.167	0.002	0.000	0.000	0.014
1984	11.528	130.982	0.378	0.072	0.081	0.583	0.246	0.168	0.294	0.071	0.167	0.201	0.002	0.000	0.000	0.026	0.000
1983	322.362	0.938	0.179	0.098	0.700	0.296	0.202	0.348	0.084	0.198	0.242	0.003	0.000	0.000	0.032	0.000	0.000
1982	2.343	0.442	0.241	0.829	0.352	0.240	0.412	0.099	0.236	0.287	0.003	0.000	0.000	0.037	0.000	0.000	0.000
1981	1.100	0.595	2.057	0.413	0.283	0.487	0.118	0.279	0.343	0.004	0.000	0.000	0.044	0.000	0.000	0.000	0.000
1980	1.474	5.060	1.017	0.336	0.573	0.139	0.333	0.415	0.005	0.000	0.000	0.054	0.000	0.000	0.000	0.000	0.000
1979	12.498	2.508	0.830	0.672	0.164	0.394	0.494	0.007	0.000	0.000	0.065	0.000	0.000	0.000	0.000	0.000	0.001
1978	6.201	2.044	1.655	0.194	0.471	0.596	0.009	0.000	0.001	0.081	0.000	0.000	0.000	0.000	0.000	0.000	0.002
1977	5.095	4.080	0.482	0.571	0.718	0.010	0.000	0.002	0.106	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.003
1976	10.068	1.188	1.407	0.860	0.018	0.000	0.002	0.137	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005
1975	2.971	3.467	2.117	0.024	0.000	0.004	0.192	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.008
1974	8.631	5.220	0.066	0.000	0.004	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.014
1973	12.884	0.168	0.005	0.008	0.317	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.023
1972	0.957	0.077	0.051	0.407	0.005	0.006	0.003	0.001	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.037
1971	0.236	0.193	1.134	0.008	0.008	0.005	0.002	0.003	0.002	0.000	0.006	0.008	0.007	0.000	0.000	0.000	0.061
1970	0.661	3.620	0.072	0.017	0.026	0.003	0.007	0.005	0.002	0.021	0.038	0.038	0.000	0.000	0.000	0.000	0.101
1969	9.785	0.972	0.263	0.233	0.004	0.018	0.011	0.003	0.037	0.080	0.083	0.000	0.000	0.000	0.000	0.000	0.168
1968	5.187	1.333	1.182	0.111	2.048	1.509	0.018	0.144	0.238	0.469	0.003	0.002	0.002	0.003	0.004	0.003	0.276
1967	3.947	18.398	0.384	3.880	5.260	0.050	0.622	1.496	2.400	0.013	0.008	0.006	0.013	0.014	0.022	0.020	0.455
1966	51.409	1.984	12.175	8.320	0.087	1.225	3.146	5.897	0.056	0.025	0.025	0.043	0.028	0.100	0.100	0.148	0.719
1965	8.491	35.874	24.938	0.198	1.700	4.271	9.222	0.086	0.045	0.037	0.071	0.076	0.224	0.233	0.321	1.627	0.148
1964	93.903	65.617	0.833	2.098	5.392	12.920	0.115	0.054	0.047	0.109	0.120	0.364	0.359	0.538	2.724	0.180	0.295
1963	168.931	5.371	8.368	7.085	15.912	0.139	0.064	0.058	0.146	0.149	0.539	0.517	0.813	4.160	0.294	0.286	0.573

1962	19.003	26.983	19.058	20.474	0.170	0.078	0.075	0.192	0.186	0.690	0.658	1.070	5.710	0.390	0.391	0.517	0.589
1961	76.103	72.088	54.883	0.231	0.099	0.092	0.239	0.237	0.868	0.817	1.390	7.419	0.506	0.503	0.669	0.233	0.849
1960	197.514	156.290	1.185	0.247	0.127	0.308	0.302	1.112	1.029	1.835	9.874	0.680	0.725	0.942	0.331	0.392	1.057
1959	412.478	3.225	1.117	0.163	0.387	0.379	1.449	1.319	2.391	12.661	0.886	0.976	1.308	0.480	0.539	0.860	1.040
1958	23.094	7.136	1.447	0.468	0.460	1.804	1.628	2.988	15.760	1.105	1.266	1.737	0.665	0.709	1.075	0.948	0.959
1957	25.397	8.719	1.496	0.559	2.498	2.058	3.718	20.450	1.362	1.608	2.214	0.867	0.955	1.410	1.244	0.381	1.440
1956	29.858	6.852	2.358	3.028	2.662	4.658	26.514	1.701	2.089	2.857	1.149	1.323	1.932	1.621	0.510	0.787	1.905
1955	24.971	10.303	8.247	3.193	5.710	33.009	2.099	2.631	3.616	1.427	1.745	2.564	2.102	0.656	1.005	1.124	2.629
1954	42.086	31.374	9.195	6.921	39.898	2.593	3.311	4.730	1.795	2.243	3.453	2.939	0.858	1.277	1.449	1.115	3.831
1953	86.102	30.543	17.934	47.153	3.063	3.956	5.878	2.174	2.726	4.351	3.840	1.063	1.581	1.785	1.402	3.082	4.103
1952	96.644	58.460	117.910	3.601	4.661	7.479	2.673	3.387	5.465	4.869	1.321	1.930	2.190	1.744	3.782	3.938	3.488
1951	146.355	301.944	9.484	5.422	9.103	3.292	4.113	6.905	6.306	1.617	2.331	2.656	2.142	4.667	4.950	0.757	5.388
1950	750.680	26.465	14.278	10.874	4.023	4.978	8.612	8.004	1.965	2.804	3.203	2.583	5.632	6.148	0.952	2.567	6.709

Table. NSSH. Modelled historic F-values.

Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2005	0.000	0.000	0.001	0.010	0.025	0.048	0.067	0.084	0.092	0.108	0.138	0.110	0.092	0.093	0.093	0.093	0.093
2004	0.000	0.000	0.001	0.024	0.047	0.071	0.094	0.185	0.223	0.273	0.324	0.374	0.273	0.264	0.273	0.262	1.340
2003	0.000	0.000	0.002	0.026	0.031	0.065	0.171	0.199	0.163	0.295	0.322	0.282	0.212	0.317	0.429	0.252	0.118
2002	0.000	0.000	0.013	0.016	0.048	0.182	0.269	0.156	0.245	0.259	0.227	0.233	0.259	0.358	0.542	0.241	0.281
2001	0.000	0.000	0.000	0.006	0.086	0.235	0.150	0.176	0.199	0.200	0.237	0.242	0.401	0.166	1.120	0.230	0.261
2000	0.000	0.000	0.001	0.037	0.213	0.102	0.149	0.192	0.216	0.318	0.434	0.620	0.476	1.590	8.330	0.219	0.687
1999	0.000	0.000	0.001	0.040	0.082	0.135	0.148	0.188	0.232	0.342	0.463	0.256	0.793	0.236	1.430	0.208	0.085
1998	0.000	0.000	0.014	0.125	0.179	0.097	0.150	0.177	0.282	0.330	0.450	0.261	0.084	0.606	6.820	0.198	0.000
1997	0.000	0.000	0.021	0.073	0.057	0.115	0.199	0.352	0.475	0.369	0.145	0.497	0.273	1.370	0.424	0.262	0.000
1996	0.000	0.000	0.010	0.006	0.037	0.115	0.274	0.340	0.373	0.033	0.074	0.140	0.463	0.514	0.001	0.303	0.000
1995	0.000	0.000	0.000	0.002	0.021	0.128	0.329	0.469	0.072	0.124	0.112	0.925	0.320	1.200	4.050	0.100	0.014
1994	0.000	0.000	0.000	0.002	0.018	0.129	0.207	0.059	0.050	0.048	0.200	0.154	0.349	0.939	2.220	0.100	0.000
1993	0.000	0.000	0.000	0.004	0.030	0.082	0.027	0.019	0.031	0.078	0.075	0.000	0.001	0.008	0.000	0.059	0.000
1992	0.000	0.000	0.000	0.003	0.025	0.013	0.005	0.011	0.020	0.034	0.175	0.486	0.963	0.041	0.048	0.029	0.000
1991	0.000	0.000	0.000	0.005	0.006	0.005	0.011	0.026	0.027	0.130	0.214	0.172	0.019	1.650	1.990	0.024	0.004
1990	0.000	0.000	0.006	0.035	0.008	0.008	0.026	0.024	0.053	0.436	1.430	0.056	1.680	0.413	0.022	0.153	0.266
1989	0.000	0.000	0.027	0.008	0.002	0.012	0.029	0.113	0.149	0.198	0.062	0.912	0.744	0.010	0.171	0.090	0.000
1988	0.001	0.001	0.015	0.030	0.043	0.040	0.223	0.436	0.857	0.206	1.460	1.060	0.088	0.875	4.760	0.381	0.000
1987	0.002	0.004	0.010	0.028	0.030	0.293	0.254	0.461	0.268	0.639	1.060	0.093	0.903	1.520	1.520	0.417	0.000
1986	0.004	0.000	0.003	0.027	0.187	0.588	0.530	0.565	1.260	1.250	0.835	0.820	2.060	2.160	0.001	1.400	0.594
1985	0.001	0.004	0.006	0.165	0.343	0.320	0.378	0.396	0.590	0.336	0.221	0.302	0.389	0.001	0.506	0.379	0.087
1984	0.005	0.000	0.010	0.070	0.074	0.121	0.083	0.085	0.059	0.116	0.112	0.035	0.000	0.294	0.242	0.070	0.000
1983	0.001	0.008	0.015	0.036	0.033	0.035	0.034	0.021	0.017	0.025	0.033	0.058	2.280	3.310	0.030	0.029	0.000
1982	0.015	0.004	0.001	0.018	0.025	0.021	0.017	0.022	0.023	0.023	0.040	0.539	0.194	0.004	0.024	0.022	0.000
1981	0.012	0.003	0.009	0.011	0.018	0.019	0.020	0.018	0.026	0.092	0.692	0.384	0.024	0.021	0.019	0.028	0.000
1980	0.007	0.000	0.001	0.021	0.011	0.018	0.027	0.042	0.093	0.033	0.002	0.055	0.017	0.016	0.023	0.058	0.000
1979	0.004	0.002	0.004	0.010	0.012	0.019	0.025	0.055	0.003	0.002	0.043	0.015	0.013	0.020	0.048	0.042	0.000
1978	0.005	0.002	0.001	0.017	0.028	0.037	0.115	0.003	0.743	0.069	0.012	0.011	0.017	0.039	0.035	0.079	0.000
1977	0.013	0.002	0.010	0.043	0.036	0.036	0.003	0.266	0.116	0.011	0.010	0.014	0.033	0.029	0.064	0.116	0.000
1976	0.003	0.003	0.001	0.030	0.397	0.002	0.000	0.109	0.009	0.008	0.012	0.027	0.024	0.052	0.090	0.015	0.000
1975	0.016	0.002	0.001	0.157	0.222	0.319	0.189	0.038	0.014	0.010	0.023	0.021	0.043	0.072	0.012	0.019	0.000
1974	0.012	0.002	0.097	0.122	0.060	0.112	0.973	0.779	0.009	0.019	0.017	0.035	0.058	0.011	0.016	0.017	0.000
1973	0.004	0.033	0.769	0.405	0.090	0.857	1.520	1.120	1.370	0.015	0.029	0.047	0.009	0.014	1.260	0.603	0.000
1972	0.842	1.830	0.987	0.098	1.290	0.956	1.820	1.250	2.980	1.780	0.039	1.570	2.070	1.110	0.332	2.110	0.000
1971	0.226	0.429	0.125	0.283	0.140	0.308	0.277	0.476	1.630	2.550	1.960	2.280	1.840	0.217	2.800	2.030	0.000
1970	0.333	0.261	1.300	0.529	1.490	0.298	0.678	1.100	1.160	1.180	1.370	1.550	3.940	1.620	0.823	1.410	0.024
1969	0.094	1.710	1.870	2.050	0.259	0.756	0.599	0.347	0.419	0.600	0.626	0.612	0.867	0.394	0.843	0.578	0.015
1968	0.775	0.722	0.724	3.230	4.590	4.750	1.810	1.210	0.936	1.580	1.290	1.320	0.771	1.960	1.250	1.360	0.067
1967	0.186	1.850	0.339	0.489	1.100	0.853	1.310	1.690	1.480	1.330	1.450	1.080	1.260	1.130	1.990	1.480	0.208
1966	0.128	0.742	0.244	0.308	0.405	0.529	0.593	0.749	1.310	0.976	1.340	1.060	0.543	1.370	1.480	1.190	0.280
1965	0.554	0.181	0.198	0.672	0.177	0.156	0.297	0.280	0.444	0.239	0.344	0.838	0.659	0.691	0.627	0.620	0.948
1964	0.062	0.067	0.536	0.061	0.083	0.187	0.138	0.031	0.072	0.283	0.306	0.333	0.284	0.366	0.365	0.320	0.849

1963	0.046	0.964	0.483	0.123	0.058	0.042	0.031	0.069	0.145	0.070	0.243	0.214	0.263	0.274	0.344	0.257	0.156
1962	0.364	0.271	0.090	0.102	0.052	0.044	0.109	0.121	0.071	0.097	0.090	0.125	0.167	0.130	0.163	0.147	0.143
1961	0.137	0.430	0.086	0.157	0.092	0.049	0.070	0.092	0.080	0.067	0.112	0.112	0.112	0.101	0.107	0.106	0.040
1960	0.108	0.147	0.733	0.759	0.168	0.104	0.091	0.098	0.080	0.128	0.136	0.145	0.214	0.193	0.204	0.139	0.084
1959	0.071	0.102	0.611	0.105	0.078	0.077	0.115	0.099	0.115	0.099	0.114	0.148	0.178	0.221	0.168	0.113	0.101
1958	1.070	0.954	1.280	0.041	0.043	0.069	0.061	0.073	0.069	0.071	0.111	0.133	0.174	0.125	0.074	0.082	0.192
1957	0.369	0.896	0.262	0.046	0.176	0.084	0.069	0.111	0.059	0.089	0.093	0.116	0.147	0.121	0.121	0.100	0.151
1956	0.331	0.622	0.540	0.042	0.107	0.076	0.110	0.072	0.111	0.105	0.131	0.176	0.165	0.115	0.143	0.130	0.219
1955	0.393	0.575	0.102	0.032	0.054	0.069	0.061	0.081	0.085	0.067	0.127	0.133	0.110	0.101	0.095	0.104	0.175
1954	0.507	0.436	0.158	0.042	0.040	0.061	0.080	0.118	0.080	0.101	0.148	0.185	0.118	0.089	0.104	0.130	0.132
1953	0.110	0.301	0.052	0.017	0.017	0.028	0.067	0.041	0.045	0.081	0.117	0.065	0.064	0.059	0.079	0.078	0.085
1952	0.252	0.282	0.017	0.012	0.014	0.091	0.057	0.067	0.078	0.087	0.067	0.049	0.055	0.068	0.055	0.073	0.096
1951	0.018	0.040	0.068	0.001	0.047	0.058	0.044	0.084	0.109	0.053	0.039	0.043	0.056	0.060	0.079	0.070	0.050
1950	0.011	0.126	0.068	0.028	0.051	0.041	0.071	0.088	0.045	0.035	0.038	0.037	0.038	0.067	0.078	0.046	0.033

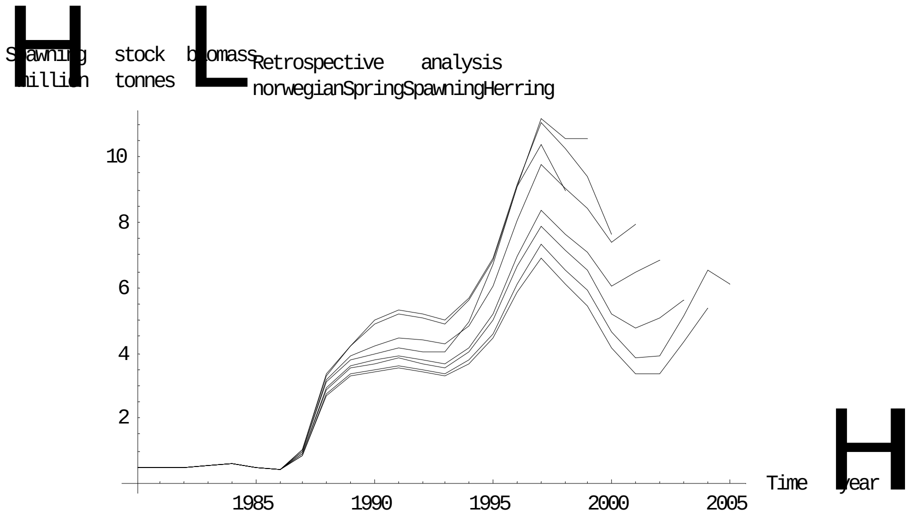

Figure 3.7.2.1.12. NSSH. Retrospective plot for the assessment in 2004.

Table 3.7.4.2 NSSH. Stock summary table. Biomass in million tonnes.

	Recruits Age 0	Total biomass	Spawning stock biomass	Fbar 5-14
1950	750.680	20.013	14.359	0.058
1951	146.355	19.274	12.635	0.070
1952	96.644	20.182	11.042	0.073
1953	86.102	17.419	9.457	0.066
1954	42.086	18.565	8.703	0.113
1955	24.971	15.725	9.324	0.078
1956	29.858	13.799	10.934	0.110
1957	25.397	11.088	9.661	0.103
1958	23.094	9.549	8.731	0.079
1959	412.478	8.076	7.200	0.113
1960	197.514	7.634	5.853	0.136
1961	76.103	7.796	4.403	0.104
1962	19.003	6.765	3.443	0.146
1963	168.931	6.913	2.641	0.253
1964	93.903	6.446	2.479	0.226
1965	8.491	5.935	2.996	0.278
1966	51.409	4.392	2.658	0.696
1967	3.947	3.018	1.304	1.519
1968	5.187	0.982	0.318	3.493
1969	9.785	0.190	0.142	0.590
1970	0.661	0.116	0.069	1.320
1971	0.236	0.130	0.032	1.525
1972	0.957	0.085	0.016	1.497
1973	12.884	0.112	0.086	1.173
1974	8.631	0.160	0.091	0.114
1975	2.971	0.302	0.079	0.190
1976	10.068	0.362	0.139	0.106
1977	5.095	0.429	0.288	0.111
1978	6.201	0.579	0.360	0.043
1979	12.498	0.635	0.391	0.024
1980	1.474	0.748	0.475	0.034
1981	1.100	0.796	0.509	0.022
1982	2.343	0.729	0.507	0.020
1983	322.362	1.086	0.579	0.029
1984	11.528	2.009	0.603	0.090
1985	35.051	5.166	0.502	0.379
1986	6.041	1.815	0.401	1.074
1987	8.945	3.117	0.877	0.404
1988	25.009	3.485	2.738	0.045
1989	67.357	4.067	3.335	0.029
1990	114.598	4.550	3.490	0.022
1991	318.995	5.187	3.628	0.025
1992	371.421	6.208	3.496	0.029
1993	92.042	7.270	3.352	0.068
1994	29.993	8.275	3.775	0.139
1995	9.773	9.061	4.592	0.240
1996	57.485	9.123	6.113	0.197
1997	37.573	9.012	7.308	0.187
1998	258.857	7.841	6.564	0.168
1999	196.635	8.863	5.930	0.212
2000	45.323	7.986	4.635	0.262
2001	16.362	6.798	3.878	0.213
2002	288.899	7.220	3.918	0.232
2003	160.617	8.542	5.107	0.132
2004	401.287	10.180	6.513	0.119

Table 3.9.1.1 NSSH. Input to the short term prediction.

Landings in 2005 1. million tonnes
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Total biomass in 2005 11.1161 million tonnes
Spawning stock biomass in 2005 6.13347 million tonnes
Fbar in 2005 0.1846
Part of year before spawning: 0.1

	Numbers (billion) 2005	Weight stock 2005	Weight stock 2006	Weight stock 2007	Weight catch (kg)	Fraction mature 2005	Fraction mature 2006	Fraction mature 2007	Exploitation pattern
0	0.000	0.001	0.001	0.001	0.007	0.000	0.000	0.000	0.000
1	163.151	0.010	0.010	0.010	0.065	0.000	0.000	0.000	0.000
2	26.549	0.047	0.050	0.050	0.143	0.000	0.000	0.000	0.002
3	19.391	0.112	0.110	0.110	0.183	0.150	0.100	0.100	0.013
4	0.921	0.154	0.160	0.160	0.211	0.450	0.600	0.450	0.047
5	2.070	0.233	0.249	0.246	0.236	0.900	0.900	0.900	0.106
6	7.492	0.265	0.282	0.279	0.263	1.000	1.000	1.000	0.174
7	7.709	0.289	0.310	0.306	0.297	1.000	1.000	1.000	0.215
8	0.614	0.317	0.339	0.335	0.342	1.000	1.000	1.000	0.239
9	0.476	0.354	0.367	0.362	0.358	1.000	1.000	1.000	0.262
10	0.078	0.362	0.379	0.375	0.361	1.000	1.000	1.000	0.254
11	0.124	0.411	0.416	0.411	0.382	1.000	1.000	1.000	0.288
12	0.306	0.394	0.406	0.401	0.389	1.000	1.000	1.000	0.294
13	1.027	0.398	0.409	0.405	0.399	1.000	1.000	1.000	0.465
14	0.551	0.413	0.423	0.418	0.420	1.000	1.000	1.000	0.666
15	0.068	0.442	0.470	0.464	0.439	1.000	1.000	1.000	0.201
16	0.020	0.445	0.470	0.464	0.439	1.000	1.000	1.000	0.282

Table 3.9.1.2 NSSH. Short term prediction and two optional runs.

Short term prediction. Averaging period 10 Averaged

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.498	0.000	0.000	12.467	8.500
6.437	0.115	0.588	11.873	7.866
6.435	0.120	0.613	11.848	7.840
6.432	0.125	0.636	11.824	7.815
6.430	0.130	0.660	11.800	7.789
6.427	0.135	0.684	11.776	7.764
6.424	0.140	0.708	11.753	7.739
6.422	0.145	0.731	11.729	7.714
6.419	0.150	0.755	11.705	7.689
6.417	0.155	0.778	11.682	7.664
6.414	0.160	0.801	11.659	7.640

Optional 1. Short term prediction Averaging period 10 Averaged - Increase 1 year on 4 year olds

SSB 2006	Fbar	Landings 2006	Biomass 3+ 2007	SSB 2007
6.489	0.000	0.000	12.457	8.490
6.424	0.115	0.676	11.767	7.771
6.421	0.120	0.704	11.739	7.741
6.418	0.125	0.732	11.711	7.712
6.415	0.130	0.759	11.683	7.683
6.412	0.135	0.786	11.655	7.654
6.410	0.140	0.814	11.628	7.626
6.407	0.145	0.841	11.600	7.597
6.404	0.150	0.868	11.573	7.569
6.401	0.155	0.895	11.545	7.541
6.398	0.160	0.921	11.518	7.513

Optional 2. Catches in 2006 and SSB in 2007 if the fishing mortality is applied to spawning stock biomass

	Catch 2006	SSB 2007
0.000	0.000	7.380
0.115	0.758	7.296
0.120	0.791	7.292
0.125	0.823	7.288
0.130	0.856	7.285
0.135	0.889	7.281
0.140	0.922	7.277
0.145	0.955	7.274
0.150	0.988	7.270
0.155	1.021	7.267
0.160	1.054	7.263

Blue Whiting.

Table. Blue whiting. Stock numbers at age derived by AMCI.

Age	1981	1982	1983	1984	1985	1986	1987	1988
0								
1	3,634,926	4,074,635	10,886,489	18,346,768	12,241,432	9,473,498	8,982,704	7,684,033
2	3,994,375	2,763,744	3,179,573	7,637,886	12,598,817	8,534,761	6,686,965	6,520,681
3	4,787,469	2,956,782	2,090,780	2,345,821	5,324,109	8,596,914	5,530,846	4,489,524
4	3,032,825	3,246,249	2,105,565	1,455,627	1,547,086	3,343,590	4,952,787	3,357,315
5	2,421,173	1,978,893	2,236,277	1,414,218	921,378	952,453	1,798,949	2,745,985
6	2,309,452	1,509,387	1,327,705	1,461,018	863,349	546,013	496,258	968,288
7	1,878,814	1,228,032	903,621	759,007	748,554	417,017	222,861	222,973
8	1,799,023	999,044	735,182	516,571	388,878	361,568	170,210	100,133
9	1,487,675	956,615	598,095	420,281	264,666	187,837	147,578	76,477
10+	3,149,132	2,465,584	2,048,759	1,513,122	990,581	606,312	324,140	211,947

Age	1989	1990	1991	1992	1993	1994	1995	1996
0								
1	8,938,636	22,336,700	9,008,614	6,160,529	5,525,904	6,505,224	7,617,300	20,406,428
2	5,786,361	6,601,063	16,718,297	7,119,122	4,769,354	4,291,179	5,060,322	5,919,291
3	4,492,794	3,896,371	4,504,638	12,659,255	5,362,474	3,612,442	3,279,957	3,817,265
4	2,841,816	2,704,454	2,391,453	3,252,181	9,078,501	3,872,129	2,628,043	2,329,541
5	1,958,331	1,572,766	1,520,596	1,665,696	2,242,592	6,296,292	2,722,504	1,788,218
6	1,505,873	992,705	812,496	1,010,437	1,105,252	1,503,193	4,251,225	1,761,823
7	444,766	626,251	412,484	490,239	610,836	685,201	950,396	2,574,480
8	102,419	184,966	260,217	248,883	296,363	378,688	433,219	575,546
9	45,994	42,593	76,856	157,008	150,456	183,730	239,426	262,351
10+	132,482	74,224	48,539	75,660	140,654	180,474	230,268	284,440

Age	1997	1998	1999	2000	2001	2002	2003	2004
0								
1	40,137,768	30,806,560	19,527,742	40,592,636	64,009,280	34,671,620	41,366,872	41,950,092
2	15,314,992	30,492,660	23,208,058	15,039,314	31,336,016	48,849,068	26,757,696	31,224,204
3	4,353,480	11,222,027	21,317,802	16,517,499	10,575,065	21,754,324	34,914,972	18,904,828
4	2,589,741	2,919,289	6,837,649	13,164,899	9,881,424	6,154,365	13,411,988	21,161,342
5	1,489,306	1,639,443	1,640,733	3,810,114	6,916,746	4,981,085	3,292,873	6,970,656
6	1,083,852	899,824	882,762	915,044	1,995,481	3,480,721	2,660,460	1,639,702
7	972,908	597,449	422,277	439,253	414,796	881,843	1,649,291	1,216,932
8	1,421,670	536,294	280,376	210,121	199,116	183,306	417,849	754,409
9	317,826	783,664	251,677	139,512	95,249	87,993	86,857	191,130
10+	301,947	341,636	528,091	388,004	239,127	147,767	111,712	90,828

Table. Blue whiting. Fishing mortality derived by AMCI.

Age	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**
0								
1	0.074	0.048	0.154	0.176	0.161	0.148	0.120	0.084
2	0.101	0.079	0.104	0.161	0.182	0.234	0.198	0.173
3	0.189	0.140	0.162	0.216	0.265	0.351	0.299	0.257
4	0.227	0.173	0.198	0.257	0.285	0.420	0.390	0.339
5	0.273	0.199	0.226	0.294	0.323	0.452	0.419	0.401
6	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
7	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
8	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
9	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
10+	0.432	0.313	0.359	0.469	0.528	0.696	0.600	0.578
F(3-7)	0.310	0.227	0.261	0.341	0.386	0.523	0.462	0.431

Age	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
0								
1	0.103	0.090	0.035	0.056	0.053	0.051	0.052	0.087
2	0.195	0.182	0.078	0.083	0.078	0.069	0.082	0.107
3	0.308	0.288	0.126	0.132	0.126	0.118	0.142	0.188
4	0.392	0.376	0.162	0.172	0.166	0.152	0.185	0.247
5	0.479	0.460	0.209	0.210	0.200	0.193	0.235	0.301
6	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
7	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
8	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
9	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
10+	0.677	0.678	0.305	0.303	0.278	0.258	0.302	0.394
F(3-7)	0.507	0.496	0.221	0.224	0.210	0.196	0.233	0.305

Age	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
0								
1	0.075	0.083	0.061	0.059	0.070	0.059	0.081	0.073
2	0.111	0.158	0.140	0.152	0.165	0.136	0.147	0.167
3	0.200	0.295	0.282	0.314	0.341	0.284	0.301	0.352
4	0.257	0.376	0.385	0.444	0.485	0.425	0.454	0.505
5	0.304	0.419	0.384	0.447	0.487	0.427	0.497	0.568
6	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
7	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
8	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
9	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
10+	0.396	0.557	0.498	0.591	0.617	0.547	0.582	0.719
F(3-7)	0.310	0.441	0.409	0.477	0.509	0.446	0.483	0.572

Table. Blue whiting. Summary table by AMCI.

Run id 20050829 194934.741

SUMMARY TABLE

Year	Recruits age 1	SSB	F 3 - 7	Catch SOP
1981	3634925	2840186	0.3102	922980
1982	4074635	2340060	0.2275	550643
1983	10886489	1903785	0.2608	553344
1984	18346767	1548446	0.3409	615569
1985	12241432	1651896	0.3858	678214
1986	9473497	1855547	0.5231	847145
1987	8982703	1655472	0.4617	654718
1988	7684032	1469257	0.4306	552264
1989	8938635	1412695	0.5067	630316
1990	22336699	1335867	0.4962	558128
1991	9008614	1803269	0.2213	364008
1992	6160528	2437900	0.2242	474592
1993	5525903	2385790	0.2096	475198
1994	6505223	2354832	0.1960	457696
1995	7617300	2180177	0.2331	505175
1996	20406428	2019352	0.3047	621104
1997	40137767	2062619	0.3104	639680
1998	30806559	2827013	0.4408	1131954
1999	19527741	3434783	0.4093	1261033
2000	40592635	3562036	0.4773	1412449
2001	64009279	4005004	0.5093	1771805
2002	34671620	4881275	0.4460	1556954
2003	41366871	5729501	0.4834	2365319
2004	41950091	5113236	0.5725	2383503

Table. Blue Whiting. Input data for short term prediction.

MFDP version 1

Run: AMCI run 2

Time and date: 15:33 29/09/2005

Fbar age range: 3-7

Recruitment, geometric mean of 1996-2003.

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	31918788	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	21639784	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	10888237	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	10452690	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	3234738	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	654252.9	0.2	1	0.25	0.25	0.172	0.702	0.172
8	485564.7	0.2	1	0.25	0.25	0.198	0.702	0.198
9	301014.8	0.2	1	0.25	0.25	0.224	0.702	0.224
10	112503.5	0.2	1	0.25	0.25	0.278	0.702	0.278

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	.	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	.	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	.	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	.	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	.	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	.	0.2	1	0.25	0.25	0.172	0.702	0.172
8	.	0.2	1	0.25	0.25	0.198	0.702	0.198
9	.	0.2	1	0.25	0.25	0.224	0.702	0.224
10	.	0.2	1	0.25	0.25	0.278	0.702	0.278

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	34118628	0.2	0.11	0.25	0.25	0.049	0.081	0.049
2	.	0.2	0.4	0.25	0.25	0.073	0.175	0.073
3	.	0.2	0.82	0.25	0.25	0.094	0.364	0.094
4	.	0.2	0.86	0.25	0.25	0.108	0.532	0.108
5	.	0.2	0.91	0.25	0.25	0.129	0.563	0.129
6	.	0.2	0.94	0.25	0.25	0.153	0.702	0.153
7	.	0.2	1	0.25	0.25	0.172	0.702	0.172
8	.	0.2	1	0.25	0.25	0.198	0.702	0.198
9	.	0.2	1	0.25	0.25	0.224	0.702	0.224
10	.	0.2	1	0.25	0.25	0.278	0.702	0.278

Input units are thousands and kg - output in tonnes

Table. Blue Whiting. Short term prediction.

2005				
Biomass	SSB	FMult	FBar	Landings
9351161	4935621	1	0.5725	2366726

2006					2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
8723133	5183464	0	0	0	10609585	6771015
.	5150761	0.056	0.0321	154401	10443755	6586761
.	5118297	0.112	0.0641	304857	10282225	6408829
.	5086070	0.168	0.0962	451485	10124864	6236976
.	5054078	0.224	0.1282	594399	9971550	6070970
.	5022320	0.28	0.1603	733709	9822159	5910590
.	4990793	0.336	0.1924	869522	9676575	5755620
.	4959497	0.392	0.2244	1001940	9534685	5605857
.	4928428	0.448	0.2565	1131064	9396379	5461104
.	4897585	0.504	0.2885	1256991	9261550	5321172
.	4866967	0.56	0.3206	1379813	9130096	5185880
.	4836571	0.616	0.3526	1499622	9001916	5055055
.	4806396	0.672	0.3847	1616505	8876915	4928529
.	4776440	0.728	0.4168	1730547	8755000	4806142
.	4746701	0.784	0.4488	1841831	8636080	4687740
.	4717178	0.84	0.4809	1950436	8520067	4573176
.	4687869	0.896	0.5129	2056440	8406877	4462308
.	4658772	0.952	0.545	2159916	8296427	4355000
.	4629885	1.008	0.5771	2260939	8188639	4251122
.	4601208	1.064	0.6091	2359576	8083436	4150546
.	4572738	1.12	0.6412	2455898	7980743	4053154

Input units are thousands and kg - output units are tonnes.