ICES Advisory Committee on Fishery Management
ICES CM 2004/ACFM:24

Report of the

Northern Pelagic and Blue Whiting Fisheries Working Group

27 April – 4 May 2004
ICES, Copenhagen

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark
Telephone + 45 33 15 42 25 · Telefax +45 33 93 42 15
www.ices.dk · info@ices.dk

TABLE OF CONTENTS

Section Page

1 INTRODUCTION ... 1
1.1 Terms of reference ... 1
1.2 List of participants ... 1
1.3 Non-standard assessment methods ... 2
1.3.1 AMCI ... 2
1.3.2 SeaStar ... 2
1.3.2.1 Tuning ... 2
1.3.2.2 Analysis of assessment uncertainty using bootstrap ... 3
1.3.2.3 Bias in the assessment due to discarding of old scales ... 4
1.3.3 ISVPA ... 5
1.4 Recommendation ... 5
1.5 Where TORs are adressed ... 5

2 ECOLOGICAL CONSIDERATIONS ... 6
2.1 Climate considerations in the Barents Sea ... 6
2.1.1 Temperature ... 6
2.1.2 Ice conditions ... 6
2.1.3 Predicting Barents Sea temperature ... 7
2.2 Zooplankton ... 8
2.3 Trophic interactions ... 8
2.3.1 Zooplankton and capelin interactions ... 8
2.3.2 Zooplankton, capelin and cod interactions ... 9
2.3.3 Predicting fish recruitment ... 9
2.3.3.1 0-group index of North East Arctic cod ... 10
2.3.3.2 Recruits of North East Arctic cod ... 10
2.3.3.3 Recruits of Barents Sea capelin ... 10
2.3.3.4 Recruits of Norwegian spring spawning herring ... 11
2.3.3.5 Key points and summary recruitment ... 11
2.4 Norwegian Sea ... 12
2.4.1 Hydrography and climate ... 12
2.4.2 Phytoplankton ... 13
2.4.3 Zooplankton ... 13
2.4.4 Herring growth and food availability ... 14
2.4.5 Predictions for zooplankton biomass and herring feeding conditions ... 14
2.5 Icelandic waters ... 15
2.5.1 Hydrography and climate ... 15
2.5.2 Zooplankton ... 15
2.6 Hydrography of the waters west of the British Isles ... 16
2.7 Present and potential application of ecological considerations in stock assessments. ... 16

3 NORWEGIAN SPRING-SPAWNING HERRING ... 37
3.1 General ... 37
3.1.1 Stock definition ... 37
3.1.2 ACFM advice and management applicable to 2003 and 2004 ... 37
3.1.3 Fishery ... 37
3.2 Data ... 39
3.2.1 Commercial catch ... 39
3.2.2 Biological data ... 40
3.2.3 Surveys ... 40
3.2.3.1 Spawning grounds ... 40
3.2.3.2 Wintering areas ... 40
3.2.3.3 Feeding areas ... 40
3.2.3.4 Nursery area ... 41
3.2.3.5 Herring larval survey ... 41
3.2.4 Other relevant data ... 41
3.2.4.1 Tagging data ... 41
3.2.4.2 Prognosis of herring condition ... 41
3.3 Assessment models: Sea Star ... 41
3.3.1 Comparison with the 2003 assessment ... 42
3.3.2 Data exploration with SeaStar ... 42

3.4 Assessment models: ISVPA 43
3.4.1 Data exploration with ISVPA 43
3.5 Exploratory assessments with ISVPA and SeaStar 44
3.5.1 Input data for comparative runs for testing of the methods 44
3.5.2 Results 45
3.5.2.1 ISVPA 45
3.5.2.2 SeaStar 45
3.5.3 The results of the two methods 45
3.5.4 Final runs 45
3.6 Final assessment including uncertainty and retrospective analysis 46
3.6.1 Short term projection 46
3.7 Biological reference points 46
3.8 Management targets 47

4 BARENTS SEA CAPELIN 111
4.1 Regulation of the Barents Sea Capelin Fishery 111
4.2 Catch Statistics 111
4.3 Stock Size Estimates 111
4.3.1 Larval and 0-group estimates in 2003 111
4.3.2 Acoustic stock size estimates in 2003 111
4.3.3 Other surveys 112
4.4 Historical stock development 112
4.5 Stock assessment autumn 2003 112
4.6 Management considerations 113
4.7 Sampling 113

5 CAPELIN IN THE ICELAND-EAST GREENLAND-JAN MAYEN AREA 123

5.1 The Fishery 123
5.1.1 Regulation of the fishery 123
5.1.2 The fishery in the 2003/2004 season 123
5.2 Catch Statistics 124
5.3 Surveys of Stock Abundance 124
5.3.1 0-group surveys 124
5.3.2 Stock abundance in autumn 2003 and winter 2004 124
5.3.2.1 The adult fishable stock 124
5.3.2.2 Estimates of immature capelin 125
5.4 Historical Stock Abundance 125
5.5 Stock Prognoses 126
5.5.1 Stock prognosis and TAC in the 2003/2004 season 126
5.5.2 Stock prognosis and assessment for the 2004/2005 season 126
5.5.3 Management of capelin in the Iceland-East Greenland-Jan Mayen area 127
5.6 Precautionary Approach to Fisheries Management 127
5.7 Special Comments 127
5.8 Sampling 128

6 BLUE WHITING 141
6.1 Stock Identity and Stock Separation 141
6.1.1 ACFM advice and management applicable to 2003 and 2004 141
6.2 Fisheries in 2003 142
6.2.1 Description of the national fisheries 142
6.3 Biological Characteristics 145
6.3.1 Length composition of Catches 145
6.3.2 Age composition of catches 145
6.3.3 Weight-at-age 146
6.3.4 Maturity-at-age 146
6.3.5 Natural Mortality 146
6.4 Stock estimates 146
6.4.1 Acoustic surveys 146
6.4.1.1 Surveys in the spawning season 146
6.4.1.2 Surveys in the feeding area 147
6.4.1.3 Russian survey in the Barents Sea 148
6.4.2 Bottom trawl surveys 148

6.4.2.1 Surveys in the southern areas ... 148
6.4.2.2 Surveys on the Faroe plateau ... 148
6.4.2.3 Survey in the North Sea ... 149
6.4.2.4 Surveys in the Barents Sea ... 149
6.4.3 Catch per unit of effort ... 149
6.4.4 Data exploration ... 149
6.4.4.1 Analysis of catch-at-age in commercial data ... 149
6.4.4.2 Data exploration with AMCI ... 150
6.4.4.3 Data exploration with ISVPA ... 151
6.4.4.4 Data exploration with ICA ... 152
6.4.4.5 Data exploration with SMS ... 154
6.4.4.6 Comparison of assessment results and surveys ... 155
6.4.5 Stock assessment ... 156
6.4.5.1 Comparison between different assessments ... 156
6.4.5.2 Final assessment with AMCI ... 157
6.5 Short-term Projections ... 159
6.6 Medium-term Projection ... 159
6.7 Precautionary Reference Points ... 160
6.8 Management considerations ... 160
6.9 Quality of catch data and biological data ... 160
6.10 Recommendations ... 161

7 ICELANDIC SUMMER-SPAWNING HERRING ... 243
7.1 The fishery ... 243
7.2 Catch in numbers, weight-at-age and maturity ... 243
7.3 Acoustic surveys ... 243
7.4 Update assessment ... 244
7.5 Data exploration ... 244
7.5.1 Analysis of catch-at-age in commercial data and in the acoustic survey ... 244
7.5.2 Data exploration with NFT ADAPT 2.1.7. ... 244
7.5.3 Data exploration with TSA ... 245
7.5.4 Data exploration with AMCI 2.3a ... 246
7.5.5 Adapt in AD-Model builder ... 246
7.5.6 Comparisons between models ... 247
7.6 Final assessment ... 247
7.7 Short term projections ... 247
7.7.1 Comments to the assessment ... 247
7.8 Management consideration ... 247
7.9 Comments on the PA reference points ... 248
7.10 Sampling ... 248

8 REFERENCES AND WORKING DOCUMENTS ... 279
8.1 References ... 279
8.2 Working Documents ... 283

ANNEX I ... 285

ANNEX II ... 287

APPENDIX ... 294

1 INTRODUCTION

1.1 Terms of reference

Code	TOR	Section
a)	assess the status of and provide catch options for 2005 for the Norwegian spring-spawning herring stock	3
b)	assess the status of and provide catch options for 2005 for the blue whiting stock;	6
c)	assess the status of and provide catch options for the 2004–2005 season for the Icelandic summer-spawning herring stocks	7
d)	assess the status of capelin in Subareas V and XIV and provide catch options for the summer/autumn 2004 and winter 2005 seasons	4
e)	provide as detailed information as possible on the age/size composition in different segments of the blue whiting fishery	6.4.4
f)	provide information on the species compositions in those fisheries that take appreciable amounts of blue whiting, and on the age/size composition by species of these catches [EC request for information on the industrial fisheries]	Not analysed
g)	propose measures to reduce exploitation of blue whiting juveniles and evaluate the potential effect on the stock and the fisheries. The evaluation should include, but not be restricted to the effects of introducing a minimum size and closed areas/seasons;	ACFM spring 03, 3.12.5b
h)	continue the evaluation of candidates of harvest control rules for blue whiting	Software not ready
i)	provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, 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 the assessment of the status of the stocks and for the projection should be clarified	See within each chapter 3-7
j)	comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented	3.3.1 and 6.4.5.2
k)	document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.	

1.2 List of participants

Alexander Krysov	Russia
Ane Iriondo	Spain
Asta Gudmundsdottir (Chair)	Iceland
Dimitri Vasilyev	Russia
Dmitry Prozorkevich	Russia
Frans van Beek	Netherlands
Hjalmar Vilhjalmsson	Iceland
Jan Arge Jacobsen	Denmark
Jens Chr. Holst	Norway
Manuel Meixide	Spain
Mikko Heino	Norway
Morten Vinther	Denmark
Nikolay Timoshenko	Russia
Reidar Toresen	Norway
Sergei Belikov	Russia
Sigurd Tjelmeland	Norway
Sveinn Sveinbjörnsson	Iceland
Maurice Clarke	Ireland

For further details see Annex 1.

1.3 Non-standard assessment methods

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.

1.3.2 SeaStar

The assessment program SeaStar is essentially the same model as used during the 2003 meeting for tuning Norwegian spring spawning herring. The model is documented on the web site www.assessment.imr.no, where the user guide and the Mathematica code can be found, as well as supplementary documentation material. Also, a pdf file of the documentation is available from the author and at ICES. Prior to this meeting the possibility of estimating a survey selection pattern along each cohort was implemented. The possibility of a user-defined catchability function also enables the estimation of survey selection.

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. The diagnostics include ordered CDF values, numerical output of the size of likelihoods terms and plots of fit between data and model that may help in deciding which are the better assumptions to use.

1.3.2.1 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. This probability is referred to as the likelihood function. There is provision for selecting different functions to describe the survey distribution. In the present tuning the gamma distribution with a constant CV is 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 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 stabilise 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. 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 fo 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 stock 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. Maturation at age in the assessment year is assumed equal to the maturation at age in the last year in the VPA. Weight at age in the assessment year is 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.

1.3.2.2 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. Catch, survey data, tagging data and larval data may be resampled separately or jointly by appropriate settings which are asked for when the routine Bootstrap is invoked from the main menu, - see the chapter "Running an assessment/Uncertainty analysis by bootstrapping" in the manual for details.

1.3.2.2.1 Surveys

The surveys are resampled from the distribution that is assumed when the likelihood function is constructed, based on the unperturbed surveys. This is done by a call to the routine drawSurveys from the routine doOneRun before the likelihood function is evaluated.

1.3.2.2.2 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.

1.3.2.2.3 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.

catchBootstrapMethod = useFResiduals

If the variable catchBootstrapMethod has the value useFResiduals a polynom of degree catchPolynomDegree is fitted to the the F-values from the baseline assessment for each year. During bootstrapping Fvalues are resampled from the residuals and new catches are calculated.

catchBootstrapMethod = useTransfer

If catchBootstrapMethod is useTransfer 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:

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

where maxTransferCoefficient is a setting.

Larvae

As for the surveys, the larval data are resampled from the assumed distribution.

In bootstrap runs first a run with the original data is performed. In the first run the setting perform<bootstrap Tag>Bootstrap must be True and the setting draw<bootstrap tag>Bootstrap must be False, where <bootstrap Tag> is Survey, Catch or Tagging. The first run may then be used as a basis for bias correction of the bootstrap.

The bootstrap replicates contain all information that later may be requested by other assessment programs: historic spawning stocks, historic recruitments and when the program is used for tuning Northeast arctic cod even the cod stock-dependent part of the predation by cod on capelin.

The bootstrap replicates may be viewed by the top-level routine showBootstrapEntities, which also is used when the standard output is produced.

1.3.2.3 Bias in the assessment due to discarding of old scales

As fish grow older the growth zones get closer and become more difficult to read. Consequently, the age of older fish is more uncertain than the age of younger fish. When the age readers experience that the outer growth zones for a particular fish cannot be distinguished from one another, the data for that fish are discarded. This introduces a bias in the age distribution for a given sample. An alternative way of recording the age can help dealing with this problem (Schweder and Tjelmeland, 2003). Using the new method, when the age reader is uncertain about the age a youngest age is recorded instead of an assumed correct age. The age distribution is calculated using the maximum likelihood method. For each fish it is recorded whether the age is certain by the censor category d = 0 and whether it is a minimum age by the censor category d = 1. The age distribution for all fish in a sample is then estimated using a traditional maximum likelihood approach by minimising:

$$\sum_{i=1}^{N}\left((1-d_i)\log(p_{a_i}) + d_i \log\left(\sum_{a=a_i}^{N} p_a\right)\right)$$

with respect to the relative age frequencies p_a, where a is the age.

Implementing this method in the assessment requires re-reading of a large number of historic data. However, this is a large undertaking and in SeaStar a provisional way of treating this problem has been implemented for Norwegian spring spawning herring. Based on a large number of age data obtained both with the traditional method and the new method the conditional probability of discarding a fish after the traditional method as function of age is found. It can then be shown that the bias corrected age distribution can be expressed as (Schweder and Tjelmeland, 2003):

$$\frac{n-m}{n(1-r_a)} f_a$$

where a total of n fish have been read, of which m fish have been discarded. r_a is the conditional probabiliy of discarding and f_a is the age distribution obtained. The bias corrected age distribution must be normalized.

This problem becomes to be especially important this year as the strong 1991 and 1992 year-classes grow into the problematic age range. Earlier, we have dealt with the problem that fish have been transferred from the 1983 year-class to the 1985 year-class, probably because of the same effect.

1.3.3 ISVPA

The ISVPA is described in last years WGNPBW report (ICES 2002/ACFM:19). Some changes have been made to the model, and these are described in the report from the meeting of the Methods Working Group in January 2003 (ICES 2003/D:03). For the assessment in 2004 ISVPA version 2004.1 was used (working document by D.A.Vasilyev).

1.4 Recommendation

The working group recommends that the time of the meeting of the working group should be changed to autumn. The reason for this is that there are acoustic surveys for herring and blue whiting during late spring and summer, and the inclusion of the information from these surveys, particularly of the strength of the incoming year-classes would improve the predictions.

It is recommended to hold a workshop with the aim to study the possibilities of improving the fish stock assessments by including environmental data.

1.5 Where TORs are adressed

Code	TOR	Section
a)	assess the status of and provide catch options for 2005 for the Norwegian spring-spawning herring stock	3
b)	assess the status of and provide catch options for 2005 for the blue whiting stock;	6
c)	assess the status of and provide catch options for the 2004–2005 season for the Icelandic summer-spawning herring stocks	7
d)	assess the status of capelin in Subareas V and XIV and provide catch options for the summer/autumn 2004 and winter 2005 seasons	4
e)	provide as detailed information as possible on the age/size composition in different segments of the blue whiting fishery	6.4.4
f)	provide information on the species compositions in those fisheries that take appreciable amounts of blue whiting, and on the age/size composition by species of these catches [EC request for information on the industrial fisheries]	Not analysed
g)	propose measures to reduce exploitation of blue whiting juveniles and evaluate the potential effect on the stock and the fisheries. The evaluation should include, but not be restricted to the effects of introducing a minimum size and closed areas/seasons;	ACFM spring 03, 3.12.5b
h)	continue the evaluation of candidates of harvest control rules for blue whiting	Software not ready
i)	provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, 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 the assessment of the status of the stocks and for the projection should be clarified	See within each chapter 3-7
j)	comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented	3.3.1 and 6.4.5.2
k)	document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.	

2 ECOLOGICAL CONSIDERATIONS

2.1 Climate considerations in the Barents Sea

2.1.1 Temperature

The Barents Sea is a shelf area, receiving inflow of Atlantic water from the west. The inflowing water demonstrates considerable interannual fluctuations in water mass properties, particularly in heat content, which again influence on winter ice conditions. The variability in the physical conditions is monitored in two sections (Fig. 2.1.1.1). Fugløya-Bear Island is situated where the inflow of Atlantic water takes place; the Vardø-N section represents the central part of the Barents Sea. In both sections there are regular hydrographic observation, and in addition, current measurements have been carried out in the Fugløya- Bear Island section continuously since August 1997.

Figure 2.1.1.2 shows the temperature and salinity anomalies in the Fugløya-Bear Island section in the period from 1977 to January 2004. Temperatures in the Barents Sea were relatively high during most of the 1990s, and with a continuous warm period from 1989-1995. During 1996-1997, the temperature was just below the long-term average before it turned warm again at the end of the decade. Even if the whole decade was warm, it was only the third warmest decade in the 20th century (Ingvaldsen *et al.*, 2002, Ingvaldsen, 2003).

In January 2003 the temperature was just above the long-term average in the whole Barents Sea, but then the temperature increased quickly until March when it was 0.7°C above the long-term mean. From April and the rest of the year, the temperature was 0.5°C above the long-term average. In January and March 2004 the temperature was still 0.5°C above the average.

In June 2003 the temperature in the Fugløya-Bear Island section was about 1°C above the long-term average, and the highest observed since the regular observations started in 1977. The temperature decreased slowly towards the long-term average during summer, but was still 0.6°C higher in October. Followed by a more rapid decrease, the temperature in January 2004 was exactly on the average.

The monthly sea temperature series from the Russian Kola meridian transect (33°30' E, 70°30'N to 72°30'N) begins in 1921 (quarterly values back to 1900). The values were calculated by averaging along the transect and from 0 to 200 m water depth vertically (Bochkov, 1982). The Kola section is strategically placed to monitor the variability in the temperature of the eastern part of the Barents Sea dominated by inflowing Atlantic water masses. Values for 2001-2003 and statistics for the period 1921-1999 are shown in Table 2.1.1.1. These values may e.g. be useful for examination of the effects of extremely cold or warm conditions on cod bioenergetics, growth, recruitment and distribution.

In the beginning of the year the temperature was slightly less than the long-term average. The temperature increased rapidly during spring/summer, and in June the temperature reached the overall maximum value with almost 1°C above the long-term average. Compared to 2002 the 2003 temperature followed approximately the same development until August. In August-October the temperature was still above the long-term average, but lower than in 2002. At the end of the year the temperature was back at the long-term average, and actually slightly colder in December. Overall the temperature in the Kola section started similar to the Fugløya-Bear Island section, but the warming period started later and reached higher values in the summer. In the autumn/winter the development in the two sections separated, as the Fugløya-Bear Island section remained constant above the long-term average while the Kola section cooled off towards the long-term average at the end of the year.

In the beginning of 2004 the Kola temperature was 4.47 in January and 4.10 in February, which is respectively 0.6 and 0.7 above the long-term average. In addition the first measurements in March indicates the temperature will stay approximately 0.7 above the long-term average for this month.

2.1.2 Ice conditions

Figure 2.1.2.1 shows the ice index for the Barents Sea. The variability in the ice coverage is closely linked to the temperature of the inflowing Atlantic water. The ice has a relatively short response time on temperature change (about one year), but usually the sea ice distribution in the eastern Barents Sea respond a bit later than in the western part. 2003 had a negative ice index, which means more ice than average. This was very surprising since the sea temperature was high. There were two reasons for this. Firstly the really ice melt did not start before mid June, which is about one month later that usual. Secondly, the ice melt during summer was extremely low, most likely due to atmospheric forcing. In 2004 the ice coverage is expected to be the same as in 2003, but the ice index will depend on the ice melting in the summer 2004.

The observed current in the section Fugløya-Bjørnøya is predominantly barotropic, and reveals large fluctuations in both current speed and lateral structure (Ingvaldsen *et al*. 2002). Based on several years of hydrographic observations, and also by current measurement from a 2-month time series presented by Blindheim (1989), it was believed that the inflow usually take place in a wide core located in the area 72°30'-73°N with outflow further north. The long-term measurements that started in August 1997 showed a more complicated structure of the current pattern in the area. The inflow of Atlantic water may also be split in several cores. Between the cores there might be a weaker inflow or a return flow. The outflow area may at times be much wider than earlier believed, stretching from 73°30'N south to 72°N. This phenomenon is not only a short time feature; it might be present for a whole month. These patterns are most likely caused by horizontal pressure gradients caused by a change in sea-level between the Barents Sea and the Arctic or the Norwegian Sea either by accumulation of water or by an atmospheric low or high.

There seems to be seasonality in the structure of the current. During winter the frequent passings of atmospheric lows, probably in combination with the weaker stratification, intensify the currents producing a structure with strong lateral velocity-gradients and a distinct, surface-intensified, relatively high-velocity, core of inflow. During the summer, when the winds are weaker and the stratification stronger, the inflowing area is wider, and the horizontal shear and the velocities are lower. In the summer season there is in inflow in the upper 200 m in the deepest part of the Bear Island Trough.

The time series of volume and heat transports reveal fluxes with strong variability on time scales ranging from one to several months (Fig. 2.1.2.2). The monthly mean volume flux is fluctuating between about 5.5 Sv into and 6 Sv out of the Barents Sea, and with a standard deviation of 2 Sv. The strongest fluctuations, especially in the inflow, occur in late winter and early spring, with both maximum and minimum in this period. The recirculation seems to be more stable at a value of something near 1 Sv, but with interruptions of high outflow episodes. High outflows occurred around April in 1998, 1999 and 2001. In 2000 there was strong outflow in January while in 2002 and 2003 strong outflow was observed in August/September. In the first half of 2003 the inflow was high, which may explain the rapid temperature increase between January and March. The intensity of the flow was reduced during spring and summer. Figure 2.1.2.3 show the variability in the inflow as calculated from a wind driven numerical model. Except for January, it is a good fit with the observations. The model results indicate that the variations in the local atmospheric pressure field may be important for the inflow of Atlantic water to the Barents Sea (Ådlandsvik and Loeng, 1991, Ingvaldsen et al., 2002).

2.1.3 Predicting Barents Sea temperature

Prediction of forthcoming environmental conditions, or at least some knowledge on the predictability, is most valuable for projecting the survival of fish through the early life stages, as well as weight and maturity at age. The natural first environmental parameter to try to forecast is sea temperature. The rates of a number of growth-related processes are controlled by temperature (Michalsen *et al*., 1998). In addition, temperature affects almost all species in the ecosystem, making it an important indicator of changes in fish population dynamics (Daan *et al*., 1994). Furthermore, the ”long memory” of the ocean, as compared to the atmosphere, makes it, at least a priori, feasible to realistically predict ocean temperature much further ahead than the typical weather forecast.

Prediction is, however, complicated by the variation in Barents Sea temperature being governed by processes of both external and local origin operating on different time scales. The volume flux and temperature of inflowing Atlantic water masses as well as heat exchange with the atmosphere, possibly linked to atmospheric teleconnections, is important in determining the temperature of the Barents Sea (Ådlandsvik and Loeng, 1991; Loeng *et al*., 1992). Thus, both slowly moving advective propagation and rapid barotropic responses due to large-scale changes in air pressure must be considered.

A successful statistical forecasting scheme is subject to the availability of long and continuous time series. We therefore base our prediction on the Kola section time series, the longest below-surface sea temperature series in the region. The climatic variations in the Barents Sea depend mainly on the volume of inflowing Atlantic water (Ådlandsvik and Loeng, 1991), which is influenced by both atmospheric processes and density differences in the ocean itself. In addition, local heat exchange with the atmosphere is important.

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

This seasonal difference is reflected in the merit of simple six months forecasts of Kola-section temperature based on linear regression models. Table 2.1.3.1 (from Ottersen *et al.*, 2000) shows that the predictive value for a specific month based on values from six months earlier varies considerably throughout the year. The tendency found was that of persistence across the spring and summer months being higher than for other seasons, allowing for reasonably reliable forecasts from spring until autumn.

The predictions (Tab. 2.1.3.1) indicate that the temperatures in the southern Barents Sea will be close to average from April to June, followed by a warm period from July to September.

2.2 Zooplankton

Sampling of zooplankton on a regular basis began in the Barents Sea in 1979, and since 1986 zooplankton abundance has been monitored at annual surveys during joint Norwegian/Russian 0-group and capelin surveys during August-October. At this time of the year most of the production has taken place and the measured zooplankton biomass can be considered as the overwintering population of zooplankton. In addition, standard sections Bjørnøya-Fugløya and Vardø-N (since 1991) are covered on average 6 and 4 times a year respectively. From 2003 onwards, the 0-group and capelin surveys were merged into a single “ecosystem cruise”.

These investigations have provided information on zooplankton (e.g. annual and regional variations in abundance, biomass and species composition) to different research groups at IMR. The results are presented in the annul report at IMR and also at ICES Northern Pelagic and Blue Whiting Fisheries and Arctic Fisheries Working Group meetings. Our main aim in the future is to incorporate zooplankton information in the prognosis of growth of capelin and other important fish species.

Plankton samples are obtained by using WP2 and the MOCNESS (Multiple Opening Closing Net and Environmental Sensing System) plankton nets. The sampling depths in the Barents Sea for the WP2 are from bottom to 0 m and 100 to 0m. At most stations the MOCNESS nets were towed in oblique hauls from 300-200, 200-150, 150-100, 100-50, 50-25, and 25-0m. The number of nets varied from about 3 to 8 according to the bottom depth.

The zooplankton samples were usually separated into two halves. One half preserved in 4% formaldehyde was used for species identification. The second half was size fractionated using sieves of 3 mesh sizes; 180 µm, 1000 µm and 2000 µm for dry weight measurements.

For each MOCNESS and WP2 profiles the biomass (mg m^{-3} and g m^{-2}) and abundance of individuals (nos. m^{-3}, nos.m^{-2}) was calculated, using the depth interval and the volume of water filtered.

The crustaceans form the most important group of zooplankton, among which the copepods of the genus *Calanus* play a key role in the sub-Arctic and Arctic ecosystems. *Calanus finmarchicus* is the most important contributor to the zooplankton biomass of the Barents Sea (Melle and Skjoldal, 1998). Krill is another group of crustaceans playing a significant role in the pelagic ecosystem as food for both fish and sea mammals. They appear both in large schools and as continuous layers, often staying deep at daytime and ascending at night. In general, amphipods are ranked third in numerical abundance of zooplankton, far exceeded by copepods and krill. Members of the hyperiid amphipod genus *Themisto* overwhelmingly dominate amphipod fauna, in the central and northern Barents Sea. In the arctic waters, the larger amphipod *T. libellula* (60mm) is a key species.

2.3 Trophic interactions

2.3.1 Zooplankton and capelin interactions

In the Barents Sea ecosystem, capelin plays a very important role, on one hand as a major predator and on the other hand as a major prey. Capelin is the main predator on zooplankton, feeding mainly on copepods, krill and amphipods. These studies from the Barents Sea have shown that zooplankton biomass in the Barents Sea in the period 1979-2003 has shown several fold variation among years (Figs 2.3.1.1, 2.3.1.2 and 2.3.1.3). Possible reasons for the large variations are the differences in advective transport and predation pressure.

We also observed an inverse relationship between zooplankton and capelin (Fig. 2.3.1.3) indicating low zooplankton abundance when capelin stock size is high and vice versa. The observations of low zooplankton abundance when capelin stock is large is not surprising as capelin is the most important predator on zooplankton in the Barents Sea ecosystem, and probably exploits most of the secondary production during their feeding season. During periods when the capelin stock was at very low levels the predation pressure on zooplankton was minimum, thus allowing zooplankton individuals to grow into older age groups. This again probably led to high individual growth rate and rapid recovery of the capelin stock. Our study verifies earlier findings (Dalpadado and Skjoldal, 1996, Drobysheva et al., 2003), which had longer data time series.

2.3.2 Zooplankton, capelin and cod interactions

Cod (Gadus morhua) is a major predator on the Barents Sea ecosystem. Growth of young Northeast Arctic cod in the Barents Sea has shown strong fluctuations. The mean length of age 3 cod in the Norwegian winter bottom trawl survey has varied between 28 and 42 cm during the period 1984-2002 (ICES 2003a). Correspondingly, the mean weight at age 3 in this survey has varied between 200 and 800 g. Thus, in order to give predictions of cod stock biomass, it is important to predict size at age and not only abundance at age.

Individual growth in fish depends on density dependent factors such as availability of prey. However growth is also dependent on a series of processes (feeding, metabolism, excretion etc.), which are controlled by temperature (Ottersen et al. 2002; Michalsen et al. 1998).

Diet investigations were carried out on 0, 1 and 2 year old Northeast Arctic cod sampled in the Barents Sea during 1984-2002 (Dalpadado and Bogstad, 2004). The purpose of this paper was twofold. First, to investigate variations in the diet of age 0-2 Northeast Arctic cod in the Barents Sea related to prey abundance. Second, to study how variability in growth of these age groups of cod is related to stomach content and food abundance.

Stomach content analyses showed that the 0 and 1 group cod fed mainly on crustaceans with krill and amphipods comprising up to 70% of their diet (Fig 2.3.2.1 and 2.3.2.2). Krill (*Thysanoessa* spp. and *M. norvegica*) and amphipods (*Themisto* spp.) were mainly found in cod stomachs sampled in the central and close to the Polar Front region in the Barents Sea where these prey organisms are reported to be abundant in summer.

A shift in the main diet from crustaceans to fish was observed from age 1 to age 2. The diet of 2-year-old cod mainly comprised capelin (*Mallotus villosus)* and other fish, and to a lesser degree, krill and amphipods (Fig 2.3.2.3). Shrimp (mainly *Pandalus spp.*) was also an important prey in both age 1 and 2 cod. A statistically significant positive relationship was obtained between capelin stock size and the amount of capelin in the diet of 2-year-old cod. Results from this study also show that the larger age 2 cod preyed more on capelin in winter and that larger cod (> 22 cm) prefer larger capelin (> 12 cm). During summer capelin migrates to Arctic waters to the north of the Polar Front to feed. Thus, to a large extent, the main distribution area of cod and capelin do not overlap, during summer. This is possibly the reason why we observed the age 2 cod to feed little on capelin during the summer-autumn period. In warm years e.g. 1992, the distribution of capelin is extended to eastern areas. Age 2 cod feed heavily on capelin during winter, in the eastern Barents Sea. Our results show that in years with low capelin abundance, the cod switched to other prey organisms such as shrimps, krill and amphipods. Similarly, the Icelandic cod also switched to other prey when capelin abundance was low (Magnússon and Pálsson 1989).

A positive significant relationship was also obtained between Total Fullness Index (TFI) and the amount of capelin in the diet and between TFI and the growth of 2-year-old cod indicating that the growth of age 2 cod is to a large extent dependent on the amount of capelin consumed.

2.3.3 Predicting fish recruitment

Predictions of the recruitment in fish stocks are essential for future harvesting. Traditionally prediction methods have not included effects of climate variability. In the following some results of multiple linear regression models are presented, where couplings between climate variables and fish stock variables have been used to model the recruitment of North East Arctic cod, Barents Sea capelin and the Norwegian spring spawning herring. The models are novel, and are still under evaluation in search for better fit (Stiansen *et al.,* 2002, Stiansen *et al*., 2003a, Stiansen, 2003). However, the fit of the model are encouraging, and the models might at present prove useful as background information in stock assessment. In the 2003 capelin assessment the presented capelin model was incorporated into the 1.5-year projection.

Four models are presented.

- For the 0-group log index of North East Arctic cod, with two year prognoses
- For the number of recruits (3 year olds) of North East Arctic cod, with two year prognoses
- For the number of recruits (1 year olds) of Barents Sea capelin, with one year prognoses
- For the number of recruits (3 year olds) of Norwegian spring spawning herring with three year prognoses

2.3.3.1 0-group index of North East Arctic cod

A model of the log 0-group index (Stiansen *et al*., 2003b) based on the NAO (North Atlantic Oscillation, see Hurrell *et al*., 2003 for an autorative overview of the NAO and it's ecological effects) and SSB (spawning stock biomass) 2 years earlier explains ~50 % of the variation in the 0-group index in the period 1966-2003 (Fig 2.3.4.1.1).

The correlation between the 0-group log index and the NAO winter index 2 years earlier is high (0.72 for the period 1978-2003). This might be explained through food availability. Melle and Holst (2001) have found a high correlation between NAO and the zooplankton biomass in the Norwegian Sea the following year. This might imply that another year later food supply is still good for cod larvae on their drift along the Norwegian coast. The good recruitment of copepods may also use one year to advect into the Barents Sea, giving a two-year time lag. The condition of the spawning stock in the preceding year may also be an important factor.

It would be more appropriate to use the SSB the same year as the 0-group index. However there is a high autocorrelation in the spawning stock from one year to another. In order to fully use the time lag of two years in the NAO - 0-group relationship we used the SSB two years earlier as well. The autocorrelation for SSB in the period 1946-2000 was 0.90 and 0.71 for time lags of one and two years, respectively.

The model is:

$$0group_t = 0.17 \times NAO_{t-2} + 1.91 \times 10^{-6} \times SSB_{t-2} + 0.36$$

where *0-group* is the log 0-group index, *NAO* the Lisboa-Iceland winter index and *SSB* the spawning stock biomass (tonnes) from the AFWG assessment 2003 (ICES, 2003a). The subscripts denote the time lag in years. Further details can be found in Stiansen *et al.* (2002).

The prognoses of the 0-group index show a medium strong increase in 2004 to a value of 1.5, followed by a lesser increase to a moderately high value of 1.7 in 2005.

2.3.3.2 Recruits of North East Arctic cod

A model of the number of three year old recruits of North East Arctic cod (Stiansen *et al*., 2003a) based on the Kola temperature, the number of 1 year old cods and the capelin maturing biomass explains ~80 % of the variation in the recruitment (fig. 2.3.4.2.1).

The model is:

$$\mathrm{Re}c3_t = 3.0 \times 10^8 \times Temp_{t-3} + 0.069 \times \mathrm{Re}c1_{t-2} + 7.1 \times 10^7 \times \log(Cap_{t-2}) - 1.7 \times 10^9$$

where *Rec3* is the number of 3 year olds from the AFWG assessment 2003 with cannibalism (ICES, 2003a), *Temp* the yearly average temperature between 0 and 200m in the Kola section three years earlier, *Rec1* is the age 1 index of NEA cod from the Norwegian bottom trawl survey in January/February 2 years earlier and *Cap* is the maturing biomass (tonnes) of capelin from survey estimate of individuals larger than 14 cm 2 years earlier. The subscripts denote the time lag in years. Further details of the model can be found in Stiansen *et a*l. (2003a).

The prognosis shows a stable medium high recruitment in 2004 and 2005 of 680×10^6 and 750×10^6 individuals, respectively.

2.3.3.3 Recruits of Barents Sea capelin

A model of the one year old recruits of Barents Sea capelin (Stiansen, 2003) based on the surface (skin) temperature in the Barents Sea, the 0-group index and the maturing biomass explains ~ 70 % of the variation in the recruitment (Fig. 2.3.4.3.1). The model has been calculated for the years 1982-2003 (1981-2002 for the dependent variables), with prognoses for 2004.

The model is:

$$\mathrm{Re}c_t = -39.5 \times skin_{t-1} + 0.45 \times 0group_{t-1} + 0.096 \times matbio_{t-1} - 61$$

where *Rec* is the numbers of recruits in 10^9 (data is survey estimates back-calculated to 1 August), *skin* the skin temperature from the NCEP reanalysed database average from January to March and over the area between 30-45°E and 71-75°N one year earlier, 0-group the capelin 0-group index one year earlier (in August) and *matbio* the capelin maturing biomass (survey estimates of fish above 14 cm length) one year earlier. The subscripts denote the time lag in years.

The Model have R^2=0.72 and P-value < 0.01, with all individual P-values <0.03. The one-year time lag of the dependent variables gives opportunity of a prognosis one year ahead. Further details can be found in Stiansen (2003). Capelin data is taken from Anon. (2003).

The prognoses show a medium recruitment for 2004, with a value of $315*10^9$ individuals.

2.3.3.4 Recruits of Norwegian spring spawning herring

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 ~85 % of the variation in the recruitment (Figure 2.3.4.4.1).

The model is:

$$\mathrm{Re}c_t = 4.54 \times skin_{t-3} + 16.3 \times 0group_{t-3} - 24.4$$

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, 2003b), *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 0.89 with the Recruitment (3 years later). When the model was tested on the 0-group index alone it gave an R^2 of 0.81. Still the model explained 4 % more of the variability when adding the skin temperature.

The prognosis shows a medium recruitment level for 2004, with a continuous increase for 2005-2006 to a medium high level.

2.3.3.5 Key points and summary recruitment

Models, based on climate and fish parameters, for prediction of recruitment have been given for 0-group index and the number of three year old fish for North East Arctic Cod, for the number of one year old fish for Barents Sea Capelin, and for the number of three year old fish for Norwegian spring spawning herring. Table 2.3.4.5.1 gives an overview of the predicted future recruitment.

- The 0-group index of North East Arctic cod will have a moderately strong increase in 2004, followed by a smaller increase in 2005, giving a medium strong recruitment in both years.
- The number of recruits of North East Arctic cod will be at a medium-high level in 2004-2005.
- The number of recruits of Barents Sea capelin will be at a medium level in 2004.
- The number of recruits of Norwegian spring spawning herring will be at a medium level in 2004 and continuously increase in 2005-2006 to a medium high level.

2.4 Norwegian Sea

2.4.1 Hydrography and climate

The Nordic Seas during the last decades have been characterized by increased input of Arctic waters. The Arctic waters to the Norwegian Sea are mainly carried by the East Icelandic Current and also to some extent by the Jan Mayen Current. 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. 2.4.1.1). In winter 2004 the index was lower than normal. NAO as it is used here is the normalised air pressure difference at sea level between Lisbon, Portugal and Reykjavik, Iceland and is an indicator of the strength of the westerly winds into the Norwegian Sea. A high NAO index (i.e. stronger westerly winds) will force Atlantic and Arctic waters more eastward.

The Institute of Marine Research, Norway, has measured temperature and salinity in three standard sections in the Norwegian Sea almost regularly since 1978. The sections are 1) the Svinøy section which runs NW from 62.37° 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° N just south of Svalbard.

Figure 2.4.1.2 shows the development in temperature and salinity in three different sections from south to north in the Norwegian Sea. During the last 7 years the temperature and salinity in the Svinøy section have been above the long-term-mean while they were about average in the Gimsøy and Sørkapp sections. Unfortunately some data are missing in the Gimsøy and Sørkapp sections. In 2003 the salinity in the Svinøy section had the largest value in the time series, about 0.08 above normal. The temperature was the next largest in the time series, about 0.9°C above normal. Only in 2002 was the temperature higher.

Figure 2.4.1.3 shows time series of temperature and salinity during the spring in the Svinøy and Gimsøy sections from 1978 to 2003. The values are calculated using the same procedure as mentioned above. The low salinities in 1978 and 1979 are a result of the Great Salinity Anomaly during the 1970's. In 1994 a large salinity anomaly comparable with the anomaly in 1978 and 1979 was seen in the Svinøy section. The temperature was also a minimum that year. The 1994 anomaly was a result of increased influence of Arctic water from the East Icelandic Current. In 2002 the salinity and temperature increased considerable in the Svinøy section to highest observed value for the time series. The condition in 2003 remained approximately unchanged compared to 2002. In the Gimsøy section there were instead a reduction in temperature and salinity for 2002 but they increased again in 2003. The salinity was then the highest since 1985.

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 Figure 2.4.1.4. There are considerable variations both in the area of Atlantic water distribution and its temperature. The distribution area of Atlantic water has decreased since the beginning of 1980s, while the temperature has shown a steady increase. Since 1978 the Atlantic water has been about 0.6°C warmer. During the years 1992-1995 the area was much lower than average for both seasons. In 1997-1999 there was a warm period followed by a substantial drop in temperature in 2000. Then in 2002 the temperature increased considerable and in 2003 it had the largest value in the time series. The temperature was in 2003 about 0.7°C higher than the long-term-mean for summer. The area of Atlantic water in 2003 increased also and had the largest value since 1987.

During research cruises in May with the aim of estimating the pelagic stock hydrographic observations are also taken, covering most of the Norwegian Sea. In 2003 there was a larger westerly distribution of Atlantic water than normal and also compared to 2002 (not shown). At 100m depth the temperature was about 0,5 °C above normal and in some areas 1,5 °C above normal.

Conclusions:

- The temperature in the Svinøy section has been the highest ever in 2002 and 2003.
- The winter NAO index in 2004, calculated for December-February, was lower than normal.
- The westerly distribution of Atlantic Water increased in 2003 and a relatively large westerly distribution is also expected in 2004.

- The averaged temperature of the Atlantic Water in the Svinøy section has increased with approximately 0.6°C since 1978.

2.4.2 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.

Figure 2.4.2.1 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 2.4.2.2 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 2002 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 relax in the grazing pressure.

- During summer and early autumn several peaks of relatively high chlorophyll a concentration were observed indicating a strong variability in minor blooms.

2.4.3 Zooplankton

Zooplankton biomass distribution in the Norwegian Sea has been mapped annually in May (since 1995) and in July (since 1994). Zooplankton samples for biomass estimation were collected by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report 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. 2.4.3.1). In Atlantic and Arctic water masses zooplankton biomass decreased to a minimum in 1997. Thereafter zooplankton biomass increased again and has remained relatively high except for a temporary reduction in 2001. Due to reduced cruise time the Arctic water mass was not sampled in 2001. For the first time in 2002, the biomass in Atlantic water equalled the biomass in Arctic water. In 2003 zooplankton biomass in Arctic water, again, was much higher than in Atlantic water. However, the confidence limits were wide due to few sampling stations in this water mass. In the Coastal water mass, which includes the Norwegian continental shelf and slope waters influenced by Norwegian coastal water, the trend was different with a general increase towards a maximum in 1998 and a decrease the following years. Biomass increased again in 2002, and reached the highest value during the time series. In 2003 Biomass was lower, but still rather high compared to the biomass in Atlantic water.

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. In 2003 average biomass for the area could not be calculated since the survey area was moved to far to the north. There is no obvious trend in the zooplankton biomass in July since 1994 (Figure 2.4.3.2).

Conclusions:

- Average zooplankton biomass in Atlantic water masses of the Norwegian Sea in May 2003 was lower than average for the time series.

2.4.4 Herring growth and food availability

Individual growth of the Norwegian spring spawning herring, as measured by condition or length specific weight after the summer feeding period in the Norwegian Sea, has been characterised by large fluctuations during the 1990's (Fig 2.4.4.1). During 1991 and 1993 individual condition was good, but from 1994 on the condition of the herring started to decline and by 1997 it reached the lowest level during the 1990's. The level observed in 1997 corresponds with the absolute long-term 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. In 2001, 2002 and 2003 the condition remained at a low level.

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. 2.4.4.2). 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.

Conclusions:

- Herring condition was lower than average for the time series in 2003.

- There is a weak relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-2003.

2.4.5 Predictions for zooplankton biomass and herring feeding conditions

A factor possibly governing zooplankton biomass is the size of the zooplankton spawning stock, or the size of the over-wintering population. Zooplankton biomass in July represents the mixed population of zooplankton species at the start of the over-wintering. A linear regression of the biomass in July on the biomass in May the following year explains ~63% of the total variation (Fig. 2.4.5.1). Average biomass in July 2002 suggested that zooplankton biomass in May 2003 should be close to average as well (Fig. 2.4.5.1). This turned out to be a correct prognosis. However, the time series is short, the variability is large and there is no trend in the July zooplankton biomass that could be related to the trend observed in the May data. Thus, this time series should be expanded before it is used for prediction.

The North Atlantic Oscillation index (NAO), is a proxy for the strength and duration of southwesterly winds, and is correlated with the inflow of Atlantic water to the Norwegian Sea. In the Norwegian Sea the average biomass of zooplankton in Atlantic water in May is strongly correlated with the average NAO for the March-April period the previous year (Fig. 2.4.5.2). 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 previous years overwintering stock, that is the previous years production and the present years spawning stock. The biomass for May 2003 was predicted at 12.98 g dry weight m^{-2}, based on the NAO for 2002. The observed biomass in 2003 was 10.8 g dry weight m^{-2}. Thus, the prognosis underestimated the biomass. Based on the same relationship the biomass for May 2004 is estimated at 10.5 g dry weight m^{-2}.

*Biomass (yr2) = 2.67*NAO yr1+11.38* (1)
$R^2=0.75$, $P=0.003$The time series for the herring condition index has been calculated for the period from 1991 to 2001. A correlation analysis 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. 2.4.5.3). The herring condition index for 2003, based on the NAO for 2002, was predicted to be 0.833. The observed condition for 2003 was 0.806, thus lower than predicted. The prediction for 2004 is 0.812, somewhat higher than in 2003.

*Condition (yr2) =0.023*NAO yr1+0.820* (2)
$R^2=0.51$, $P=0.006$Conclusions:

- A direct, but weak, relationship between zooplankton biomass in July and the zooplankton biomass in May the following year is suggested by the time series from 1994 to 2002.

- The average NAO for March-April the previous year is directly related to zooplankton biomass in May and herring condition in the autumn.

- The March-April NAO index for 2003 predicts zooplankton biomass at 10.5 g m^{-2} in May 2004 and the herring condition index at 0.806 in the autumn 2004.

2.5 Icelandic waters

2.5.1 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 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. 2.5.1.1).

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.

2.5.2 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 2.5.2.1).

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 C. 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 both during the November 2003 and February 2004 surveys. This indicates that zooplankton biomass will be above average in north Icelandic warts is spring and summer 2004.

2.6 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. Data from 1983 to 2004 are summarized in Figure 2.6.1. These represent mean values from a box with limits 52° to 54°N and 16° to 14°W (west of the Porcupine Bank) and from depths 50-600 m wherever bottom depth is 600 m or more. Both salinity and temperature show an increasing trend with the values in 2002-2004 being among the highest ones observed. This trend coincides with an increasing trend in recruitment of blue whiting. However, it is not know whether there is a causal relationship between hydrographic conditions and recruitment of blue whiting.

2.7 Present and potential application of ecological considerations in stock assessments.

The efforts put into the preparation of the ecological consideration chapter has been increasing and is at present significant. The actual use of these data in the stock assessment is, however, not proportional to the efforts made in compiling the chapter. This has obviously resulted in frustrations as those preparing the chapter have not prioritised to join the meeting. Presently the only place where these data are taken into use is in the short term prognosis of the herring stock where the condition factor is predicted one year ahead. The use of this method has given better predictions than what would be the case than for instance using the mean of historic values.

There may be many causes for the slow progress in including this type of data in the stock assessments and projections. Inclusions of new data would in many cases call for significant changes in the modelling framework, the persons carrying out the modelling are not the same as those doing the ecologic considerations, the way WGNPBW work may not necessarily be beneficial for facilitating and speeding up such a process and there may not necessarily be obvious and simple ways in including these data in the assessments.

Some ways of including ecologic considerations into the assessments could be mentioned; one example being a revision of the natural mortality of the NSSH, in particular of the younger ages which at present are set to a constant value from age 1 to 3. Another possibility would be to include the models for predicting recruitment indexes (this chapter) into the predictions.

To speed up the process towards a better integration of the ecological considerations in the assessments it is recommended that a sub group of the WGNPBW meets in Bergen during the autumn of 2004 with the aim of exploring and presenting possible ways for keeping this important process on its tracks and speeding it up.

Table 2.1.1.1. Kola section monthly temperature statistics. Temperature values for 2001, 2002 2003, long-term (1921-1999) mean, minimum and maximum temperatures and standard deviations are given for each calendar month for the 0-200 m depth interval.

Month	2003	2002	2001	Mean	Minimum	Maximum	Std Dev
JANUARY	3.7	3.8	4.6	3.88	2.70	5.00	0.47
FEBRUARY	3.3	3.6	4.2	3.44	1.80	4.70	0.51
MARCH	3.3	3.4	3.7	3.12	2.00	4.20	0.48
APRIL	3.3	3.3	3.7	2.94	1.50	3.90	0.51
MAY	3.8	3.6	3.7	3.09	1.70	4.10	0.52
JUNE	4.5	4.2	4.3	3.56	2.30	4.50	0.51
JULY	4.8	4.9	4.7	4.18	3.00	5.20	0.52
AUGUST	4.9	5.5	5.0	4.67	3.50	5.60	0.52
SEPTEMBER	5.3	5.7	5.1	4.91	3.80	5.90	0.48
OCTOBER	5.2	5.3	5.2	4.91	3.40	6.00	0.51
NOVEMBER	4.8	5.0	4.8	4.69	3.50	5.80	0.48
DECEMBER	4.2	4.5	4.7	4.32	3.50	5.50	0.43

Table 2.1.3.1. Linear regression models for monthly 0-200m temperature values in the Kola section based on corresponding temperatures from six months earlier. The equations are derived from data from January 1921 to February 1997. All coefficients of determination (R^2) are significant at the 5% level.

Predicted from month (x)	Prediction for month (y)	Equation	R^2	Prediction 2004
July	January	y=1.77 + 0.50x	0.31	
August	February	y=1.05 + 0.51x	0.27	
September	March	y=0.95 + 0.44x	0.21	
October	April	y=0.53 + 0.49x	0.25	3.1
November	May	y=0.74 + 0.50x	0.22	3.1
December	June	y=0.98 + 0.60x	0.25	3.5
January	July	y=1.60 + 0.67x	0.36	4.6
February	August	y=2.37 + 0.67x	0.41	5.1
March	September	y=2.67 + 0.72x	0.49	5.4*
April	October	y=2.71 + 0.75x	0.55	
May	November	y=2.91 + 0.57x	0.38	
June	December	y=2.71 + 0.45x	0.29	

* Preliminary, based on the assumption that the March 2004 temperature will be 0.7 above the long-term average, as indicated by measurements in the beginning of March.

Table 2.3.4.5.1. The table gives an overview of the different models, with prognoses estimates of the variable in question. The given month indicate when the prognoses can be extended for another year.

Species	Variable	Prognoses year	Prognoses available	Prognosis 2004	Prognosis 2005	Prognosis 2006
North East Arctic cod	0-group, log (0 year olds)	2	November	1.47	1.65	X
North East Arctic cod	Recruits (3 year olds)	2	January	$679*10^6$	$747*10^6$	X
Barents Sea capelin	Recruits (1 year olds)	1	November	$315*10^9$	X	X
Norwegian spring spawning herring	Recruits (3 year olds)	3	November	$3.0*10^9$	$9.0*10^9$	$12.1*10^9$

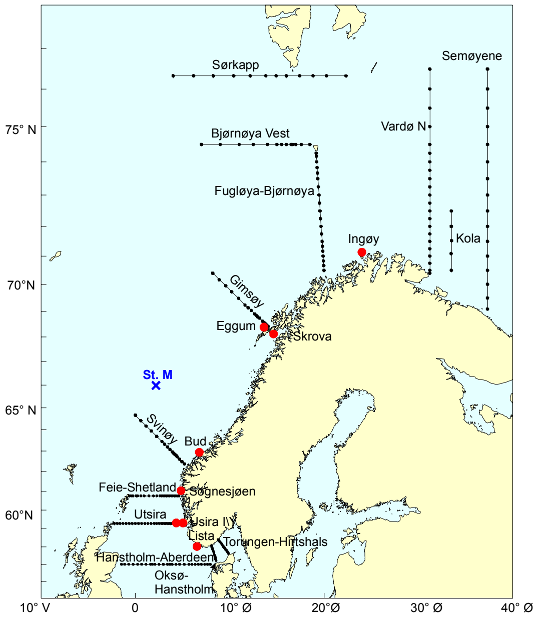


Figure 2.1.1.1 Standard sections and fixed oceanographic stations worked by Institute of Marine Research, Bergen. The University of Bergen is responsible for station M, while the Kola section is operated by PINRO, Murmansk (Sjøtun, 2004).

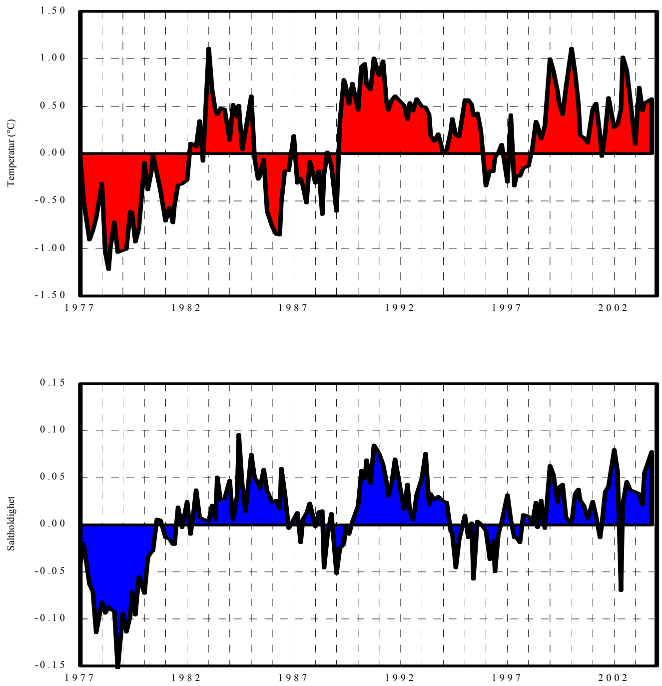


Figure 2.1.1.2 Temperature anomalies (upper panel) and salinity anomalies (lower panel) in the section Fugløya – Bear Island (Sjøtun, 2004).

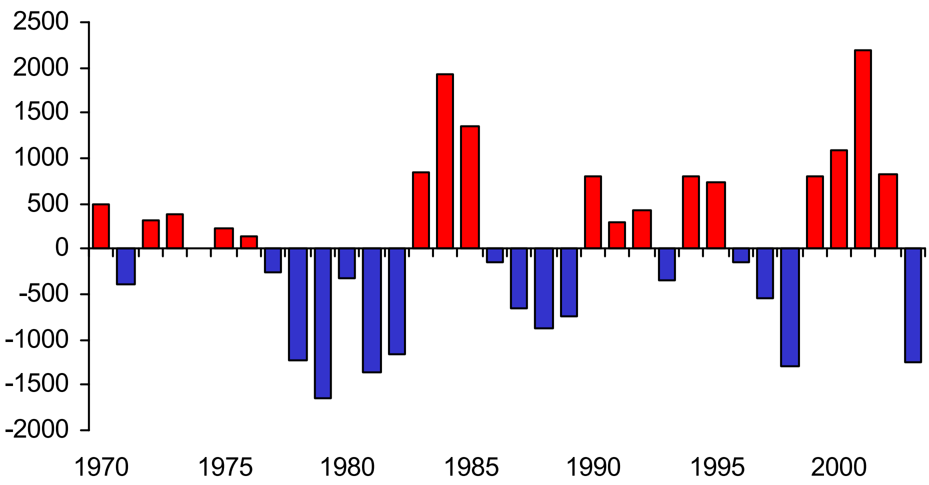


Figure 2.1.2.1. Ice index for the period 1970-2003. Positive values means less ice than average, while negative values show more severe ice conditions (Sjøtun, 2004). Transport and current.

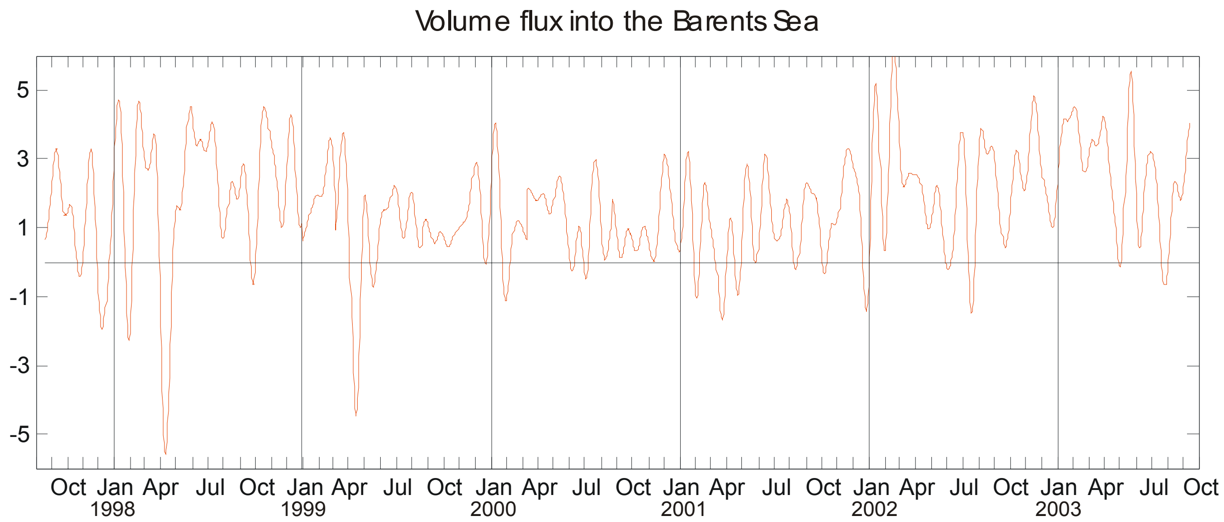


Figure 2.1.2.2 Total volume flux across the section Norway-Bear Island All data have been low pass filtered over 30 days (Sjøtun, 2004).

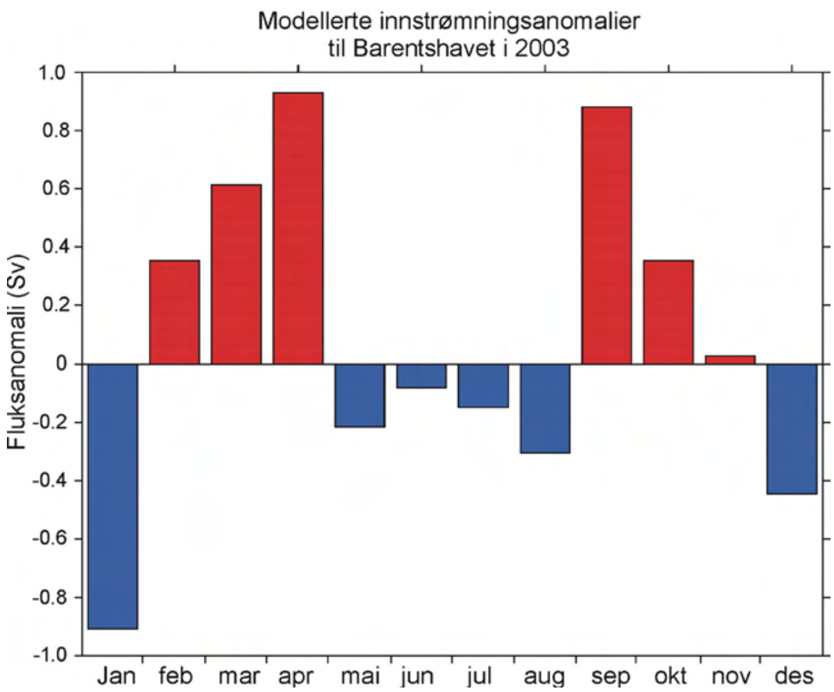


Figure 2.1.2.2 Modelled flux anomalies in 2002 through the section between Norway and Bear Island (Sjøtun, 2004).

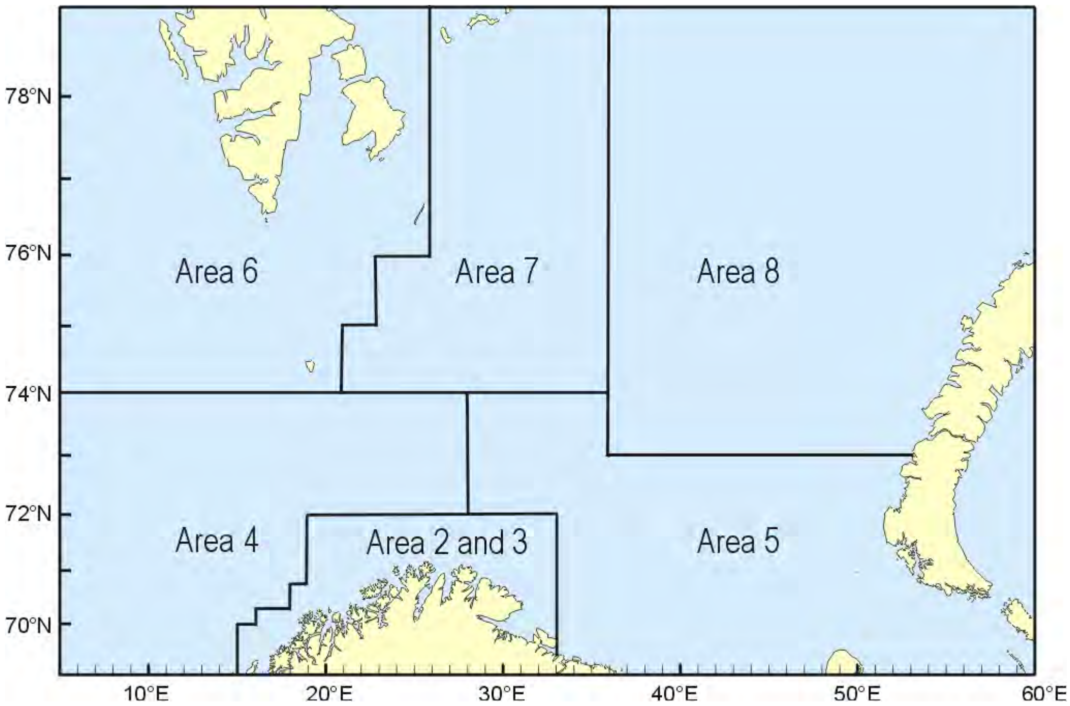


Figure 2.3.1.1 Area division for the Barents Sea used in figure 2.3.1.2.

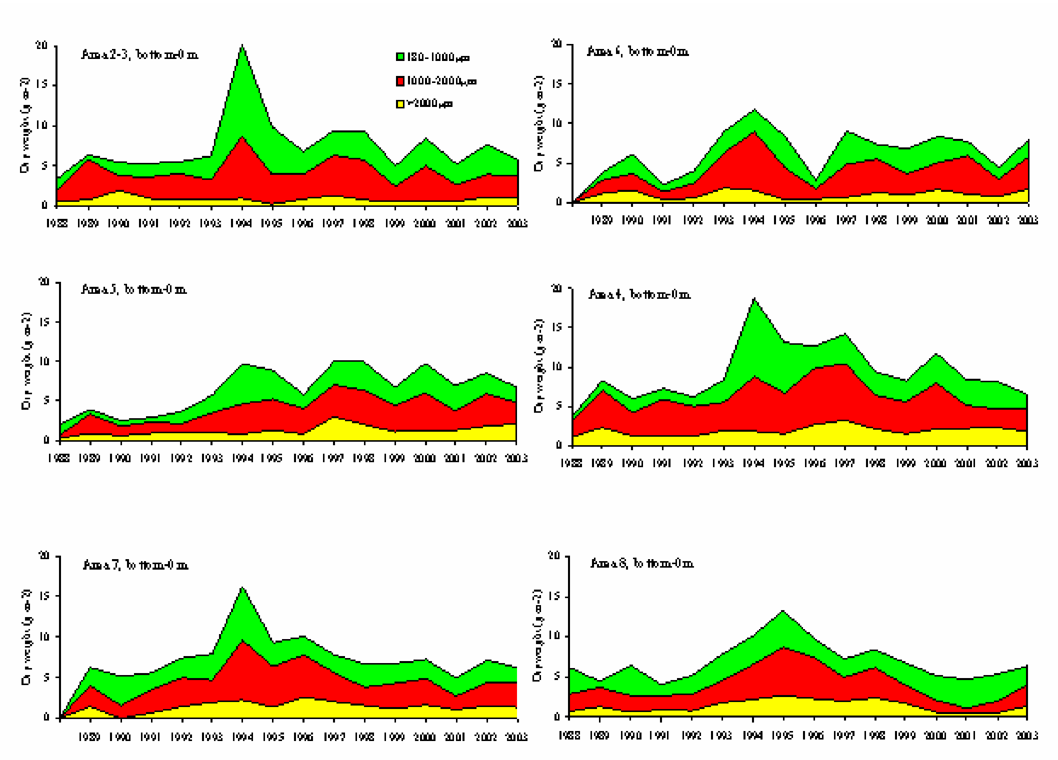


Figure 2.3.1.2. Average zooplankton biomass (g m^{-2}) for the 7 different areas in the Barents Sea during 1988-2003 (Hassel, 2004).

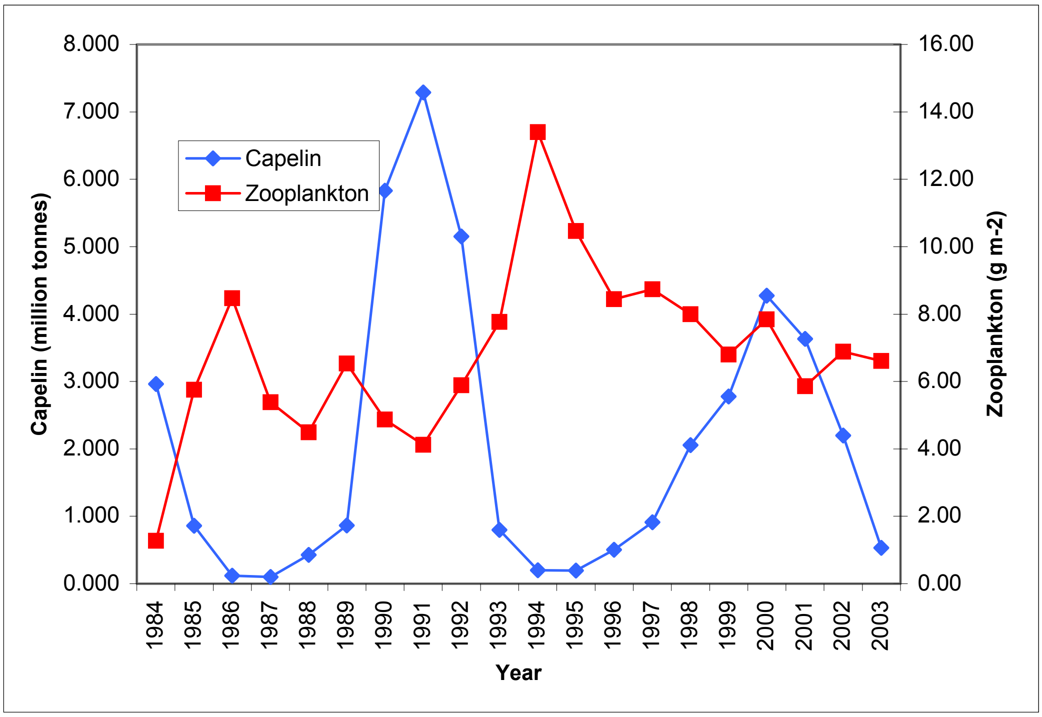


Figure 2.3.1.3 Average zooplankton biomass (g m^{-2}) together with biomass of one year and older capelin (million tonnes) during 1973 – 2003, in the Barents Sea (capelin data from Gjøsæter et al., 2000, updated to 2003).

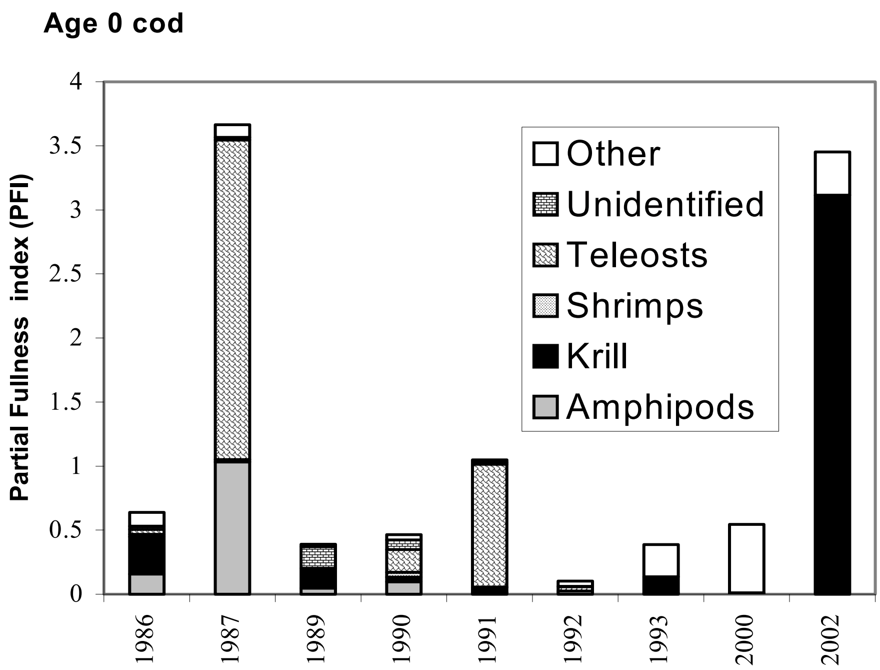


Figure 2.3.2.1 Annual variation in Partial Fullness Index (PFI) for age 0 cod from 1986-2002. Only years with more than 20 stomach samples are shown.

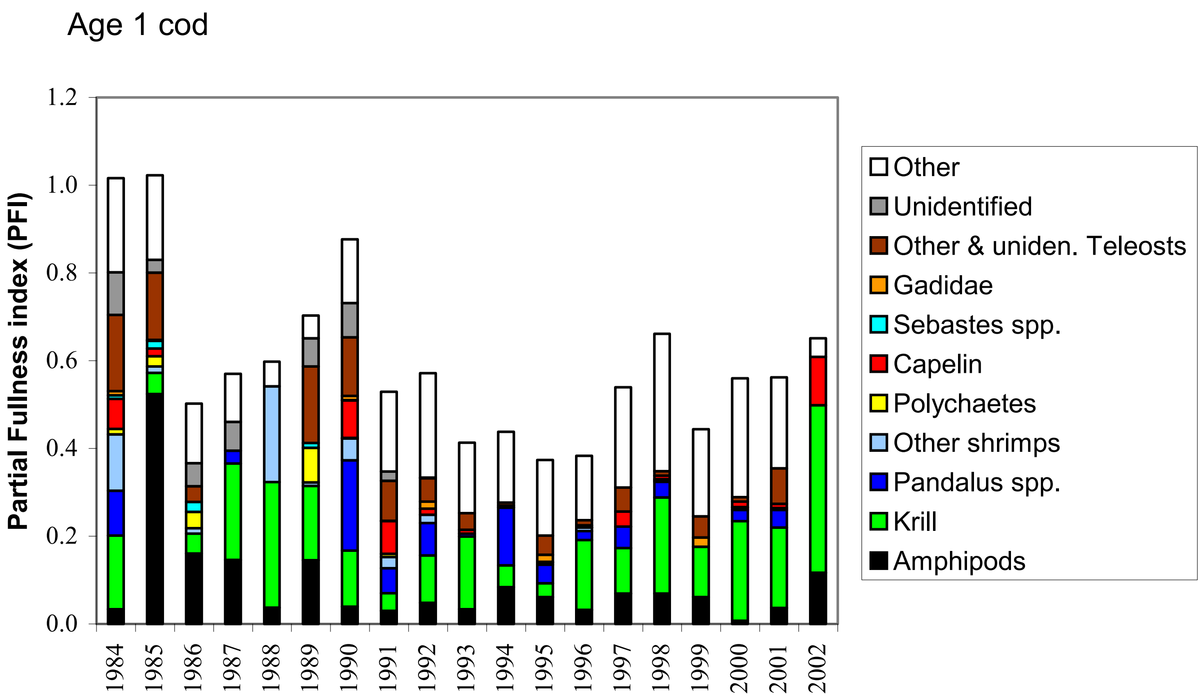


Figure 2.3.2.2. Annual variation in Partial Fullness Index (PFI) for age 1 cod from 1984-2002.

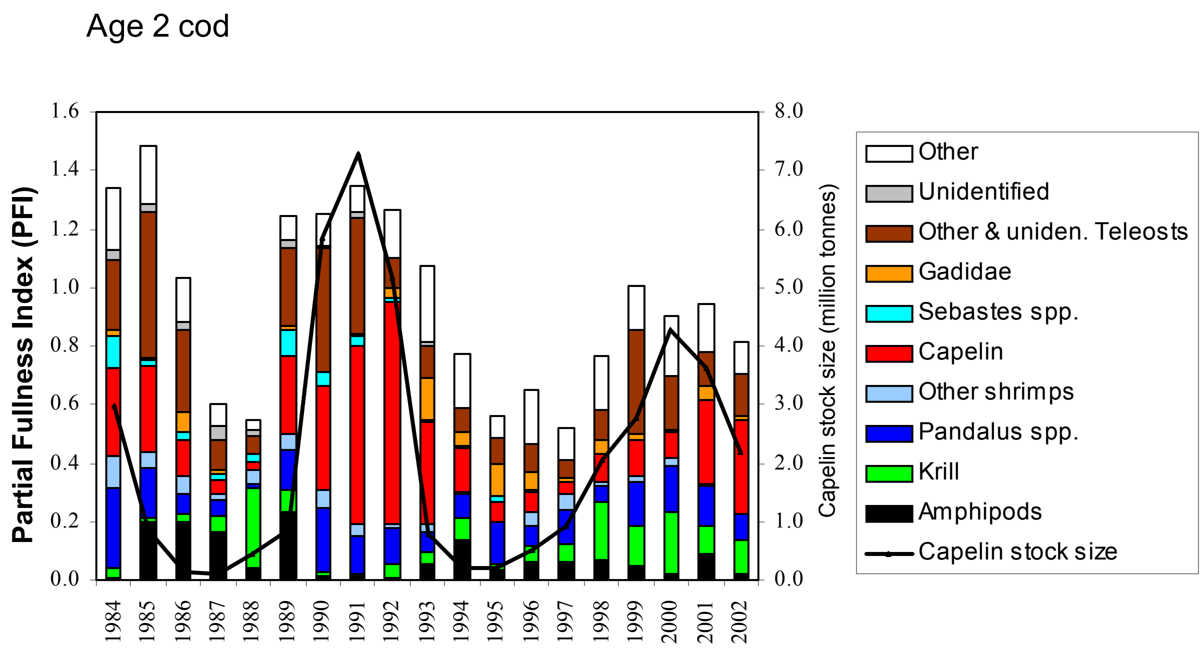


Figure 2.3.2.3. Annual variation in Partial Fullness Index (PFI) for age 2 cod from 1984-2002.

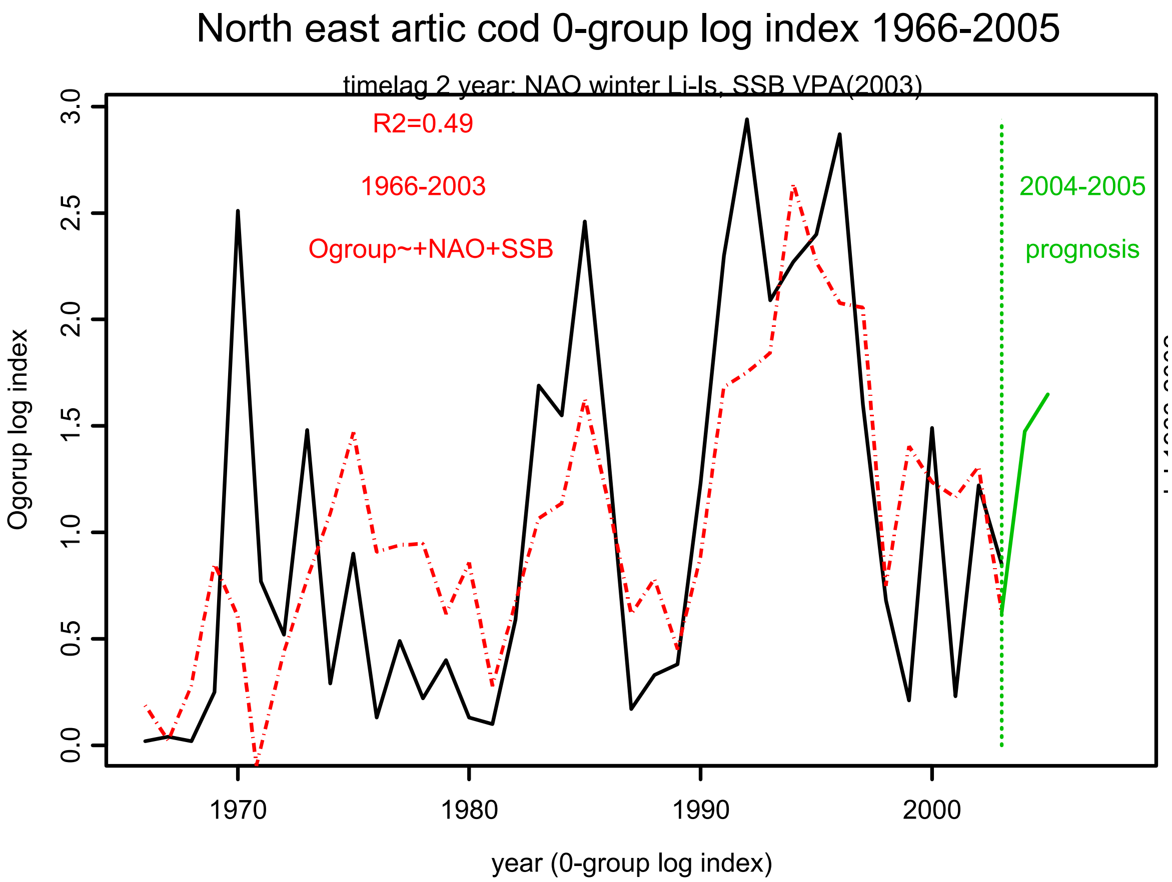


Figure 2.3.4.1.1. The figure shows the 0-group log index of North East Arctic cod (black) and the model fit (red), together with prognoses for 2004-2005 (green).

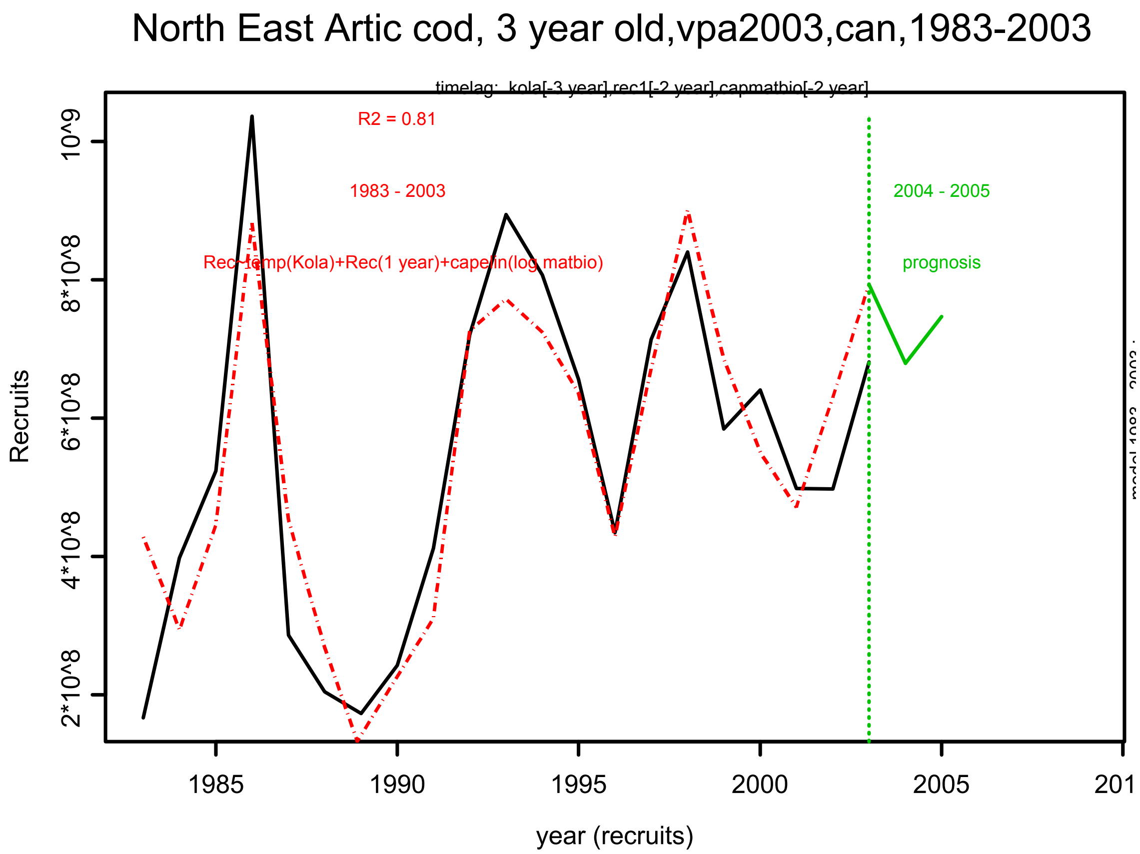


Figure 2.3.4.2.1. The figure shows the number of recruits (three year olds) of North East Arctic cod (black) and the model fit (red), together with prognoses for 2004-2005 (green).

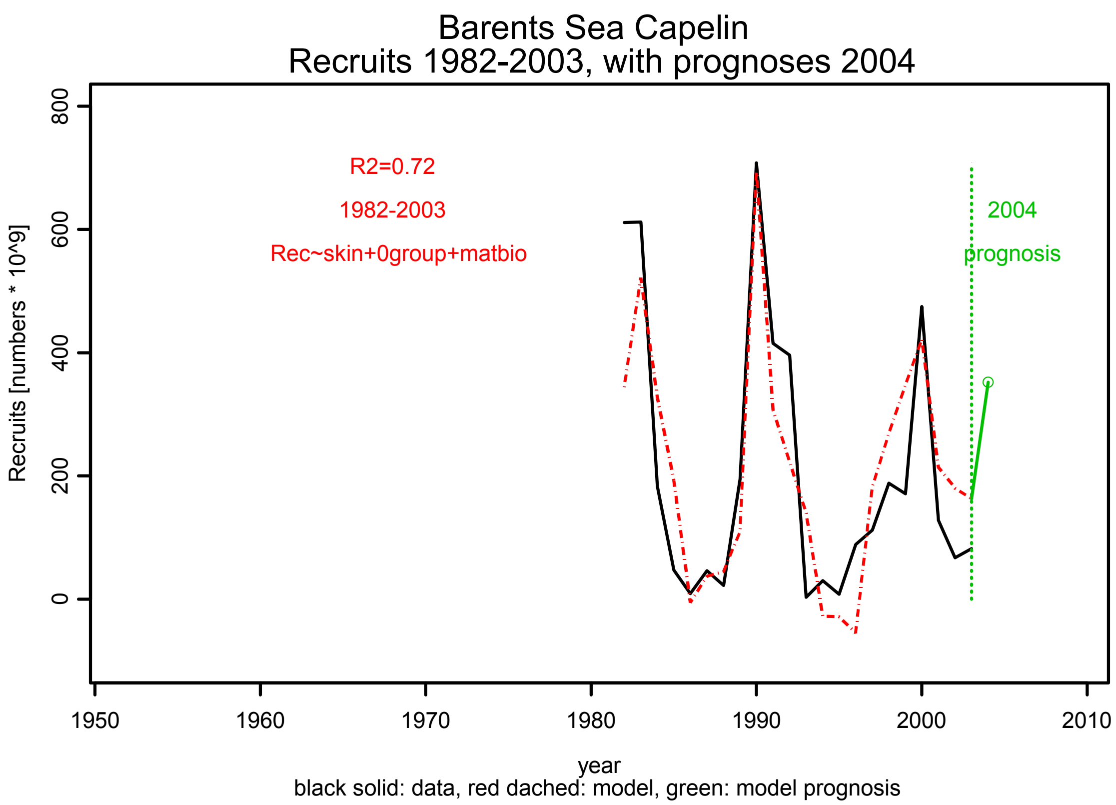


Figure 2.3.4.3.1. The figure shows the number of recruits (1 year olds) of Barents Sea Capelin (black) and the model fit (red), together with prognoses for 2004 (green).

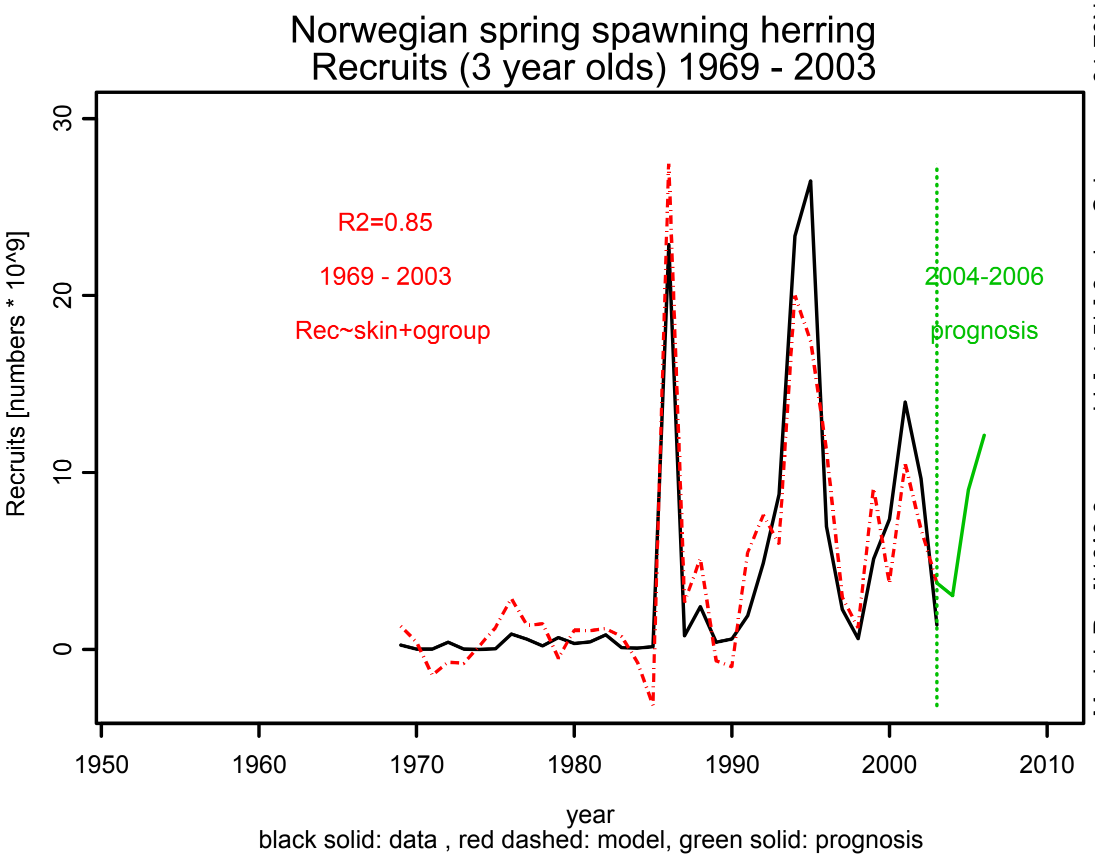


Figure 2.3.4.4.1. The figure shows the number of recruits (3 year olds) of Norwegian spring spawning herring (black) and the model fit (red), together with prognoses for 2004-2006 (green).

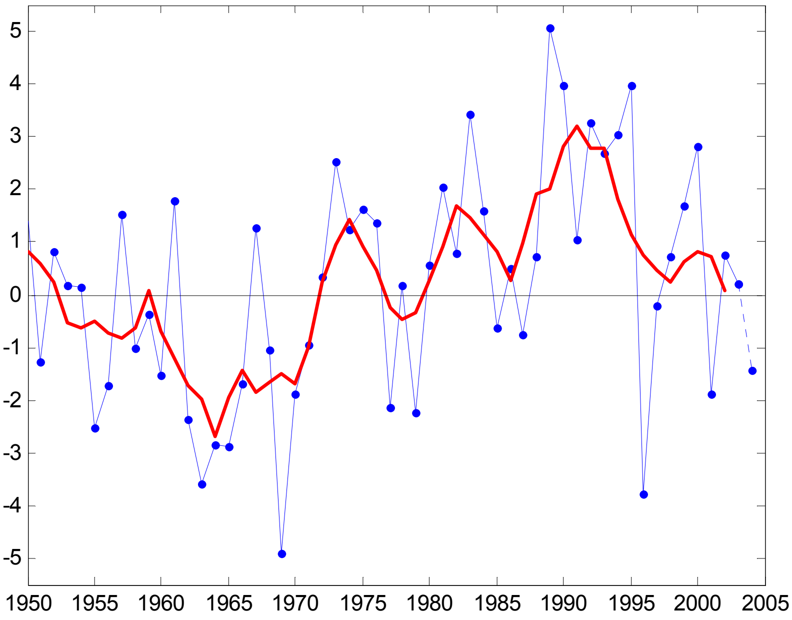


Figure 2.4.1.1. Winter (December-March) North Atlantic Oscillation index (NAO). The 2004 value is calculated from December-February.

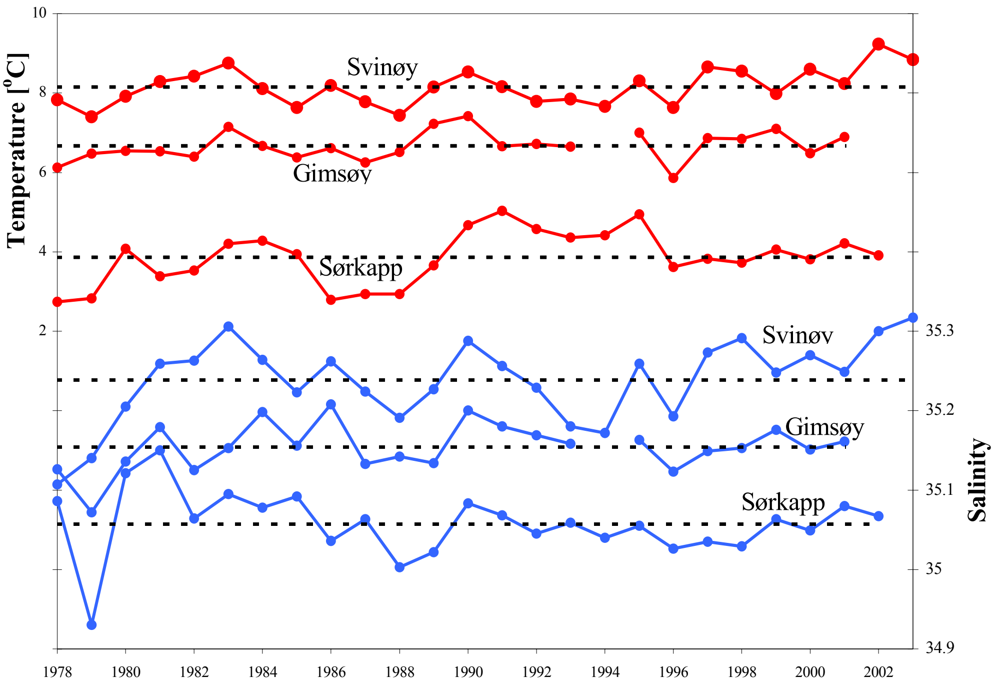
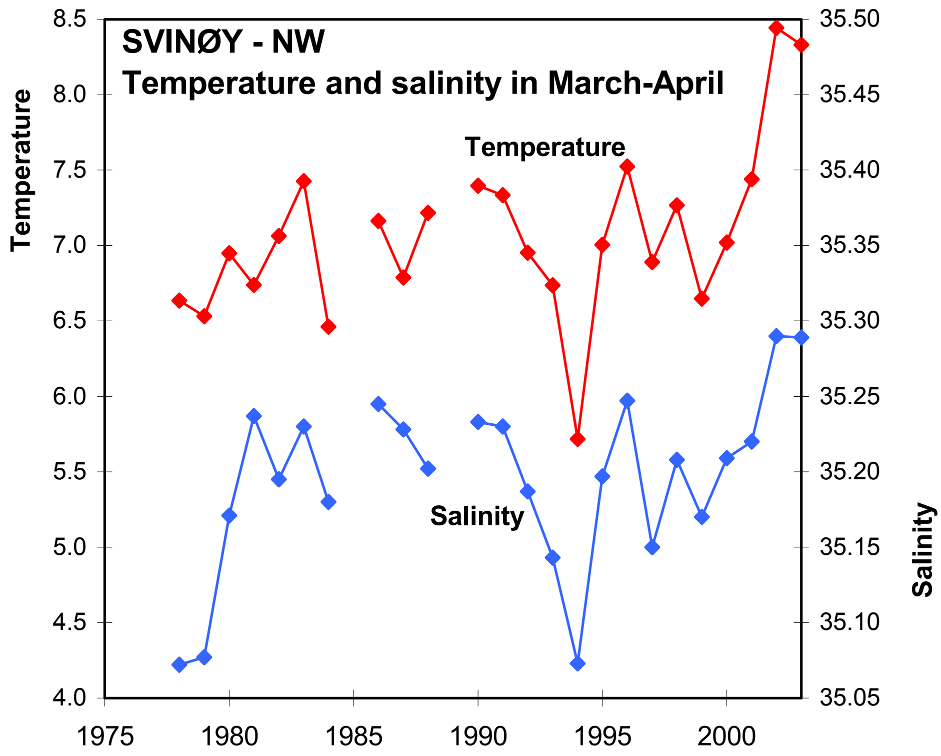


Figure 2.4.1.2 Temperature (ºC) and salinity observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.



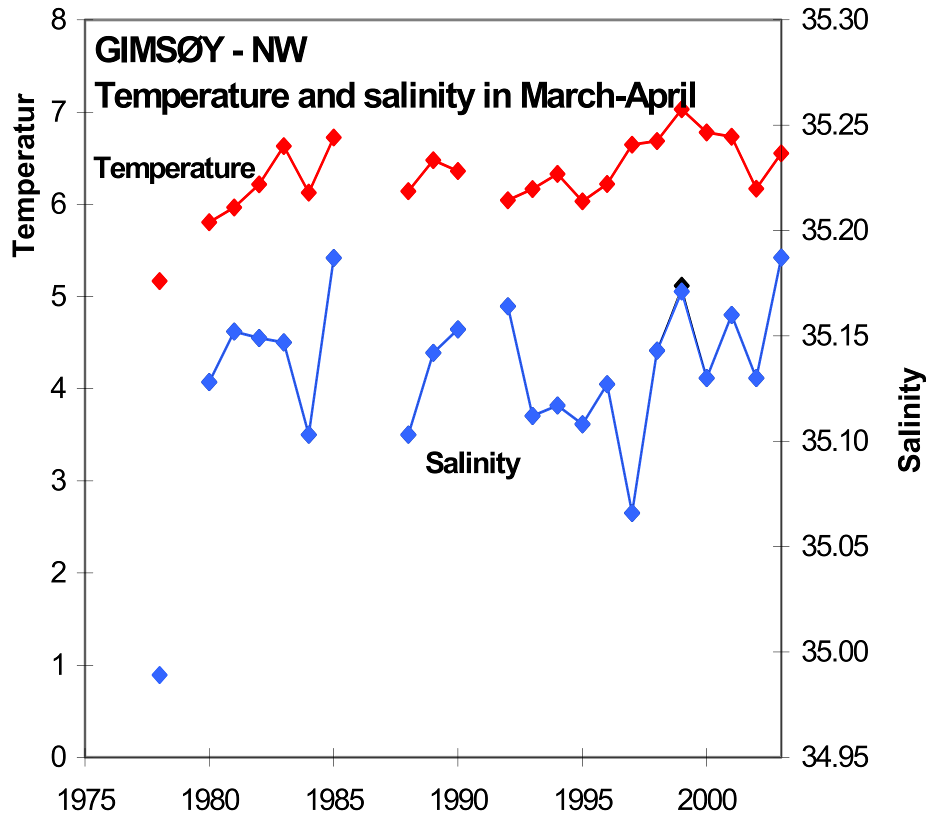


Figure 2.4.1.3 Temperature and salinity in the sections Svinøy – NW and Gimsøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

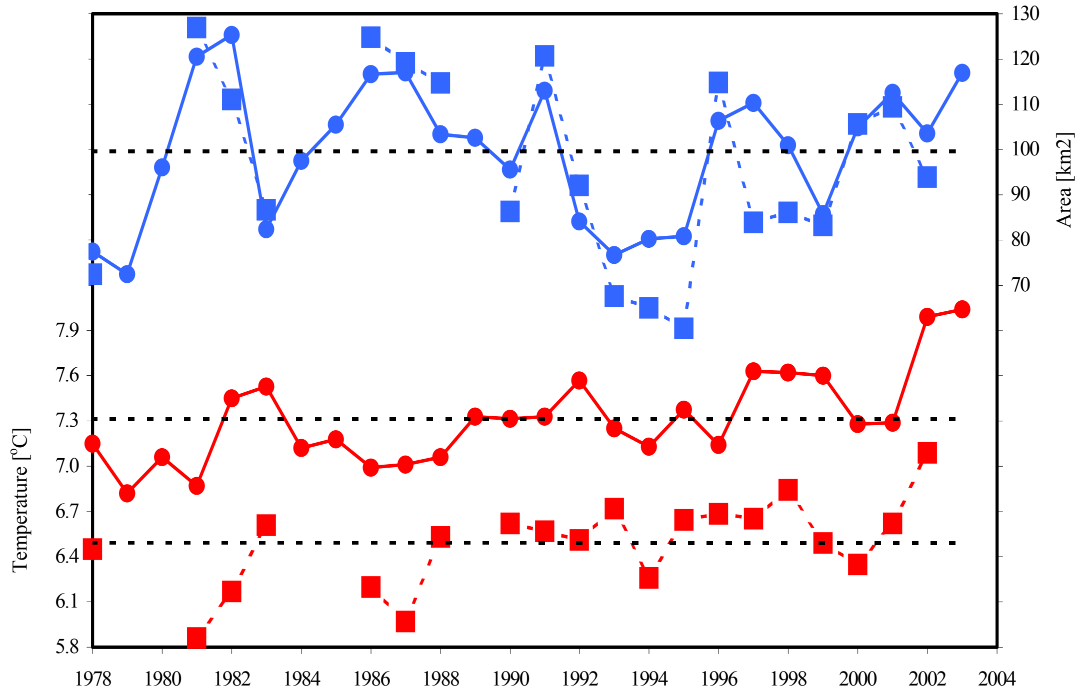


Figure 2.4.1.4 Time series of area (blue, in km^2) and averaged temperature (red) of Atlantic water in the Svinøy section, observed in March/April (dotted line) and July/August (solid line) 1978-2004.

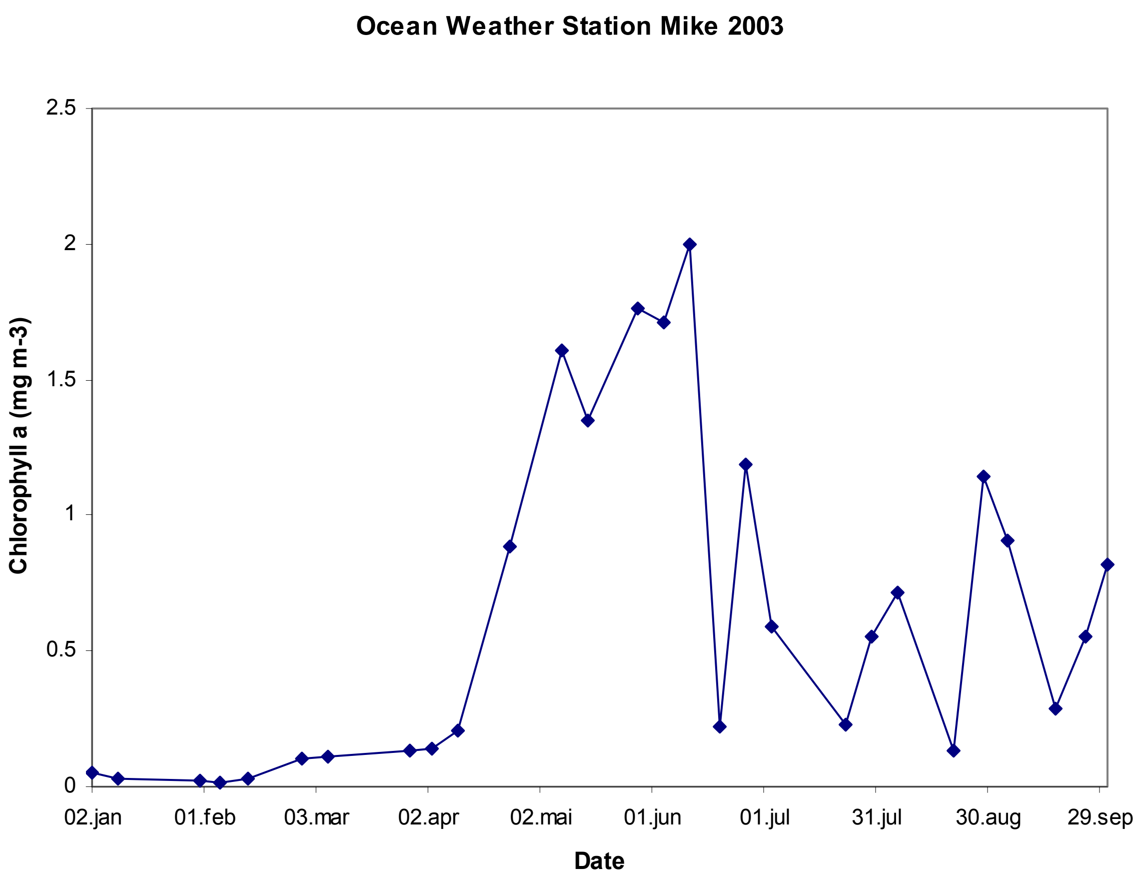


Figure 2.4.2.1 Distribution of chlorophyll *a* at 10 m depth during the year at Weather Station Mike in 2003.

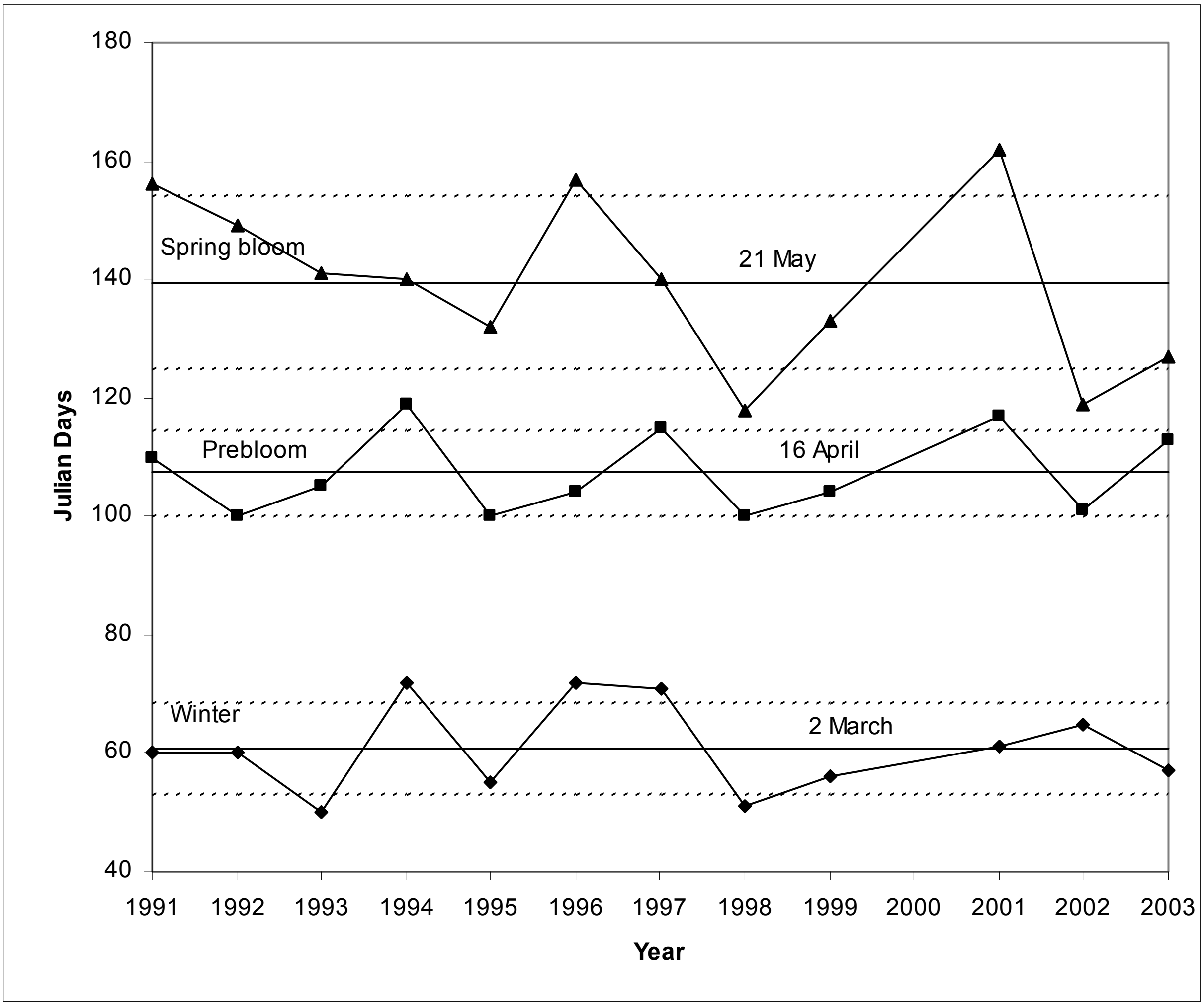


Figure 2.4.2.2 Year to year variations in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 2003. Diamonds: winter phase; squares: pre-bloom phase; triangles: spring bloom. Continuous lines represent the average for each phase. Broken lines represent one standard deviation for each phase.

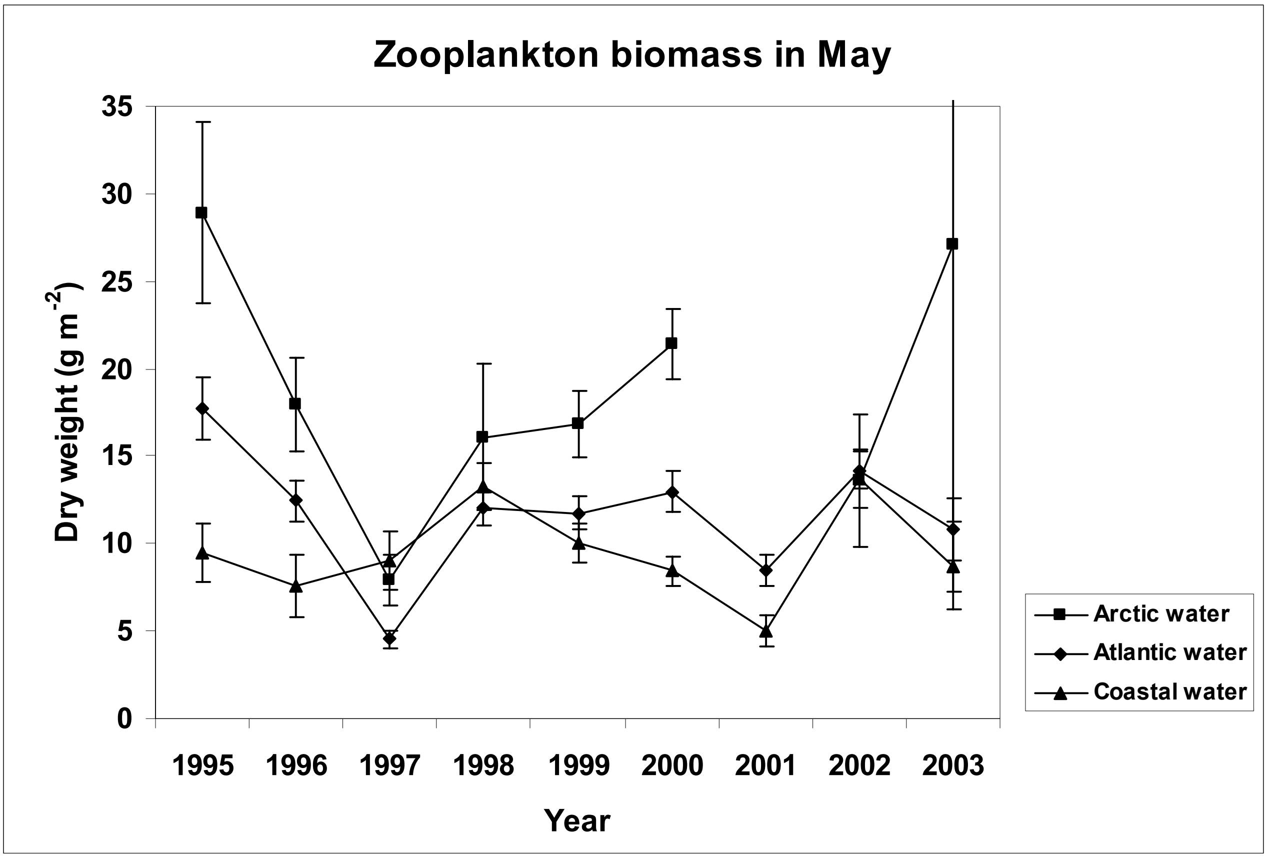


Figure 2.4.3.1 Zooplankton biomass (dry weight) in the upper 200 m in May. A: Arctic influenced water (salinity <35, west of 1.4ºE). B: Atlantic water (salinity >35). B: Norwegian Coastal water (salinity <35, west of 1.4ºE). Error bars: 95% confidence limits.

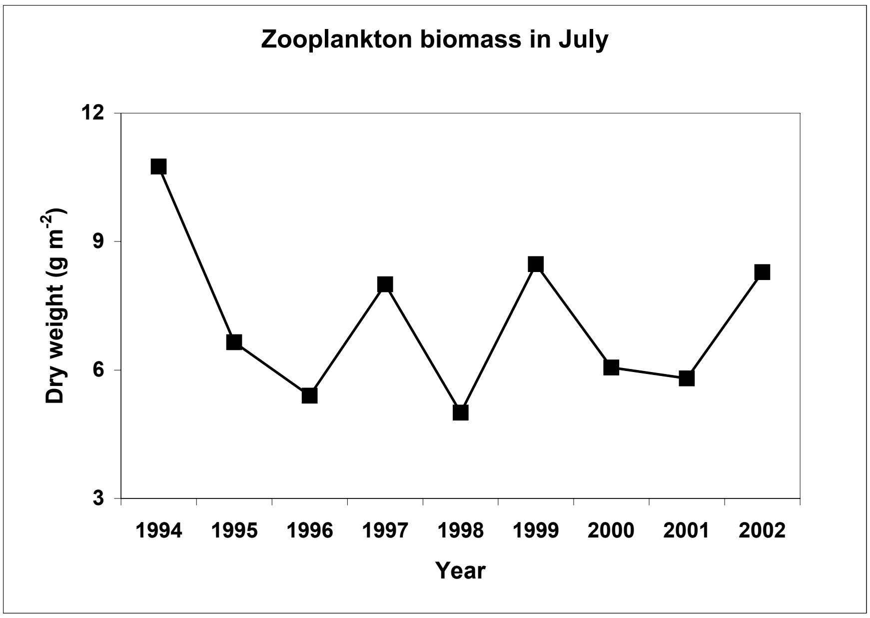


Figure 2.4.3.2 Zooplankton biomass in July-August in the eastern Norwegian Sea (0-200 m). Integrated biomass within a fixed geographical region divided by its area.

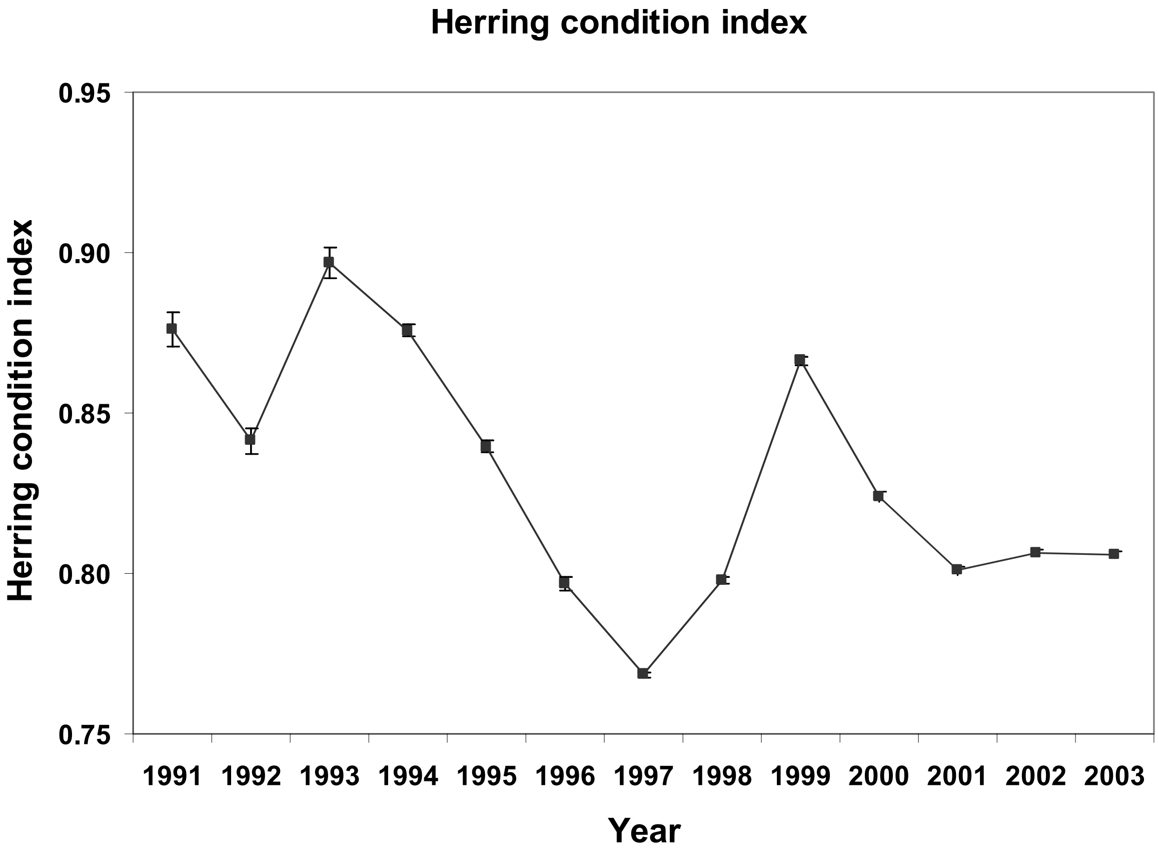


Figure 2.4.4.1 Individual weight to length ratio (herring condition index) for Norwegian spring spawning herring. Data from November and December for herring 30-35 cm body length. Error bars: 95% confidence limits.

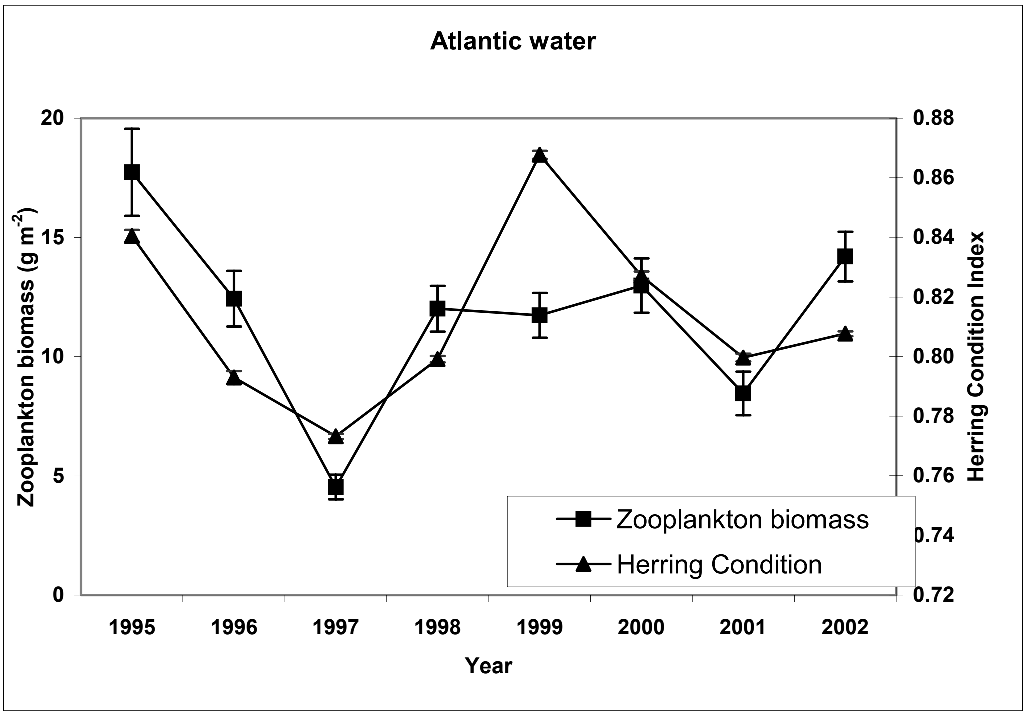


Figure 2.4.4.2 Zooplankton biomass (dry weight) in Atlantic water in the Norwegian Sea in May (0-200 m) and herring condition index (individual weight to length ratio, November and December, 30-35 cm). Error bars: 95% confidence limits. Linear regression: Condition = 0.0045 * biomass + 0.7605. R^2 = 0.3434.

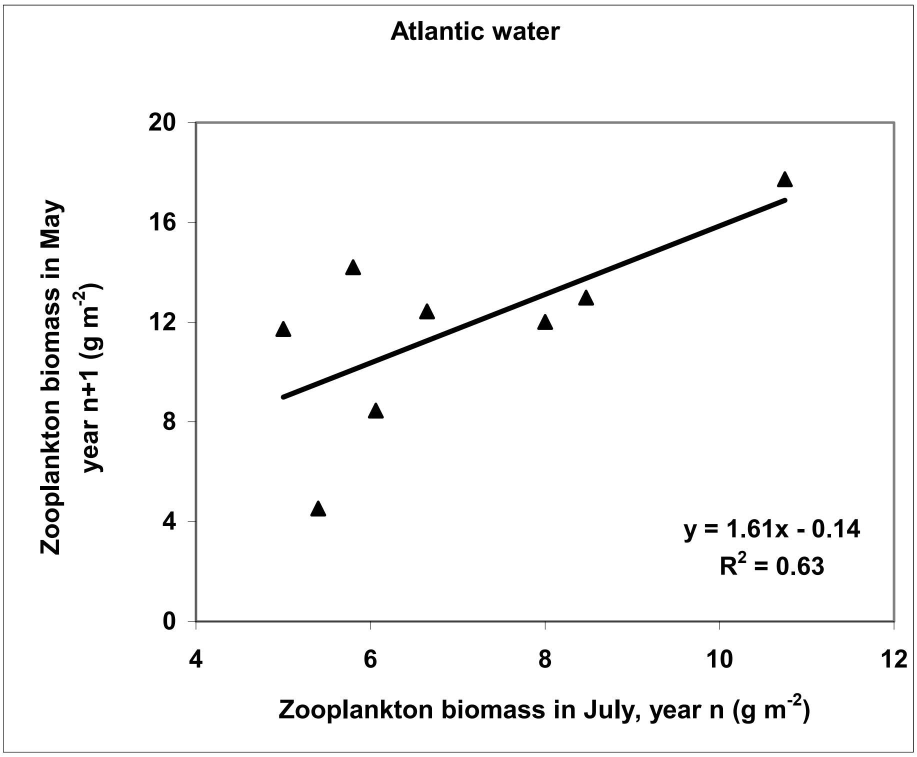


Figure 2.4.5.1 Zooplankton biomass in July (year n) vs. zooplankton biomass in May (year n+1). Open triangles: 1996 and 2001.

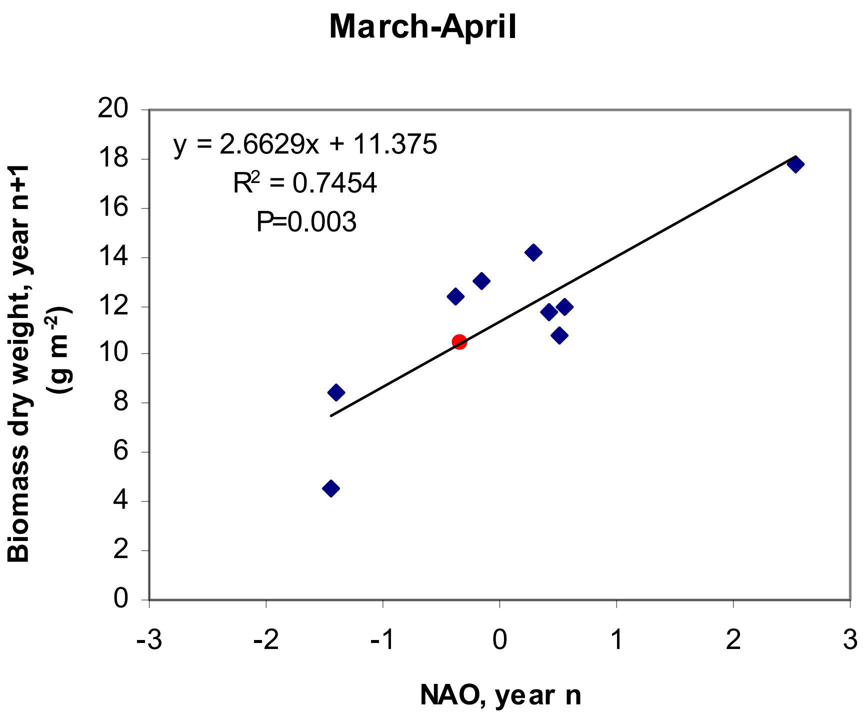


Figure 2.4.5.2 Average North Atlantic oscillation index (NAO) during March and Aril (year n) vs. zooplankton biomass in May (year n+1). Circle: prediction of zooplankton biomass in May 2004 based on equation (1).

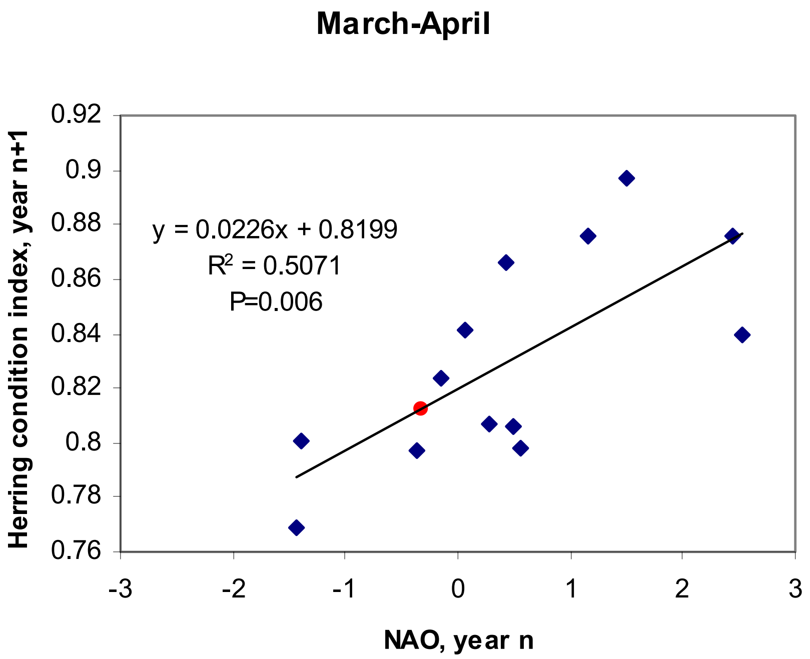


Fig. 2.4.5.3 Herring condition index (year n+1) vs. average NAO during March and April (year n). Circle: prediction of herring condition in 2004 based on equation (2).

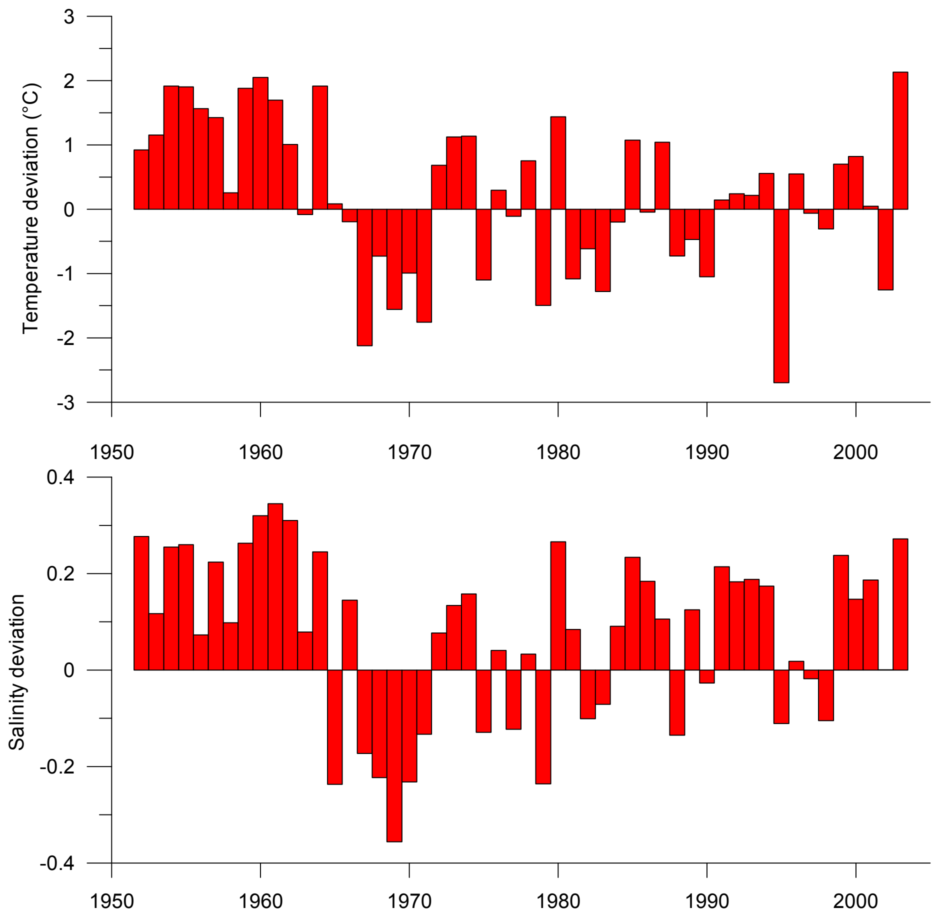


Figure 2.5.1.1 Temperature and Salinity deviations on the Siglunes section north of Icleand, mean for stations 1-5 and 0 – 200m, 1952 – 2003.

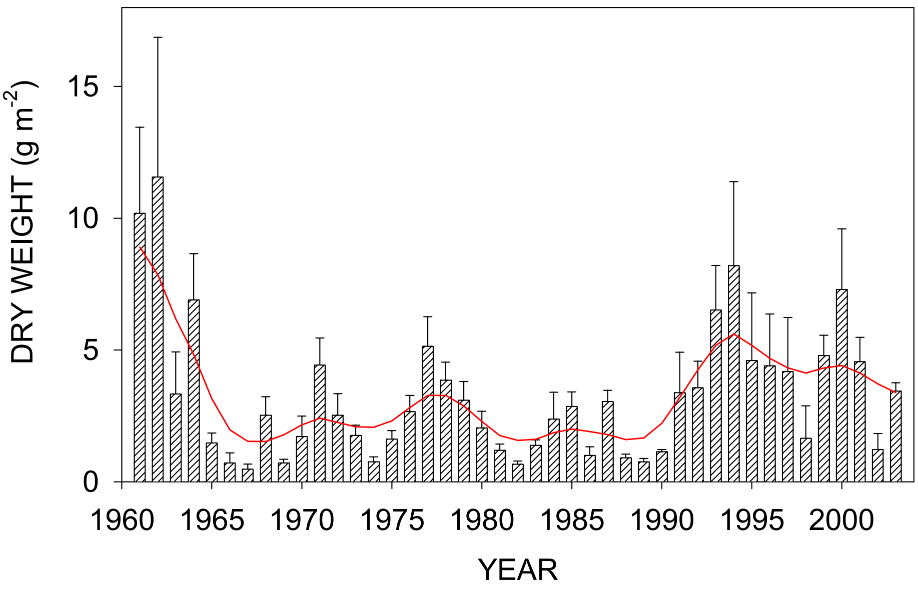


Figure 2.5.1.2 Variations in zooplankton biomass (g dry weight m^{-2}, 0-50 m) in spring at Siglunes section. The columns show means for 8 stations and the vertical bars denote standard error. The curved line shows 7 year running mean.

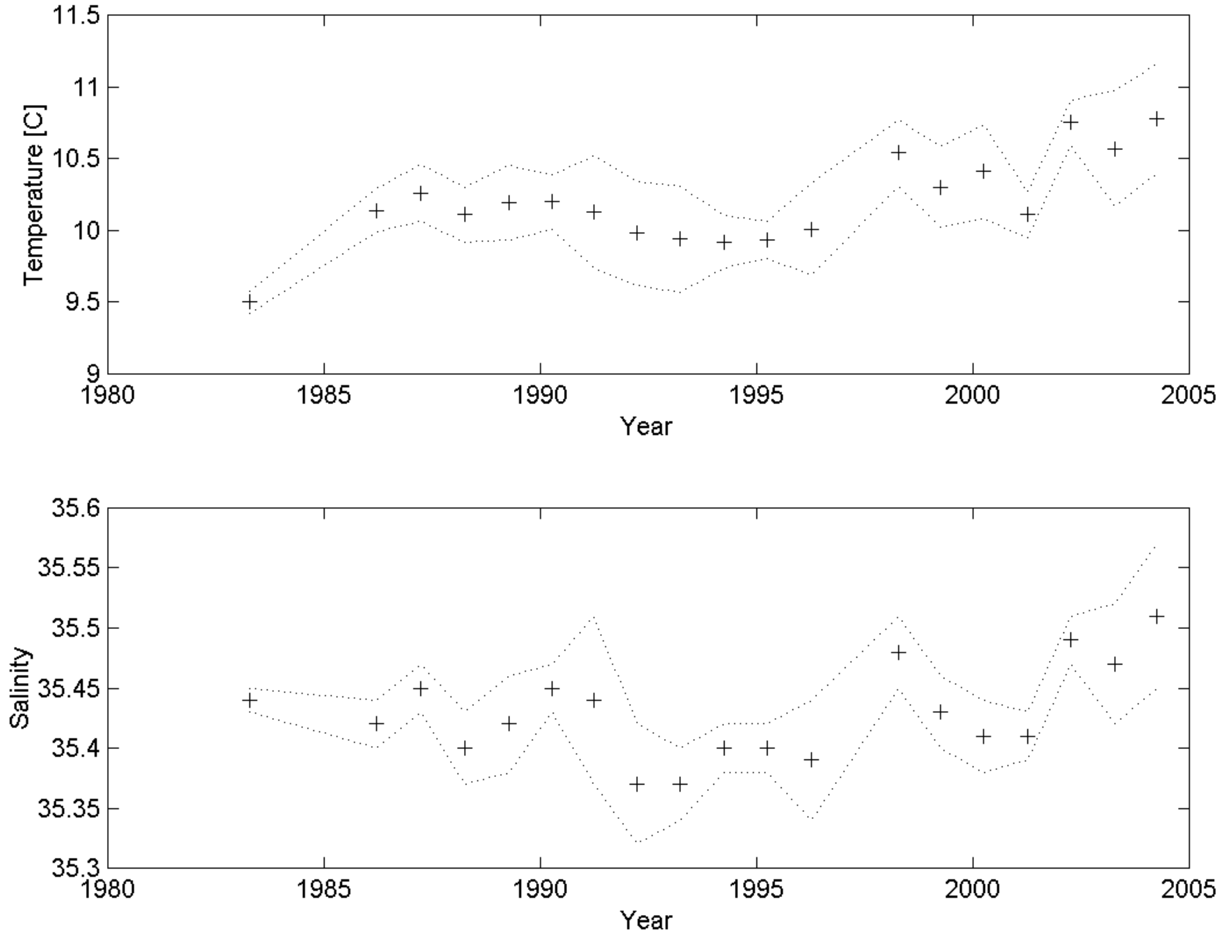


Figure 2.6 Yearly mean temperature and salinity from 50-600 m (crosses) of all stations in a box with bottom depth >600 m, west of the Porcupine bank bounded by 52° to 54°N and 16 to 14°W. Dotted lines are drawn at plus-minus one standard deviation of all observations in each box, each year.

3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 General

3.1.1 Stock definition

The Norwegian spring spawning herring is a stock that is characterized by extended migrations, a high number of vertebrae, by large size at age, different scale characteristics from other herring stocks and large variation in year-class strength. The morphological characteristics of this stock resembled those of Icelandic spring spawning herring. However, the latter stock has disappeared.

ICES areas IIa, IIb and I constitute the distribution area. 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, spawn on the Norwegian coast (mainly between 62^o and 71^{o}N) and feed in the Norwegian Sea. The immature stock is distributed mainly in the Barents Sea, but some herring have their nursery area on the Norwegian coast. Historically, for instance in the period 1900-1950, significant spawning took place on the Norwegian coast south of 60^{o}N (ICES area IV), but at present hardly any herring migrate to these spawning grounds. The adult component seldom mixes with herring of other stocks. However this can occur with immature herring (in certain fjord areas and in the eastern Barents Sea). In this case genetic characteristics are used as a supplement to the above mentioned separation criteria.

In the coming years special attention should be paid to the large 2002 year class, where a substantial part grew up in the Norwegian Sea instead of in the Barents Sea. It is expected that the growth of the Norwegian Sea part of this year class will be much higher than for the Barents Sea component, and also the natural mortality is expected to be lower in the Norwegian Sea component.

3.1.2 ACFM advice and management applicable to 2003 and 2004

In 2002 ACFM stated that "the stock is inside safe biological limits. The stock is harvested at or slightly below $\mathbf{F}_{pa}$ = 0.15. The recruitment of the very strong 1992 year class led to an increase in SSB in 1997 to approximately 9 million t, but SSB has since declined to just over 5 million t in 2001. The incoming year classes 1998 and 1999 are estimated to be strong." Further "ICES advises that this fishery should be managed according to the agreed management plan, corresponding to a catch of 710 000 t in 2003".

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."

There was no agreement on the TAC in 2003, but the sum of autonomous allocations from most of the individual Parties amount to 711 500 tonnes.

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 2003, 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.

3.1.3 Fishery

The total official catch in 2003 was 733.494 tonnes. The total catch used by the working group is 772.927 tonnes. The catches of Norwegian spring-spawning herring (NSSH) by all countries in 2003 by ICES rectangles are shown in Figure 3.1.3.1 (total whole year) and in Figure 3.1.3.2 (per quarter). In 2003 the catch provided as catch by rectangle represented 94.5% of the total catch. 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 2003 during the ICES PGSPFN (Planning Group on Surveys on Pelagic Fish in the Norwegian Sea) investigations (ICES 2003/D:10 Ref ACFM, ACME).

Denmark: The Danish fishery of NSSH is carried out mostly by purse seiners and most of the catches were landed in Norway. In 2003 the first fishing period started in the southern part of Division IIa in February (catch 6,400 t) and continued into March when app. 6,100 t were caught. The second fishing period was in June in the Norwegian Sea and in the Jan Mayen area (app. 1,100 t). Landings from the latter half of the year were insignificant.

The Faroes: The Faroese fishery for NSSH (7 combined purse seiners/trawlers) started in late February 2003 in Norwegian EEZ (ICES Division IIa), relatively close to the coast off Sundmøre (Svinøy) and continued in that area and further north in early March. In mid May the fishery resumed in the international waters around 71-72°N (IIa), and simultaneously in the international area and Jan Mayen zone around 68-69°N and in the northern part of the Faroese area (IIa). The fishery continued in June and early July in the Jan Mayen area, gradually moving northeast into the international area and further into the Svalbard area (IIa and IIb) in late July and August. In late August the fishery had moved southeast into the Norwegian zone and continued in the Lofoten area and off Vesterålen (67-71°N) in September and October. The fishery continued in the until late October. More than half of the catches were taken with pelagic trawls and the rest with purse-seines.

France: France reported no catches in 2003.

Germany: The main German fleet fishing for pelagic species is based in Bremerhaven and Rostock. It consists of 4 large pelagic freezer trawlers with overall lengths of 70 m, 95 m, 117 m and 124 m ; engine power 3700 hp, 4400 hp, 8300 hp and 8600 hp and 25 – 40 crew members. The vessels are owned and managed by Dutch companies but operating under German flag.

They are specially designed for pelagic fisheries: The catch is pumped into large refrigerated seawater tanks to keep the catch fresh until further processing, which is usually block freezing. The freezing capacity of the 4 vessels ranges between 60,000 and 230,000 cartons (up to 5,500 t fish).

In 2003, the directed NSSH fishery started in early June with an exploratory fishery in rectangles 72F5 to 74F7. Only 179 t of herring were caught within 4 days. The next trip yielded 380 t in rect. 60F0 beginning of August. The bulk of German catch (2240 t) was caught in the 2nd and 3rd week of August close to the border to division IIb (rect. 73F9 to 75G2, and one haul in IIb). The last trip for herring in IIa was conducted in the 2nd, 3rd and 4th week of September and yielded 277 t in rect. 73F9-G0, 92 t over the continental shelf break NW of the Lofoten and 164 t SW of the Lofoten.

Iceland: The Icelandic catch quota for NSSH was set at 103 234 tonnes in 2003. The Icelandic fishery in 2003 began in the second week of May in international waters east of Jan Mayen and later in the month the fishery continued there as well as in the western part of the international waters in the Norwegian Sea between the Jan Mayen and Faroese zones (see the figure below). In June the fishery was mostly conducted in the international zone east-northeast of Jan Mayen but also at the borders of the Icelandic, Jan Mayen and international zones in the second week of June. In July the fishery moved still further north in the international zone and into the southern Spitzbergen zone and continued there untill the last week of August when it moved into the Norwegian EEZ. In September the fishery moved closer to the Norwegian coast and finished northwest of Lofoten in the last week of September. The bulk of the catch was caught in June (52 thous. tonnes) and May (26 thous. tonnes) and only about 1500 tonnes were caught in September. The total catch was 102 737 tonnes of which 61 882 tonnes were taken in midwater trawl and 40 855 tonnes in purse-seine.

A total of 28 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).

Ireland: The information on the Ireland fishery was restricted to official catch.

Netherlands: The Dutch fleet fishing for pelagic species (herring, blue whiting, mackerel, horse mackerel, argentines) consists of 16 freezer trawlers and pair trawlers. They have a seasonal fishery in May-June directed towards Atlanto-Scandian herring in the Smutt-havet area (ICES Sub-area II) during which they also catch blue whiting.

Furthermore they have a seasonal fishery from February to April in ICES Divisions VIIb,c and VIa,b directed towards blue whiting.

Norway: The Norwegian fishery is carried out by many size categories of vessels. Of the total national quota of 484 500 t, 51% is allocated to purse seiners, 9% to trawlers and 39% to smaller coastal purse seiners. By far the larger part of the Norwegian fishery takes place in northern Norwegian coastal waters (Vestfjord area) where the herring winters from September until mid January. Here the herring occurs in concentrations that are easily available to the fishery. In 2003 only about 25 000 tonnes were caught in the wintering areas in Northern Norway in January-February. 91 000 t were taken in the spawning area on the Norwegian coast in February-March. Only negligible quantities (403 tonnes) were caught in the areas south of 62 N during the spawning period in 2003. Only 160 t were caught in the spring/summer fishery in the Norwegian Sea. The remaining part of the Norwegian quota (approximately 297 000 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 438 140 tonnes

Poland: The Poland reported no catches in 2003.

Russia: In 2003 the Russian fishery started within the shelf region of the Norwegian EEZ, near Trena Bank (approximately 65° N-66° N) in the beginning of February and Sklina and Buagrunnen Bank (approximately 63 °N - 65° N) in the end this month. In March the fishing was in progress in the same regions. In February and March the catch was 5 054 t.

In May-June the commercial vessels conducted fishing in the northern part of the international area in the Norwegian Sea in region of the Polar Front and in the Jan Mayen area. In May-June the catch was 8 262 t. In July-September vessels caught herring in the international area in the Norwegian Sea in the region of the Polar Front and the zone of Spitsbergen.

In September Russian vessels followed the southward migrating fish and continued their fishery in the Norwegian EEZ. In September the fishery of the herring was prolonged in the EEZ of Norway. The herring migrated southwestwards, along the depths of the continental slope. In July-September the catch was 68 809 t. In the first decade of October the fishery of the herring were finished in the Norwegian EEZ. In October the catch was 18 692 t. The total Russian catch of Norwegian spring spawning was 122 846 tonnes of which about 5% were taken by purse seine and 95% with pelagic trawl. The entire Russian catch was utilized for human consumption.

Sweden: NSS herring is fished by seins and pelagic trawlers, in 2003 was around 60% landed by seins. The major part is landed in Norway. In the beginning of the year the catches stem from the southern parts of IIa and moves in the second half of the year further to the north.

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. Generally the catch is landed into factories in Norway and is worth around £2.5 million to the Scottish fleet.

3.2 Data

3.2.1 Commercial catch

The total annual catches of Norwegian spring-spawning herring for the period 1972–2003 (2003 preliminary) are presented in Tables 3.2.1.1 (by fishery) and 3.2.1.2 (by country).

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 (Table 3.2.1.1).

In Røttingen *et al* (2002) the possibility of incorrect catch statistics because of the water content in herring deliveries and errors concerning conversion factors between fillets and live weight of herring were discussed. The paper gave an assessment of underreporting in 2001 of live weight of 18 000 tonnes, which is 3% of the total catch of Norwegian spring-spawning herring landed in Denmark and Norway in 2001 (588 000 tonnes). This underreporting element is probably valid also for other pelagic stocks.

For 2003 Norway increased the allowed subtraction for water content from the weighted catches to 13%. This value has been 4% in the years before 2003, thus an increase at 9%. However, for 2004 EU and Norway have agreed to set the subtraction to 2%. This percentage was set into practical effect from 1 February 2004.

As compared to earlier years the actual Norwegian catch thus rose by 9% in 2003 due to the application of a water content at 13%. This accounts for a tonnage of 39433 which was added to the Norwegian catch for 2003 by the working group. This was done as the Norwegian catch is large and the additional tonnage is a significant contribution to the total catch and should be reflected in the catch numbers used by the working group. For 2004 (next report) the official catch will be used.

The combination of national catch-at-age and weight-at-age data for 2003 to obtain the total international catch-at-age and weight-at-age was done using the computer programme SALLOC, a standard ICES software. The official catch, sampled catch, and catch as used by the Working Group, together with number of samples, catch-at-age, and weight-at-age for each fishery are given in Tables 3.2.1.3 and 3.2.1.4.

The Working Group noted that not all nations participating in the international fishery for Norwegian spring-spawning herring in 2003 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 area is given in Table 3.2.1.5. In general one used the Norwegian age distribution and weights for un-sampled fisheries in the Norwegian Sea in quarter 1,4, and the Russian age distributions and weight keys for quarter 3-4 for un-sampled fisheries in quarter 3-4. and the Iceland age distribution for quarter 2 for un-sampled fisheries in quarter 2. The Russian age distribution in quarter 3 was calculated using Russian length-age keys for quarter 3 for IIb ICES area.

3.2.2 Biological data

The natural mortalities and the weights in stock are in Table 3.2.2.1, weight in catches in Table 3.2.2.2, catches in Table 3.2.2.3, proportion maturity by age in Table 3.2.2.4 and natural mortality in Table 3.2.2.5. The weight in stock at 1 January 2004 was taken as the unweighted mean of Norwegian samples from December 2003for corresponding year classes, except for age 1 and 2 for which the mean weight of the corresponding year classes in the joint IMR-PINRO survey in the Barents Sea in September 2003 was used (Anon. 2003). The weight in catches in 2003 was taken from the total international weight-at-age (table 3.2.1.5) which were produced using the computer programme SALLOC, a standard ICES software.

3.2.3 Surveys

3.2.3.1 Spawning grounds

There was no acoustic survey to estimate the abundance of herring in the spawning areas in 2003. Earlier estimates are listed in Table 3.2.3.1.1.

3.2.3.2 Wintering areas

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 2003 a survey covering both the fjordic and oceanic wintering area was carried out by the RV G.O.Sars and R/V Johan Hjort. The combined result of the survey (Table 3.2.3.2.1) covers the entire 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.

An acoustic survey earlier took place on the wintering area in January. This series was ended in 1999 (Table 3.2.3.2.2).

3.2.3.3 Feeding areas

The feeding areas in the Norwegian Sea were surveyed acoustically by the ICES coordinated herring survey (PGNAPES, former PGPFN) during the period 25th April to 10th June 2003 (ICES 2003/D10). A complete set of the PGSPFN reports from the years 1995-2003 is found on www.imr.no/PGSPFN. The abundance estimate is given in Table 3.2.3.3.1.

3.2.3.4 Nursery area

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 1991-2002 are given in Table 3.2.3.4.1. 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 3.2.3.4.2. The results from the 0-group herring survey in Norwegian Fjords and Coastal areas are given in Table 3.2.3.4.3 and the results from the joint Norwegian-Russian 0-group survey in the Barents Sea are given in Table 3.2.3.4.4.

3.2.3.5 Herring larval survey

The larval survey in 2004 was carried out during the period 1-11 April. The survey started at Fugløya (70^0N) and continued along the Norwegian shelf south to Stad (62^0N). On a previous survey the area south of Stad had been covered, but no herring larvae were found in this area. High concentrations of herring larvae were found in the whole area north of Stad. Most of the larvae were in the first post yolksac stage and the mean length was 12.63 mm. This is more than 2 mm less than last year. The number of larvae was, however, much higher than last year (Table 3.2.3.5.1), and a higher number has only been recorded once, in 1997. Like the previous year a high proportion of the larvae were found in the northern part of the investigated area. The total number of larvae was estimated to be $56.4*10^{12}$.

3.2.4 Other relevant data

3.2.4.1 Tagging data

With the exception of 1999 and 2001, tagging has been carried out annually since 1975. The tagging experiments in 2003 were carried out in November in the wintering area (Tysfjorden, 68°05.5' N, 16°22.3' E) where a total of 20798 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 2003, and a total of 88 072 million herring were screened in these factories. Magnet efficiency was very close to 100% in 2003. All tagged herring recovered were sent to the Institute of Marine Research, Bergen, where they were measured, weighed and aged. In 2003 130 tags from herring that were four years or more when tagged, were recovered from the factories (Table 3.2.4.1).

3.2.4.2 Prognosis of herring condition

A prognosis of the herring condition index for 2005 was used to estimate weight-at-age for the herring in 2005 in the short-term prognosis for NSSH. The prognosis of the herring condition was derived from a regression of herring condition during the time period 1990 to present on a two-month mean of the NAO index with a one-year time lag as described in Section 2.4.5. Figure 2.4.3 shows the relationship between observed and modelled data of the herring condition.

3.3 Assessment models: Sea Star

In SeaStar (see 1.3.1) assessments he catchabilities of the acoustic surveys are assumed to have no age structure, i.e. 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.

The input data used are:

Catch data	Table 3.2.2.3
Acoustic surveys	Table 3.2.3.1.1, 3.2.3.2.1, 3.2.3.3.1, 3.2.3.4.1, 3.2.3.4.2
Tag data	Table 3.2.4.1
Larval data	Table 3.2.3.5.1
0-group data	Table 3.2.3.4.4

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 lognormal 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 corect for this age bias (WD by Schweder and Tjelmeland to the 2003 WG meeting).

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.

3.3.1 Comparison with the 2003 assessment

Before the exploratory analysis a comparison between the 2004 assessment and the 2003 assessment was made with the same settings as used in 2003, as recommended by ACFM. Figure 3.3.1.1 shows the perceived number by age for the two assessments together with the perceived number by age in 2003 in the assessment that later was chosen by the WG after an exploratory analysis.

With the same settings the new data do not lead to any appreciable change in the perceived stock in number by age in 2003. The 1998 year class has been slightly lifted. The run chosen by the WG as assessment this year leads to a lifting of the 1991 and 1998 year classes. The reason for this is that the data in the acoustic December and Norwegian Sea surveys, rather than information from the Barents Sea are now used to assess these year classes. For the same reason the 1997 year class is now perceived smaller. There is also a slight increase in the 1992 year class.

3.3.2 Data exploration with SeaStar

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 2003 assessment the 1997-1999 year classes were 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
Oldest10	Age 10 was set as the oldest true age group
CorrAgeBias	The bias in age reading was attempted corrected with the same method as

	used in one exploratory run in 2002
SurvSel	A survey selection curve was estimated along each tuned cohort
NoLarvae	The larval data were left out

The estimated parameter catchabilities, spawning stock biomass in 2003 and 2002 and the contribution to the likelihood function from the various data sources are shown in Table 3.3.2.1 for the exploratory runs. Figure 3.3.2.1 shows the spawning stock timeseries for the runs. The catchabilities reflect how well each survey conforms to the modelled stock. The survey on the feeding areas in the Norwegian Sea seems to be the closest to the modelled stock, as has been the case also in previous assessments.

The perceived spawning stock is appreciably increased when the tagging data are removed and appreciably 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 0.115 as opposed to 0.128 last year and the M-value for young herring in the Barents Sea is estimated at 0.188, as opposed to 0.507 last year. The large reduction in perceived natural mortality for the young herring is probably connected to removing the 1997-1999 year classes from the Barents Sea estimation which resulted in an increase of year class strength for the 1998 and 1999 year class. If the oldest true age group is set to 10 years the spawning stock is drastically increased. However, this does also result in a drastic decrease of information. The trade-off between the benefit of including older fish in the analysis versus the problems connected to increasing bias as the fish grows old should be investigated further.

If the estimation allows for a survey selection to be estimated along each cohort the perceived spawning stock is increased. The change is, however, small, in accordance with the assumption made that once a year class is fully recruited to a survey the catchability remains constant.

3.4 Assessment models: ISVPA

3.4.1 Data exploration with 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), except the following two aspects:

1. Starting year of analysis was 1950 instead of 1986 in previous years;
2. two selection patterns were fitted: first - for 1950-1985, and second - for 1986-2003.

Year of change in selection pattern was chosen not in correspondence with change in fishing regime, but later in order to retain similarity with previous assessments by means of ISVPA, when first year of analysis was 1986 and single selection pattern was estimated.

Profiles of components of ISVPA loss function for different sources of information are represented on figure 3.4.1.1. Survey in feeding area in May (N5 on figures) was treated the same way as in last year and was used for tuning in form of age proportions, weighted by stock abundance. This helps to exclude influence of possible occasional changes in this survey selection which may be the reason for deterioration of the signal from this survey when it is used for tuning in form of abundance-at-age. Weighting by abundance is used in order to make stress on abundant years as probably giving survey information of better quality. Treated as weighted age proportions, this survey corresponding to signals from most of other sources of information (compare curves N5 on figure 3.4.1.1 and figure 3.4.1.2, the last one representing signals for the case when survey N5 is used in form of abundance-at-age). More considerations of survey data use in form of age proportions with examples of its implementation for real and simulated data are given in (Vasilyev, 2003). Overall loss function of the model (curve 7 on figure 3.4.1.1) has clear minimum.

If to restrict interval of years in the analysis to 1986-2003, the only change is slight change in the shape of the loss function component, corresponding to signal from catch-at-age data without significant change in its position (figure 3.4.1.3 to be compared to figure 3.4.1.1).

If to disregard all auxiliary information and find solution only on the basis of signal from catch-at-age alone, the result is very close to the result, when all information is used (including survey N5 in form of age proportions). This confirms that catch-at-age data, considered in frames of separability assumption, gives valuable signal about stock size and it seems to be not rational to disregard it. Results in terms of SSB for the above mentioned runs, as well as for runs, when age groups 3 and 4 were excluded from surveys N5, are presented on figure 3.4.1.4. For better resolution figure represents the estimates from 1990. As it can be seen, change in age diapason in survey 5 does not produce significant impact on results, while treatment of surveys 5 as abundance-at-age index shifts SSB estimates in final years down.

Bearing in mind that if survey N5 data are treated as age proportions (influence of possible changes in survey catchability is excluded), this data source gives the signal about the stock which is more in line with signals from most of other sources of information, including catch-at-age alone, in the final ISVPA run just this treatment of this data source was used. Other model settings in comparison with those used in previous assessment, are listed in the table 3.4.1.1.

Plots of residuals for all used sources of information are presented on figure 3.4.1.5. Looking at plot of residual in logarithmic catch-at-age it should be remind that for catch-controlled version, where abundance-at-age values are calculated via reported catch-at-age data and estimated selection pattern is used only for estimation of terminal abundance, residuals represent measure of separability, but not directly and not as measure of deviations of estimated abundances from "real" ones.

Figure 3.4.1.6 represents the estimated selection patterns (normalized to1 by sum). The estimates show reasonably higher selection of younger ages in the first period.

Tables 3.4.1.2 and 3.4.1.3 represent estimates of abundance and fishing mortality coefficients. Summary results of final ISVPA run are presented in table 3.4.1.4 and on figure 3.4.1.7.

Results of retrospective runs are shown on figure 3.4.1.8. Estimates of fishing mortality are rather stable, while stability of estimates of recruitment is lower.

3.5 Exploratory assessments with ISVPA and SeaStar

The two methods (ISVPA, (WD Vasilyev 2004), and SeaStar Chapter 1.3) were tested, in an exploratory phase. The methods are different in the way that while the SeaStar method is tuned against abundance series only, and assuming that the catch data are without errors, the ISVPA is tuned against the abundance series and the catch data with the assumption of a constant selection pattern in the fisheries. In earlier years, the two methods have shown differences in results, both in terms of trends in the stock in recent years, but also in terms of stock levels. Last year, it was therefore not easy for the working group to agree on what method to use for the assessment.

3.5.1 Input data for comparative runs for testing of the methods

Exploratory assessments were made in order to compare the performance of the two methods. The tuning input data for these runs are in the text table below. The data sets were made as equal as possible, with almost the same abundance series. In SeaStar, it has been common to use tagging data. The tagging data has not been used in ISVPA, since these data has not been in the form of an abundance index series. The tagging data were therefore not applied in the runs for comparison of the methods. Both methods use, however, all the acoustic abundance estimates, with the same age ranges. In addition, ISVPA uses the catch data for tuning. SeaStar does not use the catch data for tuning, but in the back-calculation of the different year-classes (the VPA). The SeaStar method also uses the o-group series for the Barents Sea, a series which is not used in ISVPA. In addition, both methods use the standard input data for assessments such as stock weights, maturity proportion by year, natural mortalities etc.

Tuning data series in assessments	Series used for method test
Catch at age data 1950 – 2003	X (ISVPA only)
Acoustic abundance estimates on the spawning grounds 1988-2000	X
Acoustic abundance series in the wintering areas in December 1992-2003	X
Acoustic abundance series in the wintering areas in January 1991-1999	X
Acoustic abundance series in the feeding area (Norwegian Sea) 1996-2002	X
Acoustic abundance series of young fish in the Barents Sea 1991-2003	X
Tagging experiments	
O-group data from the Barents Sea 1965-2003	X (SeaStar only)
Larval surveys	

3.5.2 Results

3.5.2.1 ISVPA

Figures 3.5.2.1 show the results of the minimisation of the object function of the different abundance indices and for the fit to the catch data for the ISVPA. The figures show well defined minima for all data series except for the young herring survey in the Barents Sea.

Figures 3.4.1.5 a-g show bubble plots of the residuals of the fit to the various data series.

The residuals (on log-scale) of the fit to the catch data, as shown in the bubble plots (Figure 3.4.1.5 a) have a tendency of high residuals for the young age groups (1 and 2 year olds). For the older age groups, the residuals are lower in value, but show a tendency of cohort effects.

The residual pattern of the fit to the survey indices (Figure 3.4.1.5 b-g) show somewhat higher residuals than those for the fit to the catch data, and there seem to be cohort effects. However, the higher values and the cohort effects seem to be associated with the small year-classes, especially the 1986 year-class.

3.5.2.2 SeaStar

Because the selection pattern in the fishery may vary according to the strength of the year- classes, the catch data are not used in the tuning procedures in SeaStar. In the recent 20 years, the 9 strongest cohorts are modelled and fitted to the survey data in a maximum likelihood procedure. The modelled year-class trajectories in relation to the observed once in acoustic estimates are shown in Figures 3.6.1-3.6.6. There is a variation in how well the model are fitted to the observed data. There seems to be both cohort and year effects for all series. The 1983 year-class seems to be overestimated in the wintering area surveys in January and on the spawning grounds, while the strong 1991 and 92 year-classes seem to be underestimated in the feeding area surveys.

3.5.3 The results of the two methods

The results in the form of spawning stock trajectories are shown in Figure 3.5.3. It shows that the methods performed similarly (showed the same overall trend and status of the stock) when the present set of data were used. However, it is at present impossible to compare the methods, in terms of statistical fit to the data because they do not give comparable statistical output.

The investigation of the two methods show that they give similar results with their present sets of data. The fulfilment of the assumption of the constant selection pattern is therefore shown not to be the major cause for the difference between the models. More important is the choice of data series and how these are handled.

3.5.4 Final runs

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. The result of this final SeaStar run is different from the one in the comparative runs and the results are given in Figure 3.5.3.

A final run with the ISVPA run was also made. For this method, additional data were not used, but the acoustic survey index for the Norwegian Sea was used for tuning of age proportions in the stock (detrended). This resulted in a difference in comparison with the comparative runs. The results are shown in Figure 3.5.3.

The working group chose the final run of the SeaStar method as the run to use as an assessment of the stock, and to use the results from this run as a basis for the predictions because this method incorporated all data series. However, SeaStar misses the information on stock abundance which may be found in the catch data and which ISVPA makes use of.

3.6 Final assessment including uncertainty and retrospective analysis

Figure 3.6.1 shows the fit of the VPA scaled with the estimated catchability to the observations in the survey on the spawning grounds for the tuned year classes. Figure 3.6.2 shows a similar fit for the December survey in Vestfjorden, Figure 3.6.3 for the January survey in Vestfjorden, Figure 3.6.4 for the May survey in the Barents Sea, Figure 3.6.5 for the feeding areas in the Norwegian Sea and Figure 3.6.6 for the Barents Sea September survey. With exception of the 1991 year class in the December survey, possibly the 1983 year class in the survey on the spawning grounds and the 1999 and 1998 year class in the survey on the feeding grounds all year classes seem to recruit well to all surveys and have a reasonably good fit. However, the 1996 year class seems to be somewhat systematically underrepresented in the survey on the feeding areas.

Table 3.6.1 shows the modelled historic abundance and Table 3.6.2 the F-values for the period 1950-2003. Table 3.6.3 shows the historic development of spawning stock, recruitment and abundance-averaged F-values over ages 5-14. It should be noted that SeaStar calculates the number of fish in the plus-group by summing the number of fish in the plus-group the year before and the number of fish in the oldest true age group the year before, adjusted for natural mortality and catch. Therefore, the spawning stock time series might not be comparable with data calculated earlier with a different method.

Figure 3.6.7 shows the retrospective plot. The assessment the present year is well in accordance with the assessment made in 2003. In 1999 there was a substantial increase in the assessment from the preceding years. It is interesting to note that in 1999 all year classes increased with respect to the previous year in the January survey and the survey on the spawning grounds, as all year classes also did in the September survey in 1998. These increases had a substantial effect on the assessment, but this effect diminished in the following years.

Figure 3.6.8 shows a histogram of the spawning stock in 2004 for the bootstrap replicates. The standard deviation is about 4 million tonnes - a drastic increase from last year. The distribution is also more skewed than last year. This reason for the changes of the distributional form should be investigated further. However, the median spawning stock is close to the maximum likelihood value.

Figure 3.6.9 shows a scatter plot of the co-variation between terminal F-values and the spawning stock. While the co-variation between the terminal F-values for the adult year classes and the spawning stock show a smooth distribution, the scatter plot involving the terminal F-values for the 2002 and 2003 year classes seems to consist of disjunctive clusters. This might be an indication of a problem in using the Barents Sea data which should be looked upon more closely.

Figure 3.6.10 shows the spawning stock time series for the present assessment together with the spawning stock time series for the 2003 assessment, Figure 3.6.11 a similar plot for the abundance averaged F for ages 5-14 and Figure 3.6.12 a similar plot for recruitment at age 0.

The main settings for the final SeaStar runs in 2003 and 2004 are found in table 3.6.4.

3.6.1 Short term projection

Table 3.6.1.1 shows the input data to the short term prediction. For the weight at age in 2005 the weight at age in 2004 which is taken from December 2003 data was multiplied with the ratio of the projected condition factor in December 2004 to the measured condition factor in December 2003. The condition factors are described in section 3.2.4.2. The exploitation pattern was set to the F-values estimated for 2003. It is assumed that a catch of 0.825 million tonnes is taken in 2004. The weight at age in the catch is taken as the weight at age in the catch in 2003 and adjusted with the projected condition factor as is the case for the weight at age in the stock. The proportion mature at age was set equal to the proportion mature at age in 2003 with the exception for an adjustment for the 2002 year class as 3 year old which as set at 0.15 instead of 0.0.

Table 3.6.1.2 shows the results of the short term prediction. For a population weighted fishing mortality over the ages 5-14 of about the agreed value of 0.125 the expected catch in 2004 is about 0.9 million tonnes. The spawning stock will remain virtually unchanged from 2004 to 2006.

3.7 Biological reference points

The process of establishing biological reference points (including a $\mathbf{B}_{lim}$ a value of 2.5 million tonnes) for this stock is given in Røttingen (2000). The SGPRP03 stated that the segmented regression was significant on a 5% level and gave a change point of 2.3 million tonnes. Further, the SGPRP03 has the opinion that these numbers are close to each other and as this stock is managed to an agreed harvest control rule, there is no need to change the $\mathbf{B}_{lim}$ value.

If the spawning stock falls below 5.0 million tonnes ($\mathbf{B}_{pa}$) the managers have, according to the harvest control rule, decided on a linear reduction in fishing mortality from the agreed maximum fishing mortality 0.125 ($\mathbf{F}_{pa}$ is set to 0.15) at $\mathbf{B}_{pa}$ to 0.05 at $\mathbf{B}_{lim}$. The WGNPBW agrees on the conclusion of the SGPRP03 on the $\mathbf{B}_{lim}$, and is, due to the elements in the agreed harvest control rule, also of the opinion that there is no reason at present to change the values for the biological reference points $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$.

3.8 Management targets

EU, Faroe Islands, Iceland, Norway, and Russia agreed to implement a long-term management plan. 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.

Table 3.2.1.1 Catches of Norwegian spring-spawning herring (tonnes) since 1972.

Year	A	B[1]	C	D	Total	Total catch used in WG
1972	-	9895	3,266[2]	-	13,161	13,161
1973	139	6,602	276	-	7,017	7,017
1974	906	6,093	620	-	7,619	7,619
1975	53	3,372	288	-	3,713	13,713
1976	-	247	189	-	436	10,436
1977	374	11,834	498	-	12,706	22,706
1978	484	9,151	189	-	9,824	19,824
1979	691	1,866	307	-	2,864	12,864
1980	878	7,634	65	-	8,577	18,577
1981	844	7,814	78	-	8,736	13,736
1982	983	10,447	225	-	11,655	16,655
1983	3,857	13,290	907	-	18,054	23,054
1984	18,730	29,463	339	-	48,532	53,532
1985	29,363	37,187	197	4,300	71,047	169,872
1986	71,122[3]	55,507	156	-	126,785	225,256
1987	62,910	49,798	181	-	112,899	127,306
1988	78,592	46,582	127	-	125,301	135,301
1989	52,003	41,770	57	-	93,830	103,830
1990	48,633	29,770	8	-	78,411	86,411
1991	48,353	31,280	50	-	79,683	84,683
1992	43,688	55,737	23	-	99,448	104,448
1993	117,195	110,212	50	-	227,457	232,457
1994	288,581	190,643	4	-	479,228	479,228
1995	320,731	581,495	0	-	902,226	902,226
1996	462,248	758,035	0	-	1,220,283	1,220,283
1997[5]			0	-	1,426,507	1,426,507
1998[5]			0	-	1,223,131	1,223,131
1999[6]			0	-	1,235,433	1,235,433
2000[7]			0	-	1,207,201	1,207,201
2001[8]			0	-	770,066	770,066
2002[9]			0	-	806,086	806,086
2003[10]			0	-	733,494	772,927

A = catches of adult herring in winter
B = mixed herring fishery in remaining part of the year
C = by-catches of 0- and 1-group herring in the sprat fishery
D = USSR-Norway by-catch in the capelin fishery (2-group)
[1] Includes also by-catches of adult herring in other fisheries
[2] In 1972, there was also a directed herring 0-group fishery
[3] Includes 26,000 t of immature herring (1983 year class) fished by USSR in the Barents Sea
[4] Preliminary, as provided by Working Group members
[5] Details of catches by fishery and ICES area given in ICES 1999
[6] Details of catches by fishery and ICES area given in ICES 2000
[7] Details of catches by fishery and ICES area given in ICES 2001
[8] Details of catches by fishery and ICES area given in ICES 2002
[9] Details of catches by fishery and ICES area given in ICES 2003
[10] Details of catches by fishery and ICES area given in Tables 3.2.3-3.2.5

Table 3.2.1.2 Total catch of Norwegian spring-spawning herring (tonnes) since 1972. Data provided by Working Group members.

Year	Norway	USSR/ Russia	Denmark	Faroes	Iceland	Ireland	Nether-lands	Greenland	UK	Germany	France	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	-	15,9711	7,003	605	-	14,863	1,223,131
1999	740,640	157,328	37,010	55,527	203,381	2,412	5,871	-	9,207	-	-	-	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	+	6,439	-	12,230	1,588	-	-	9,818	770,066
2002	487,233	113,763	18,998	32,302	127,197	+	9,392	-	3,482	3,017	-	1,226	9,486	806,086
2003[1]	438,140	122,846	14,144	27,943	102,727	+	8,678	-	9,214	3,371	-	-	6,431	733,494

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

Table 3.2.1.3. Catch-at-age by country - Norwegian spring spawning herring.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15+
Norwegian Spring-		0	15	2003																					
1	Norway	1	IIa	128918	140521	140521	111	1812	11387	0	0	0	3652	19925	74088	23610	35262	1743	9247	28857	193184	43592	6352	2579	1683
2	Norway	2	IIa	0	6297	6297	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Norway	3	IIa	0	62783	62783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Norway	4	IIa	245435	267524	267524	155	5709	10064	0	0	0	7039	80597	222644	49818	58036	7033	19100	61886	170109	75832	5660	2214	1905
5	Norway	1	IVa	0	65	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	374	374	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Norway	4	IVa	0	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	1	IIa	5064	5064	5064	57	2019	6876	0	186	1230	606	4284	5191	6031	959	364	349	784	942	529	312	39	24
9	Russia	2	IIa	8262	8262	8262	11	250	1402	0	1537	0	226	6249	9615	1183	799	343	1171	2287	3691	1083	303	73	217
10	Russia	3	IIa	68809	68809	68809	23	360	3550	0	578	518	23500	57154	77526	11641	8685	2312	7884	21818	20866	6110	1649	0	0
11	Russia	4	IIa	0	18692	18692	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Russia	3	IIb	0	22019	22019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Denmark	1	IIa	12127	12127	12127	4	483	487	0	0	0	165	2192	6327	4301	2068	1861	8229	7774	5459	2977	0	0	0
14	Denmark	2	IIa	1110	1110	1110	3	245	245	0	0	0	750	3695	478	87	0	87	41	0	0	0	0	0	0
15	Denmark	3	IIa	0	268	268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Denmark	4	IIa	0	639	639	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Iceland	2	IIa	78051	78051	78051	16	654	700	0	0	0	683	27075	123718	31852	23471	3055	9753	34216	55792	42912	20252	2542	0
18	Iceland	3	IIa	0	15824	15824	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Iceland	2	IIb	0	661	661	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Iceland	3	IIb	0	8191	8191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Sweden	1	IIa	0	1695	1695	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Sweden	3	IIa	0	1950	1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Sweden	4	IIa	0	2786	2786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Germany	2	IIa	0	180	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Germany	3	IIa	0	3127	3127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Germany	3	IIb	0	64	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	UK(Scot)	1	IIa	0	5157	5157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	UK(Scot)	3	IIa	0	4057	4057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Faroes	1	IIa	0	1416	1416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Faroes	2	IIa	0	7608	7608	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Faroes	3	IIa	0	11813	11813	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Faroes	4	IIa	0	5512	5512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Faroes	3	IIb	0	1594	1594	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Netherlands	2	IIa	0	6809	6809	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Netherlands	3	IIa	0	1869	1869	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.2.1.4. Weight (kg) at age by country - Norwegian spring spawning herring.

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12	CW 13	CW 14	CW 15+
Norwegian Spring-	0	15	2003																						
1	Norway	1	IIa	128918	140521	140521	111	1812	11387	0	0	0	0,151	0,181	0,224	0,254	0,279	0,316	0,316	0,309	0,317	0,336	0,349	0,332	0,431
2	Norway	2	IIa	0	6297	6297	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Norway	3	IIa	0	62783	62783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Norway	4	IIa	245435	267524	267524	155	5709	10064	0	0	0	0,179	0,236	0,274	0,308	0,334	0,319	0,35	0,363	0,378	0,384	0,398	0,428	0,46
5	Norway	1	IVa	0	65	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Norway	2	IVa	0	374	374	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Norway	4	IVa	0	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	1	IIa	5064	5064	5064	57	2019	6876	0	0,054	0,045	0,15	0,163	0,23	0,248	0,295	0,319	0,362	0,368	0,382	0,373	0,373	0,388	0,426
9	Russia	2	IIa	8262	8262	8262	11	250	1402	0	0,043	0	0,146	0,222	0,254	0,308	0,372	0,385	0,395	0,39	0,402	0,396	0,436	0,45	0,455
10	Russia	3	IIa	68809	68809	68809	23	360	3550	0	0,085	0,127	0,169	0,217	0,266	0,313	0,348	0,327	0,384	0,394	0,402	0,405	0,459	0	0
11	Russia	4	IIa	0	18692	18692	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Russia	3	IIb	0	22019	22019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	Denmark	1	IIa	12127	12127	12127	4	483	487	0	0	0	0,156	0,171	0,205	0,252	0,333	0,317	0,316	0,326	0,343	0,357	0	0	0
14	Denmark	2	IIa	1110	1110	1110	3	245	245	0	0	0	0,2	0,208	0,258	0,301	0	0,318	0,318	0	0	0	0	0	0
15	Denmark	3	IIa	0	268	268	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Denmark	4	IIa	0	639	639	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Iceland	2	IIa	78051	78051	78051	16	654	700	0	0	0	0,213	0,188	0,224	0,266	0,298	0,344	0,347	0,356	0,39	0,402	0,396	0,436	0
18	Iceland	3	IIa	0	15824	15824	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Iceland	2	IIb	0	661	661	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Iceland	3	IIb	0	8191	8191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Sweden	1	IIa	0	1695	1695	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	Sweden	3	IIa	0	1950	1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	Sweden	4	IIa	0	2786	2786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Germany	2	IIa	0	180	180	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Germany	3	IIa	0	3127	3127	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Germany	3	IIb	0	64	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	UK(Scot)	1	IIa	0	5157	5157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	UK(Scot)	3	IIa	0	4057	4057	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Faroes	1	IIa	0	1416	1416	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Faroes	2	IIa	0	7608	7608	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Faroes	3	IIa	0	11813	11813	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Faroes	4	IIa	0	5512	5512	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	Faroes	3	IIb	0	1594	1594	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	Netherlands	2	IIa	0	6809	6809	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	Netherlands	3	IIa	0	1869	1869	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3.2.1.5

Summary of Sampling by Country - Norwegian spring spawning herring.

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	448.00	0	0	0	0.00
Total IVa	0.00	448.00	0	0	0	0.00

Sum of Offical Catches : 448.00
Unallocated Catch : 0.00
Working Group Catch : 448.00

AREA : IIb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	0.00	22019.00	0	0	0	0.00
Iceland	0.00	8852.00	0	0	0	0.00
Germany	0.00	64.00	0	0	0	0.00
Faroes	0.00	1594.00	0	0	0	0.00
Total IIb	0.00	32529.00	0	0	0	0.00

Sum of Offical Catches : 32529.00
Unallocated Catch : 0.00
Working Group Catch : 32529.00

AREA : IIa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	9214.00	0	0	0	0.00
Sweden	0.00	6431.00	0	0	0	0.00
Russia	82135.00	100827.00	91	11828	2629	98.72
Norway	374353.00	477125.00	266	21451	7521	99.79
Netherlands	0.00	8678.00	0	0	0	0.00
Iceland	78051.00	93875.00	16	700	654	144.99
Germany	0.00	3307.00	0	0	0	0.00
Faroes	0.00	26349.00	0	0	0	0.00
Denmark	13237.00	14144.00	7	732	728	100.01
Total IIa	547776.00	739950.00	380	34711	11532	106.08

Sum of Offical Catches : 739950.00
Unallocated Catch : 0.00
Working Group Catch : 739950.00

Table 3.2.1.5 continued

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	5157.00	0	0	0	0.00
Sweden	0.00	1695.00	0	0	0	0.00
Russia	5064.00	5064.00	57	6876	2019	99.86
Norway	128918.00	140586.00	111	11387	1812	99.80
Faroes	0.00	1416.00	0	0	0	0.00
Denmark	12127.00	12127.00	4	487	483	100.02
Period Total	146109.00	166045.00	172	18750	4314	99.82

Sum of Offical Catches : 166045.00
Unallocated Catch : 0.00
Working Group Catch : 166045.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Russia	8262.00	8262.00	11	1402	250	99.89
Norway	0.00	6671.00	0	0	0	0.00
Netherlands	0.00	6809.00	0	0	0	0.00
Iceland	78051.00	78712.00	16	700	654	144.99
Germany	0.00	180.00	0	0	0	0.00
Faroes	0.00	7608.00	0	0	0	0.00
Denmark	1110.00	1110.00	3	245	245	99.89
Period Total	87423.00	109352.00	30	2347	1149	140.16

Sum of Offical Catches : 109352.00
Unallocated Catch : 0.00
Working Group Catch : 109352.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	4057.00	0	0	0	0.00
Sweden	0.00	1950.00	0	0	0	0.00
Russia	68809.00	90828.00	23	3550	360	98.50
Norway	0.00	62783.00	0	0	0	0.00
Netherlands	0.00	1869.00	0	0	0	0.00
Iceland	0.00	24015.00	0	0	0	0.00
Germany	0.00	3191.00	0	0	0	0.00
Faroes	0.00	13407.00	0	0	0	0.00
Denmark	0.00	268.00	0	0	0	0.00
Period Total	68809.00	202368.00	23	3550	360	98.50

Sum of Offical Catches : 202368.00
Unallocated Catch : 0.00
Working Group Catch : 202368.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Sweden	0.00	2786.00	0	0	0	0.00
Russia	0.00	18692.00	0	0	0	0.00
Norway	245435.00	267533.00	155	10064	5709	99.78
Faroes	0.00	5512.00	0	0	0	0.00
Denmark	0.00	639.00	0	0	0	0.00
Period Total	245435.00	295162.00	155	10064	5709	99.78

Sum of Offical Catches : 295162.00
Unallocated Catch : 0.00
Working Group Catch : 295162.00

Table 3.2.1.5 continued

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
UK(Scot)	0.00	9214.00	0	0	0	0.00
Sweden	0.00	6431.00	0	0	0	0.00
Russia	82135.00	122846.00	91	11828	2629	98.72
Norway	374353.00	477573.00	266	21451	7521	99.79
Netherlands	0.00	8678.00	0	0	0	0.00
Iceland	78051.00	102727.00	16	700	654	144.99
Germany	0.00	3371.00	0	0	0	0.00
Faroes	0.00	27943.00	0	0	0	0.00
Denmark	13237.00	14144.00	7	732	728	100.01
Total for Stock	547776.00	772927.00	380	34711	11532	106.08

Sum of Offical Catches : 772927.00
Unallocated Catch : 0.00
Working Group Catch : 772927.00

DETAILS OF DATA FILLING-IN

```
  Filling-in for record : (  2)   Norway                 2 IIa
Using Only
  >>  (  1)  Norway                1 IIa

  Filling-in for record : (  3)   Norway                 3 IIa
Using Only
  >>  (  4)  Norway                4 IIa

  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                 4 IVa
Using Only
  >>  (  4)  Norway                4 IIa

  Filling-in for record : ( 11)   Russia                 4 IIa
Using Only
  >>  ( 10)  Russia                3 IIa

  Filling-in for record : ( 12)   Russia                 3 IIb
Using Only
  >>  ( 10)  Russia                3 IIa

  Filling-in for record : ( 15)   Denmark                3 IIa
Using Only
  >>  ( 10)  Russia                3 IIa

  Filling-in for record : ( 16)   Denmark                4 IIa
Using Only
  >>  ( 10)  Russia                3 IIa
```

Table 3.2.1.5 continued

```
  Filling-in for record : ( 18)   Iceland                3 IIa
Using Only
  >>  ( 10)  Russia                 3 IIa

  Filling-in for record : ( 19)   Iceland                2 IIb
Using Only
  >>  ( 10)  Russia                 3 IIa

  Filling-in for record : ( 20)   Iceland                3 IIb
Using Only
  >>  ( 10)  Russia                 3 IIa

  Filling-in for record : ( 21)   Sweden                 1 IIa
Using Only
  >>  (  8)  Russia                 1 IIa

  Filling-in for record : ( 22)   Sweden                 3 IIa
Using Only
  >>  ( 10)  Russia                 3 IIa
```

Filling-in for record : (23) Sweden 4 IIa
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (24) Germany 2 IIa
Using Only
>> (17) Iceland 2 IIa

Filling-in for record : (25) Germany 3 IIa
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (26) Germany 3 IIb
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (27) UK(Scot) 1 IIa
Using Only
>> (8) Russia 1 IIa

Filling-in for record : (28) UK(Scot) 3 IIa
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (29) Faroes 1 IIa
Using Only
>> (8) Russia 1 IIa

Filling-in for record : (30) Faroes 2 IIa
Using Only
>> (17) Iceland 2 IIa

Filling-in for record : (31) Faroes 3 IIa
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (32) Faroes 4 IIa
Using Only
>> (11) Russia 4 IIa

Filling-in for record : (33) Faroes 3 IIb
Using Only
>> (10) Russia 3 IIa

Filling-in for record : (34) Netherlands 2 IIa
Using Only
>> (17) Iceland 2 IIa

Filling-in for record : (35) Netherlands 3 IIa
Using Only
>> (10) Russia 3 IIa

Table 3.2.1.5 continued

Catch Numbers at Age by Area

Ages	IVa	IIb	IIa	Total
0	0.00	0.00	0.00	0.00
1	0.00	273.25	3163.60	3436.84
2	0.00	244.88	4257.12	4502.00
3	12.69	11109.47	63403.38	74525.54
4	70.81	27019.18	299133.03	326223.00
5	260.45	36649.90	713443.94	750354.25
6	82.23	5503.21	176088.75	181674.19
7	122.20	4105.78	168598.55	172826.53
8	6.19	1092.98	22873.35	23972.52
9	32.19	3727.11	73680.24	77439.54
10	100.54	10314.32	211805.73	222220.59
11	664.08	9864.26	567839.50	578367.88
12	151.22	2888.46	220107.83	223147.52
13	21.84	779.55	43258.66	44060.05
14	8.86	0.00	9109.77	9118.64
15	5.80	0.00	4760.62	4766.42

Mean Weight at Age by Area (Kg)

Ages	IVa	IIb	IIa	Total
0	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0850	0.0598	0.0618
2	0.0000	0.1270	0.0646	0.0680
3	0.1516	0.1690	0.1696	0.1695
4	0.1833	0.2170	0.2157	0.2158
5	0.2256	0.2660	0.2543	0.2549
6	0.2552	0.3130	0.2846	0.2855
7	0.2800	0.3480	0.3160	0.3167
8	0.3161	0.3270	0.3251	0.3252
9	0.3167	0.3840	0.3489	0.3506
10	0.3102	0.3940	0.3585	0.3602
11	0.3176	0.4020	0.3573	0.3581
12	0.3369	0.4050	0.3781	0.3784
13	0.3495	0.4590	0.3931	0.3942
14	0.3329	0.0000	0.3994	0.3994
15	0.4313	0.0000	0.4476	0.4476

Table 3.2.2.1 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

Table 3.2.2.2 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
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

Table 3.2.2.3 Catch data for Norwegian spring spawning herring, billion individuals

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(
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	(

Table 3.2.2.4 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
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

Table 3.2.2.5 Norwegian spring spawning herring. Natural mortality used for all years.

Age	0	1	2	3 and older
	0.9	0.9	0.9	0.15

Table 3.2.3.1.1 Norwegian Spring-spawning herring. Estimates from the acoustic surveys on the spawning stock in February-March. Numbers in millions.

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

In 1992, 1993 and 1997 there was no estimate due to poor weather conditions.
No surveys have been conducted after 2000.

Table 3.2.3.2.1 Norwegian Spring-spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in November-December. Numbers in millions.

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002***
Age											
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	**2003****
Age	
1	586
2	406
3	2167
4	10670
5	13237
6	1047
7	678
8	41
9	134
10	301
11	1214
12	502
13	10
14+	37
Total	31030

*Much of the youngest yearclasses (-98,-99) wintered outside the fjords this winter and are not included in the estimate
**2003 is the first year with a combined estimate from the Tysfjord, Ofotfjord and oceanic areas off Vesterålen/Troms.

Table 3.2.3.2.2 Norwegian Spring Spawning herring. Estimates obtained on the acoustic surveys in the wintering areas in January. Numbers in millions. No surveys carried out in 2000-2002.

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Age									
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 3.2.3.3.1 Norwegian spring-spawning herring. Estimates from the international acoustic surveys on the feeding areas in the Norwegian Sea in May. Numbers in millions.

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Age							
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	874
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	1135	0	28
15+			415	128	1135	85	26
Total	50514	44915	37415	26016	22953	23353	26142

Year	**2003**
Age	
1	32073
2	8115
3	6561
4	9985
5	9961
6	1499
7	732
8	146
9	228
10	1865
11	2359
12	1769
13	
14	287
15+	45
Total	75625

Table 3.2.3.4.1. 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
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
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
3		5.7	1.5	18.0	8.0	1.8	0.4	0.01	0.00	0.00	8.8	0.0
4				1.7	1.1	0.6	0.35	0.01	0.00	0.00	0.00	0.0
5						0.03	0.05	0.00	0.00	0.00	0.00	0.0

[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

Table 3.2.3.4.2. Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea in August/September 2000-2001 and 2003 and October/December 2002.

Year	2000	2001	2002	2003
Age				
0	0.00	0.00	106.5	0.00
1	14.7	0.5	1,3	99.9
2	11.5	10.5	0.00	4.3
3	0.00	1.7	0.00	2.5
4	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	0.00

Table 3.2.3.4.3 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–2002 (numbers in millions).

Year	Area				Total
	South of 62°N	62°N-65°N	65°N-68°N	North of 68°30'	
1975		164	346	28	538
1976		208	1 305	375	1 888
1977		35	153	19	207
1978		151	256	196	603
1979		455	1 130	144	1 729
1980		6	2	109	117
1981		132	1	1	134
1982		32	286	1 151	1 469
1983		162	2 276	4 432	6 866
1984		2	234	465	701
1985		221	177	104	502
1986		5	72	127	204
1987		327	26	57	410
1988		14	552	708	1 274
1989		575	263	2 052	2 890
1990		75	146	788	1 009
1991		80	299	2 428	2 807
1992		73	1 993	621	2 891
1993	290	109	140	288	827
1994	157	452	323	6 168	7 101
1995	0	27	2	0	29
1996	0	20	114	8 800	8 934
1997	208	69	544	5 244	6 065
1998	424	273	442	11 640	12 779
1999	121	658	271	6 329	7 379
2000	570	127	996	7 237	8 930
2001	89	324	134	1421	1968
2002	67	1227	284	3573	5151
2003					27515

*A new survey design was introduced in 2003 which resulted in better coverage and higher numbers. The number of 2003 is thus not directly comparable with the earlier years.. A new area system was also introduced and the data is not be given by area in 2003. From 2004 the two series will probably be presented in two tables.

Table 3.2.3.4.4 Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1974-2002.

Year	Log index	Year	Log index
1974	0.01	1989	0.58
1975	0.00	1990	0.31
1976	0.00	1991	1.19
1977	0.01	1992	1.05
1978	0.02	1993	0.75
1979	0.09	1994	0.28
1980	0.00	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	0.30	2003	0.68

Table 3.2.3.5.1 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

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.

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.

.

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

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	

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		

*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			

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

*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

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

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	

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		

Table 3.2.4.1 continued 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

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	

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		

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			

Table 3.3.2.1 Summary of SeaStar exploratory runs. s1-s4 means survey 1 to survey 6, log-lik means log-likelihood value per term.

	Default	NoTags	EstimateM	Oldest10	CorrAgeBias	SurvSel	NoLarvae
Spawning stock	6.966	8.623	5.828	10.245	7.741	6.488	5.872
cat1	0.837	0.727	0.982	0.592	0.750	0.782	0.899
cat2	0.786	0.667	0.940	0.592	0.703	0.740	0.877
cat3	0.867	0.776	1.023	0.685	0.791	0.856	0.917
cat5	1.013	0.849	1.208	0.705	0.929	1.029	1.122
cat4	0.392	0.344	1.035	0.315	0.370	0.360	0.426
cat6	0.492	0.427	0.969	0.380	0.468	0.450	0.553
catZero	0.003	0.003	0.032	0.002	0.003	0.003	0.003
Log-lik, s 1	-1.606	-1.573	-1.603	-1.587	-1.567	-1.109	-1.635
Log-lik, s 2	-1.344	-1.371	-1.344	-1.579	-1.358	-0.959	-1.350
Log-lik, s 3	-1.768	-1.770	-1.769	-1.769	-1.739	-1.402	-1.779
Log-lik, s 4	-3.247	-3.272	-3.274	-3.271	-3.271	-3.247	-3.250
Log-lik, s 5	-1.817	-1.795	-1.789	-1.759	-1.853	-1.418	-1.798
Log-lik, s 6	-3.355	-3.386	-3.480	-3.382	-3.385	-3.405	-3.366
No data, s 1	20	20	20	16	20	20	20
No data, s 2	50	50	50	39	50	50	50
No data, s 3	18	18	18	14	18	18	18
No data, s 4	18	18	18	18	18	18	18
No data, s 5	48	48	48	40	48	48	48
No data, s 6	9	9	9	9	9	9	9
M	0.150	0.150	0.115	0.150	0.150	0.150	0.150
MYoung	0.900	0.900	0.188	0.900	0.900	0.900	0.900

Table XXX. Summary of SeaStar exploratory runs. s1-s4 means survey 1 to survey 6, log-lik means log-likelihood value per term.

	Default	NoTags	EstimateM	Oldest10	CorrAgeBias	SurvSel	NoLarvae
Spawning stock	6.966	8.623	5.828	10.245	7.741	6.488	5.872
cat1	0.837	0.727	0.982	0.592	0.750	0.782	0.899
cat2	0.786	0.667	0.940	0.592	0.703	0.740	0.877
cat3	0.867	0.776	1.023	0.685	0.791	0.856	0.917
cat5	1.013	0.849	1.208	0.705	0.929	1.029	1.122
cat4	0.392	0.344	1.035	0.315	0.370	0.360	0.426
cat6	0.492	0.427	0.969	0.380	0.468	0.450	0.553
catZero	0.003	0.003	0.032	0.002	0.003	0.003	0.003
Log-lik, s 1	-1.606	-1.573	-1.603	-1.587	-1.567	-1.109	-1.635
Log-lik, s 2	-1.344	-1.371	-1.344	-1.579	-1.358	-0.959	-1.350
Log-lik, s 3	-1.768	-1.770	-1.769	-1.769	-1.739	-1.402	-1.779
Log-lik, s 4	-3.247	-3.272	-3.274	-3.271	-3.271	-3.247	-3.250
Log-lik, s 5	-1.817	-1.795	-1.789	-1.759	-1.853	-1.418	-1.798
Log-lik, s 6	-3.355	-3.386	-3.480	-3.382	-3.385	-3.405	-3.366
No data, s 1	20	20	20	16	20	20	20
No data, s 2	50	50	50	39	50	50	50
No data, s 3	18	18	18	14	18	18	18
No data, s 4	18	18	18	18	18	18	18

No data, s 5	48	48	48	40	48	48	48
No data, s 6	9	9	9	9	9	9	9
M	0.150	0.150	0.115	0.150	0.150	0.150	0.150
MYoung	0.900	0.900	0.188	0.900	0.900	0.900	0.900

Table 3.4.1.1. Model settings used in final ISVPA run for NSS herring - Norwegian spring spawning herring.

Settings/options for the ISVPA run	**WG 2003**	**WG 2004**
Numbers of age structured tuning series	6	6
Version of the model	Catch-controlled	Catch-controlled
Numbers of biomass tuning series	0	0
Constraint	Unbiased model description of logarithmic catch-at-age	Unbiased model description of logarithmic catch-at-age
Number of years with a separable constraint	1986-2002	1950-2003
Reference age for separable constraint	no	no
Constant selection pattern	Yes	Yes, two selection patterns for two periods
S on the last age	Equal to that for previous age	Equal to that for previous age
Age span for calculation of reference F	5-14	5-14
Weight given to age groups and years in separable period	1	1
Catchability model for all fleets	Constant, q(a) are estimated	Constant, q(a) are estimated
Age range for the analysis	1-16+	1-16+
Survey weights for all ages in all fleets	1	1
What is minimized for residuals in logarithmic catch-at-age	MDN	MDN
What is minimized for logarithmic abundance-at-age (for indeces)	MDN, except SSE for survey N5	MDN, except AMD for surveys N3 and N4

Table 3.4.1.2 NSS herring. Estimates of stock abundance by ISVPA - Norwegian spring spawning herring.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16+
1950	30138411	16104151	11500353	3920266	4495539	7722200	6835114	1624898	2376953	2946662	2563065	6147022	6703771	1196992	1832064	4063072
1951	321818228	10978107	6164882	9642203	3202757	3697250	6139084	5299858	1324807	1963664	2434628	2125430	5110344	5428301	968658	6234970
1952	59433332	125990650	4208314	5300040	7943053	2596696	3029732	4805614	4003128	1068743	1613417	1999853	1729549	4163331	4349327	5228356
1953	30542849	18329683	50437844	3585669	4505658	6277869	2108545	2417991	3783502	3094930	846399	1309173	1621372	1389554	3410388	8148533
1954	31362621	9194585	7081640	42725632	3042981	3784447	5073507	1738860	1978297	2965086	2297465	671260	1042206	1308227	1104339	5890969
1955	10298732	8242364	3192812	5848166	35442516	2486544	3038356	3911935	1377806	1517373	2143495	1550035	495746	803704	1002611	4616271
1956	6854115	2356458	3025841	2661799	4777135	28608328	2034147	2439237	3112183	1106752	1126589	1570682	1145610	372234	613267	3285015
1957	8726573	1496307	558208	2496283	2057611	3820221	22252939	1648755	1910304	2433571	831335	785693	1098810	834535	261937	1925278
1958	7137281	1449653	468394	458837	1802244	1628315	3076105	17311433	1352299	1526112	1925280	633524	563810	807243	596200	1599604
1959	3230913	1117655	164470	386915	378318	1448319	1318657	2467275	13996930	1098343	1199424	1470721	453711	413468	629023	1112603
1960	156311627	1187003	246857	127551	308157	301593	1110573	1028473	1900295	11023226	863154	917036	1082168	308407	284068	732438
1961	72099785	54892071	232330	99565	92900	239164	236947	866630	817212	1446433	8408813	663880	668972	789022	212845	376648
1962	26987917	19063330	20478021	171023	78182	76156	191934	185944	688766	657736	1118690	6562042	525298	534041	620669	820305
1963	5382250	8370244	7086609	15915022	139779	64416	58868	146459	149003	537997	517319	854320	4893283	411122	408906	845568
1964	65619925	836998	2098946	5394045	12922779	115392	53773	47328	109080	119620	363140	359444	573799	3354731	280008	1779087
1965	35893563	24939430	199828	1700261	4272528	9224761	86608	44891	37953	70786	75775	223866	232930	351929	2170484	552178
1966	1992966	12182425	8320080	88590	1225740	3147565	5899068	56454	24815	25801	43206	28110	99445	100474	174230	828809
1967	18411013	387660	3883065	5260491	51294	622119	1497501	2401299	13429	8092	6064	12881	13990	21486	19589	123423
1968	1374507	1187442	112722	2050487	1508869	19471	144604	238705	470356	3301	1676	1972	3201	3784	2257	19063
1969	972036	280189	235187	5081	20249	11544	3585	37254	81045	84675	986	422	955	435	845	4224
1970	4348950	71859	23437	27826	3631	9265	5576	2436	21210	38584	39482	570	178	637	189	3596
1971	329396	1430591	8046	14328	6694	2569	4912	1738	1169	5824	8903	7913	0	60	363	0
1972	106156	106568	527373	5237	11386	4611	1877	3198	447	0	922	1252	1754	0	0	0
1973	134959	17017	30320	421094	1283	6476	1667	972	0	0	0	0	0	960	0	0
1974	5181226	52639	5835	23880	339060	500	4176	0	0	0	0	0	0	0	0	0
1975	3484678	2101556	18915	4929	20330	269097	192	0	0	0	0	0	0	0	0	0
1976	1181702	1414469	853281	13248	4120	16654	203163	0	0	0	0	0	0	0	0	0
1977	3438676	478914	574315	712858	6359	3546	14334	162724	0	0	0	0	0	0	0	0
1978	2137845	1394108	192735	473812	591672	5162	3052	11949	130069	0	0	0	0	0	0	0
1979	2549826	867653	566037	163088	396528	490410	3636	2627	9709	107288	0	0	0	0	0	0
1980	4839758	1034259	351550	481299	138640	334926	411694	2827	2261	8357	89993	0	0	0	0	0
1981	617367	1967189	420243	296638	408864	117215	280699	339655	2024	1939	7193	74964	0	0	0	0
1982	465161	250301	792212	357842	251059	343938	98847	237414	284662	1422	1573	6085	63627	0	0	0
1983	907877	188419	101637	669044	300675	211907	290224	83260	199635	239401	1112	1320	5203	54652	0	0
1984	127343366	366131	75541	84527	556192	249961	176656	243468	70463	167562	199255	824	0	0	46242	0
1985	4898450	51772865	147270	60859	67754	421623	198256	140324	195075	53954	129065	165490	709	0	0	15890
1986	6735948	1983176	20917147	106810	38002	43009	242287	115904	69752	109455	37162	82327	96052	611	0	2398
1987	3815091	2737752	804329	17502773	75610	19256	22638	111126	30179	21071	22772	13923	9628	8453	526	0
1988	3616859	1547064	1090279	673945	14599612	47755	13325	12937	69670	14842	9323	15425	4716	2257	781	0
1989	10739134	1468726	623181	880035	556822	12055403	32334	8056	5602	46436	4544	5410	10163	1571	0	0
1990	28037640	4364976	581071	533695	754092	474019	10075324	24612	6192	4192	36909	2635	4026	8450	1111	2025
1991	50065878	11398999	1764758	482846	456890	638036	397922	8461982	19988	3920	1719	29527	1669	3299	6725	127
1992	137219228	20353118	4632364	1511113	413010	391941	535527	334269	7080258	14885	2946	1399	24774	0	0	0
1993	182796101	55789079	8274106	3975436	1269919	350861	336240	449817	282375	5884664	10508	1943	975	20177	0	0
1994	49090778	74319266	22677530	7095234	3322545	1012066	293987	286020	359697	225758	4684500	9044	1672	839	17366	0
1995	18243865	19958808	30210794	19488580	6004789	2522117	718201	238583	238628	274962	161228	3433212	5159	1013	0	1823
1996	5405047	7417402	8113925	25949242	16452550	4590562	1579054	403769	190961	190684	171951	61081	2109002	665	0	0
1997	38016920	2197528	2996472	6951843	21672664	12703356	3078516	982181	251589	159092	157286	86685	36273	1039131	572	0
1998	33342379	15456526	879535	2458064	5732135	16987811	9084312	1943496	542472	160073	118358	105318	46740	13482	494709	0
1999	154995219	13556000	6231301	691781	1890822	4591997	12988420	6646504	1318865	346330	98345	78360	87422	26857	0	458838
2000	113165751	63016354	5508252	5235649	562190	1502374	3553965	9690247	4640561	864819	199744	71172	30298	68563	13888	197233
2001	58193004	46009761	25611359	4663051	3986477	451472	1190387	2683691	7135099	3024675	543055	105505	46173	5017	0	116832
2002	15771098	23659510	18704849	21948999	3864457	3035211	352637	935520	2034835	5362734	2132898	399062	68801	36490	1205	39208
2003	128782619	6412050	9579823	15915644	18297624	3090686	2312963	275899	718906	1507319	4005044	1523231	294762	47774	24971	0

Table 3.4.1.3 NSS herring. Estimates of fishing mortality by ISVPA - Norwegian spring spawning herring.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	0.0284	0.0333	0.0376	0.0437	0.0510	0.0627	0.0576	0.0635	0.0604	0.0747	0.0736	0.0647	0.0585	0.0650	0.0650	0.0650
1951	0.0237	0.0278	0.0314	0.0365	0.0425	0.0523	0.0480	0.0529	0.0503	0.0622	0.0613	0.0540	0.0488	0.0542	0.0542	0.0542
1952	0.0286	0.0336	0.0380	0.0441	0.0515	0.0633	0.0581	0.0641	0.0609	0.0754	0.0743	0.0653	0.0591	0.0656	0.0656	0.0656
1953	0.0307	0.0361	0.0408	0.0474	0.0553	0.0680	0.0625	0.0689	0.0655	0.0811	0.0799	0.0702	0.0635	0.0705	0.0705	0.0705
1954	0.0566	0.0665	0.0753	0.0878	0.1028	0.1272	0.1166	0.1289	0.1224	0.1526	0.1502	0.1315	0.1185	0.1321	0.1321	0.1321
1955	0.0507	0.0597	0.0675	0.0787	0.0921	0.1137	0.1043	0.1152	0.1094	0.1363	0.1341	0.1176	0.1060	0.1181	0.1181	0.1181
1956	0.0719	0.0848	0.0961	0.1122	0.1317	0.1635	0.1496	0.1656	0.1571	0.1969	0.1937	0.1691	0.1521	0.1699	0.1699	0.1699
1957	0.0636	0.0749	0.0848	0.0990	0.1160	0.1437	0.1316	0.1456	0.1382	0.1727	0.1699	0.1486	0.1338	0.1493	0.1493	0.1493
1958	0.0574	0.0675	0.0764	0.0891	0.1043	0.1291	0.1183	0.1308	0.1242	0.1549	0.1524	0.1335	0.1202	0.1341	0.1341	0.1341
1959	0.0671	0.0790	0.0895	0.1045	0.1225	0.1519	0.1390	0.1539	0.1460	0.1827	0.1798	0.1571	0.1414	0.1578	0.1578	0.1578
1960	0.0829	0.0978	0.1109	0.1298	0.1525	0.1898	0.1735	0.1923	0.1823	0.2292	0.2254	0.1964	0.1764	0.1974	0.1974	0.1974
1961	0.0501	0.0589	0.0666	0.0776	0.0908	0.1121	0.1028	0.1136	0.1079	0.1343	0.1322	0.1159	0.1045	0.1164	0.1164	0.1164
1962	0.0519	0.0611	0.0691	0.0806	0.0943	0.1165	0.1068	0.1180	0.1121	0.1396	0.1374	0.1204	0.1086	0.1210	0.1210	0.1210
1963	0.0734	0.0864	0.0980	0.1145	0.1344	0.1669	0.1526	0.1690	0.1604	0.2010	0.1978	0.1726	0.1552	0.1734	0.1734	0.1734
1964	0.0816	0.0962	0.1091	0.1276	0.1499	0.1865	0.1705	0.1890	0.1792	0.2252	0.2215	0.1931	0.1734	0.1940	0.1940	0.1940
1965	0.1688	0.2007	0.2294	0.2712	0.3230	0.4116	0.3723	0.4178	0.3935	0.5106	0.5009	0.4280	0.3793	0.4302	0.4302	0.4302
1966	0.3089	0.3727	0.4319	0.5217	0.6394	0.8614	0.7591	0.8780	0.8135	1.1526	1.1214	0.9057	0.7769	0.9119	0.9119	0.9119
1967	0.4301	0.5263	0.6186	0.7649	0.9711	1.4249	1.2027	1.4637	1.3176	2.3016	2.1780	1.5306	1.2396	1.5458	1.5458	1.5458
1968	0.4810	0.5924	0.7010	0.8769	1.1352	1.7693	1.4447	1.8298	1.6084	4.0713	3.4594	1.9372	1.4964	1.9624	1.9624	1.9624
1969	0.2571	0.3084	0.3555	0.4257	0.5157	0.6783	0.6046	0.6901	0.6441	0.8761	0.8558	0.7096	0.6176	0.7140	0.7140	0.7140
1970	0.2917	0.3512	0.4063	0.4892	0.5972	0.7977	0.7059	0.8125	0.7549	1.0535	1.0265	0.8372	0.7220	0.8427	0.8427	0.8427
1971	0.1725	0.2052	0.2346	0.2776	0.3308	0.4221	0.3815	0.4284	0.4034	0.5242	0.5142	0.4389	0.0000	0.4412	0.4412	0.0000
1972	0.2584	0.3101	0.3575	0.4282	0.5189	0.6829	0.6085	0.6947	0.6483	0.0000	0.8621	0.7145	0.6216	0.0000	0.0000	0.0000
1973	0.0941	0.1111	0.1262	0.1478	0.1739	0.2171	0.1981	0.2200	0.0000	0.0000	0.0000	0.0000	0.0000	0.2258	0.0000	0.0000
1974	0.0256	0.0300	0.0339	0.0394	0.0460	0.0565	0.0519	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1975	0.0141	0.0166	0.0187	0.0217	0.0252	0.0309	0.0285	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1976	0.0153	0.0179	0.0203	0.0235	0.0000	0.0000	0.0309	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1977	0.0163	0.0192	0.0216	0.0251	0.0292	0.0000	0.0330	0.0363	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1978	0.0120	0.0141	0.0159	0.0184	0.0215	0.0263	0.0000	0.0266	0.0253	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1979	0.0086	0.0101	0.0114	0.0132	0.0153	0.0188	0.0173	0.0000	0.0000	0.0223	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.0062	0.0072	0.0081	0.0094	0.0110	0.0134	0.0124	0.0136	0.0129	0.0000	0.0157	0.0000	0.0000	0.0000	0.0000	0.0000
1981	0.0107	0.0125	0.0141	0.0163	0.0190	0.0233	0.0214	0.0236	0.0224	0.0277	0.0272	0.0240	0.0000	0.0000	0.0000	0.0000
1982	0.0071	0.0083	0.0094	0.0109	0.0127	0.0155	0.0143	0.0157	0.0149	0.0184	0.0181	0.0160	0.0145	0.0000	0.0000	0.0000
1983	0.0147	0.0172	0.0194	0.0225	0.0263	0.0322	0.0296	0.0326	0.0310	0.0382	0.0377	0.0332	0.0301	0.0334	0.0000	0.0000
1984	0.0172	0.0202	0.0228	0.0265	0.0308	0.0378	0.0348	0.0383	0.0365	0.0450	0.0443	0.0000	0.0000	0.0000	0.0392	0.0000
1985	0.0829	0.0978	0.1109	0.1297	0.1525	0.1898	0.1734	0.1923	0.1823	0.2292	0.2254	0.1964	0.0000	0.0000	0.0000	0.1973
1986	0.0002	0.0060	0.0463	0.1270	0.2726	0.4185	0.5705	0.7043	0.9854	1.9502	1.8338	1.9128	2.0377	0.0000	0.0000	2.2033
1987	0.0002	0.0050	0.0384	0.1044	0.2211	0.3345	0.4484	0.5451	0.7359	1.2482	1.1986	1.2326	1.2833	2.5641	2.5641	0.0000
1988	0.0002	0.0040	0.0308	0.0834	0.1745	0.2607	0.3449	0.4143	0.5456	0.8569	0.8296	0.8484	0.8760	1.3668	1.3668	0.0000
1989	0.0000	0.0011	0.0082	0.0217	0.0438	0.0634	0.0813	0.0952	0.1195	0.1674	0.1637	0.1663	0.1699	0.2226	0.0000	0.0000
1990	0.0000	0.0009	0.0068	0.0179	0.0361	0.0522	0.0668	0.0781	0.0977	0.1363	0.1334	0.1354	0.1384	0.1803	0.1803	0.1803
1991	0.0000	0.0005	0.0035	0.0092	0.0184	0.0265	0.0338	0.0394	0.0491	0.0679	0.0664	0.0674	0.0688	0.0888	0.0888	0.0888
1992	0.0000	0.0003	0.0026	0.0069	0.0139	0.0199	0.0254	0.0296	0.0369	0.0508	0.0497	0.0505	0.0515	0.0000	0.0000	0.0000
1993	0.0000	0.0004	0.0032	0.0084	0.0170	0.0244	0.0311	0.0363	0.0452	0.0624	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1994	0.0000	0.0007	0.0053	0.0139	0.0280	0.0404	0.0516	0.0603	0.0753	0.1045	0.1023	0.1038	0.1061	0.1375	0.1375	0.0000
1995	0.0000	0.0014	0.0109	0.0290	0.0589	0.0855	0.1100	0.1291	0.1627	0.2301	0.2248	0.2285	0.2337	0.3094	0.0000	0.3094
1996	0.0000	0.0018	0.0138	0.0367	0.0747	0.1090	0.1407	0.1656	0.2097	0.2996	0.2925	0.2974	0.3045	0.0000	0.0000	0.0000
1997	0.0000	0.0030	0.0233	0.0626	0.1295	0.1913	0.2502	0.2975	0.3843	0.5739	0.5582	0.5690	0.5847	0.8331	0.8331	0.0000
1998	0.0000	0.0024	0.0185	0.0496	0.1018	0.1493	0.1940	0.2295	0.2933	0.4275	0.4167	0.4242	0.4350	0.5985	0.5985	0.0000
1999	0.0000	0.0018	0.0138	0.0367	0.0747	0.1089	0.1406	0.1655	0.2096	0.2995	0.2924	0.2973	0.3044	0.4081	0.0000	0.4081
2000	0.0000	0.0020	0.0151	0.0402	0.0821	0.1198	0.1549	0.1826	0.2318	0.3330	0.3249	0.3305	0.3385	0.4567	0.4567	0.4567
2001	0.0000	0.0011	0.0084	0.0222	0.0449	0.0651	0.0834	0.0977	0.1226	0.1719	0.1681	0.1707	0.1745	0.2288	0.0000	0.2288
2002	0.0000	0.0014	0.0110	0.0292	0.0594	0.0863	0.1110	0.1303	0.1642	0.2323	0.2270	0.2307	0.2360	0.3125	0.3125	0.3125
2003	0.0000	0.0011	0.0084	0.0223	0.0452	0.0655	0.0840	0.0983	0.1234	0.1731	0.1692	0.1719	0.1757	0.2303	0.2303	0.0000

Table 3.4.1.4 NSS herring. ISVPA summary results - Norwegian spring spawning herring.

year	B(1+)	SSB	R(1)	F(5-14, w-d by N(a))
1950	17654939	13087729	30138411	0.062
1951	19330620	12791718	321818228	0.052
1952	20864054	11446095	59433332	0.061
1953	18874740	10643050	30542849	0.067
1954	19532880	9281788	31362621	0.127
1955	16695288	10189255	10298732	0.100
1956	14624094	11993781	6854115	0.161
1957	11624893	10465208	8726573	0.137
1958	10178054	9590630	7137281	0.130
1959	8179188	7907567	3230913	0.151
1960	7834329	6419458	156311627	0.212
1961	8030732	4825066	72099785	0.126
1962	7265547	4065023	26987917	0.122
1963	7199450	3200784	5382250	0.164
1964	7233232	3477027	65619925	0.162
1965	6313123	3549972	35893563	0.387
1966	4394338	2940251	1992966	0.781
1967	2878785	1378546	18411013	1.371
1968	882363	259517	1374507	1.329
1969	118483	88390	972036	0.724
1970	86249	38367	4348950	0.936
1971	135049	12229	329396	0.440
1972	93787	3825	106156	0.609
1973	121493	105214	134959	0.210
1974	181322	123921	5181226	0.046
1975	328544	113353	3484678	0.031
1976	380820	171208	1181702	0.028
1977	445331	321860	3438676	0.035
1978	577341	393351	2137845	0.022
1979	632388	420964	2549826	0.018
1980	744878	492880	4839758	0.013
1981	784267	513912	617367	0.022
1982	717629	509712	465161	0.015
1983	751829	578310	907877	0.031
1984	1946065	602738	127343366	0.037
1985	4987381	509171	4898450	0.190
1986	1689898	418786	6735948	1.140
1987	2867516	859788	3815091	0.660
1988	3268714	2689645	3616859	0.179
1989	3752458	3238683	10739134	0.063
1990	4147921	3272179	28037640	0.065
1991	4634905	3398520	50065878	0.038
1992	5675250	3275232	137219228	0.034
1993	7348727	3201482	182796101	0.051
1994	8648050	3696603	49090778	0.068
1995	9697402	4717313	18243865	0.118
1996	9967246	6615146	5405047	0.110
1997	10390956	8412726	38016920	0.187
1998	9329120	7924784	33342379	0.163
1999	11535696	7656487	154995219	0.144
2000	11114284	6377770	113165751	0.191
2001	10718409	5923945	58193004	0.109
2002	11149780	6569109	15771098	0.156
2003	13418021	8681218	128782619	0.081

	2003	2004
Year classes in main tuning (main surveys)	1983, 1990-1993,1996	1983,1990-1993,1996-1999
Distributional assumption main surveys (surveys 1,2,3 and 5)	Gamma, CV	Gamma, CV
Distributional assumption surveys in the Barents Sea (survey 4 and 6)	Lognormal, Standard deviation	Lognormal, Standard deviation
Inclusion of larval data	Yes	Yes
Distributional assumption larval data	Gamma, CV	Gamma, CV
Inclusion of tagging data	Yes	Yes
Distributional assumption tagging data	Poisson	Poisson
Inclusion of zerogroup data	Yes	Yes
Distributional assumption zerogroup data	Lognormal, Standard deviation	Lognormal, Standard deviation

Table 3.6.4 Settings used in SeaStar for assessments in 2003 and 2004 - Norwegian spring spawning herring.

Table 3.6.1 Modelled historic abundance SeaStar. - Norwegian spring spawning herring.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1950	750.68	26.46	14.28	10.87	4.02	4.98	8.61	8.00	1.96	2.80	3.20	2.58	5.63	6.15	0.95	2.57	5.69
1951	146.36	301.94	9.48	5.42	9.10	3.29	4.11	6.90	6.31	1.62	2.33	2.66	2.14	4.67	4.95	0.76	6.83
1952	96.64	58.46	117.91	3.60	4.66	7.48	2.67	3.39	5.46	4.87	1.32	1.93	2.19	1.74	3.78	3.94	6.24
1953	86.10	30.54	17.93	47.15	3.06	3.96	5.88	2.17	2.73	4.35	3.84	1.06	1.58	1.79	1.40	3.08	8.28
1954	42.09	31.37	9.19	6.92	39.90	2.59	3.31	4.73	1.80	2.24	3.45	2.94	0.86	1.28	1.45	1.12	9.16
1955	24.97	10.30	8.25	3.19	5.71	33.01	2.10	2.63	3.62	1.43	1.75	2.56	2.10	0.66	1.01	1.12	8.40
1956	29.86	6.85	2.36	3.03	2.66	4.66	26.51	1.70	2.09	2.86	1.15	1.32	1.93	1.62	0.51	0.79	7.75
1957	25.40	8.72	1.50	0.56	2.50	2.06	3.72	20.45	1.36	1.61	2.21	0.87	0.95	1.41	1.24	0.38	7.12
1958	23.09	7.14	1.45	0.47	0.46	1.80	1.63	2.99	15.76	1.11	1.27	1.74	0.66	0.71	1.08	0.95	6.28
1959	412.48	3.23	1.12	0.16	0.39	0.38	1.45	1.32	2.39	12.66	0.89	0.98	1.31	0.48	0.54	0.86	6.08
1960	197.51	156.29	1.18	0.25	0.13	0.31	0.30	1.11	1.03	1.83	9.87	0.68	0.72	0.94	0.33	0.39	5.86
1961	76.10	72.09	54.88	0.23	0.10	0.09	0.24	0.24	0.87	0.82	1.39	7.42	0.51	0.50	0.67	0.23	5.35
1962	19.00	26.98	19.06	20.47	0.17	0.08	0.08	0.19	0.19	0.69	0.66	1.07	5.71	0.39	0.39	0.52	4.72
1963	168.93	5.37	8.37	7.08	15.91	0.14	0.06	0.06	0.15	0.15	0.54	0.52	0.81	4.16	0.29	0.29	4.40
1964	93.90	65.62	0.83	2.10	5.39	12.92	0.11	0.05	0.05	0.11	0.12	0.36	0.36	0.54	2.72	0.18	3.76
1965	8.49	35.87	24.94	0.20	1.70	4.27	9.22	0.09	0.04	0.04	0.07	0.08	0.22	0.23	0.32	1.63	3.22
1966	51.41	1.98	12.17	8.32	0.09	1.23	3.15	5.90	0.06	0.02	0.03	0.04	0.03	0.10	0.10	0.15	3.75
1967	3.95	18.40	0.38	3.88	5.26	0.05	0.62	1.50	2.40	0.01	0.01	0.01	0.01	0.01	0.02	0.02	3.27
1968	5.19	1.33	1.18	0.11	2.05	1.51	0.02	0.14	0.24	0.47	0.00	0.00	0.00	0.00	0.00	0.00	2.82
1969	9.78	0.97	0.26	0.23	0.00	0.02	0.01	0.00	0.04	0.08	0.08	0.00	0.00	0.00	0.00	0.00	2.43
1970	0.66	3.62	0.07	0.02	0.03	0.00	0.01	0.01	0.00	0.02	0.04	0.04	0.00	0.00	0.00	0.00	2.09
1971	0.24	0.19	1.13	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	1.80
1972	0.96	0.08	0.05	0.41	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.55
1973	12.88	0.17	0.00	0.01	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.33
1974	8.63	5.22	0.07	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15
1975	2.97	3.47	2.12	0.02	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99
1976	10.07	1.19	1.41	0.86	0.02	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.85
1977	5.10	4.08	0.48	0.57	0.72	0.01	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73
1978	6.20	2.04	1.66	0.19	0.47	0.60	0.01	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.63
1979	12.50	2.51	0.83	0.67	0.16	0.39	0.49	0.01	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.54
1980	1.47	5.06	1.02	0.34	0.57	0.14	0.33	0.42	0.01	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.47
1981	1.10	0.59	2.06	0.41	0.28	0.49	0.12	0.28	0.34	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.40
1982	2.34	0.44	0.24	0.83	0.35	0.24	0.41	0.10	0.24	0.29	0.00	0.00	0.00	0.04	0.00	0.00	0.35
1983	334.36	0.94	0.18	0.10	0.70	0.30	0.20	0.35	0.08	0.20	0.24	0.00	0.00	0.00	0.03	0.00	0.30
1984	11.53	135.86	0.38	0.07	0.08	0.58	0.25	0.17	0.29	0.07	0.17	0.20	0.00	0.00	0.00	0.03	0.26
1985	35.72	4.67	55.24	0.15	0.06	0.06	0.44	0.19	0.13	0.24	0.05	0.13	0.17	0.00	0.00	0.00	0.24
1986	6.04	14.51	1.89	22.33	0.11	0.04	0.04	0.26	0.11	0.06	0.15	0.04	0.08	0.10	0.00	0.00	0.20
1987	8.99	2.45	5.90	0.77	18.71	0.08	0.02	0.02	0.13	0.03	0.02	0.05	0.01	0.01	0.01	0.00	0.18
1988	25.39	3.65	0.99	2.37	0.64	15.64	0.05	0.01	0.01	0.08	0.01	0.00	0.04	0.00	0.00	0.00	0.15
1989	70.01	10.31	1.48	0.40	1.99	0.53	12.95	0.04	0.01	0.00	0.06	0.00	0.00	0.03	0.00	0.00	0.13

Table 3.6.1. continued on next page

Table 3.6.1 continued.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1990	122.95	28.46	4.19	0.59	0.34	1.71	0.45	10.85	0.03	0.00	0.00	0.05	0.00	0.00	0.03	0.00	0.11
1991	331.07	49.99	11.57	1.69	0.49	0.29	1.46	0.38	9.13	0.02	0.00	0.00	0.04	0.00	0.00	0.02	0.10
1992	397.93	134.60	20.32	4.70	1.45	0.42	0.25	1.24	0.32	7.65	0.02	0.00	0.00	0.03	0.00	0.00	0.11
1993	96.53	161.78	54.72	8.26	4.04	1.22	0.35	0.21	1.06	0.27	6.38	0.01	0.00	0.00	0.03	0.00	0.09
1994	32.48	39.24	65.78	22.24	7.08	3.37	0.97	0.30	0.18	0.88	0.21	5.11	0.01	0.00	0.00	0.02	0.08
1995	9.08	13.20	15.95	26.74	19.12	5.99	2.57	0.68	0.24	0.15	0.72	0.15	3.80	0.01	0.00	0.00	0.09
1996	66.32	3.69	5.37	6.49	22.96	16.13	4.58	1.62	0.37	0.19	0.11	0.56	0.05	2.42	0.00	0.00	0.08
1997	38.96	26.96	1.50	2.16	5.55	19.10	12.43	3.07	1.02	0.22	0.16	0.09	0.42	0.03	1.31	0.00	0.06
1998	264.99	15.84	10.96	0.60	1.74	4.53	14.77	8.85	1.94	0.57	0.14	0.12	0.05	0.28	0.01	0.78	0.06
1999	202.12	107.74	6.44	4.40	0.45	1.27	3.55	11.08	6.44	1.31	0.37	0.08	0.08	0.04	0.13	0.00	0.66
2000	12.71	82.18	43.80	2.62	3.66	0.35	0.97	2.66	8.05	4.46	0.86	0.22	0.05	0.03	0.03	0.03	0.51
2001	24.16	5.17	33.41	17.80	2.17	2.63	0.27	0.73	1.91	5.72	2.87	0.54	0.12	0.03	0.01	0.00	0.45
2002	202.84	9.82	2.10	13.58	15.23	1.72	1.87	0.20	0.54	1.37	4.15	2.00	0.40	0.08	0.02	0.00	0.38
2003	170.68	82.47	3.99	0.81	11.51	12.51	1.24	1.31	0.14	0.38	0.94	2.95	1.41	0.29	0.06	0.01	0.32

Table 3.6.2 Modelled historic F-values SeaStar - Norwegian spring spawning herring..

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
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	0.046
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	0.070
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	0.054	0.068	0.055	0.073	0.073
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	0.058	0.079	0.078	0.078
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	0.130
1955	0.393	0.575	0.102	0.032	0.054	0.069	0.060	0.081	0.085	0.067	0.127	0.133	0.110	0.101	0.095	0.104	0.104
1956	0.331	0.622	0.540	0.042	0.107	0.075	0.110	0.072	0.111	0.105	0.131	0.176	0.165	0.115	0.143	0.130	0.130
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	0.100
1958	1.069	0.954	1.282	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	0.082
1959	0.070	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	0.113
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	0.139
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	0.106
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	0.147
1963	0.046	0.964	0.483	0.123	0.058	0.042	0.031	0.069	0.145	0.069	0.243	0.214	0.263	0.274	0.344	0.257	0.257
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	0.320
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	0.620
1966	0.128	0.742	0.244	0.308	0.405	0.529	0.593	0.749	1.307	0.976	1.343	1.064	0.543	1.370	1.484	1.188	1.188
1967	0.186	1.845	0.339	0.489	1.099	0.853	1.311	1.690	1.483	1.328	1.451	1.082	1.257	1.131	1.992	1.478	1.478
1968	0.775	0.722	0.724	3.232	4.591	4.749	1.812	1.214	0.936	1.577	1.288	1.320	0.771	1.964	1.245	1.362	1.362
1969	0.094	1.707	1.867	2.046	0.259	0.756	0.599	0.347	0.419	0.600	0.626	0.612	0.867	0.394	0.843	0.578	0.578
1970	0.333	0.261	1.297	0.529	1.486	0.298	0.678	1.105	1.164	1.178	1.368	1.555	3.941	1.618	0.823	1.406	1.406
1971	0.226	0.429	0.125	0.283	0.140	0.308	0.277	0.476	1.626	2.550	1.958	2.279	1.841	0.217	2.804	2.028	2.028
1972	0.842	1.834	0.987	0.098	1.293	0.956	1.819	1.252	2.980	1.779	0.039	1.571	2.069	1.110	0.332	2.106	2.106
1973	0.004	0.033	0.769	0.405	0.089	0.857	1.521	1.117	1.365	0.015	0.029	0.047	0.009	0.014	1.264	0.603	0.603
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	0.017
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	0.042	0.072	0.012	0.019	0.019
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	0.015
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	0.116
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	0.079
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	0.042
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	0.058
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	0.020	0.019	0.028	0.028
1982	0.015	0.004	0.001	0.018	0.024	0.020	0.017	0.021	0.023	0.023	0.040	0.539	0.194	0.004	0.024	0.022	0.022
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	3.311	0.030	0.029	0.029
1984	0.005	0.000	0.010	0.070	0.074	0.121	0.083	0.084	0.059	0.116	0.112	0.035	0.000	0.294	0.242	0.070	0.070
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	0.379
1986	0.004	0.000	0.003	0.026	0.187	0.588	0.530	0.565	1.264	1.250	0.835	0.820	2.057	2.161	0.001	1.396	1.396
1987	0.002	0.004	0.010	0.028	0.029	0.293	0.254	0.461	0.268	0.639	1.062	0.093	0.903	1.516	1.516	0.417	0.417
1988	0.001	0.001	0.015	0.029	0.043	0.039	0.223	0.436	0.857	0.206	1.464	1.056	0.088	0.875	4.757	0.381	0.381
1989	0.000	0.000	0.027	0.008	0.002	0.012	0.027	0.113	0.149	0.198	0.062	0.912	0.744	0.010	0.171	0.090	0.090

Table 3.6.2 Continued on next page

Table 3.6.2 Continued

1990	0.000	0.000	0.006	0.035	0.008	0.008	0.026	0.023	0.053	0.436	1.430	0.056	1.678	0.413	0.022	0.153	0.153
1991	0.000	0.000	0.000	0.005	0.006	0.005	0.011	0.026	0.026	0.130	0.214	0.172	0.019	1.646	1.990	0.024	0.024
1992	0.000	0.000	0.000	0.003	0.025	0.013	0.005	0.010	0.020	0.032	0.175	0.486	0.963	0.041	0.048	0.029	0.029
1993	0.000	0.000	0.000	0.004	0.029	0.080	0.027	0.019	0.031	0.078	0.072	0.000	0.001	0.008	0.000	0.059	0.059
1994	0.000	0.000	0.000	0.002	0.017	0.124	0.203	0.058	0.050	0.047	0.200	0.146	0.349	0.939	2.220	0.100	0.100
1995	0.000	0.000	0.000	0.002	0.020	0.119	0.312	0.456	0.072	0.124	0.110	0.925	0.299	1.200	4.053	0.100	0.100
1996	0.000	0.000	0.009	0.006	0.034	0.111	0.250	0.316	0.358	0.032	0.074	0.136	0.463	0.465	0.001	0.303	0.303
1997	0.000	0.000	0.023	0.067	0.054	0.107	0.190	0.311	0.426	0.348	0.144	0.497	0.265	1.365	0.364	0.262	0.262
1998	0.000	0.000	0.012	0.136	0.163	0.092	0.137	0.167	0.239	0.282	0.413	0.259	0.084	0.576	6.599	0.161	0.161
1999	0.000	0.000	0.001	0.034	0.090	0.121	0.140	0.170	0.217	0.273	0.369	0.227	0.780	0.236	1.245	0.163	0.163
2000	0.000	0.000	0.001	0.035	0.180	0.113	0.131	0.179	0.191	0.291	0.317	0.430	0.402	1.505	8.044	0.166	0.166
2001	0.000	0.000	0.000	0.006	0.083	0.192	0.168	0.152	0.183	0.172	0.211	0.159	0.232	0.132	0.921	0.168	0.168
2002	0.000	0.000	0.047	0.016	0.047	0.174	0.208	0.178	0.206	0.233	0.189	0.202	0.156	0.173	0.398	0.170	0.170
2003	0.000	0.000	0.002	0.104	0.031	0.067	0.171	0.153	0.200	0.247	0.294	0.236	0.187	0.177	0.175	0.173	0.173

Table 3.6.3 Summary table SeaStar. Biomass in million tonnes - Norwegian spring spawning herring..

	Recruits Age 0	Total biomass	Spawning stock biomass	Fbar 5-14
1950	750.680	19.642	13.992	0.058
1951	146.355	19.798	13.145	0.070
1952	96.644	21.187	12.028	0.073
1953	86.102	18.945	10.949	0.066
1954	42.086	20.508	10.593	0.113
1955	24.971	17.830	11.383	0.078
1956	29.858	15.933	13.016	0.110
1957	25.397	13.161	11.686	0.103
1958	23.094	11.493	10.634	0.079
1959	412.478	9.893	8.969	0.113
1960	197.514	9.460	7.626	0.136
1961	76.103	9.461	6.024	0.104
1962	19.003	8.246	4.880	0.146
1963	168.931	8.346	4.015	0.253
1964	93.903	7.838	3.814	0.226
1965	8.491	7.147	4.120	0.278
1966	51.409	5.552	3.650	0.696
1967	3.947	4.183	2.273	1.519
1968	5.187	1.943	1.131	3.493
1969	9.785	1.087	0.972	0.590
1970	0.661	0.892	0.729	1.320
1971	0.236	0.807	0.572	1.525
1972	0.957	0.673	0.483	1.497
1973	12.884	0.766	0.692	1.173
1974	8.631	0.706	0.628	0.114
1975	2.971	0.773	0.542	0.190
1976	10.068	0.768	0.539	0.106
1977	5.095	0.780	0.630	0.111
1978	6.201	0.892	0.667	0.043
1979	12.498	0.905	0.656	0.024
1980	1.474	0.981	0.702	0.034
1981	1.100	1.002	0.710	0.022
1982	2.343	0.904	0.679	0.020
1983	334.362	1.245	0.723	0.029
1984	11.528	2.170	0.712	0.090
1985	35.722	5.432	0.593	0.379
1986	6.041	1.939	0.472	1.074
1987	8.995	3.287	0.968	0.404
1988	25.393	3.664	2.896	0.043
1989	70.008	4.260	3.515	0.027
1990	122.947	4.766	3.667	0.022
1991	331.066	5.435	3.804	0.024
1992	397.925	6.509	3.667	0.028
1993	96.526	7.637	3.508	0.065
1994	32.477	8.714	3.963	0.134
1995	9.076	9.572	4.859	0.225
1996	66.315	9.685	6.496	0.185
1997	38.959	9.677	7.842	0.173
1998	264.987	8.475	7.122	0.155
1999	202.118	9.642	6.583	0.192
2000	12.705	8.746	5.293	0.233
2001	24.157	7.352	4.577	0.184
2002	202.841	7.795	4.594	0.197
2003	170.677	8.794	5.787	0.126

Table 3.6.1.1. Norwegian spring-spawning herring, input data to the short term prediction, SeaStar.

Landings in 2004, 0.825 million tonnes
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Spawning stock biomass in 2004, 6.30015 million tonnes
Fbar in 2004, 0.16583
Weight at age in stock and catch are assumed equal
Basis for weight in stock prediction: predicted condition factor
Basis for weight in catch prediction: mean of 2000-2002
Part of year before spawning: 0.1

Age	Numbers (billion)	Weight stock (kg)	Weight catch (kg)	Weight catch (kg)	Fraction mature	Expl. pattern
	2004	2004	2005			
0	0	0.001	0.001	0.007	0	0
1	69.392	0.01	0.01	0.063	0	0
2	33.527	0.037	0.037	0.094	0	0.002
3	1.621	0.055	0.055	0.171	0	0.104
4	0.632	0.212	0.214	0.218	0.45	0.031
5	9.601	0.241	0.243	0.257	0.9	0.067
6	10.069	0.279	0.281	0.288	1	0.171
7	0.902	0.302	0.304	0.319	1	0.153
8	0.964	0.337	0.34	0.327	1	0.2
9	0.1	0.354	0.357	0.354	1	0.247
10	0.255	0.355	0.358	0.363	1	0.294
11	0.6	0.36	0.363	0.361	1	0.236
12	2.006	0.371	0.374	0.381	1	0.187
13	1.006	0.4	0.403	0.397	1	0.177
14	0.21	0.412	0.415	0.402	1	0.175
15	0.044	0.445	0.448	0.45	1	0.173
16	0.284	0.445	0.448	0.45	1	0.173

Table 3.6.1.2. Norwegian spring-spawning herring, short term prediction. Total biomass is not included because the recruitment was set to 0 in the calculations.

Norwegian spring-spawning herring, WG 2004
Date and time: 04-05-2004 at 14:00
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Basis for 2004: TAC constrained; recruitment: no recruitment in the prediction

	2004			2005				2006
SSB	FMult	Fbar	Landings	SSB	FMult	Fbar	Landings	SSB
6.30015	1	0.16583	0.825	6.391	0.51	0.084	0.609	6.667
				6.380	0.6	0.100	0.725	6.556
				6.370	0.71	0.117	0.839	6.446
				6.365	0.75	0.125	0.892	6.396
				6.359	0.81	0.134	0.952	6.339
				6.348	0.9	0.150	1.063	6.233
				6.338	1.01	0.167	1.172	6.130
				6.327	1.11	0.184	1.279	6.028
				6.317	1.21	0.201	1.385	5.928
				6.306	1.31	0.217	1.490	5.830
				6.296	1.41	0.234	1.592	5.734
				6.285	1.51	0.251	1.694	5.639

Input units are millions and kg; output in kilotonnes

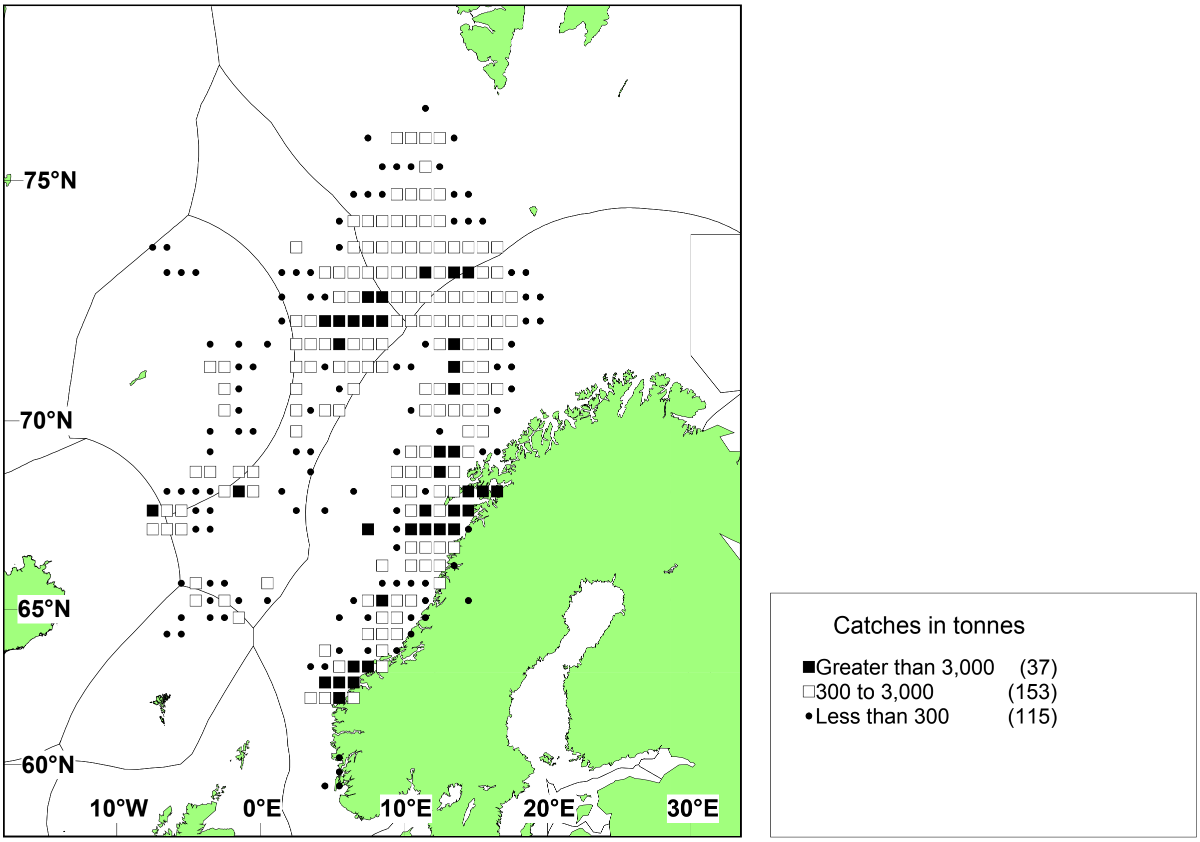
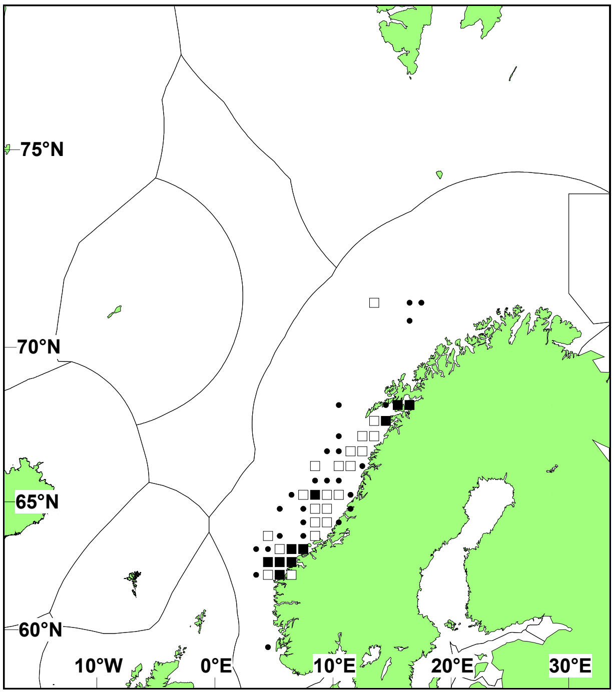
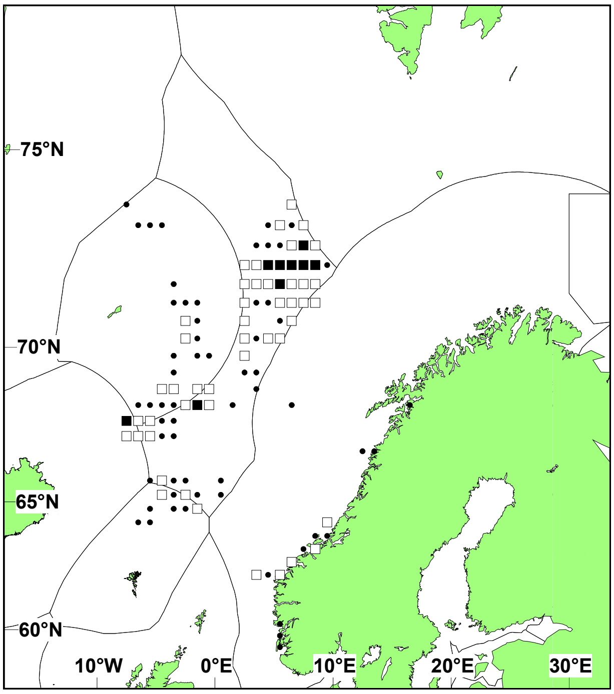


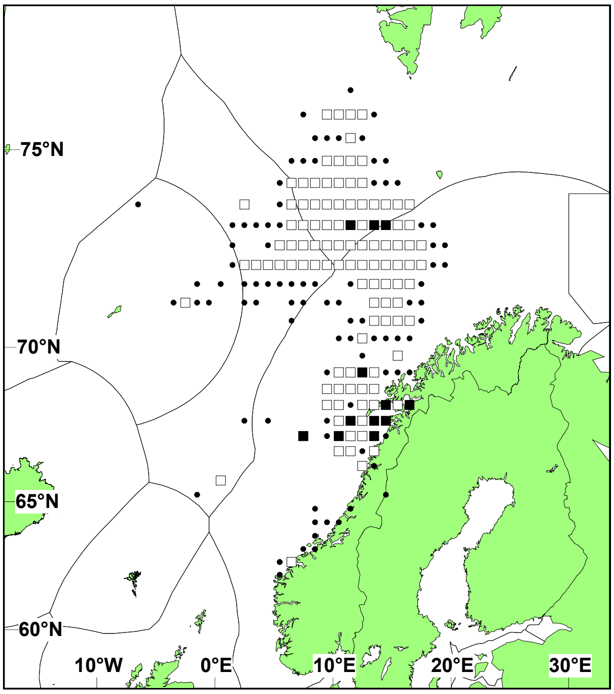
Figure 3.1.3.1. Total catches of Norwegian spring-spawning herring in 2003 by ICES rectangle. Grading of the symbols: black dots less than 300 t, open squares 300-3 000 t, and black squares > 3 000 t.



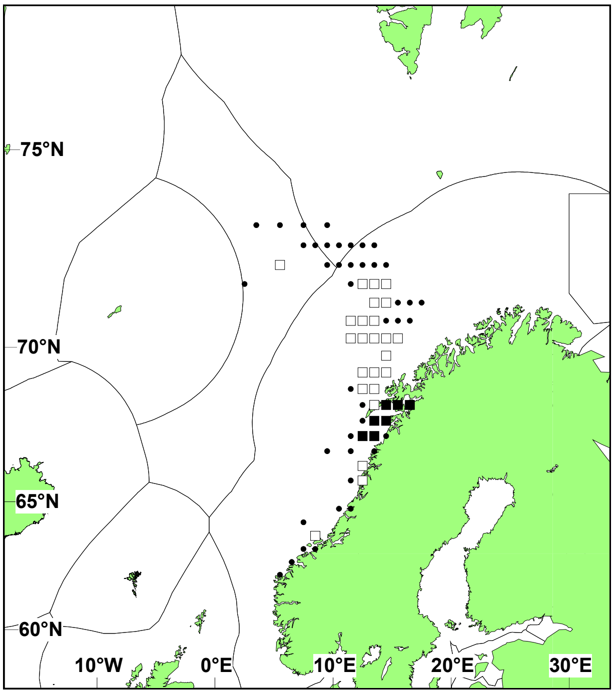
Quarter 1



Quarter 2



Quarter 3



Quarter 4

Figure 3.1.3.2. Total catches of Norwegian spring-spawning herring in 2003 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.

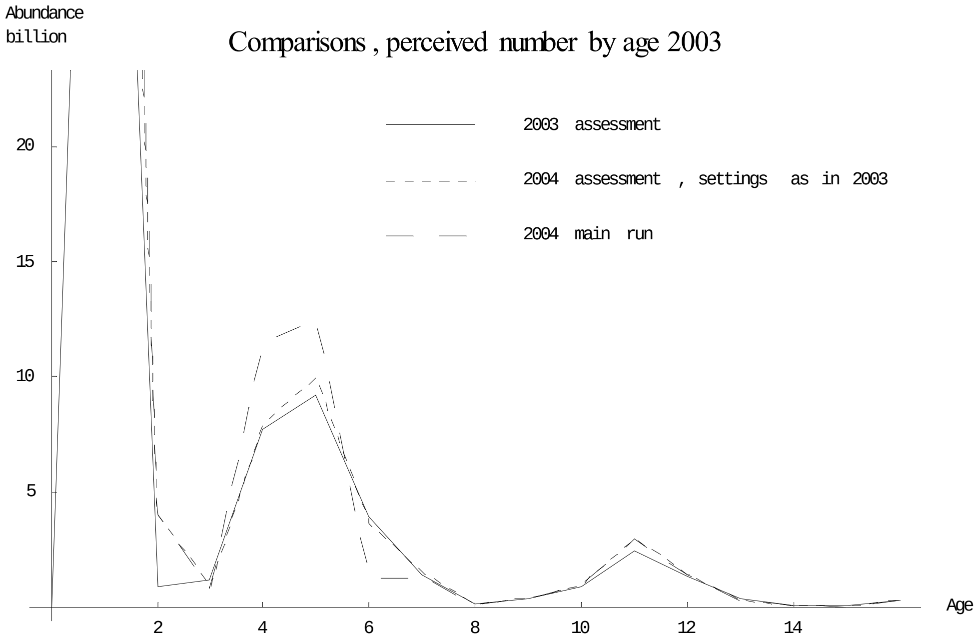


Figure 3.3.1. Comparison of perceived number by age in 2003 in SeaStar 2003 and 2004 assessments - Norwegian spring spawning herring.

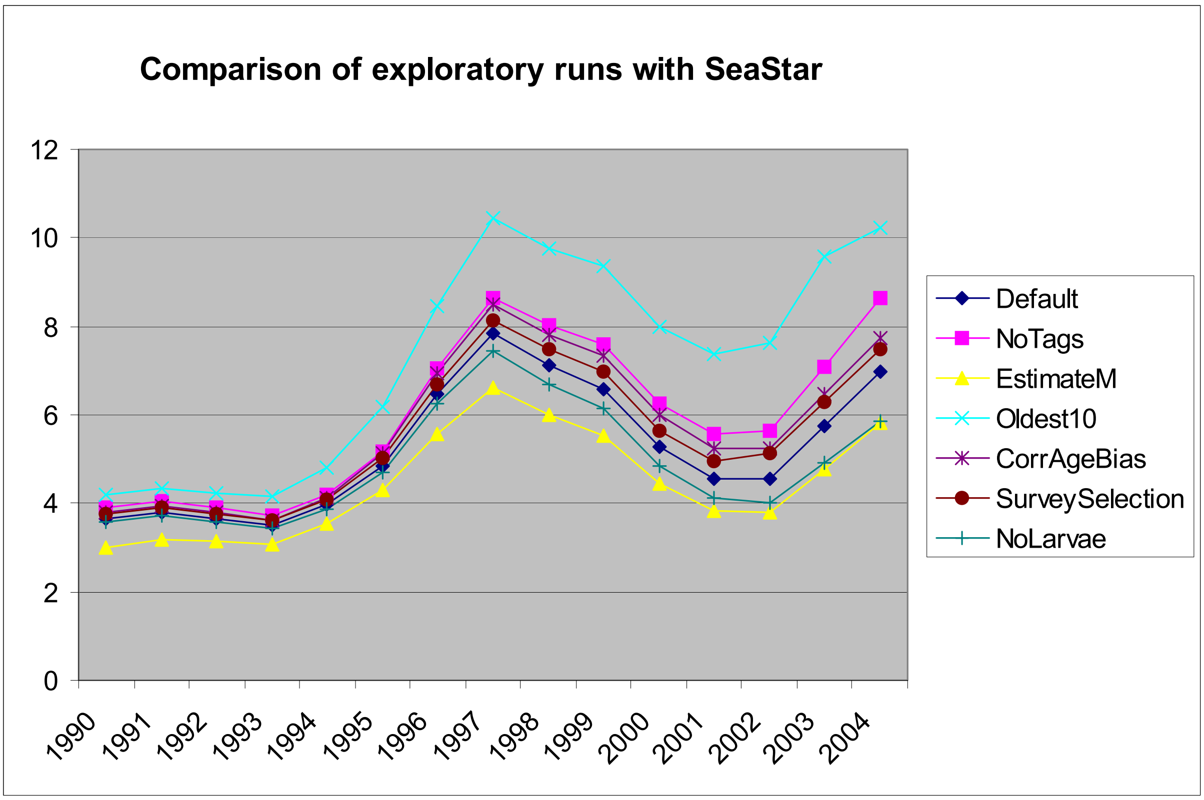
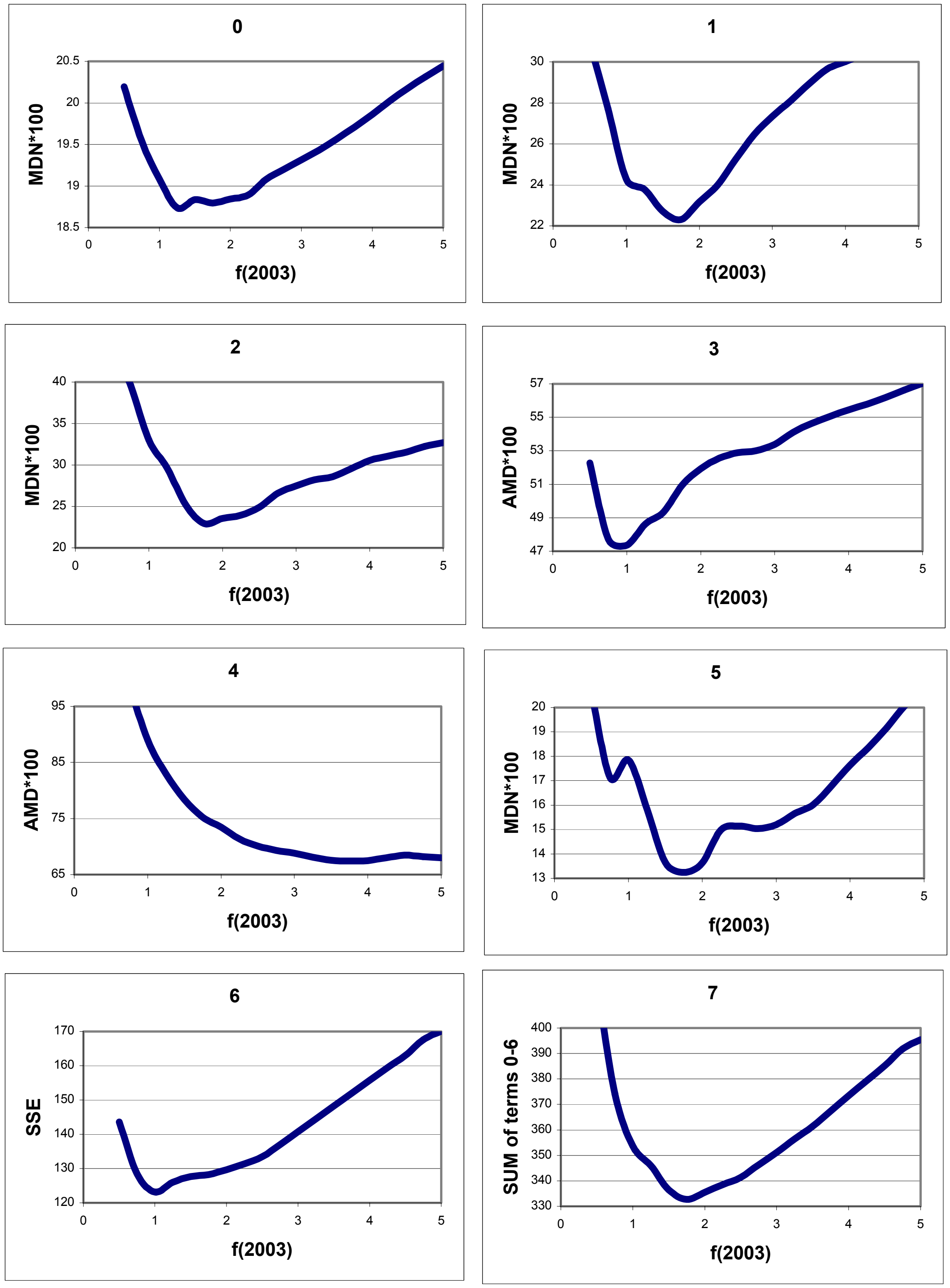


Figure 3.3.2 Spawning stock timeseries for SeaStar runs - Norwegian spring spawning herring..



NSS Herring. **ISVPA, catch-controlled version**

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 3.4.1.1 Profiles of components of ISVPA loss function for different sources of data. Survey N5 is used in form of age proportions - Norwegian spring spawning herring..

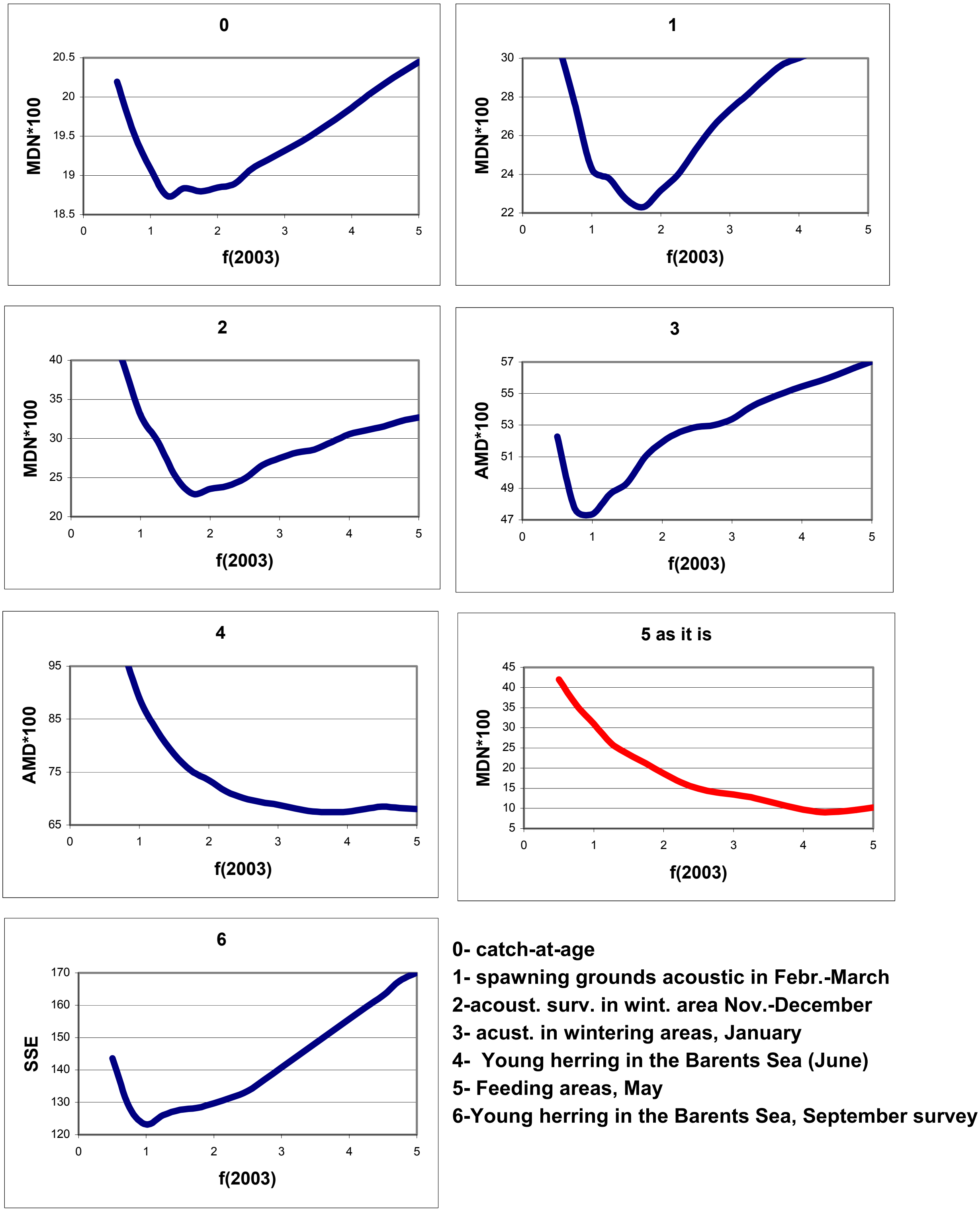


Figure 3.4.1.2 Profiles of components of ISVPA loss function for different sources of data. Survey N5 is used as abundance-at-age index - Norwegian spring spawning herring.

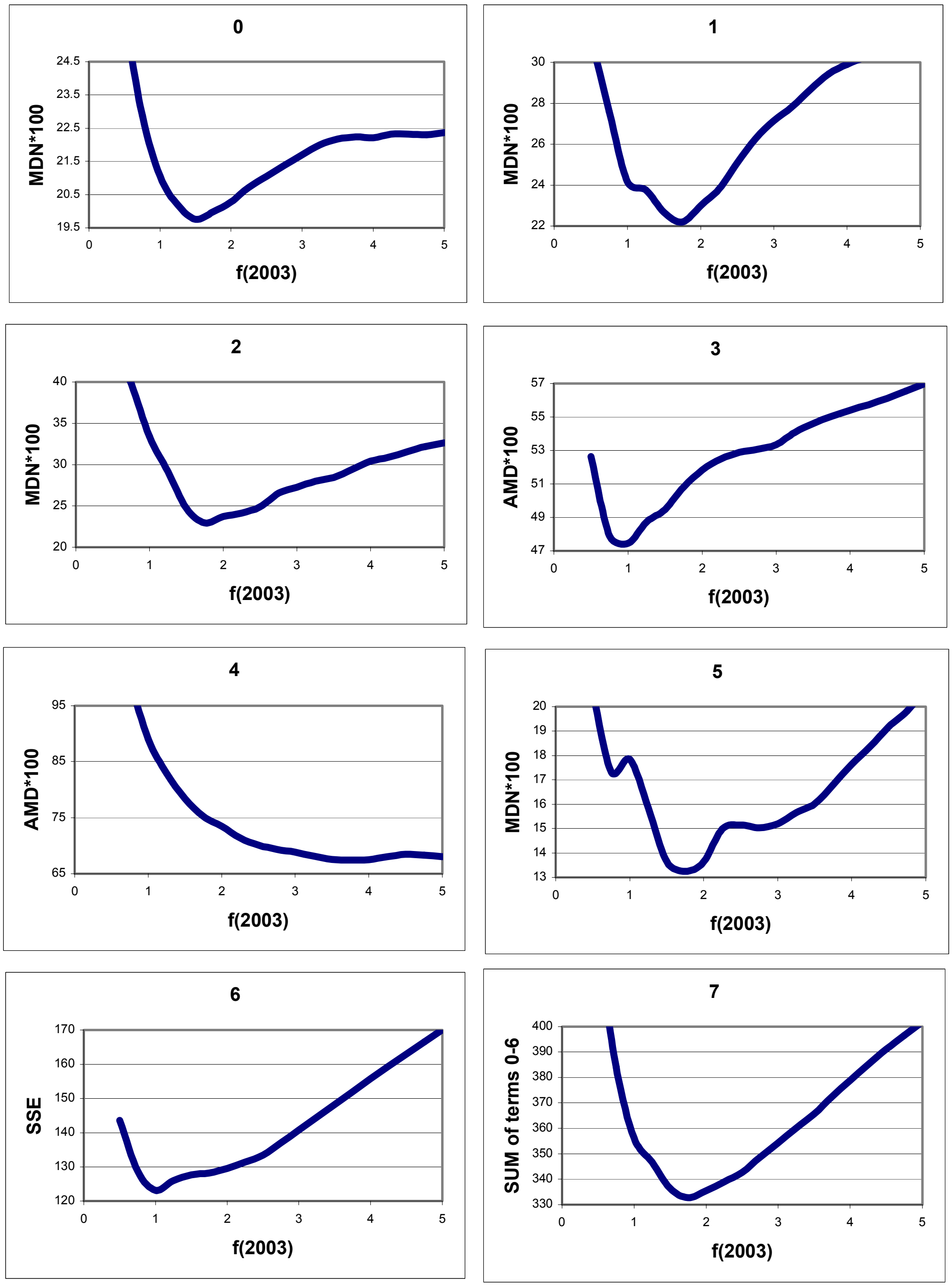


Figure 3.4.1.3 Profiles of components of ISVPA loss function for different sources of data. Survey N5 is used in form of age proportions, years of run: 1986-2003 - Norwegian spring spawning herring..

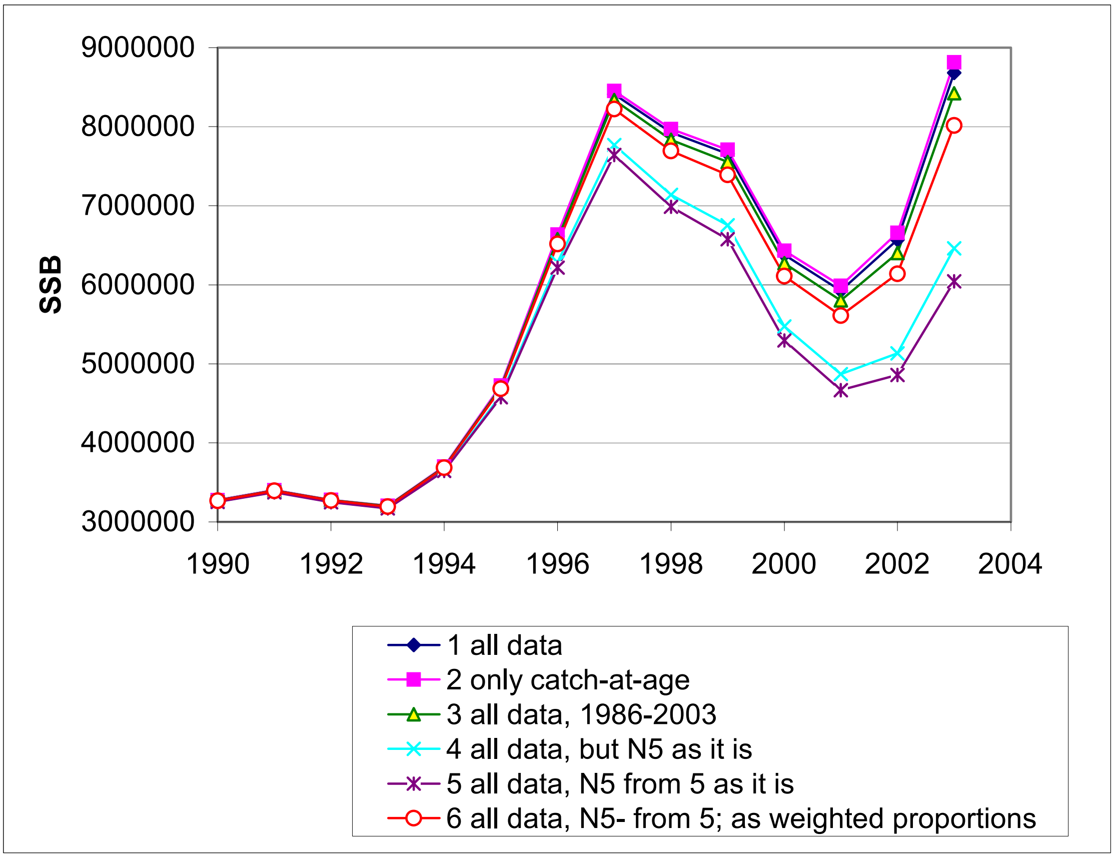


Figure 3.4.1.4 NSS herring. ISVPA. Norwegian spring spawning herring. Comparison of runs:

1- all data, years: 1950-2003, survey N5 - as age proportions

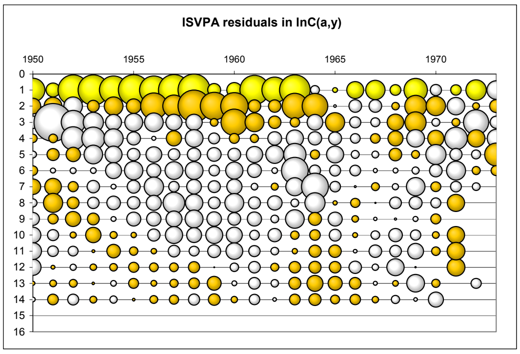
2 - no surveys (only catch-at-age is used), years: 1950-2003

3 - all data, years: 1986-2003, survey N5 - as age proportions

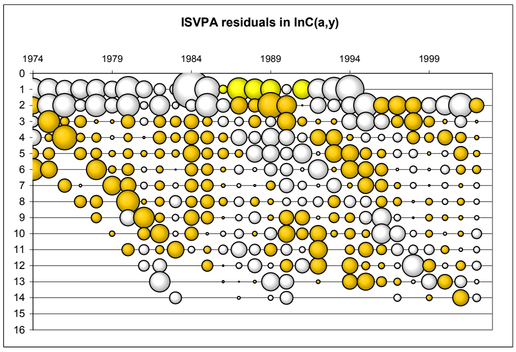
4 - all data, years: 1950-2003, survey N5 - as abundance index

5 - all data, years: 1950-2003, survey N5 - as abundance index, first age of survey N5 is 5.

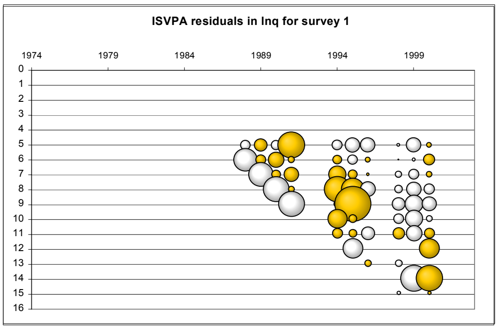
6 - all data, years: 1950-2003, survey N5 - as age proportions, first age of survey N5 is 5.



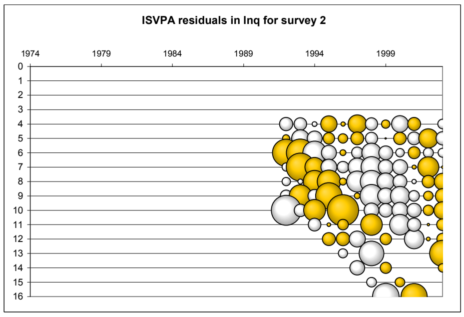
A



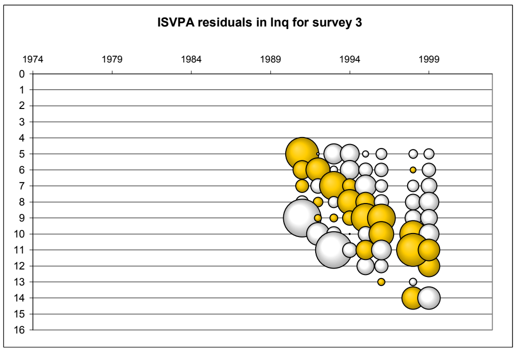
B



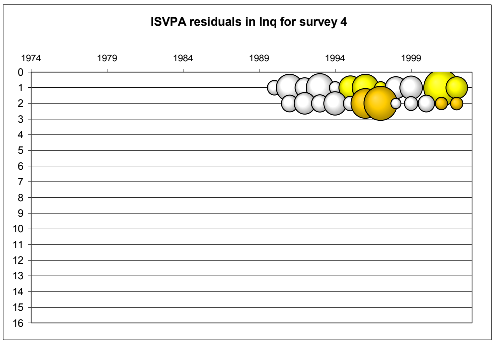
C



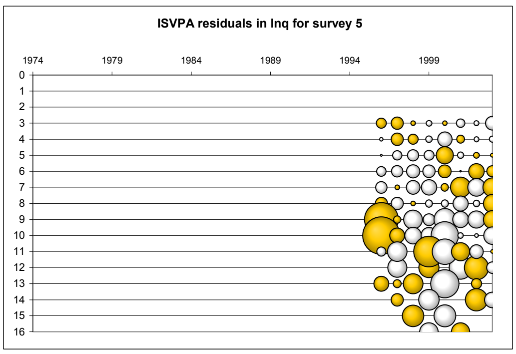
D



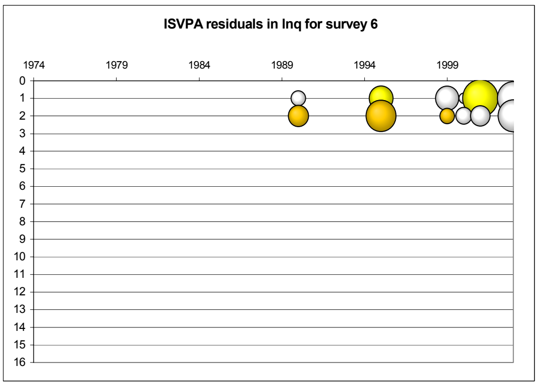
E



F



G



H

Figure 3.4.1.5 NSS Herring. ISVPA. Plots of residuals - Norwegian spring spawning herring..

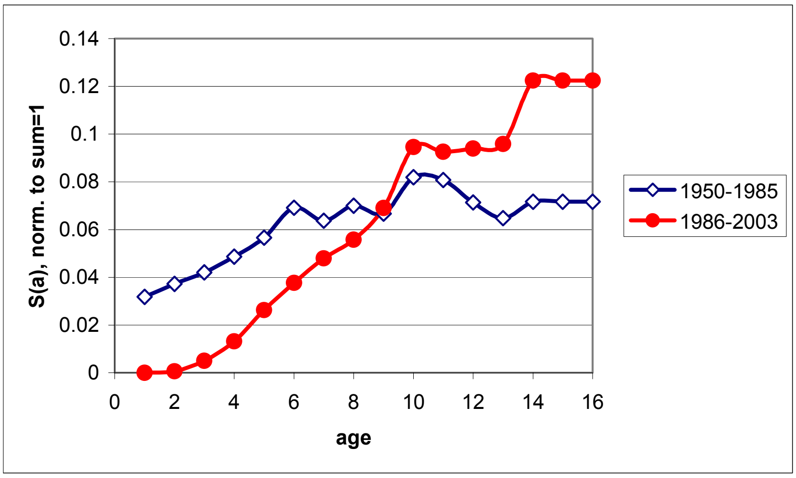


Figure 3.4.6.1 Estimated ISVPA selection patterns

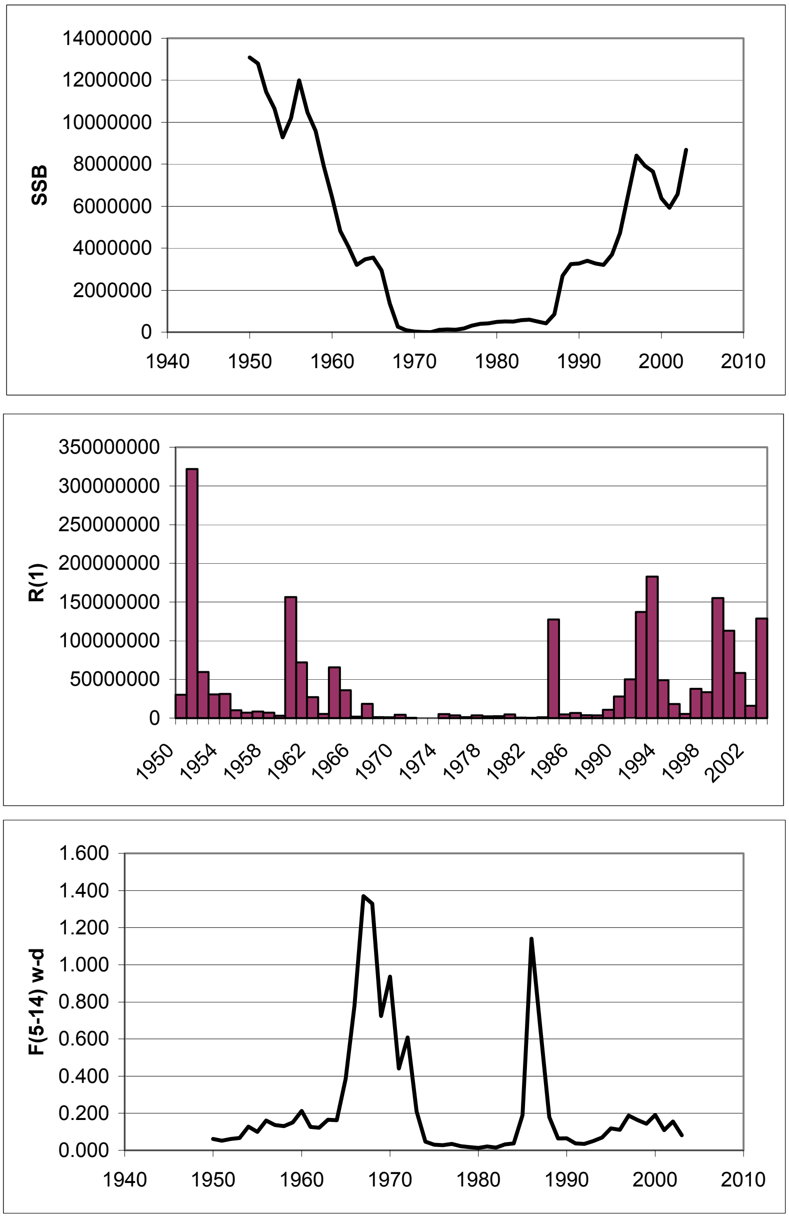


Figure 3.4.1.7 NSS herring. ISVPA summary results - Norwegian spring spawning herring.

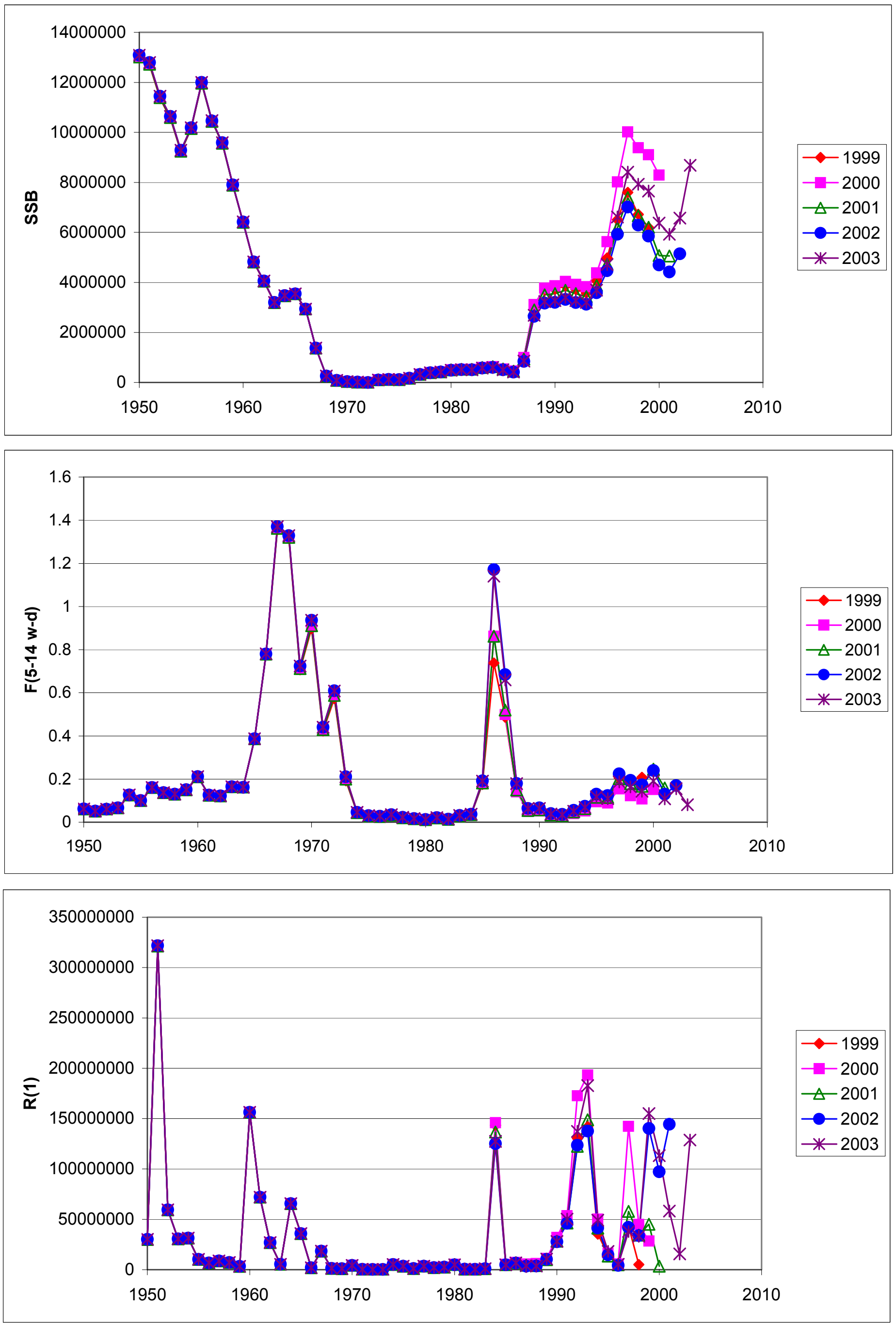


Figure 3.4.1.8 NSS herring. ISVPA. Retrospective runs - Norwegian spring spawning herring

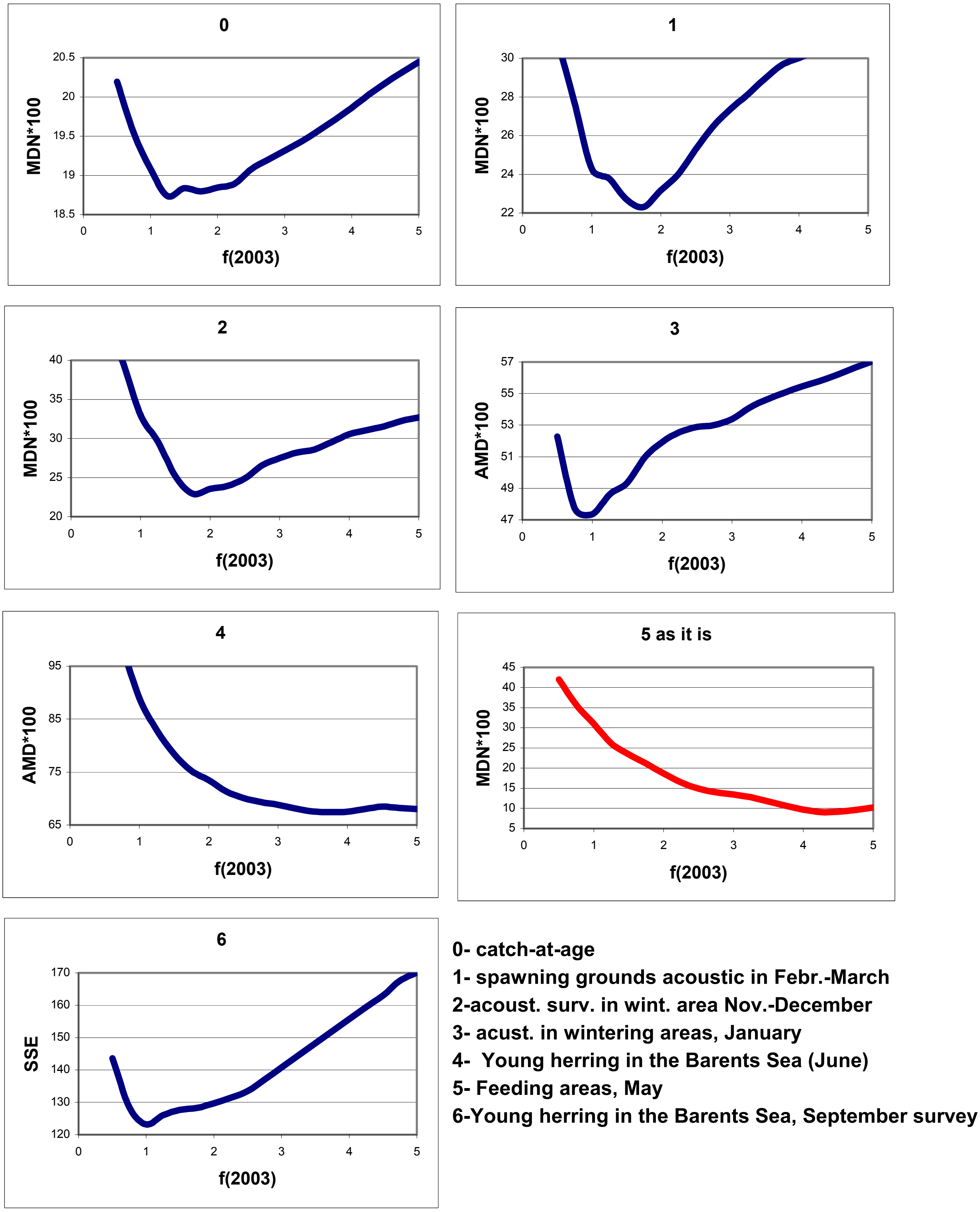


Figure 3.5.2.1 Profiles of components of ISVPA loss function for different sources of data. Survey N5 is used as abundance-at-age index. Norwegian spring spawning herring.

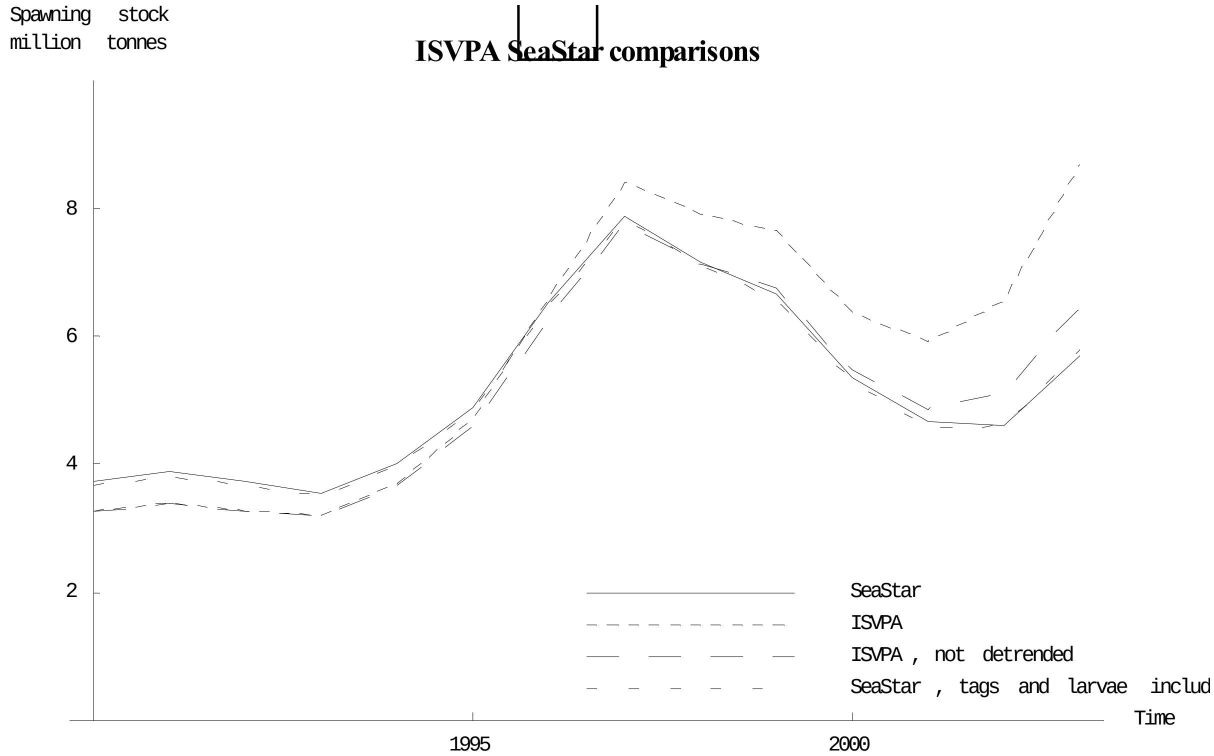
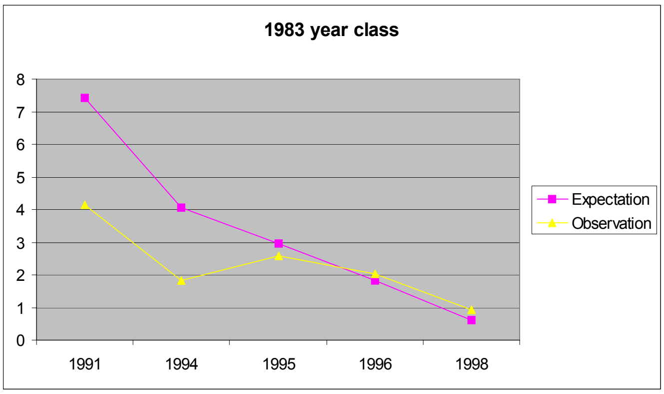
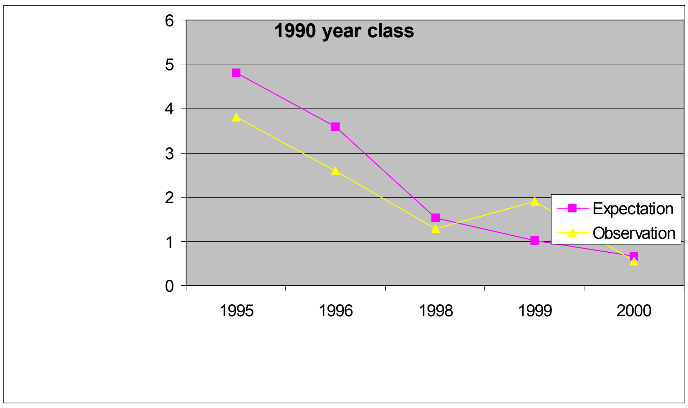
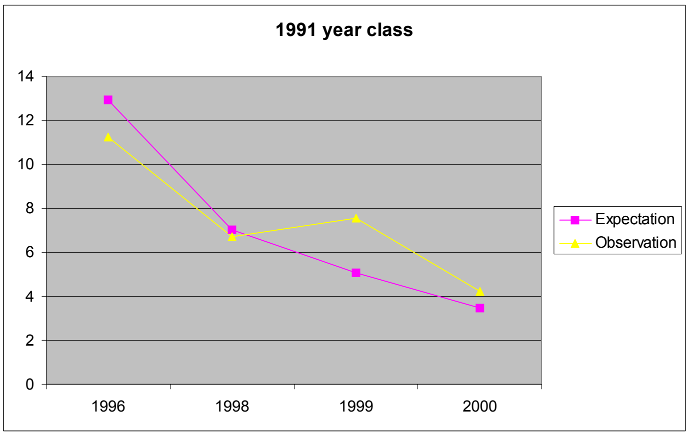
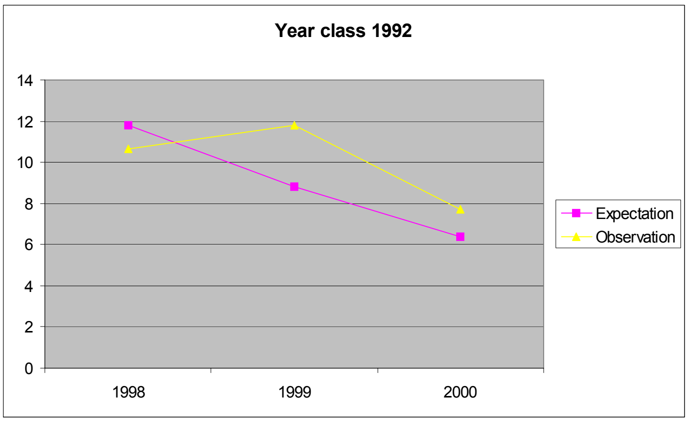


Figure 3.5.3 Spawning stock trajectories for Norwegian spring spawning herring for four different runs of SeaStar and ISVPA.


1983 year class
8
7
6
5
4
3
2
1
0
1991
1994
1995
1996
1998
Expectation
Observation


1990 year class
6
5
4
3
2
1
0
1995
1996
1998
1999
2000
Expectation
Observation


1991 year class
14
12
10
8
6
4
2
0
1996
1998
1999
2000
Expectation
Observation



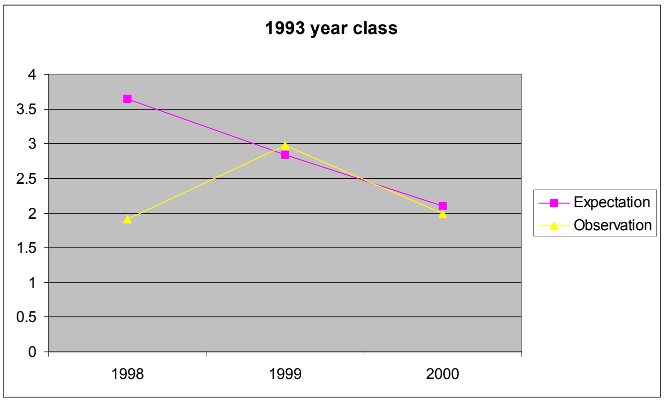
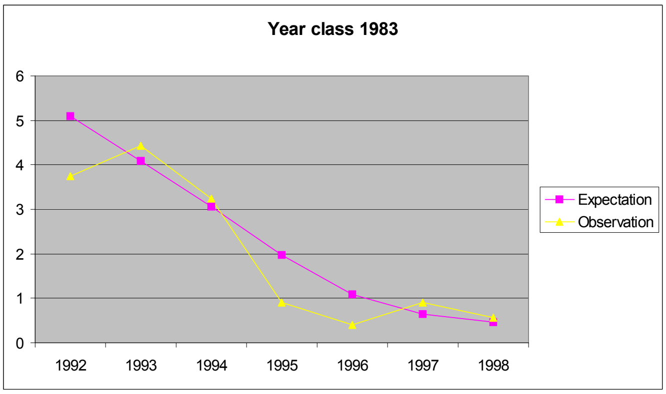
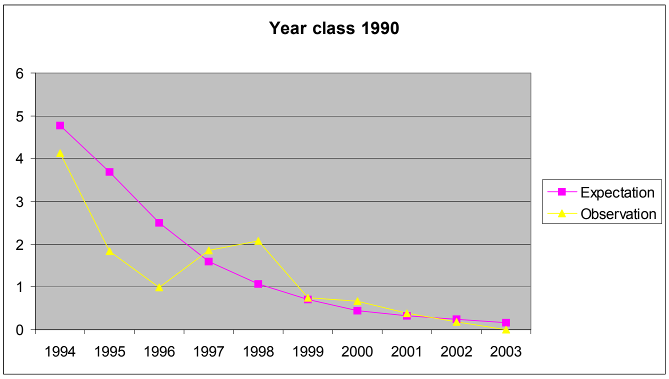
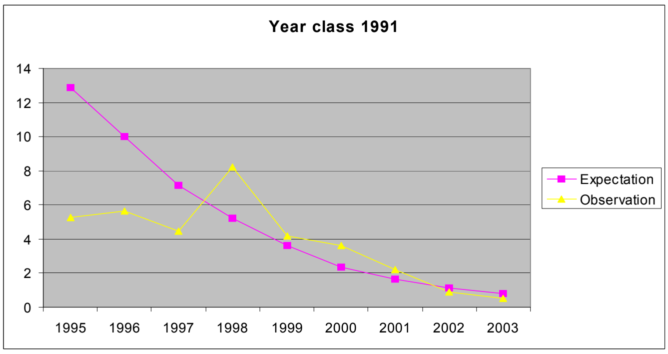
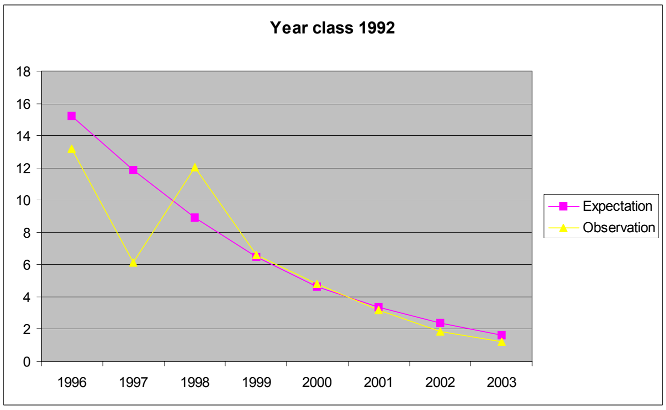


Figure 3.6.1 Fit of the VPA scaled with the estimated catchability to the observations in the survey on the spawning grounds for the tuned year classes - Norwegian spring spawning herring.


Year class 1983
Expectation
Observation


Year class 1990
Expectation
Observation


Year class 1991
Expectation
Observation


Year class 1992
Expectation
Observation

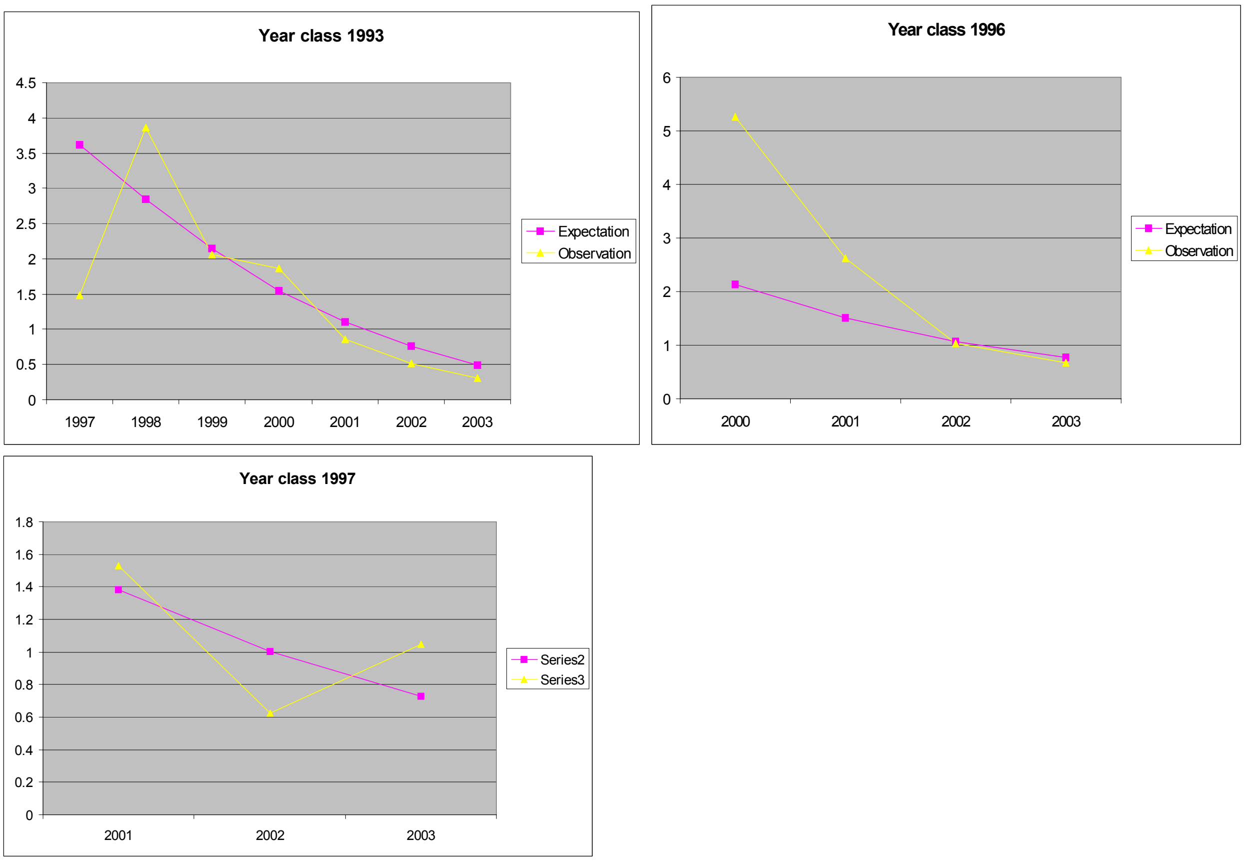


Figure 3.6.2 Fit of the VPA scaled with the estimated catchability to the observations in the December survey in Vestfjorden - Norwegian spring spawning herring.

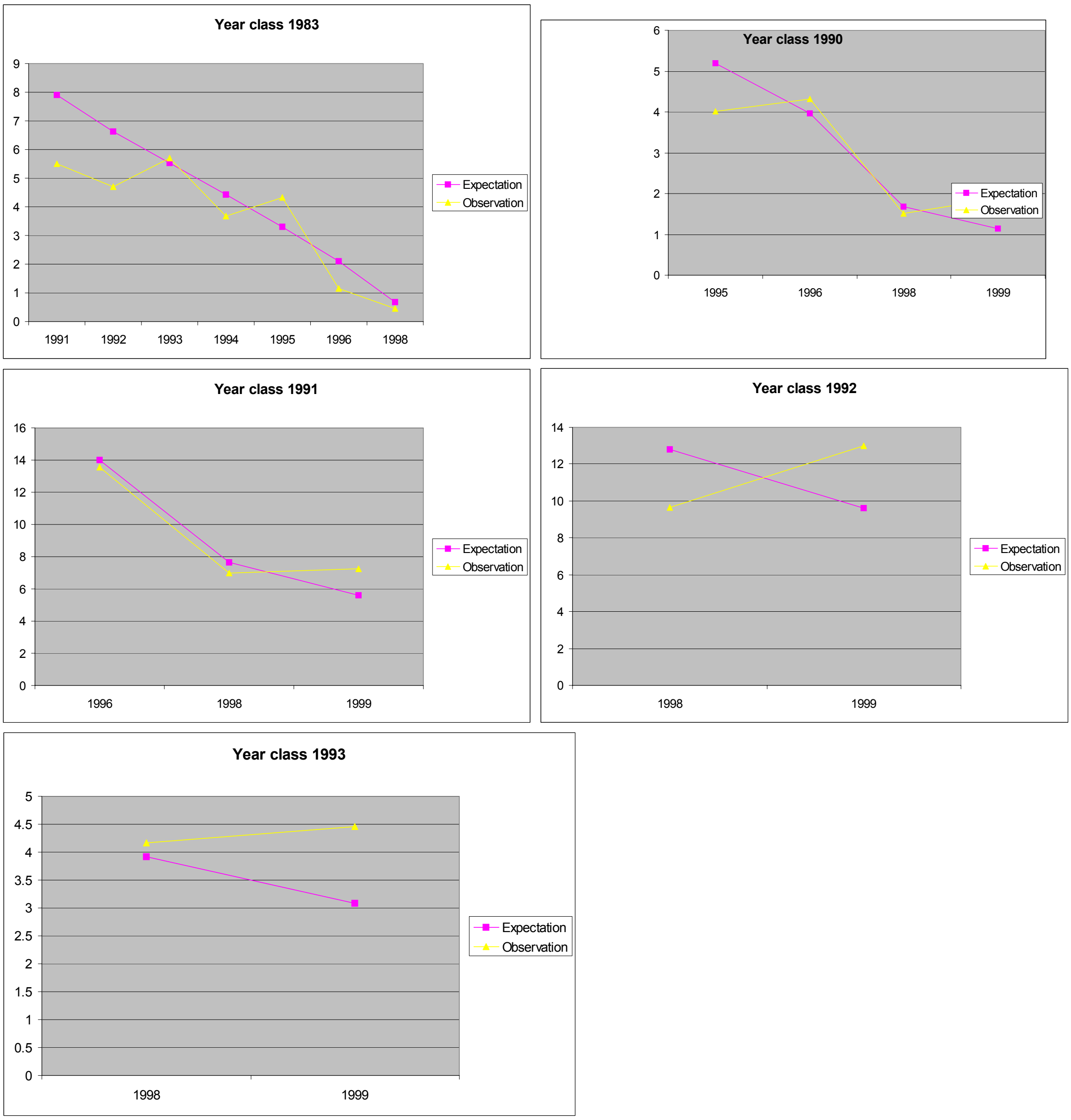
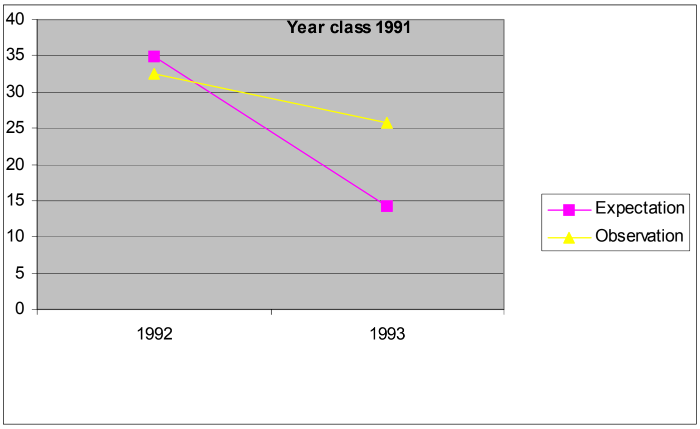
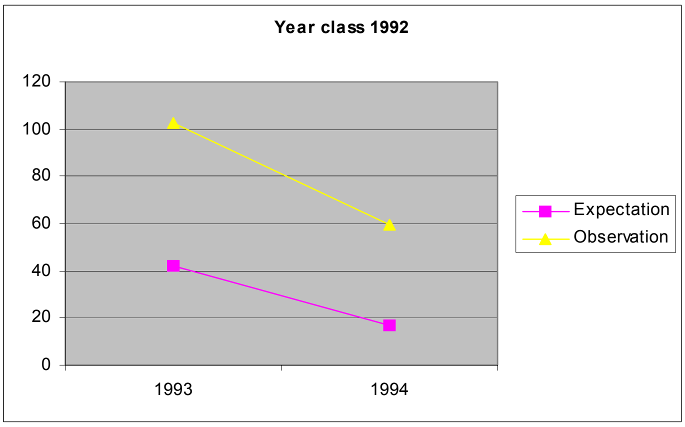


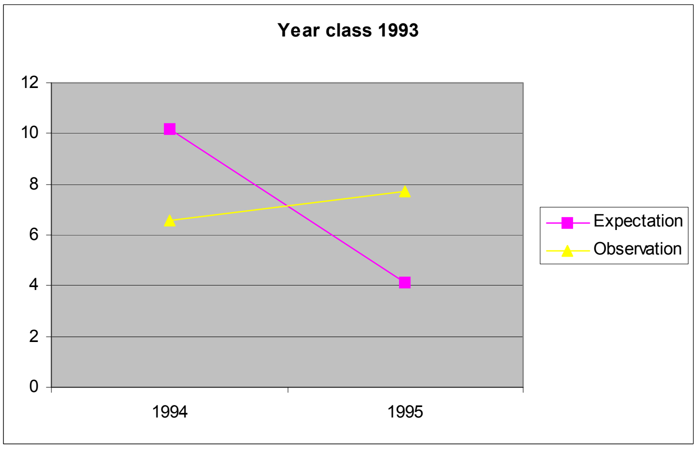
Figure 3.6.3 Fit of the VPA scaled with the estimated catchability to the observations in the January survey in Vestfjorden - Norwegian spring spawning herring.



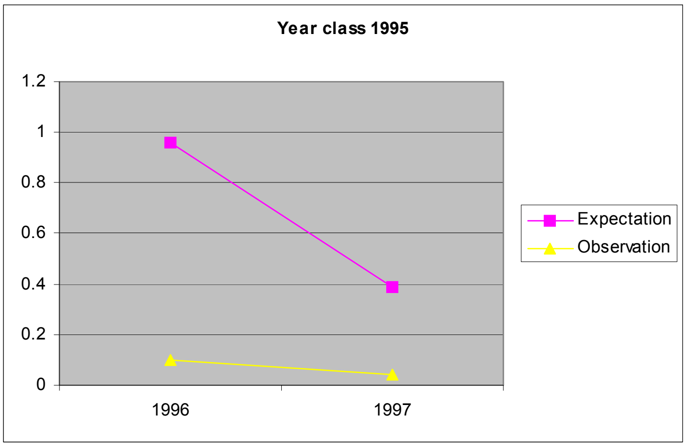
Year class 1991
40
35
30
25
20
15
10
5
0
1992
1993
Expectation
Observation



Year class 1992
120
100
80
60
40
20
0
1993
1994
Expectation
Observation



Year class 1993
12
10
8
6
4
2
0
1994
1995
Expectation
Observation



Year class 1995
1.2
1
0.8
0.6
0.4
0.2
0
1996
1997
Expectation
Observation

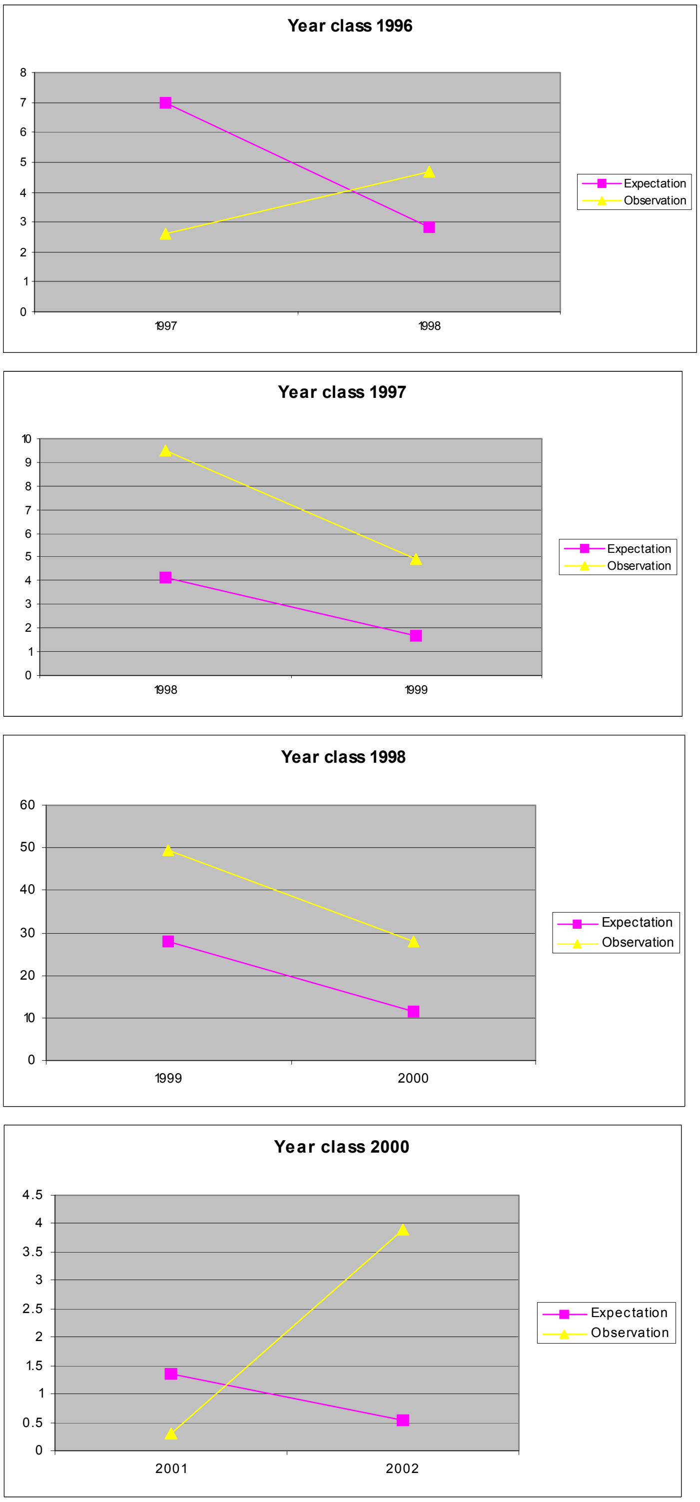


Figure 3.6.4 Fit of the VPA scaled with the estimated catchability to the observations in the May survey in the Barents Sea - Norwegian spring spawning herring.

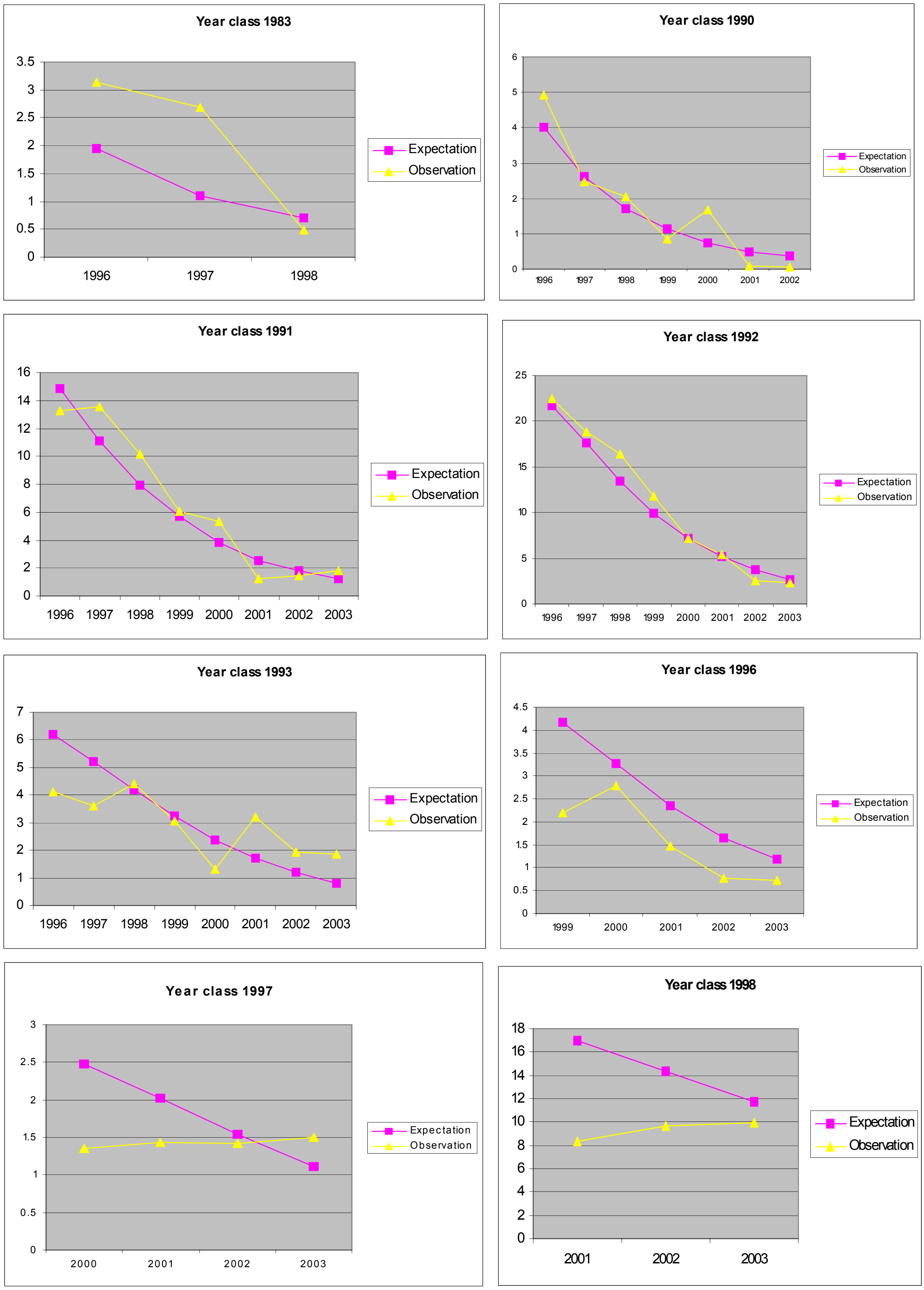


Figure 3.6.5 Fit of the VPA scaled with the estimated catchability to the observations in the feeding areas in the Norwegian Sea - Norwegian spring spawning herring.

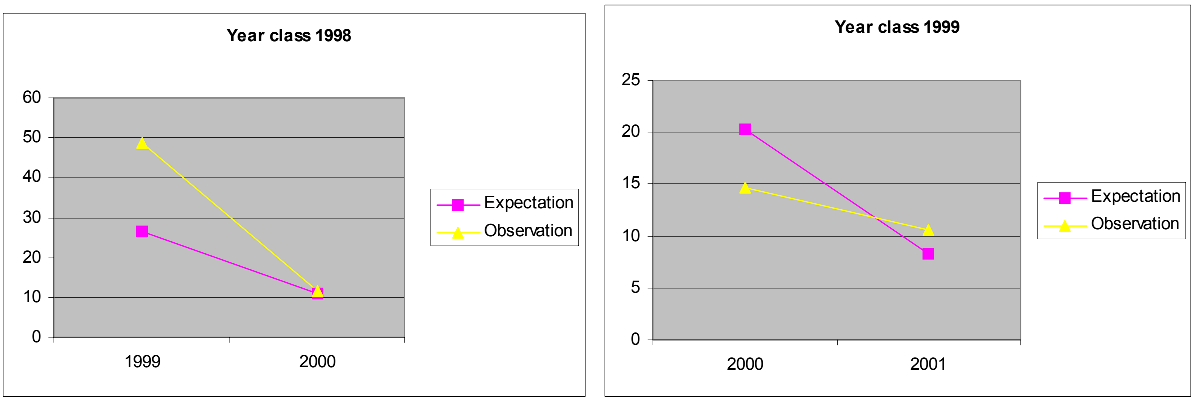


Figure 3.6.6. Fit of the VPA scaled with the estimated catchability to the observations for the Barents Sea September survey - Norwegian spring spawning herring..

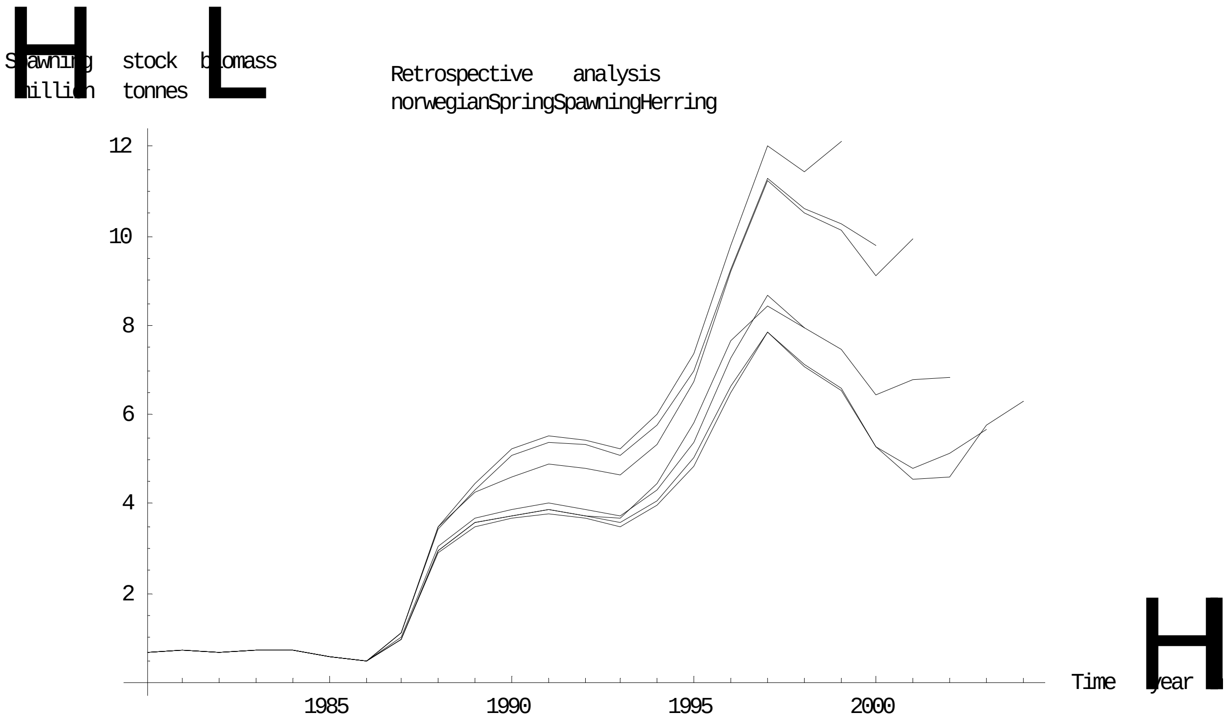


Figure 3.6.7 Retrospective plot from SeaStar for Norwegian spring spawning herring.

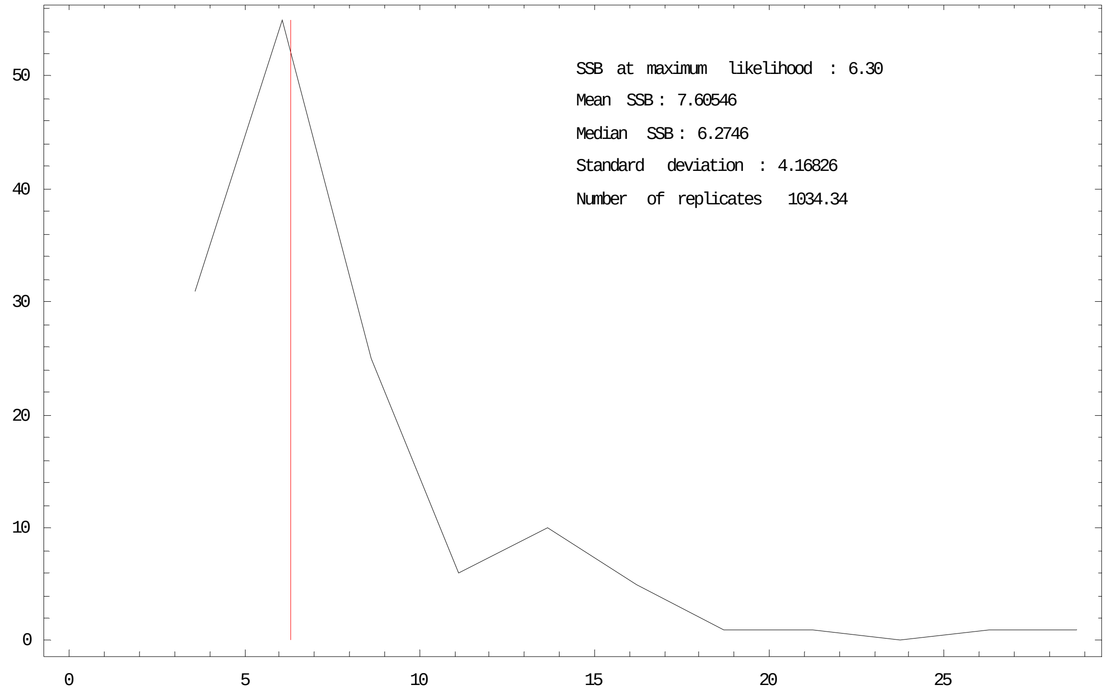


Figure 3.6.8 Histogram of perceived SSB 2004 from SeaStar bootstrap runs - Norwegian spring spawning herring.

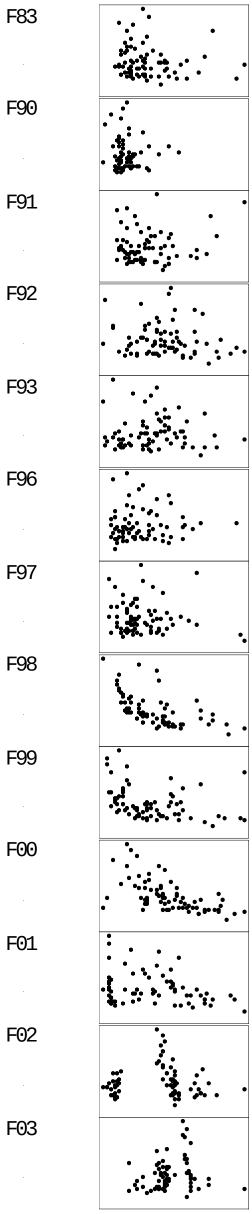


Figure 3.6.9 Scatter plot of terminal F-values vs SSB for SeaStar bootstrap runs - Norwegian spring spawning herring.

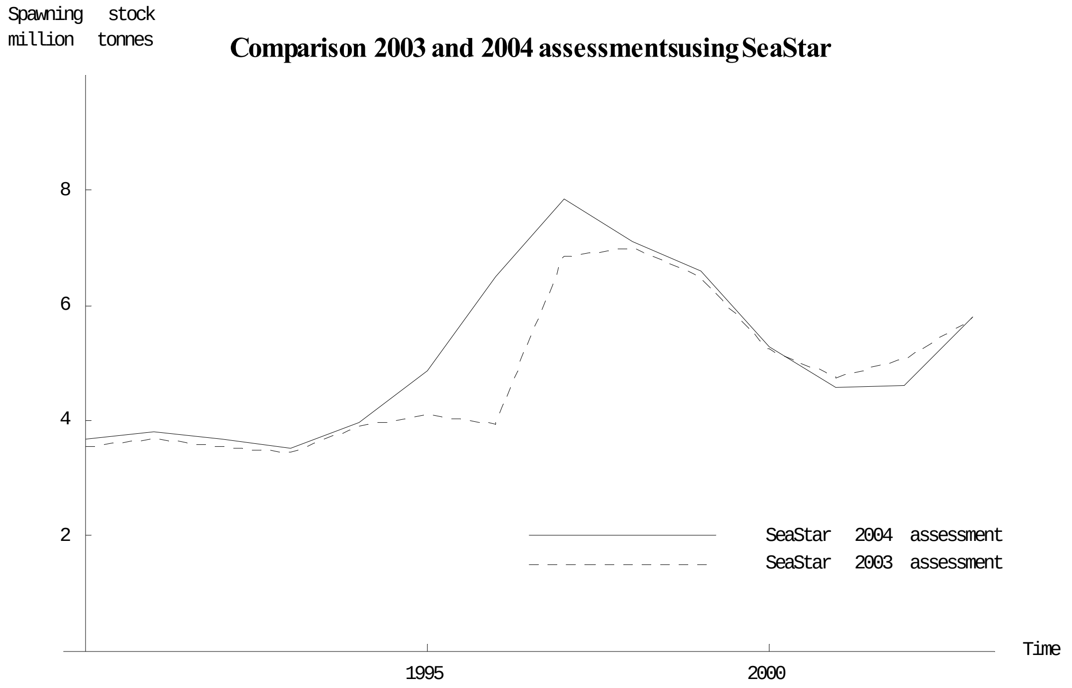


Figure 3.6.10 Comparison of assessments made in 2004 and 2003 by SeaStar - Norwegian spring spawning herring.

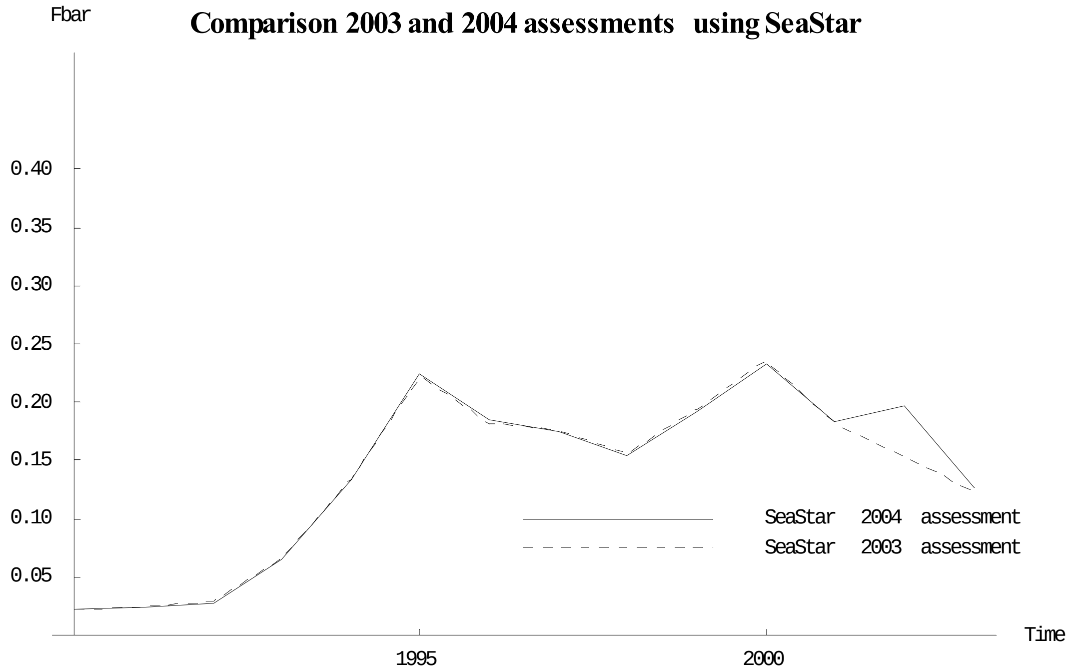


Figure 3.6.11 Comparison of Fbar in 2003 and 2004 assessments using SeaStar - Norwegian spring spawning herring.

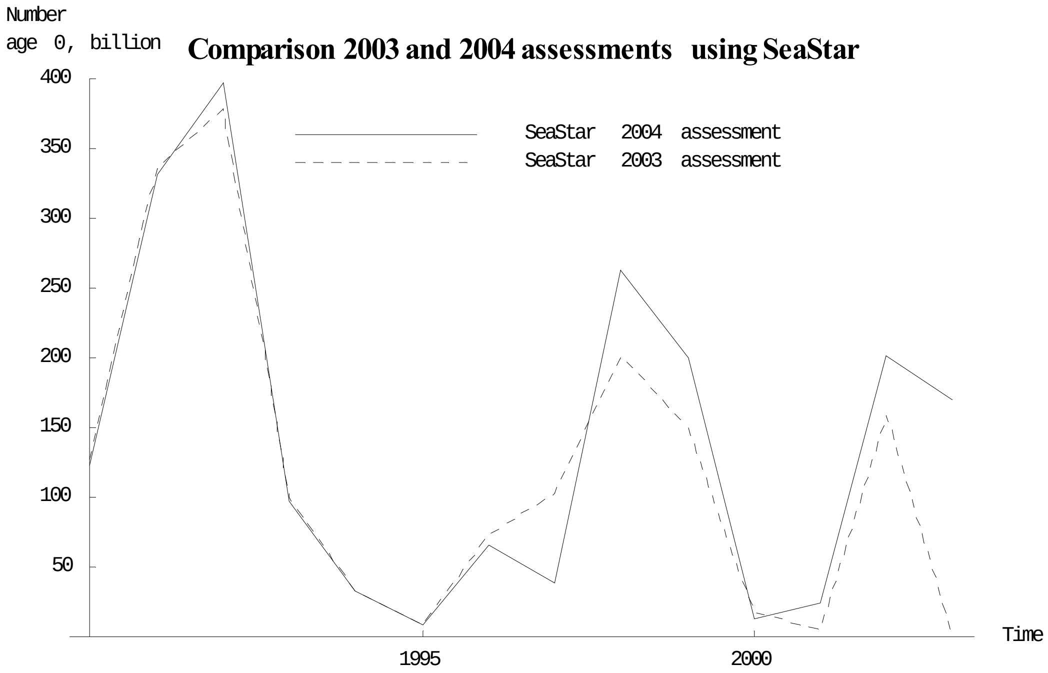


Figure 3.6.12 Comparison of number at age 0 in 2003 and 2004 assessments using SeaStar - Norwegian spring spawning herring.

4 BARENTS SEA CAPELIN

4.1 Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. In recent years no autumn fishery has taken place, except for a small Russian experimental fishery. The fishery was closed from 1 May to 15 August until 1984. During the period 1984 to 1986, the fishery was closed from 1 May to 1 September. A minimum landing size of 11 cm has been in force for several years. From the autumn of 1986 to the winter of 1991, and from the autumn 1993 to the winter 1999 no fishery took place. The fishery was re-opened in the winter season 1991 and again in the winter season 1999, on a recovered stock.

In its autumn meeting of 2003, ACFM considered a harvest control rule, which was consistent with the precautionary approach. This rule defined the harvest level based on a maximum probability of 5% that SSB would fall below $\mathbf{B}_{\text{lim}}$ of 200 000 t (corresponding to no catch of pre-spawning capelin in 2003). ACFM also recommended that this harvest control rule be applied in 2003. (See also paragraph 4.5). During its Autumn 2003 meeting the Mixed Russian Norwegian Fishery Commission decided that no fishing should take place on Barents Sea capelin for the winter season 2004.

In 2002, the Mixed Russian Norwegian Fishery Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn.

4.2 Catch Statistics

The international catch by country and season in the years 1965-2003 is given in Table 4.2.1. The catch by age and length groups during the spring season 2003 is given in Table 4.2.2. The total catch in winter 2003 given in Table 4.2.1 was 282 000 t. This is 28 000 t below the quota set for 2003. No catches were taken during autumn 2003.

4.3 Stock Size Estimates

4.3.1 Larval and 0-group estimates in 2003

Norwegian larval surveys based on Gulf III plankton samples have been carried out in June each year since 1981. The estimated total number of larvae is shown in Table 4.3.1.1. These larval abundance estimates do not show a high correlation with year class strength at age one, but should reflect the amount of larvae produced each year (Gundersen and Gjøsæter, 1998). The year 1986 was exceptional, in that no larvae were found. This may have been due to late spawning that year, and eggs may have hatched after the survey was carried out. Also in other years some spawning is known to have taken place during the summer, and offspring from such late spawning is not reflected in the larval abundance estimates in Table 4.3.1.1. Since 1997, permission has not been granted to enter the Russian EEZ during the larval survey or permission has been granted so late that it could not be employed to good purpose, and consequently the total larval distribution area has not been covered. The estimate of $11.9 \cdot 10^{12}$ larvae in 2003 is half of the estimate in 2002, at the same level as that obtained in 2001 and above the average for the period 1981-2003. During the international 0-group surveys in August an area-based index for the abundance of 0-group capelin is calculated (Table 4.3.1.1). Gundersen and Gjøsæter (1998) found these indices to be well correlated ($r^2 = 0.75$) with the 1-group acoustic estimates for the same year class obtained by the annual capelin acoustic surveys in autumn. Data points up to 1994 were included in this analysis. When this regression is updated with the survey results from 1981-2003 the parameters in the regression were changed slightly and the r^2 was reduced to 0.65. Based on this regression, (ln 1-group estimate = -1.74 + 1.18 · ln 0-group index), the 0-group index obtained in 2003 of 630 would correspond to a year class strength of 347 billion one-year-olds in autumn 2004. A year class of this size would be about 1.6 times an average year class in the period 1972-2002.

4.3.2 Acoustic stock size estimates in 2003

Two Russian and three Norwegian vessels jointly carried out the 2003 acoustic survey as part of an ecosystem-survey during autumn (WD by Bogstad *et al.*). The coverage of the total stock was considered complete. The results from the survey are given in Table 4.3.2.1, and are compared to previous years' results in Table 4.3.2.2. The stock size was estimated at 0.5 million tonnes. About 50% (0.28 mill t) of the stock biomass consisted of maturing fish (> 14 cm).

4.3.3 Other surveys

During the period of 20/02-08/03, two Russian research vessels surveyed and good coverage the area of capelins spawning stock distribution. It was about 99 thousand square nautical miles and located in the Norwegian, Russian and Grey Zones. Capelin as very scattered concentrations were recorded in the area from the 32°-37° everywhere. Typical "moving schools" practically were not found. The most part of fish was dispersed in the layers close to the bottom. It was weak migration $\mathbf{F}_{low}$ in the central part and there was not a considerable $\mathbf{F}_{low}$ in the east of the Barents Sea. The maturing stock, determined as the part of the stock exceeding 14 cm length, was estimated at **5224.42x10^{6} ind.,** and **104.95x10^{3} tonnes**. Capelin at the age of 3 and 4 (poor year-classes of 2001 and 2000) made up the bulk of the capelin spawning stock, in 28/60 proportion, in spring 2004.

During the Norwegian demersal fish survey in February 2004 observations of capelin by acoustics and by pelagic and demersal trawls were made. Although no stock size estimate was attempted, due to inadequate coverage and low number of pelagic trawl hauls for identification and sampling purposes, the overall impression was very low abundance of capelin found pelagically and sporadic catches of capelin in the bottom trawl hauls. Samples of cod stomachs during this period give valuable information for the modelling of maturing capelin as prey for cod (Bogstad and Gjøsæter, 2001).

4.4 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1991-2003 is given in Tables 4.4.1-4.4.7. The methods and assumptions used for constructing the tables are explained in Appendix A to ICES 1995 Assess: 9. In that report, the complete time series back to 1973 can also be found. It should be noted that several of the assumptions and parameter values used in constructing these tables differ from those used in the assessment. For instance, in the assessment model the M-values for immature capelin are calculated using new estimates of the length at maturity and M-values for mature capelin are calculated taking the predation by cod into account. This will also affect the estimates of spawning stock biomass given in the stock summary table (Table 4.4.7). It should be noted that these values, coming from a deterministic model cannot directly be compared to those coming from the probabilistic assessment model (Bifrost) used for this stock. However, as a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

Estimates of stock in number by age group and total biomass for the period are shown in Table 4.4.1. Catch in numbers at age and total landings are shown for the spring and autumn seasons in Tables 4.4.2 and 4.4.3. Natural mortality coefficients by age group for immature and mature capelin are shown in Table 4.4.4. Stock size at 1 January in numbers at age and total biomass is shown in Table 4.4.5. Spawning stock biomass per age group is shown in Table 4.4.6. Table 4.4.7 gives an aggregated summary for the entire period 1973-2003.

4.5 Stock assessment autumn 2003

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 2003 meeting (ICES 2003/ACFM:23), the assessment of Barents Sea capelin was left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who reported directly to ACFM before its autumn 2003 meeting (Bogstad *et al.,* WD).

A probabilistic projection of the spawning stock to the time of spawning at 1 April 2004 was presented, using the spreadsheet model CapTool (implemented in the @RISK add-on for EXCEL). The projection was based on a probabilistic maturation model with parameters estimated by the model Bifrost (Gjøsæter *et al*. 2002) with uncertainty taken into account and data on size and composition of the cod stock (from the Arctic Fisheries Working Group, ICES 2003/ACFM:22, but made probabilistic in CapTool in accordance with the risk analysis made by the Arctic Fisheries Working Group). It was very good relationship between results of calculation SSB which geting by CapTool model and Russian winter capelin survey.

There is clearly a need for a target biomass reference point for capelin. Calculations of B_{target} were attempted, but were not presented because the results were considered preliminary. A $\mathbf{B}_{lim}$ (SS$\mathbf{B}_{lim}$) management approach was suggested for this stock. In 2002, the Mixed Russian Norwegian Fishery Commission agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 t of capelin should be allowed to spawn. Consequently, 200 000 t was used as a $\mathbf{B}_{lim.}$.

Probabilistic prognoses for the maturing stock from October 1 2003 until April 1 2004 were made, with a CV of 0.20 on the abundance estimate. The meeting concluded that capelin recruitment in 2004 could be seriously negatively affected by the stock of young herring now found in the Barents Sea.

ACFM at its autumn 2003 meeting (ICES 2003/CRR:261) took all the points in the report into account. ACFM advised that no fishing should take place in spring 2004. This was based on adopting the forecast of the SSB using the limit reference points referred above, and following the harvest control rule that the SSB should fall below $\mathbf{B}_{lim}$ with a maximum 5% probability. ACFM also considered that adjustments of the harvest control rule should be further investigated for the purpose of taking better account of the uncertainty in the predicted estimate of spawner abundance, the likely interactions with herring, and the role of capelin as prey.

4.6 Management considerations

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season does not begin until January, advice for this stock must be given during the autumn ACFM meeting and the TAC must be set by the Mixed Norwegian-Russian Fishery Commission during its meeting in November-December. As previously decided by the Northern Pelagic and Blue Whiting Fisheries Working Group, the assessment of Barents Sea capelin is left to the parties responsible for the autumn survey, i.e. IMR in Bergen and PINRO in Murmansk, who will meet in Kirkenes from 05-08 October 2004 and report directly to the 2004 ACFM autumn meeting.

4.7 Sampling

The sampling from scientific surveys and from commercial fishing on capelin in 2003 and winter 2004 is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Russian capelin investigation winter 2003	135	4808	-
Russian fishery winter-spring 2003	114	19449	800
Norwegian capelin investigations winter 2003	163	5581	1742
Norwegian fishery winter-spring 2003	44	4340	1461
Acoustic survey autumn 2003 (Norway)	196	7707	2231
Acoustic survey autumn 2003 (Russia)	142	7330	725
Other samples 2003 (Norway)	139	8500	-
Other sample 2003 (Russia)	79	5739	50
Norwegian capelin investigations winter 2004	213	6590	1994
Russian capelin investigation winter 2004	167	9368	883

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

Year	Winter				Summer-Autumn			Total
	Norway	Russia	Others	Total	Norway	Russia	Total	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	11	358	1591
1973	1078	35	0	1112	213	10	223	1336
1974	749	80	0	829	237	82	319	1149
1975	559	301	43	903	407	129	536	1439
1976	1252	231	0	1482	739	366	1105	2587
1977	1441	345	2	1788	722	477	1199	2987
1978	784	436	25	1245	360	311	671	1916
1979	539	343	5	887	570	326	896	1783
1980	539	253	9	801	459	388	847	1648
1981	784	428	28	1240	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	374	36	1161	758	439	1197	2358
1984	330	257	42	628	481	367	849	1477
1985	340	234	17	590	113	164	278	868
1986	72	51	0	123	0	0	0	123
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	528	156	20	704	31	195	226	929
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	0	0	0	0	1	1	1
1999	46	32	0	78	0	23	23	101
2000	283	95	8	386	0	28	28	414
2001	368	180	8	557	0	11	11	568
2002	391	228	17	635	0	16	16	651
2003	190	93	0	282	0	0	0	282

Table 4.2.2 Barents Sea CAPELIN. International catch in number (10^6) and biomass (t) during the spring season 2003, as used by the Working Group

Length	Age 1		Age 2		Age 3		Age 4		Age 5+		Sum			
cm	N	B	N	B	N	B	N	B	N	B	N	%	B	%
5.0-5.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5.5-6.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.0-6.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6.5-7.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.0-7.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7.5-8.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.0-8.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8.5-9.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.0-9.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9.5-10.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.0-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10.5-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.0-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11.5-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.0-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12.5-	0	0	0	0	4480	41	0	0	0	0	4480	0	41	0
13.0-	0	0	0	0	227047	2138	4692	43	0	0	231739	2	2180	1
13.5-	0	0	0	0	248431	2598	123197	1262	0	0	371627	3	3860	1
14.0-	0	0	0	0	462853	5347	330091	3869	0	0	792944	6	9217	3
14.5-	0	0	0	0	311292	4088	776663	10559	4692	72	1092647	8	14718	5
15.0-	0	0	0	0	352191	5178	1058475	15343	0	0	1410666	11	20521	7
15.5-	0	0	0	0	168810	2828	1364395	23405	36993	678	1570199	12	26910	10
16.0-	0	0	0	0	139504	2736	1482273	28883	53564	1091	1675342	13	32710	12
16.5-	0	0	0	0	132094	2741	1534349	34363	56778	1409	1723222	13	38513	14
17.0-	0	0	0	0	21942	581	1370535	35220	36723	777	1429201	11	36579	13
17.5-	0	0	0	0	36700	1094	1188436	34896	78429	2270	1303564	10	38259	14
18.0-	0	0	0	0	9384	302	759772	24561	95860	3037	865016	6	27900	10
18.5-	0	0	0	0	33854	1096	454478	16325	46960	1661	535292	4	19082	7
19.0-	0	0	0	0	0	0	235440	8719	4692	175	240132	2	8895	3
19.5-	0	0	0	0	0	0	52999	2207	0	0	52999	0	2207	1
20.0-	0	0	0	0	0	0	16624	790	0	0	16624	0	790	0
20.5-	0	0	0	0	0	0	372	20	0	0	372	0	20	0
21.0-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21.5-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sum	0	0	0	0	2148582	30766	1075279	240464	414691	11170	1331606	100	282400	100

Table 4.3.1.1 Barents Sea CAPELIN. Larval abundance estimate (10^{12}) in June, and 0-group index in August.

Year	Larval abundance	0-group index
1981	9.7	570
1982	9.9	393
1983	9.9	589
1984	8.2	320
1985	8.6	110
1986	0.0	125
1987	0.3	55
1988	0.3	187
1989	7.3	1300
1990	13.0	324
1991	3.0	241
1992	7.3	26
1993	3.3	43
1994	0.1	58
1995	0.0	43
1996	2.4	291
1997	6.9	522
1998	14.1	428
1999	36.5	722
2000	19.1	303
2001	10.7	221
2002	22.4	327
2003	11.9	630

Table 4.3.2.1 Barents Sea CAPELIN. Estimated stock size from the acoustic survey in September-October 2003. Based on TS value 19.1 log L –74.0 dB, corresponding to $\sigma = 5.0 \cdot 10^{7} \cdot L^{1.91}$.

	Age/Year class						
Length (cm)	1	2	3	4	Sum	Biomass	Mean
	2002	2001	2000	1999	(10^6)	(10^3 t)	weight (g)
6.5 - 7.0	4482				4482	4.5	1.0
7.0 - 7.5	8670				8670	9.3	1.1
7.5 - 8.0	4980				4980	7.5	1.5
8.0 - 8.5	14626				14626	28.9	2.0
8.5 - 9.0	15621				15621	35.4	2.3
9.0 - 9.5	13086				13086	37.1	2.8
9.5 - 10.0	9251	5			9256	29.5	3.2
10.0 - 10.5	6994	2			6996	26.5	3.8
10.5 - 11.0	3238	29			3267	14.9	4.6
11.0 - 11.5	1317	262			1579	7.4	4.7
11.5 - 12.0	163	952			1115	6.7	6.0
12.0 - 12.5	16	1137			1153	7.9	6.9
12.5 - 13.0		902			902	7.3	8.1
13.0 - 13.5		1407	98		1505	13.4	8.9
13.5 - 14.0		1450	161		1611	16.7	10.4
14.0 - 14.5		1430	741		2171	26.2	12.1
14.5 - 15.0		1211	1443	19	2673	37.7	14.1
15.0 - 15.5		570	1785	47	2402	39.3	16.4
15.5 - 16.0		181	2113	190	2484	45.2	18.2
16.0 - 16.5		58	2171	199	2428	47.9	19.7
16.5 - 17.0			1351	260	1611	36.2	22.4
17.0 - 17.5			765	346	1111	27.6	24.9
17.5 - 18.0			330	199	529	14.4	27.2
18.0 - 18.5			21	97	118	3.6	30.6
18.5 - 19.0			3	42	45	1.5	33.6
19.0 - 19.5				3	3	0.1	37.1
TSN (10^6)	82444	9596	10982	1402	104424		
TSB (10^3 t)	200.8	97.4	201.6	33.0		532.8	
Mean length (cm)	8.8	13.5	15.8	16.9	10.1		
Mean weight (g)	2.4	10.2	18.4	23.5			5.1
SSN (10^6)		3450	10723	1402	15572		
SSB (10^3 t)		48.2	198.7	32.6		279.6	

Based on TS value: 19.1 log L - 74.0, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.9}$

Table 4.3.2.2 Barents Sea CAPELIN. Stock size in numbers by age, total stock biomass and biomass of the maturing component. Stock in numbers (unit:10^9) and stock and maturing stock biomass (unit:10^3 tonnes) are given at 1. October.

Year	Stock in numbers (10^9)						Stock in weight ('000 t)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	Maturing
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330
1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280

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

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	29.5	8.3	88.9	111.8	188.4	171.4	474.7	128.0	67.3	92.9
2	5.1	9.4	12.5	44.2	76.5	111.5	116.8	246.6	102.3	13.0
3	6.4	1.6	2.2	2.2	12.1	27.9	35.9	33.0	54.4	14.6
4	0.3	0.4	0.1	0.1	0.7	0.9	0.8	1.2	0.6	1.9
5	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0
Sum	41.4	19.7	103.7	158.3	277.8	311.7	628.4	408.8	224.7	122.4
Biomass	259	189	467	866	1860	2580	3840	3480	2122	662

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

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5	0.4	0.0
3	0.0	0.0	0.0	0.0	0.0	1.6	5.5	7.6	10.0	2.1
4	0.0	0.0	0.0	0.0	0.0	1.2	8.4	12.1	14.2	10.8
5	0.0	0.0	0.0	0.0	0.0	0.1	1.0	2.2	0.7	1.4
Sum	0.0	0.0	0.0	0.0	0.0	3.0	15.1	22.5	25.3	14.3
Landings	0	0	0	0	0	78	386	557	635	635

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

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.0	0.0	0.0	0.0	0.0	0.4	0.1	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.4	0.3	0.0
3	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.2	0.6	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	0.0	0.1	1.6	1.5	0.6	0.9	0.0
Landings	0	0	0	1	1	23	28	11	16	0

Table 4.4.4 Barents Sea CAPELIN. Natural mortality coefficients (per month) for immature fish (M_{imm}), used for the whole year, and for mature fish (per season) (M_{mat}) used January to March, by age group and average for age groups 1-5.

	1994		1995		1996		1997		1998	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077
2	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077
3	0.201	0.602	0.019	0.058	0.041	0.122	0.062	0.185	0.071	0.212
4	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212
5	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212
Avr	0.221	0.700	0.052	0.152	0.043	0.133	0.042	0.127	0.053	0.158

Table 4.4.4 (Continued)

	1999		2000		2001		2002		2003	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.047	0.142	0.028	0.083	0.060	0.180	0.060	0.180	0.060	0.180
2	0.047	0.142	0.028	0.083	0.060	0.180	0.060	0.180	0.152	0.456
3	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120	0.142	0.426
4	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120	0.142	0.426
5	0.025	0.074	0.026	0.079	0.040	0.120	0.040	0.120	0.142	0.426
Avr	0.034	0.101	0.027	0.080	0.048	0.144	0.048	0.144	0.128	0.383

Table 4.4.5 Barents Sea CAPELIN. Estimated stock size in numbers (unit:10^9) by age group and total, and biomass ('000 t) of total stock, by 1. January.

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	120.3	13.8	118.2	172.0	225.5	238.5	576.1	194.7	102.3	141.3
2	1.4	10.8	5.7	72.5	82.2	165.8	135.3	413.3	94.6	75.4
3	33.3	1.9	6.5	10.2	32.5	67.3	88.1	100.9	182.6	44.5
4	9.8	2.4	1.4	1.8	1.6	8.5	24.7	31.1	27.0	0.5
5	1.3	0.1	0.3	0.1	0.1	0.5	0.8	0.7	0.9	0.0
Sum	166.1	28.9	132.2	256.6	341.9	480.6	824.9	740.6	407.5	261.7
Biomass	737	156	313	779	1240	2456	3571	4558	3539	2008

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

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0	0	0	0	0	0	0	0	0	0
2	0	1	3	1	1	2	24	5	0	169
3	34	15	71	175	217	650	819	943	867	663
4	60	38	24	49	34	193	472	539	339	0
5	11	1	7	2	2	10	0	0	9	0
Sum	105	55	105	228	254	856	1315	1487	1215	832

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

Year	Stock biomass	Recruit-ment Age 1	Spawning stock biomass	Landings
1965				224
1966				389
1967				409
1968				537
1969				680
1970				1314
1971				1392
1972	5831			1592
1973	6630	1140	1242	1336
1974	7121	737	343	1149
1975	8841	494	90	1439
1976	7584	433	1147	2587
1977	6254	830	890	2987
1978	6119	855	460	1916
1979	6576	551	193	1783
1980	8219	592	87	1648
1981	4489	466	1731	1986
1982	4205	611	546	1760
1983	4772	612	47	2358
1984	3303	183	171	1477
1985	1087	47	106	868
1986	157	9	13	123
1987	107	46	16	0
1988	361	22	11	0
1989	771	195	141	0
1990	4901	708	179	0
1991	6647	415	1584	929
1992	5371	396	998	1123
1993	991	3	460	586
1994	259	30	105	0
1995	189	8	55	0
1996	467	89	105	0
1997	866	112	228	1
1998	1860	188	254	1
1999	2580	171	856	106
2000	3840	475	1315	414
2001	3480	128	1487	568
2002	2122	67	1215	651
2003	662	93	832	282

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

5.1 The Fishery

5.1.1 Regulation of the fishery

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

The fishery of the Icelandic capelin has, therefore, been regulated by preliminary catch quotas set prior to each fishing season (July–March). Predictions of TACs have been computed from autumn survey data the year before on the abundance of 1 and 2 year old capelin. The process includes historical relationships between such data and the back-calculated abundance of the same year classes, growth rate and stock in numbers, natural mortality and the provision of a remaining spawning stock biomass of 400 000 t. Final catch quotas for each season have then been set according to the results of acoustic surveys of the maturing, fishable stock, carried out in autumn (October–November) and/or winter (January/February) in that fishing season. A more detailed description of the method is given in Section 1.3.5. A summary of the results of this catch regulation procedure is given in Table 5.1.1.

Over the years the fishery has been closed during April - late June and the season has started in July/August or later, depending on the state of the stock. Due to very low stock abundance there was a fishing ban lasting from December 1981 to November 1983. In addition, areas with high abundances of juvenile age 1 and 2 capelin (in the shelf region off NW-, N- and NE-Iceland) have usually been closed to the summer and autumn fishery.

5.1.2 The fishery in the 2003/2004 season

In accordance with a previously determined procedure, ACFM recommended that the preliminary TAC should not exceed 555 000 t. This is 2/3 of the total TAC prediction of 835 000 t for the 2003/2004 season. This advice was accepted by all parties concerned.

The season opened on 20 June, with insignificant catches taken off the northeast and eastern north coast of Iceland and later more intensive fishery developed in deep waters off the shelf edge north of Iceland. The fishing grounds soon shifted to the northwest and north. Catch rates were low in the beginning but improved in July as the capelin migrated northward. Towards the end of July, the northward migration stopped and the capelin soon scattered. At that time the total catch was about 200 000 t, mainly taken in July on both sides of the Iceland/Greenland EEZ between about 68°N and 69°30’N. After July the capelin remained scattered and no catches were made for the rest of the year. The small fishery, which in later years has been conducted near the shelfbreak off the eastern north coast of Iceland in December, did not materialize.

The total catch in the 2003 summer and autumn season was just under 200 000 t (Table 5.2.1).

In the first half January 2004 the research ship and a large fleet of scouting vessels only found scattered concentrations of capelin. In view of the uncertain stock prognosis (see section 5.7) a complete fishing ban was enforced, to last until a sufficiently large assessment of fishable stock abundance had been obtained. In the meantime, the Marine Research Institute and the Association of Owners of Fishing Boats arranged for a watch by commercial vessels of the most likely fishing areas in the near future.

On 17 January, one of these fishing vessels found large fishable concentrations of adult capelin at the shelf edge off the eastern north coast of Iceland. These, as well as less dense concentrations further south and east, were assessed by the research vessel in the following days and the fishing ban was subsequently lifted.

During the last week of January and in early February, the fishery gradually moved south, generally following the shelf edge east of Iceland. Catch rates remained high during most of this period. For this reason the large concentrations, which were located by the Icelandic research vessel about 40-60 nautical miles farther east, were not fished at the time.

The first spawning run entered the warm Atlantic water off the southeast coast round 20 February, which is unusually late. From there, the capelin migrated slowly westward in near-shore areas. As usual, catch rates were high in the shallow water area until early March, when stormy weather prevented fishing for a week. As often happens under such circumstances, spawning began and the capelin did not form fishable schools again in but a few places. Due to the late arrival and slow migration speed west along the south coast, only a few schools rounded the Reykjanes promontory to spawn off the west coast. Some of the spawners, located in the easternmost area around mid-February, probably followed the earlier migration(s) and intermingled with them in late February/early March. The remainder was never fished and their fate is therefore unknown.

The total catch during the 2004 winter season was 543 000 t (Table 5.2.1). Due to the abrupt end of the fishery before mid-March, about 135 000 t of the TAC, finally set for the 2003/04 season, was not taken.

5.2 Catch Statistics

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

The total catch in numbers during the summer/autumn 1982–2003 and winter 1983–2004 seasons is given by age and years in Tables 5.2.2 and 5.2.3.

The distribution of the catch during the summer-autumn 2003 and winter 2004 seasons is given by length groups at age in Tables 5.2.4 and 5.2.5.

5.3 Surveys of Stock Abundance

5.3.1 0-group surveys

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

Acoustic estimates of the abundance of 1-group capelin have also been obtained during the August 0-group surveys (e.g. Vilhjálmsson 1994). However, due to the large variability of this time series, the August abundance indices have not been used for stock projections for more than a decade. Directed collection of data on juvenile age 1 and 2 capelin in August has been discontinued. The abundance of 1-group capelin by number, mean length and weight for 1983–2001 is given in Table 5.3.1.2.

5.3.2 Stock abundance in autumn 2003 and winter 2004

5.3.2.1 The adult fishable stock

A survey specifically aimed at estimating the adult fishable stock was not made in the autumn of 2003. Like in autumn 2002, hardly any adult capelin were located during the assessment of juvenile capelin in November 2003.

Due to the unusually large uncertainty associated with the prediction of the fishable stock size in the 2003/04 season, twelve fishing vessels carried out a coordinated pilot survey off NW- N- and E-Iceland in the first week of January 2004. Although capelin were recorded over fairly wide areas, densities were very low. On the basis of the findings by the scouting vessels, a research vessel carried out an acoustic survey of the most promising areas during 3-12 January. The total adult stock biomass came to only 127 000 t and as a results all fishing permits were temporarily revoked.

Following these catastrophic results, it was arranged that the most likely areas be monitored by fishing vessels during the latter half of January in order to ensure the shortest possible time needed for the research vessel to obtain a new estimate. On 16 January and in the following few days, a large migration was located near the shelf break off the eastern north coast as well as smaller concentrations of lesser densities further to the east and southeast. All of these capelin were assessed by acoustics during 18-30 January and the fishing ban was lifted. The total abundance of capelin in the area was estimated at 780 000 t, with the 2001 year class strongly dominating both by numbers and weight.

Since weather conditions were inadequate, especially when working off the northern east coast in late January, it was decided to run a third survey of the adult fishable stock east of Iceland. This survey took place during 10-18 February and may be divided into two parts. In the beginning, capelin were assessed in the fishing area at and just out from the shelf edge off the southern east coast. Dense schools were recorded in the southernmost part of this area where catch rates were also high. Densities declined rapidly further north and at about 65˚N had become very low. However, another area containing very dense and large concentrations was discovered 40-60 nautical miles farther east, from about

64˚50'N south to 64˚N, between 09˚W and 10˚W. Scattered capelin were recorded between 64˚N and 63˚50'N, 09˚-09˚30'W and small schools of capelin were also recorded south of this by a Faroese research vessel in the beginning of the third week of February. Since the bulk of the capelin in this easternmost area were slowly migrating to the northwest, there is little doubt that part of the adult stock entered Faroese waters in February 2004. However, on the basis of the available evidence it cannot be determined how far south the capelin distribution in this eastern area reached. East of 10˚W, the capelin were somewhat smaller and their maturation less advanced than that of the capelin in the western area. The total abundance was estimated at about 925 000 t, of which approximately 1/3 was recorded in the western area and 2/3 in the area east of 10˚W.

The total biomass of adult capelin, assessed north and later east of Iceland in January and February 2004 varied greatly between surveys. In retrospect it seems clear, that neither of the January estimates can have covered but parts of the total distribution area. It is obvious, that the first survey did not reach far enough to the north (stopped at 68˚N), while weather disturbed the latter part of the late January survey. The large migration, located at the shelf break off the easternmost north coast around mid-January, obviously entered Icelandic waters from the northwest, migrated south along and just outside the shelf edge east of Iceland and formed the bulk of the capelin that was fished east of Iceland in late January-early February. On the other hand the more oceanic concentrations appear, at least in part, to have arrived from due north, i.e. from more easterly feeding areas than the other.

Details of the January and February 2004 acoustic estimates of adult capelin are given in Tables 5.3.2.1.2 - 5.3.2.1.4.

5.3.2.2 Estimates of immature capelin

An acoustic survey was carried out in November in order to assess the abundance of immature age 1 and 2 capelin (year classes 2000 and 2001). The survey only recorded juvenile capelin off the shelf northwest of the Vestfirdir peninsula. These capelin were extremely scattered and the total estimate was only 4.6 and $3.1*10^9$ by number of the 2002 and 2001 year classes, respectively. Like in autumn 2002, hardly any adult capelin were recorded.

The winter (January-February) 2004 assessment surveys of the mature fishable stock also recorded immature capelin east of Iceland and off the eastern north coast, but their numbers were very low on all occasions.

During 13-22 April 2004 a survey of the area north and west of the Vestfirdir peninsula (NW-Iceland) in otder to locate and assess eventual concentrations of young adolescent capelin, which might be located there as the corresponding stock component was in April 2003. Survey coverage was limited to the north by drift ice at about 67˚40'N, whereas in the Denmark Strait the ice edge was at approximately 15 nautical miles on the Icelandic side of the equidistance line between Greenland and Iceland. The 2004 April survey recorded no capelin at all, although it covered the area west of Vestfirdir where the highest concentrations were located in April 2003.

While the above survey results may correctly reflect an extremely low abundance of the 2002 year class, there may be environmental factors at play, affecting i.e. the geographic distribution of the juvenile stock (see Section 5.7) and therefore its availability to the survey as it was run.

5.4 Historical Stock Abundance

The historical estimates of stock abundance are based on the "best" acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys, the "best" in each case being defined as that estimate on which the final decision of TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (ICES 1991/Assess:17), abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 August and 1 January of the following year for the 1978/79–2003/04 seasons. The results are given in Tables 5.4.1 and 5.4.2 (1 August and 1 January, respectively). Table 5.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979–2003.

The observed annual mean weight at age, obtained from catch and survey data from January, was used to calculate the stock biomass on 1 January. The observed average weight at age of adult capelin in autumn (Table 5.5.1.2) is used to calculate stock biomass of the maturing components in summer. Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is underestimated.

5.5 Stock Prognoses

5.5.1 Stock prognosis and TAC in the 2003/2004 season

The models (ICES 1993/Assess:6; Section 3.1.5) for predicting the numbers of maturing capelin of ages 2 and 3 from the November 2001 acoustic assessment of the 1999 and 1998 year classes gave estimates of 63.0 and $15.6 * 10^9$ maturing 2- and 3-group capelin on 1 August 2003.

The Working Group decided that the Aril 2003 estimate of the abundance of immature 2-group capelin (year class 2001) could be used for predicting the abundance of maturing capelin of the 2001 year class on 1 August 2003. This was done by projecting the April 2003 estimate back to November 2002, using a monthly M=0.035, i.e. to the time of estimations used for predicting the younger year class in the fishable and spawning stock for the last two decades. On the other hand, the contribution by the 2000 year class was, as usual, from the historic relationship between the total abundance of each year class at age 3 and the contribution of the same year class at age 4. In order to correspond to the timeline used in the past, the data for the older component (2000 year class) were projected back in time to November 2003 using a monthly M = 0.035. The resulting projections of 63.0 and 15.6 billion mature fish belonging to the 2001 and 2000 year classes respectively, are given in Table 5.5.1.1.

During the last ten years the weight at age of adult capelin has been inversely related to adult stock abundance and simple linear regressions result in R^2 = 0.64 and 0.68 for age groups 2 and 3, respectively. These two regression plots are shown in Figure 5.5.3.2. Applying the appropriate regression equations; $y = -0.034x + 19.4$; $r^2 = 0.64$; $p<0.05$ for the younger component, and $y = -0.068x + 29.0$; $r^2 = 0.68$; $p<0.05$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 2003 combined, *i.e.* $78.6 * 10^9$ fish, results in estimated mean weights of 16.7 and 23.9 g for age groups 2 and 3 respectively.

Applying the estimated mean weight, results in a predicted TAC of 845 000 t spread evenly from August 2003-March 2004. This corresponds to a preliminary TAC of 555 000 t. As in previous years, decisions on the final TAC for the 2003/2004 season should be based on surveys carried out in October/November 2003 and January/February 2004.

The fishable stock biomass, obtained by multiplying the stock in numbers by the predicted mean weight of maturing capelin in autumn, was projected forward to spawning time in March 2003 assuming a monthly M = 0.035 and a remaining spawning stock of 400 000 t. This resulted in a predicted TAC of 845 000 t spread evenly over August 2003-March 2004 (Table 5.5.1.3). Using the same approach as in previous years*, i.e.* that the preliminary TAC be set at 2/3 of the predicted total for the season, the Working Group recommended that a preliminary TAC for the 2003/04 capelin fishery be set at 555 000 t.

According to the results of the last of the surveys carried out in January-February 2004 (survey results described in section 5.3.2; Tables 5.3.2.1.2 - 5.3.2.1.4), the fishable spawning stock was estimated at $50.7 * 10^9$ fish on 15 February 2004. At that time the observed mean weight in the fishable stock was 18.3 g and the stock biomass was about 925 000 t (Table 5.3.2.1.4). With the usual prerequisites of a monthly natural mortality rate of 0.035 and a remaining spawning stock of 400 000 t, the above abundance estimate indicated that a TAC of 525 000 t was available for the remainder of the 2004 winter fishery. Adding this to the catch already taken from June 2003 – mid-February 2004 gave a total TAC of 875 000 t for the 2003/2004 season. The TAC deviates from that predicted for the 2003/04 season by 40 000 t. This is explained by a 30% larger contribution in numbers of age group 2(3) (year class 2001) on one hand and somewhat lower mean weights than predicted.

About 135 000 t of the TAC remained at the end of the winter fishery. As a result 535 000 t of capelin remained to spawn in 2004 (Table 5.1.1).

5.5.2 Stock prognosis and assessment for the 2004/2005 season

As described in section 5.3.2.2., all attempts to locate and assess immature age 1 and 2 capelin (age 2 and 3 in 2004) were unsuccessful. In fact, only trace amounts were measured where surveys located any of these capelin at all. Therefore, there are no data available to the Working Group for predicting likely fishable/spawning stock size in the 2004/2005 season.

Under these circumstances, the Working Group recommends that a fishery is not opened, unless further surveys in 2004 and/or 2005 reveal large enough numbers and biomass of capelin of the 2001 and 2002 year classes to sustain a fishery and to meet the prerequisite of a remaining spawning stock of 400 000 t in spring 2005.

5.5.3 Management of capelin in the Iceland-East Greenland-Jan Mayen area

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

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

Acoustic survey estimates of juvenile capelin abundance have been used to predict fishable stock abundance in the following year (fishing season). Historical average mean weight at age (in later years a relationship between numerical stock abundance and growth), growth rates and natural mortality have been used for calculations and projections of maturing and fishable stock biomass.

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

The final decision on a TAC for each fishing season has been based on the results of acoustic stock abundance surveys in late autumn or in January/February of the following year during the fishing season.

The procedure just described has worked well in the past for ‘normal’ ranges of stock abundance. However, it is clear that extra care should be taken when dealing with stock abundance below or above the norm, corresponding to TACs lower than 500 000 t or greater than 1 600 000 t.

5.6 Precautionary Approach to Fisheries Management

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

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

5.7 Special Comments

In the last two years great difficulties have been encountered in locating and assessing the juvenile part of the stock (ages 1 and 2; 2 and 3 after 31 December). In this period, the quarterly monitoring of environmental conditions of Icelandic waters, show a rise in sea temperatures north and east of Iceland, which probably also reaches farther north and northwest. The temperature increase is so large that it has probably led to displacements of the juvenile part of the capelin stock. On the basis of experience gained before and during assessment surveys of the 2003/2004 season, these displacements have obviously been so large that juvenile capelin, in particular the 2001 year class, were not available to the autumn 2003 assessment survey as it was carried out. Therefore, while the very low numbers of immature capelin of the 2001 and 2002 year classes hitherto recorded should be taken seriously, they do not necessarily indicate a radical decline of the adult fishable stock in the 2004/2005 season.

An overview of stock developments during 1978–2004 is given in Table 5.7.1.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 2003	15	1200	1465
Survey 2003	15	1377	1320
Fishery 2004	30	3000	2756
Survey 2004	60	6000	5882

Table 5.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season, landings and remaining spawning stock (000 tonnes) in the 1991/92–2003/04 seasons.

Season	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04
Prelim. TAC	0	500	900	950	800	1100	850	950	866	975	1050	1040	835
Rec. TAC	740	900	1250	850	1390	1600	1265	1200	1000	1090	1325	1000	875
Landings	677	788	1179	842	930	1571	1245	1100	934	1065	1249	988	741
Spawn. stock	475	460	460	420	830	430	492	500	650	450	475	410	535

Table 5.2.1 The international capelin catch 1964–2004 (thousand tonnes).

	Winter season					Summer and autumn season						
Year	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	EU	Season total	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2	-	611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1	-	324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2	-	205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0	-	102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0	96.5	78.0	3.5	2.5	18.0	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9							

Table 5.2.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August-December) 1982–2003.

					Year						
Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-	0.6	0.5	0.8	+	+	0.3	1.7	0.8	0.3	1.7
2	-	7.2	9.8	25.6	10.0	27.7	13.6	6.0	5.9	2.7	14.0
3	-	0.8	7.8	15.4	23.3	6.7	5.4	1.5	1.0	0.4	2.1
4	-	-	0.1	0.2	0.5	+	+	+	+	+	+
Total number	-	8.6	18.2	42.0	33.8	34.4	19.3	9.2	7.7	3.4	17.8
Total weight	-	133.4	548.5	919.7	772.9	458.6	371.4	121.0	111.2	56.0	298.1

					Year						
Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.2	0.6	1.5	0.2	1.8	0.9	0.3	0.2	+	+	0.3
2	24.9	15.0	9.7	25.2	33.4	25.1	4.7	12.9	17.6	18.3	12.9
3	5.4	2.8	1.1	12.7	10.2	2.9	0.7	3.3	1.2	2.5	1.1
4	0.2	+	+	0.2	0.4	+	+	0.1	+	+	+
Total number	30.7	18.4	12.3	38.4	45.8	28.9	5.7	16.5	18.8	20.8	14.3
Total weight	611.6	324.1	205.7	773.7	763.6	440.5	102.4	265.1	294.0	339.7	199.5

Table 5.2.3 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January-March) 1983–2004.

					Year						
Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
2	-	2.1	0.4	0.1	+	+	0.1	1.4	0.5	2.7	0.2
3	-	18.1	9.1	9.8	6.9	23.4	22.9	24.8	7.4	29.4	20.1
4	-	3.4	5.4	6.9	15.5	7.2	7.8	9.6	1.5	2.8	2.5
5	-	-	-	0.2	-	0.3	+	0.1	+	+	+
Total number	-	23.6	14.5	17.0	22.4	30.9	30.8	35.9	9.4	34.9	22.8
Total weight	-	439.6	348.5	391.8	560.5	657.2	665.1	686.8	202.4	621.1	489.6

				Year							
Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.6	1.3	0.6	0.9	0.3	0.5	0.3	0.4	0.1	0.1	0.6
3	22.7	17.6	27.4	29.1	20.4	31.2	36.3	27.9	33.1	32.2	24.6
4	3.9	5.9	7.7	11.0	5.4	7.5	5.4	6.7	4.2	1.9	3.0
5	+	+	+	+	+	+	+	+	+	+	+
Total number	27.2	24.8	35.7	41.0	26.1	39.2	42.0	35.0	37.4	34.4	28.2
Total weight	567.1	539.8	723.6	797.6	481.3	658.9	830.3	806.2	955.0	648.0	542.9

Table 5.2.4 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the summer/autumn season of 2003 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
9.5	57	0	0		57	0.4
10	0	0	0		0	0.0
10.5	86	0	0	0	86	0.6
11	0	29	0	0	29	0.2
11.5	57	258	0	0	315	2.2
12	57	315	0	0	372	2.6
12.5	29	1432	0	0	1461	10.2
13	0	2320	0	0	2320	16.2
13.5	0	3322	29	0	3351	23.4
14	0	2578	172	0	2749	19.2
14.5	0	1518	315	0	1833	12.8
15	0	859	229	0	1088	7.6
15.5	0	200	258	0	458	3.2
16	0	86	86	0	172	1.2
16.5	0	0	29	+	29	0.2
Total number	286	12917	1117	+	14320	
Percentage	2.0	90.2	7.8	+	100.0	100.0
Total weight	1.7	176.2	21.6	+	199.5	

Table 5.2.5 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2004 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Percentage
11	67	0	0	0	67	0.2
11.5	55	0	0	0	55	0.2
12	86	34	0	0	120	0.4
12.5	86	302	0	0	387	1.4
13	89	1564	0	0	1652	5.9
13.5	102	2398	0	0	2499	8.9
14	45	3037	23	0	3104	11.0
14.5	11	4143	197	0	4351	15.5
15	11	3779	400	0	4190	14.9
15.5	11	3669	461	0	4141	14.7
16	11	2875	703	11	3601	12.8
16.5	0	1606	539	0	2145	7.6
17	0	792	345	0	1137	4.0
17.5	0	320	258	0	578	2.1
18	0	76	28	0	104	0.4
18.5	0	0	12	0	12	0.0
19	0	0	0	0	0	0.0
19.5	0	0	12	0	12	0.0
Total number	574	24594	2978	11	28157	
Percentage	2.0	87.3	10.6	0.0	100.0	100.0
Total weight	11.2	474.1	57.5	0.2	542.9	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970-2003 and their division by areas.

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

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

	1996	1997	1998	1999	2000	2001	Year 2002	2003
NW-Irminger Sea	2	5	+	NA	NA	NA	NA	NA
W-Iceland	17	14	7	25	1	25	+	17
N-Iceland	57	30	34	51	7	53	4	8
East Iceland	6	12	5	7	4	4	+	1
Total	82	61	46	83	12	82	5	26

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2001.

	1983	1984	1985	1986	1987	1988	Year 1989	1990	1991	1992	1993	1994	1995	1996
Number (10^9)	155	286	31	71	101	147	111	36	50	87	33	85	189	138
Mean length (cm)	10.4	9.7	10.2	9.5	9.1	8.8	10.1	10.4	10.7	9.7	9.4	9.0	9.8	9.3
Mean weight (g)	4.2	3.6	3.8	3.3	3.0	2.6	3.4	4.0	5.1	3.4	3.0	2.8	3.4	2.9

	1997	1998	1999	2000	2001	2002	Year 2003
Number (10^9)	143	87	55	94	99	No survey	
Mean length (cm)	9.3	9.0	9.5	9.5	10.0		
Mean weight (g)	2.8	2.9	3.2	3.1	3.7		

Table 5.3.2.1.1 Acoustic abundance estimate of immature capelin, 6-21 November 2003

Length (cm)	NUMBERS (10^{-6}) (Age) Year class (1) 2002	(2) 2001	(3) 2000	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (1) 2002	(2) 2001	(3) 2000	Total
9	200	0	0	200	3.1	0.6	0.0	0.0	0.6
9.5	200	0	0	200	3.6	0.7	0.0	0.0	0.7
10	200	0	0	200	4.2	0.8	0.0	0.0	0.8
10.5	200	0	0	200	9.0	1.8	0.0	0.0	1.8
11	600	0	0	600	5.3	3.2	0.0	0.0	3.2
11.5	1200	0	0	1200	6.2	7.4	0.0	0.0	7.4
12	700	100	0	800	7.2	5.0	0.7	0.0	5.8
12.5	700	100	0	800	8.2	5.7	0.8	0.0	6.6
13	300	200	0	600	9.3	2.8	1.9	0.0	4.7
13.5	200	300	0	400	10.7	2.1	3.2	0.0	5.4
14	0	400	0	500	12.5	0.0	5.0	0.0	5.0
14.5	100	400	0	500	13.9	1.4	5.6	0.0	7.0
15	0	600	0	600	16.0	0.0	9.6	0.0	9.6
15.5	0	400	0	500	17.8	0.0	7.1	0.0	7.1
16	0	200	0	300	20.5	0.0	4.1	0.0	4.1
16.5	0	200	100	200	23.0	0.0	4.6	2.3	6.9
17	0	0	0	0	25.4	0.0	0.0	0.0	0.0
17.5	0	0	0	0	27.6	0.0	0.0	0.0	0.0
18	0	0	0	0	32.0	0.0	0.0	0.0	0.0
Total	4600	3100	100	7800		31.7	42.6	2.3	76.6
Average length						11.3	15.7	16.7	15.7
Average weight						6.9	17.7	22.3	17.9

Table 5.3.2.1.2 Acoustic abundance estimate of mature capelin, 3-12 January, 2004

Length (cm)	NUMBERS (10^{-6}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total
12	1	0	0	1	6.2	0.0	0.0	0.0	0.0
12.5	10	0	0	10	7.4	0.1	0.0	0.0	0.1
13	10	0	0	10	8.3	0.1	0.0	0.0	0.1
13.5	10	200	0	210	9.6	0.1	1.9	0.0	2.0
14	10	500	0	510	11.0	0.1	5.5	0.0	5.6
14.5	0	800	0	800	12.5	0.0	10.0	0.0	10.0
15	0	1200	0	1200	14.8	0.0	17.8	0.0	17.8
15.5	0	1200	0	1200	16.6	0.0	19.9	0.0	19.9
16	0	1000	100	1100	19.0	0.0	19.0	1.9	20.9
16.5	0	800	105	905	21.8	0.0	17.4	2.2	19.6
17	0	600	100	700	24.5	0.0	14.7	2.5	17.2
17.5	0	300	50	350	27.4	0.0	8.2	1.4	9.6
18	0	100	10	110	29.1	0.0	2.9	0.3	3.2
18.5	0	0	30	30	32.7	0.0	0.0	1.0	1.0
19	0	0	5	5	33.8	0.0	0.0	0.2	0.2
Total	41	6700	400	7141		0.4	117.4	9.3	127.1
Average length						13.2	15.6	16.8	15.6
Average weight						9.4	17.6	23.6	17.8

Table 5.3.2.1.3 Acoustic abundance estimate of mature capelin, 18-30 January, 2004

Length (cm)	NUMBERS (10^{-6}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total
12.5	1	0	0	1	6.9	0.1	0.0	0.0	0.1
13	50	200	0	200	8.3	0.2	1.7	0.0	1.9
13.5	200	700	0	900	10.0	2.0	7.0	0.0	9.0
14	100	2200	100	2400	11.1	1.1	24.4	1.1	26.6
14.5	30	4100	0	4200	12.7	0.4	52.1	0.0	52.5
15	0	4400	100	4500	14.3	0.0	62.9	1.4	64.4
15.5	0	5400	200	5600	16.2	0.0	87.5	3.2	90.7
16	0	5700	200	5900	18.6	0.0	106.0	3.7	109.7
16.5	0	4700	300	5000	20.9	0.0	98.2	6.3	104.5
17	0	4900	200	5200	23.6	0.0	115.6	4.7	120.4
17.5	0	3700	700	4400	26.5	0.0	98.1	18.6	116.6
18	0	1800	400	2100	29.2	0.0	52.6	11.7	64.2
18.5	0	500	100	600	31.6	0.0	15.8	3.2	19.0
19	0	0	5	5	30.6	0.0	0.0	0.2	0.2
Total	381	38300	2305	41006		3.8	721.9	54.0	779.7
Average length						13.8	15.9	16.9	16.0
Average weight						10.7	18.9	23.5	19.0

Table 5.3.2.1.4 Acoustic abundance estimate of mature capelin, 10-18 February, 2004

Length (cm)	NUMBERS (10^{-6}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total	Avg wt (g)	BIOMASS (10^{-9}) (Age) Year class (2) 2002	(3) 2001	(4) 2000	Total
12	367	0	0	367	6.9	2.5	0.0	0.0	2.5
12.5	226	84	0	310	8.8	2.0	0.8	0.0	2.7
13	536	591	0	1126	9.9	5.3	5.8	0.0	11.1
13.5	734	2280	0	3015	11.1	8.1	25.3	0.0	33.5
14	1070	3803	28	4902	12.8	13.7	48.8	0.4	62.9
14.5	592	5435	84	6110	14.5	8.7	79.0	1.2	88.8
15	311	7605	480	8394	16.7	5.2	127.0	8.0	140.2
15.5	170	7717	816	8701	18.7	3.2	144.5	15.3	162.9
16	84	6590	872	7548	21.1	1.8	139.4	18.4	159.6
16.5	0	4226	620	4847	24.1	0.0	101.8	15.0	116.7
17	0	2534	986	3520	26.2	0.0	66.2	26.0	92.2
17.5	0	704	479	1183	29.2	0.0	20.3	14.1	34.5
18	0	84	282	367	33.3	0.0	2.8	9.4	12.2
18.5	0	84	84	198	34.1	0.0	2.8	2.8	6.8
Total	4198	41739	4732	50698		50.6	764.5	110.6	926.8
Average length						14.2	15.3	16.3	15.2
Average weight						13.8	18.3	23.3	18.3

Table 5.4.1 The estimated number (billions) of capelin on 1 August 1978–2003 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components are also given.

	Year									
Age/maturity	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1 juvenile	163.8	60.3	66.1	48.9	146.4	124.2	250.5	98.9	156.2	144.0
2 immature	15.3	16.4	4.2	3.7	15.0	42.5	40.9	100.0	29.4	37.2
2 mature	81.9	91.3	35.4	39.7	17.1	53.7	40.7	64.6	35.6	65.4
3 mature	29.1	10.1	10.8	2.8	2.3	9.8	27.9	27.0	65.8	20.1
4 mature	0.4	0.3	+	+	+	0.1	0.4	0.4	0.7	0.1
Number immat.	179.2	76.7	70.3	52.6	161.4	166.7	291.4	198.9	185.6	181.2
Number mature	111.4	101.7	46.2	42.5	19.4	63.6	69.0	92.0	102.1	85.6
Weight immat	751	366	283	209	683	985	1067	1168	876	950
Weight mature	2081	1769	847	829	355	1085	1340	1643	2260	1689

	Year									
Age/maturity	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 juvenile	80.8	63.9	117.5	132.9	162.9	144.3	224.1	197.3	191.2	165.4
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	45.1	28.7	35.2
2 mature	70.3	42.8	31.9	67.7	70.7	86.9	59.8	102.2	100.7	90.3
3 mature	24.5	15.8	6.8	6.7	6.4	10.9	13.2	23.0	29.6	19.0
4 mature	0.4	+	+	+	+	0.2	-	+	+	+
Number immat.	104.8	74.2	127.6	142.6	179.5	164.7	259.2	242.4	219.9	200.6
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	125.1	130.3	109.3
Weight immat	438	309	542	702	747	702	1019	1188	985	758
Weight mature	1663	1173	751	1273	1311	1585	1268	1819	1900	1590

	Year						
Age/maturity	1998	1999	2000	2001	2002	2003	2004
1 juvenile	167.9	138.0	145.6	139.7	165.9*	NA	
2 immature	19.2	24.4	25.0	9.0	23.9	26.9**	
2 mature	89.5	85.9	65.7	86.7	68.0	82.1	NA
3 mature	23.2	12.6	16.0	16.9	5.9	15.7	17.7**
4 mature	+	+					
Number immat.	187.1	162.4	170.6	148.7	189.8*	26.9***	
Number mature	112.7	98.5	81.7	103.6	73.9	97.8	17.7***
Weight immat	621	612	645	615	877*	415***	
Weight mature	1576	1703	1519	1817	1280	1544	410***

* Preliminary

** Predicted

NA: Not available

Table 5.4.2 The estimated number (billions) of capelin on 1 January 1979–2004 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

	Year									
Age/maturity	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2 juvenile	137.6	50.6	55.3	41.2	123.7	105.0	211.6	83.2	131.9	120.5
3 immature	12.8	13.8	3.5	3.0	12.6	35.7	34.3	83.9	25.6	31.2
3 mature	51.8	53.4	16.3	8.0	14.3	39.8	25.2	34.5	22.1	34.1
4 mature	14.8	3.6	4.9	0.5	2.0	7.6	15.6	10.5	37.0	11.7
5 mature	0.3	0.2	+	+	+	0.1	0.3	0.2	0.2	+
Number immat.	150.4	64.4	58.8	44.2	136.3	140.7	245.9	167.1	157.5	151.3
Number mature	66.9	57.2	21.2	8.5	16.3	47.5	41.1	45.2	59.1	45.8
Weight immat.	1028	502	527	292	685	984	1467	1414	1003	1083
Weight mature	1358	980	471	171	315	966	913	1059	1355	993
Number sp.st.	29.0	17.5	7.7	6.8	13.5	21.6	20.7	19.6	18.3	18.5
Weight sp. st	600	300	170	140	260	440	460	460	420	400

	Year									
Age/maturity	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	188.1	165.2	160.0	138.8
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	24.1	29.5
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4	50.1
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8	7.9
5 mature	0.3	+	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	217.6	203.1	184.1	168.3
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2	58.0
Weight immat.	434	291	501	487	622	573	925	800	672	621
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881	1106
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8	27.6
Weight sp. st.	440	115	330	475	499	460	420	830	430	492

	Year					
Age/maturity	1999	2000	2001	2002	2003	2004
2 juvenile	140.9	115.8	122.2	117.3	139.2*	NA
3 immature	16.1	20.5	21.0	7.6	20.1	22.6*
3 mature	53.2	68.2	46.3	59.3	58.4	54.2
4 mature	16.0	10.0	10.5	10.5	2.9	6.2
5 mature	+	+	+	+	+	+
Number immat.	157.0	136.3	143.2	124.9	159.3*	22.6**
Number mature	69.3	78.2	56.8	69.8	61.3	60.4
Weight immat.	585	535	655	510	750*	315**
Weight mature	1171	1485	1197	1445	1214	1204
Number sp.st.	29.5	34.2	21.3	22.9	20.7	28.2
Weight sp. st.	500	650	450	475	410	535

*Preliminary/Predicted
**Year class 2001 only
NA: Not available

Table 5.5.1.1 Data used in the comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for the calculation of preliminary TACs.

Year class	Age 1 Acoustics N_1	Age 2 Back-calc. Mature N_{2mat}	Age 2 Acoustics Immature N_{2imm}	Age 2 Back-calc. Total N_{2tot}	Age 3 Back-calc. Mature N_{3tot}
1980	23.7	17.1	1.7	32.1	9.8
1981	68.0	53.7	8.2	96.2	27.9
1982	44.1	40.7	4.6	81.6	27.0
1983	73.8	64.6	12.6	164.6	65.8
1984	33.8	35.6	1.4	65.0	20.1
1985	58.0	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.6	15.8
1987	43.9	42.8	1.8	53.1	6.8
1988	29.2	31.9	1.3	42.0	6.7
1989	*39.2	67.7	5.2	77.2	6.4
1990	60.0	70.7	2.3	87.3	10.9
1991	104.6	86.9	10.8	107.0	13.2
1992	100.4	59.8	6.9	95.0	24.0
1993	119.0	102.2	46.3	147.2	29.6
1994	165.0	100.7	16.4	129.4	19.0
1995	111.9	90.3	30.8	125.5	23.2
1996	128.5	89.5	6.3	108.7	12.6
1997	121.0	85.9	5.0	110.3	16.0
1998	89.8	65.7	11.0	84.1	16.9
1999	103.0	86.7	2.4	95.8	5.9
2000	100.3	68.0	3.7	89.8	15.7
2001	***74.4	82.1	5.0	**87.1	
2002	NA				

* Invalid due to ice conditions.
** Preliminary
*** Projected from assessment in April 2003
NA: Not available

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

	Years							
	1981	1982	1983	1984	1985	1986	1987	1988
Age 2	19.2	16.5	16.1	15.8	15.5	18.1	17.9	15.5
Age 3	24.0	24.1	22.5	25.7	23.8	24.1	25.8	23.4
	1989	1990	1991	1992	1993	1994	1995	1996
Age 2	18.0	18.1	16.3	16.5	16.2	16.0	15.3	15.8
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	20.6
	1997	1998	1999	2000	2001	2002	2003	
Age 2	14.3	14.1	16.8	17.1	16.3	No data	No data	
Age 3	20.3	18.1	20.6	24.7	23.9	No data	No data	

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1986/87–2003/04 seasons.
The last row gives contemporary advice on TACs for comparison.
Age 2 and age 3 = Numbers in billions in age groups at the beginning of season.
Fishable stock = calculated weight of maturing capelin in thousand tonnes (ref. August).
TAC calc = predicted in thousand tonnes.

Season	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95
Year classes	84-83	85-84	86-85	87-86	88-87	89-88	90-89	91-90	92-91
Age 2	34.9	55.5	64.8	43.2	31.1	39.4	56.4	93.1	89.6
Age 3	55.0	13.7	29.0	25.5	8.2	3.7	18.3	22.6	27.0
Fishable stock	1926	1268	1800	1350	724	755	1398	2123	2170
Calculated TAC	1215	642	1105	713	170	197	755	1385	1427
Advised TAC	1333	1115	1036	550	265	740	*900	1250	850

Season	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04
Year classes	93-92	94-93	95-94	96-95	97/96	98 /97	99/98	00/99	01/02
Age 2	92.5	90.0	83.8	94.4	89.2	70.9	77.1	77.2	63.0
Age 3	14.9	35.0	30.9	30.8	23.3	19.2	16.9	17.3	15.6
Fishable stock	1916	2352	2019	2088	1885	1584	1620	1642	1424
Calculated TAC	1200	1635	1265	1420	1285	975	1050	1040	835
Advised TAC	1390	1600	1265	1200	1000	**1090	1350	1005	875

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

** In March 2001, 100 000 t were added to the 990 000 t recommended after the January/February 2001 survey due to much higher mean weights in the catch during 1 February-10 March than measured during the survey.

Table 5.7.1 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2004. Recruitment of 1 year old fish (unit 10^9) and total stock biomass ('000 t) are given for 1 August Spawning stock biomass ('000 t) is given at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated and ending in March of the following year.

Year	Recruitment	Total Stock biomass	Landings	Spawning stock biomass
1978	164	2832	1195	600
1979	60	2135	980	300
1980	66	1130	684	170
1981	49	1038	626	140
1982	146	1020	0	260
1983	124	2070	573	440
1984	251	2427	897	460
1985	99	2811	1312	460
1986	156	3106	1333	420
1987	144	2639	1116	400
1988	81	2101	1037	440
1989	64	1482	808	115
1990	118	1293	314	330
1991	133	1975	677	475
1992	163	2058	788	499
1993	144	2287	1179	460
1994	224	2287	864	420
1995	197	3007	929	830
1996	191	2885	1571	430
1997	165	2348	1245	492
1998	168	2197	1100	500
1999	138	2315	933	650
2000	146	2164	1071	450
2001	140	2432	1249	475
2002	*165.9	*2157	988	410
2003	NA	**1544	741	535

*Preliminary
** Adults only
NA: Not available

Figure 5.5.2.1. The relationship between the measured numbers of immature 1-group capelin in autumn acoustic surveys and the numbers of maturing capelin in 1 August of the following year (left hand figure) and between measuredtotal numbers of 2-group capelin and the maturing 3-group capelin in the following year (right hand figure).

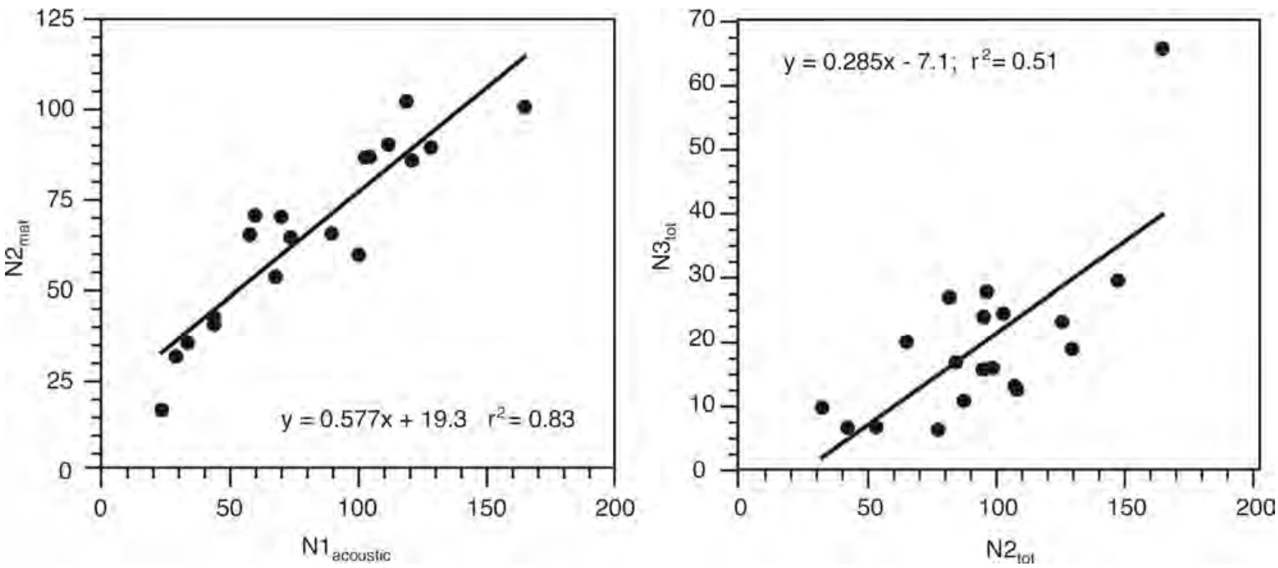
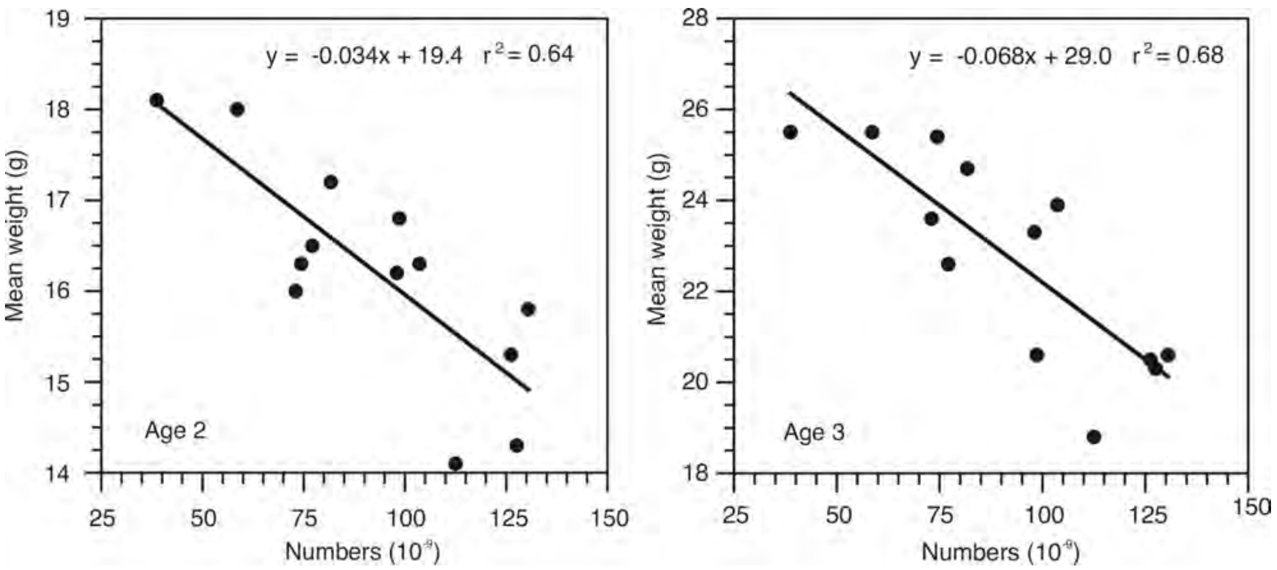


Figure 5.5.2.2. The relationship between the total numbers in the maturing stock and the mean weight of maturing 2-group (left hand figure) and 3-group (right hand figure) in autumn 1989ö2001.



6 BLUE WHITING

6.1 Stock Identity and Stock Separation

Blue whiting is a pelagic gadoid which is widely distributed in the eastern North Atlantic. The highest concentrations are found along the ridge of the continental shelf in areas II, V, VI 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. 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; Heino *et al*. 2003). 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.

6.1.1 ACFM advice and management applicable to 2003 and 2004

In 1998 ACFM 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 ACFM in following years has been given within a framework defined by these reference points.

In 2002 ACFM stated that "the stock is harvested outside safe biological limits. The spawning stock biomass for 2001 at the spawning time (April) is inside safe biological limits while the SSB for 2002 is expected to be below $\mathbf{B}_{pa}$. Fishing mortality has increased rapidly in recent years, and is estimated at 0.82 in 2001. Total landings in 2001 were almost 1.8 million t. The incoming year classes seem to be strong. ICES recommends that the fishing mortality be less than $\mathbf{F}_{pa}$=0.32, corresponding to landings of less than 600 000 t in 2003. Implementation of a rebuilding plan is not necessary since according to the current assessment the state of the stock is better than previously estimated".

In 2003 ACFM stated that "the current estimates of SSB and fishing mortality are uncertain. Nevertheless, the spawning stock biomass in 2003 is likely to be above $\mathbf{B}_{pa}$. Therefore, based on the most recent estimates of fishing mortality and SSB, ICES classifies the stock as likely to be harvested outside safe biological limits ($F>\mathbf{F}_{lim}$). Total landings in 2002 were almost 1.6 million t. The incoming year classes seem to be strong. ICES recommends 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 will also assure a high probability that the spawning stock biomass in 2005 will be above $\mathbf{B}_{pa}$".

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.*

The agreed management plan was, however, not implemented. Although the Coastal States and Russia were able to agree on this management plan for blue whiting in 2002, in the same vein as earlier agreements on mackerel and herring, it has not been possible to reach an agreement on the allocation of blue whiting and this has been a major outstanding issue for NEAFC in recent years. All parties want as large a percentage as possible and the dispute about percentages has dragged on. In the absence of agreements on a TAC for 2002 and 2003 and the allocation of the TAC, the Coastal States and the Russian Federation implemented unilateral measures to limit blue whiting catches for these years. TAC's have been set by EU and Iceland only. During the year 2003, the EU increased its TAC for international waters with 250 000 t. During 2004 the year 2004 it increased its total TAC with 350 000 t applicable to all areas. The fisheries by Norway, Russia and Far Oer are not restricted by TACs.

6.2 Fisheries in 2003

Total catches figures in 2003 were provided by members of the WG. They were estimated to be 2.3 million t compared to 1.6 million t last year. Time series with catches by nations and area are given in Tables 6.2.1-6.2-7.

Spatial and temporal distribution of the catches of blue whiting in 2003 is given by quarter and ICES rectangles in Figure 6.2.1. The distribution of the catch by ICES rectangles for the whole year is given in Figure 6.2.2. In 2003 the catch provided as catch by rectangle represented approximately 99.9% of the total WG catch.

6.2.1 Description of the national fisheries

Denmark:

The Danish directed fishery blue whiting fishery is mainly conducted by trawlers using a minimum mesh size of 40mm. Blue whiting is also taken as by-catch using trawl with mesh sizes between 16 and 36 mm for Norway pout. This fishery is minor. The directed fishery caught 74,400 t mainly in Divisions IIa, IVa, Vb1 and VIa with small catches from Divisions IIIa and XII. By-catches of blue whiting (8,500 t) are caught mainly in the Norway pout fishery in the North Sea and in the Skagerrak. Some blue whiting by-catches are also taken during the human consumption herring fishery in the Skagerrak.

Germany:

The main German fleet fishing for pelagic species is based in Bremerhaven and Rostock. It consists of 4 large pelagic freezer trawlers with overall lengths of 70 m, 95 m, 117 m and 124 m ; engine power 3700 hp, 4400 hp, 8300 hp and 8600 hp and 25 – 40 crew members. The vessels are owned and managed by Dutch companies but operating under German flag.

They are specially designed for pelagic fisheries: The catch is pumped into large refrigerated seawater tanks to keep the catch fresh until further processing, which is usually block freezing. The freezing capacity of the 4 vessels ranges between 60,000 and 230,000 cartons (up to 5,500 t fish).

The German Blue Whiting fishery is conducted in the first and second quarter. The fishery starts in Divisions VIIb, c and XII in March and continues through Divisions VIa and b in April to divisions Vb1 and 2 in May. Occasionally there is a minor blue whiting by-catch in the directed herring fishery in Div. IIa and b in quarter 3. Very little discards have been reported by observers from the mackerel and horse mackerel fishery in the 4th quarter in area VII.

Faroe Islands:

In January the fishery (9 combined purse seiners/trawlers) concentrated on the southern part of the Faroese EEZ (ICES Division Vb). In February the fishery had moved south to the Porcupine area west of Ireland (Division VIIc,k and VIb) in the EU zone. Later in February and March the fishery continued in international waters Div. VIb, VIIc,k and XII outside the EU zone with a few catches in the EU zone. In early April the fishery continued in international waters (VIb), however, most catches were taken in the northern part of VIb (EU zone) and in the southern part of the Faroe zone (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 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 July and August, also including Division Vb. The fishery continued on the Faroe-Iceland ridge in September and October, gradually moving closer towards the Faroe Islands, and in November till the end of 2003 the catches were exclusively taken in Faroese waters (IIa and Vb). More than 90% of the catches were taken with pelagic trawl (44 mm # in cod end).

In August some blue whiting was caught as by-catch in the herring fishery in the Svalbard zone. The industrial fleet (3 trawlers) operated mainly in Norwegian waters (ICES Division IVa) in 2003 with catches of blue whiting scattered throughout the year.

France:

No information available.

Iceland:

Iceland and Faroes have a bilateral agreement of mutual fishing rights for blue whiting in each other's EEZs. Iceland set a total blue whiting catch quota of 547 000 tonnes in 2003 for the Icelandic- Faroese EEZs and international waters

The Icelandic directed fishery for Blue whiting started on 11 March in International waters west of the British Isles (ICES Divisions XII, VIb) and about the same time in Icelandic waters with small catches at SE-Iceland. In April the main fishery had moved further north and was largely conducted in Faroese waters SW of the Faroes but with some small catches in International waters west of the British Isles and in Icelandic waters.

In early May the fishery was mainly conducted in the Faroese zone but shifted gradually into the Icelandic zone in the latter half of May. In June, July and August most of the Icelandic Blue whiting catch was fished in the Icelandic area but in September the fishery moved increasingly into the Faeroese zone. In October there was again an increase in catches in the Icelandic area with more than half the catch taken there. In November and December most of the fishery took place in the Faroese zone. The total Icelandic catch was 501 494 tonnes.

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

A total of 21 purse-seiners/trawlers participated in the Icelandic fishery. 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). The total average catch/hour for individual vessels was in the range of 6.9-36.3 tonnes with an average of 17.6 tonnes for the whole fleet.

Ireland:

There have been Irish fisheries for blue whiting since the late 1980's, when larger recirculated sea water (RSW) vessels carried out exploratory voyages. However the current Irish fishery for blue whiting developed in response to restrictive quotas for mackerel and herring in the 1990's. Catches peaked in 1998, when approximately 46,000 t were landed by 7 vessels. These vessels are the larger Irish RSW and freezer trawlers, in excess of 60m length. In 2003, the total Irish catch was 22,580 t, landed by 6 vessels. In 2003, the EU TAC for Sub-areas V, VI, VII, XII and XII was 107,281 t, with an Irish quota share of 17,165 t. However additional allocations of quota were made to Ireland in 2003.

Fishing takes place from March to May between the Porcupine (VIIbcjk) and Rockall Banks (VIb) using large single trawls that have been specially modified to take bulk catches from deep water. Maximum circumference of the gear is 1,700 m with a mesh-size in the cod-end liner of 35 to 40 m. The Irish fishery is dominated by landings for fish meal, but there is some activity by freezer trawlers, for human consumption.

Netherlands:

The Dutch fleet fishing for pelagic species (herring, blue whiting, mackerel, horse mackerel, argentines) consists of 16 freezer trawlers and pair trawlers. The fishery directed towards blue whiting takes place during the 1st half of the year, mainly in ICES Division Vb, VIa,b and VIIb,c. Total catches in 2003 were 48 000 t and are landed frozen for human consumption. There is a seasonal fishery in May-June directed towards NSSH in international waters (ICES Sub-area II) during which they also catch some blue whiting.

Norway:

Norway set a blue whiting quota of 250 000 t for the directed fisheries in the Norwegian EEZ, Jan Mayen zone and international waters for 2003. In addition, through international agreements, 120 000 t in the EEZ of EU and 36 200 t in the Faroese zone were made available to the Norwegian fleet. A separate quota of 80 000 t was given to the mixed industrial fishery in the Norwegian EEZ in the North and Norwegian Seas south of 64ºN. The total quota for Norwegian vessels in 2003 was 486 200 t.

The main Norwegian fishery is a directed pelagic trawl fishery, regulated by vessel quotas, and is carried out on and west of the spawning areas west of the British Isles. A total of 46 large combined purse seiners/trawlers took part in the fishery in 2003.

In 2003, 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 season. The fishery in EEZ of EU was stopped 30 April and that in the Faroese zone 2 May after the quotas in the respective zones were taken. In contrast to the usual pattern, a directed fishery continued in the Norwegian EEZ where significant proportions of young blue whiting, particularly of age 1 years, occurred in the catches. The fishery in the Norwegian EEZ, Jan Mayen zone and international waters was stopped on 30 June. At this point, the quota was exceeded by 115%. The total catch in the directed fishery was about 703 000 t, which is a new record.

Blue whiting were also fished in the North Sea and in the southern Norwegian Sea (areas south of 64ºN) in the mixed industrial fishery targeting blue whiting and Norway pout. The quota regulation was not put in effect, and an estimated catch of approximately 131 000 t was taken in this fishery in 2003; this a new record.

North of 64ºN in area IIa, small amounts (about 1336 t) of blue whiting were caught as by-catch and landed by vessels targeting argentines along the shelf edge. These catches are included in the numbers for the mixed industrial fishery.

Portugal:

In 2003 Portuguese landings of blue whiting amounted to 2 652 tonnes. Most of the catch was taken by a trawl fishery (87%) The rest was taken by artisanal (13%) and purse seine (0.2%) fisheries. About 68% of the blue whiting was landed by trawlers in two main harbours, Portimão, on the southern coast and Matosinhos on the northern coast. The rest of the landings took place in other 15 harbours.

Russia:

At the beginning of the year 10-15 fishing vessels operated in the blue whiting fishery in the south of the Norwegian Sea. From 8 February fishery to the southwest of Rockall started. At the beginning of March 9 vessels operated there, and in the end of that month their number increased to 14. Spawning blue whiting was distributed at depth between 450 and 600 m. In the first half of April the catch rates were declining with fish migrating to the northeast. By mid-April the fishery at Rockall practically finished. It started there 2 weeks earlier and finished one week later than in 2002. The vessels moved to the southern part of the Norwegian Sea. Catch rates there were increasing until about mid-April, when they declined slightly, however, remained fairly good for directed fishery until mid-June. The first trawlers came to the central part of the Norwegian Sea at the beginning of May, and their number was growing with increasing catch rates. However, already in July no more than 5 fishing vessels were operating there targeting blue whiting. The scale of this fishery increased again in the end of October, when up to 30 vessels engaged in the fishery in the north of the Norwegian Sea. The fish remained there longer than in 2002, when as early as in the middle of the month it began to follow the southward migrations of the fish. In 2003 more westerly migration pattern was observed, which forced the vessels to stop fishery in mid-November. Some of these vessels moved to fishing blue whiting in the southern part of the sea.

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 (42 t) were also caught by longliners. 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 12 550 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 (1 233 t).

The decrease in the Spanish landings is 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.

Sweden:

The fishery for blue whiting did expand substantially during 2003. It is pursued by pelagic trawlers (both single and pair-trawlers). Almost 80% is landed in Norway, the rest is landed in Denmark, Iceland, Faroes, United Kingdom and Sweden. Nearly all the catch is taken in the 3rd quarter.

UK (Scotland):

The Scottish directed fishery for blue whiting takes place during the first and second quarters of each year. Approximately one third of the pelagic fleet participates in this fishery which is pursued mainly in ICES areas VI and VII. The vessels operating in this fishery are large pelagic trawlers using industrial fishing gear. Generally the catch is landed for fish meal, into factories in Shetland, Faroes, Ireland and Denmark and is worth around £2 million to the Scottish fleet. A summary of the fleet structure is given in Tables 3.1.3.1 and 6.2.8.

6.3 Biological Characteristics

6.3.1 Length composition of Catches

Data on the combined length composition of the 2003 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 Denmark, the Faroes, Iceland, Ireland, the Netherlands, Norway and Russia. Length composition of blue whiting varied from 12 to 44 cm, with 67% of fish ranging from 23–28 cm in length and 98% from 18-33 cm. The mean length in this fishery was 25.1 cm (Table 6.3.1.1). Length compositions of the blue whiting catch and by-catch from “other fisheries” in the Norwegian Sea (south of 64ºN), the North Sea and Skagerrak were presented by Norway, Denmark and Sweden (Table 6.3.1.2). The catches of blue whiting from the mixed industrial fisheries consisted of fish with lengths of 12–37 cm and a mean of 21.2 cm. Spain and Portugal caught blue whiting in the Southern area. The Spanish data used for length distribution of catches showed a length range from 11 - 40 cm with a mean length of 21.1 cm (Table 6.3.1.3).

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 2003, age compositions were provided by Denmark, the Faroe Islands, Germany, Iceland, Ireland, Norway, the Netherlands 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 6.3.2.1.

Age compositions for blue whiting by-catches from “other fisheries” in the North Sea and Skagerrak were provided by Norway and sampled catch accounted for 82% 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 6.3.2.2.

For the fisheries in the Southern area, age compositions representing 100% of the catch were presented by Spain and Portugal. The age compositions in the southern fishery are given in Table 6.3.2.3.

The combined age composition for the directed fisheries in the Northern area, i.e. the spawning area and the Norwegian Sea, as well as for the 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 6.3.2.4. The 2000 year class was the most numerous in the catches, followed by the 1999, 2001 and 2002 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). The allocations are shown in the Annex II.

6.3.3 Weight-at-age

Mean weight-at-age data were available from Denmark, the Faroes, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Russia, 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 6.3.3.1 shows the mean weight-at-age for the total catch during 1981 - 2003 used in the stock assessment. The weight-at-age for the stock was assumed to be the same as the weight-at-age for the catch.

6.3.4 Maturity-at-age

Maturity-at-age used in the assessment was obtained by combining maturity ogives from the southern and northern areas, weighted by catch in numbers-at-age (ICES 1995/Assess:7). These are the same as those used since 1994 (Table 6.3.4.1). Although the values of maturity-at-age probably are too low, sufficient information for estimating new ogives is not available.

6.3.5 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*.

6.4 Stock estimates

6.4.1 Acoustic surveys

The time series from the acoustic surveys used in the analytic assessment are given in Tables 6.4.1.1-6.4.1.3.

6.4.1.1 Surveys in the spawning season

An international blue whiting spawning stock survey was carried out on the spawning grounds west of the British Isles in March-April 2004 (Heino et al., WD a). Four vessels participated in the survey: "Celtic Explorer", "Fridtjof Nansen", "Johan Hjort" and "Tridens". This is the first international survey with such a broad international participation, which allowed for broad spatial coverage as well as a relatively dense net of trawl and hydrographical stations.

The highest abundances of blue whiting were observed along the shelf edge from the northern Porcupine bank to the Hebrides, south/southwest of the Faroe Plateau and the adjacent banks, and west of Rockall. Limits of the oceanic distribution were found in south and southwest. The distribution of acoustic backscattering densities for blue whiting as recorded by the four vessels are shown in Figure 6.4.1.1.1.

The blue whiting spawning stock estimate based on the international survey is 10.6 million tonnes and 119 x 10^9 individuals. An age-disaggregated total stock estimate is presented in Table 6.4.1.1.1, showing that the stock was dominated by blue whiting of 4 years in age (year class 2000). Age class 3 years was also abundant, followed by age classes 2 and 5 years (Figure 6.4.1.1.2). Blue whiting of ages 3-5 years made up 78% of spawning stock biomass. There was some variability in the age structure between different areas with the highest mean age observed in the Hebrides area.

Results from the individual vessels are reported in more detail in respective survey reports (O'Donnell et al., WD; Heino et al., WD b). Of these the Norwegian one is used in tuning the assessment. For this reason, it was decided to keep the spatial coverage of this survey similar to earlier years although a more systematic survey design was adopted (ICES 2003/D:10). As shown in the text table below, the results from this survey are very much in agreement with those from the international survey: the spawning stock is estimated to amount to 10.9 million tonnes and 128 x 10^9 individuals; this is in accordance with a slightly smaller average size recorded in the Norwegian in comparison to the international survey. There is also a slight difference in age distribution in favour of younger fish in the Norwegian survey.

Survey	Abundance, 10^9 individuals		Biomass, mill. tonnes		Mean weight,	Mean length,
	total	spawning	total	spawning	g	cm
International (incl. Norway)	130	119	11.1	10.6	85.5	26.4
Norwegian	137	128	11.4	10.9	83.2	26.1

In comparison to earlier years, both total and spawning stock biomass estimates are similar to those obtained in 2002 and 2003. The stock in 2004 is, however, composed of fewer and larger fish than in 2002 and 2003. To a large extent this reflects the ageing of year class 2000 that has numerically dominated the total stock estimate since 2002. In fact, this year class has broken the earlier record numbers each year in 2002-2004.

An age-stratified stock estimate from the Norwegian survey is given in Table 6.4.1.1.2. This shows the dominance of blue whiting of age 4 years, but that also age group 3 years is relatively abundant. In comparison to earlier years, absolute numbers of blue whiting of age 2 and 3 years are lower than estimated in 2002 and 2003, but those of age 5 years are more abundant. Age and length distributions are displayed in Figure 6.4.1.1.4.

Estimates of total and spawning biomass of blue whiting in the spawning area based on Russian and Norwegian surveys since 1983, together with the one from the international survey in 2004, are given in Table 6.4.1.1.3. Usually, acoustic estimates have been well above the analytical assessments. Therefore the acoustic estimates have been used only as relative indices. A factor contributing to the high acoustic estimates is the acoustic target strength that is probably too low.

6.4.1.2 Surveys in the feeding area

Since 1995, Norway, Russia, Iceland, and Faroes, and in the period 1997-2000 the EU, have coordinated their survey efforts on pelagic fish stocks in the Norwegian Sea. In 2003 these were coordinated through PGSPFN, and a detailed description of the results can be found in the corresponding report (ICES 2003/D:10). Here the three surveys where blue whiting were among the focal species are briefly reviewed.

An international acoustic survey, with one vessel from the Faroes, Iceland and Norway each, covered most of the temperate parts of the Norwegian Sea in May-June 2004. This survey covers post-spawning adult blue whiting in the south-western part of the survey area as well as juvenile and adult fish in the Norwegian Sea. Total stock estimate from the survey was almost twice as high as in the previous year (see the text table below). However, this increase was largely due to more extensive coverage in the south-western parts of the survey area. Results from comparable surveys from 2000 onwards are presented in Table 6.4.1.2.1; these are calculated for the area north of 63°N and east of 8°W that has had good annual coverage during all these years (see Heino et al., WD c,d). The time series shows a relatively low total stock biomass in the survey area in 2000, and much higher and relatively stable biomass in 2001-2003. In 2003 year classes 2000 and 2002 were most numerous. The stock biomass was dominated by year class 2000.

Iceland has carried out an acoustic survey in summer in the Icelandic EEZ since 1998; age-disaggregated results are available from 1999 onwards (Table 6.4.1.2.2). The survey in 2003 gave stock estimate that was well above the one from the previous year (see the text table below). However, the survey in 2003 had a wider coverage than those before. This reflects wider distribution of blue whiting in the Icelandic waters, and it could be argued that the increase reflects genuine increase of blue whiting in the area (see the discussion in Heino et al., WD c,d). Table 6.4.1.2.2 gives nevertheless also an estimate that is calculated for the more restricted area covered all years. The results show rather broad age structure. Year class 2002 is the most numerous one. In the wider survey area, year class 2000 is also very abundant. Virtually all 0-group blue whiting were observed in the core survey area and had a relatively low abundance.

Year	Total stock biomass (million t)	
	International survey in May-June	Icelandic survey in June-August
1998	6.6	1.6
1999	4.2	1.8
2000	2.5	1.2
2001	5.9	2.1
2002	6.0	1.9
2003	11.7	3.1

Norway conducted a survey in the northern Norwegian Sea in July-August (ICES 2003/D:10). Although this survey is similar in timing to the survey that is used as a tuning time series (Table 6.4.1.3), the coverage in 2003 (and in 2002) was much reduced in comparison to the earlier years. The survey is therefore not comparable to the one in 2001 and before. In comparison to 2002, the survey suggests small decreases in biomass (-13%) and stock numbers (-21%). The most abundant year class was that from 2000.

6.4.1.3 Russian survey in the Barents Sea

The Russian research vessels tried to assess biomass of the blue whiting in the Barents Sea in 2000 for the first time. In October-December 2003 three research vessels in the Barents Sea and adjacent waters conducted multi-species trawl-acoustic survey on demersal fish including blue whiting.

Estimated biomass of blue whiting over the whole surveyed area constituted nearly 350 thousand tonnes and abundance was 5,3 milliard individuals. The maximum quantity of fish estimated to be about 250 thousand tonnes occurred in the ICES Div. 11a.

Length frequencies of blue whiting varied from 18 to 41 cm with individuals oft 24-28 cm long being predominant.

6.4.2 Bottom trawl surveys

6.4.2.1 Surveys in the southern areas

Bottom trawl surveys have been conducted off the Galician (NW Spain) and Portuguese coasts since 1980 and 1979 respectively, following a stratified random sampling design and covering depths down to 500 m. Since 1983, the area covered in the Spanish survey was extended to completely cover Spanish waters in Division VIIIc. The area covered in the Portuguese survey was also extended in 1989 to the 750 m contour. A new stratification in the Spanish surveys has been established since 1997. Stratified mean catches and standard errors from the Spanish and Portuguese surveys are shown in Tables 6.4.2.1 and 6.4.2.2. In both areas 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 2003 estimate is relatively low in both the Spanish (58 kg/haul) and the Portuguese autumn survey (76 kg/haul). The Portuguese autumn surveys generally give higher values than in the summer surveys, and a better correlation with the Spanish surveys (Figure 6.4.2.1).

6.4.2.2 Surveys on the Faroe plateau

On the Faroe plateau two annual demersal bottom trawl surveys are carried out, the spring survey in March (1996-2003) and the autumn survey in August/September (1994-2003). The surveys are 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, and 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. 0-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 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 6.4.2.3). Since the Icelandic age-length keys were from the June-August period, the cannot be used to split the spring data for two reasons, firstly because in spring the 0-group is not present in the catches, whereas is present in the June-August age-length keys, and secondly because the length growth is very fast at the young stages of blue whiting and the resulting age distribution in spring would be biased. Therefore the 1-group were visually separated from the length distribution from the spring surveys (Table 6.4.2.4). In the spring surveys the 1-group is usually well separated in the length distribution (Table 6.4.2.5). In 2004 the 1-group was separated from otolith samples during the survey. Blue whiting otoliths will be sampled in future bottom trawl surveys.

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 6.4.2.2 shows the bottom trawl 0-group index (number of blue whiting caught 10^{-3}) from autumn 1996-2003 compared to the following 1-group spring index lagged one year to match the 0-group index, the correlation is very high, the r^2 is around 0.98.

6.4.2.3 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 since 1984 (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 have not been attempted. The results are summarized in Table 6.4.2.6 and show 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.

6.4.2.4 Surveys 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 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 (starting from 2004 otoliths will be collected systematically). The existing age readings suggest that virtually all blue whiting less than 21 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 supposed 1-group blue whiting from 1981 onwards is given in Table 6.4.2.7 and follows methods described in Heino et al. (2003b). The data suggest that there is good correspondence between 1-group blue whiting in the Barents Sea and estimated recruitment in the main Atlantic stock: correlation between the 1-group index and recruitment as estimated in the final AMCI in 2004 assessment is 0.88. Earlier analyses also suggest that large inFlows of warm Atlantic water tend to result in higher abundance of blue whiting in the area (Heino et al. 2003b). Whether this holds for 1-group blue whiting in particular remains to be seen.

6.4.3 Catch per unit of effort

The Spanish pair trawl CPUE series (Table 6.4.3.1) 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 final assessments since 2003. The data show a slight decreasing trend in CPUE (Figure 6.4.3.1).

CPUE data in the spawning area is available from the Norwegian commercial fleet. The CPUE is calculated as an overall aggregated CPUE and is based on data from the vessels that have submitted their logbooks (in 2003 only 7 of 46 vessels did so, representing about 11% of catch). The data suggest an overall increasing trend in CPUE since early 1990s (Figure 6.4.3.2). However, no attempt has been made to correct the data for the increase in catchability caused by technological improvements, nor is a measure of variability available prior to 2003. As in previous years, the data have not been used in the assessment.

6.4.4 Data exploration

6.4.4.1 Analysis of catch-at-age in commercial data

Percentage distributions of catch of blue whiting by year class in 2003 by ICES Divisions grouped into larger areas are shown in Figure 6.4.4.1. The total catch at age is grouped into a northern area (I and IIa), central area (Iceland and Faroes; Va, b), North Sea (IVa and IIIa), the spawning area (VIa, b, VII and XII) and a southern area (VIII and IXa). The percentages of the catches in the area of the total catch is given below each chart.

The small 1-group immature fish (2002 year class) were mainly taken in the northern area (Norwegian Sea) and in the North Sea. Although high proportions of small fish were taken in the southern area, the contribution of these to the whole catch is insignificant. It should be noted that significant amounts of older blue whiting (ages 2-4) were also taken in the northern area. In the central area (Iceland and the Faroes) mainly 2-5 year old blue whiting comprised the catches, or mainly mature fish. In the spawning area mainly 4 and 5 year olds were caught (ranging from 3-8 year olds) representing a third of the total catches.

6.4.4.2 Data exploration with AMCI

The AMCI assessment in 2003 was based on version 2.2, which at a later stage was found to contain a bug that affected the results. The bug was corrected in version 2.3, and that program version was used by SGAMHBW, who used artificial data to compare AMCI, ISVPA and SeaStar. Version 2.3 has thus been subject to certain quality control. Shortly before the WG meeting, a new version of AMCI was released, version 2.3a. The new version contains some additional features and bug fixes, but comparisons between versions 2.3 and 2.3a did not reveal any differences, nor were the new features used. Comparison between version 2.2 and 2.3/2.3a with the settings from the final AMCI assessment in 2003 shows that recruitment is estimated similarly, but that the general level of spawning stock biomass is lower for the new versions and that general level of fishing mortality is higher for the new versions (Figure 6.4.4.2.1).

In order to evaluate robustness of the assessment, a set of assessment runs was conducted with the settings from the final AMCI assessment in 2003 as a starting point. The only difference in the settings was that recruitment was estimated up to the penultimate assessment year (in 2003 this value was fixed). The main diagnostic in these exploratory runs was the sensitivity of estimated values of spawning stock biomass, recruitment and fishing mortality to altered assumptions.

Catch-at-age data are input at yearly resolution (Table 6.3.2.4). However, AMCI operates internally on a quarterly basis. Similarly as in 2003 WG, The spawning stock is derived from the mean stock numbers in the first quarter, and the survey indices are related to the mean values in the survey season (Table 6.4.5.1.1). The yearly fishing mortality 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.

Estimation of recruitment in the final assessment year (final assessment year refers here to 2003 even though Norwegian spawning stock survey from 2004 is used in the assessment) is very fragile as there are only two data points that provide information on this: catch at age 1 years in 2003, and the Norwegian spawning stock survey 2004 estimate for age 2 years. The value of the former piece of information is restricted by variable selection on young fish, that of the latter by the partial recruitment to the spawning stock at that age. As the starting point, no estimation of recruitment in 2003 was attempted (see below for exceptions). Instead, information from surveys (summarized in section 6.4.4.6.2) was used to make a guesstimate, 20 x 10^9, a value similar to geometric mean recruitment in the period 1993-2002 in the final AMCI assessment.

In the final assessment from 2003, selection pattern in the first year was fixed to a pattern obtained from an earlier program run. This is a restrictive assumption, and it is not clear whether it was made intentionally. Nevertheless, estimating the selection affected only the earlier part of the assessment (Figure 6.4.4.2.2). Whether selection was assumed to equal over age range 8-10+ years of 6-10+ years had a negligible effect; the latter range was chosen for the final assessment as blue whiting is expected to be fully recruited to the fisheries by age 4 years, and residuals did not suggest any unwanted patterns. This is referred to as the "basic" model below.

Down-weighting of catch at age 1 year by a factor of 0.5 was applied by 2003 WG. Excluding this down-weighting results in some increase F and some decrease in recruitment and SSB in the most recent years (Figure 6.4.4.2.2).

SGAMHBW (ICES 2004/ACFM24) suggested excluding certain ages from the survey tuning time series (age 8 years from the Norwegian spawning stock survey, ages 7-8 years from the Russian spawning stock survey, and ages 5-7 years from the Norwegian Sea survey). This had little effect on the estimation results (Figure 6.4.4.2.2).

Eye-balling the catch at age data draws attention to very high catch numbers of blue whiting of age 1 years in 2003. In fact, the catch was second highest in record. This could happen if year class 2002 were particularly strong, or if selection pattern of the fisheries changed. Fisheries-independent survey data do not support the former alternative (see discussion above on determining recruitment in 2003), whereas a closer scrutiny of fisheries (section 6.4.4.1) supports the view that the selection pattern may have changed. In particular, Norwegian directed fisheries caught large numbers of young blue whiting in the southern parts of Norwegian Sea in a fishery that has no counterpart in the preceding ten years or so. This motivated a series of model runs to see the effect of this juvenile fishery on the assessment.

First, trying to estimate recruitment in 2003 was not successful (Figure 6.4.4.2.3): with the basic settings, this gives an estimate that is larger than recruitment in 1997 and 2001 (years with record recruitment in the final assessment), which is at odds with survey information. Including data from the Icelandic acoustic summer survey (ages 0-1 years) and/or the Barents Sea winter survey (age 1 years) did not make the situation better; rather, inclusion of the Barents Sea data caused convergence problems.

Second, with recruitment in 2003 assumed at 20 x 10^9 and “basic” settings as before, catch data corresponding to this age and year were given zero weight. This results in some increase in spawning stock biomass and recruitment and decrease in fishing mortality (Figure 6.4.4.2.3).

Finally, with recruitment in 2003 assumed at 20 x 10^9 and “basic” settings as before, gain factor at age 1 years was increased from 0.2 to 0.5 in order to let selection pattern to adjust better to fluctuations in fishing on juveniles. As in the previous case, this results in some increase in spawning stock biomass and recruitment and decrease in fishing mortality (Figure 6.4.4.2.3). On the basis of catch residuals (Figure 6.4.4.2.4) that showed less structuring for the later years than in the previous run, this model was chosen as the final AMCI model.

6.4.4.3 Data exploration with ISVPA

For blue whiting exploratory runs with ISVPA two versions of the model were carried out: 1) effort-controlled version, which give more confidence to the assumption of constant selection pattern in the fisheries Abundance-at-age is calculated via theoretical (model-derived) catches: 2) catch-controlled version, in which abundance-at-age is calculated directly via reported catch-at-age and the estimated selection pattern is used only for calculation of terminal abundances. But despite of “local” use of selection pattern in catch-controlled version, separabilization of the model gives the possibility to derive residuals for catch-at-age and to tell about solution determined only by catch at age data. Estimates produced by the catch-controlled version follow closer the observed catches and have lower residuals in catch-at-age, but are less resistant with respect to errors (especially outliers) in catch-at-age data.

As in previous years, in both versions of the model the parameter estimation procedure ensuring unbiased separable representation of fishing mortality was used.

In the assessments by both versions of ISVPA, three sets of age-structured survey data were used: Norwegian spawning acoustic, Russian spawning acoustic, and Norwegian sea acoustic. Each of the three survey data sets were split into two periods because of change in survey equipment which may have caused a change in catchability. The 2004 Norwegian spawning acoustic surveys was not included in the assessment, while the most recent year with data in Russian acoustic surveys is 1996, and 2001 in the Norwegian sea survey. That is why it is important to have additional signals from catch-at-age alone for determining the current status of the stock.

Exploratory runs with the catch controlled versions revealed that in comparison to the 2002 and 2003 assessments, when distinct minima were found in the SSQ or the median of distribution of squared residuals at a specific terminal fishing mortality in all the above mentioned sources of auxiliary data, in this year assessment only minima were found only in the second period of the Norwegian spawning acoustic survey and in the second period of the Norwegian sea surveys (see figures 6.4.4.3.1 and 6.4.4.3.2). However, the effort- controlled version gave more well-shaped minima, that is they give more distinct information about the stock.

The overall loss function, composed only from data sources, containing minima gives a more clear minimum in comparison to loss function composed of all available sources of information (compare two curves in the third column on figures 6.4.4.3.1 and 6.4.4.3.2). That is why for final ISVPA runs only data giving more clear signals about the current stock size were used (second period of Norwegian spawning acoustic, second part of Norwegian sea acoustic, and signal from catch-at-age). Incorporation of data giving no distinct minima will result in deterioration of the shape of overall signal and in driving the solution to improbably high and less certain values of fishing mortality in the terminal year.

It also should be mentioned that the signal about the current stock size from catch-at-age alone is weaker in comparison to the 2002 and 2003 assessment and required to use more robust measure of closeness: median of distribution of squared residuals, instead of their sum (see graphs of the first row in figure 6.4.4.3.1). This may be explained by a change in the catch-at-age data in 2003 or poorer quality of these data in comparison to previous years.

Application of the two versions of the model revealed very similar historical trends in SSB estimates (figure 6.4.4.3.3). Both versions showed an increase of SSB in 2003 with respect to 2002, but the effort-controlled version indicates that this increase is much lower in comparison to increase in SSB in recent previous years.

A comparison of modelled catches with the reported values for two versions of ISVPA are presented in Figure 6.4.4.3.4. The “catch-controlled” version of ISVPA follows more closely the reported catch values than the “effort-controlled” version of the program. It should be mentioned that for both versions, modelled catches in 2002 are higher than reported ones. This may indicate underreported catches in that year.

Figures 6.4.4.3.5 and 6.4.4.3.6 represent residuals in catch-at-age and surveys for both versions of ISVPA. Residuals in catch-at-age for the "catch-controlled" version are lower. This indicates that estimated abundances are in closer agreement with the reported catches. Residuals in catch-at-age of the "effort-controlled" version display cohort effects. This effect indicates that estimates of abundance are less based on reported catch-at-age and more based on modelled values, derived from the estimated selection pattern. Cohort effects are usually regarded as undesirable, especially when catch-at-age data are assumed to be measured without error.

In the report of ICES Working Group on methods of stock assessment (2002) obvious outliers were demonstrated in the blue whiting catch-at-age data. In cohort analyses, where calculations of abundance are dependent on the reported catches, such outliers can influence abundance estimates at other ages. In models where abundance estimation is influenced by reported catches, tracing outliers in catch residuals is hindered by adaptation of the estimates of fishing mortality to reported catches. However it does not mean that these estimates are tending towards true values. In fact the opposite is true. For abundance estimates that are based on modelled catch-at-age data (through estimated selection pattern), the cohort effects in catch residuals may outline errors in the catch-at-age data. Thus higher residuals, indicate cohorts that are less influenced by reported catch data.

If the purpose of an analysis is only to achieve better fit to reported catch-at-age data, and there are no outliers in the catch data, then a cohort effect is not desirable. However, if we are dealing with real data with noise and outliers, it is necessary to test the robustness of estimates, not merely to get a good fit to bad data.

These considerations may be supported by the fact that abundance estimates, produced by the "catch-controlled" version, which has lower residuals in catch-at-age, has lower coherence with survey data. This is demonstrated by less distinct minima of loss function profiles for corresponding surveys (compare shapes of curves 2 and 6 on figures 6.4.4.3.1 and 6.4.4.3.2).

Results of retrospective runs may be regarded as an additional support in favor of more robust effort-controlled version (figure 6.4.4.3.7): results of effort-controlled version are apparently historically more stable.

The above described factors:

- theoretically higher resistance to outliers in catch-at-age data,
- better shaped minima for signals from surveys, as well as
- more stable estimates of SSB and F in retrospective analysis

made it possible to choose the effort-controlled version of the ISVPA model - the same version which was used for blue whiting stock assessment in previous years for the final run by means of ISVPA.

Results of the ISVPA final run are presented in tables 6.4.4.3.1 - 6.4.4.3.3 and on figure 6.4.4.3.8. Figure 6.4.4.3.9 represents bootstrap-derived estimates of uncertainty in the results.

These results indicate a slight increase in SSB in 2003 with respect to SSB value in 2002. The results are also in line with results, obtained by this model in the previous year. The value of SSB for 2002 in 2003 stock assessment was estimated as 6.090 million tons and the estimate for 2002 in this year assessment by means of ISVPA is equal to 6.190 million tons (see figure 6.4.4.3.10). This year estimates of fishing mortality are substantially higher in comparison to last year assessment. But as it is shown in figure 6.4.4.3.4, the model in this year assessment treats the 2002 catch data as underreported. In last year assessment this year was the terminal and its catch data were regarded by the model as true. The question of whether to transfer the probable errors in the catches in terminal year into errors in stock estimates, or into errors in fishing mortality estimates (compare stable fishing mortalities, but change in trend in SSB for AMCI 2003 and 2004 assessments) - is an interesting problem.

6.4.4.4 Data exploration with ICA

In order to explore the data, a number of runs were made using the ICA program. Initially, the same settings were used as last year, using the newly available survey and catch at age data. The analysis was planned to investigate the effect of:

- Splitting the acoustic survey series into more recent and earlier periods
- Iterative or manual down weighting
- Length of the separable period
- Reference age for separable constraint

- Choice of reference age for separable constraint
- Down weighting of age 1 in the catch numbers
- Fixed or varying exploitation pattern
- Removal of ages from the tuning fleets

Exploratory runs were made using the same procedure as last year. The results of the later runs are presented in Table 6.4.4.4.1. In all cases, the model fit was poor, with poor definition of the minima in the SSQ surfaces.

The effect of splitting of the acoustic surveys into two series each, as has been carried out by the WG for some years, was tested by comparing run 10 and 12. Splitting the three series did not alter the residual pattern or the model fit appreciably. However, the split produced a higher estimate of SSB and a lower estimate of F.

Choice of iterative down weighting was tested by comparison of runs 11 and 12. Iterative down weighting did not improve the model fit, but did produce a higher estimate of F, in the final year, than using the same settings as in 2003. SSB estimates were not changed, however. The WG decided to continue the procedure of manual weighting, in subsequent runs.

The effect of using differing separable periods was tested by comparison of runs 13 and 14. Using a longer separable period improved the residual pattern somewhat. However in all cases a strong year effect was observed in 2002. Using a longer separable period produced slightly lower F in the final year, but also a lower SSB (Table 6.4.4.4.1).

Last year, age 6 was used as the reference age for fitting the exploitation pattern. The choice of this reference age was tested by comparing runs 13 and 25. The change in reference age did not improve the model diagnostics, but produced a lower estimate of F, though SSB was not changed appreciably. It was considered more correct to use age 3, the first fully recruited age in the fishery. This change produced a different exploitation pattern to that of last year, and the WG considered the new pattern to be more realistic. This pattern was maintained in subsequent runs.

Varying the exploitation pattern was tested by comparing runs 12 and 15. There was no improvement in the model fit or residual pattern, but splitting the exploitation pattern in two periods, produced higher F and lower SSB estimates.

For consistency with settings used for AMCI, age 1 fish were down weighted in the catch numbers, by 50%. Comparing runs 16b and 20b tested this effect. The diagnostics were not improved by applying the down weighting, nor were the estimates of SSB or F altered. The effect of down weighting of age 1 by a higher value (90%) was tested by comparing run 20b and 24. Again, there was not an appreciable change in either diagnostics or outputs.

At the meeting to evaluate assessment methods on this stock (SGAMHBW ICES 2004/ACFM24), it was recommended to remove certain ages from the tuning series. These ages were as follows:

- Norwegian acoustic survey, age 8
- Russian acoustic survey, age 7 and 8
- Norwegian Sea survey, ages 5, 6 and 7.

The effect of removing these ages was tested for two separable periods by comparing runs 22b and 26. There was some improvement in the diagnostics, upon removal of these ages. However, the removal of the ages produced considerably higher estimates of SSB and lower estimates of F in the final year.

Finally, the effect of excluding the 2004 survey data was tested by comparing runs 19 (without 2004) and 25 (with 2004). There was no appreciable improvement in the diagnostics, but the inclusion of the 2004 survey produced a higher estimate of SSB and lower estimate of F in the final year.

The final run (run 26) used age 3 as reference age with an 8 year separable period and age 1 fish were down weighted by 50%. For comparison with the inputs used elsewhere, no ages were removed from the tuning fleets. Diagnostics for this run are presented in Figure 6.4.4.4.1, 6.4.4.4.2 and 6.4.4.4.5 and outputs are given in Table 6.4.4.4.2 and Figure 6.4.4.4. Modelled catch numbers and fishing mortalities from this final ICA run are presented in Table 6.4.4.4.3 and Table 6.4.4.4.4. Confidence intervals in the estimates of F, SSB and recruitment from this run are also presented in Figure 6.4.4.4. It can be seen that uncertainty has shown a increasing trend in most recent years, especially since 1999.

Settings used for ICA final run	2003	2004
Number of age structured tuning series	3, each split	3, each split
Number of biomass tuning series	0	0
Number of years for separable constraint	5	8
Reference age for separable constraint	6	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%

In 2004, the WG attempted to evaluate the behaviour of the ICA program to a variety of model inputs. The final run represented a slight improvement in diagnostics over pervious runs. To aid comparisons, the final run used settings were as close to AMCI, ISVPA and SMS as possible. These settings produced similar estimates of SSB and recruitment in the final year (Figure 6.4.5.3.1), though the estimate of F is somewhat lower.

6.4.4.5 Data exploration with SMS

SMS (**S**tochastic **M**ulti **S**pecies model) 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 CPUE (or acoustic) at age time series are minimized assuming a log-normal distribution for both data sources. SMS uses maximum likelihood to weight the various data sources, and the objective function for the catch observation is then defined as presented below:.

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

where
C is catch at age number
C^ is expected catch at age number
y is year
a is age group
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 pattern and a year effect.

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 year. The likelihood for CP*UE(survey,s,a)* 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_{CPUE},). Parameters are estimated from an minimization of -log(L).

The estimated model parameters include stock numbers the first year, recruitment, selection pattern and year effect for the separable catch at age model, and catchability at age for CPUE time series. Standard errors of the parameters are estimated from the Hessian matrix. SMS is implemented using the ad-model builder (Otter Research Ltd.), which is software package to create non-linear statistical models. The SMS model is still under development, but the "single species part" has extensively been tested in the last year on both simulated and real data (Vinther pers. com.).

Various configurations with respect to inclusion of data sources and options were tried with SMS, all giving an increase in both F and SSB for the last assessment year. The presented data configuration has been chosen as it is similar to the one used by the AMCI model.

Catch data

Catch data for the period 1981-2003, age 1 to age 10+ were used. The age selection pattern was assumed constant within two periods, 1981-1992 and 1993-2003. 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

The survey data for the SMS were the same as used for the AMCI model runs. The presented AMCI runs assume that catchability is changed in the middle of the survey period. SMS assumes a constant catchability throughout a time series, but a change in catchability was obtained by splitting the three surveys into six independent surveys. The configuration with respect to time periods, catchability at age and its variance is presented below.

Survey	Year range	Catchability at age	Variance at age of survey observation
Norwegian acoustic survey	1981-1990 1991-2003	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

Results

The log-likelihood contributions for the individual times series show that most information is from catch data (Table 6.4.4.5.1). The likelihood contributions are in general lower from the surveys and very poor from the Norwegian Sea survey. The same information can be found in the residuals plot (Figure 6.4.4.5.1) where the catch residuals are clearly smaller than the survey residuals. Catch residuals for the older ages shows a consistent shift for the last two years indicating that the separability assumption might be problematic. Survey residuals have a very clear year effect, often seen for acoustic time series.

The estimated selection pattern (Figure 6.4.4.5.2) indicates a shift towards younger age groups in the most recent separable period. The survey catchabilities at age (Table 6.4.4.5.2) are considerably lower in the most recent period for the older age-groups. Observed and predicted yield are fairly overlapping, however with some discrepancy for the years 2000-2002 (Figure 6.4.4.5.3).

Estimated stock numbers are presented in Table 6.4.4.5.3), fishing mortality in Table 6.4.4.5.4, and stock summary in Table 6.4.4.5.5 and Figure 6.4.5.1.1. The uncertainty of estimated stock numbers in 2003, SSB and F are presented in Figure 6.4.4.5.4. A CV at 45% for the estimated 1-group stock number and 30% CV for the 2-group emphasize that rather little is known about the abundance of the recruiting ages to the fishery. There is a steep increase in the uncertainties of SSB in 2003 (CV=22%) compared to SSB in 2002 (CV=14%).

6.4.4.6 Comparison of assessment results and surveys

6.4.4.6.1 Estimates of SSB

Spawning stock biomass indices (stock estimates normalized to zero mean and unity variance) obtained from Norwegian and Russian spawning stock surveys as well as analytical assessments with AMCI, ICA, ISVPA and SMS are compared in Figure 6.4.4.6.1. All analytical assessments show fluctuating SSB indices up to mid 1990s followed by an upward trend. The annual fluctuation in the survey SSB estimates is much larger than the SSB signal suggested by the analytical assessments up to mid 1990s. However, after mid 1990s the Norwegian acoustic survey index displays a similar increase as the analytical assessments with the exception of 2001 which is an outlier in the time series. All analytical assessments show an increase from 2002 to 2003, whereas the survey shows a modest decrease. This discrepancy is hardly a source of concern given the strong year effects in the earlier parts of the survey time series.

6.4.4.6.2 Estimates of recruitment

The assessment and surveys give a consistent perception on the strength of year classes 2000 and 2001. The present assessment suggests that year class 2000 is one of the strongest year classes observed in the time series. This year class has appeared as a strong one in the majority of surveys from age 1 years onwards (Table 6.4.4.6.2.1). Year class 2001 also appears as a strong one, but most surveys suggest it is not as strong as year class 2000.

Strength of year class 2002 (as recruits in 2003) was not estimated in the final AMCI assessment, but estimation was attempted in the exploratory runs with various packages. These estimates were uncertain and mostly driven by catch at age 1 years in 2003, and suggested year class 2002 to be a strong one. Survey information does not support this result: at age 0, it was very weak in all surveys, whereas at age 1 years it appears as an intermediate year class.

Both catch and survey information on year class 2003 are still very limited. Catches at age 0 in 2003 do not contain any clear signal. Survey information (Table 6.4.4.6.2.1) gives a mixed picture (from weak to exceptionally strong). Nevertheless, there is a slight dominance of signals suggesting this year class to be a strong one, giving reasons for cautious optimism.

6.4.5 Stock assessment

6.4.5.1 Comparison between different assessments

The results of the final assessments carried out with the AMCI, ICA, ISVPA and SMS models are compared in Figure 6.4.5.1.1. In general, the different assessments are in better agreement with each other compared to previous years.

SSB: All assessment models show good agreement in the historical estimates of SSB except for the most recent years. However, the trends remain the same. From 1998 onwards each time series indicate a considerable continued increase in SSB with a maximum in 2003. The estimates of SSB by the different assessments in 2003 range between 4 and 6million t and seems to be well above $\mathbf{B}_{pa}$. The lowest SSB is estimated by AMCI and is associated with lower estimates of recruitment compared to the other models. The increase in SSB in the last 3 year is not in line with estimates of SSB estimates from the acoustic survey in spawning season, which indicates a high but constant SSB in the last 3 years (Figure 6.4.4.6.1).

Fishing mortality: The historical pattern and level of fishing mortalities are estimated to be the same by the different models. Fishing mortally increased since 1994 at or close to the highest level observed in 2003, with the exception of ICA and ISVPA which estimate a decrease in F in the last year. The estimates of F in 2003 by AMCI, ISVPA and SMS are well above $\mathbf{F}_{pa}$ and close to $\mathbf{F}_{lim}$.

Recruitment: All models suggest an in increase in the overall level of recruitment after 1995. As well the patterns as the values of recruitment at age 1 are estimated by AMCI, ICA and SMS and are almost identical up to 1999. Thereafter the pattern remains the same but the values diverge. The recruitment estimated by ISVPA, however, differs from the other models. From 1996 onwards until 2001, ISVPA shows a continued increase in recruitment. Year class 2002 is estimated by ICA, ISVPA and SMS from the catch of this year class as 1 year old in 2003. The estimates of this year class are therefore very uncertain. AMCI has not attempted to estimate this year class and the value presented is assumed.

Catches: All models estimate catches in those periods where separabilty of the fishing pattern has been assumed. The estimates of modelled catches are compared with the reported ones in Figure 6.4.5.1.1. The figure 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 AMCI and ICA predict a lower catch than reported in 2003. ISVPA also show noticeable discrepancies between observed and modelled catches in some earlier years.

The overall picture, given by the different models is the same, an increase in SSB and an increase in fishing mortality in recent years, with the exception of ICA and ISVPA which suggest a decrease in F in 2003. The WG felt it difficult to make a choice between the models. There is little information supporting a specific choice between them. Nevertheless, the WG felt it necessary to make a choice as a basis for the predictions.

All models appear to be sensitive for the inclusion of a new year of data and the results differ from last year. Log catch ratio of the cohorts indicate that there may be a shift in the exploitation pattern between 2002 and 2003 (not shown).

As observed in previous years, there seems to be a conflict between the information from the catches and the surveys. The surveys contributed most to the total SSQ in the analyses. In general the minimum SSQ of the models attempted is poor defined. The diagnostics from all models show large residuals between the observed and predicted indices for all surveys. There appear to be very strong year effects in all surveys and similar in all models. The catch residuals show no trends with the exception of ISVPA where clear cohort effects exist.

It was noted that the AMCI software version, used this year was different from last year and had apparently been corrected for observed deficiencies. This resulted in a different assessment (considerably lower SSB and higher F) as last year, using last years data (Figure 6.4.5.2.7). The SMS model was used for the first time and the results of this assessment were very close to AMCI. The ISVPA model used was the same as last year, but gave quite different results. Last year a decrease in fishing mortality was estimated. This year the estimates of F by ISVPA are in line with AMCI and SMS. ISVPA catch residuals seem to be very dependent on year class (either all positive or all negative) and both ISVPA and SMS do not use the 2004 data. Only AMCI and ICA use data from the 2004 acoustic survey on the spawning grounds.

Taking the considerations above into account the Working Group preferred the assessment by AMCI as a basis for the predictions.

6.4.5.2 Final assessment with AMCI

6.4.5.2.1 Configuration and diagnostics

The key settings and data for the final blue whiting assessment in 2004 are shown in the table below. The key settings of the final assessment in 2002-2003 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
AMCI version	2.1	2.2[1]	2.3a
Age range for the analysis	0-10+	1-10+	1-10+
Last age a plus-group?	Yes	Yes	Yes
Age at recruitment (from Jan 1 in the year of spawning)	0.5	1	1
Recruitment in the terminal year	Fixed	Fixed	Fixed
Recruitment in the terminal year-1	Estimated	Fixed	Estimated
Catch data			
Weights for the partial objective functions for the catch fleet			
Sum of squares of log catches-at-age	1	1	1
Sum of squares of log yearly yields	1	1	1
Weights of catch-at-age, age 0 and 1 years	0.1, 0.5	n.a., 0.5	n.a., 0.5
Gain factors in selection pattern for ages 0 and 1 years	0.5, 0.2	n.a., 0.2.	n.a., 0.5
Gain factors in selection pattern for older ages	0.1	0.1	0.1
Selectivity for age 10 equals average of selectivity at age 8-9?	No	Yes	Yes
Age-structured tuning time series			
Norwegian acoustic survey on the spawning grounds, ages 2-8	1981-2002	1981-2003	1981-2004
Time series split in two periods (≤1990 and after)	Yes	Yes	Yes
Flat selectivity for ages 6-8?	Yes	No	No
Weight in tuning for the partial objective function	1	1	1
Russian acoustic survey on the spawning grounds, ages 3-8,	1982-1996	1982-1996	1982-1996
Time series split in two periods (≤1991 and after)	Yes	Yes	Yes
Flat selectivity for ages 7-8?	Yes	No	No
Weight in tuning for the partial objective function	1	1	1
Norwegian Sea acoustic survey, ages 1-7	1981-2001	1981-2001	1981-2001
Time series split in two periods (≤1990 and after)	Yes	Yes	Yes
Flat selectivity for ages 5-7?	Yes	No	No
Weight in tuning for the partial objective function	1	1	1
CPUE time series from Spanish pair trawlers, ages 1-6[2]	1983-2001	not used	not used
Flat selectivity for ages 5-6?	Yes	n.a.	n.a.
Weight in tuning for the partial objective function	1	n.a.	n.a.
Biomass tuning time series	0	0	0

Survey data used in tuning are shown in Table 6.4.5.1.1. As in previous years, the three acoustic surveys were 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 separable, but with an allowance for a gradual change in the selection from year to year. The gain factor for change in selection was 0.5 for age 1, and 0.1 for the older ages. This implies that the selection at age 1 is allowed to vary more according to the year-to-year variation in the catches than the selection at the older ages. Selection at ages 6-10 years was assumed constant (in 2003 selection was estimated for all age groups except for 10+ years that was taken as average of two selection at two previous ages).

Recruitment as 1-yr old fish in 2003 was set to $20x10^9$. This is similar to geometric mean recruitment in the period 1993-2002 and in accordance with what is known on this year class from surveys.

The key results are presented in Tables 6.4.5.2.2–6.4.5.2.4 and summarized in Figure 6.4.5.2.1. Residuals of the model fit are shown in Figure 6.4.4.2.4. Some cohort effects are visible in the catch residuals for the early cohorts. More importantly, there are blocks of positive and negative residuals for the latest years (i.e., systematic differences in modelled and observed catches), suggesting changes in selection pattern that were not tracked by the model. Year effects occur throughout the survey time series. The minimum SSQ (between the fitted model and the observed data) is not very well defined: a range of terminal F's can give SSQ that are close to the global minimum (Figure 6.4.5.2.2). Thus, the data do not allow unique characterisation of the stock in the most recent years. Selection pattern in terms of age- and year-specific F's is shown in Figure 6.4.5.2.3.

---

[1] AMCI 2.3 was used for scanning over terminal F's.

[2] Age 1 was down-weighted by factor 0.01.

6.4.5.2.2 Trends in fishing mortality, SSB and recruitment

The results of the final assessment (Table 6.4.5.2.4) indicate that fishing mortality has steadily increased since mid-1990s. The exploitation pattern shows some fluctuations with the major exploitation being on adults and a sharp increase for age 1 years in 2003. SSB has been at a historically high level since 1999 and continues to display an increasing trend. Recruitment of the 2000 year class is the highest in the time series. All year classes 1995-2001 are strong, indicating a possible change in recruitment dynamics of the stock: even the weakest year class born after 1996, that of 1998, is much stronger than was typical before 1995.

A bootstrap run (Figure 6.4.5.2.4) gives an indication of the uncertainty in the assessment. Even though temporal patterns in recruitment, spawning stock biomass and fishing mortality are reproduced, uncertainty in the absolute level of these metrics during the recent years is clearly visible. In particular, the development of fishing mortality and spawning stock biomass is uncertain. The estimates of terminal F and SSB are negatively correlated (Figure 6.4.5.2.5).

6.4.5.2.3 Retrospective analysis and comparison with last years assessment

Retrospective analysis (Figure 6.4.5.2.6) shows that the pattern in recruitment and the generally upward trend in fishing mortality would have been rather consistently estimated in earlier assessments, but that the trend in spawning stock biomass is unstable. In comparison to the final assessment in 2003 WG, the patterns in recruitment and fishing mortality are similar but fishing mortality is at a higher level in 2004 (Figure 6.4.5.2.7). However, spawning stock biomass is estimated lower in 2004 and with a qualitatively different trend.

6.5 Short-term Projections

Last year the short-term prognoses by the WG were based on a deterministic prediction using MFDP. However, ACFM considered the point estimates of stock size and fishing mortality by the blue whiting assessment too uncertain as a basis for such a prognoses and based its advice on a methodology which addresses the uncertainty and the interdependence between the estimates of SSB and F.

The Working Group decided to present the forecast in a similar way as was carried out by ACFM, last year. The short-term projections were based on a stochastic simulation using a non-parametric bootstrap of the residuals of the model fit to the catch and survey data and was carried out using STPR3 (Skagen 2002). For the population in 2004 the bootstrap run of the AMCI assessment was used. In 2004 a fishing mortality of $\mathbf{F}_{sq}$ (=F_{2003}) was assumed. For 2005 the prognoses was based on several assumptions of the catch level in that year. The input for the prediction is given in Table 6.5.1. The results in terms of probabilities achieving a certain fishing mortality in 2005 and surviving stock in 2006 are shown in Table 6.5.2 with 25 and 75% confidence intervals.

The confidence intervals estimated by the model are likely to be underestimates of the true uncertainty because the recruitment estimates of the 2002 year class have been assumed to be without uncertainty.

6.6 Medium-term Projection

Medium-term projections were carried out with STPR version 3, i.e., the same software as used in short-term projection. The input files were generated with AMCI and were based on the final AMCI run and corresponding bootstrap replicates. The projections were based on bootstrap replicates of stock numbers in the beginning of 2004, status quo fishing mortality in 2004, historic maturity ogive and natural mortality and stock and catch weights-at-age, and selectivity estimated for 2003. Recruitment in 2004 and forward was based on Ockham's razor stock and recruitment model with variance parameter σ=0.684.

In general, medium-term projections in the most recent period are largely defined by the presently assumed stock size, recruitment and exploitation level, while the period further in the future is mostly affected by assumptions on recruitment dynamics and exploitation level. Three scenarios for both exploitation level and recruitment were considered (Table 6.6.1). Annual catches were assumed to be either 1.0, 1.5 or 2.0 million tonnes, or the highest possible catch when the target catch could not be taken. Mean recruitment level in the Ockham's razor recruitment model was chosen to be either the value obtained from the final AMCI fit (yielding mean recruitment at 13.8 x 10^9 individuals), geometric mean of recruitment estimated for the period 1993-2002 (18.7 x 10^9 individuals) or arithmetic mean of recruitment estimated for the period 1993-2002 (23.3 x 10^9 individuals).

The projections suggest that the highest exploitation level is not sustainable for any of the considered recruitment levels, and that the lowest exploitation level is sustainable in the medium term for all of the considered recruitment levels (Table 6.6.1). Intermediate exploitation scenario was only sustainable for the highest considered recruitment level.

6.7 Precautionary 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.

The present reference points are based on assessments of the stock carried out at the end of the 1990s and are based on a relatively short time series. Since then major changes have been observed in the stock and in the fishery. This adds to the need to revise the reference points, because of their role as targets for rebuilding and guidelines for future exploitation.

The 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 $\mathbf{B}_{lim}$. 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 2004 by WGNPBW, the $\mathbf{B}_{loss}$ is estimated between 1.35 million t (AMCI), 1.7 million t (ISVPA) and 1.55 million t (ICA and SMS). The estimates of $\mathbf{B}_{loss}$ values in recent years vary considerable, however, around the present $\mathbf{B}_{lim}$. The relatively large changes in the blue whiting assessments and the differences in stock dynamics estimated by different assessment methods make it difficult to estimate a stable value for $\mathbf{B}_{lim}$. 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

It should be noted that the PA reference points presently applied in the ICES advice are based on an ICA assessment in 1998. Since then regular changes have been made in the assessment by selecting other assessment methods or different assessment configurations.

6.8 Management considerations

The fishery for blue whiting has expanded rapidly in recent years, while no agreement on TAC has been reached. The reported catches in 1998 to 2003 were all well above 1 million t reaching a historic high in 2003 of 2.3 million t. The SSB has been at a fairly high level, due to continued exceptionally good recruitment in recent years. The year classes 1995-2001 are all well above average strength and there are indications that the 2003 year class also may be strong. Without the strong year classes recruited in recent years, the intensive fishery would have led to a severe depletion of the stock before now.

However, the assessments made in 2004 give a more optimistic view of the development of the stock compared to those made in 2001-2003. The main reason is that the incoming year classes are seemingly stronger than estimated previously. The SSB in 2003 is, according to all alternative assessments made, above the $\mathbf{B}_{pa}$ presently used.

6.9 Quality of catch data and biological data

The extent of discarding in the fishery is not known. It is assumed that any discarding that occurs in the industrial fishery is confined to net bursting through overloading or through the catch exceeding the RSW tank capacity. On freezer vessels landing a catch for human consumption the role of grading in handling the catch is not known. If grading occurs in this sector then landing figures may not reflect the whole catch.

The type and frequency of by-catch in the fishery has not been sufficiently explored. Each fishery could be expected to have a different by-catch profile. The submission of by catch data for each of the blue whiting fisheries would enable the WG to report on the likely impacts of blue whiting fisheries on other stocks and fisheries.

The text table below shows the number of samples and total landings by the three fisheries, Directed, Mixed, and Southern, and by quarter.

Quarter		Directed	Mixed	Southern	Total
1	Number of samples	111	8	115	234
	Landings (t)	541258	12082	3905	557245
2	Number of samples	346	39	130	515
	Landings (t)	868935	43235	4195	916365
3	Number of samples	385	21	142	548
	Landings (t)	528913	57628	3982	590523
4	Number of samples	133	20	146	299
	Landings (t)	237941	40752	4394	283087
Total	Number of samples	975	88	533	1596
	Landings (t)	2177047	153697	16476	2347220

In total 1596 samples were collected from the fisheries, 188,770 fish measured and 26,207 fish aged. Sampled fish were not evenly distributed throughout the fisheries. The most intensive sampling took place in the south. Here one sample was taken for every 31 tonnes, followed by the mixed fishery with one sample for every 1747 tonnes, and lastly the directed fishery where there was one sample for every 2233 tonne 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 Tables 6.9.1 and 6.9.2. As can be seen, no sampling was carried out by France, Scotland, and Sweden.

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.

6.10 Recommendations

- It is recommended to initiate research on the recruitment mechanism of blue whiting and to seek an answer to the question why the productivity of blue whiting in the northeast Atlantic, through higher recruitment, has increased during the last 10 years.

- Comparison of age distributions from surveys and landings originating from different research institutes indicate that there are differences in the interpretation of the structure in the otoliths resulting in different age estimates. The WG recommends that an otolith exchange programme will be carried out in 2004 which makes it possible to investigate the magnitude of the problem.

- It is recommended that existing information on discards and by-catch in the fisheries is made available to the WG.

- The WG considers that the basic knowledge of the blue whiting could be strengthened, and it is therefore recommended that more internationally coordinated basic research should be carried out, including surveying the total geographical distribution and studying the structure (age and size distribution) of blue whiting in various sub-regions throughout the year.

It would be helpful to the working group's deliberations if countries participating in the fishery could enumerate the number, capacity and effort of vessels prosecuting the fishery.

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the directed fisheries (Sub-areas I and II, Division Va, XIVa and XIVb) 1987–2003, 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
Denmark	-	-	-	-	-	-	-	-	-	-	-	-	15	7,721	5,723	13,608	38,226
Estonia	-	-	-	-	-	-	-	-	-	377	161	904	-	-	-	-	-
Faroes	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594	11,507	17,980	64,496	82,977	115,755
Germany	1,010	3	1,341	-	-	-	-	2	3	32	-	78	-	-	3117	1,072	813
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iceland	-	-	4,977	-	-	-	-	-	369	302	10,464	68,681 4)	96,295	155,024	245,814	195,483	312,334
Latvia	-	-	-	-	-	-	-	422	-	-	-	-	-	-	-	-	
Netherlands	-	-	-	-	-	-	-	-	72	25	-	63	435	-	5180	906	592
Norway 5)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	64,581	100,922	215,075
Norway 6)	-	-	-	566	100	912	240	-	-	58	1,386	12,132	5,455	-	28,812	-	-
Poland	56	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sweden	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	850	57,206
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
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

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 blue whiting in other fisheries.

Table 6.2.2 Landings (tonnes) of BLUE WHITING from directed fisheries (Division Vb,VIa,b, VIIb,c. VIIg-k and Sub-area XII) 1987–2003 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
Denmark	2,655	797	25	-	-	3,167	-	770	-	269	-	5051	19,625	11,856	18,110	2,141	17,813
Estonia	-	-	-	-	-	6,156	1,033	4,342	7754	10,605	5,517	5,416	-	-	-	-	-
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
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
Iceland	-	-	-	-	-	-	-	-	-	-	-	-	64,135	105,833	119,287	91,853	189,159
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
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
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
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
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
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) Including some directed fishery also in Division IVa.
2) Revised for the years 1987, 1988, 1989, 1992, 1995,1996,1997

3) From 1992 only Russia

Table 6.2.3 Landings (tonnes) of BLUE WHITING from directed fisheries and by-catches caught in other fisheries in Divisions IIIa, IVa 1987–2003, as estimated by the WG.

Country	1987	1988	1989	1990	1991	1992	1993 3)	1994	1995	1996	1997	1998 2)	1999	2000	2001	2002	2003
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	35,530	26,896
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		
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
Faroes 5) 6)												296	265	42	6,741		
Germany 1)	115	280	3	-	-	25	9	-	-	-	-			-	81	-	36
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	
Netherlands	-	-	-	20	-	2	46	-	-	-	793			-	-	50	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
Norway 5)															58,182		
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	69	-	-
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
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

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 6.2.4 Landings (tonnes) of BLUE WHITING from the Southern areas (Sub-areas VIII and IX and Divisions VIIg-k and VIId,e) 1987–2003, as estimated by the Working Group.

Country	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Germany	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600 2)	88 2)
Ireland	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	98 2)	96 2)
Netherlands	-	-	-	450	10	-	-	-	-	-	-	10 1)	-	-	-	3208 2)	2471,8 2)
Norway	4	-	-	-	-	-	-	-	-	-	-			-	-	-	-
Portugal	9,148	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439	1,900	2,625	2,032	1,746	1,659	2,651
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
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

1) Directed fisheries in VIIIa

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

Table 6.2.5 Total landings of blue whiting by country and area for 2003 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									46					46
IIa	38,226	105,563		813	240,273		215,075		174,425			57,206	592	832,173
IIb									16,973					16,973
IIIa	7,316	1,243										7,603		16,162
IVa	18,886	4,137		36			117,145			65		723	0	140,992
IVb	694	332											0	1,026
IXa								2,651						2,651
Va		10,192			72,061									82,253
Vb	9,439	138,435	1,572	8,104	180,568		16,483		104,630	30			9,008	468,269
VIa	5,044	30,297		9,573		1	72,332			3,253			5,537	126,037
VIb	985	10,361	3,256	907	7,060	5,619	221,028		55,716	20,441			12,542	337,915
VIIb						25				251				276
VIIbc			3,592	3,282			121,216							128,090
VIIc		11,094				8,586				3,160			18,010	40,850
VIIg						4								4
VIIgk			4,945				71,262							76,207
VIIgk+XII		14,357			1,531				3,466					19,354
VIIh													142	142
VIIIabd			784										596	1,380
VIIIc+IXa											13,825			13,825
VIIj				88		96				181			1,876	2,241
VIIk		3,884				6,740							0	10,624
XII	2,345					1,509								3,854
XIVb									63					63
Grand Total	82,935	329,895	14,149	22,803	501,493	22,580	834,540	2,651	355,319	27,382	13,825	65,532	48,303	2,321,406

Table 6.2.6 Landings (tonnes) of BLUE WHITING from the main fisheries, 1987–2003, 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**

Table 6.2.7 Total landings of blue whiting by quarter and area for 2003 in tonnes. Landing figures provided by Working Group members.

Area	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Grand Total
I	46				46
IIa	6,494	356,694	389,168	79,816	832,173
IIb	6,508	10,465			16,973
IIIa	24	2,002	12,230	1,906	16,162
IVa	13,778	42,769	55,446	28,999	140,992
IVb	25	0	1,001		1,026
IXa	586	734	603	728	2,651
Va	1,326	9,116	51,460	20,351	82,253
Vb	19,153	242,563	68,757	137,795	468,269
VIa	3,107	117,839	813	4,278	126,037
VIb	220,002	116,505	1,408		337,915
VIIb	255	21			276
VIIbc	128,090				128,090
VIIc	39,031	1,819			40,850
VIIg		4			4
VIIgk	76,207				76,207
VIIgk+XII	18,979	375			19,354
VIIh	142			-	142
VIIIabd	221	6	1,153		1,380
VIIIc+IXa	3,319	3,461	3,379	3,666	13,825
VIIj	2,056	113	-	72	2,241
VIIk	10,624				10,624
XII	3,854				3,854
XIVb		63			63
Grand Total	553,826	904,551	585,418	277,612	2,321,406

Table 6.2.8 Scottish Blue Whiting Fleet 2003

	Quarter 1	Quarter 2
No of Vessels	12	6
Fishing Gear	Industrial Trawl	Industrial Trawl
Length Range Vessels (m)	51 - 74	51 - 74
Mean Length Vessels (m)	60	59
Vessel Type	Pelagic Trawler	Pelagic Trawler
Power range(kw)	1700 - 6210	1700 - 4330
Mean Power (KW)	2353	2017
Average crew size	10	10
Catch Market	Fish Meal	Fish Meal
No of Vessels in Pelagic Fleet	33	
Approx Annual Value (£000's)	2000	

Table 6.3.1.1 Blue whiting. Landing in numbers ('000) by length group (cm) and quarters for the Nothern area in 2003.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12		1			1
13		2	996	10	1 009
14	2	33	1 093	20	1 149
15	53	443	161	819	1 477
16	551	795	43	996	2 385
17	658	75 382	3 106	2 402	81 549
18	636	296 292	8 602	1 148	306 678
19	1 122	585 536	18 315	2 261	607 234
20	9 307	422 709	67 563	26 551	526 130
21	30 376	278 637	128 766	54 021	491 800
22	84 753	401 772	215 736	108 496	810 756
23	203 226	587 015	412 634	139 752	1342 626
24	509 897	798 318	575 120	188 154	2071 488
25	652 430	697 924	581 374	195 229	2126 957
26	642 613	745 563	491 912	158 284	2038 372
27	465 444	468 176	301 613	108 754	1343 989
28	392 580	427 543	210 312	88 149	1118 584
29	235 319	313 269	159 687	44 790	753 065
30	207 968	219 153	91 570	31 199	549 891
31	153 237	108 838	56 758	23 809	342 642
32	79 028	61 254	33 470	13 519	187 272
33	65 828	26 774	10 559	7 200	110 362
34	29 047	18 271	9 306	7 047	63 671
35	13 122	14 216	3 832	2 063	33 233
36	11 072	10 790	4	595	22 461
37	8 017	10 058	961	64	19 100
38	4 763	5 429	5	41	10 237
39	2	2 604	1	22	2 629
40	4 579	3 481	1	14	8 076
41		296		22	318
42		666		1	667
43		665			665
44		9			9
45					
46					
47					
48					
49					
50					
TOTAL numbers	3805 632	6581 915	3383 499	1205 435	14976 480

Official Catch (t)	563 721	867 968	522 534	237 800	2192 024

Table 6.3.1.2 Blue whiting. Landing in numbers ('000) by length group (cm) and quarters for the North Sea and Skagerrak in 2003.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11					
12	203		505	408	1 117
13	203	663	16 865	5 895	23 626
14		884	68 220	33 412	102 515
15	407	2 651	47 563	30 131	80 753
16	6 509	9 087	14 024	21 788	51 407
17	10 836	20 973	4 548	3 673	40 029
18	5 862	49 633	20 844	4 406	80 745
19	6 047	93 089	78 135	15 402	192 672
20	7 360	122 964	164 478	47 150	341 951
21	14 442	85 317	187 222	102 863	389 844
22	27 090	54 189	114 893	64 146	260 319
23	19 749	61 897	69 859	44 150	195 655
24	13 147	56 575	53 373	35 768	158 863
25	8 950	36 265	57 542	39 706	142 463
26	9 116	21 884	24 508	25 219	80 727
27	5 751	13 911	15 727	18 160	53 549
28	5 233	6 997	8 653	11 079	31 963
29	3 181	6 058	7 579	6 529	23 347
30	4 198	4 889	6 632	5 366	21 084
31	1 017	2 366	2 526	2 040	7 950
32	666	442	1 516	1 836	4 460
33	462	1 261	1 011	1 020	3 754
34		221	505	816	1 542
35		442		612	1 054
36					
37				204	204
38					
39					
40					
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	150 428	652 657	966 729	521 781	2291 595

Official Catch (t)	12 097	44 231	64 006	35 495	155 829

Table 6.3.1.3 Blue whiting. Landing in numbers ('000) by length group (cm) and quarters for the Southern area in 2003.

Length	Q1	Q2	Q3	Q4	All year
5					
6					
7					
8					
9					
10					
11				4	4
12					
13					
14		13	22	2	37
15	527	15	54	114	711
16	3 500	445	323	1 647	5 915
17	8 965	2 830	1 102	2 791	15 688
18	6 874	8 461	7 051	3 583	25 969
19	2 898	8 605	17 616	11 303	40 422
20	2 635	7 230	12 082	7 680	29 626
21	6 566	10 665	8 684	7 419	33 334
22	7 395	10 946	7 749	9 961	36 051
23	8 137	8 060	5 289	7 820	29 306
24	6 373	5 738	3 368	4 622	20 100
25	2 993	2 739	1 956	3 743	11 430
26	2 179	1 331	1 339	1 944	6 793
27	1 275	1 013	572	1 186	4 046
28	973	501	449	586	2 509
29	616	211	156	471	1 454
30	251	86	102	268	707
31	96	16	32	120	264
32	155	13	7	86	262
33	32	11	5	9	57
34	12	13	6	1	32
35	15	5	1	4	26
36	6	6	3	1	15
37	1	4	2	1	8
38	8	4	1		13
39	1	2	1		4
40		3	1		5
41					
42					
43					
44					
45					
46					
47					
48					
49					
50					
TOTAL numbers	62 483	68 965	67 972	65 366	264 785

Official Catch (t)	3 905	4 195	3 982	4 394	16 477

Table 6.3.2.1 BLUE WHITING. Catch in number (millions) by age group in the directed fisheries (Sub-areas I and II, Divisions Va, and XIVa+b, Vb, VIa+b, VIIbc and VIIg-k) in 1992-2003.

												2003
												58
												2464
												3626
												7964
												4726
												2006
												1090
												398
												119
												18
												27
												22,495
												2,177,047

fisheries (Divisions IIIa and IV) for 1992-2003.

												2003
												222
												1191
												369
												368
												73
												18
												23
												1
												1
												1
												1
												2,269
												153,697

												2003
												7
												88
												79
												47
												26
												12
												4
												1
	1	1	4	5	3	3	4	2	0	0	0	1
Total	522	477	347	390	394	402	422	399	384	398	321	264
Tonnes	28,722	32,256	29,468	27,664	25,099	30,122	29,400	26,402	24,654	24,964	19,165	16,476

Table 6.3.2.4. Blue Whiting: Catch in numbers (thousands) of the total stock in 1981-2003

Age	1981	1982	1983	1984	1985	1986	1987	1988
0								
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
0								
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
0							
1	2,131,494	1,656,926	788,200	1,814,851	4,363,690	1,821,053	3,742,841
2	1,519,327	4,181,175	1,549,100	1,192,657	4,486,315	3,232,244	4,073,497
3	904,074	3,541,231	5,820,800	3,465,739	2,962,163	3,291,844	8,378,955
4	577,676	1,044,897	3,460,600	5,014,862	3,806,520	2,242,722	4,824,590
5	295,671	383,658	412,800	1,550,063	2,592,933	1,824,047	2,035,096
6	251,642	322,777	207,200	513,663	585,666	1,647,122	1,117,179
7	282,056	303,058	151,200	213,057	170,020	344,403	400,022
8	406,910	264,105	153,100	151,429	97,032	168,848	121,280
9	104,320	212,452	68,800	58,277	76,624	102,576	19,701
10+	169,235	85,513	140,500	139,791	66,410	142,743	27,493

Table 6.3.3.1. Blue Whiting: Mean weights-at-age in the total catch and stock in 1981-2003

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

Table 6.3.4.1. 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 6.4.1.1 Age stratified acoustic survey estimates of blue whiting in the spawning area west of the British Isles by Norwegian reserach vessels, March/ April 1981-2004. Number in millions.

Numbers	age										
	1	2	3	4	5	6	7	8	9	10	total
1981		2372	7583	3253	3647	4611	4638	3654	2591	1785	34134
1982		no survey									
1983		297	2108	2723	6511	3735	3650	3153	2279	1182	25638
1984		15767	1721	1616	1719	1858	1128	567	440	348	25164
1985		no survey									
1986		1003	5829	4122	624	228	203	250	137	170	12566
1987		4960	8417	22589	4735	282	417	385	159	27	41971
1988		9712	9090	12367	20392	7355	723	599	326	398	60962
1989		6787	22270	9973	10504	7803	933	293	177	46	58786
1990		14169	12670	11228	5587	6556	3273	516	183	108	54290
1991		11147	6340	8497	7407	4558	2019	545	96	16	40625
1992		1232	26123	4719	1574	1386	810	616	257	19	36736
1993		4489	3321	26771	2643	1270	557	426	108	22	39607
1994		1603	2950	4476	11354	1742	1687	908	770	207	25697
1995		8538	9874	7906	6861	9467	1795	1083	482	149	46155
1996		8781	7433	8371	2399	4455	4111	1202	459	162	37373
1997		no survey									
1998		18218	34991	4697	1674	279	407	381	351	86	61084
1999		19034	60309	26103	1481	316	72	153	141	0	107609
2000	12783	8613	31011	41382	6843	898	427	228	139	115	102439
2001	16479	44162	12843	13805	8292	718	175	51	0	0	96525
2002	20455	71996	54740	12757	5266	8404	1450	305	15	176	175564
2003	26520	23992	70303	28756	5735	2430	1708	260	229		133184
2004	3860	18569	40669	50137	15649	4454	2218	1313	426		137295

used in the assessment

Table 6.4.1.2. 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								

[red box] used in the assessment

Table 6.4.1.3. Age stratified acoustic survey estimates of blue whiting in the Norwegian Sea in July
Number in millions, biomass in thousand t, mean length in cm, mean weight in grams

Numbers	age										total
	0	1	2	3	4	5	6	7	8	9	
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	0	68	96689
2002		no survey									0
2003		no survey									0

used in the assessment

Table 6.4.1.1.1 Age and length distribution of blue whiting in the international survey by R/Vs "Celtic Explorer", "Fridtjof Nansen", "Johan Hjort" and "Tridens", west of the British Isles, March-April 2004.

Length (cm)	Age in years (year class) 1 2003	2 2002	3 2001	4 2000	5 1999	6 1998	7 1997	8 1996	9 1995	10 1994	Numbers (10^6)	Biomass (10^6 kg)	Mean weight (g)	Prop. mature (%)
14.0 - 15.0	117	0	0	0	0	0	0	0	0	0	117	2	12.6	0
15.0 - 16.0	475	0	0	0	0	0	0	0	0	0	475	8	17.2	0
16.0 - 17.0	792	0	0	0	0	0	0	0	0	0	792	16	20.6	0
17.0 - 18.0	1006	0	0	0	0	0	0	0	0	0	1006	25	24.7	0
18.0 - 19.0	1181	0	0	0	0	0	0	0	0	0	1181	34	29.1	0
19.0 - 20.0	756	549	0	0	0	0	0	0	0	0	1305	44	33.9	28
20.0 - 21.0	339	1408	0	0	0	0	0	0	0	0	1746	70	40.2	48
21.0 - 22.0	90	1839	42	3	0	0	0	0	0	0	1974	94	47.5	57
22.0 - 23.0	18	2429	1100	272	7	0	0	0	0	0	3826	215	56.3	67
23.0 - 24.0	102	4851	2697	1150	18	0	0	0	0	0	8817	545	61.8	83
24.0 - 25.0	11	3667	7002	5717	634	103	0	0	0	0	17134	1167	68.1	93
25.0 - 26.0	0	1538	9795	9150	1190	35	43	0	0	0	21751	1616	74.3	97
26.0 - 27.0	0	837	6311	9981	2601	80	0	80	0	0	19891	1611	81.0	99
27.0 - 28.0	0	141	3696	8956	2410	842	49	101	53	0	16249	1459	89.8	99
28.0 - 29.0	0	225	2266	4382	3319	520	222	579	94	0	11608	1187	102	100
29.0 - 30.0	0	58	514	2852	2400	982	553	133	58	0	7551	833	110	100
30.0 - 31.0	0	59	383	1207	1672	943	677	195	0	0	5136	631	123	100
31.0 - 32.0	0	0	125	448	1381	787	544	180	0	0	3465	476	137	100
32.0 - 33.0	0	0	6	278	473	437	456	238	0	0	1888	291	154	100
33.0 - 34.0	0	0	97	0	254	89	243	146	537	0	1367	226	166	100
34.0 - 35.0	0	0	315	0	52	52	153	153	0	0	725	122	168	100
35.0 - 36.0	0	0	0	0	36	518	23	22	114	0	714	146	205	100
36.0 - 37.0	0	0	0	0	157	94	16	94	9	0	370	85	229	100
37.0 - 38.0	0	0	0	0	0	0	87	0	132	87	307	80	262	100
38.0 - 39.0	0	0	0	0	170	13	13	13	13	13	233	53	229	100
39.0 - 40.0	0	0	0	0	0	13	17	13	107	13	163	44	272	100
40.0 - -41.0	0	0	0	0	0	7	7	7	7	7	35	12	333	100
41.0 – 42.0	0	0	0	0	0	3	3	4	4	4	18	5	299	100
TSN (10^6)	4886	17603	34350	44397	16775	5521	3111	1962	1131	127	129900			
TSB (10^6 kg)	138	1092	2697	3762	1775	713	427	262	205	34	11100			
Mean length (cm)	18.1	23.5	25.9	26.7	28.7	30.5	31.4	30.9	34.0	38.2	26.4			
Mean weight (g)	28.3	62.0	78.5	84.7	106	129	137	133	181	263	85.5			
Condition	4.8	4.8	4.5	4.4	4.5	4.6	4.4	4.5	4.6	4.7	4.6			
% mature	3	76	96	99	100	100	100	100	100	100	91.5			
% of SSB	+	8	25	36	17	7	4	3	2	+				

Table 6.4.1.1.2 Age and length distribution of blue whiting in the survey by R/V "Johan Hjort" west of the British Isles, March-April 2004.

Length (cm)	1 (2003)	2 (2002)	3 (2001)	4 (2000)	5 (1999)	6 (1998)	7 (1997)	8 (1996)	9 (1995)	Numbers (10^6)	Biomass (10^6 kg)	Mean weight, (g)	Proportion mature
	Age in years (year class)												
14.0 - 15.0	87	0	0	0	0	0	0	0	0	87	1.3	14.5	0
15.0 - 16.0	243	0	0	0	0	0	0	0	0	243	5.2	21.3	0
16.0 - 17.0	373	0	0	0	0	0	0	0	0	373	9.1	24.4	0
17.0 - 18.0	704	0	0	0	0	0	0	0	0	704	21	29.8	0
18.0 - 19.0	763	0	0	0	0	0	0	0	0	763	24.7	32.4	0
19.0 - 20.0	759	0	0	0	0	0	0	0	0	759	29.1	38.3	0
20.0 - 21.0	272	1036	0	0	0	0	0	0	0	1308	51.7	39.6	41
21.0 - 22.0	350	1173	701	0	0	0	0	0	0	2224	108.2	48.7	57
22.0 - 23.0	49	3046	1169	259	0	0	0	0	0	4523	260	57.5	69
23.0 - 24.0	239	5854	3403	1593	64	0	0	0	0	11152	694.9	62.3	86
24.0 - 25.0	21	3925	8592	8205	601	394	0	0	0	21738	1508	69.4	95
25.0 - 26.0	0	2201	12453	10563	1178	0	42	0	0	26437	1973.1	74.6	98
26.0 - 27.0	0	784	6616	9476	2661	80	0	42	0	19657	1614.9	82.2	99
27.0 - 28.0	0	270	3933	9797	2147	661	0	78	58	16944	1540.4	90.9	100
28.0 - 29.0	0	166	2845	5180	2861	585	312	460	103	12512	1294.2	103.4	100
29.0 - 30.0	0	114	476	2559	2477	893	427	149	29	7125	791.6	111.1	100
30.0 - 31.0	0	0	348	1798	1387	1081	302	75	0	4991	618.3	123.9	100
31.0 - 32.0	0	0	27	597	1369	410	525	97	0	3025	414.6	137.1	100
32.0 - 33.0	0	0	18	109	682	178	418	292	0	1697	262.3	154.6	100
33.0 - 34.0	0	0	0	0	114	89	144	55	32	434	71.5	164.6	100
34.0 - 35.0	0	0	88	0	0	0	19	19	0	126	16.8	133.8	100
35.0 - 36.0	0	0	0	0	0	83	0	0	103	186	38.2	205.2	100
36.0 - 37.0	0	0	0	0	108	0	0	0	0	108	25.9	240.5	100
37.0 - 38.0	0	0	0	0	0	0	0	0	62	62	15.6	250.7	100
38.0 - 39.0	0	0	0	0	0	0	29	29	0	58	13	223	100
39.0 - 40.0	0	0	0	0	0	0	0	19	39	58	16.1	279	100
TSN (10^6)	3860	18569	40669	50137	15649	4454	2218	1313	426	137295			
TSB (10^6 kg)	138	1211	3136	4267	1631	510	290	166	71	11420			
Mean length (cm)	18.8	23.8	25.6	26.6	28.5	29.3	30.9	30.4	32.8	26.1			
Mean weight (g)	35.6	65.2	77.1	85.1	104.2	114.5	130.7	126.1	167.6	83.2			
Condition	5.4	4.8	4.6	4.5	4.5	4.6	4.4	4.5	4.7	4.7			
% mature	8	78	97	99	100	100	100	100	100	93.2			
% of SSB	0	9	28	39	15	5	3	2	1				

Table 6.4.1.1.3. Blue whiting biomass estimates (million tonnes) in the spawning area.

	Russia		Norway		International	
Year	total	spawning	total	spawning	total	spawning
1983	3.6	3.6	4.7	4.4		
1984	3.4	2.7	2.8	2.1		
1985	2.8	2.7				
1986	6.4	5.6	2.6	2.0		
1987	5.4	5.1	4.3	4.1		
1988	3.7	3.1	7.1	6.8		
1989	6.3	5.7	7.0	6.1		
1990	5.4	5.1	6.3	5.7		
1991	4.6	4.2	5.1	4.8		
1992	3.6	3.3	4.3	4.2		
1993	3.8	3.7	5.2	5.0		
1994			4.1	4.1		
1995	6.8	6.0	6.7	6.1		
1996	7.1	5.8	5.1	4.5		
1997						
1998			5.5	4.7		
1999			8.9	8.5		
2000			8.3	7.8		
2001			6.7	5.6		
2002	5.2		12.2	10.9		
2003	18.5	16.6	11.4	10.4		
2004	4.3	4.1	11.4	10.9	11.1	10.6
Mean	5.7	5.2	6.5	5.9	11.1	10.6

Table 6.4.1.2.1. Blue Whiting. Age stratified acoustic survey estimates in the PGSPFN/PGNAPES coordinated May/June survey Norwegian Sea (not used in the assessment Estimate is for the area north of 63°N and east of 8°W only.

Year	Age (yrs)										
	1	2	3	4	5	6	7	8	9	10	Total
Numbers (millions)											
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
Biomass (1000 tonnes)											
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
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
Weight (g)											
2000	36.7	83	93.5	115.8	122.1	225.1					45.3
2001	31.9	70.7	101.3	138.4	155.9						48.7
2002	42.7	56.6	87.8	120.7	147.2	144.5		210		269	64.1
2003	41.3	71.6	81.9	114.2	137.9	153.3	255.5	219.3			66.9

Table 6.4.1.2.2. 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
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

	0	1	2	3	4	5	6	7	8	9+	total
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			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

	0	1	2	3	4	5	6	7	8	9+	total
mean length (cm)□											
1999											19.7
2000											18.8
2001	15.1	22.4	25.3	26.4	28.1	29.9	31.8	32.6	33	37	18.3
2002	14.8	22.8	24.9	26.2	27.6	29.3	30.6	30.9	36.9	35	23.1
2003	13.2	21.3	25.1	26.4	27.9	29.2	31	31.1	33.9	31	23.4

	0	1	2	3	4	5	6	7	8	9+	total
mean weight (gr)□											
1999	18	77	94	113	132	158	174	254	248	307	66
2000	16	71	90	115	136	161	208	186	241		53
2001	24	72	109	127	143	165	190	218	194	234	51
2002	20	69	96	111	126	142	157	173	267	205	80
2003	14	59	99	115	129	148	172	175	212	257	88

Table 6.4.2.1 Stratified mean catch (Kg/haul and Number/haul) and standard error of BLUE WHITING in bottom trawl surveys in Spanish waters (Divisions VIIIc and IXa north). All surveys in September-October.

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36
1997	7.60	4.44	44.21	10.61	60.18	17.54	44.01	8.00
1998	5.29	1.92	41.09	7.64	73.80	24.06	44.48	7.82
1999	31.41	7.28	108.46	17.24	150.24	39.53	108.12	14.62
2000	39.52	9.73	88.89	14.32	62.23	27.65	74.42	11.25

	70-120 m		121-200 m		201-500 m		TOTAL 70-500 m	
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	92.66	14.60	111.76	19.87	169.21	50.26	124.27	17.83
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

Number/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	267	181.71	3669	1578.86	1377	262.98	2644	963.20
1986	368	237.56	2486	1006.67	752	238.87	1763	616.40
1987	-	-	-	-	-	-	-	-
1988	83	71.74	6112	1847.36	7276	6339.88	5694	2086.00
1989	629	537.29	3197	876.75	566	213.11	2412	599.00
1990	220	115.48	2219	426.46	578	185.43	1722	276.00
1991	2922	1645.73	5563	1184.69	1789	847.33	4214	780.88
1992	124	50.81	1412	233.99	845	199.12	1069	146.87
1993	14	8.61	257	69.61	894	427.77	401	124.53
1994	346	234.12	2002	456.50	997	245.91	1487	689.00
1995	1291	864.97	2004	341.48	485	137.81	1493	240.37
1996	147	82.71	1167	167.20	2097	385.23	1263	142.30
1997	224	121.69	1425	359.12	1254	330.37	1228	234.50
1998	123	44.12	1442	334.24	1823	592.92	1347	251.37
1999	795	218.58	3996	697.66	5279	1521.62	3861	576.10
2000	1574	360.78	3701	568.17	2036	857.01	2940	406.62

	70-120 m		121-200 m		201-500 m		TOTAL 70-500 m	
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	2502	427.23	4358	847.87	6119	2026.39	4474	727.32
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

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

		20-100 m		100-200 m		200-500 m		500-750 m		TOTAL: 20-500 m		TOTAL: 20-750 m	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy	y	sy
1979	June	0	0	33	23	86	35	-	-	31	12	-	-
	Oct./Nov.	5	5	17	8	103	48	-	-	28	9	-	-
1980	March	0	0	178	173	5	1	-	-	72	69	-	-
	May/June	1	3	4	2	45	18	-	-	11	4	-	-
	October	4	3	10	4	587	306	-	-	117	58	-	-
1981	March	0	0	24	17	186	113	-	-	42	22	-	-
	June	0	0	4	2	178	25	-	-	34	4	-	-
1982	April/May	0	0	3	3	136	39	-	-	26	7	-	-
	September	1	1	85	42	271	123	-	-	86	29	-	-
1983	March	1	1	14	10	259	96	-	-	54	18	-	-
	June	0	0	23	8	177	47	-	-	42	9	-	-
1985	June	0	0	194	146	405	162	-	-	159	68	-	-
	October	4	3	133	84	341	39	-	-	120	35	-	-
1986	June	4	1	59	19	196	31	-	-	65	10	-	-
	October	2	1	357	144	650	111	-	-	276	63	-	-
1987	October	3	0	297	64	747	229	-	-	263	50	-	-
1988	October	4	2	165	47	457	106	-	-	155	28	-	-
1989	July	0	0	42	21	323	143	79	36	-	-	78	24
	October	7	4	70	26	306	84	24	2	-	-	79	16
1990	July	2	2	153	103	242	42	50	5	-	-	96	35
	October	11	5	90	28	762	234	42	10	-	-	153	35
1991	July	1	1	140	40	268	38	64	18	-	-	98	15
	October	8	5	83	18	259	53	121	27	-	-	91	11
1992	February	7	7	43	35	249	21	73	3			68	12
	July	1	1	29	18	216	43	27	5	-	-	47	9
	October	1	1	22	7	208	44	80	3	-	-	54	7
1993	February	0	0	19	14	105	31	36	0	-	-	42	10
	July	0	0	3	3	151	28	55	5	-	-	34	4
	November	0	0	90	0	189	43	6	1	-	-	86	9
1994	October	0	0	374	30	283	32	49	7	-	-	174	11
1995	July	0	0	18	14	130	20	52	3	-	-	35	5
	October	18	15	103	21	328	91	31	12	-	-	94	16
1996	October	25	24	12	2	36	6	25	7			22	8
1997	June	0	0	3	3	116	42	45	12	-	-	27	7
	October	2	1	54	20	77	13	7	2	-	-	32	8
1998	July	0	0	8	5	105	17	38	3	-	-	25	3
	October	1	1	384	87	427	101	20	2	-	-	212	36
1999	July	1		60		66		25		-	-	37	n/a
	October	0		70		78		18		-	-	41	n/a
2000	July	23	13	109	34	116	10	63	6	-	-	75	13
	October	11	4	155	53	196	22	54	4	-	-	100	19
2001	July	18	7	238	37	305	37	57	14	-	-	152	23
	October	106	6	474	224	294	66	0	0	-	-	295	97
2002	October	19	12	176	81	180	24	0	0	-	-	116	34
2003	October	24	10	114	14	119	30	34	6	-	-	76	8

Table 6.4.2.3. Catch in number by age of blue whiting from the summer (August/September) bottom trawl surveys on the Faroe plateau 1996-2003. 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

Table 6.4.2.4. Catch in number of 1-group (age 1) blue whiting from the spring (March) bottom trawl surveys on the Faroe plateau 1996-2003. The number of 1-group in 2004 was taken out by age readings while for the previous 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 6.4.2.5).

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

Table 6.4.2.5. Length distribution (cm) of blue whiting from the spring bottom trawl surveys on the Faroe plateau 1994-2003. Shaded areas in the years 1994-2003 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
10	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0		0	0	0	0	0	0	0
12	0	0	0		0	0	0	0	0	0	0
13	0	0			0	0	0	0	0	0	0
14	0	0			0	0	0		0	0	159
15	0	0			0				0	0	1285
16									0		3508
17											3106
18											2035
19											1932
20				132							1005
21				130							589
22				263	98	222		1299		56	1544
23			164	331	157	386	105	2235	1120	377	1471
24	0	112	793	356	183	623	221	2348	1047	472	2401
25	0	224	1051	139	179	1022	312	2664	1859	856	2462
26	0	291	1456	94	136	1259	668	2687	2670	602	3909
27	8	194	841	82	93	789	1049	2493	4125	691	3100
28	4	89	548	61	57	529	1148	2954	4564	240	2659
29	5	49	195	93	48	314	1105	1774	5014	184	2080
30	23	27	159	16	28	105	939	731	4852	229	965
31	36	28	108	38	43	140	549	526	2924	126	1311
32	43	176	65	30	63	114	434	94	1899	90	754
33	48	79	112	32	12	96	361	201	1812	18	452
34	15	154	159	40	26	61	196	140	928	32	233
35	24	252	74	14	33	63	172	158	341	9	282
36	40	134	134	45	20	2	149	101	418	0	22
37	40	201	127	58	14	50	126	40	253	0	52
38	31	230	27	41	6	33	47	2	61	0	9
39	31	107	19	0	8	12	16	0	126	0	0
40	16	93	29	3	0	0	17	0	0	0	0
41	7	12	12	0	0	12	15	0	0	0	0
42	2	0	0	0	0	16	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0
Sum	1761	3623	10515	3237	1466	6956	8411	22505	37898	4855	37325
1-group	1388	1171	4442	1239	262	1108	782	2058	3885	873	13016

Table 6.4.2.6. Abundance index of blue whiting in the Norwegian shrimp survey in the northern North Sea in October. Blue whiting <19cm in total body length most likely belong to 0-group.

Year					1984	1985	1986	1987	1988	1989	1990	1991	1992
Catch rate	All				264	254	214	258	76.9	234	129	77.4	175
(ind./nm)	<19cm				58.5	36.2	0.00	0.64	0.00	56.9	0.03	0.29	0.02

Year		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003*
Catch rate	All	135	204	410	256	594	583	297	341	457	306	162
(ind./nm)	<19cm	0.12	0.00	174	75.9	4.8	0.62	2.38	4.23	2.74	0.04	6.23

* Changes in survey gear make values for 2003 not strictly comparable to the earlier part of the time series

Table 6.4.2.7. Abundance index on blue whiting in the Norwegian winter survey (late January-early March) in the Barents Sea. Blue whiting <21cm in total body length most likely belong to 1-group.

Year		1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Catch rate	All	0.10	0.24	5.41	7.63	38.3	24.1	11.8	6.57	1.88	18.4	55.8	33.9
(ind./nm)	<21cm	0.00	0.01	4.49	6.64	6.32	0.86	0.11	0.07	0.45	12.1	14.8	4.96

Year		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Catch rate	All	8.22	3.73	1.95	22.9	216	20.2	14.9	108	394	120	69.7
(ind./nm)	<21cm	0.16	0.02	0.27	13.8	186	8.93	1.65	59.4	341	70.9	7.38

Table 6.4.3.1. 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 6.4.4.3.1. Summary results of blue whiting stock assessment by means of ISVPA

	R(1)	B(1+)	SSB	F(3-7)
1981	6707.9	38985.3	4051.4	0.242
1982	7874.8	32997.4	3256.8	0.178
1983	4605.2	26474.9	2466.9	0.304
1984	17840.8	35131.4	1891.8	0.364
1985	16083.7	40054.9	1891.0	0.386
1986	19619.3	47445.5	2381.0	0.522
1987	9079.1	40100.3	2368.5	0.512
1988	9951.1	35438.8	2167.7	0.576
1989	10352.5	32036.4	1920.2	0.535
1990	14670.5	34759.7	1742.0	0.615
1991	7374.7	29056.1	1794.5	0.244
1992	6810.8	27783.5	2146.1	0.220
1993	14402.4	34379.2	2140.7	0.198
1994	17494.9	42746.0	2418.5	0.211
1995	7169.7	38540.2	2795.3	0.256
1996	14250.7	41552.5	2723.1	0.316
1997	28163.8	56851.2	2587.8	0.305
1998	32914.6	72980.4	2959.5	0.477
1999	38579.7	87789.8	3436.8	0.433
2000	50376.4	110603.6	4008.4	0.510
2001	70135.7	144073.7	4996.3	0.464
2002	38704.2	137333.2	6192.4	0.650
2003	36608.6	122599.3	6462.7	0.530

Table 6.4.4.3.2. Blue whiting. Estimates of stock abundance by means of ISVPA

	1	2	3	4	5	6	7	8	9	10+
1981	6707.94	4138.11	7688.27	5674.44	2024.87	1882.14	1677.73	2288.92	1957.72	4945.12
1982	7874.84	5165.39	3096.57	5398.34	3741.02	1312.84	1137.39	1016.63	1262.54	2991.86
1983	4605.22	6155.25	3951.90	2260.22	3763.94	2577.28	860.39	746.83	625.42	928.40
1984	17840.83	3497.21	4511.28	2674.16	1411.35	2300.26	1436.70	481.35	368.34	609.92
1985	16083.68	13376.73	2514.50	2948.77	1585.58	815.01	1184.82	743.37	212.00	590.41
1986	19619.29	12004.63	9552.19	1623.14	1715.61	896.78	407.61	595.47	313.55	717.21
1987	9079.11	14267.44	8239.50	5727.60	842.44	855.23	372.79	170.71	188.53	356.92
1988	9951.13	6615.34	9821.86	4968.47	2999.32	424.14	360.86	158.43	55.37	83.90
1989	10352.47	7169.31	4475.79	5730.26	2468.68	1424.19	163.68	140.46	44.28	67.31
1990	14670.52	7512.04	4904.27	2666.73	2944.32	1216.93	582.08	67.41	43.25	152.17
1991	7374.71	10500.79	5031.66	2806.32	1284.17	1349.89	444.57	214.67	17.11	32.21
1992	6810.83	5675.44	7850.81	3527.45	1845.91	830.54	813.01	268.50	117.87	43.10
1993	14402.38	5271.30	4279.12	5586.11	2370.82	1222.12	516.23	506.57	153.87	70.67
1994	17494.86	11203.55	4004.43	3085.07	3826.47	1602.30	780.81	330.53	301.25	116.69
1995	7169.72	13566.97	8471.86	2863.89	2088.89	2553.79	1006.68	491.70	192.18	134.56
1996	14250.68	5502.78	10102.40	5897.02	1864.27	1335.79	1514.71	598.83	264.36	221.65
1997	28163.76	10792.72	4016.72	6786.37	3642.60	1125.91	732.55	833.82	288.60	468.18
1998	32914.63	21379.96	7905.92	2715.41	4231.58	2222.64	626.29	408.96	410.00	164.97
1999	38579.73	24134.90	14861.22	4854.87	1463.09	2198.93	983.10	278.83	143.04	292.11
2000	50376.44	28526.22	16990.94	9344.88	2713.66	791.79	1032.19	464.11	106.94	256.43
2001	70135.74	36715.44	19645.56	10253.34	4899.34	1368.02	334.75	439.53	151.03	130.91
2002	38704.19	51554.62	25617.13	12149.16	5585.42	2576.99	616.01	151.68	158.10	219.89
2003	36608.63	27546.10	34228.73	14409.23	5688.67	2481.29	895.28	216.24	35.12	490.06

Table 6.4.4.3.3. Blue whiting. Estimates of fishing mortality coefficients by means of ISVPA

	1	2	3	4	5	6	7	8	9	10+
1981	0.0613	0.0899	0.1536	0.2166	0.2333	0.3037	0.3010	0.3950	0.3950	0.3950
1982	0.0464	0.0678	0.1148	0.1606	0.1726	0.2226	0.2207	0.2858	0.2858	0.2858
1983	0.0752	0.1107	0.1906	0.2709	0.2925	0.3844	0.3808	0.5068	0.5068	0.5068
1984	0.0880	0.1299	0.2252	0.3227	0.3491	0.4634	0.4589	0.6200	0.6200	0.6200
1985	0.0925	0.1368	0.2377	0.3416	0.3699	0.4929	0.4880	0.6632	0.6632	0.6632
1986	0.1185	0.1764	0.3115	0.4558	0.4962	0.6778	0.6704	0.9501	0.9501	0.9501
1987	0.1166	0.1734	0.3058	0.4469	0.4862	0.6629	0.6557	0.9258	0.9258	0.9258
1988	0.1279	0.1907	0.3389	0.4994	0.5448	0.7521	0.7436	1.0747	1.0747	1.0747
1989	0.1207	0.1797	0.3178	0.4659	0.5074	0.6948	0.6871	0.9780	0.9780	0.9780
1990	0.1344	0.2008	0.3582	0.5307	0.5799	0.8070	0.7975	1.1711	1.1711	1.1711
1991	0.0619	0.0908	0.1552	0.2189	0.2358	0.3070	0.3043	0.3995	0.3995	0.3995
1992	0.0562	0.0824	0.1403	0.1973	0.2124	0.2755	0.2731	0.3567	0.3567	0.3567
1993	0.0512	0.0749	0.1272	0.1783	0.1918	0.2480	0.2459	0.3197	0.3197	0.3197
1994	0.0543	0.0795	0.1352	0.1899	0.2044	0.2648	0.2625	0.3422	0.3422	0.3422
1995	0.0646	0.0949	0.1623	0.2293	0.2471	0.3224	0.3194	0.4205	0.4205	0.4205
1996	0.0779	0.1148	0.1979	0.2818	0.3043	0.4008	0.3970	0.5299	0.5299	0.5299
1997	0.0756	0.1113	0.1915	0.2723	0.2940	0.3865	0.3829	0.5099	0.5099	0.5099
1998	0.1103	0.1637	0.2876	0.4184	0.4546	0.6157	0.6092	0.8505	0.8505	0.8505
1999	0.1019	0.1510	0.2639	0.3817	0.4140	0.5563	0.5506	0.7584	0.7584	0.7584
2000	0.1163	0.1730	0.3051	0.4457	0.4849	0.6609	0.6537	0.9226	0.9226	0.9226
2001	0.1078	0.1599	0.2806	0.4074	0.4425	0.5979	0.5916	0.8225	0.8225	0.8225
2002	0.1401	0.2096	0.3754	0.5588	0.6114	0.8573	0.8469	1.2631	1.2631	1.2631
2003	0.1199	0.1785	0.3155	0.4621	0.5031	0.6884	0.6808	0.9675	0.9675	0.9675

Table 6.4.4.4.1. Blue whiting. Description of ICA runs, performed by WG in 2004. Mean F and SSB over the time series presented for each run to aid comparison with values in the final year.

Run	Separable period	Ages removed	Down weighting	No. fleets	Ref. age	Exploitation pattern	Age 1 weight	F	Mean F	SSB	SSB Mean
10	5	No	Manual	3	6	1 period	1	0.55	0.40	5.8	2.3
11	5	No	Iterative	6	6	1 period	1	0.50	0.40	6.4	2.3
12	5	No	Manual	6	6	1 period	1	0.47	0.30	6.4	2.3
13	8	No	Manual	6	6	1 period	1	0.45	0.40	5.3	2.4
14	4	No	Manual	6	6	1 period	1	0.50	0.40	6.5	2.3
15	5	No	Manual	6	6	two periods of 3	1	0.61	0.38	5.4	2.4
19	8	No	Manual	6	3	1 period	1	0.48	0.33	4.8	2.6
23	5	No	Manual	6	6	two periods of 3	1	0.47	0.38	6.4	2.4
16b	5	No	Manual	6	3	1 period	1	0.39	0.31	6.8	2.6
24	5	No	Manual	6	3	1 period	0.1	0.34	0.32	6.7	2.6
18b	3	No	Manual	6	3	1 period	1	0.33	0.29	7.7	2.9
25	8	No	Manual	6	3	1 period	1	0.37	0.32	5.8	2.6
20b	5	No	Manual	6	3	1 period	0.5	0.39	0.32	6.7	2.6
21b	5	Yes	Manual	6	3	1 period	0.5	0.31	0.30	8.0	2.9
22b	8	Yes	Manual	6	3	1 period	0.5	0.27	0.30	7.9	3.0
26*	8	No	Manual	6	3	1 period	0.5	0.37	0.30	6.1	2.8

* Final

Table 6.4.4.4.2. Summary table for final ICA run in 2004 for blue whiting.

Year	Recruits, age 1 (‘000s)	SSB (t)	Landings (t)	F $year^{-1}$	SOP %
1981	3597990	4083115	907732	0.2158	98
1982	4544990	2931273	513203	0.1712	93
1983	16805190	1993806	561332	0.2009	101
1984	19666890	1665859	626592	0.2541	101
1985	11068850	1919693	676812	0.317	99
1986	9594110	2225553	801786	0.4671	94
1987	9282250	1899261	656588	0.3842	100
1988	7616070	1624370	552020	0.4682	99
1989	10083700	1576645	598147	0.477	94
1990	22643940	1557809	558788	0.4033	100
1991	9938560	2071724	363724	0.2031	99
1992	6625190	2717521	473789	0.1494	99
1993	6078760	2622049	475143	0.1696	99
1994	6850130	2566783	458028	0.17	100
1995	8333210	2307944	505938	0.2134	100
1996	22692290	2148154	629286	0.2922	101
1997	46643560	2321325	640089	0.2828	100
1998	29952190	3101413	1123732	0.4196	99
1999	21828850	3811625	1251463	0.3524	99
2000	42443380	3879908	1409143	0.4499	99
2001	63280810	4208597	1775305	0.454	100
2002	47627280	5138254	1556955	0.4497	100
2003	62652030	6087012	2321407	0.3691	98

Table 6.4.4.4.3. Predicted catch numbers for separable period, as estimated in ICA final run for blue whiting in 2004.

AGE	1996	1997	1998	1999	2000	2001	2002	2003
1	916.1	1823.6	1720	1058	2607.4	3921.6	2924.2	3176.6
2	459.6	1205.9	3618.1	1926.9	1788.9	3455	5101.5	3187.2
3	681.5	809.9	3121.1	5310.4	4207.1	3039.7	5766.9	7247.5
4	681.2	657.9	1123.8	2406.7	6086.2	3665.3	2600.8	4261.7
5	444.2	366.5	512.4	470.3	1525.6	2868.1	1694.5	1036.5
6	515.1	288.5	342.1	259.6	358.1	867.6	1600.7	818.2
7	600	276.6	223.8	142.4	163.7	167.5	398.1	634
8	245	423.3	277.7	122.2	116.2	99.5	100	206.8
9	98.4	110.5	276.2	95.9	64.3	44.9	37.7	32.7

Table 6.4.4.4.4. Fishing mortalities per year, as estimated in ICA final run for blue whiting in 2004.

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1	0.0823	0.0366	0.1619	0.1372	0.139	0.0776	0.1047	0.0635	0.0993	0.0816	0.03
2	0.0986	0.1179	0.191	0.247	0.1746	0.121	0.0917	0.1233	0.1451	0.1093	0.0684
3	0.1562	0.1261	0.1631	0.2308	0.3332	0.2383	0.1509	0.133	0.352	0.1964	0.1089
4	0.1086	0.1817	0.1554	0.2333	0.2371	0.5577	0.4063	0.2063	0.2527	0.342	0.1268
5	0.2682	0.1174	0.1426	0.2287	0.2639	0.5478	0.4879	0.544	0.4183	0.2624	0.2751
6	0.293	0.21	0.1923	0.3253	0.4343	0.4554	0.3732	1.0442	0.6518	0.573	0.201
7	0.253	0.2208	0.351	0.2522	0.3164	0.5365	0.5029	0.4133	0.7103	0.6426	0.3035
8	0.3071	0.2298	0.3909	0.4231	0.2648	0.4301	0.7525	0.5156	0.4649	1.2155	0.2025
9	0.2521	0.2193	0.302	0.3778	0.3714	0.4607	0.4178	0.4613	0.4924	0.4946	0.212
10	0.2521	0.2193	0.302	0.3778	0.3714	0.4607	0.4178	0.4613	0.4924	0.4946	0.212

Table 6.4.4.4.4. (continued). Fishing mortalities per year, as estimated in ICA final run for blue whiting in 2004.

AGE	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	0.0702	0.0489	0.0507	0.04	0.0455	0.0441	0.0654	0.0549	0.0701	0.0707	0.0701	0.0575
2	0.0956	0.0688	0.0254	0.076	0.0804	0.0778	0.1154	0.097	0.1238	0.1249	0.1237	0.1015
3	0.1489	0.1237	0.1108	0.1309	0.2049	0.1983	0.2942	0.2471	0.3154	0.3183	0.3152	0.2588
4	0.1689	0.2076	0.1063	0.1993	0.3218	0.3114	0.4621	0.3881	0.4954	0.4999	0.4951	0.4064
5	0.1267	0.1773	0.2471	0.2438	0.2967	0.2871	0.426	0.3578	0.4568	0.4609	0.4565	0.3747
6	0.1795	0.1568	0.1766	0.2539	0.3307	0.32	0.4748	0.3988	0.5091	0.5138	0.5088	0.4177
7	0.1228	0.1825	0.2092	0.2393	0.3071	0.2972	0.4411	0.3704	0.4729	0.4772	0.4726	0.388
8	0.2446	0.0992	0.2312	0.3014	0.3826	0.3703	0.5495	0.4615	0.5892	0.5945	0.5888	0.4833
9	0.1954	0.1769	0.1686	0.2353	0.3073	0.2974	0.4413	0.3706	0.4731	0.4774	0.4729	0.3881
10	0.1954	0.1769	0.1686	0.2353	0.3073	0.2974	0.4413	0.3706	0.4731	0.4774	0.4729	0.3881

Table 6.4.4.5.1 Blue whiting. Objective function contributions (negative log-likelihood) for the SMS model

Data source	Likelihood contribution
Catch data	-149.05
Tuning data	
Norwegian acoustic survey, 1981-1990 1991-2003	2.87 5.05
Russian acoustic survey1982-1991 1992-1996	2.08 1.38
Norwegian Sea 1981-1990 1991-2001	15.42 16.55
Total tuning data	59.26

Table 6.4.4.5.2 Blue whiting, Survey catachability by fleet and period as estimated by SMS

Survey	**Period**	**age 2**	**age 3**	**age 4**	**age 5**	**age 6**	**age 7-8**
Norwegian acoustic survey	1981-1990	0.78	1.98	2.61	2.96	2.80	3.04
	1991-2003	0.95	2.19	3.00	1.98	1.59	1.53

Survey	**Period**		age 3	age 4	age 5	age 6	age 7-8
Russian acoustic survey	1982-1991		1.56	2.18	2.59	3.19	3.85
	1992-1996		2.69	3.35	2.80	1.60	1.26

Survey	**Period**	age 1	age 2	age 3	age 4	age 5	age 6-7
Norwegian Sea	1981-1990	0.40	0.45	0.68	0.82	0.82	0.69
	1991-2001	0.64	0.40	0.56	0.47	0.27	0.22

Table 6.4.4.5.3 Blue Whiting, SMS exploratory run, Stock numbers (thousands)

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	3107287	3993368	15287046	19734898	11006136	8756361	9632978	6952793
2	3419737	2357016	3072474	11614377	14675308	8118077	6319045	7165759
3	4416428	2489815	1753948	2242461	8201771	10234512	5474521	4464704
4	2440933	3038455	1769304	1211081	1474498	5293882	6285043	3602515
5	2206883	1599287	2075021	1164635	748793	890266	2998842	3889850
6	2135198	1379440	1051120	1304335	678596	423927	466552	1749454
7	1915789	1216853	840946	603576	676466	338609	190698	242362
8	1738816	1021826	702884	452560	287959	308326	136520	91156
9	1501514	918893	585803	374850	213408	129599	122424	64504
10	3138668	2452146	1932585	1343064	810097	460640	234361	168577
TSB	3208931	2569775	2049201	2191103	2720337	2913365	2583034	2385492
SSB	2903101	2320272	1801178	1560608	1884231	2244204	1998779	1850030

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	9270161	23335785	8257778	5574977	5244130	5873522	8021319	24496664
2	5181629	6679984	16895114	6377019	4321040	4137598	4655447	6292154
3	5077399	3486392	4527276	12643956	4799372	3343691	3224170	3570703
4	2950445	3107599	2156911	3244375	9136958	3427023	2428339	2253342
5	2241717	1664179	1777140	1488975	2263750	6059402	2332750	1558030
6	2284172	1168692	882202	1183377	1004412	1487553	4091568	1480898
7	916830	1020351	533889	547333	747058	643870	982891	2524064
8	117064	366603	418954	314853	329485	481576	427519	610268
9	43530	46090	148300	245328	188282	203766	308344	253004
10	111305	60962	43305	112199	213801	248663	289682	353910
TSB	2215203	1942988	3044320	3265534	2999344	2816755	2628409	2449222
SSB	1771899	1508598	1955697	2577452	2473462	2363735	2183796	2009328

Age	1997	1998	1999	2000	2001	2002	2003
1	45328501	27570442	20732646	35451807	56872588	33706885	41437715
2	18921179	34999489	20796931	15816625	26551578	42830827	25441430
3	4713620	14166848	25288883	15287831	11304423	19137604	30976491
4	2356909	3107317	8566991	15944720	9003779	6795283	11599290
5	1323916	1382027	1595260	4690347	7859320	4580068	3500874
6	902267	765109	695245	858222	2261408	3915916	2312505
7	824791	501367	364348	356748	389822	1065440	1872383
8	1418197	462386	241723	188960	164235	185991	515727
9	321209	744490	203359	115816	78721	71351	82183
10	319443	336314	475342	325183	183721	114017	81907
TSB	3008259	5008790	5400765	5121381	5655542	7215784	7451686
SSB	2038728	3176026	3868681	3876646	3972157	4793498	5523205

Table 6.4.4.5.4 Blue Whiting, SMS exploratory run, Fishing mortality

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	0.0764	0.0622	0.0748	0.0962	0.1044	0.1262	0.0959	0.0940
2	0.1174	0.0955	0.1149	0.1479	0.1604	0.1940	0.1474	0.1445
3	0.1740	0.1416	0.1704	0.2193	0.2378	0.2876	0.2185	0.2142
4	0.2228	0.1814	0.2182	0.2808	0.3046	0.3683	0.2798	0.2744
5	0.2699	0.2197	0.2643	0.3401	0.3689	0.4462	0.3389	0.3324
6	0.3623	0.2949	0.3547	0.4566	0.4952	0.5989	0.4549	0.4461
7	0.4285	0.3488	0.4196	0.5401	0.5857	0.7084	0.5381	0.5277
8	0.4378	0.3564	0.4287	0.5517	0.5984	0.7237	0.5497	0.5391
9	0.4378	0.3564	0.4287	0.5517	0.5984	0.7237	0.5497	0.5391
10	0.4378	0.3564	0.4287	0.5517	0.5984	0.7237	0.5497	0.5391
Avg. F 3-7	0.292	0.237	0.285	0.367	0.398	0.482	0.366	0.359

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	0.1277	0.1230	0.0585	0.0548	0.0370	0.0324	0.0428	0.0583
2	0.1963	0.1890	0.0898	0.0842	0.0564	0.0494	0.0653	0.0888
3	0.2909	0.2802	0.1332	0.1249	0.1368	0.1199	0.1583	0.2154
4	0.3726	0.3588	0.1706	0.1599	0.2107	0.1846	0.2438	0.3318
5	0.4514	0.4347	0.2066	0.1937	0.2199	0.1927	0.2544	0.3463
6	0.6059	0.5835	0.2774	0.2600	0.2447	0.2144	0.2831	0.3853
7	0.7166	0.6901	0.3281	0.3075	0.2391	0.2095	0.2766	0.3765
8	0.7321	0.7050	0.3352	0.3142	0.2806	0.2458	0.3246	0.4418
9	0.7321	0.7050	0.3352	0.3142	0.2806	0.2458	0.3246	0.4418
10	0.7321	0.7050	0.3352	0.3142	0.2806	0.2458	0.3246	0.4418
Avg. F 3-7	0.487	0.469	0.223	0.209	0.210	0.184	0.243	0.331

Age	1997	1998	1999	2000	2001	2002	2003
1	0.0586	0.0819	0.0706	0.0891	0.0836	0.0813	0.1047
2	0.0894	0.1250	0.1077	0.1359	0.1274	0.1240	0.1596
3	0.2167	0.3030	0.2612	0.3294	0.3090	0.3007	0.3871
4	0.3338	0.4667	0.4024	0.5074	0.4759	0.4632	0.5962
5	0.3483	0.4870	0.4199	0.5295	0.4967	0.4834	0.6222
6	0.3876	0.5419	0.4672	0.5892	0.5526	0.5378	0.6923
7	0.3787	0.5295	0.4566	0.5757	0.5400	0.5256	0.6765
8	0.4444	0.6214	0.5358	0.6756	0.6337	0.6168	0.7939
9	0.4444	0.6214	0.5358	0.6756	0.6337	0.6168	0.7939
10	0.4444	0.6214	0.5358	0.6756	0.6337	0.6168	0.7939
Avg. F 3-7	0.333	0.466	0.401	0.506	0.475	0.462	0.595

Table 6.4.4.5.5 Blue Whiting, SMS exploratory run, Stock summary

Year	Recruits age 1	SSB tonnes	F
1981	3107287	2903101	0.292
1982	3993368	2320272	0.237
1983	15287046	1801178	0.285
1984	19734898	1560608	0.367
1985	11006136	1884231	0.398
1986	8756361	2244204	0.482
1987	9632978	1998779	0.366
1988	6952793	1850030	0.359
1989	9270161	1771899	0.487
1990	23335785	1508598	0.469
1991	8257778	1955697	0.223
1992	5574977	2577452	0.209
1993	5244130	2473462	0.21
1994	5873522	2363735	0.184
1995	8021319	2183796	0.243
1996	24496664	2009328	0.331
1997	45328501	2038728	0.333
1998	27570442	3176026	0.466
1999	20732646	3868681	0.401
2000	35451807	3876646	0.506
2001	56872588	3972157	0.475
2002	33706885	4793498	0.462
2003	41437715	5523205	0.595

Table 6.4.4.6.2.1. Summary of recruitment indices for blue whiting.

	Survey	Year	Age	Raw numbers	Age-specific Normalized index	Age-specific Normalized log(index)	Average per age Normalized index	Average per age Normalized log(index)
Year class 2000	Icelandic summer acoustic	2000	0	10683	-0.03	0.30		
	North Sea shrimp	2000	0	4.233	-0.39	0.39		
	Faroese bottom trawl summer	2000	0	11120	-0.18	0.30	-0.20	0.33
	Norwegian Sea summer acoustic	2001	1	61470	2.90	1.33		
	Spanish CPUE	2001	1	16223	0.97	0.85		
	Icelandic summer acoustic	2001	1	4090	-0.78	-0.54		
	Barents Sea bottom trawl	2001	1	340768	3.92	1.52		
	PGSPFN May acoustic	2001	1	85772	1.33	1.10		
	Faroese bottom trawl spring	2001	1	2058	-0.19	0.24		
	Faroese bottom trawl summer	2001	1	65857	1.21	1.20	1.34	0.81
	Norwegian spawning st. acoustic	2002	2	71996	3.47	1.72		
	Spanish CPUE	2002	2	13725	-0.48	-0.34		
	Icelandic summer acoustic	2002	2	3107	0.00	0.27		
	PGSPFN May acoustic	2002	2	46656	1.26	0.88		
	Faroese bottom trawl summer	2002	2	10026	-0.56	-0.38	0.74	0.43
Year class 2001	Icelandic summer acoustic	2001	0	27305	1.79	1.49		
	North Sea shrimp	2001	0	2.735	-0.43	0.24		
	Faroese bottom trawl summer	2001	0	17431	0.15	0.66	0.50	0.80
	Spanish CPUE	2002	1	10520	0.07	0.35		
	Icelandic summer acoustic	2002	1	10785	1.05	0.87		
	Barents Sea bottom trawl	2002	1	70859	0.49	1.07		
	PGSPFN May acoustic	2002	1	15251	-1.05	-1.30		
	Faroese bottom trawl spring	2002	1	3885	0.31	0.85		
	Faroese bottom trawl summer	2002	1	12348	-0.64	-0.58	0.04	0.21
	Norwegian spawning st. acoustic	2003	2	23992	0.59	0.89		
	Spanish CPUE	2003	2	10461	-1.13	-1.16		
	Icelandic summer acoustic	2003	2	4899	0.91	0.86		
	PGSPFN May acoustic	2003	2	21487	-0.15	0.21		
	Faroese bottom trawl summer	2003	2	17338	-0.06	0.28	0.03	0.22
Year class 2002	Icelandic summer acoustic	2002	0	3815	-0.79	-1.00		
	North Sea shrimp	2002	0	0.036	-0.49	-1.25		
	Faroese bottom trawl summer	2002	0	1113	-0.69	-1.55	-0.66	-1.27
	Spanish CPUE	2003	1	9069	-0.15	0.18		
	Icelandic summer acoustic	2003	1	9158	0.60	0.63		
	Barents Sea bottom trawl	2003	1	7377	-0.32	0.42		
	PGSPFN May acoustic	2003	1	35688	-0.36	-0.12		
	Faroese bottom trawl spring	2003	1	873	-0.51	-0.59		
	Faroese bottom trawl summer	2003	1	18043	-0.44	-0.18	-0.20	0.06
	Norwegian spawning st. acoustic	2004	2	18569	0.27	0.70	0.27	0.70
Year class 2003	Icelandic summer acoustic	2003	0	5011	-0.66	-0.66		
	North Sea shrimp	2003	0	6.23	-0.35	0.53		
	Faroese bottom trawl summer	2003	0	60646	2.37	1.67	0.46	0.51
	Faroese bottom trawl spring	2004	1	13016	2.82	2.02	2.82	2.02

Table 6.4.5.1.1 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	Season	Number	Min.obs.num	2	3	4	5	6	7	8
1981	1	1	1	2372	7583	3253	3647	4611	4638	3654
1982	1	1	1	-1	-1	-1	-1	-1	-1	-1
1983	1	1	1	297	2108	2723	6511	3735	3650	3153
1984	1	1	1	15767	1721	1616	1719	1858	1128	567
1985	1	1	1	-1	-1	-1	-1	-1	-1	-1
1986	1	1	1	1003	5829	4122	624	228	203	250
1987	1	1	1	4960	8417	22589	4735	282	417	385
1988	1	1	1	9712	9090	12367	20392	7355	723	599
1989	1	1	1	6787	22270	9973	10504	7803	933	293
1990	1	1	1	14169	12670	11228	5587	6556	3273	516
1991	1	1	1	11147	6340	8497	7407	4558	2019	545
1992	1	1	1	1232	26123	4719	1574	1386	810	616
1993	1	1	1	4489	3321	26771	2643	1270	557	426
1994	1	1	1	1603	2950	4476	11354	1742	1687	908
1995	1	1	1	8538	9874	7906	6861	9467	1795	1083
1996	1	1	1	8781	7433	8371	2399	4455	4111	1202
1997	1	1	1	-1	-1	-1	-1	-1	-1	-1
1998	1	1	1	18218	34991	4697	1674	279	407	381
1999	1	1	1	19034	60309	26103	1481	316	72	153
2000	1	1	1	8613	31011	41382	6843	898	427	228
2001	1	1	1	44162	12843	13805	8292	718	175	51
2002	1	1	1	71996	54740	12757	5266	8404	1450	305
2003	1	1	1	23992	70303	28756	5735	2430	1708	260
2004	1	1	1	18569	40669	50137	15649	4454	2218	1313

Russian acoustic spawning stock survey, ages 3-8

Year	Season	Number	Min.obs.num	3	4	5	6	7	8
1982	1	2	10	540	2750	1340	1380	1570	2350
1983	1	2	10	2330	2930	9390	3880	1970	1370
1984	1	2	10	2900	800	1100	4200	2200	1200
1985	1	2	10	13220	930	580	1780	860	610
1986	1	2	10	18750	23180	2540	610	620	750
1987	1	2	10	4480	19170	5860	1070	500	810
1988	1	2	10	3710	4550	8610	4130	1270	480
1989	1	2	10	11910	7120	6670	6970	4580	2750
1990	1	2	10	9740	12140	5740	2580	1470	220
1991	1	2	10	10300	5350	5130	2630	1770	870
1992	1	2	1	20010	6700	1350	440	390	170
1993	1	2	1	4728	12337	5304	2249	1316	621
1994	1	2	1	-1	-1	-1	-1	-1	-1
1995	1	2	1	12657	10028	8942	2651	1093	408
1996	1	2	1	15285	10629	4897	6940	1482	653

Norwegian Sea acoustic survey, ages 1-7

Year	Season	Number	Min.obs.num	1	2	3	4	5	6	7
1981	3	3	1	182	728	4542	3874	2678	2834	2964
1982	3	3	1	184	460	1242	4715	3611	3128	2323
1983	3	3	1	22356	396	468	756	1404	576	468
1984	3	3	1	30380	13916	833	392	539	539	343
1985	3	3	1	5969	23876	12502	658	423	188	235
1986	3	3	1	2324	2380	7224	6944	1876	952	336
1987	3	3	1	8204	4032	5180	5572	1204	224	168
1988	3	3	1	4992	2880	2640	3480	912	120	96
1989	3	3	1	1172	1125	812	379	410	212	22
1990	3	3	1	-1	-1	-1	-1	-1	-1	-1
1991	3	3	1	-1	-1	-1	-1	-1	-1	-1
1992	3	3	1	792	1134	6939	766	247	172	90
1993	3	3	1	830	125	1070	6392	1222	489	248
1994	3	3	1	-1	-1	-1	-1	-1	-1	-1
1995	3	3	1	6974	2811	1999	1209	1622	775	173
1996	3	3	1	23464	1057	899	649	436	505	755
1997	3	3	1	30227	25638	1524	779	300	407	260
1998	3	3	1	24244	47815	16282	556	212	100	64
1999	3	3	1	14367	9750	23701	9754	1733	466	79
2000	3	3	1	25813	3298	2721	3078	23	46	6
2001	3	3	1	61470	22051	7883	3225	1824	156	12

Table 6.4.5.2.2 Blue Whiting: AMCI: Fishing mortality at age

Age	1981	1982	1983	1984	1985	1986	1987	1988
0								
1	0.079	0.051	0.150	0.167	0.153	0.141	0.117	0.082
2	0.105	0.084	0.111	0.164	0.178	0.226	0.196	0.171
3	0.192	0.145	0.172	0.223	0.261	0.340	0.297	0.256
4	0.229	0.177	0.207	0.264	0.284	0.407	0.384	0.336
5	0.270	0.201	0.230	0.295	0.317	0.441	0.415	0.394
6	0.426	0.315	0.366	0.467	0.515	0.675	0.598	0.571
7	0.426	0.315	0.366	0.467	0.515	0.675	0.598	0.571
8	0.426	0.315	0.366	0.467	0.515	0.675	0.598	0.571
9	0.426	0.315	0.366	0.467	0.515	0.675	0.598	0.571
10+	0.426	0.315	0.366	0.467	0.515	0.675	0.598	0.571
F(3-7)	0.309	0.230	0.268	0.343	0.378	0.508	0.459	0.425

Age	1989	1990	1991	1992	1993	1994	1995	1996
0								
1	0.103	0.093	0.035	0.056	0.052	0.051	0.053	0.087
2	0.197	0.188	0.077	0.082	0.076	0.068	0.082	0.108
3	0.310	0.298	0.124	0.130	0.123	0.117	0.143	0.190
4	0.395	0.387	0.159	0.168	0.162	0.150	0.186	0.250
5	0.480	0.473	0.204	0.204	0.193	0.189	0.235	0.302
6	0.676	0.694	0.298	0.294	0.268	0.252	0.300	0.393
7	0.676	0.694	0.298	0.294	0.268	0.252	0.300	0.393
8	0.676	0.694	0.298	0.294	0.268	0.252	0.300	0.393
9	0.676	0.694	0.298	0.294	0.268	0.252	0.300	0.393
10+	0.676	0.694	0.298	0.294	0.268	0.252	0.300	0.393
F(3-7)	0.507	0.509	0.217	0.218	0.202	0.192	0.233	0.306

Age	1997	1998	1999	2000	2001	2002	2003
0							
1	0.074	0.084	0.061	0.066	0.090	0.076	0.147
2	0.112	0.155	0.137	0.158	0.179	0.176	0.188
3	0.202	0.292	0.274	0.326	0.365	0.360	0.392
4	0.260	0.372	0.376	0.457	0.519	0.533	0.581
5	0.306	0.412	0.373	0.459	0.513	0.531	0.624
6	0.396	0.545	0.481	0.606	0.651	0.672	0.727
7	0.396	0.545	0.481	0.606	0.651	0.672	0.727
8	0.396	0.545	0.481	0.606	0.651	0.672	0.727
9	0.396	0.545	0.481	0.606	0.651	0.672	0.727
10+	0.396	0.545	0.481	0.606	0.651	0.672	0.727
F(3-7)	0.312	0.433	0.397	0.491	0.540	0.554	0.610

Table 6.4.5.2.3 Blue Whiting: AMCI: Stock numbers at age

Age	1981	1982	1983	1984	1985	1986	1987	1988
0								
1	3,358,560	3,920,662	11,450,733	19,016,674	12,011,291	9,429,937	9,260,073	7,706,866
2	3,646,770	2,540,889	3,049,799	8,071,385	13,176,051	8,441,022	6,703,938	6,744,415
3	4,653,650	2,688,114	1,912,560	2,233,705	5,609,587	9,026,187	5,514,923	4,510,929
4	2,972,687	3,144,862	1,903,280	1,319,077	1,462,819	3,536,511	5,259,410	3,355,998
5	2,382,764	1,935,421	2,156,270	1,266,828	829,411	901,975	1,926,442	2,931,706
6	2,318,133	1,489,750	1,296,697	1,402,144	772,294	494,748	475,267	1,041,651
7	1,895,226	1,239,011	890,443	736,471	719,817	377,893	206,160	213,916
8	1,786,152	1,012,973	740,573	505,735	378,081	352,216	157,467	92,792
9	1,490,579	954,674	605,467	420,615	259,629	185,000	146,767	70,875
10+	3,125,753	2,467,369	2,045,399	1,505,584	988,851	610,897	331,648	215,333

Age	1989	1990	1991	1992	1993	1994	1995	1996
0								
1	9,015,810	21,516,302	9,083,595	6,104,599	5,532,517	6,497,652	7,573,674	20,506,834
2	5,810,531	6,657,906	16,054,254	7,181,951	4,726,460	4,298,298	5,054,060	5,881,274
3	4,654,779	3,906,181	4,515,464	12,168,161	5,417,764	3,587,060	3,288,330	3,811,197
4	2,859,083	2,794,777	2,374,004	3,266,477	8,743,640	3,924,255	2,612,946	2,333,582
5	1,963,991	1,577,184	1,553,519	1,658,442	2,261,142	6,089,206	2,764,650	1,776,401
6	1,618,655	994,703	804,571	1,037,457	1,106,862	1,526,552	4,124,997	1,789,768
7	481,955	674,164	406,848	488,895	632,802	693,470	971,525	2,501,784
8	98,975	200,732	275,743	247,220	298,204	396,463	441,337	589,224
9	42,933	41,223	82,102	167,554	150,793	186,830	252,316	267,668
10+	132,424	73,035	46,733	78,287	149,952	188,422	238,818	297,869

Age	1997	1998	1999	2000	2001	2002	2003	2004
0								
1	41,591,472	28,588,844	19,033,352	33,972,100	47,003,316	34,434,780	20,000,000	20,000,000
2	15,383,627	31,619,636	21,525,614	14,655,518	26,035,112	35,167,888	26,140,904	14,138,587
3	4,321,176	11,259,105	22,162,550	15,374,727	10,247,773	17,817,244	24,143,876	17,736,556
4	2,580,689	2,890,398	6,882,722	13,796,895	9,088,456	5,822,901	10,176,097	13,357,787
5	1,488,655	1,629,131	1,631,072	3,870,062	7,153,127	4,428,360	2,798,812	4,662,082
6	1,075,412	897,695	883,237	919,738	2,001,306	3,506,905	2,131,377	1,227,227
7	988,848	592,305	426,066	446,908	410,819	854,297	1,466,585	843,135
8	1,382,238	544,629	281,121	215,584	199,620	175,366	357,267	580,156
9	325,547	761,296	258,493	142,244	96,295	85,212	73,338	141,328
10+	312,460	351,395	528,108	398,011	241,315	144,116	95,905	66,949

Table 6.4.5.2.4. Blue whiting. AMCI summary table

SUMMARY TABLE

Year	Recruits age 1	SSB	F (3-7)	Catch SOP
1981	3,358,560	2,807,506	0.3087	922,980
1982	3,920,661	2,292,762	0.2305	550,643
1983	11,450,733	1,845,598	0.2681	553,344
1984	19,016,673	1,507,602	0.3431	615,569
1985	12,011,290	1,648,462	0.3782	678,214
1986	9,429,937	1,887,405	0.5078	847,145
1987	9,260,072	1,695,170	0.4585	654,718
1988	7,706,865	1,506,629	0.4254	552,264
1989	9,015,810	1,447,483	0.5074	630,316
1990	21,516,302	1,350,967	0.5093	558,128
1991	9,083,595	1,786,877	0.2165	364,008
1992	6,104,598	2,403,472	0.2183	474,592
1993	5,532,516	2,363,797	0.2025	475,198
1994	6,497,651	2,342,592	0.1921	457,696
1995	7,573,674	2,176,386	0.2328	505,175
1996	20,506,833	2,014,202	0.3056	621,104
1997	41,591,472	2,066,203	0.3122	639,680
1998	28,588,843	2,845,329	0.4334	1,131,954
1999	19,033,352	3,447,824	0.397	1,261,033
2000	33,972,101	3,492,714	0.4908	1,412,449
2001	47,003,317	3,679,005	0.5399	1,771,805
2002	34,434,779	4,066,588	0.5535	1,556,954
2003	20,000,000	4,294,960	0.6103	2,365,319
2004		3,789,678		

Table 6.5.1. Blue Whiting. Input data for the stochastic short-term prediction

STPR3
Run: AMCI based Short term pred BW 2005
Time and date: May 2
Fbar age range: 3-7
Ochhams razor' stock-recruitment function (p1: 13.8 10*9 individuals; p2: 1.5 million tonnes)

2004								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	from S/R	0.2	0.11	0.25	0		0.1468	
2		0.2	0.40	0.25	0		0.1879	
3		0.2	0.82	0.25	0		0.392	
4		0.2	0.86	0.25	0		0.5806	
5		0.2	0.91	0.25	0		0.6245	
6		0.2	0.94	0.25	0	sampled	0.7275	sampled
7		0.2	1.00	0.25	0	from	0.7275	from
8	from AMCI	0.2	1.00	0.25	0	table	0.7275	table
9	bootstrap	0.2	1.00	0.25	0	6.3.3.1	0.7275	6.3.3.1
10		0.2	1.00	0.25	0		0.7275	

2004								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	from S/R	0.2	0.11	0.25	0		0.1468	
2	.	0.2	0.40	0.25	0		0.1879	
3	.	0.2	0.82	0.25	0		0.392	
4	.	0.2	0.86	0.25	0		0.5806	
5	.	0.2	0.91	0.25	0		0.6245	
6	.	0.2	0.94	0.25	0	sampled	0.7275	sampled
7	.	0.2	1.00	0.25	0	from	0.7275	from
8	.	0.2	1.00	0.25	0	table	0.7275	table
9	.	0.2	1.00	0.25	0	6.3.3.1	0.7275	6.3.3.1
10	.	0.2	1.00	0.25	0		0.7275	

2005								
Age	Stock size	Natural mortality	Maturity ogive	Prop. of F bef. spaw.	Prop. of M bef. spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	from S/R	0.2	0.11	0.25	0		0.1468	
2	.	0.2	0.40	0.25	0		0.1879	
3	.	0.2	0.82	0.25	0		0.392	
4	.	0.2	0.86	0.25	0		0.5806	
5	.	0.2	0.91	0.25	0		0.6245	
6	.	0.2	0.94	0.25	0	sampled	0.7275	sampled
7	.	0.2	1.00	0.25	0	from	0.7275	from
8	.	0.2	1.00	0.25	0	table	0.7275	table
9	.	0.2	1.00	0.25	0	6.3.3.1	0.7275	6.3.3.1
10	.	0.2	1.00	0.25	0		0.7275	

Table 6.5.2 Blue Whiting
Probabilistic catch forecast for 2005 assuming status quo F in 2004.
Confidence intervals correspond to 25 and 75 percentiles.

F2004=F2003=0.61(0.56-0.74); median catch 2004=1779 (1661-1915); median SSB 2004=3381 (2927-3851)

	F2005		SSB 2005		SSB 2006	
Catch 2005	median	confidence interval	median	confidence interval	median	confidence interval
800	0.230	(0.197-0.269)	3915	(3381-4556)	4087	(3521-4681)
900	0.262	(0.224-0.307)	3891	(3354-4531)	4003	(3431-4589
1000	0.295	(0.252-0.346)	3866	(3327-4506)	3916	(3350-4500)
1075	*0.320*	*(0.273-0.376)*	*3848*	*(3306-4487)*	*3849*	*(3283-4429)*
1100	0.329	(0.280-0.387)	3841	(3299-4481)	3828	(3261-4407)
1200	0.364	(0.309-0.428)	3816	(3270-4455)	3742	(3176-4319(
1300	0.400	(0.339-0.471)	3789	(3241-4429)	3657	(3095-4232)
1400	0.436	(0.369-0.516)	3761	(3213-4400)	3566	(3008-4145)
1500	0.474	(0.400-0.562)	3733	(3185-4272)	3476	(2924-4057)
2000	0.681	(0.569-0.818)	3587	(3019-4223)	3041	(2499-3633)
2500	0.929	(0.764-1.136)	3416	(2845-4058)	2608	(2070-3188)
2930	1.183	(0.954-1.489)	3252	(2664-3903)	2250	(1770-2820)

Table 6.6.1. Medium term projection for blue whiting spawning stock biomass based on the final AMCI run and 3 different scenarios for mean recruitment and catch regime. SSBs below B_{pa} are highlighted.

Mean recruitment when SSB>1.5 mill. tonnes	Year	Catch 2.0 mill. tonnes			Catch 1.5 mill. tonnes			Catch 1.0 mill. tonnes		
		25%	50%	75%	25%	50%	75%	25%	50%	75%
Fitted 1981-2002 (13.8 bill.)	2005	3019	3587	4223	3185	3733	4373	3327	3866	4506
	2010	0	0	0	0	908	1699	2465	3307	4057
	2015	0	0	0	0	0	0	1515	2409	3320
Geometric mean 1993-2002 (18.7 bill.)	2005	3071	3641	4266	3228	3792	4409	3361	3921	4542
	2010	0	0	843	1324	2354	3322	3696	4691	5668
	2015	0	0	0	0	254	2165	4001	5092	6245
Arithmetic mean 1993-2002 (23.3 bill.)	2005	3111	3676	4307	3261	3825	4454	3395	3959	4582
	2010	0	1198	2399	2447	3628	4797	4843	6056	7205
	2015	0	0	0	1916	3459	5038	6253	7538	9028

Table 6.9.1 Blue whiting. Total landings, No. of samples, No. of fish measured and No. of fish aged by country and quarter for 2003.

Country	Quarter	Landings (t)	No. Of samples	No. Fish measured	No. Fish aged
Denmark	1	10088	2	91	91
	2	21661	8	401	401
	3	43821	9	412	412
	4	7365	1	50	50
	Total	82935	20	954	954
Faroe Islands	1	42646	7	1554	600
	2	166556	9	2047	900
	3	73601	7	1518	700
	4	47092	5	1135	500
	Total	329895	28	6254	2700
France	1	11793	0	0	0
	2				
	3	1570	0	0	0
	4	786	0	0	0
	Total	14149	0	0	0
Germany	1	3617	0	0	0
	2	18379	6	257	257
	3	807	0	0	0
	4				
	Total	22803	6	257	257
Iceland	1	7846	2	200	100
	2	143559	46	7008	3850
	3	231589	69	5568	3342
	4	118499	29	2288	1504
	Total	501493	146	15064	8796
Ireland	1	22480	12	2358	1296
	2	28	0	0	0
	3				
	4	72	0	0	0
	Total	22580	12	2358	1296
Norway	1	347863	52	2488	2307
	2	369542	59	3926	1512
	3	95729	35	2746	894
	4	38262	20	1959	257
	Total	851396	166	11119	4970
Portugal	1	586	85	9923	203
	2	734	92	10669	239
	3	603	85	9651	255
	4	728	80	9459	208
	Total	2651	342	39702	905
Russia	1	63956	39	6210	364
	2	144372	208	36810	1672
	3	80700	285	29016	1368
	4	66291	98	13626	100
	Total	355319	630	85662	3504
Scotland	1	20768	0	0	0
	2	6479	0	0	0
	3	30	0	0	0
	4	104	0	0	0
	Total	27381	0	0	0
Spain	1	3319	30	2542	300
	2	3461	38	2439	300
	3	3379	57	5680	425
	4	3666	66	6822	425
	Total	13825	191	17483	1450
Sweden	1	15	0	0	0
	2	7627	0	0	0
	3	57673	0	0	0
	4	217	0	0	0
	Total	65532	0	0	0
The Netherlands	1	22268	5	1264	125
	2	33967	49	8349	1225
	3	1021	1	304	25
	4	5	0	0	0
	Total	57261	55	9917	1375
Grand Total		2347220	1596	188770	26207

Table 6.9.2. Blue Whiting. Sampling levels in 2003 per area

Area	landings	nos samples	nos measured	nos aged
I	46	1	49	49
IIa	832,173	629	74,780	8,441
IIb	16,973	0	0	0
IIIa	16,162	7	345	345
IVa	140,992	78	7,342	1,231
IVb	1,026	0	0	0
IXa	2,651	342	39,702	905
Va	82,253	29	2,966	1,722
Vb	468,269	136	23,311	5,728
VIa	126,037	24	2,575	1,021
VIb	337,915	75	7,544	2,452
VIIb	276	0	0	0
VIIbc	128,090	14	750	651
VIIc	40,850	10	2,081	621
VIIg	4	0	0	0
VIIgk	71,262	7	504	200
VIIg-k	4,945	0	0	0
VIIgk+XII	19,354	36	6,217	300
VIIh	142	0	0	0
VIIIabd	1,380	1	304	25
VIIIc+IXa	13,825	191	17,483	1,450
VIIj	2,241	2	569	50
VIIk	10,624	9	1,929	1,000
XII	3,854	0	0	0
XIVb	63	5	319	16
total	2,321,406	1,596	188,770	26,207

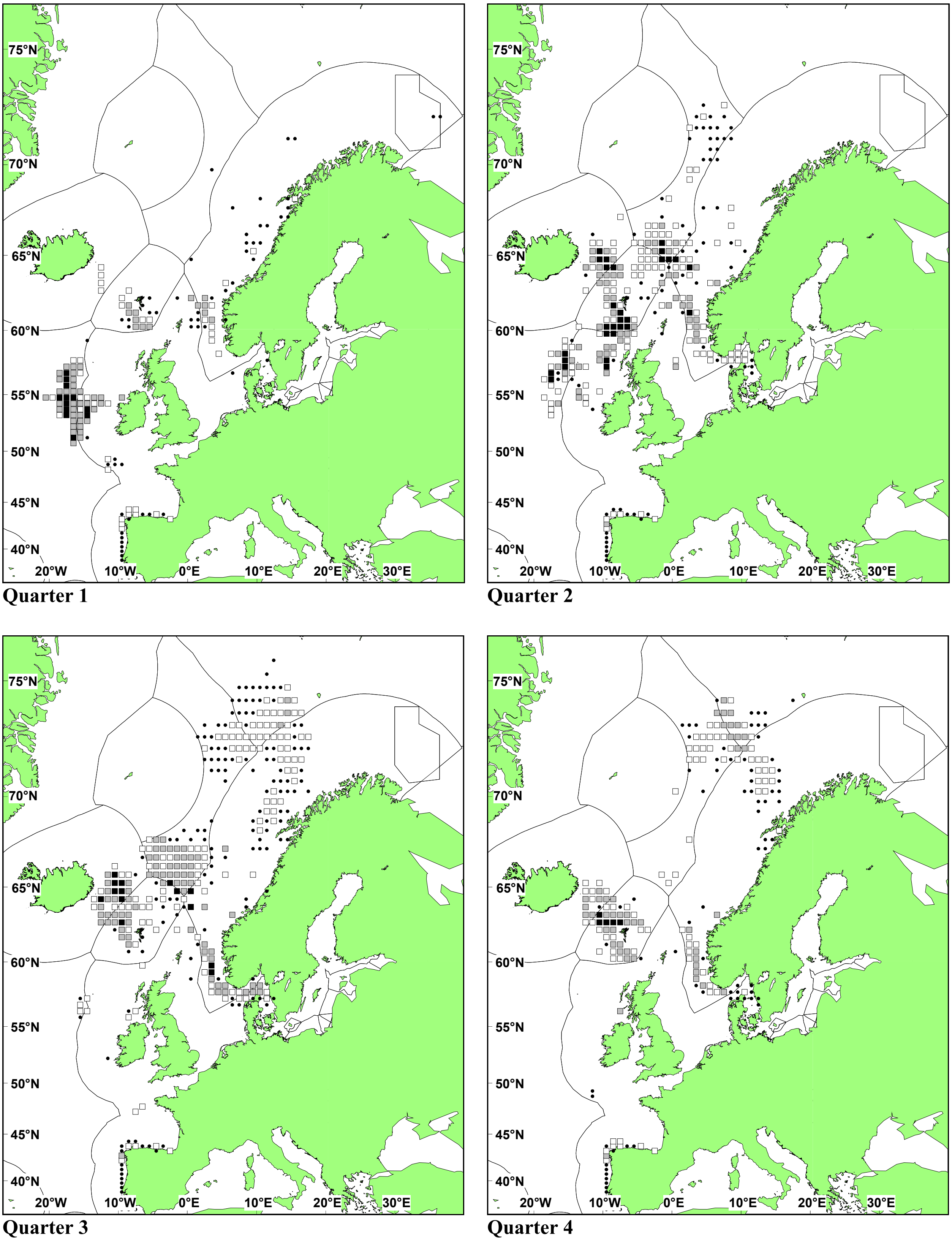


Figure 6.2.1. Total catches of blue whiting in 2003 by quarter and ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t.

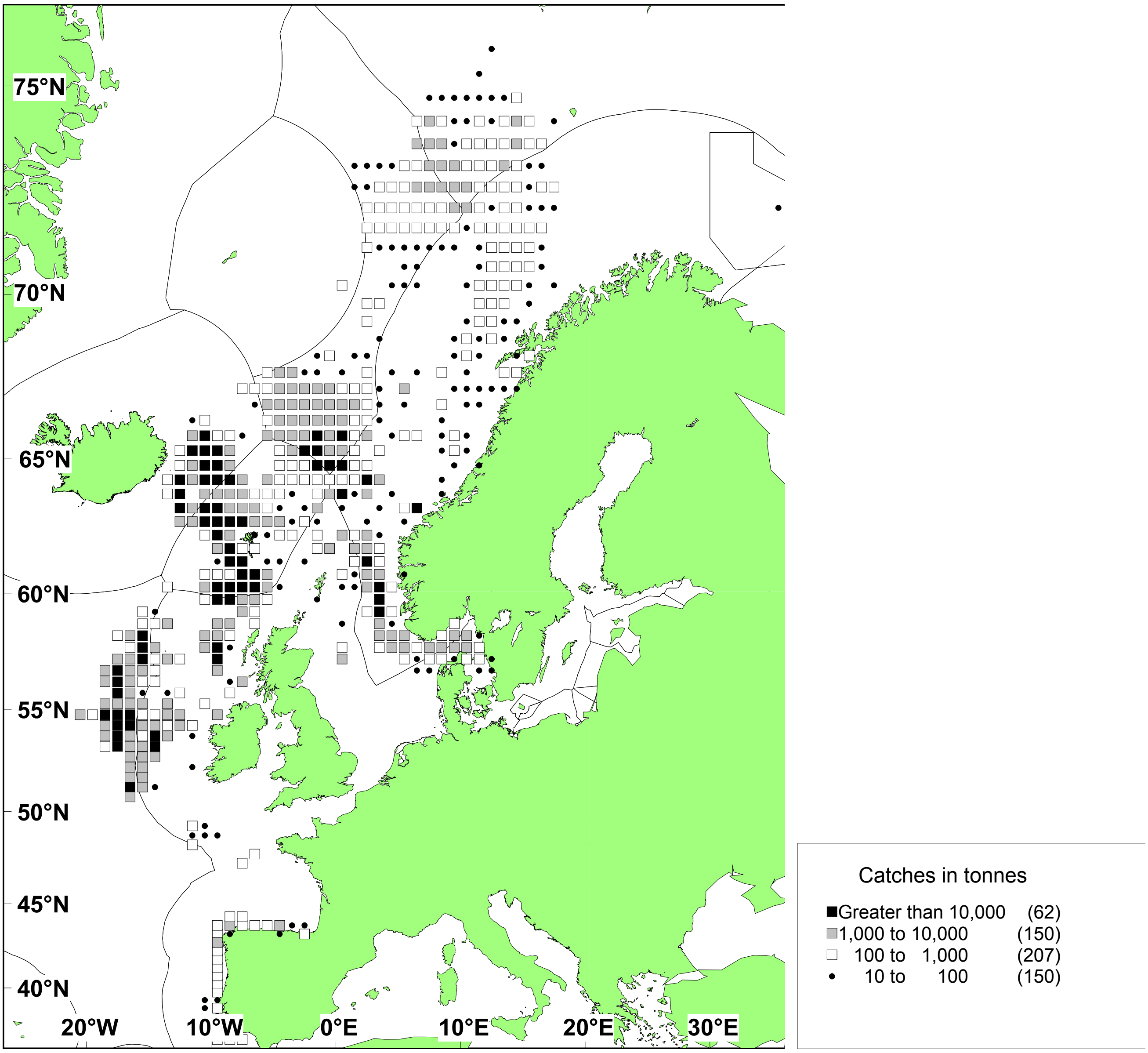


Figure 6.2.2. Total catches of blue whiting in 2003 by ICES rectangle. Grading of the symbols: small dots 10-100 t, white squares 100-1 000 t, grey squares 1 000-10 000 t, and black squares > 10 000 t.

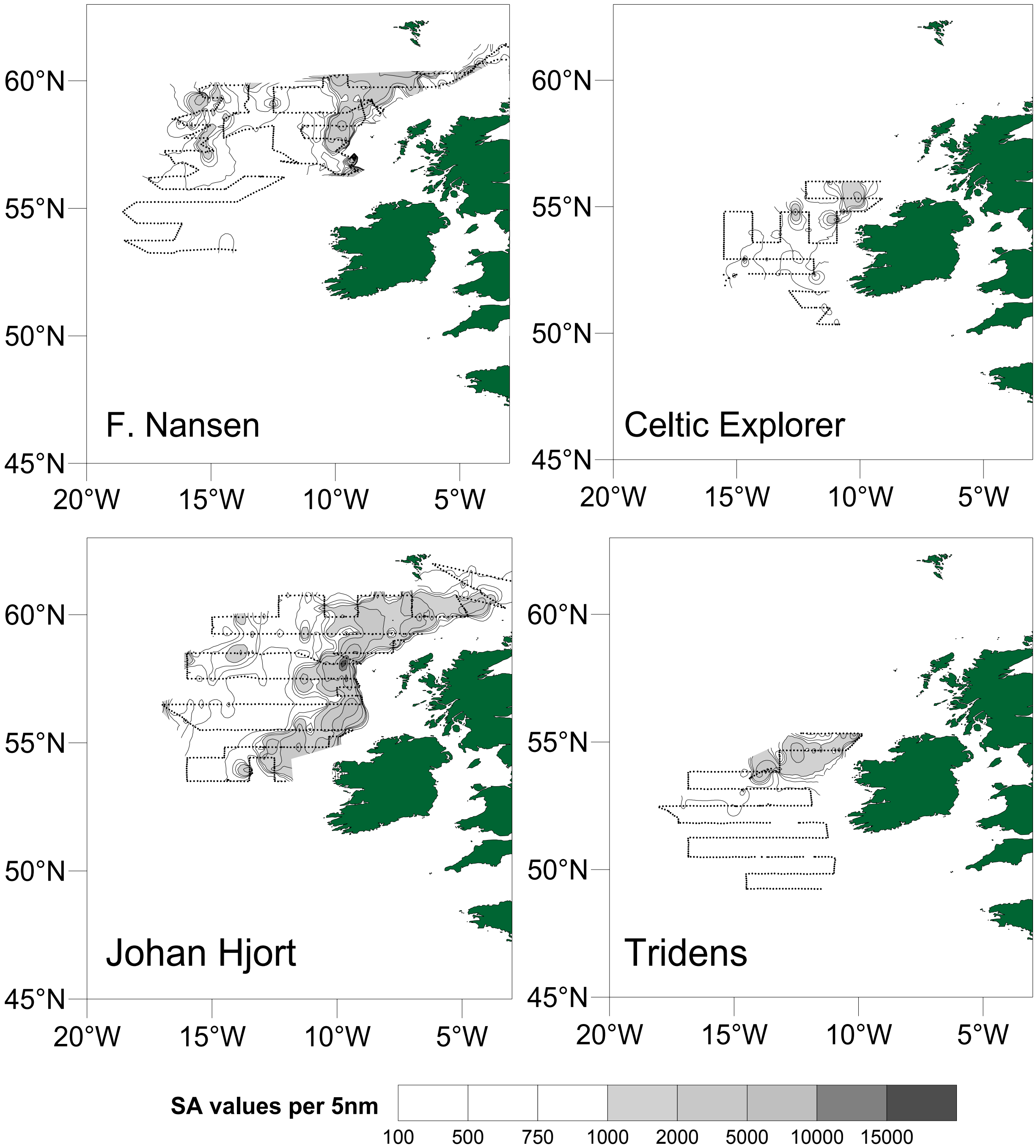


Figure 6.4.1.1.1. Density of blue whiting in terms s_A-values ($m^2/n.mile^2$) based on 5 nm values reported by each of the four research vessels during the international blue whiting spawning stock survey in March-April 2004.

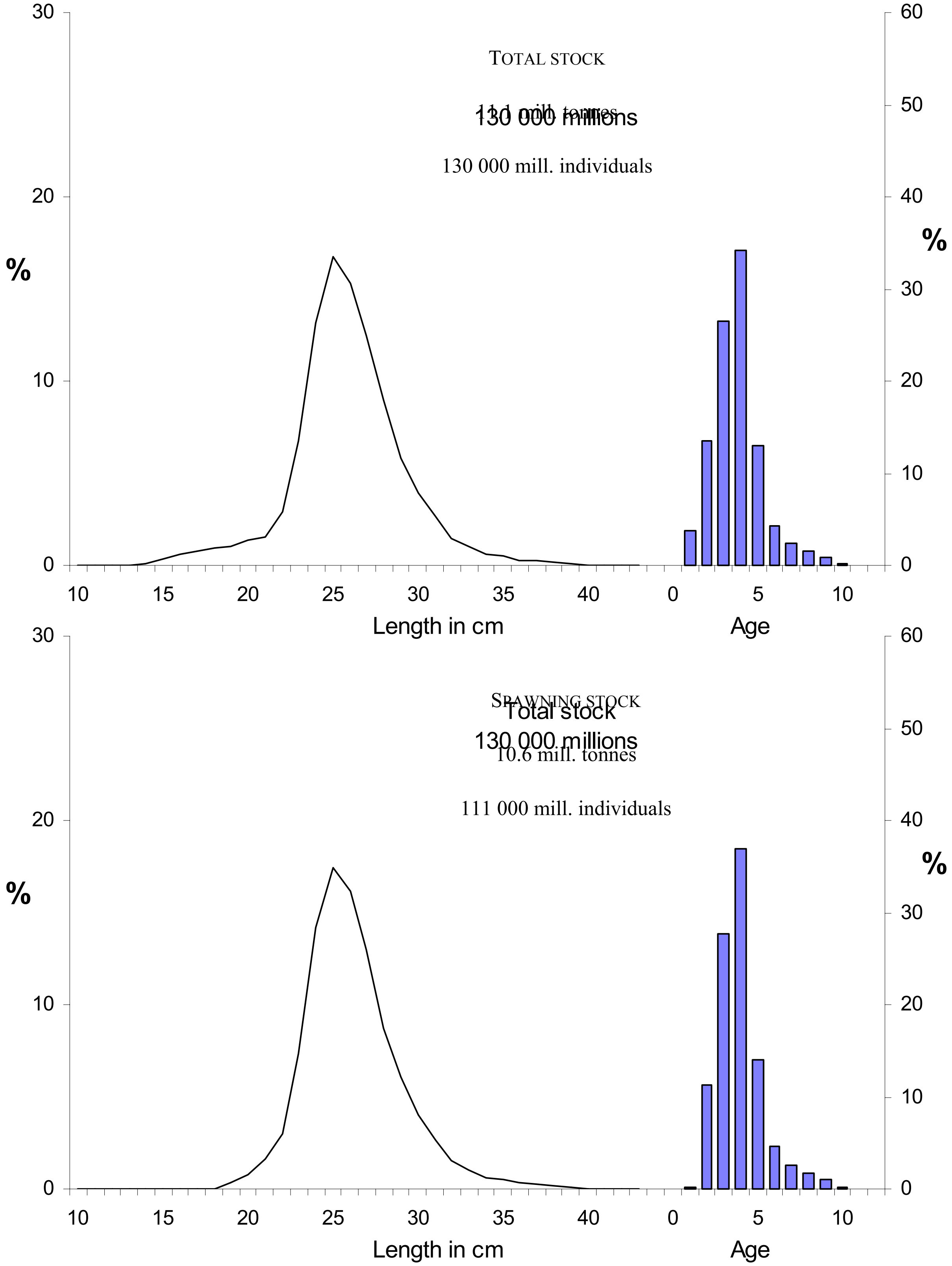


Figure 6.4.1.1.2. Length and age distribution of blue whiting estimated from the international blue whiting spawning stock survey in March-April 2004.

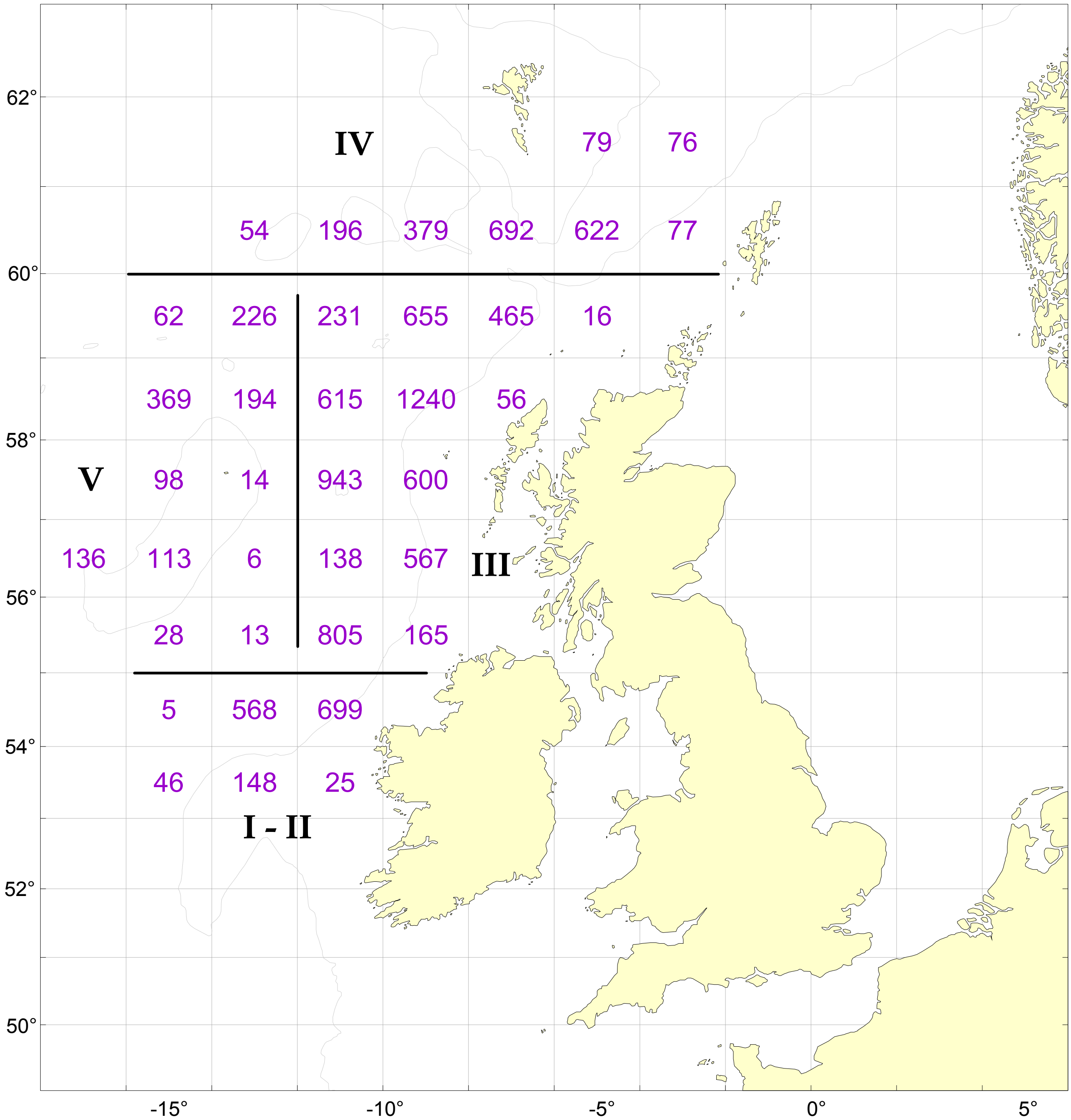


Figure 6.4.1.1.3. Blue whiting biomass in 1000 tonnes, spring 2004. R/V Johan Hjort, March-April 2004.

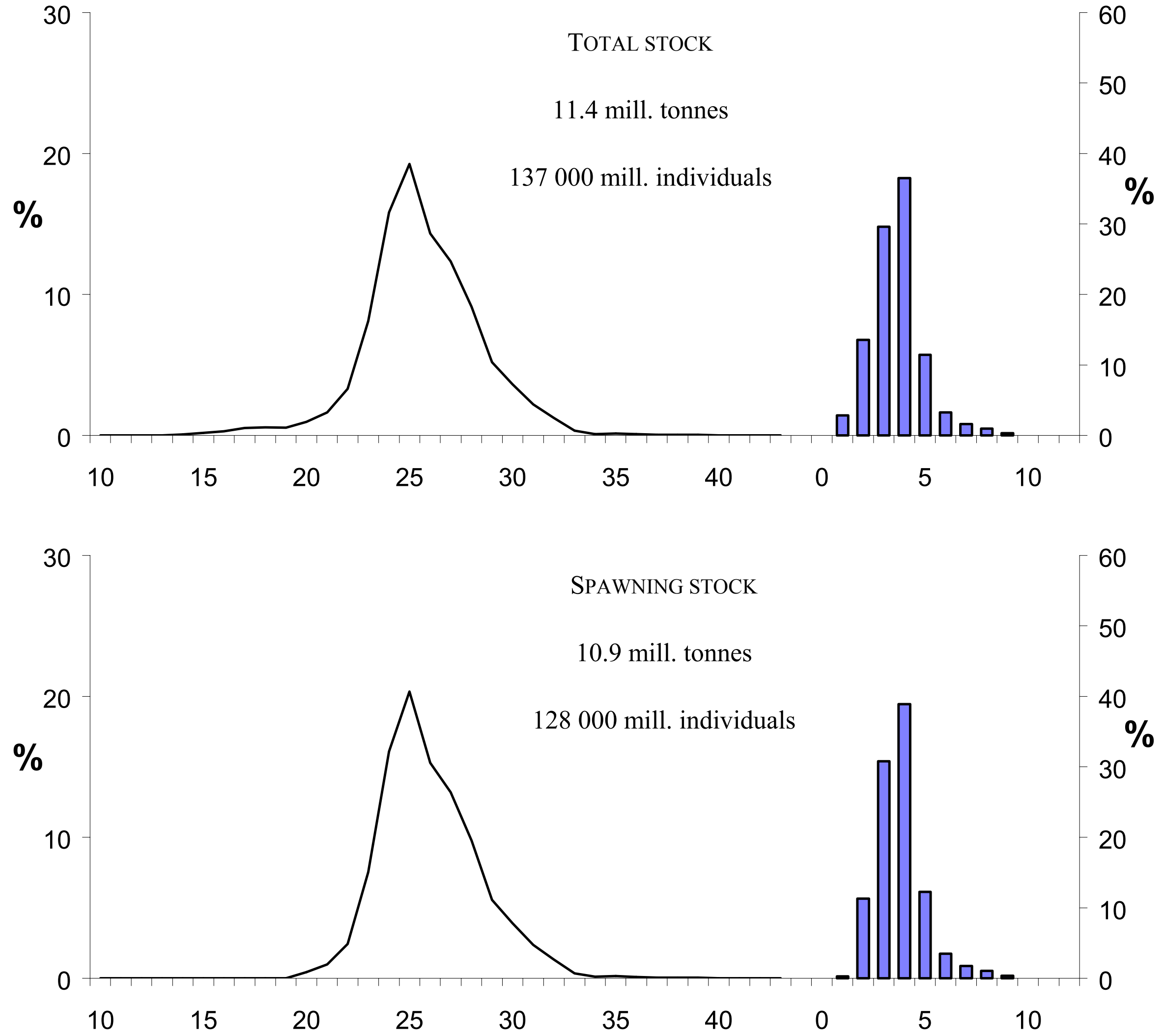


Figure 6.4.1.1.4. Length and age distribution of blue whiting as estimated by R/V Johan Hjort in March-April 2004.

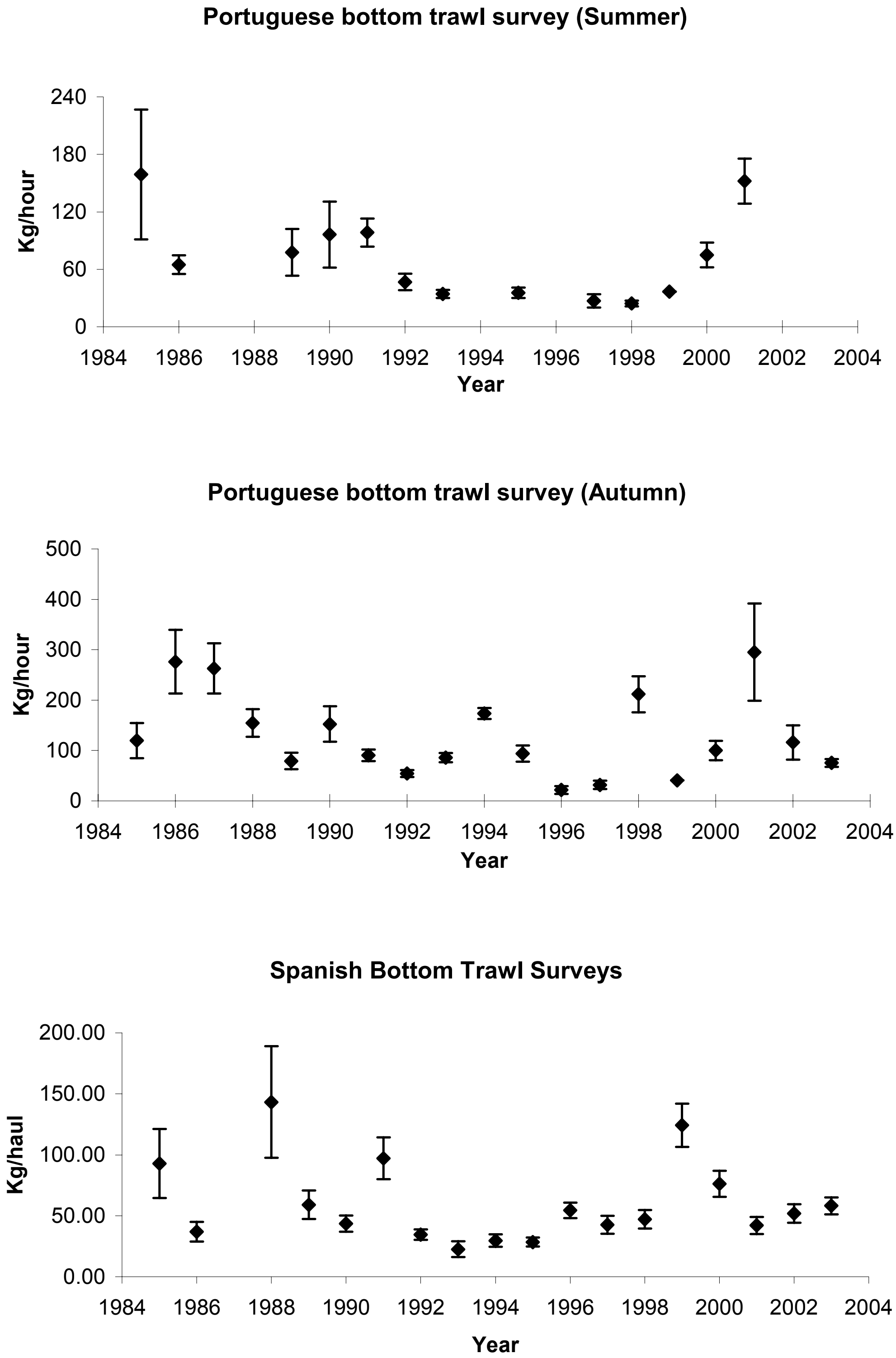


Figure 6.4.2.1 Blue whiting. Mean catch rates in the bottom trawl surveys from the southern area.

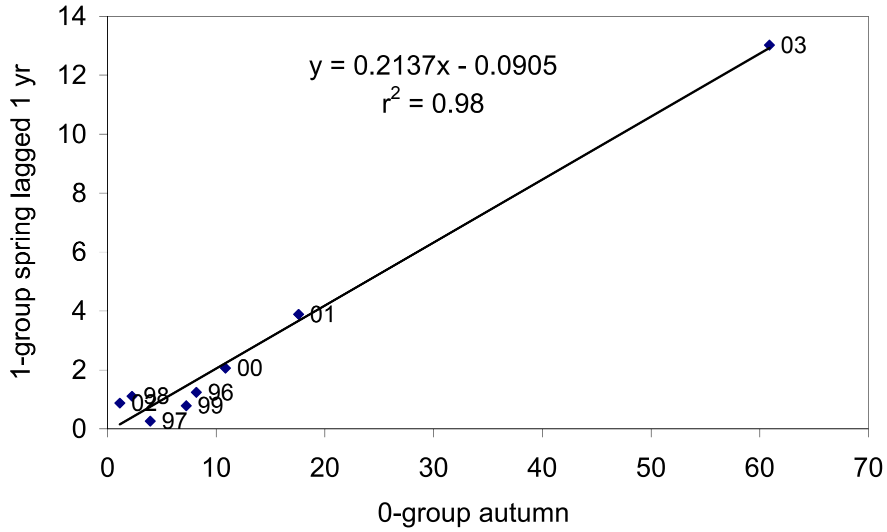


Figure 6.4.2.2. Bottom trawl 0-group index (number of blue whiting caught 10^{-3}) from autumn 1996-2003 compared to the following 1-group spring index lagged one year to match the 0-group index.

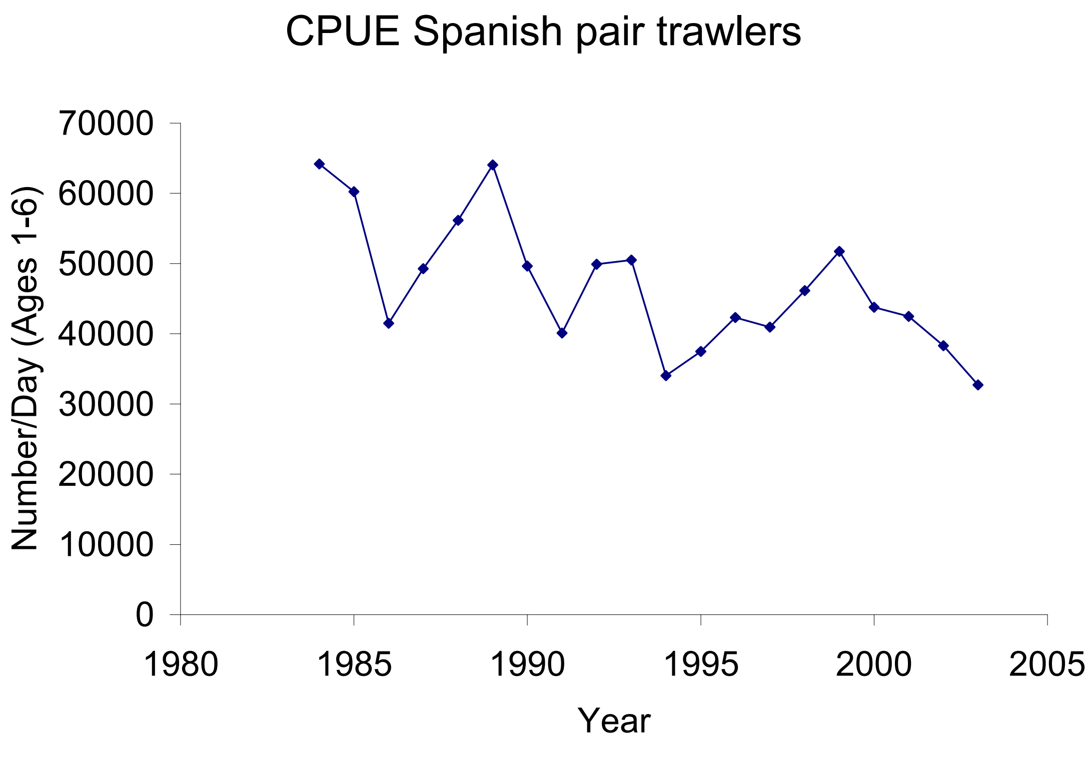


Figure 6.4.3.1 Blue whiting CPUE from Spanish Pair trawlers in ICES Div VIIIc and IXa (North)

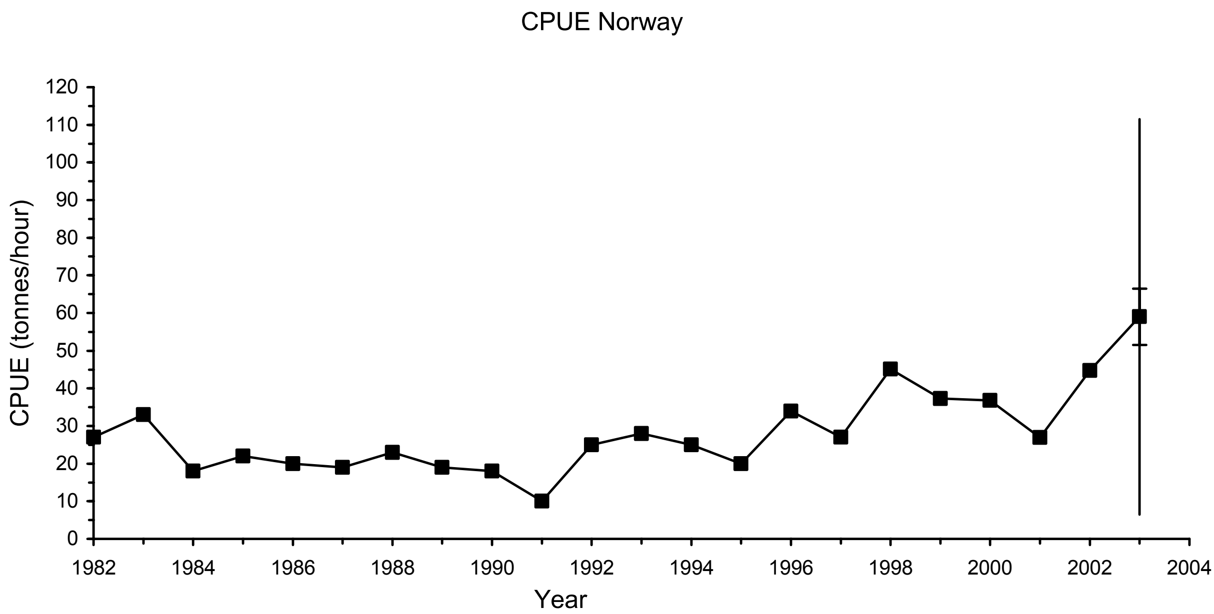


Figure 6.4.3.2. Blue whiting. Overall aggregated CPUE from the Norwegian directed fisheries in 1982–2003 (tonnes/hour). Vertical bars show strandard deviation and 95% confidence limits.

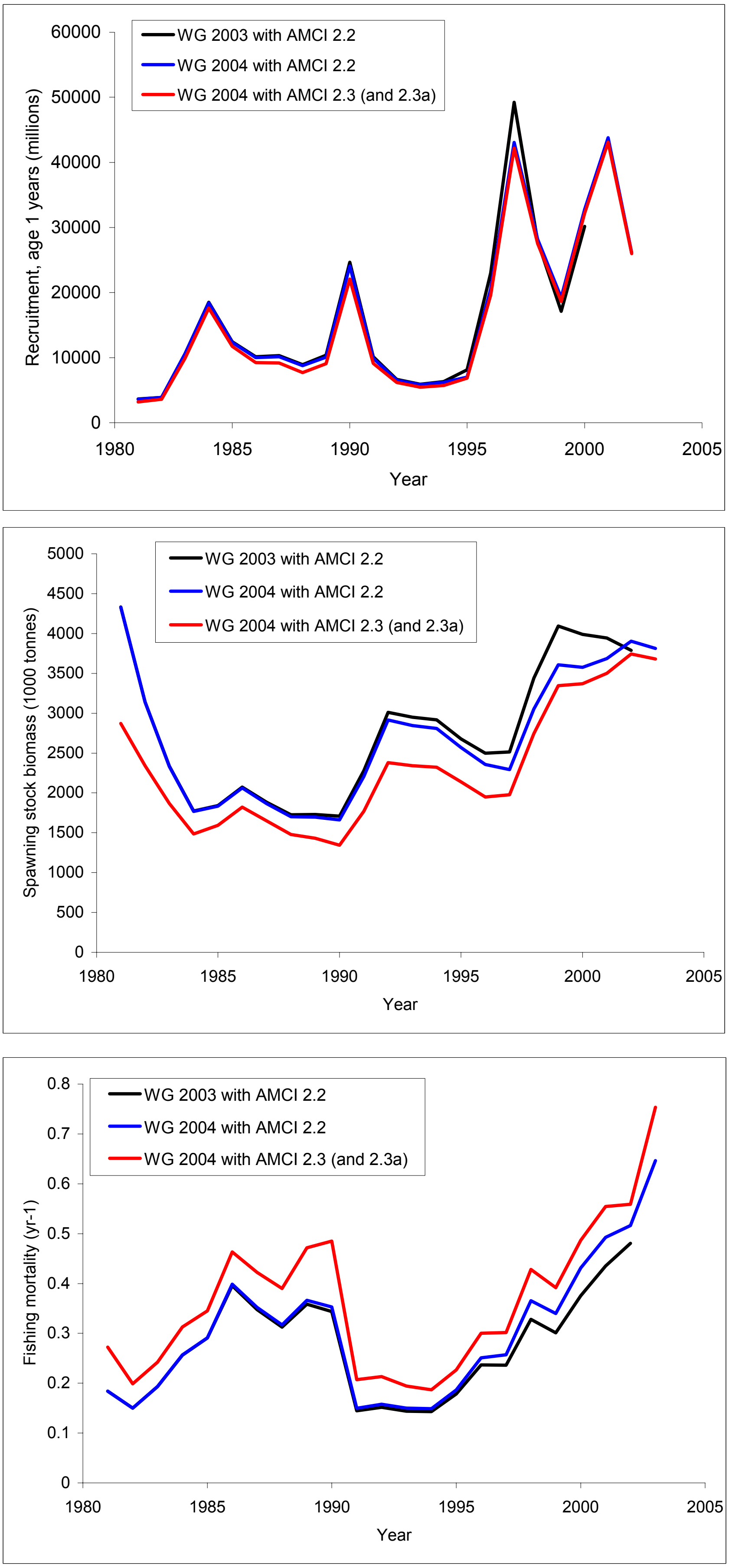


Figure 6.4.4.2.1. Blue Whiting. Comparison on blue whiting assessments with the settings from assessment from 2003 and from data available to either WG2003 and 2004 with different versions of AMCI.

Figure 6.4.4.2.2. Blue Whiting. Data exploration with AMCI. Effects of deviations from WG2003 settings including restricting age ranges of survey time series as recommended by SGAMHBW.

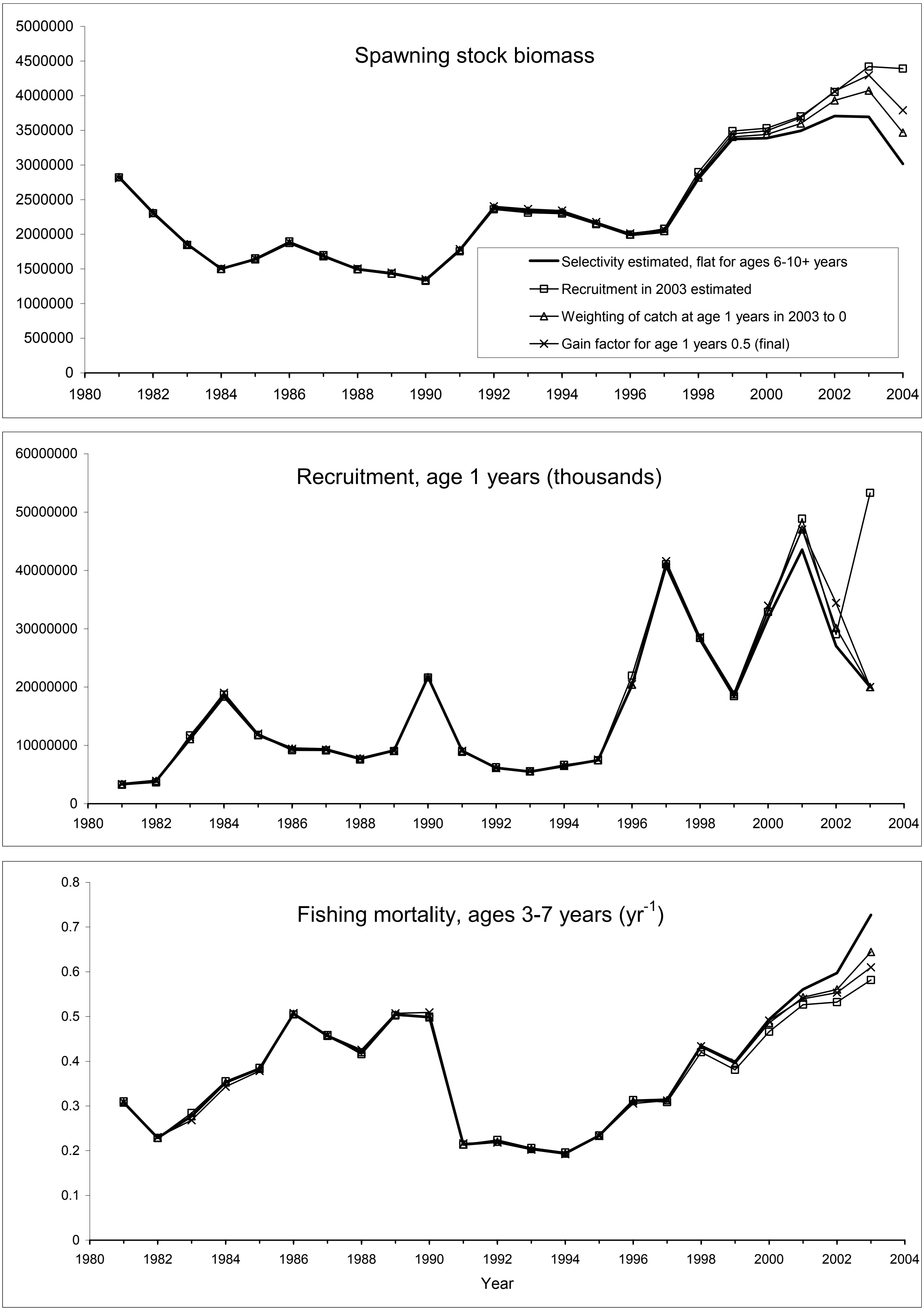
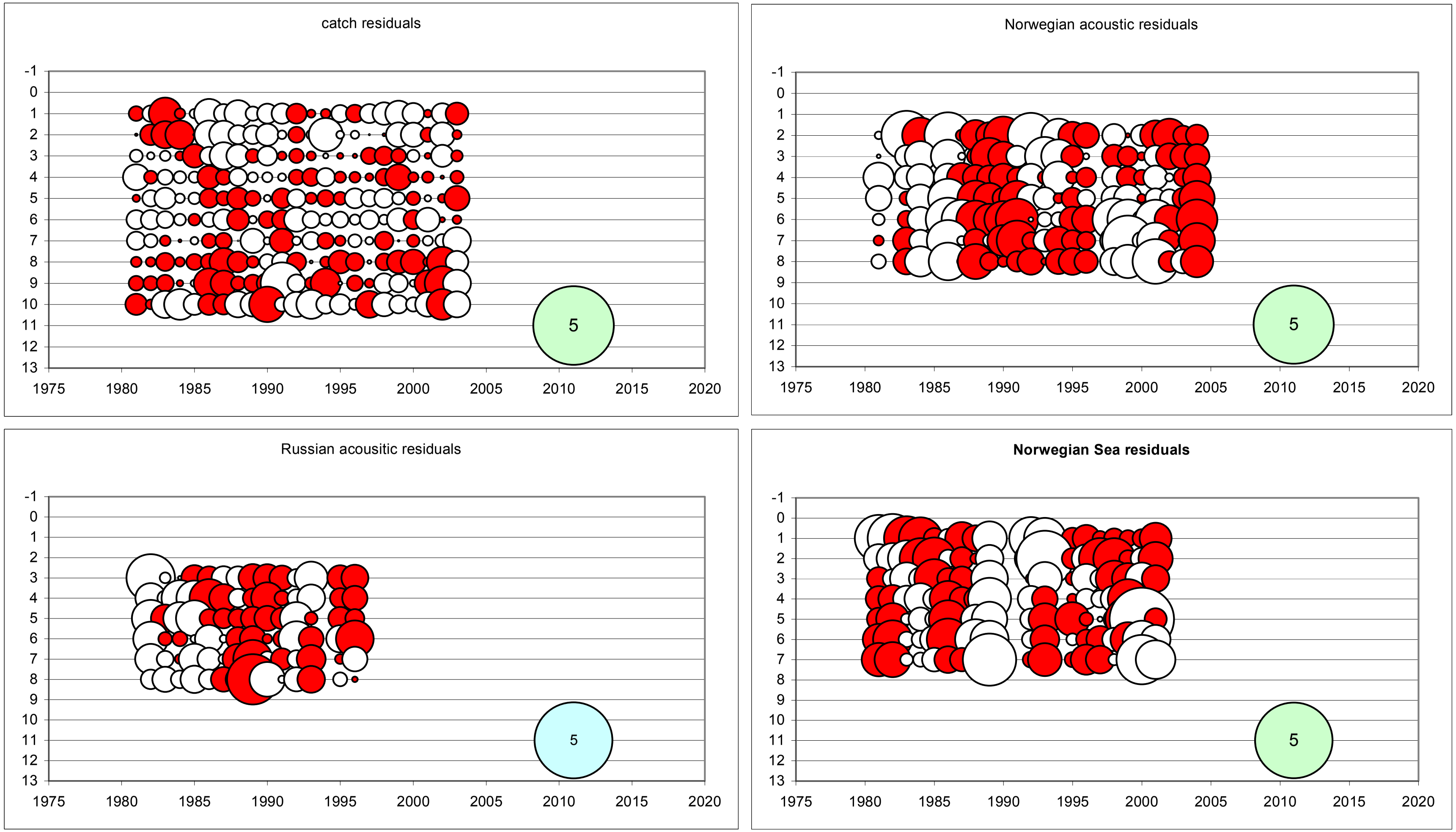


Figure 6.4.4.2.3. Blue Whiting. Further data exploration with AMCI, with particular attention on the effects of assumption on year class 1 years (the recruits).

Figure 6.4.4.2.4. Blue Whiting. Diagnostics from AMCI



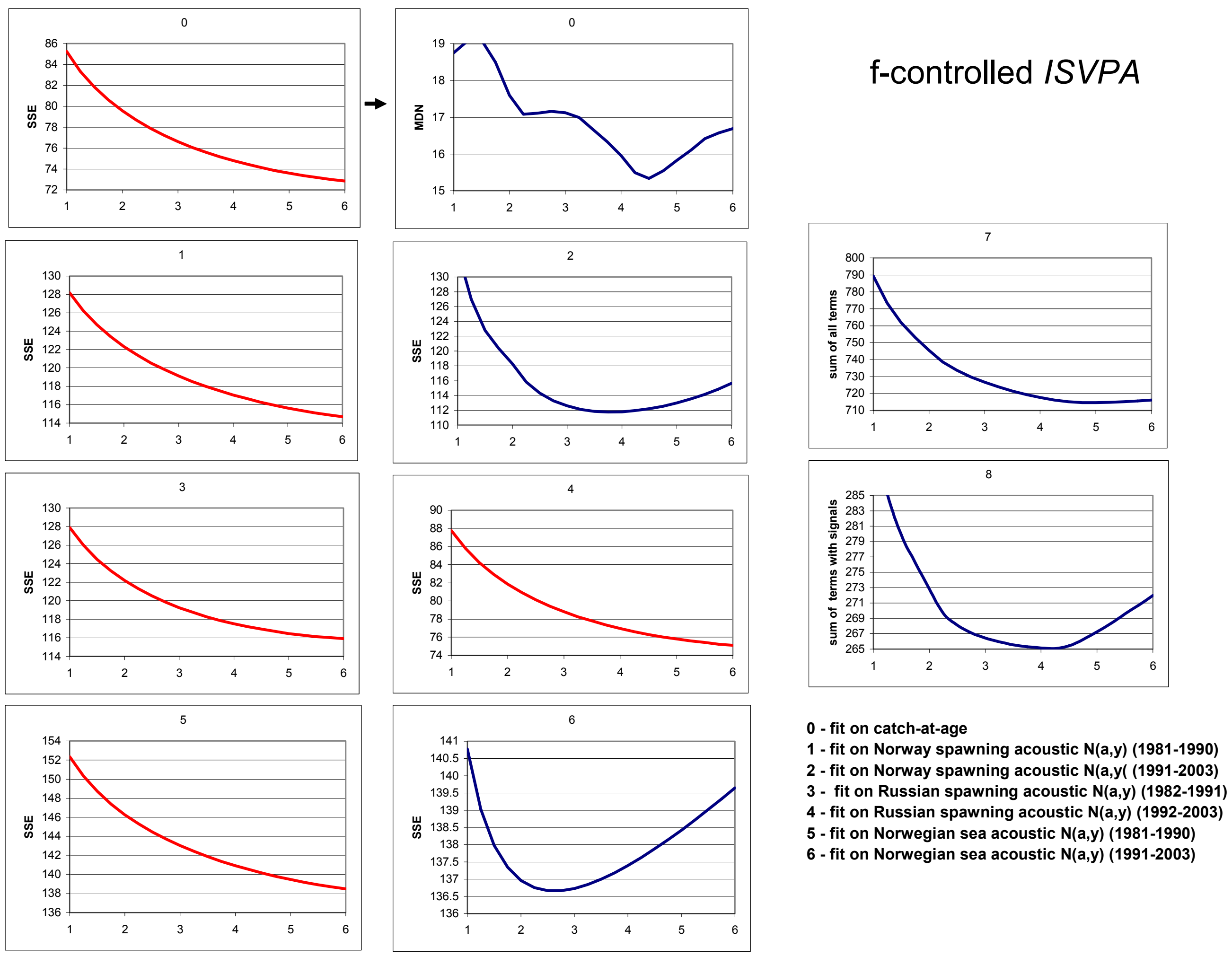


Figure 6.4.4.3.1
Blue whiting. Profiles of components of the effort-controlled ISVPA loss function.

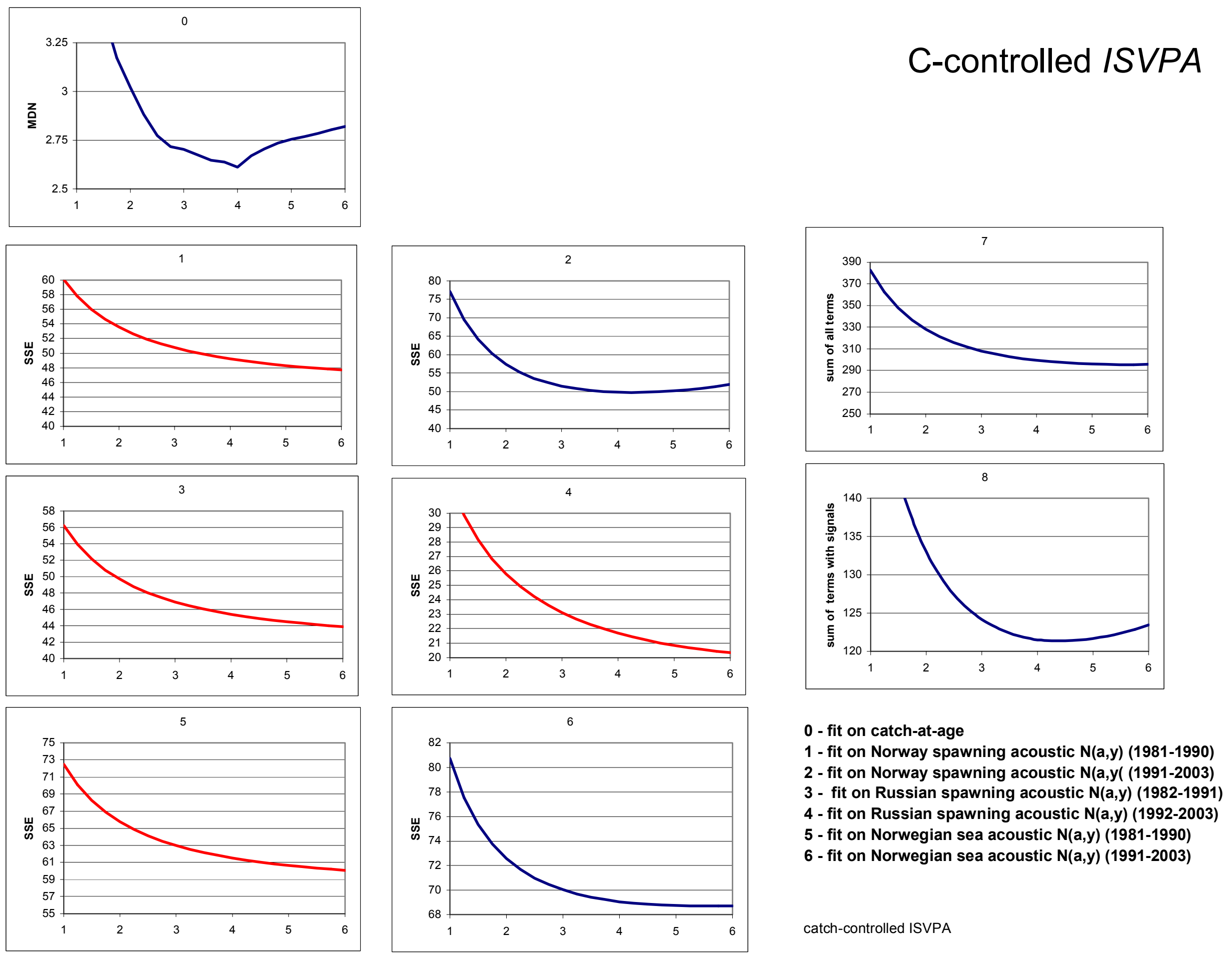


Figure 6.4.4.3.2
Blue whiting. Profiles of components of the catch-controlled ISVPA loss function.

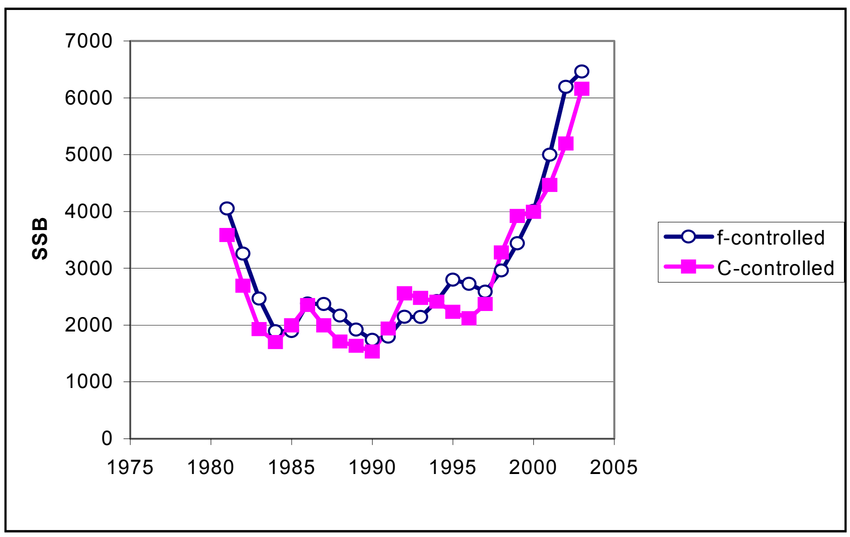
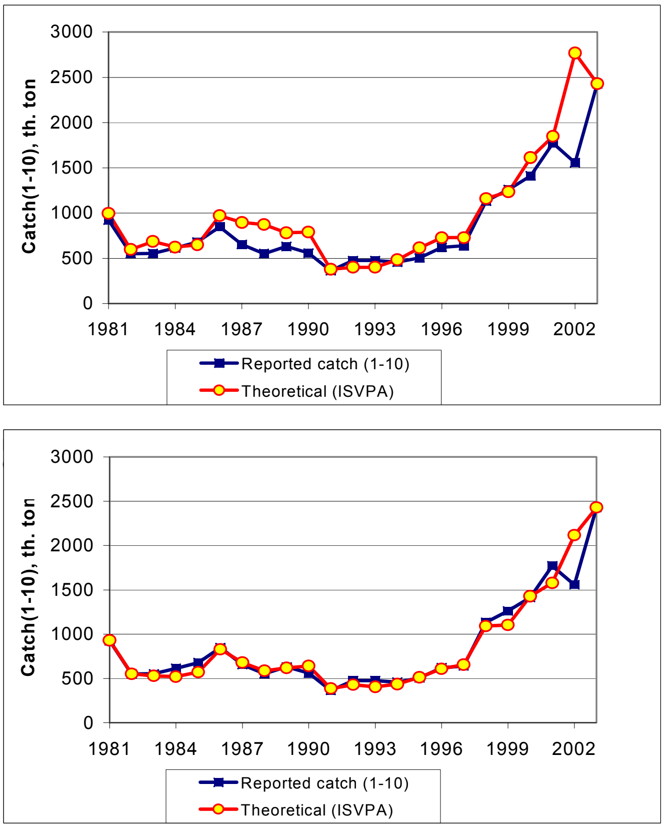


Figure 6.4.4.3.3
Blue whiting. Estimates of SSB from effort-controlled and catch-controlled versions of ISVPA.



Blue whiting.
Comparison of reported and theoretical catches (C-controlled ISVPA)

Figure 6.4.4.3.4 Blue whiting. Comparison of theoretical catches with reported values for two versions of ISVPA.

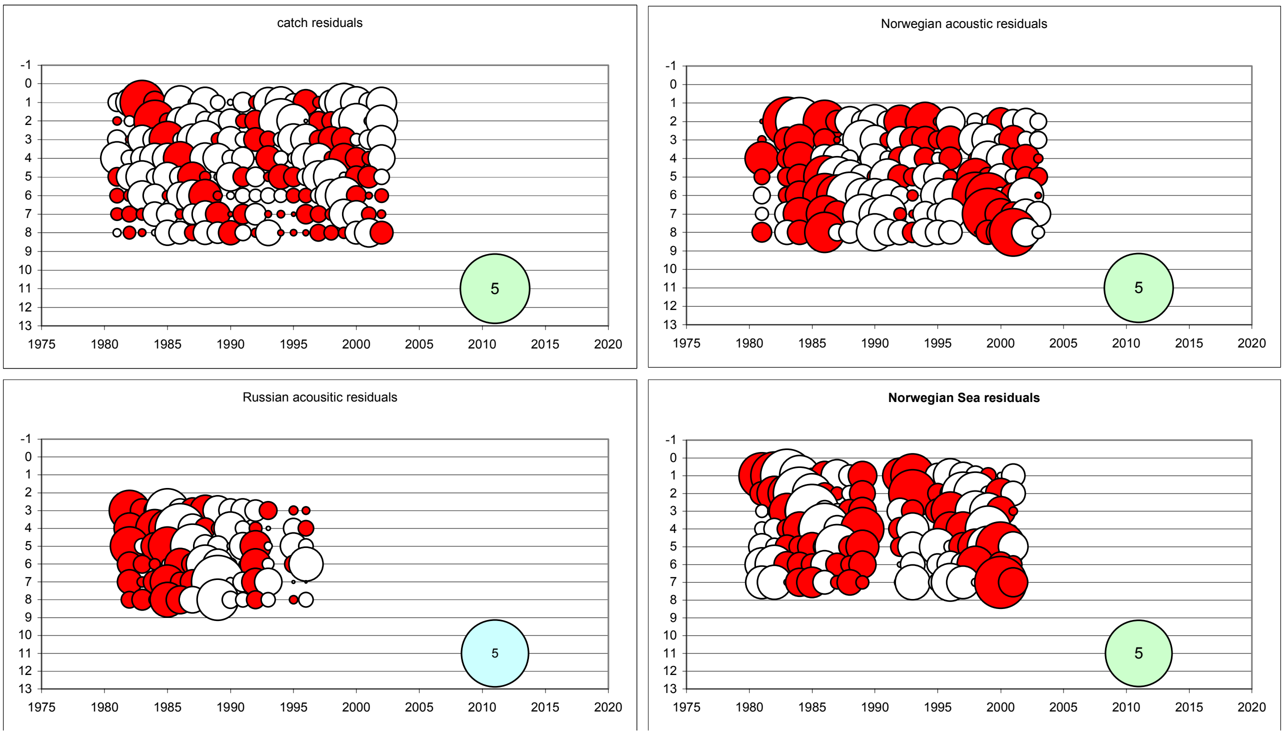


Figure 6.4.4.3.5. Plots of residuals for the effort-controlled ISVPA

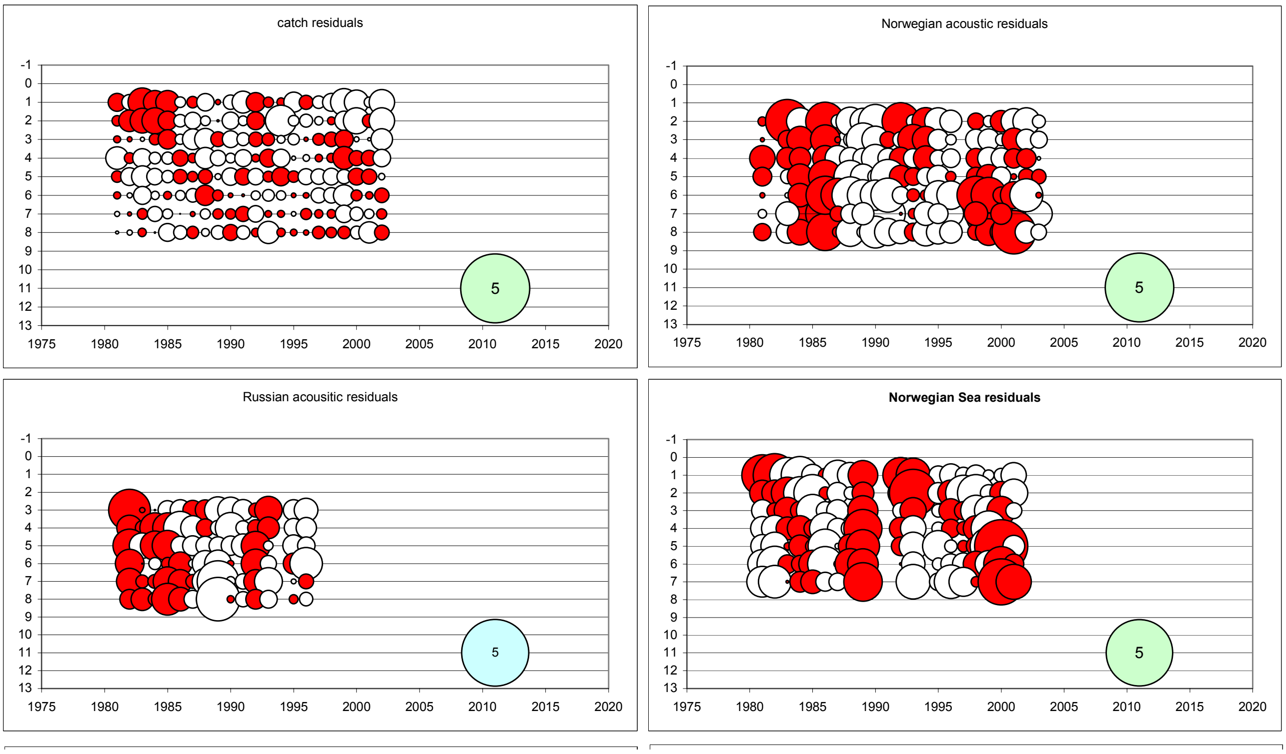
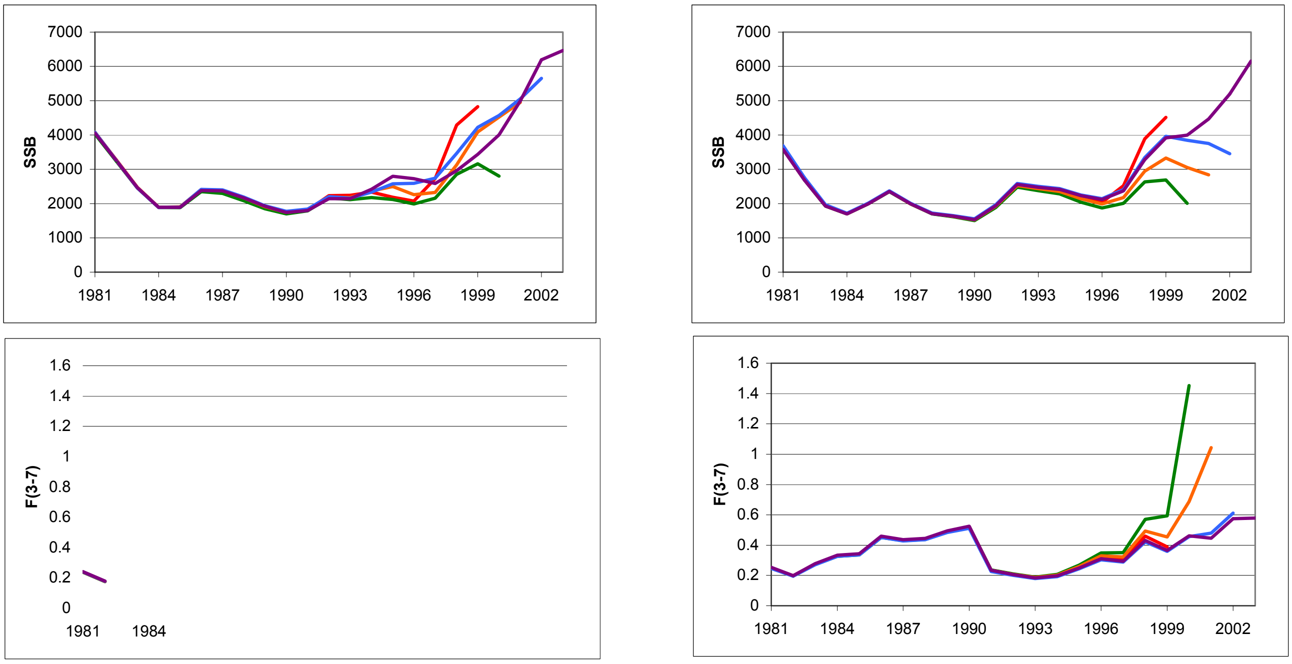


Figure 6.4.4.3.6. Plots of residuals for the catch-controlled ISVPA



Blue whiting, f-controlled ISVPA, retrospective runs

Blue whiting, catrch-controlled ISVPA, retrospective runs

Figure 6.4.4.3.7 Comparison of ISVPA retrospective runs for effort-controlled and catch-controlled versions.

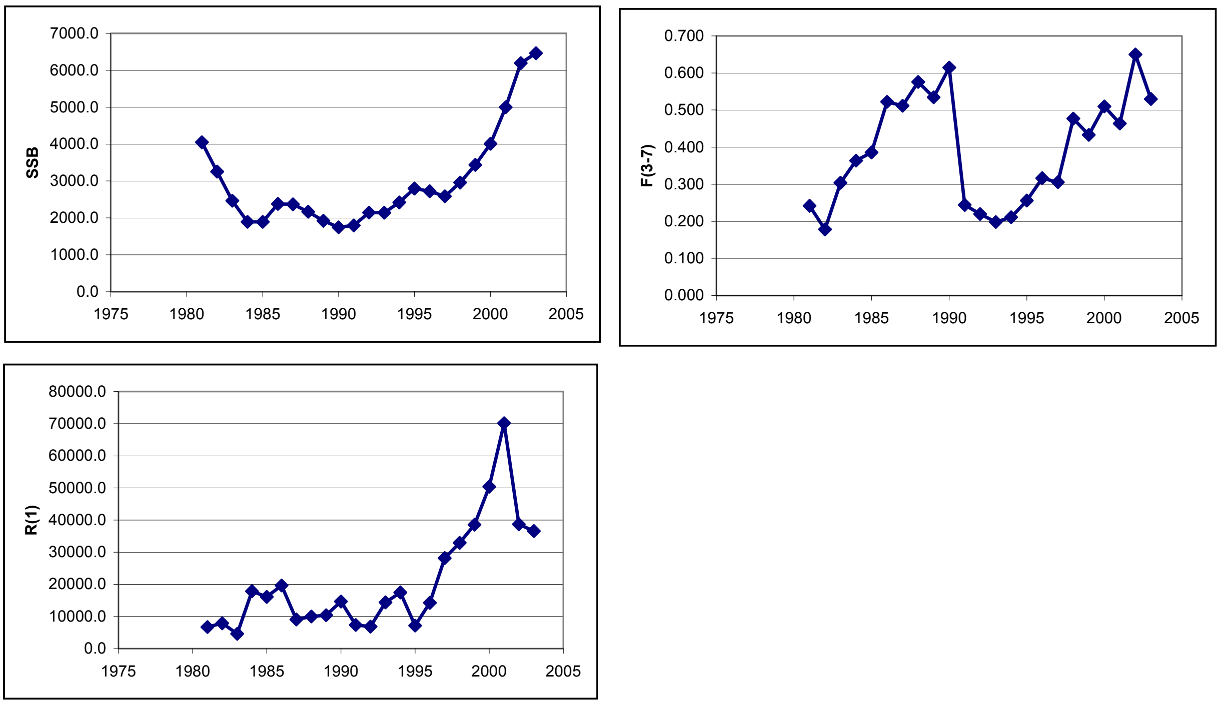
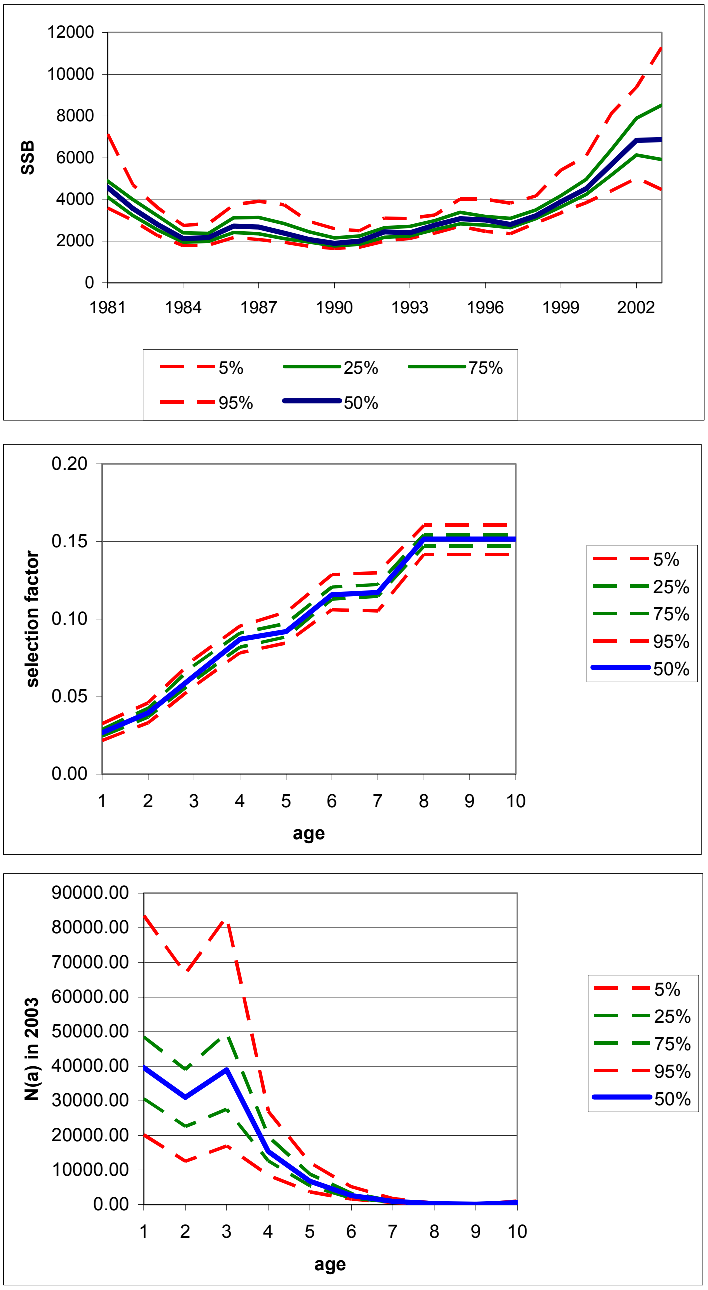


Figure 6.4.4.3.8. Results of blue whiting stock assessment by mean of ISVPA



Blue whiting. ISVPA (f-controlled). Boostrap

Figure 6.4.4.3.9. Estimates of uncertainty in the results of blue whiting stock assessment by means of ISVPA.

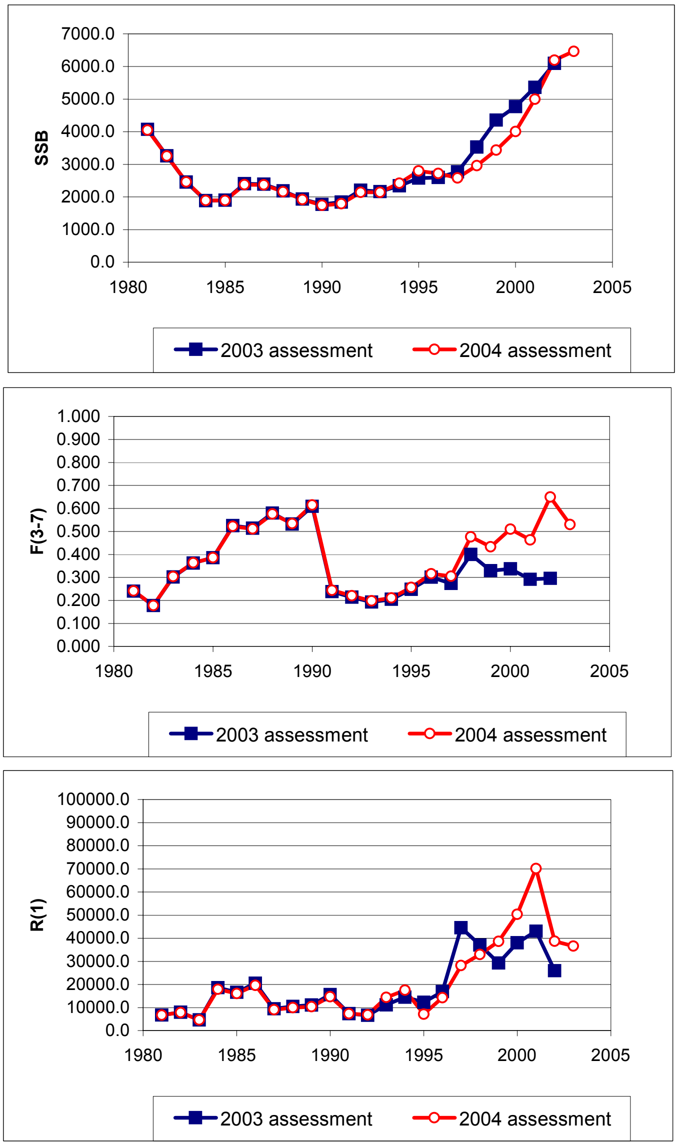


Figure 6.4.4.3.10 Comparison of results of blue whiting stock assessment by means of ISVPA made in 2003 and 2004.

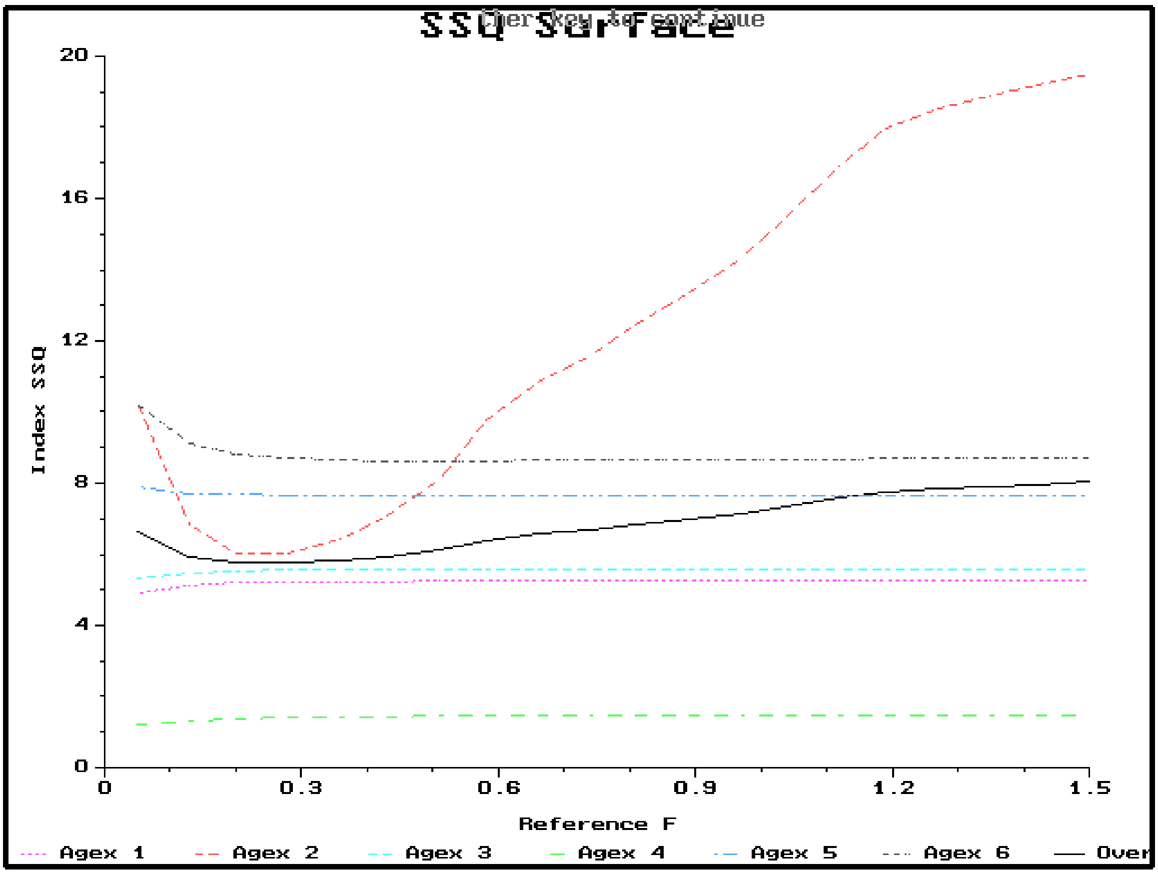


Figure 6.4.4.4.1. Blue Whiting. SSQ surface plot for final ICA run for blue whiting in 2004.

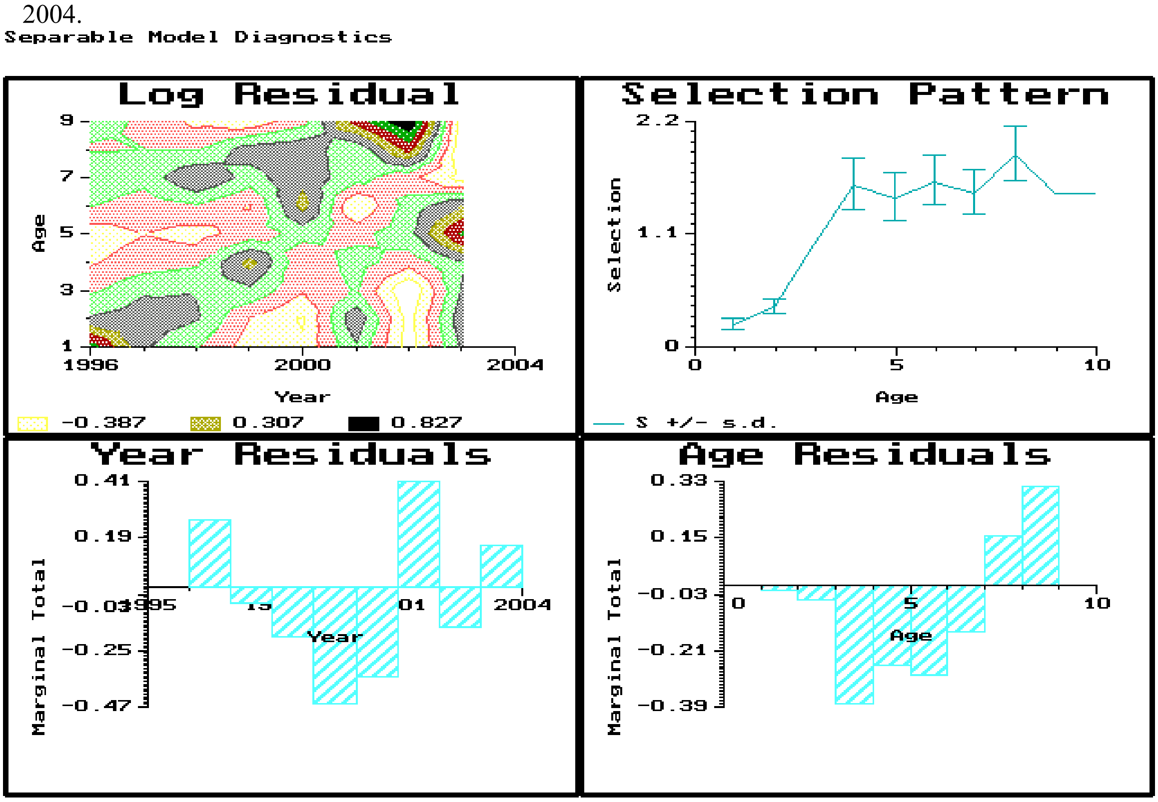


Figure 6.4.4.4.2. Blue Whiting. Catch residuals and selection pattern for final ICA run for blue whiting in 2004.

Stock Summary

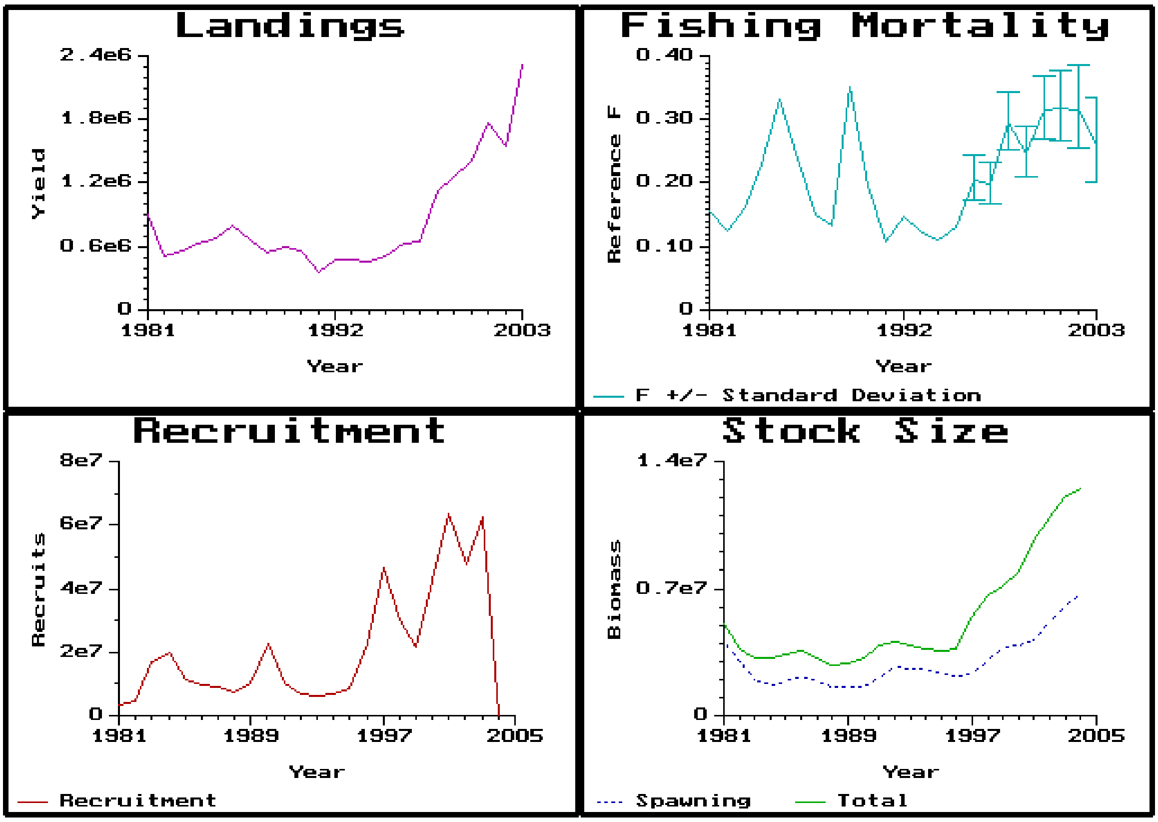


Figure 6.4.4.4.3. Standard plots from ICA final run (run 22b) for blue whiting in 2004.

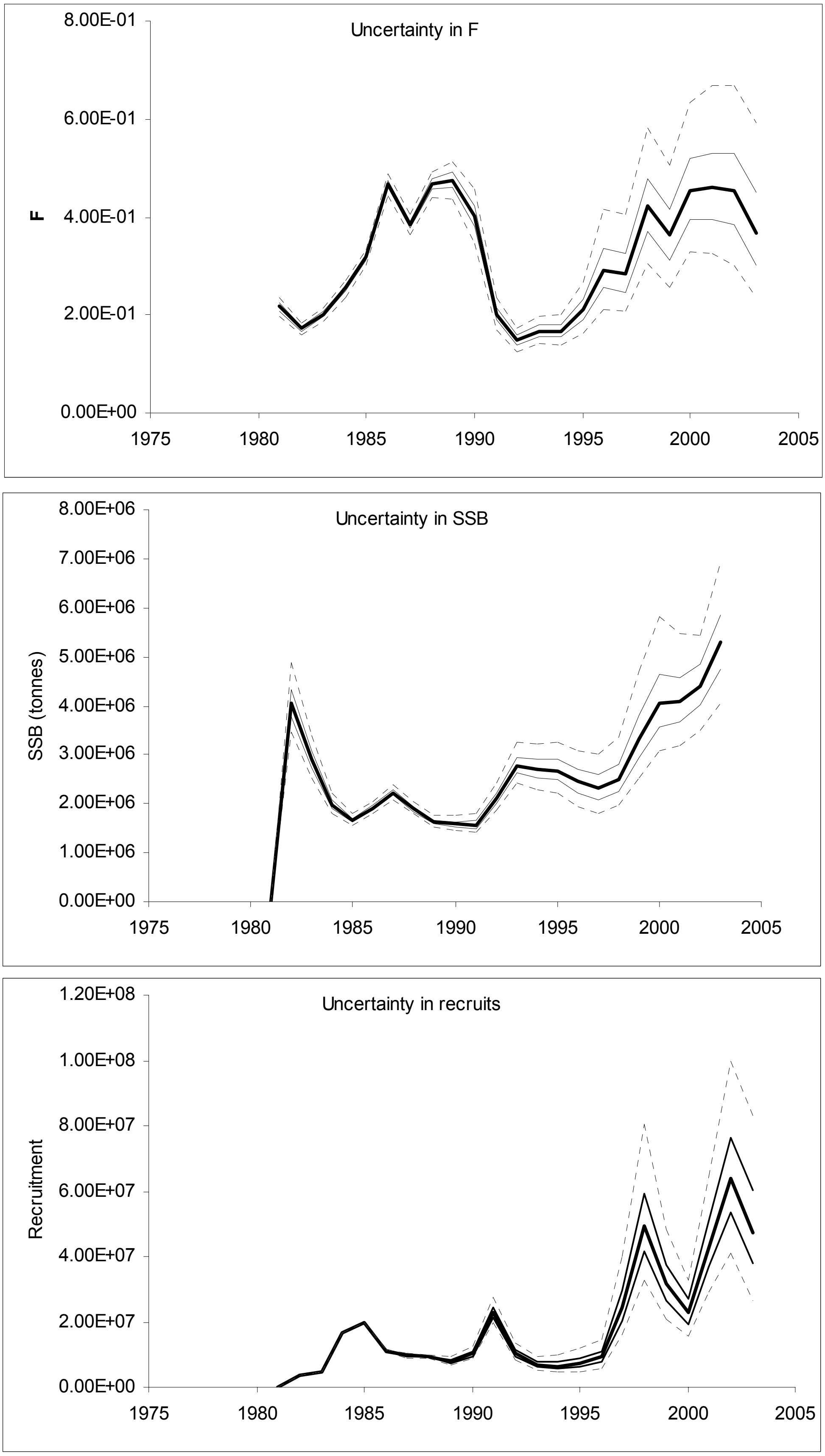


Figure 6.4.4.4.4. Uncertainty in the final ICA run (run 26) for blue whiting in 2004. Results of bootstrapping, with 5%, 25%, 50%, 75% and 95% percentiles presented.

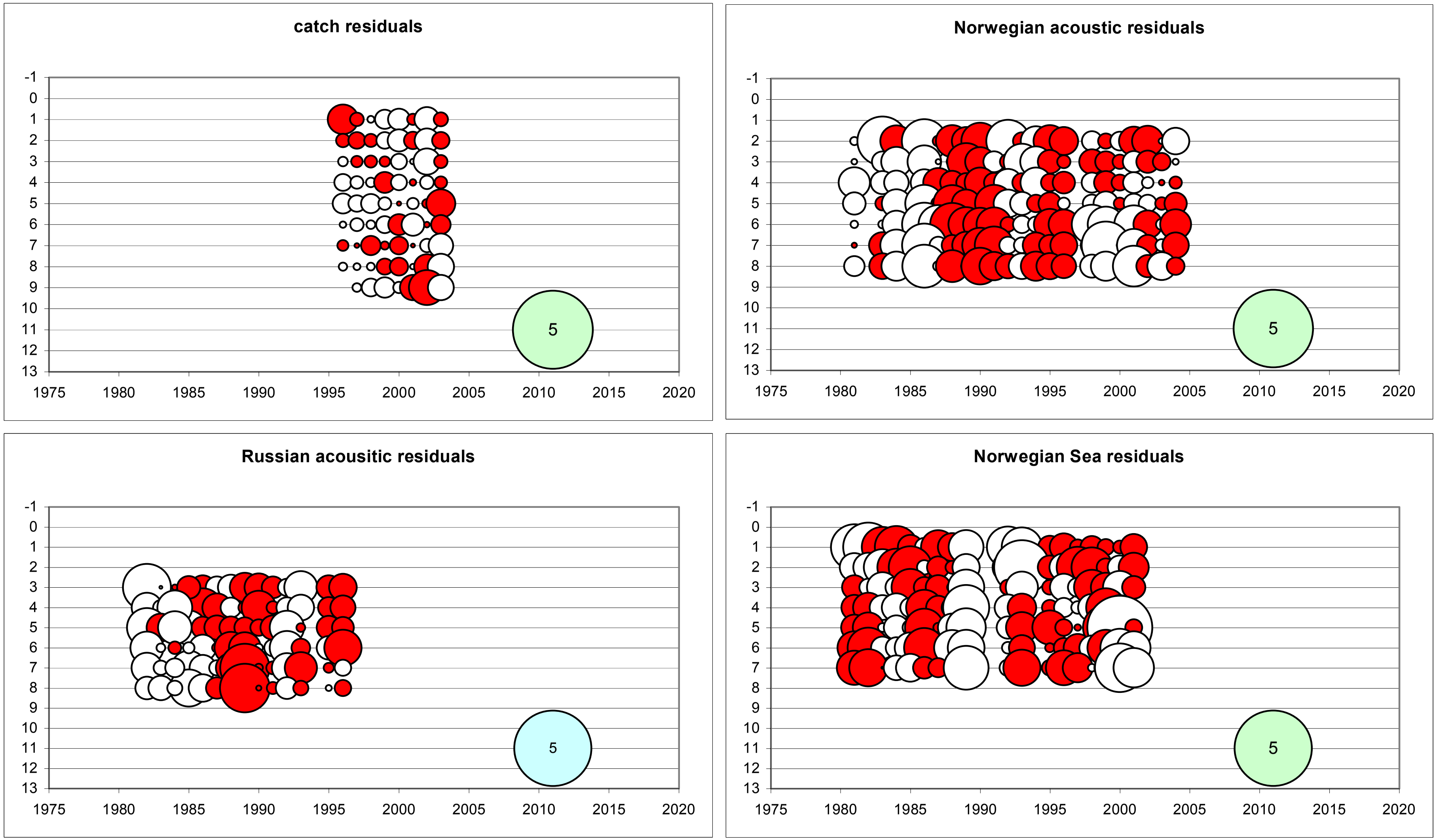
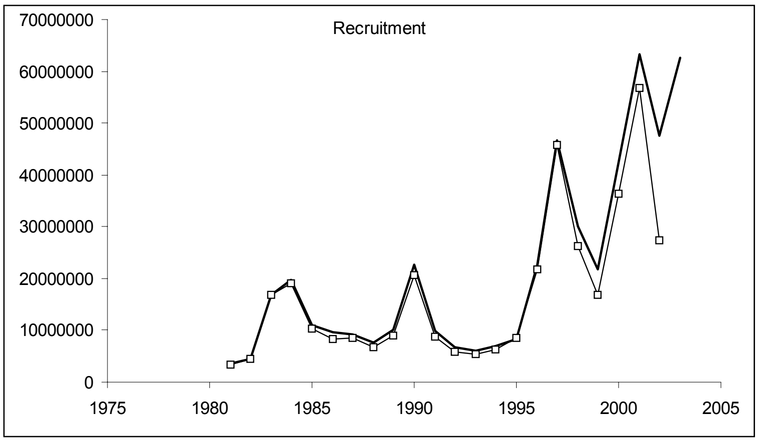
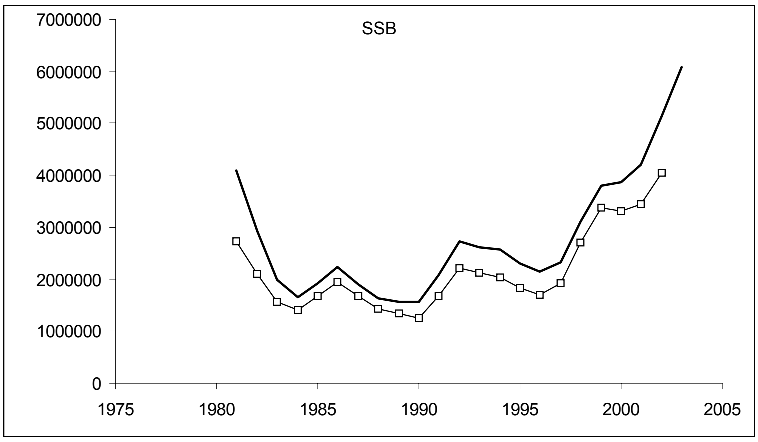
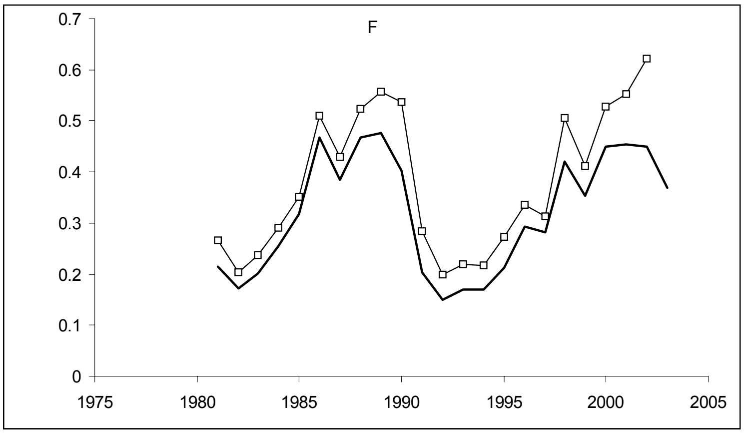
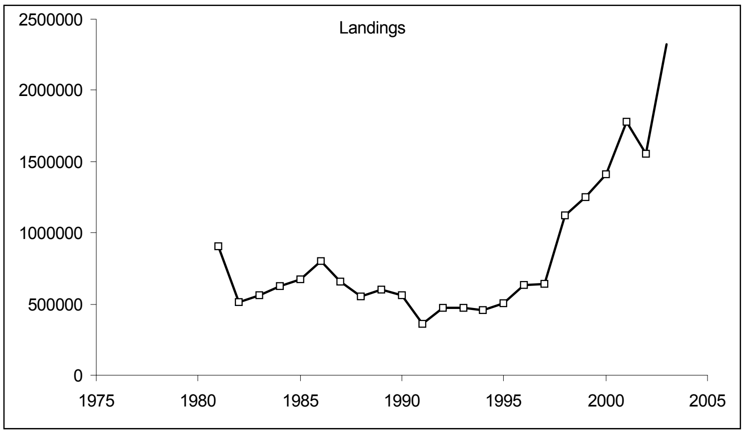


Figure 6.4.4.4.5 Blue Whiting. Diagnostics from ICA


Recruitment
70000000
60000000
50000000
40000000
30000000
20000000
10000000
0
1975
1980
1985
1990
1995
2000
2005


SSB
7000000
6000000
5000000
4000000
3000000
2000000
1000000
0
1975
1980
1985
1990
1995
2000
2005


F
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1975
1980
1985
1990
1995
2000
2005


Landings
2500000
2000000
1500000
1000000
500000
0
1975
1980
1985
1990
1995
2000
2005

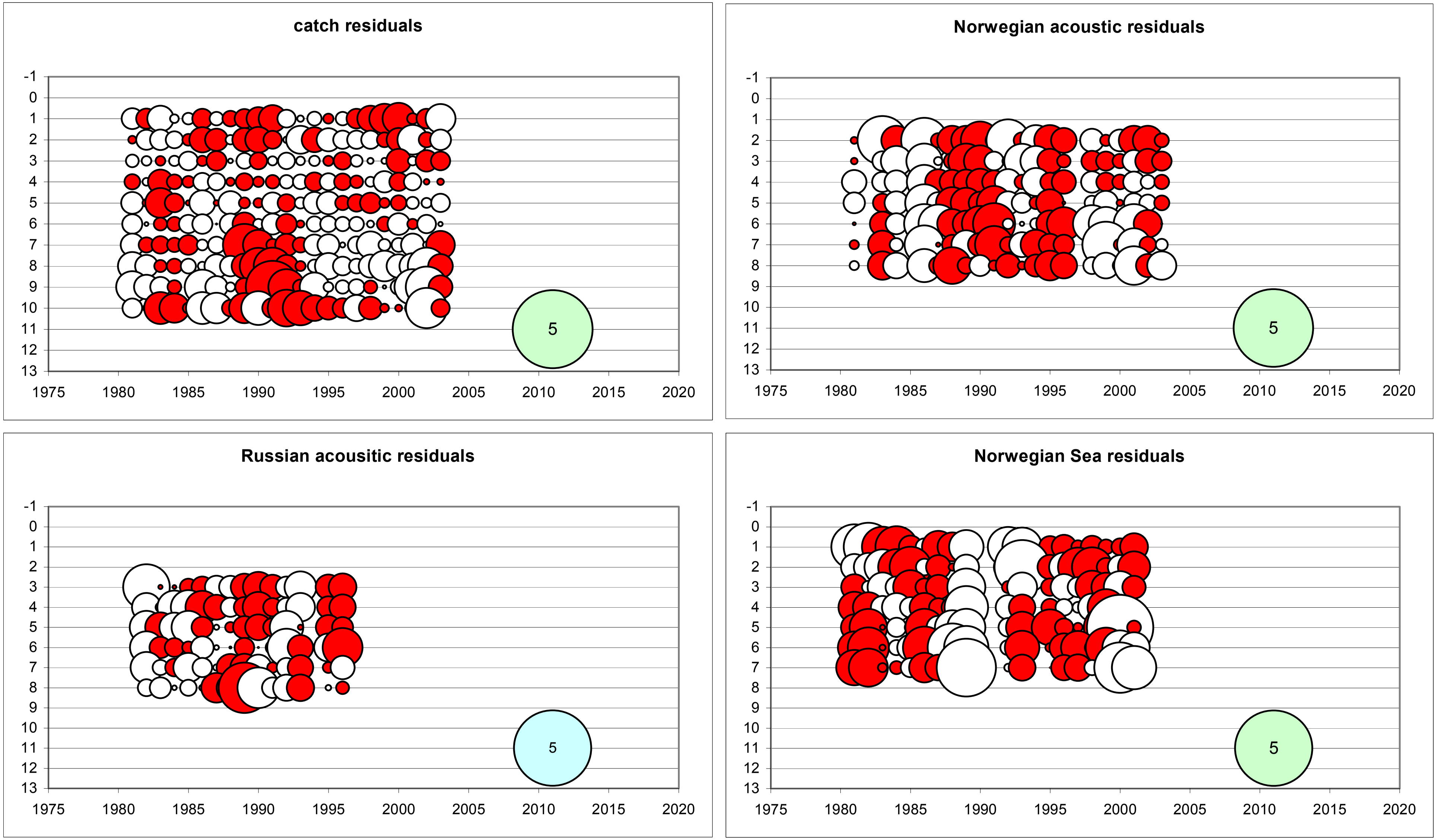


Figure 6.4.4.5.1 Blue Whiting. Diagnostics from SMS

Figure 6.4.4.5.2 Selection patters for blue whiting catches as estimated by SMS (Each series sums up to 1)

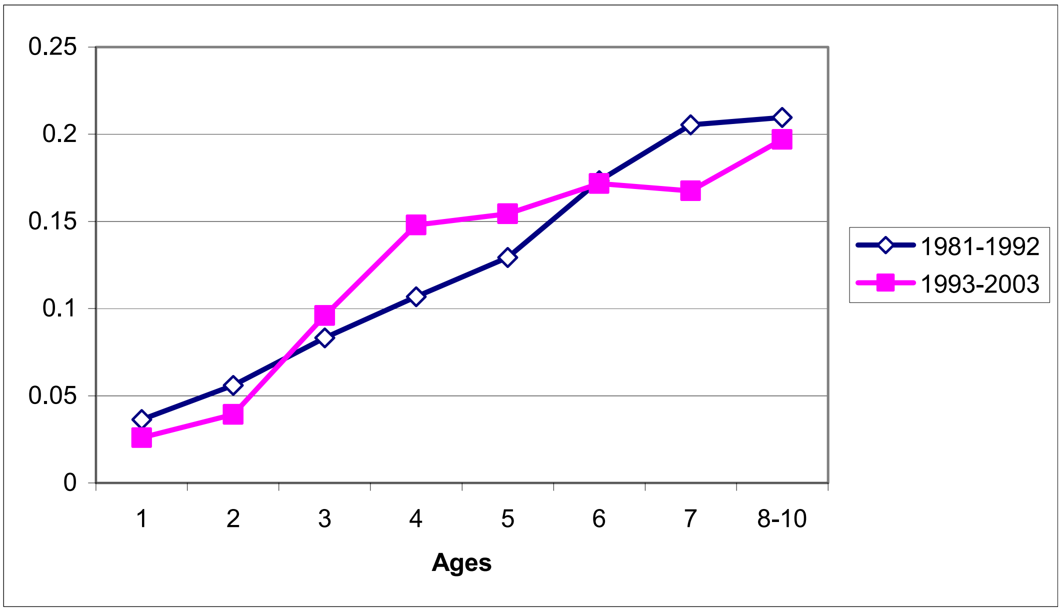


Figure 6.4.4.5.3 Blue whiting, observed yield and predicted yield by SMS model

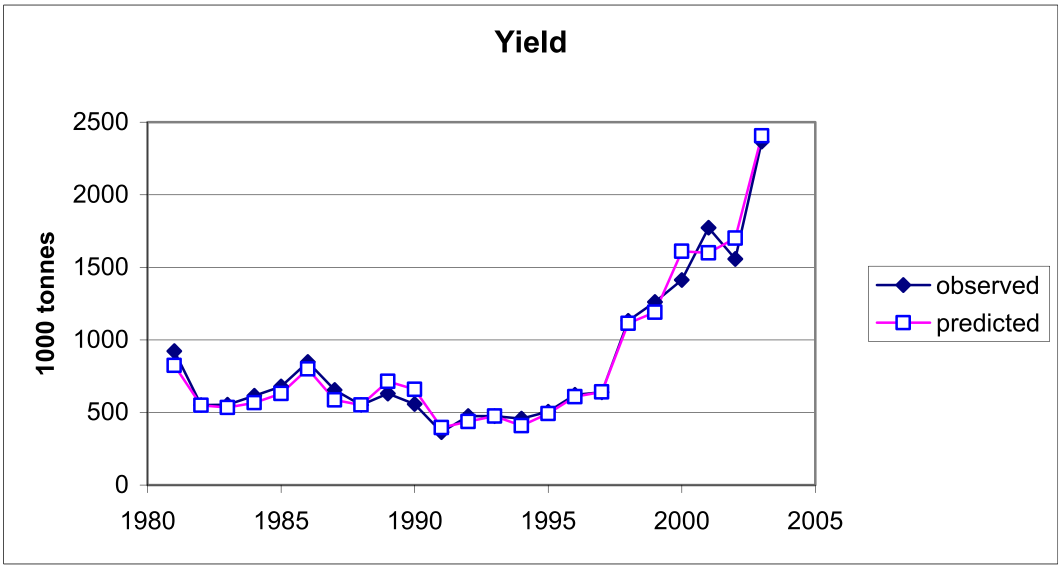
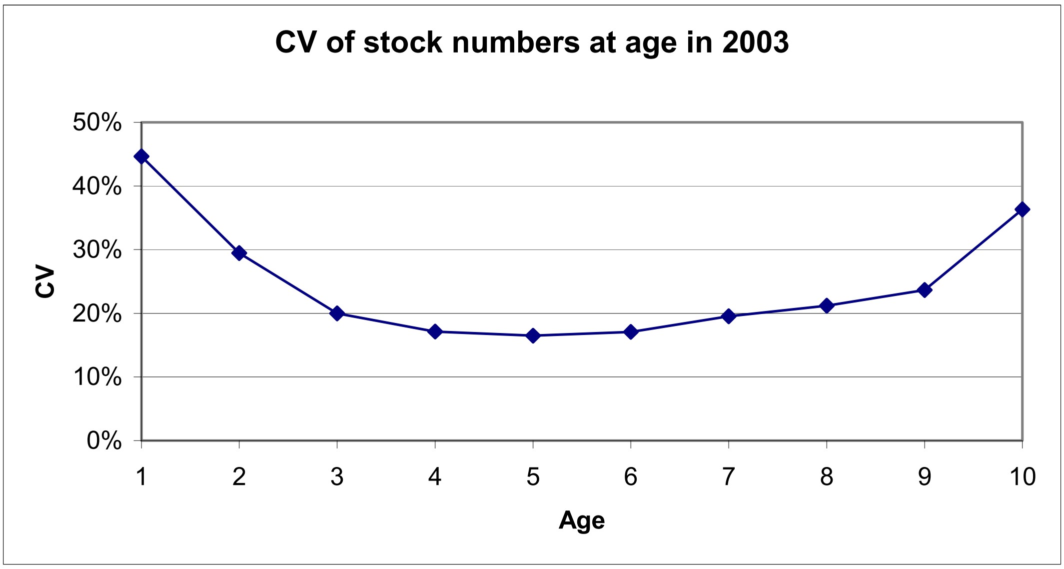
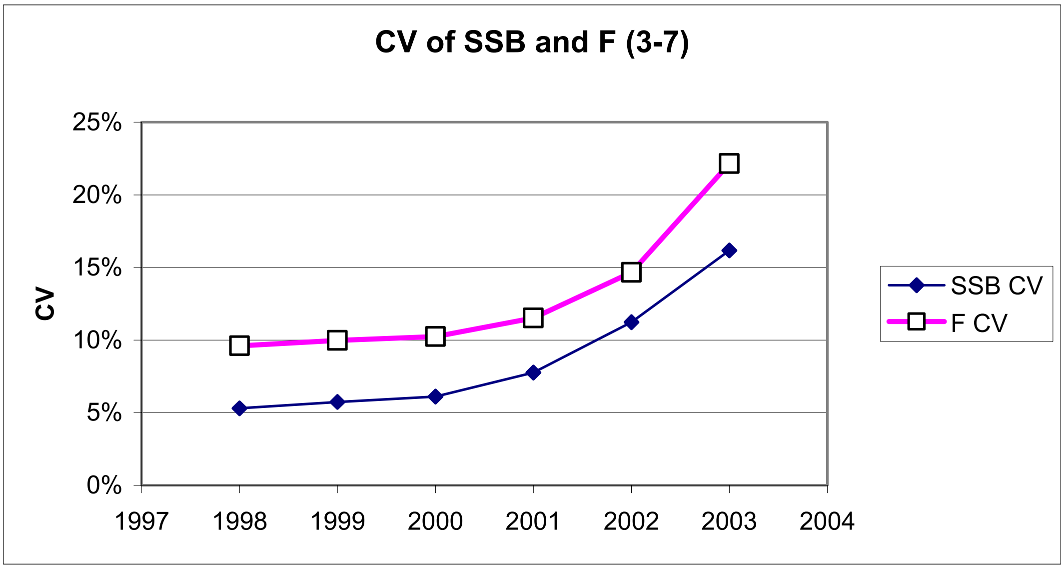


Figure 6.4.4.5.4 Blue whiting, Uncertainties of estimated stock numbers at age in 2003 and SSB and F as estimated by SMS





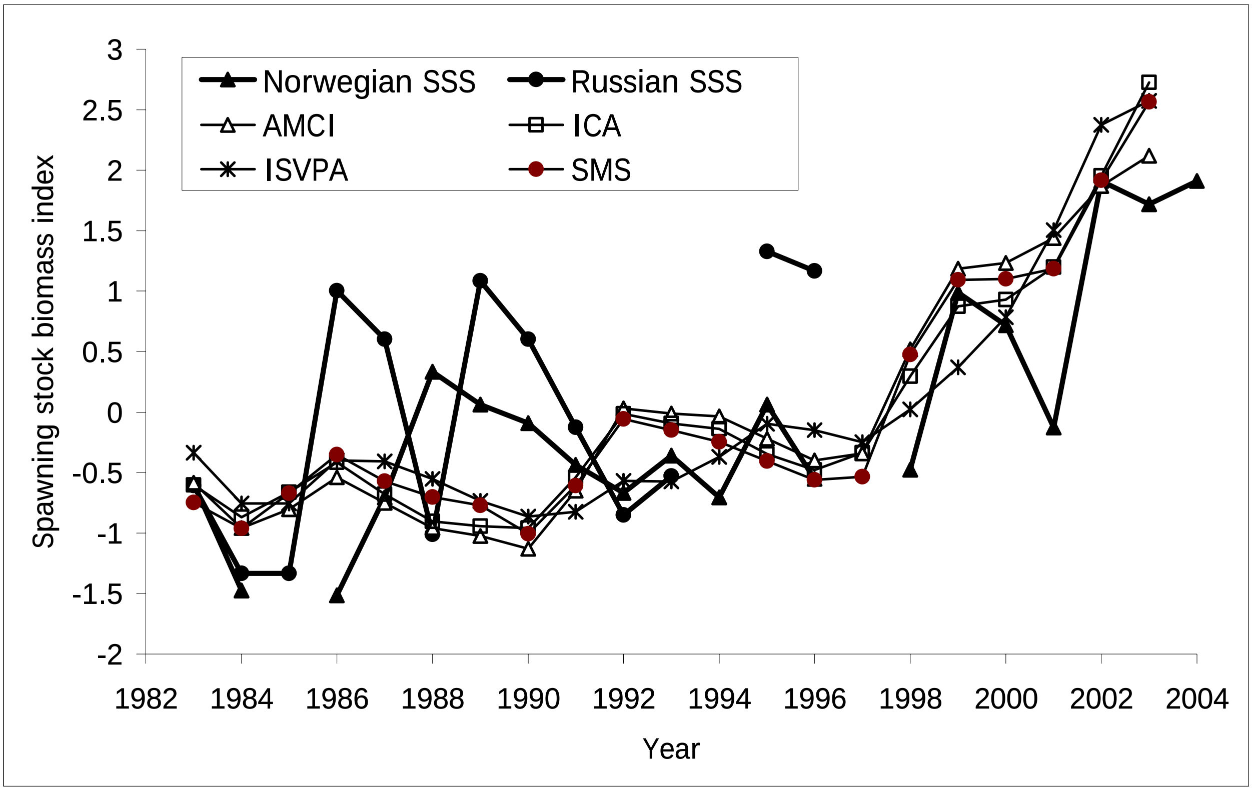


Figure 6.4.4.6.1. Blue whiting. Comparison of normalized spawning stock biomass estimates obtained from acoustic surveys and analytical assessments.

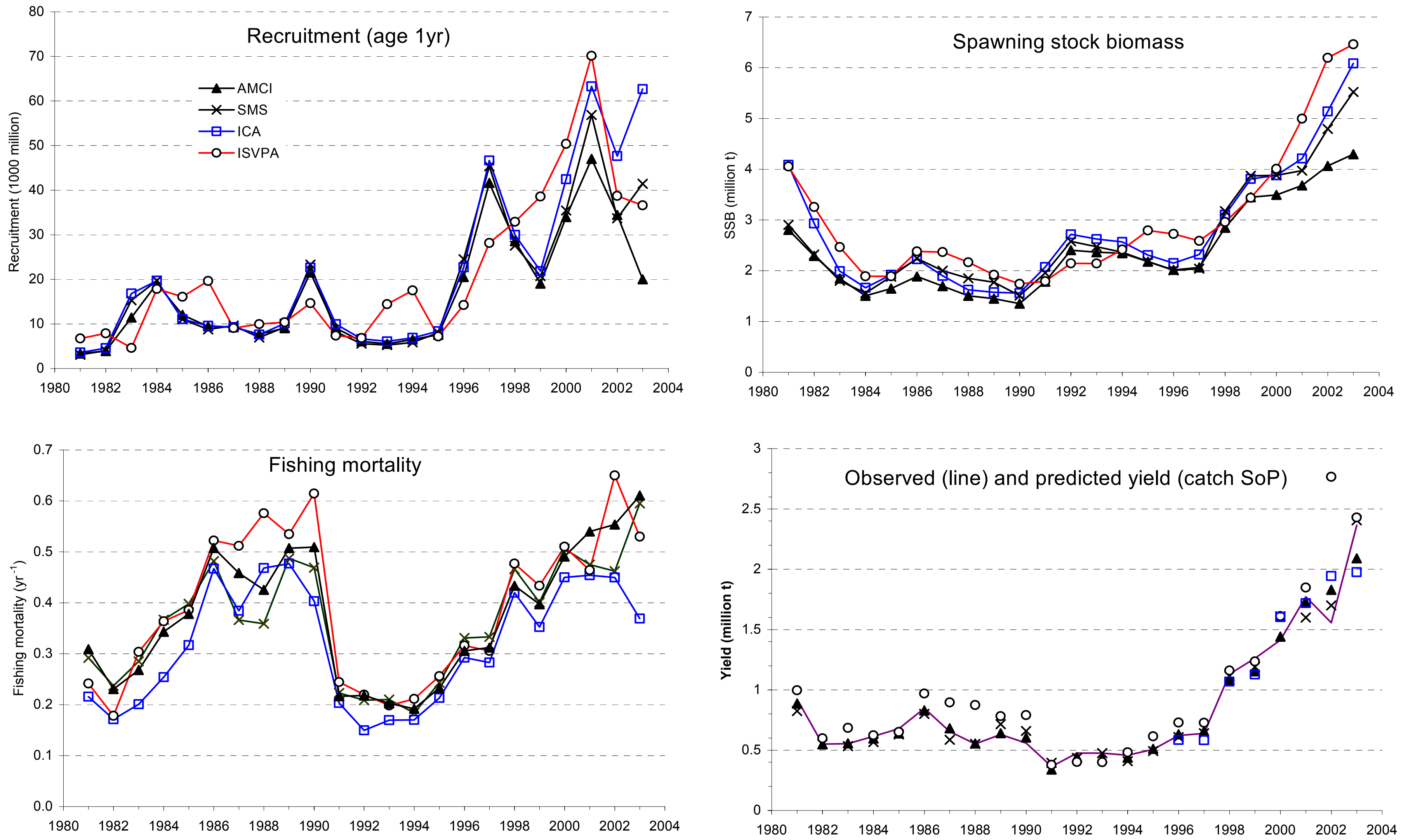


Figure 6.4.5.1.1. Blue Whiting: Comparisons between final AMCI, ISVPA ICA and SMS assessments.

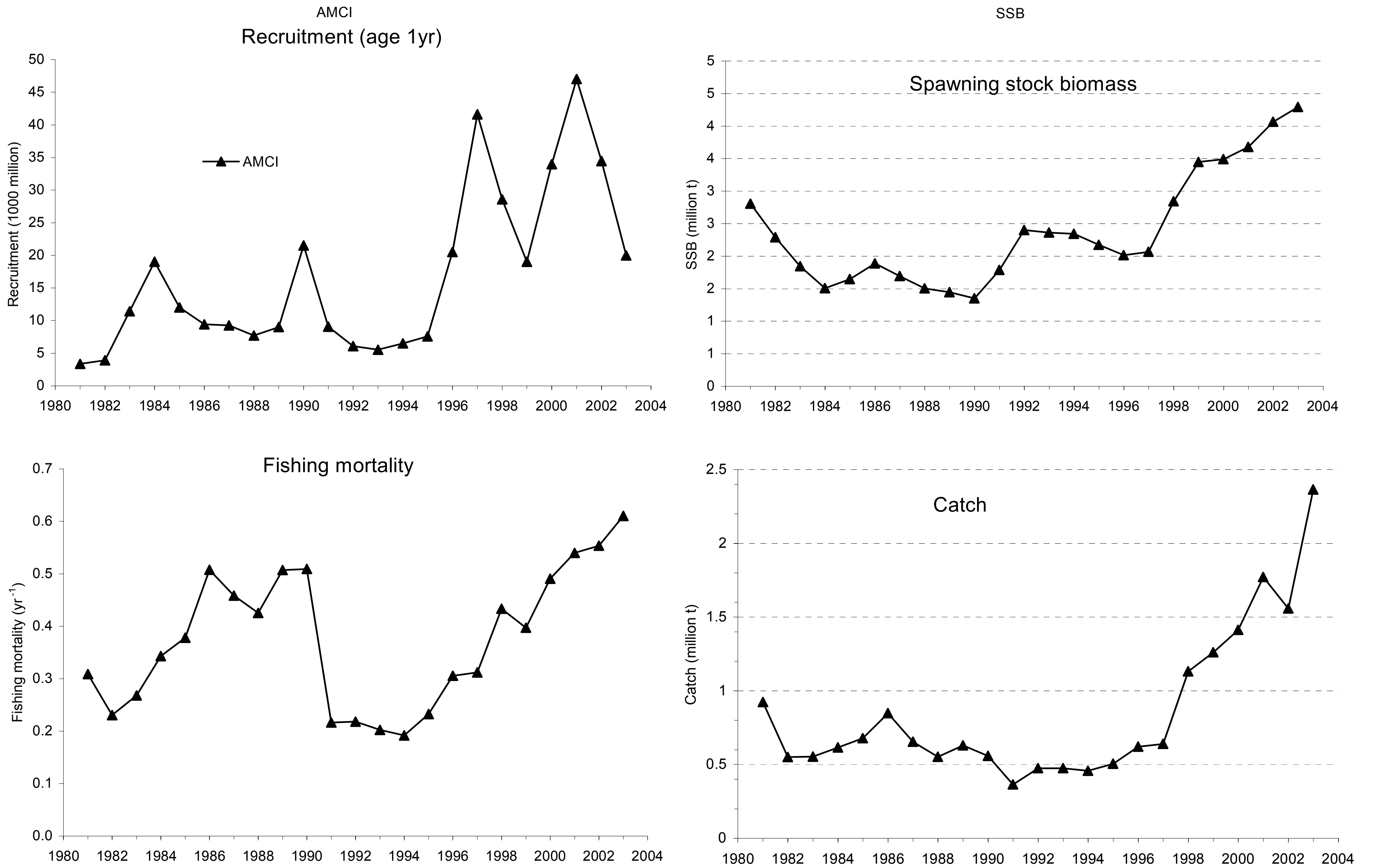


Figure 6.4.5.2.1. Blue Whiting: Summary of the final AMCI assessment.

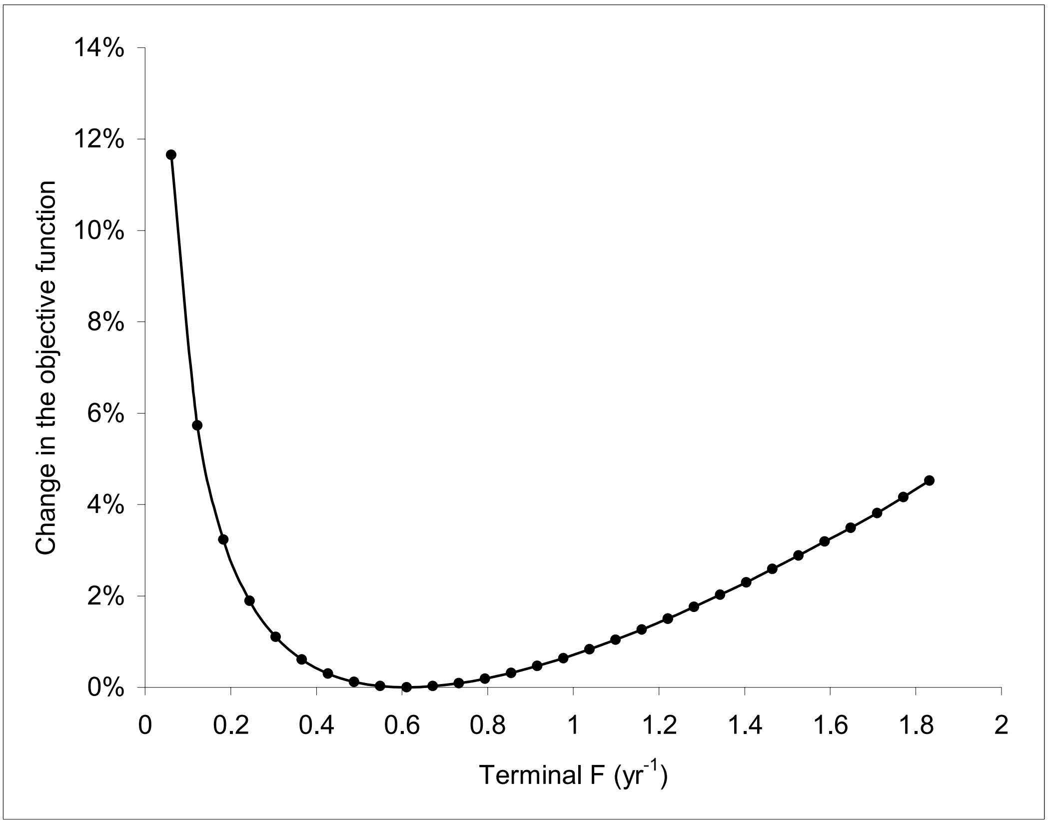


Figure 6.4.5.2.2. Final AMCI assessment for blue whiting. Relative change in the objective function relative to the minimum for various values of terminal F (year 2003).

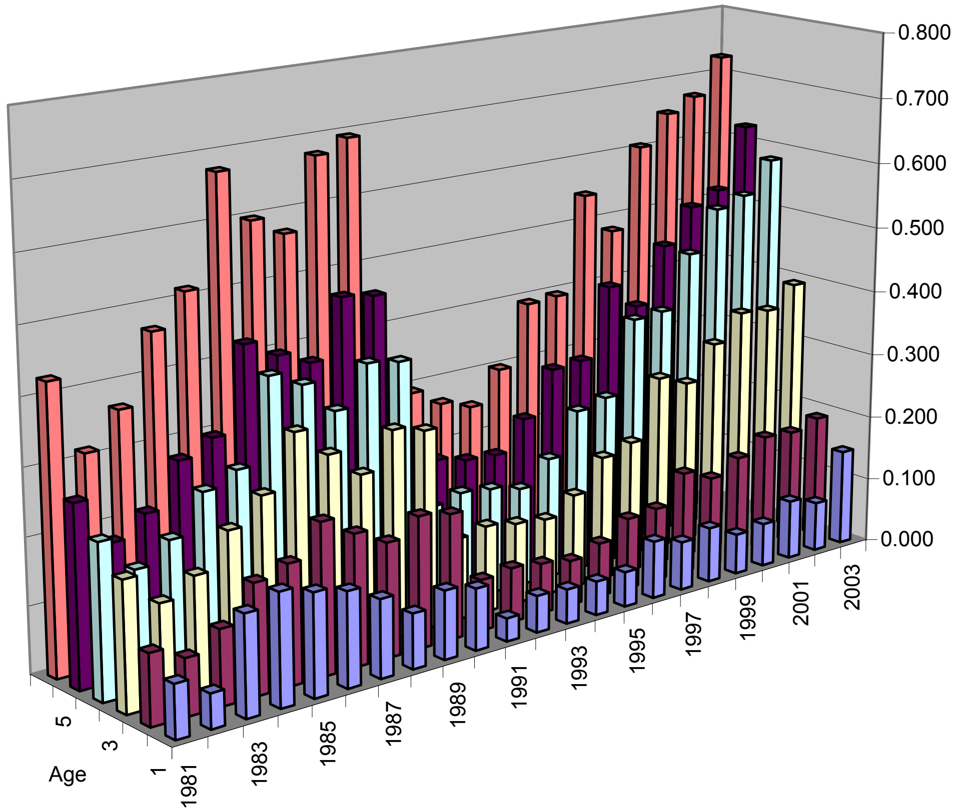


Figure 6.4.5.2.3. Final AMCI assessment on blue whiting. Fishing mortality at age and year.

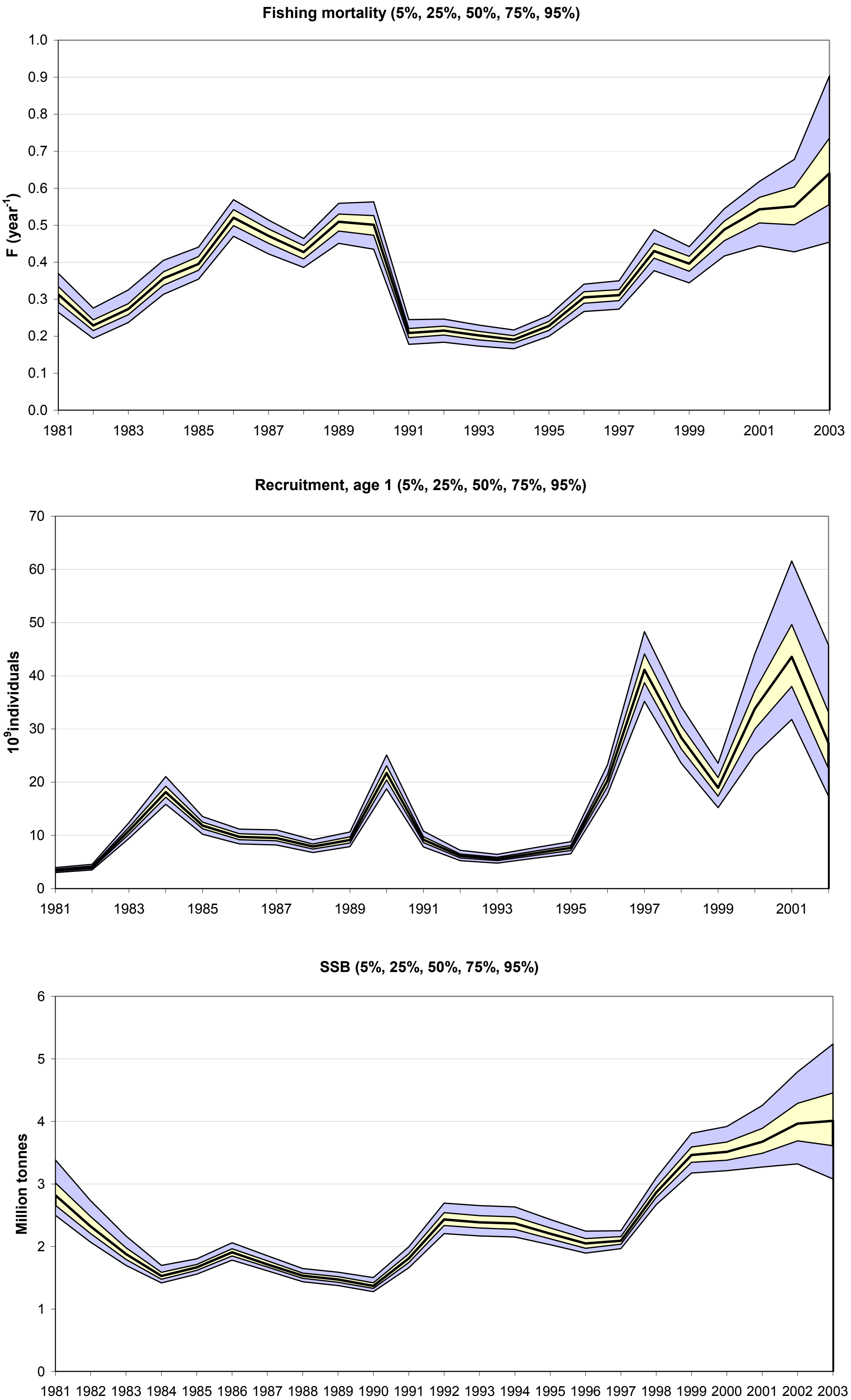


Figure 6.4.5.2.4. An evaluation of uncertainty in AMCI assessment obtained by bootstrapping the residuals of the final AMCI assessment (1000 replicates).

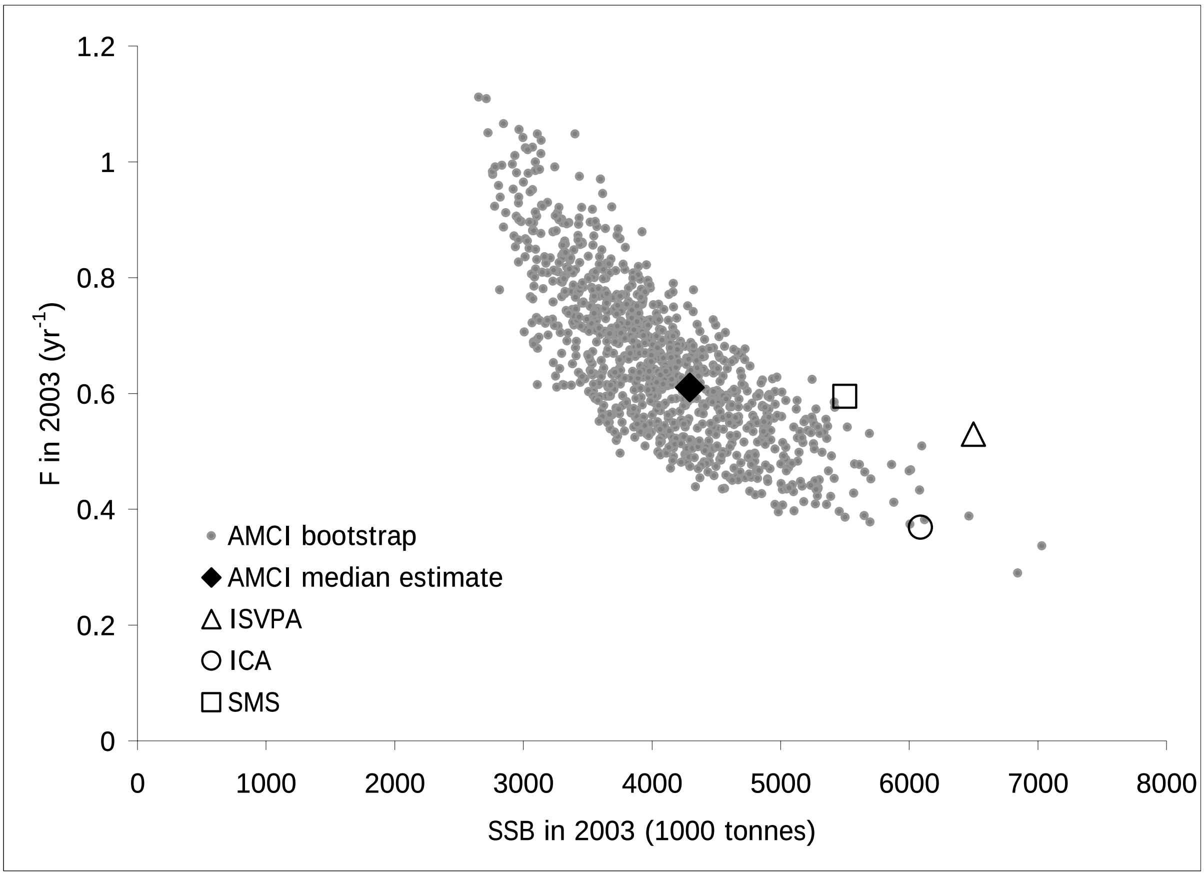


Figure 6.4.5.2.5. Interdependence between estimated fishing mortality and spawning stock biomass in the terminal year in AMCI bootstrap replicates. Point estimates for F and SSB obtained through different assessment models.

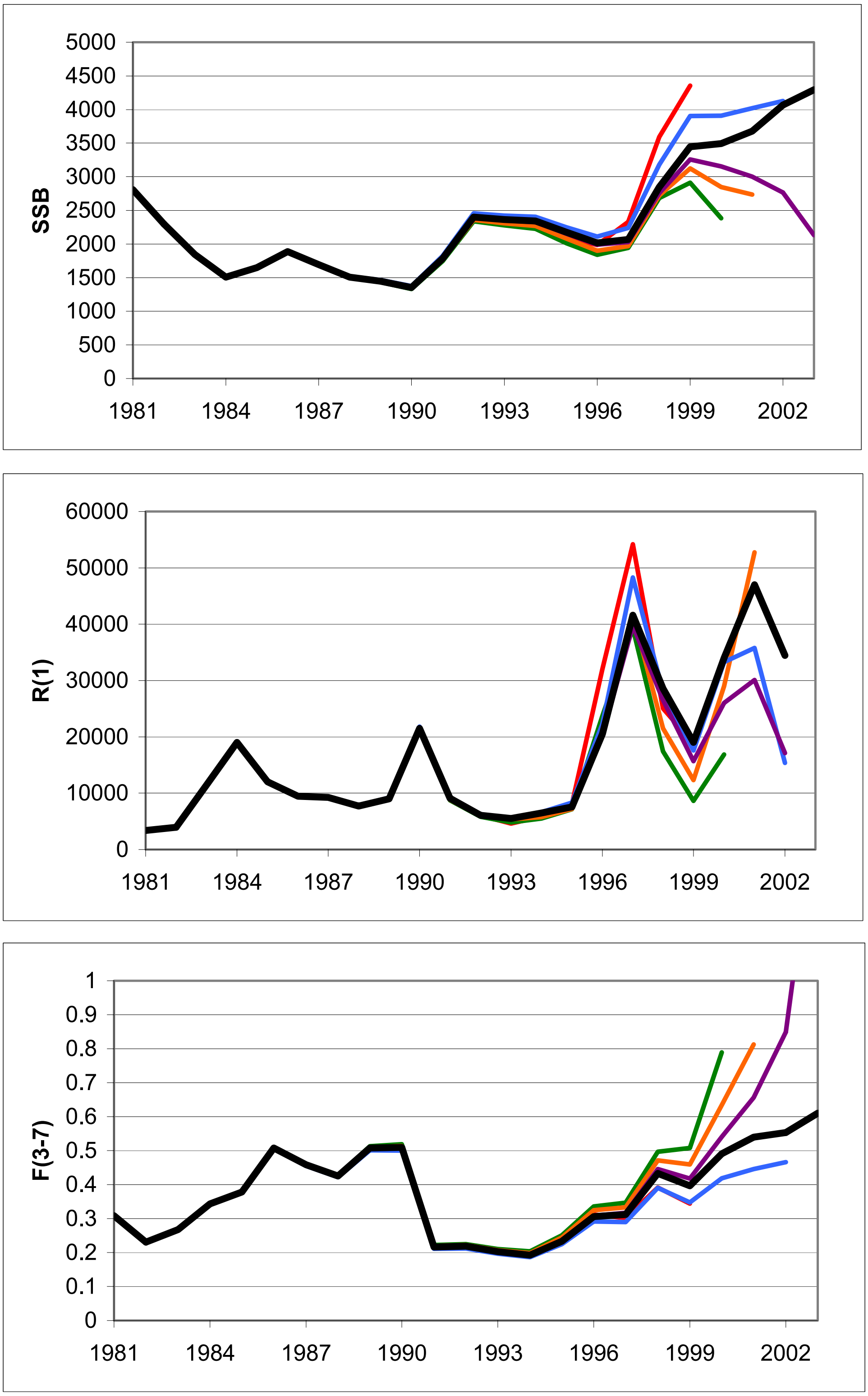


Figure 6.4.5.2.6. Blue whiting. AMCI, retrospective runs

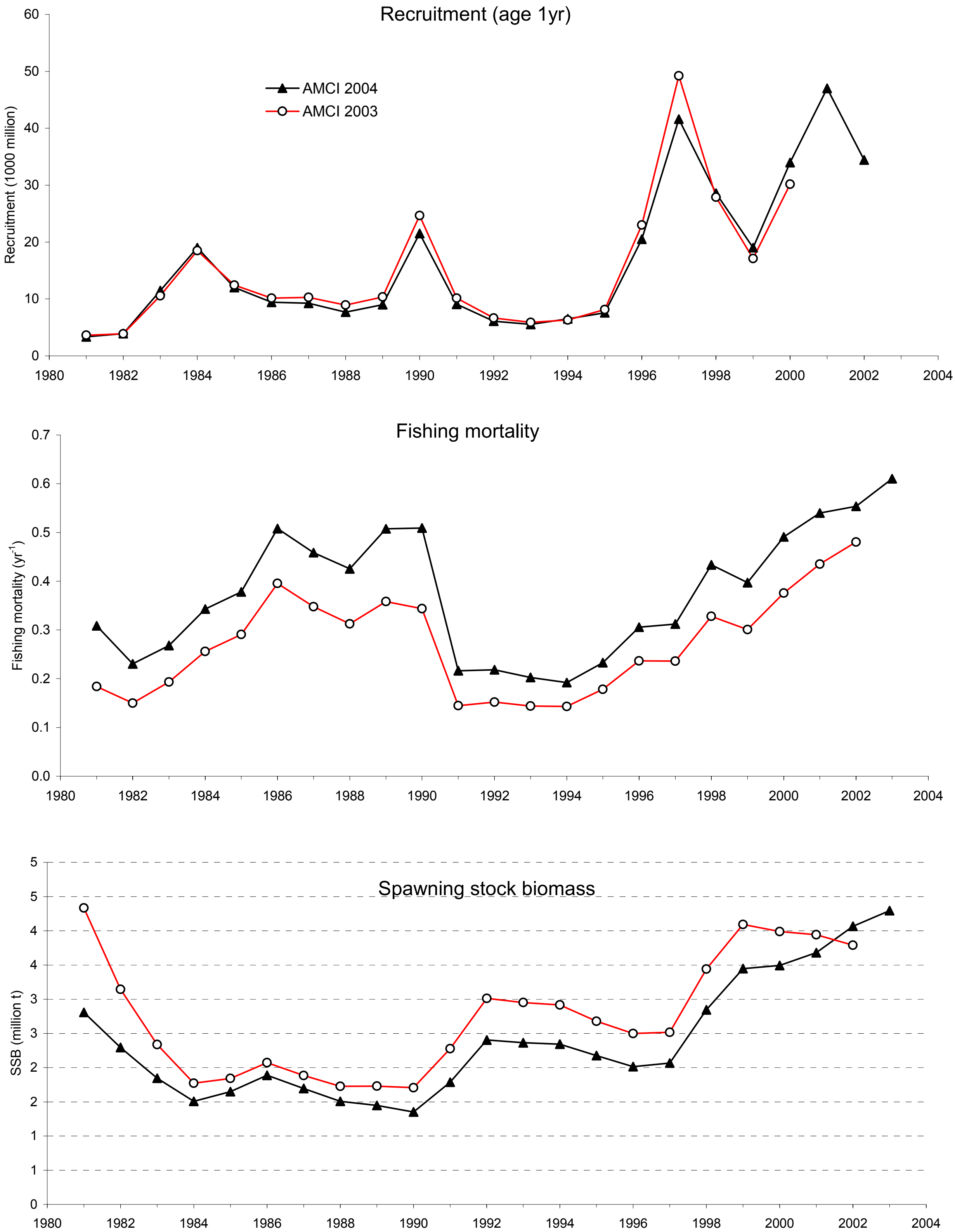


Figure 6.4.5.2.7. Blue Whiting: Comparisons between final AMCI assessments by the WGNPBW in 2003 and 2004

7 ICELANDIC SUMMER-SPAWNING HERRING

7.1 The fishery

The catches of Icelandic summer-spawning herring from 1983 - 2003 are given in Tables 7.1.1. No discards were reported for the 2003/2004 season. The main fishery started in September and terminated in January. The catch in September-January was about 120 000 tonnes. The catch was taken with traditional purse-seines and pelagic trawls. Only a purse-seine fishery took place off the east -southeast coast of Iceland in September and December but in all the other months both purse-sein and pelagic trawl fishery took place off the east-southeast and west-northwest coast. Because small herring was frequently present in the catches, especially at SE- and SW-Iceland, area closure was common during the 2003/2004 season.

A total of about 46 000 tonnes were fished off west and about 80 000 tonnes off east Iceland and 61% of the catch was taken by purse-sein. About 53% of the catch was reduced to oil and fishmeal. The remainder was either salted or frozen for human consumption.

Until 1990, the herring fishery took place during the last three months of the calendar year, but from 1990-2002 and 2004 the autumn fishery has continued until January or early February of the following year. In 2003 the season was further extended to the end of April and in the summers of 2002 and 2003 an experimental fishery for spawning herring with a catch of about 5 000 t each year was conducted at the south coast. In 1994 the fishery started in September. Therefore, all references to the years 1990-1993 imply seasons starting in October of that year, but after that in September. Landings, catches and recommended TACs since 1984 are given in thousand tonnes in Table 7.1.1.

7.2 Catch in numbers, weight-at-age and maturity

The catches of the Icelandic summer-spawners in numbers at age for the period 1982- 2003 are given in Table 7.2.1. Like last year age is now given as real age instead of rings, as in earlier WG reports.

During the 1995/96 - 1997/98 seasons, catches were mainly distributed on the 4 year classes from 1988–1991. On the other hand, catches during the 1998/99 and 1999/2000 seasons were dominated by the strong 1994 year class. In 2000/2001 the very strong 1994 and 1996 year classes were most abundant in the catch, but in 2001/2002 the 1996 year class was the most abundant. In 2002/2003 the 1998 and 1999 year classes were the most common in the catch followed by the 1996 and 1994 year classes. In 2003/2004 the very strong year classes of 1999 and 2000 dominated in the catches with 42% and 35% in numbers respectively (Figure 7.2.1). The 1998 year class was 7.5% in numbers in the catch but the very strong year classes of 1994 and 1996 which dominated in the catches in 1998/1999-2001/2002 were only 1.4% and 3.6% in numbers respectively.

The weight at age for each year is given in Table 7.2.2. The weights from the catch are used as the weights for the stock. Proportion mature at age is given in Table 7.2.3.

7.3 Acoustic surveys

The Icelandic summer-spawning herring stock has been monitored by annual acoustic surveys since 1974 (Table 7.3.1). These surveys have been conducted in October-December or January. A survey was conducted in late November 2003 at the east coast of Iceland. On the traditional fishing grounds off the east coast the survey recorded about 200 000 t of which 177 000t were adult herring. Another survey to the west of Iceland was conducted in late January 2004. A total of 546 000 tonnes were recorded of which adult herring was estimated to be 431 000 t. The total estimation of the adult stock was therefore 608 000 t.

The 2003/2004 acoustic assessment surveys confirmed that the 1999 year class is strong (Table 7.3.1) and it seems that the 2000 year class is also strong (Figure 7.3.1).

The sum of results obtained in winter 2003/2004 acoustic surveys have been used as basis for the present assessment (Table 7.3.1).

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain a one-to-one relationship between acoustic and VPA estimates of stock size. It was found that a modification of the target strength, from TS=21.7 log (L) - 75.5 dB to TS=20 log (L)-72 dB, gave a much better fit between the two data sets. The latter target strength has been the basis of calculations of stock abundance from acoustic survey data since 1993.

7.4 Update assessment

This year an update assessment should be performed for the Icelandic summer spawning herring. The assessment was made in AMCI 2.2 as in last year and compared to last years assessment (Figure 7.4.1) As can been seen the new assessment fits well regarding the fishing mortality, but that the spawning stock biomass has been overestimated in last year's assessment. This fits quite well, as the larger herring was not found in this year acoustic survey. The results from the update assessment are shown in table 7.4.1. The update assessment was also run in AMCI 2.3a. From figure 7.4.1 it can be seen that the spawning stock biomass is constantly below the estimates derived with AMCI 2.2. This is due to a bug in AMCI 2.2. Last year an error was made in estimating selection for the catch and the catchability in the survey. Selection above age 5 was supposed to be flat, but in reality it was estimated for all age groups. The same is true for the catchability. The model was over parameterized and results should therefore be interpretated with caution.

7.5 Data exploration

In previous years when the ADAPT-type of VPA (which is different from NFT ADAPT 2.1.7 used later here) was used there was a general trend to overestimate SSB and underestimate F. The terminal F gain by that method was not in line with the mortality sign derived from the catch data. In last year (2003) an AMCI assessment was made and seemed to produce a more reliable F. But at the last minute it was discovered that the residuals derived from the AMCI model showed a cyclic pattern, which could possibly mean some time trend in the model. The assessment was accepted but it was decided to look closer into this pattern at later time. Before assessment runs would be done this year (2004) it was decided to look first at the input data.

7.5.1 Analysis of catch-at-age in commercial data and in the acoustic survey

Using catchdata from 1981 catchcurves were plotted (Figures 7.5.1.1-7.5.1.2). From them it can be seen that the total mortality sign is between 0.3 and 0.4 provided that the effort has been the same the whole time. It can also be seen, that in later years the fish is fully recruited to the fishery at younger ages. By using data from the years 1981-2003 and ages 2-15 a Shepherd-Nicholson model was run for the catchdata resulting in CV=0.82 which is high in catch in numbers, but can result from variable selection. It was discovered that agegroup 15 was sometimes used as a plus group and sometimes not, so it was excluded from further dataexploration. The CV was estimated as 0.40, 0.45, 0.53 and 0.48 when using ages 4-11, 4-12, 3-12 and 3-11 respectively.

Using acoustic survey data from 1981-2004 catchcurves were also plotted (Figures 7.5.1.3-7.5.1.4). They are a bit difficult to interpret. The lines are zigzagged which can be a result of a faulty agereadings, but the mortality sign could be somewhere around 0.4 provided that the catchability at age is the same. However in the last year (2004) there is a huge drop in the curves for older year classes, as the survey did not find the oldest part of the stock. Until now in 2004 only ages 6 and older have been used in the tuning in the assessments, whereas until 2002 the sum of 6 years and older was used. A comparison between ages in the survey was made by fitting a line through the origin (Figure 7.5.1.5) and the correlation from the regression tabulated (Table 7.5.1.1). Based on Table 7.5.1.1 ages 3-9 could be used as age disaggregated indices in an assessment. Ages 10 and 11 could possibly be used, as the correlation is moderate for these ages. A biomass index was made for the acoustic survey. The weights from the catchdata are used as survey weights. The weights were summed over ages 3-9 and 3-11. The index is almost the same for both agegroup categories (Figure 7.5.1.6).

7.5.2 Data exploration with NFT ADAPT 2.1.7.

<u>Input data:</u>

- c@a, years 1981-2003, age groups 2-12. Informations from age groups 13 and above ignored.
- U@a, years 1981-2004, age groups 3-9.

<u>Excercises performed:</u>

- Run 1: Tuning range 1981-2004, age groups 3-9
- Run 2: Tuning range 1988-2004, age groups 3-9
- Run 3: Tuning range 1988-2004, age groups 3 and 4

Results:

Run 1 and 2 indicate that there is a discrepancy in the two data sets with retrospective estimates of catchability showing an increasing trend (Figure 7.5.2.1). Given the model assumption of constant catchability this results in a persistent overestimation of biomass and underestimation of fishing mortality.

From run 2 there were indications that the catchability trend may only be in age groups 5-9 but that trends in age groups 3 and 4 may be less pronounced or non existent. When tuning with only age groups 3 and 4 (run 3) the retrospective pattern in biomass and fishing mortality is considered resonable in the sense that the pattern is not just one sided (Figures 7.5.2.2 and 7.5.2.3). The biomass of age groups 4 and above in 2003 is estimated to be 732 kt with at standard deviation of 258kt (CV=0.35, estimates based on 1000 bootstrap runs).

Although change in hidden mortality may a priori be an equally likely hypothesis as change in catchability it cannot be explored with the tool used. If change in mortality is suspected it may only be applicable to older fish. It is considered less likely that the catchability has increased as less survey effort has been a restricting factor since the herring stock has become more widely distributed.

7.5.3 Data exploration with TSA

Input data:

- c@a, years 1986-2003, age groups 4-12. Informations from age groups 13 and above ignored as well as age groups 2 and 3.

- U@a, years 1988-2004, age groups 4-8, which are shifted towards the end of the year before, so they are then ages 3-7 at the end of the years 1987-2003.

Excercises performed:

- Run 1: Only catch data used

- Run 2: Catch- and surveydata used. Catchability in the survey estimated by using random walk.

- Run 3: Catch- and surveydata used. No random walk term.

- Run 4: Natural mortality is estimated. A model is run where M is fixed for all age groups but changes in time according to the model $M(t)=0.1 + \Theta\ g(t)$, where $g(t)=0$ for t=1986-1993, $g(t)=(0.2, 0.5, 0.8)$ in 1994-1996 and $g(t)=1$ from 1997-2003. The parameter Θ is estimated.

Results:

Run 2 is significantly better than Run 3 and is regarded as the best run of the first three runs. The biomass of age groups 4 to 12 in 2003 is estimated to be 555 kt with a standard deviation of 35.8 kt. The unweighted F is estimated to be 0.135 for age groups 5-12 with a standard deviations of log(F) as 0.094 .

The results for the log likelihood function from run 4 is as follow:

	M is fixed	M estimated
catchability fixed	0.00	5.28
catchablility estimated	3.34	6.09

One parameter is significant at approximately P=0.05 when the likelihood function increases by 2.0 and an increase of 3.0 is needed so that addition of 2 parameters is significant. According to these values a model where M is fixed and catchability is fixed is rejected. More is gained by estimating variable M by time than by estimating catchability. A model where both M and catchability is estimated is not significant better than model where only variable M is estimated. So this means that there is no reason to reject that the catchability is unchanged. When using this model with variable M by years the biomass of agegroups 4 to 12 in 2003 is 583.5 kt with a standard deviation of 39.7 kt. The unweighted F for age groups 5-12 in 2003 is estimated as 0.171 with the standard deviation of the log(F) as 0.108. (Estimation of standard deviations of F and stock values in TSA only represent errors from the random variations but assume that the true model is applied. The actual uncertainty is therefore considerably higher)

Althoug the model behaves better with variable M by years it isn't thereby proven that a change in the natural mortality is real. On the other hand it is not considered unlikely as the herring has changed its distribution from being in Fjords and close to the coast to being almost all around the country in deeper waters since 1997/1998.

7.5.4 Data exploration with AMCI 2.3a

Input data:

- c@a, years 1981-2003, age groups 2-12+. Last year (2003) it was recommended in the technical minutes to try to use a plus group to diminish for effects from misreading of scales as it is very difficult to read scales from old herring, but until now ages 2-15 has been used.

- U@a, years 1981-2004, age groups 3-9

Excercises performed:

In all runs the objective function was: $\sum\lambda_a(\log(c_a)-\log(\hat{c}_a)) + \sum(\log(y)-\log(\hat{y})) + \sum(\log(s_a)-\log(\hat{s}_a))$ where c_a and $\hat{c}_a$ are the observed versus the fitted catch numbers by age, y and ŷ are observed and fitted yield and s_a and $\hat{s}_a$ are the observed versus the fitted survey values by age. $\lambda_a = 0.5$ for age 2, otherwise set to 1.

- Run 1: Uses all data. Selection was estimated parametric by age with the condition of flat selection for ages 5 and older. Selection was allowed to change with time for youngest ages. The gainfactor was set to 0.2 for ages 2 and 3 and 0.1 for ages 4 and 5. Catchablility was estimated parametric at age for ages 3, 4 and 5 and kept flat above that and kept the same for all years.

- Run 2: Catchdata used from years 1986-2003. Tuning range 1988-2004. Selection was estimated with the same conditions as in run 1, but the gainfactor was set to 0.4, 0.3, 0.2 and 0.1 for ages 2, 3, 4 and 5 respectively. Catchability was estimated like in run 1.

- Run 3: Catchdata used from years 1986-2003. Tuning range 1988-2004. Three seperable periods were used, 1986-1991, 1992-1997 and 1998-2003. Gain factor was 0. Catchability was estimated like in run 1.

- Run 4: Catchdata used from years 1986-2003. Tuning range 1988-2004. The same seperable periods were used as in run 3, but in the middle period the selection was estimated parametric at age, except for the plus group that was set to the same selection as age 11, and then allowed to change gradually by setting the gainfactors as 0.4, 0.3, 0.2 and 0.1 for ages 2,3,4 and 5 and older. Catchablity was estimated like in run 1.

Results:

In all the runs recruitment at age 2 in 2003 could not be estimated reliably, so it was set to a geometric mean of 650 derived in last year. It was observed that the geometric mean value for the new assessments is 520, but it doesn't have any effect on the assessments. In run 2 selection at age 2 in the first year was poorly estimated and in run 3 and 4 there was a year trend in the survey residuals. So run 1 is regarded as the best amci run. As seen from the diagnostic plot for run 1 (Figure 7.5.4.1) it can be seen that the fitted catch doesn't fit the observed very well around 1990 and 2000. There can be a plausible explanation for the discrepancy around 1990. There was the change in the assessment from the fishing year to a fishing season, so there are most likely data discrepancies in the years 1990 and 1991. The run 1 doesn't either follow the survey very well in the last years. Recruitment is estimated record high for the year classes 1999 and 2000. A retrospective run was made for this assessment (Figure 7.5.4.2)

7.5.5 Adapt in AD-Model builder

Input data:

- c@a, years 1981-2003, age groups 2-12.

- U@a, years 1988-2004, age groups 3-12

A cohort model using Popes approximation was used. Catchability was fixed from age 8 onwards. CV in the survey data was estimated for each age agegroup.

Results:

The results from this run are shown in figure 7.5.5.1. The recruitment is estimated very high for the 1999 and the 2000 year classes. It doesn't follow the survey very well and in the residual plot for the survey it can be seen that the model expected higher numbers for the older age groups in the last survey. A retrospective run was made for this run (Figure 7.5.5.2). As can been seen from it there has been a tendency to overestimate the spawning stock in the past years.

7.5.6 Comparisons between models

The assessments made with the different models were compared (Figure 7.5.6.1) as well as with the assessment made last year (2003) run in AMCI 2.3, although it is not quite comparable with the other exploratory assessment. Last year age groups 2 to 15 were used in the tuning fleet but now only ages 3 to 9 have been used. And now terminal fishing mortality is computed for ages 5-10 instead of 5-15, as 12 is used as a plus group in this year's assessment. In general all the assessments have the same trend. The F values from last year's assessment are somewhat different from the Fs of the other 4 assessments, and the F-values for the NFT Adapt run are different in the first years. For the Adapt- and the TSA assessment biomass of 4+ is shown. Usually about 90% of age group 4 is mature, so it can easily be compared to the spawning stock. Regarding the spawning stock all runs show similar trend, except that TSA is a level higher in the last year and NFT Adapt is level higher in earlier years. The recruitment is very similar over the years and all runs estimate high recruitment for the 1999 and 2000 year classes. In this TSA run a time variable natural mortality is used and the update assessment is overparametrized so they have to be left out. As the other models tested are showing the same trend both in SSB and Fs it was not considered justifiable to replace the assessment model from last year.

7.6 Final assessment

Run 1 from the AMCI was chosen as the final assessment. According to this assessment the spawning stock biomass was about 490 thousand tonnes in 2003 (Table 7.6.1). The annual unweighted fishing mortality was 0.25. Stock numbers and fishing mortalities are shown in Tables 7.6.2 and 7.6.3.

7.7 Short term projections

AMCI is a forward running program and if the AMCI is used for short-term projection using the stock numbers from the AMCI run a TAC of 160 000 t would be obtained. Instead a deterministic short-term projection was made using the MFDP program. The stock numbers for all ages from the AMCI were used except the estimate of the 4 year old in 2004 (the 2000 year class) which is considered unrealistically high. This year class was mixed heavily with the 1999 year class on the fishing grounds. Because of relatively slow growth of the 1999 year class reference length for area closures was lowered compared to previous years and this may have resulted in too high a signal of this year class in the fishery. Although there is indication from surveys and catch data that the 2000 year class is large this indication does not point to a historically large year class as estimated in the assessment run. Furthermore it has been shown that there is a tendency to overestimate the stock biomass when large year classes are entering the stock (Figure 7.5.5.2). It is estimated in all runs higher than the 1999 year classes. The size of the 2000 year class was, therefore, set at the same level as the 1999 year class in the year 2004. Selection is the mean selection in the last 3 years. Proportion of M before spawning is 0.5 and proportion of F before spawning is 0. The input data is shown in table 7.7.1 and the results from the run in table 7.7.2 Fishing at 0.22 (= $\mathbf{F}_{0.1}$) would correspond to a catch of 106 thousand tonnes in 2004/2005 season.

7.7.1 Comments to the assessment

It has been pointed out that there are discrepancies in the catch- and survey datasets, which make it difficult to assess the stock. A project is ongoing, where all scales are being reread back to 1992.

7.8 Management consideration

During the last 20 years the Icelandic summer-spawning herring stock has been managed at levels corresponding fairly closely to fishing at $\mathbf{F}_{0.1}$.

7.9 Comments on the PA reference points

The Working Group points out that managing this stock at an exploitation rate at or near $\mathbf{F}_{0.1}$ has been successful in the past. Thus the Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa}$= $\mathbf{F}_{0.1}$= 0.22, $\mathbf{B}_{pa}$= $\mathbf{B}_{lim}$ * $e^{1.645\sigma}$= 300 000 t where $\mathbf{B}_{lim}$= 200 000 t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February this year and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The present working group agrees with this conclusion.

7.10 Sampling

Investigation	No. of samples	Length measured individuals	Aged individuals
Fishery	42	2402	2223
Acoustic, wintering area	22	6408	3395

Table 7.1.1 Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs
1984	50.3	50.3	50.0
1985	49.1	49.1	50.0
1986	65.5	65.5	65.0
1987	73.0	73.0	70.0
1988	92.8	92.8	100.0
1989	97.3	101.0	90.0
1990/1991	101.6	105.1	90.0
1991/1992	98.5	109.5	79.0
1992/1993	106.7	108.5	86.0
1993/1994	101.5	102.7	90.0
1994/1995	132.0	134.0	120.0
1995/1996	125.0	125.9	110.0
1996/1997	95.9	95.9	100.0
1997/1998	64.7	64.7	100.0
1998/1999	87.0	87.0	90.0
1999/2000	92.9	92.9	100.0
2000/2001	100.3	100.3	110.0
2001/2002	95.3	95.3	125.0
2002/2003	92.7	93.6	105.0
2003/2004*	125.2	125.2	110.0

*Preliminary

Table 7.2.1 Icelandic summer spawners. Catch in numbers (millions) and total catch in weight (thous. tonnes). 1982 refers to season 1982/1983.

Age/Year	1982	1983	1984	1985	1986	1987	1988
2	0.454	1.475	0.421	0.112	0.100	0.029	0.879
3	19.187	22.499	18.015	12.872	8.172	3.144	4.757
4	28.109	151.718	32.244	24.659	33.938	44.590	41.331
5	38.280	30.285	141.354	21.656	23.452	60.285	99.366
6	16.623	21.599	17.043	85.210	20.681	20.622	69.331
7	38.308	8.667	7.113	11.903	77.629	19.751	22.955
8	43.770	14.065	3.916	5.740	18.252	46.240	20.131
9	6.813	13.713	4.113	2.336	10.986	15.232	32.201
10	6.633	3.728	4.517	4.363	8.594	13.963	12.349
11	10.457	2.381	1.828	4.053	9.675	10.179	10.250
12	2.354	3.436	0.202	2.773	7.183	13.216	7.378
13	0.594	0.554	0.255	0.975	3.682	6.224	7.284
14	0.075	0.100	0.260	0.480	2.918	4.723	4.807
15	0.211	0.003	0.003	0.581	1.788	2.280	1.957
Catch	56.528	58.867	50.304	49.368	65.500	75.439	92.828

Age/year	1989	1990	1991	1992	1993	1994	1995
2	3.974	11.009	35.869	12.006	0.869	6.225	7.411
3	22.628	14.345	92.758	79.782	35.560	110.079	26.221
4	26.649	57.024	51.047	131.543	170.106	99.377	159.170
5	77.824	34.347	87.606	43.787	87.363	150.310	86.940
6	188.654	77.819	33.436	56.083	25.146	90.824	105.542
7	43.114	152.236	54.840	41.932	28.802	23.926	74.326
8	8.116	32.265	109.418	36.224	18.306	20.809	20.076
9	5.897	8.713	9.251	44.765	24.268	19.164	13.797
10	7.292	4.432	3.796	9.244	14.318	17.973	8.873
11	4.780	4.287	2.634	2.259	3.639	16.222	9.140
12	3.449	2.517	1.826	0.582	0.878	2.955	7.079
13	1.410	1.226	0.516	0.305	0.300	1.433	2.376
14	0.844	1.019	0.262	0.203	0.200	0.345	0.927
15	0.348	0.610	0.298	0.102	0.100	0.345	0.124
Catch	101.000	105.097	109.489	108.504	102.741	134.003	125.851

Age/Year	1996	1997	1998	1999	2000	2001	2002	2003
2	1.100	9.323	16.161	0.629	7.958	10.206	14.149	23.470
3	18.723	27.072	37.787	43.537	52.921	23.944	70.982	235.988
4	45.304	28.397	151.853	65.871	131.153	76.666	78.395	283.519
5	92.948	29.451	42.833	145.127	44.334	107.849	43.905	50.527
6	69.878	42.267	19.872	24.653	102.925	46.646	57.266	25.898
7	86.261	35.285	30.280	20.614	10.962	51.585	21.433	24.010
8	37.447	28.506	22.572	25.853	9.312	18.504	42.272	11.330
9	13.207	21.828	32.779	21.163	17.218	11.356	9.668	9.743
10	6.854	8.160	14.366	14.436	9.471	7.933	4.632	1.429
11	4.012	3.815	4.802	6.973	7.610	8.547	6.429	3.750
12	1.672	1.696	2.199	2.164	1.930	5.090	7.839	3.479
13	4.179	6.570	1.084	2.426	5.199	4.346	9.738	1.743
14	1.672	1.378	5.081	0.473	0.552	1.611	4.478	1.272
15	0.100	1.802	3.036	0.961	0.166	0.864	4.537	0.816
Catch	95.882	64.682	86.998	92.896	100.332	95.278	93.601	125.2

Table 7.2.2 Icelandic summer spawners. Weight at age (g).

Age/Year	1983	1984	1985	1986	1987	1988	1989
2	59	49	53	60	60	75	63
3	132	131	146	140	168	157	130
4	180	189	219	200	200	221	206
5	218	217	266	252	240	239	246
6	260	245	285	282	278	271	261
7	309	277	315	298	304	298	290
8	329	315	335	320	325	319	331
9	356	322	365	334	339	334	338
10	370	351	388	373	356	354	352
11	407	334	400	380	378	352	369
12	437	362	453	394	400	371	389
13	459	446	469	408	404	390	380
14	430	417	433	405	424	408	434
15	472	392	447	439	430	437	409

Age/Year	1990	1991	1992	1993	1994	1995	1996
63	75	74	63	74	67	69	78
144	119	139	144	150	135	129	140
190	198	188	190	212	204	178	166
232	244	228	232	245	249	236	208
276	273	267	276	288	269	276	258
317	286	292	317	330	302	292	294
334	309	303	334	358	336	314	312
346	329	325	346	373	368	349	324
364	351	343	364	387	379	374	360
392	369	348	392	401	398	381	349
444	387	369	444	425	387	400	388
399	422	388	399	387	421	409	403
419	408	404	419	414	402	438	385
428	436	396	428	420	390	469	420

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004*
2	62	78	64	58	78	80	66	66
3	137	147	143	158	140	149	149	149
4	197	184	211	214	217	202	183	183
5	234	213	236	256	242	245	225	225
6	270	246	268	284	281	275	255	255
7	299	286	300	326	294	311	283	283
8	323	314	318	333	309	325	328	328
9	342	341	349	366	339	347	347	347
10	358	351	347	383	350	383	328	328
11	363	354	377	402	367	390	368	368
12	373	350	359	405	375	402	387	387
13	412	372	403	422	403	442	385	385
14	394	400	408	406	426	463	380	380
15	429	437	445	444	425	453	430	430

* Predicted

Table 7.2.3 Icelandic summer spawners. Proportion mature at age.

Age/Year	1983	1984	1985	1986	1987	1988	1989
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.010	0.000	0.030	0.010	0.045	0.060
4	0.640	0.820	0.900	0.890	0.870	0.900	0.930
5	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age/Year	1990	1991	1992	1993	1994	1995	1996
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.013	0.020	0.049	0.054	0.157	0.049
4	0.780	0.720	0.930	0.999	1.000	0.982	0.990
5	1.000	1.000	1.000	1.000	0.992	0.998	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age/Year	1997	1998	1999	2000	2001	2002	2003	2004*
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.160	0.265	0.074	0.279	0.101	0.190	0.286	0.192
4	0.925	0.935	0.879	0.831	0.981	0.734	0.795	0.837
5	0.989	0.995	0.977	0.992	0.997	0.898	0.962	0.952
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

* Predicted (mean of 2001-2003)

Table 7.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-2003. The surveys are conducted in October-December or January. The year given is the following year, i.e. if the survey is conducted in the season 1973/1974, then 1974 is given.

	Ages														
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1974	-1	154	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1975	-1	5	137	19	21	2	2	-1	-1	-1	-1	-1	-1	-1	-1
1976	-1	136	20	133	17	10	3	3	-1	-1	-1	-1	-1	-1	-1
1977	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1978	-1	212	424	46	19	139	18	18	10	-1	-1	-1	-1	-1	-1
1979	-1	158	334	215	49	20	111	30	30	20	-1	-1	-1	-1	-1
1980	-1	19	177	360	253	51	41	93	10	-1	-1	-1	-1	-1	-1
1981	625	361	462	85	170	182	33	29	58	10	-1	-1	-1	-1	-1
1982	-1	17	75	159	42	123	162	24	8	46	10	-1	-1	-1	-1
1983	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1984	-1	171	310	724	80	39	15	27	26	10	5	12	-1	-1	-1
1985	-1	28	67	56	360	65	32	16	17	18	9	7	4	5	5
1986	201	652	208	110	86	425	67	41	17	27	26	16	6	6	1
1987	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1988	406	126	352	836	287	53	37	76	25	21	14	17	8	6	3
1989	370	725	181	249	381	171	42	23	30	16	10	9	5	3	2
1990	-1	178	593	177	302	538	185	-1	-1	-1	18	-1	-1	-1	-1
1991	710	805	227	304	137	176	387	40	10	2	-1	-1	-1	-1	-1
1992	465	745	850	353	273	94	81	210	32	11	-1	17	-1	-1	-1
1993	1418	254	858	687	160	99	87	44	92	39	-1	-1	-1	-1	-1
1994	183	234	533	860	443	55	69	43	86	55	2	-1	6	-1	-1
1995	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
1996	845	98	165	515	316	361	166	110	52	29	16	27	19	8	2
1997	266	792	65	139	459	280	410	150	101	50	35	15	65	32	-1
1998	1629	237	716	100	116	240	161	130	97	35	15	11	43	8	15
1999	-1	-1	188	790	240	101	73	47	77	47	10	10	-1	22	-1
2000	1069	527	740	296	606	99	71	164	108	98	15	44	5	13	7
2001	2832	101	561	1069	323	609	30	31	38	13	18	6	9	4	1
2002	561	942	247	187	265	173	302	69	48	55	54	16	18	1	-1
2003	-1	1642	1800	549	221	257	159	273	97	44	43	13	32	2	-1
2004	-1	949	1529	1941	316	108	90	34	47	4	3	5	8	3	2

Table 7.4.1 Results from an update assessment in 2004.

Run id 20040502 173313.344

SUMMARY TABLE

Year	Recruits age 2	SSB	F 5 -15	Catch SOP
1981	817853	246943	0.1273	39461
1982	290683	253260	0.1957	56472
1983	301676	274056	0.1390	58694
1984	532266	274503	0.0978	50132
1985	1283269	304134	0.1030	49309
1986	725519	310118	0.2906	65361
1987	349083	414524	0.3768	75295
1988	507432	473754	0.4816	92711
1989	496756	426726	0.3595	100868
1990	984376	387355	0.3681	104854
1991	1235351	345822	0.2466	109235
1992	773890	404424	0.2191	108275
1993	788730	523648	0.1676	102513
1994	345142	533841	0.2474	133753
1995	278752	487415	0.2526	125673
1996	972202	388208	0.2167	95722
1997	501559	359335	0.1835	64261
1998	870369	393129	0.2418	86849
1999	542287	382407	0.2214	92735
2000	612731	445461	0.2044	100406
2001	1966939	418931	0.2302	95352
2002	2533473	427220	0.2520	93673
2003	650000	590439	0.1639	125160

Table 7.5.1.1 Within survey consistency, correlation of N at age a in year y with N at age a+1 in year y+1 over the years 1981-2004.
The numbers in bold indicate where the correlation is considered strong.

a	a+1	r
2	3	.67
3	4	**.94**
4	5	**.95**
5	6	**.91**
6	7	**.93**
7	8	**.94**
8	9	**.87**
9	10	.77
10	11	.79
11	12	.64
12	13	.57
13	14	.68
14	15	.63

Table 7.6.1 Icelandic summer spawners. Summary table from final amci run.
Run id 20040503 224235.175

SUMMARY TABLE

Year	Recruits age 2	SSB	F 5 -10	Catch SOP
1981	635	166	0.2705	39
1982	227	173	0.4113	56
1983	236	184	0.3604	58
1984	440	192	0.2584	50
1985	1009	219	0.2340	49
1986	587	234	0.3200	65
1987	358	318	0.3260	75
1988	518	358	0.3649	92
1989	364	320	0.3429	100
1990	878	294	0.3844	104
1991	1076	255	0.4221	109
1992	671	315	0.3946	108
1993	606	431	0.2854	102
1994	291	435	0.3958	133
1995	264	379	0.4129	125
1996	781	287	0.3601	95
1997	431	269	0.2719	64
1998	716	300	0.3510	86
1999	385	291	0.3273	92
2000	468	339	0.3255	100
2001	1556	305	0.3451	95
2002	3047	307	0.3127	93
2003	520	488	0.2496	125

Table 7.6.2 Icelandic summer spawners. Stock size.

```
Run id 20040503  224235.175
 Stocknumbers at age,
 in area  1
 Data by 1. Jan., except at youngest age which are
 at recruitment time
```

	1981	1982	1983	1984	1985	1986	1987	1988
2	636.0	227.7	236.4	440.6	1009.5	587.4	358.4	518.8
3	257.4	620.0	221.9	230.1	429.2	983.7	572.2	349.2
4	206.7	228.7	544.4	191.7	199.9	374.1	851.2	498.3
5	99.4	168.1	175.4	414.7	153.6	160.9	288.0	658.2
6	161.8	68.6	100.8	110.7	289.8	110.0	105.7	188.1
7	168.4	111.7	41.1	63.6	77.4	207.5	72.3	69.0
8	34.8	116.3	67.0	26.0	44.4	55.4	136.3	47.2
9	23.0	24.1	69.7	42.3	18.1	31.8	36.4	89.0
10	41.5	15.9	14.4	44.0	29.5	13.0	20.9	23.8
11	4.5	28.6	9.5	9.1	30.7	21.2	8.5	13.7
12	7.9	8.5	22.3	20.1	20.4	36.6	38.0	30.4

	1989	1990	1991	1992	1993	1994	1995	1996
2	364.9	878.3	1076.7	671.9	606.7	291.9	264.2	781.8
3	505.3	354.7	851.7	1037.5	646.8	586.9	280.9	253.1
4	303.9	439.1	306.0	720.0	874.6	554.0	476.5	226.4
5	377.9	233.5	328.5	224.0	529.1	671.8	397.2	328.8
6	413.5	242.7	143.8	194.9	136.6	359.9	409.2	237.8
7	118.2	265.5	149.5	85.3	118.8	92.9	219.2	245.0
8	43.4	75.9	163.6	88.7	52.0	80.8	56.6	131.2
9	29.6	27.8	46.7	97.0	54.1	35.4	49.2	33.9
10	55.9	19.0	17.2	27.7	59.2	36.8	21.6	29.5
11	14.9	35.9	11.7	10.2	16.9	40.3	22.4	12.9
12	27.7	27.4	39.0	30.1	24.6	28.2	41.7	38.4

	1997	1998	1999	2000	2001	2002	2003	2004
2	431.4	716.3	385.5	468.0	1556.1	3047.1	520.0	520.0
3	752.9	415.6	686.8	371.3	450.1	1497.8	2940.4	499.0
4	207.8	636.6	343.5	573.9	304.1	369.7	1248.3	2478.1
5	161.7	157.1	453.7	250.1	412.4	213.8	264.2	925.9
6	207.5	111.5	100.1	295.9	163.4	264.2	141.5	186.2
7	150.1	143.1	71.0	65.3	193.4	104.7	174.9	99.7
8	154.6	103.5	91.2	46.3	42.6	123.9	69.3	123.3
9	82.8	106.6	65.9	59.5	30.3	27.3	82.0	48.9
10	21.4	57.1	67.9	43.0	38.8	19.4	18.1	57.8
11	18.6	14.7	36.4	44.3	28.1	24.9	12.8	12.7
12	32.4	35.1	31.8	44.5	58.0	55.2	53.0	46.4

Table 7.6.3. Icelandic summer spawning herring. Fishing mortality at age.

Run id 20040503 224235.175

Local partial fishing mortalities at age

Area 1 , Fleet 1

	1981	1982	1983	1984	1985	1986	1987	1988
2	0.0006	0.0012	0.0022	0.0014	0.0011	0.0013	0.0011	0.0015
3	0.0184	0.0301	0.0459	0.0409	0.0373	0.0446	0.0383	0.0392
4	0.1067	0.1651	0.1721	0.1219	0.1169	0.1616	0.1572	0.1766
5	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
6	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
7	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
8	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
9	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
10	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
11	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
12	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649
Fref	0.2705	0.4113	0.3604	0.2584	0.2340	0.3200	0.3261	0.3649

Local partial fishing mortalities at age

Area 1 , Fleet 1

	1989	1990	1991	1992	1993	1994	1995	1996
2	0.0034	0.0060	0.0124	0.0134	0.0083	0.0140	0.0181	0.0128
3	0.0404	0.0477	0.0679	0.0708	0.0548	0.1084	0.1155	0.0971
4	0.1635	0.1903	0.2118	0.2081	0.1637	0.2326	0.2710	0.2366
5	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
6	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
7	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
8	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
9	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
10	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
11	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
12	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601
Fref	0.3429	0.3844	0.4221	0.3946	0.2854	0.3958	0.4129	0.3601

Local partial fishing mortalities at age

Area 1 , Fleet 1

	1997	1998	1999	2000	2001	2002	2003
2	0.0124	0.0174	0.0129	0.0143	0.0135	0.0109	0.0164
3	0.0678	0.0906	0.0795	0.0997	0.0967	0.0822	0.0711
4	0.1801	0.2388	0.2174	0.2304	0.2522	0.2360	0.1988
5	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
6	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
7	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
8	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
9	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
10	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
11	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
12	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496
Fref	0.2719	0.3510	0.3273	0.3255	0.3451	0.3127	0.2496

Table 7.7.1 Input data for short term prediction.
MFDP version 1
Run: a
Time and date: 00:40 5/4/2004
Fbar age range: 5-12

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	520	0.1	0	0	0.5	0.066	0.011	0.066
3	499	0.1	0.192	0	0.5	0.149	0.0688	0.149
4	926	0.1	0.837	0	0.5	0.183	0.1898	0.183
5	926	0.1	0.952	0	0.5	0.225	0.2496	0.225
6	186	0.1	1	0	0.5	0.255	0.2496	0.255
7	180	0.1	1	0	0.5	0.283	0.2496	0.283
8	123	0.1	1	0	0.5	0.328	0.2496	0.328
9	49	0.1	1	0	0.5	0.347	0.2496	0.347
10	58	0.1	1	0	0.5	0.328	0.2496	0.328
11	13	0.1	1	0	0.5	0.368	0.2496	0.368
12	46	0.1	1	0	0.5	0.387	0.2496	0.387

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	520	0.1	0	0	0.5	0.066	0.011	0.066
3	.	0.1	0.192	0	0.5	0.149	0.0688	0.149
4	.	0.1	0.837	0	0.5	0.183	0.1898	0.183
5	.	0.1	0.952	0	0.5	0.225	0.2496	0.225
6	.	0.1	1	0	0.5	0.255	0.2496	0.255
7	.	0.1	1	0	0.5	0.283	0.2496	0.283
8	.	0.1	1	0	0.5	0.328	0.2496	0.328
9	.	0.1	1	0	0.5	0.347	0.2496	0.347
10	.	0.1	1	0	0.5	0.328	0.2496	0.328
11	.	0.1	1	0	0.5	0.368	0.2496	0.368
12	.	0.1	1	0	0.5	0.387	0.2496	0.387

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	520	0.1	0	0	0.5	0.066	0.011	0.066
3	.	0.1	0.192	0	0.5	0.149	0.0688	0.149
4	.	0.1	0.837	0	0.5	0.183	0.1898	0.183
5	.	0.1	0.952	0	0.5	0.225	0.2496	0.225
6	.	0.1	1	0	0.5	0.255	0.2496	0.255
7	.	0.1	1	0	0.5	0.283	0.2496	0.283
8	.	0.1	1	0	0.5	0.328	0.2496	0.328
9	.	0.1	1	0	0.5	0.347	0.2496	0.347
10	.	0.1	1	0	0.5	0.328	0.2496	0.328
11	.	0.1	1	0	0.5	0.368	0.2496	0.368
12	.	0.1	1	0	0.5	0.387	0.2496	0.387

Table 7.7.2 Short term prediction table.
MFDP version 1
Run: b
MFDP Index file 3/05/2004
Time and date: 00:16 5/4/2004
Fbar age range: 5-12

2004/2005

Biomass	SSB	FMult	FBar	Landings
684	525	0.8814	0.22	106

2005/2006					2006/2007	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
668	530	0	0	0	753	614
.	530	0.1	0.025	13	739	601
.	530	0.2	0.0499	26	725	588
.	530	0.3	0.0749	39	711	575
.	530	0.4	0.0998	51	698	563
.	530	0.5	0.1248	64	685	551
.	530	0.6	0.1498	75	673	539
.	530	0.7	0.1747	87	660	527
.	530	0.8	0.1997	98	648	516
.	530	0.9	0.2246	109	637	505
.	530	1	0.2496	120	625	494
.	530	1.1	0.2746	131	614	484
.	530	1.2	0.2995	141	603	473
.	530	1.3	0.3245	151	592	463
.	530	1.4	0.3494	161	582	454
.	530	1.5	0.3744	171	571	444
.	530	1.6	0.3994	180	561	435
.	530	1.7	0.4243	189	552	426
.	530	1.8	0.4493	198	542	417
.	530	1.9	0.4742	207	533	408
.	530	2	0.4992	215	524	400

Input units are millions and kg - output in kilotonnes

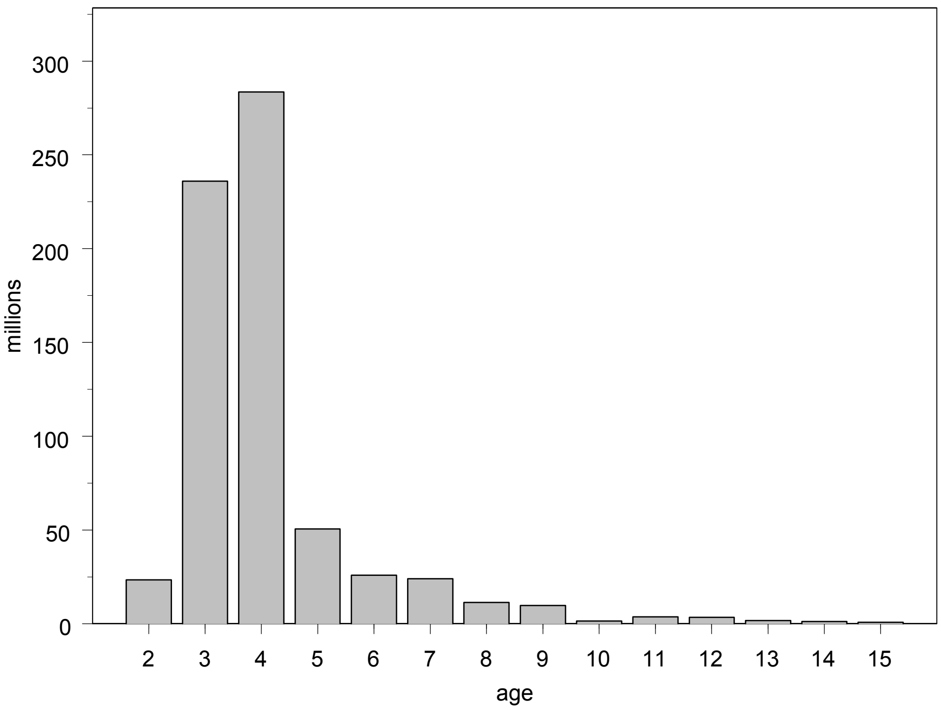


Figure 7.2.1 Icelandic summer spawning herring. Catch at age in numbers in 2003.

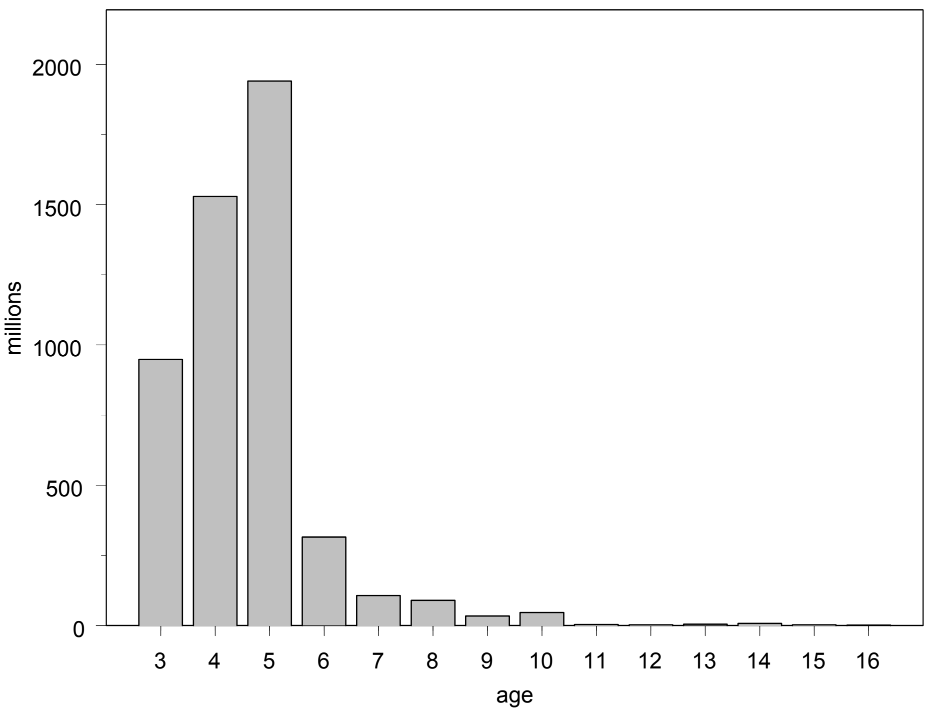


Figure 7.3.1 Icelandic summer spawning herring. Acoustic estimates by age in millions.

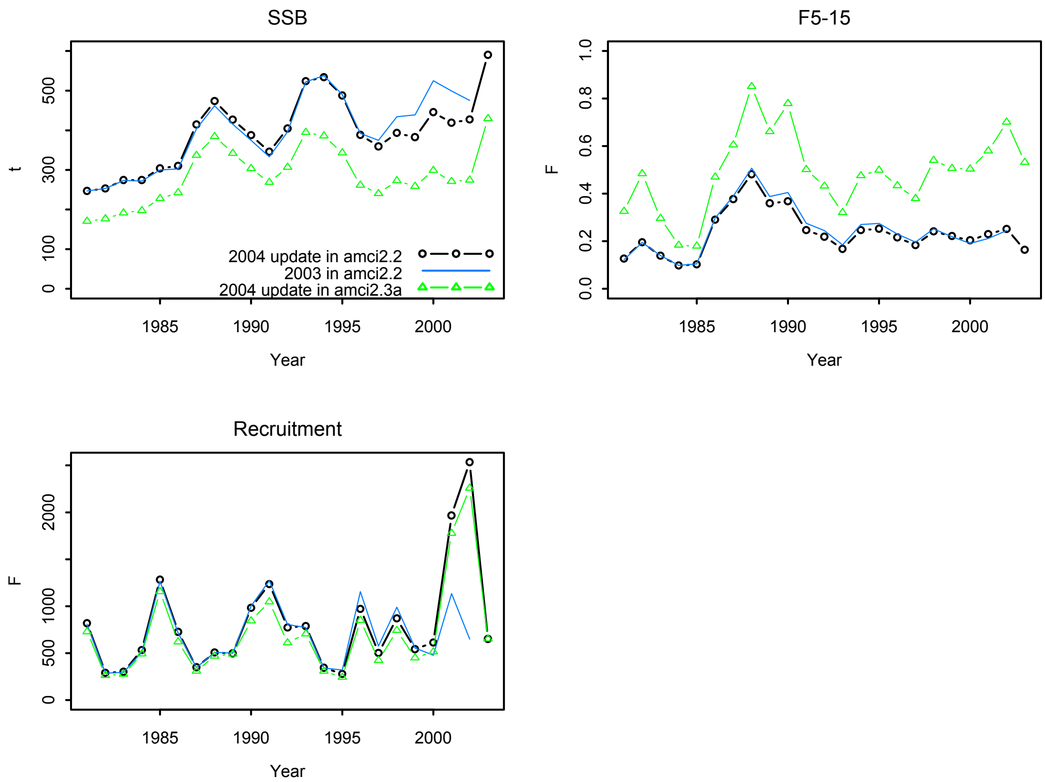


Figure 7.4.1 Results from the assessment made in 2003 and the update assessment (2004).

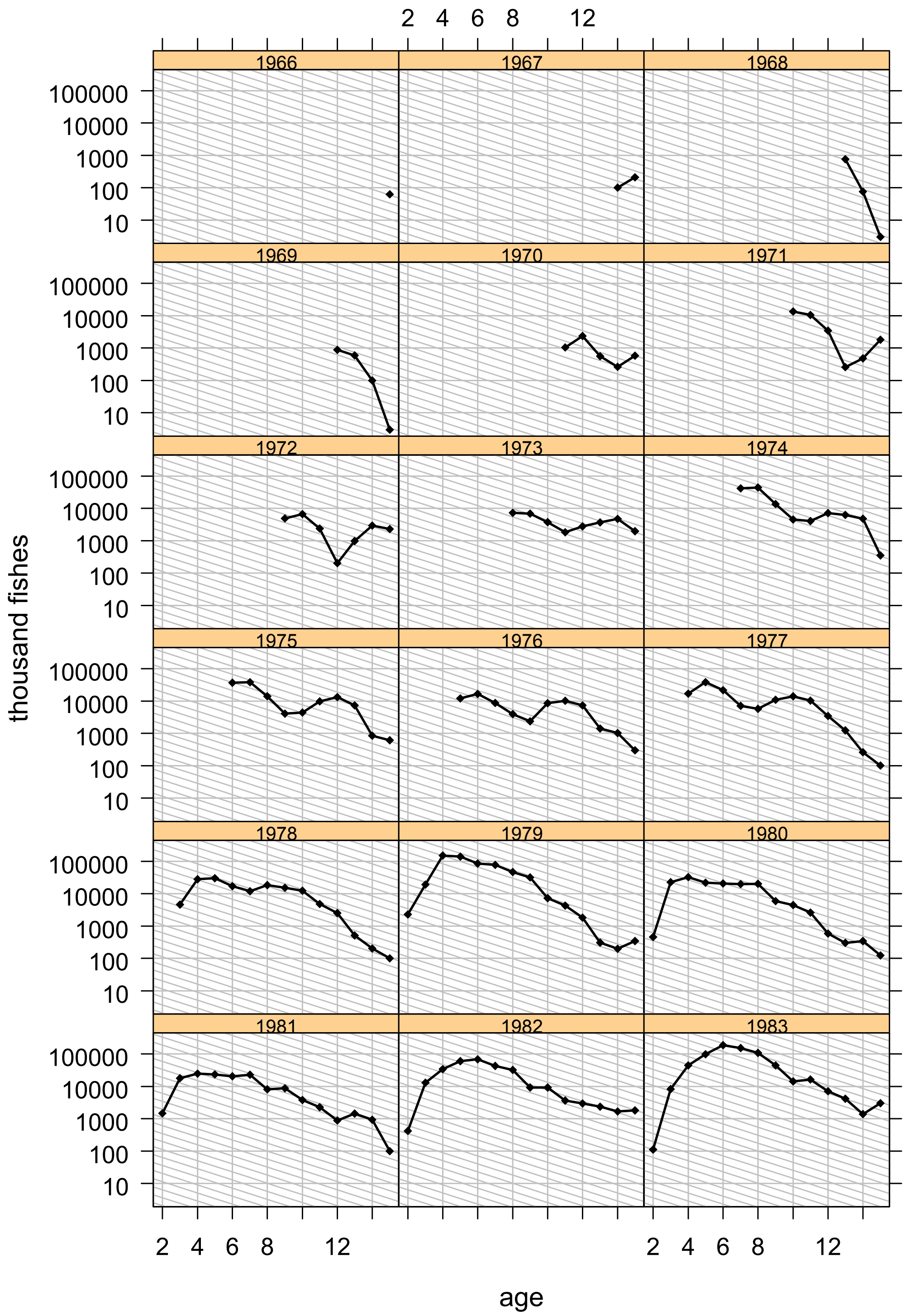


Figure 7.5.1.1. Catchcurves by yearclasses and years. Grey lines correspond to Z=0.4

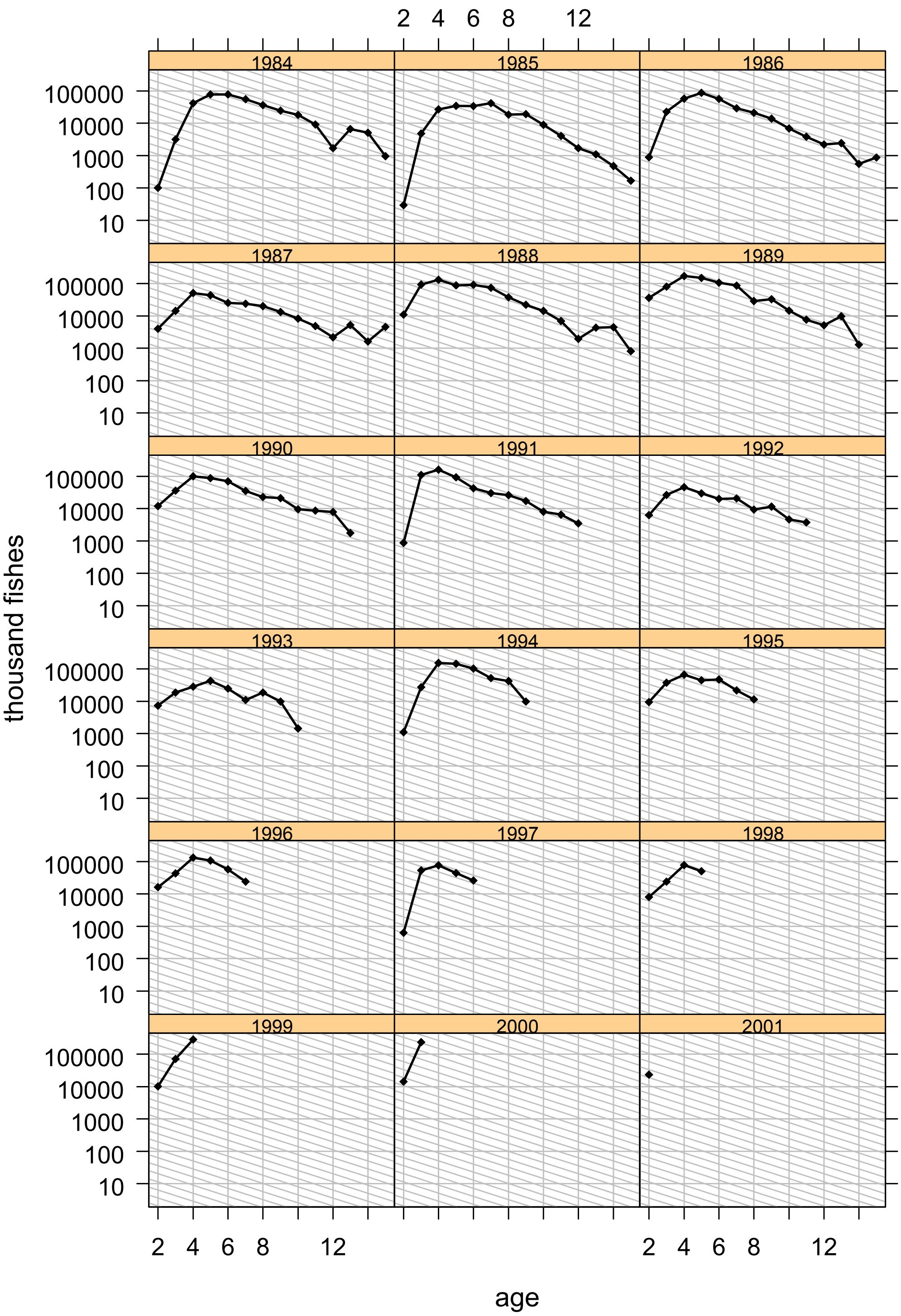


Figure 7.5.1.1 cont. Catchcurves by yearclasses and years. Grey lines correspond to Z=0.4

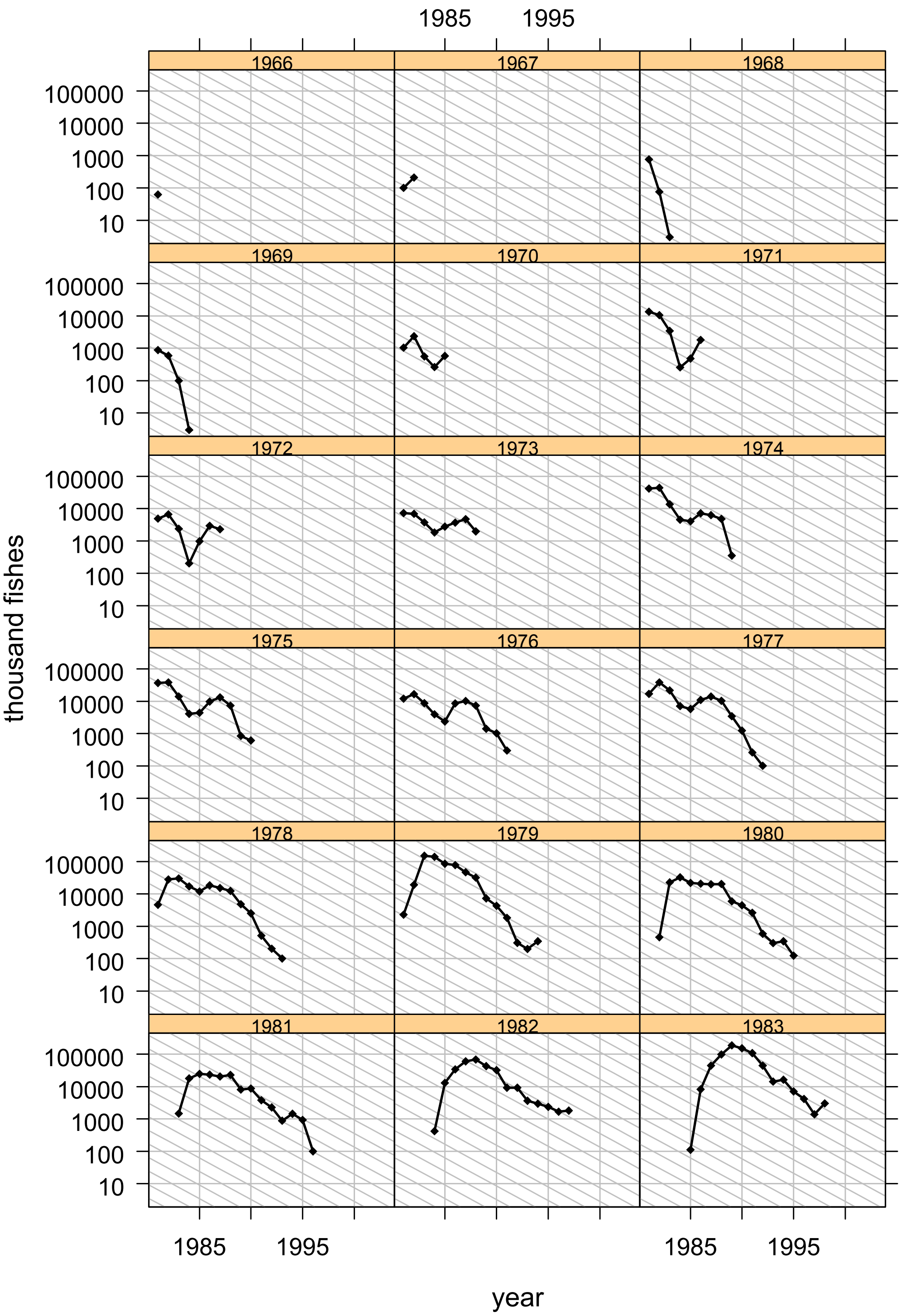


Figure 7.5.1.2. Catchcurves by yearclasses and years. Grey lines correspond to Z=0.4

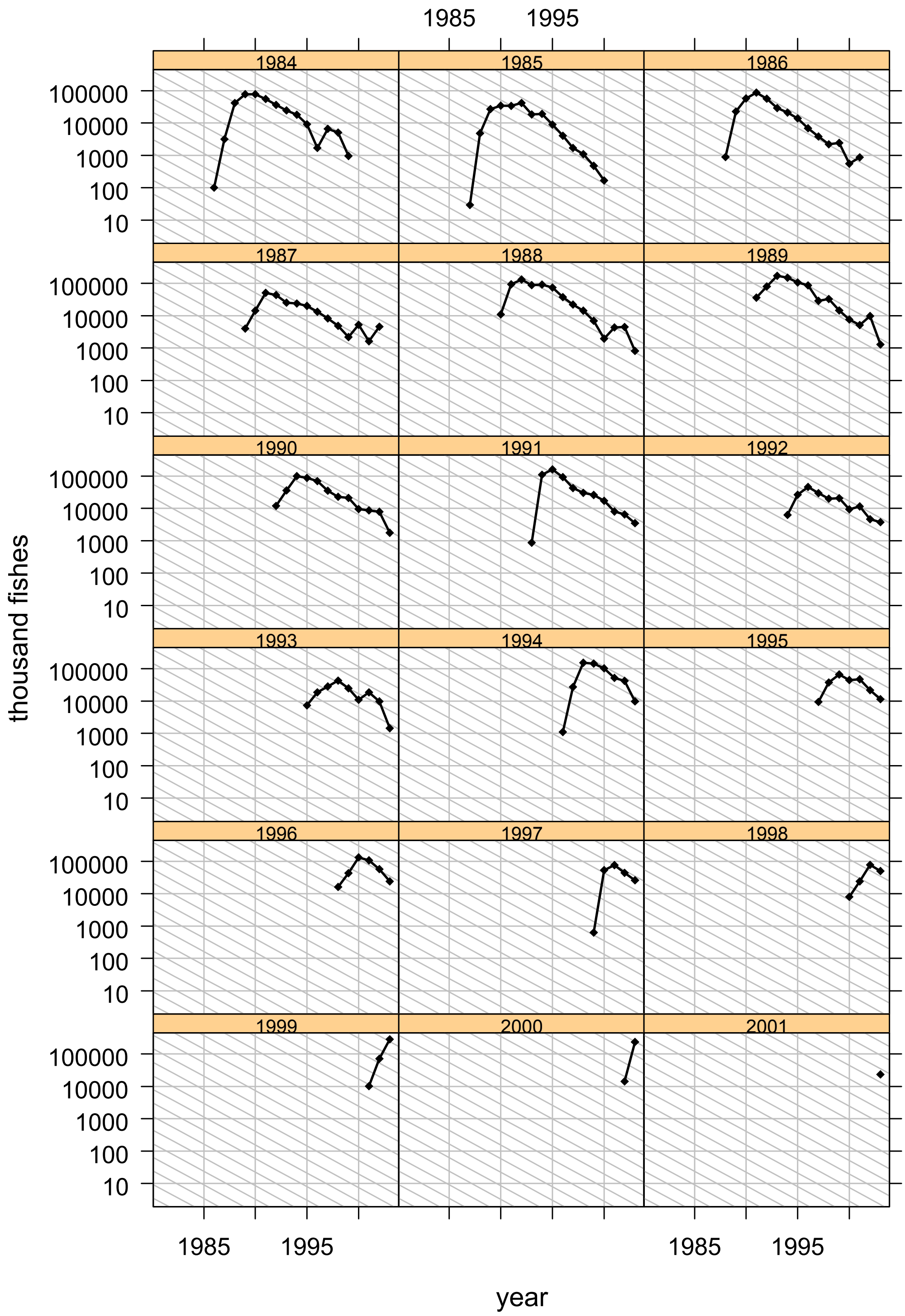


Figure 7.5.1.2 cont.. Catchcurves by yearclasses and years. Grey lines correspond to Z=0.4

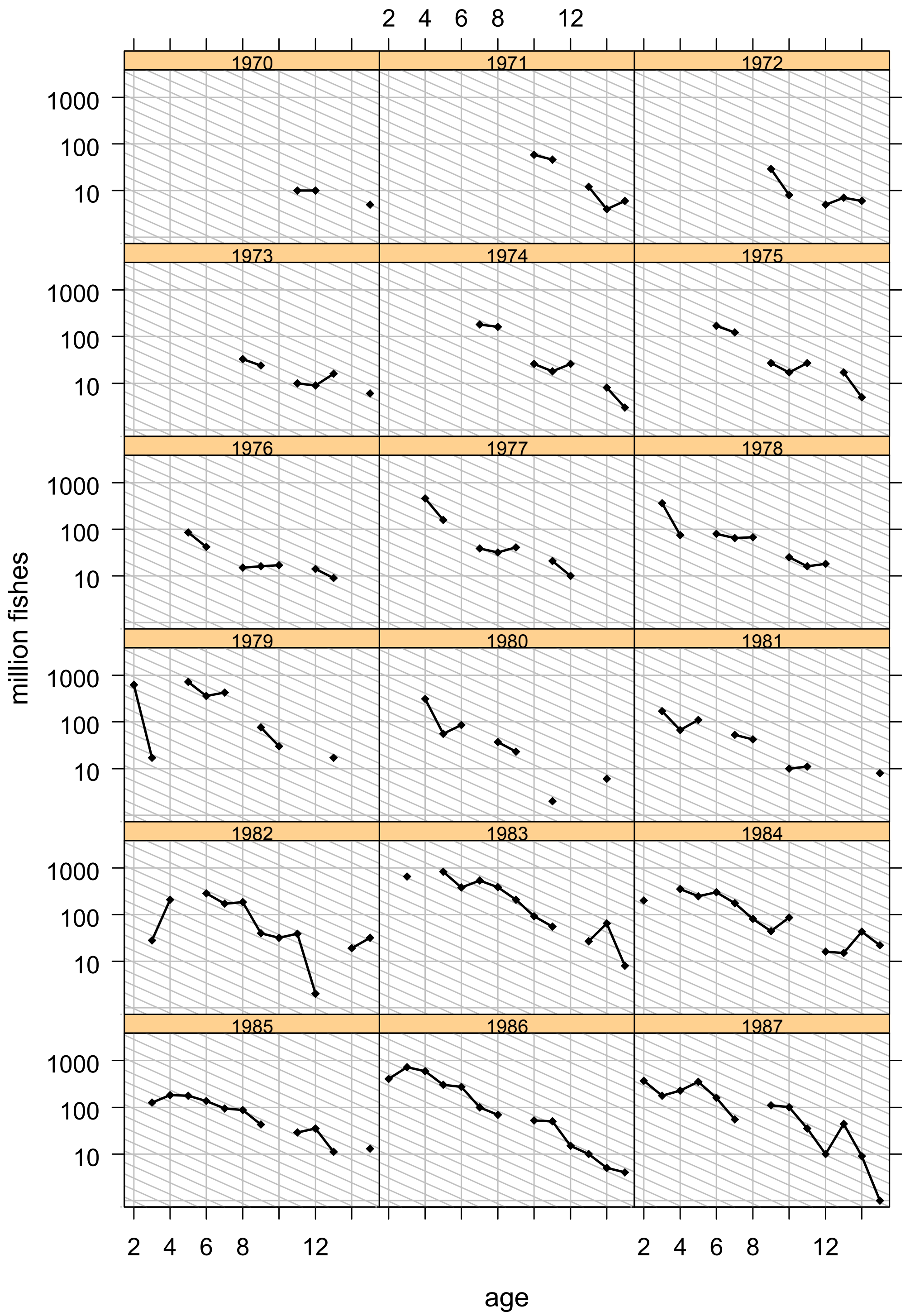


Figure 7.5.1.3. Catchcurves made from acoustic survey data. Grey lines correspond to Z=0.4

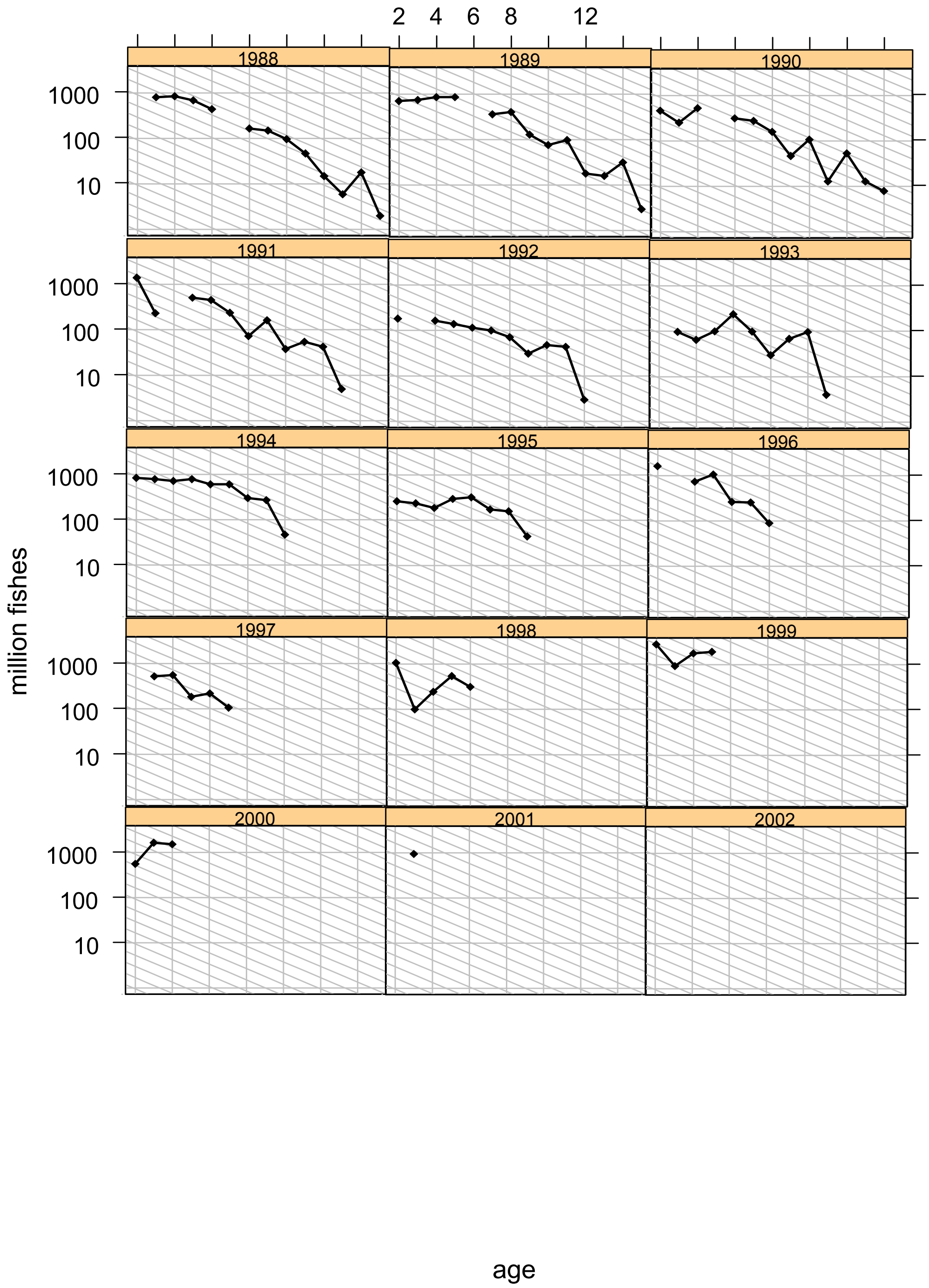


Figure 7.5.1.3 cont. Catchcurves made from acoustic survey data. Grey lines correspond to Z=0.4

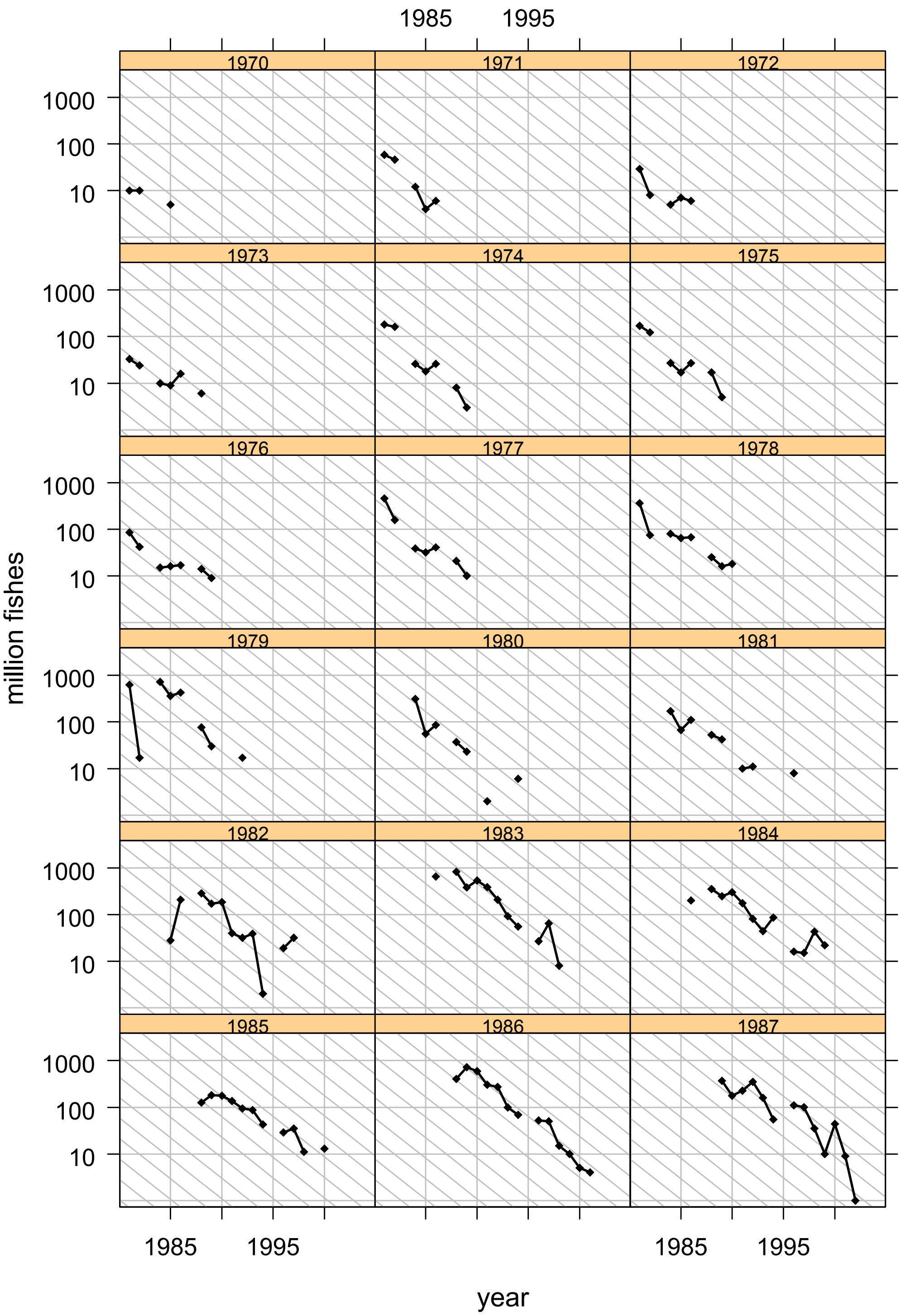


Figure 7.5.1.4. Catchcurves from survey data. Grey lines correspond to Z=0.4.

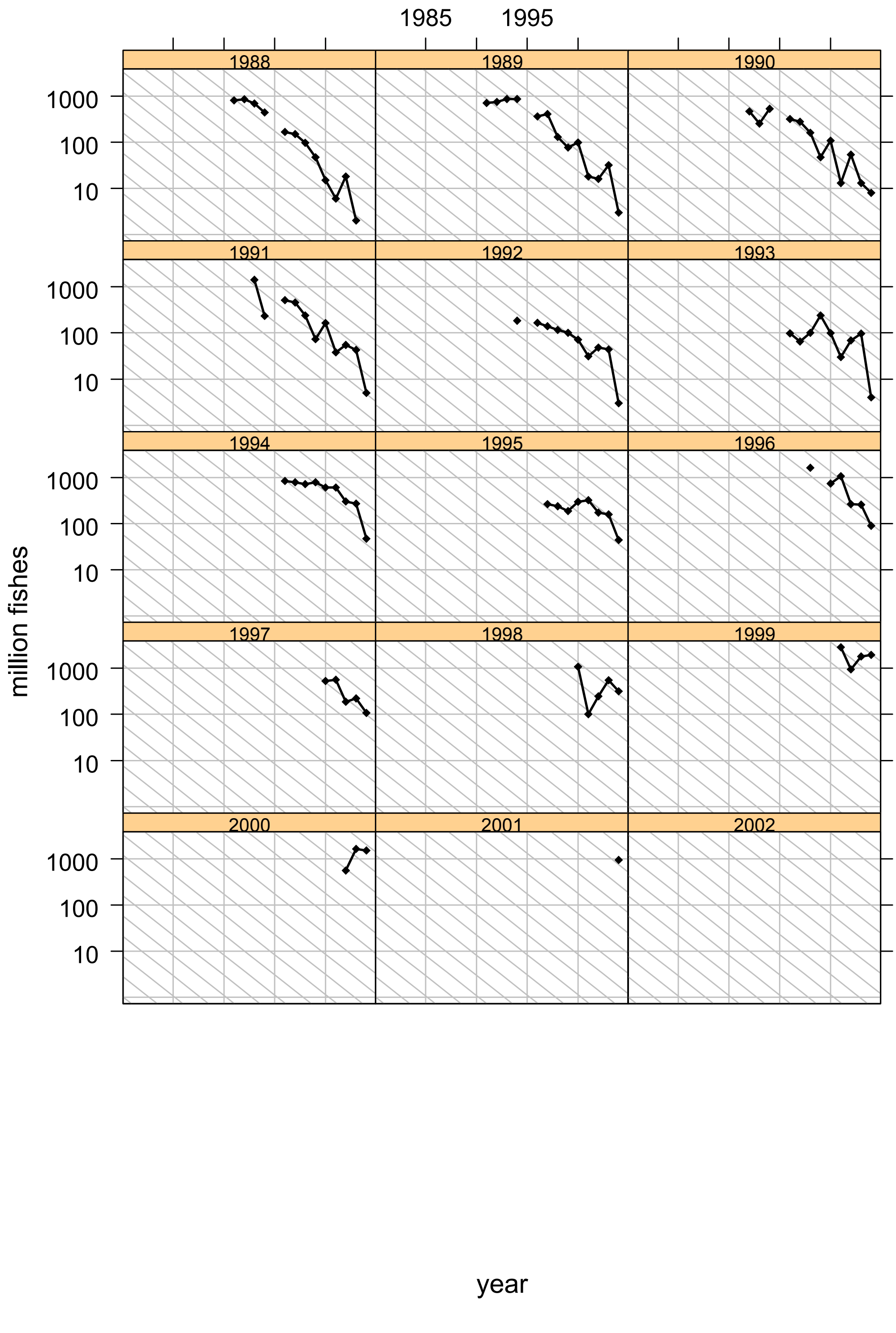


Figure 7.5.1.4 cont. Catchcurves from survey data. Grey lines correspond to Z=0.4.

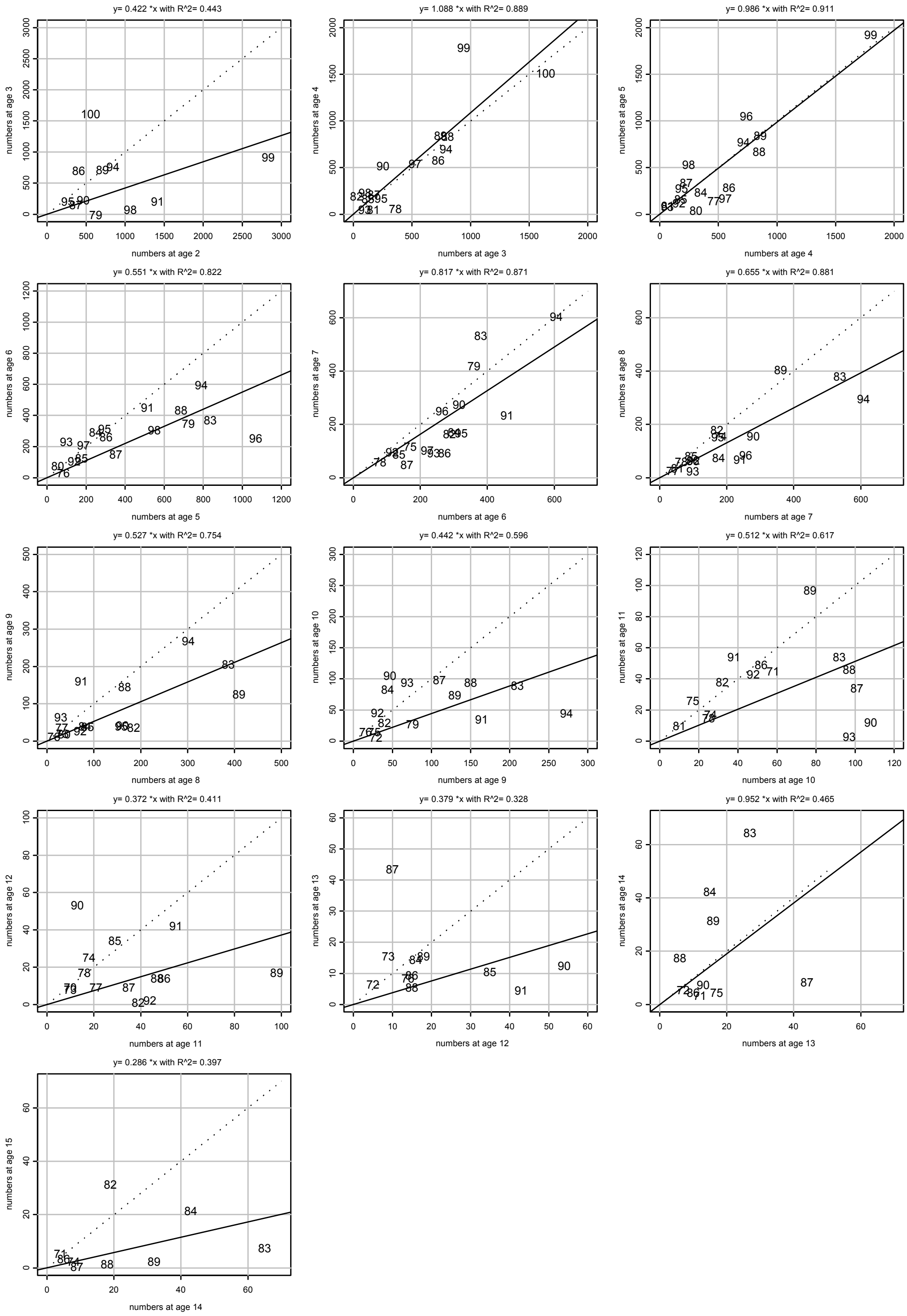


Figure 7.5.1.5. Comparison between ages in the survey. Yearclasses are denoted in the graphs. Solid line is the fitted line through origin and dotted line is line with slope 1.

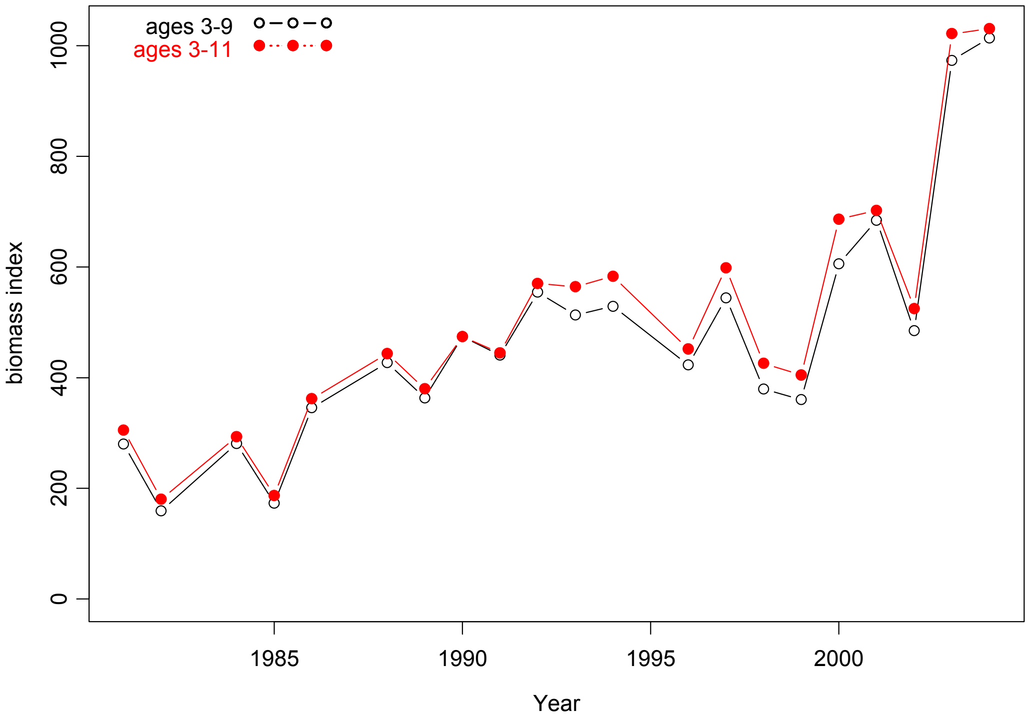
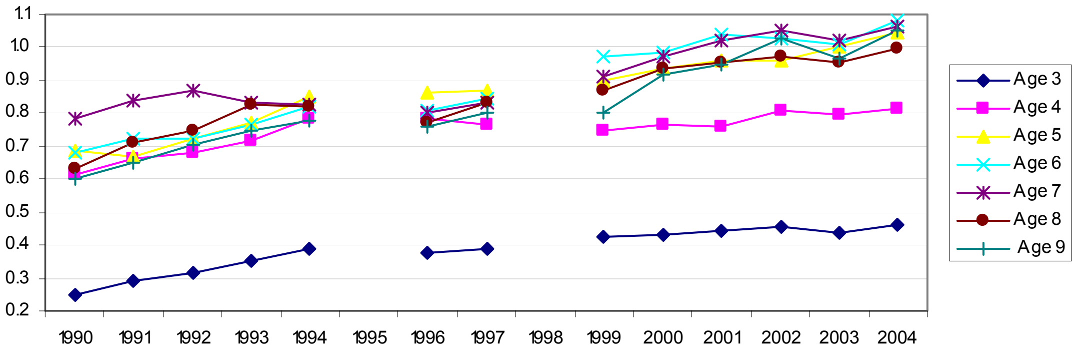
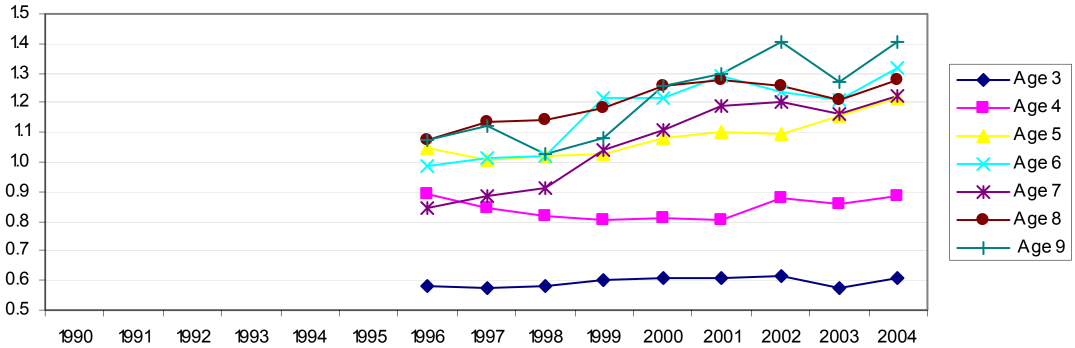


Figure 7.5.1.6 A biomass index for the icelandic acoustic survey 1981-2004 by age groups 3-9 and 3-11

Run 1: Tuning year range 1981-2004



Run 2: Tuning year range 1988-2004



Run 3: Tuning year range 1988-2004 - only age 3 and 4

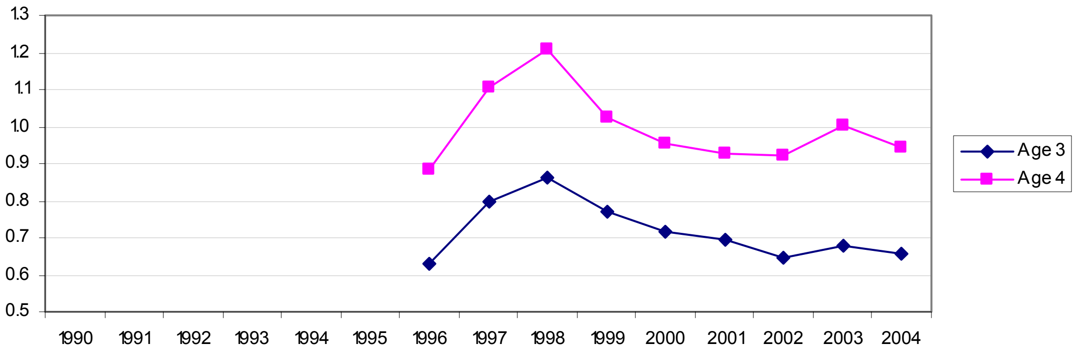
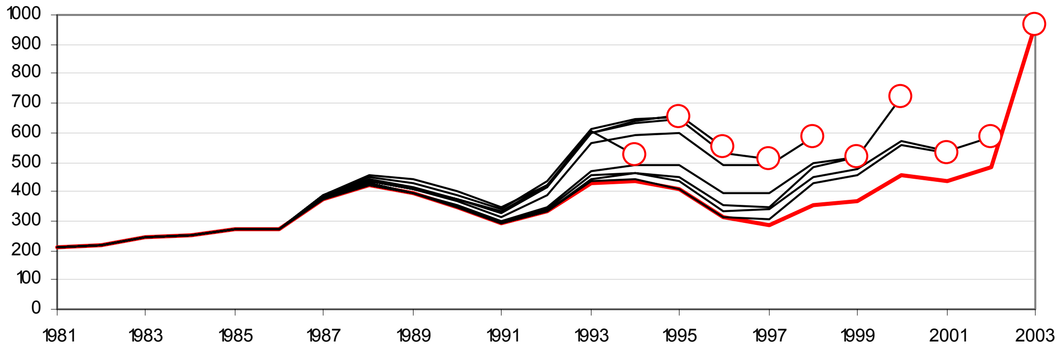
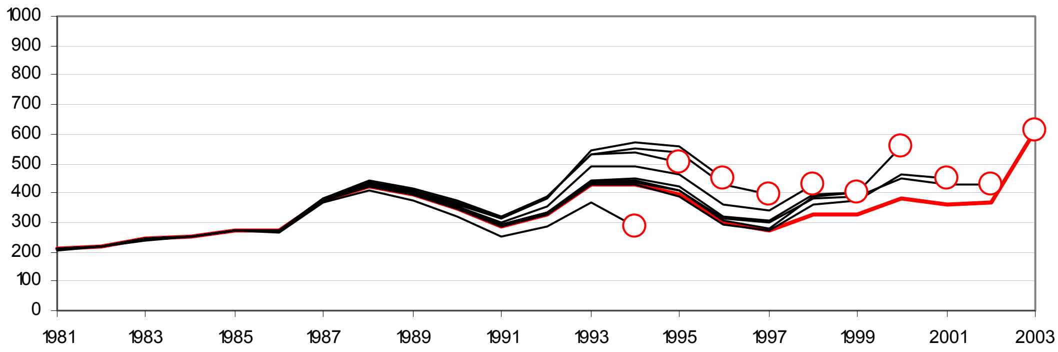


Figure 7.5.2.1 Retrospective patterns in q in Adapt runs.

Run 1



Run 2



Run 3

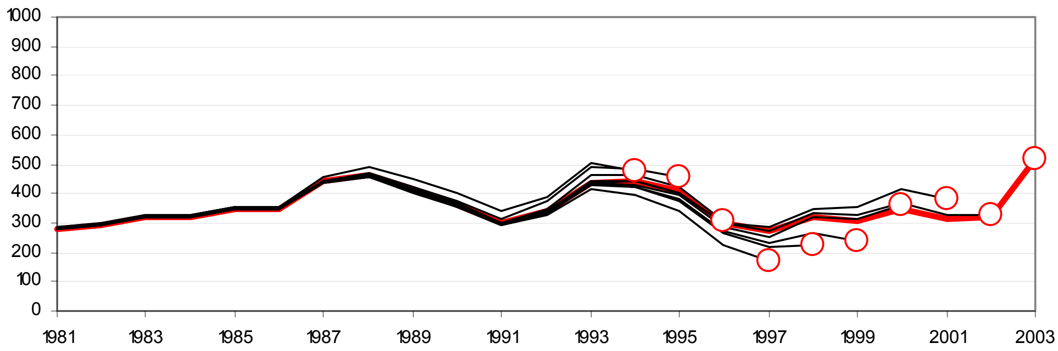
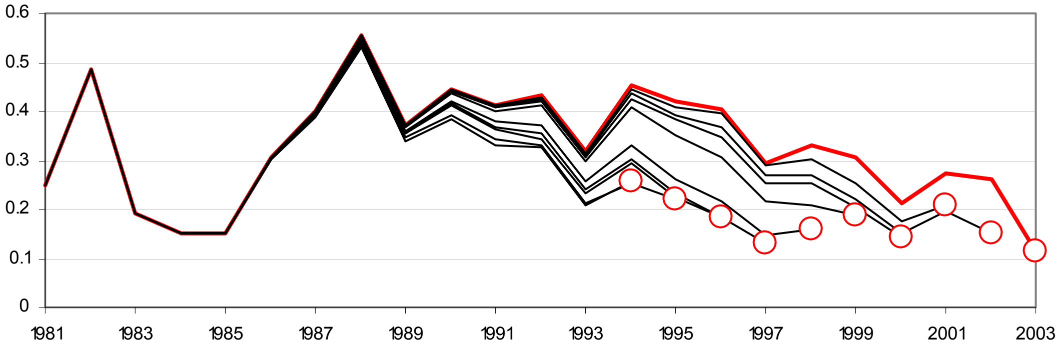
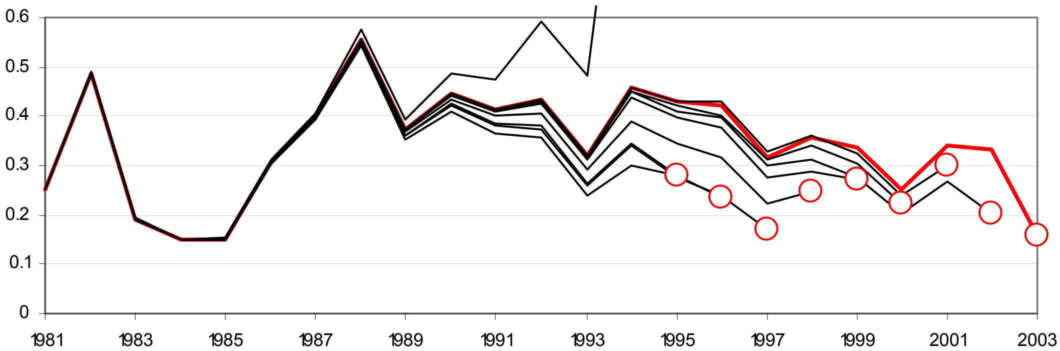


Figure 7.5.2.2 Retrospective analysis of SSB

Run 1



Run 2



Run 3

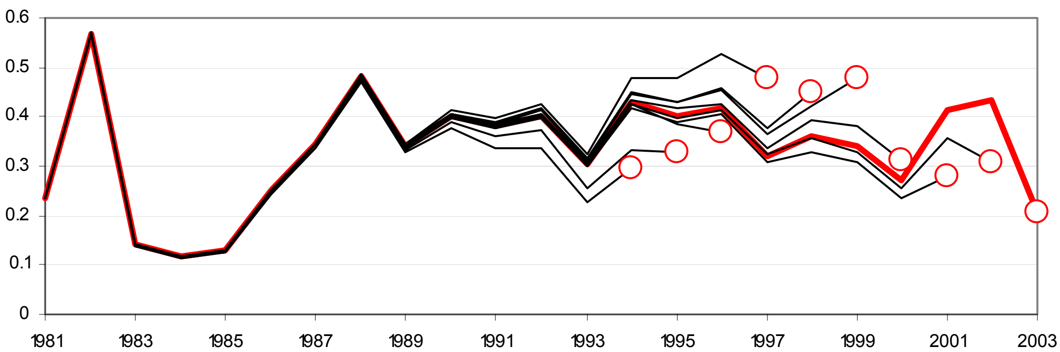


Figure 7.5.2.3 Retrospective analysis of fishing mortality (F5-10 unweighted)

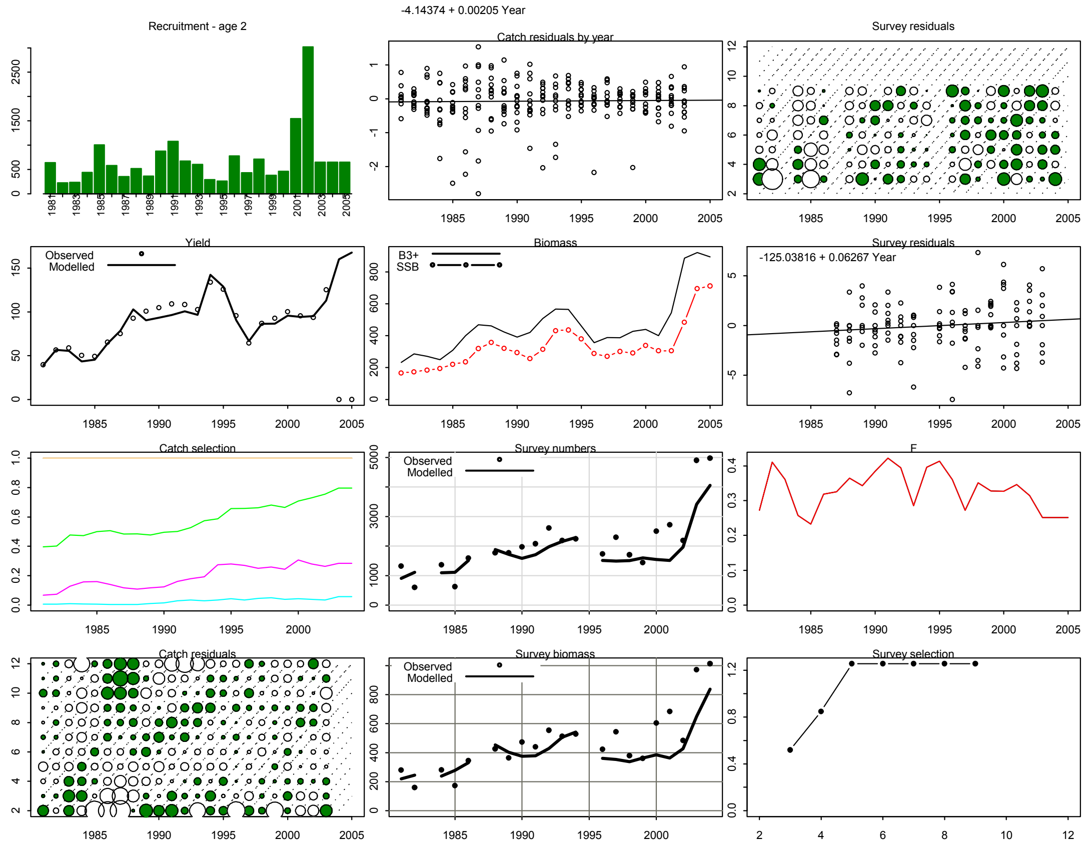


Figure 7.5.4.1 Diagnostic plots for run 1.

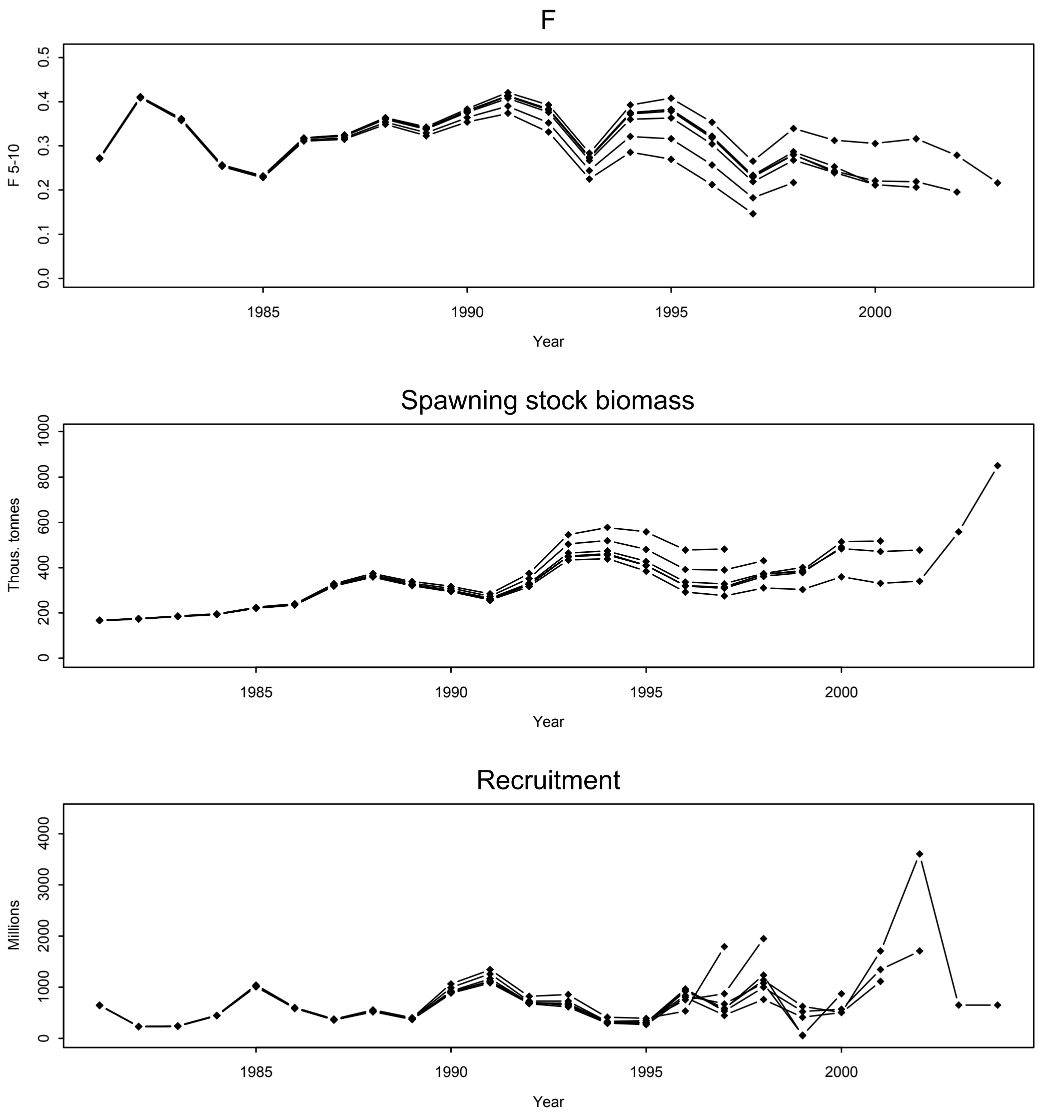


Figure 7.5.4.2 Retrospective run for amci run 1.

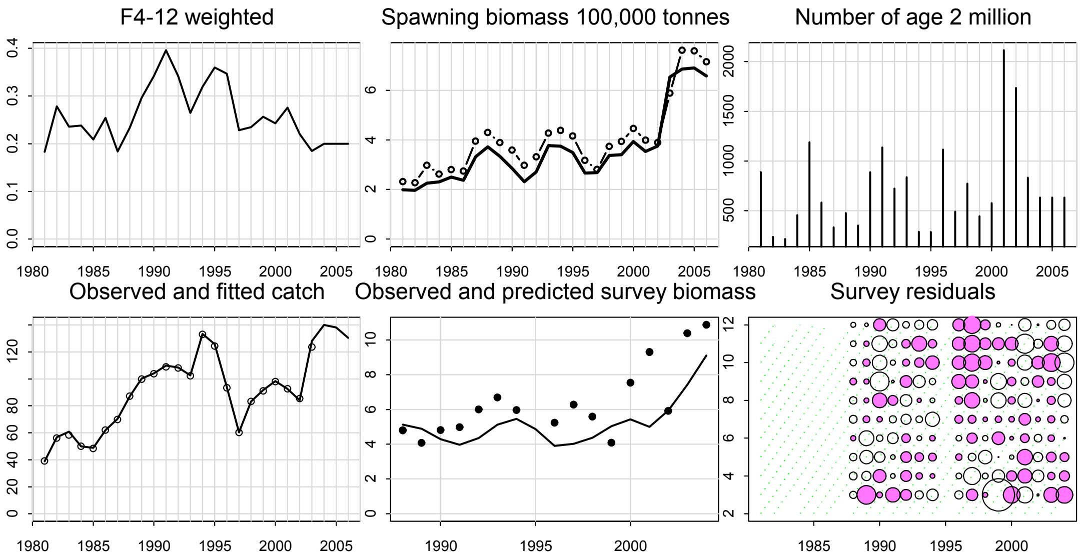


Figure 7.5.5.1 Diagnostic plots from a run with Adapt in AD-Modelbuilder.

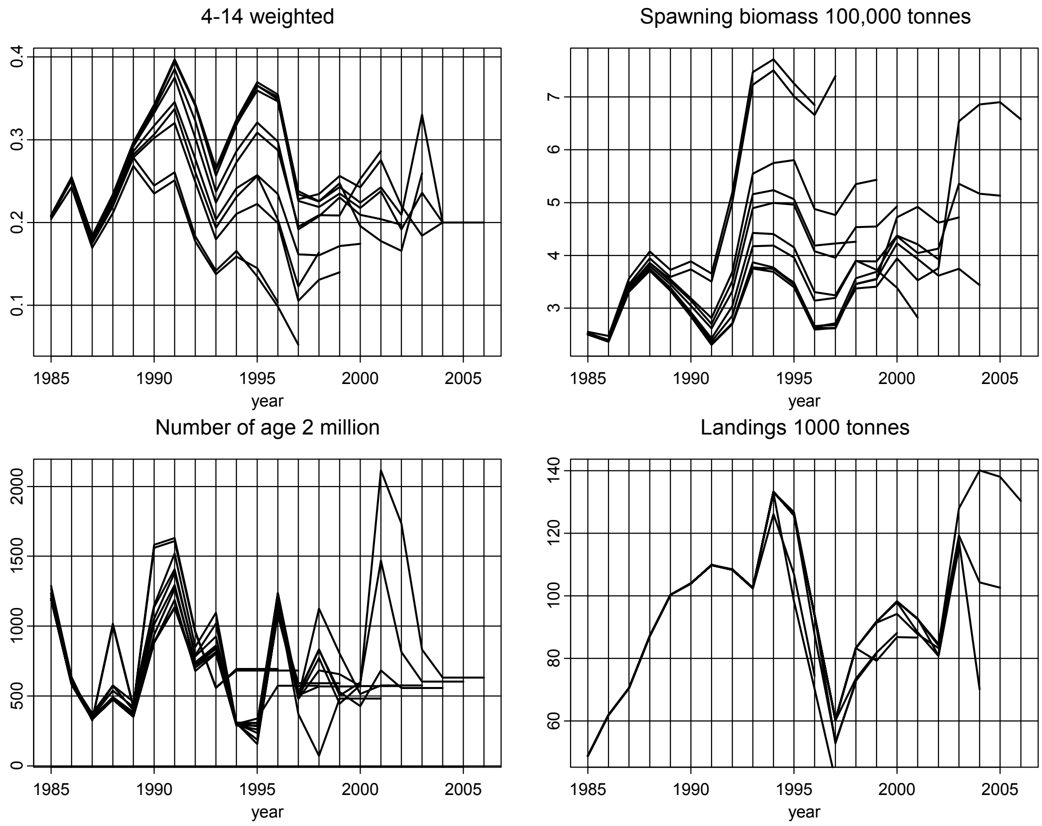


Figure 7.5.5.2 A retrospective plot for an Adapt run.

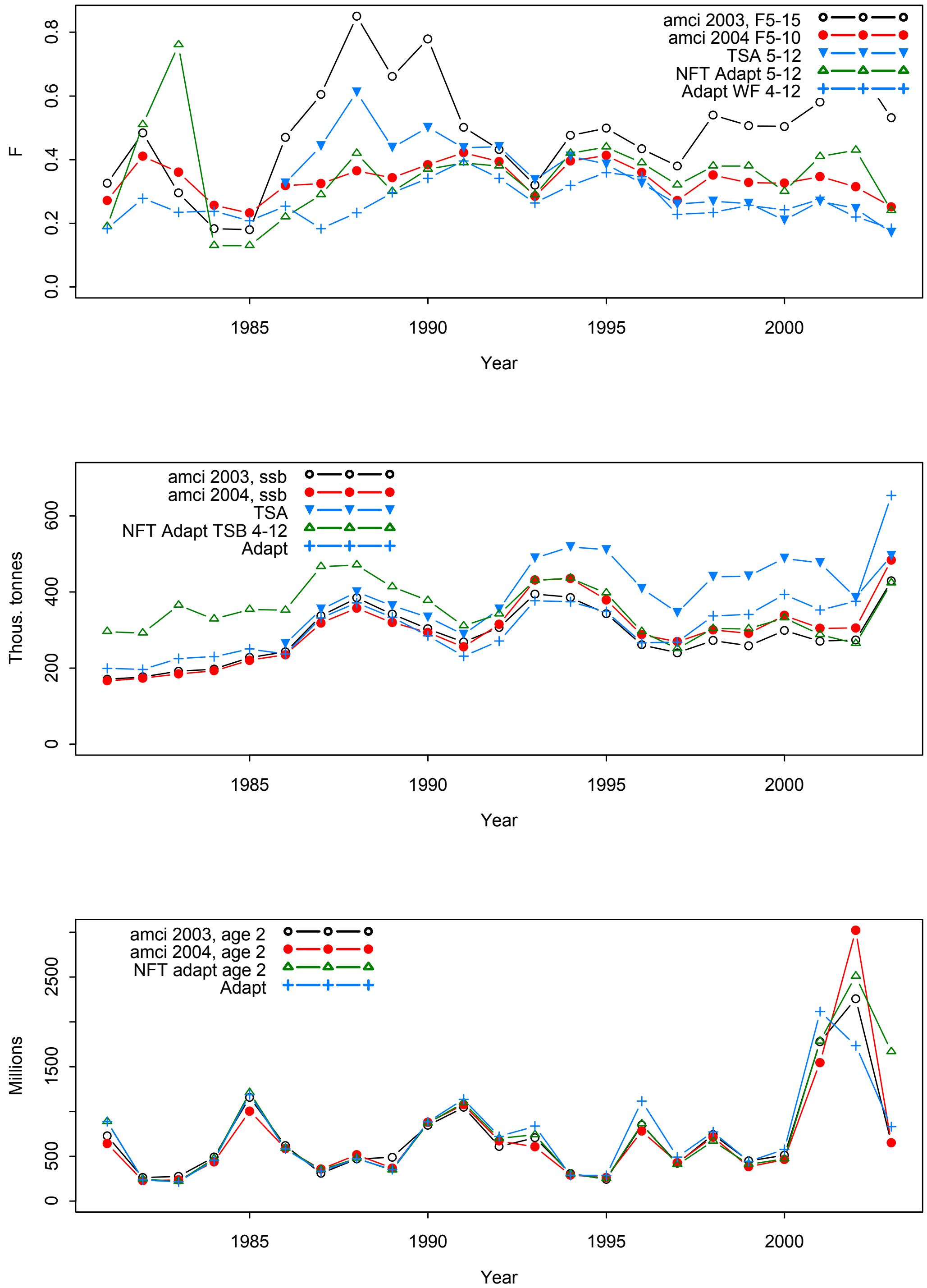


Figure 7.5.6.1 Comparisons of exploratory runs and the assessment made last year (2003).

8 REFERENCES AND WORKING DOCUMENTS

8.1 References

Anon. 2001. Havets Miljø 2001. FiskenHav. Særnr. 2, 2001. Institute of Marine Research, Bergen, Norway. In Norwegian with English subtitles.

Anon. 2003. Report of the 2003 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock, Murmansk, 3-6 October 2003.

Asplin, L. and E. Dahl. 2003. Havets Miljø 2003. Fisken og Havet, særnr. 2, 2003. Institute of Marine Research, Bergen, Norway. In Norwegian with English subtitles.

Ådlandsvik B, Loeng H (1991) A study of the climatic system in the Barents Sea. Polar Research 10: 45-49

Blindheim, J. (1989). Cascading of Barents Sea bottom water into the Norwegian Sea. Rapports et Proces-verbaux Réunions Conseil permanent International pour l'Exploration de la Mer, 188, 49-58.

Bochkov YA (1982) Water temperature in the 0-200m layer in the Kola-Meridian in the Barents Sea, 1900-1981. Sb. Nauchn. Trud. PINRO 46: 113-122

Bogstad B., A. Filin, H. Gjøsæter, D. Prozorkevich, S. Ratushnyy, S. Tjelmeland, and N. Ushakov. 2003. Report from the 2002 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock. Kirkenes, October 7-9, 2002. Working Document to The Northern Pelagic and Blue Whiting Fisheries Working Group, Copenhagen, 29 April-8 May 2003.

Bogstad, B. and S. Mehl. 1997. Interactions between cod and its prey species in the Barents Sea. Proceedings of the International Symposium on The Role of Forage Fishes in Marine Ecosystems. University of Alaska, Fairbanks. Alaska Sea Grant College Program Report No. 97-01, p. 591-615.

Bogstad, B. and H. Gjøsæter. 2001. Predation by cod (*Gadus morhua*) on capelin (*Mallotus villosus*) in the Barents Sea: implications for capelin stock assessment. Fisheries Research, 53:197-209.

Daan N, Heessen HJL, Pope JG (1994) Changes in the North Sea cod stock during the twentieth century. ICES mar. Sci. Symp. 198: 229-243

Dalpadado, P. and B. Bogstad 2004. Diet of juvenile cod (age 0-2) in the Barents Sea in relation to food availability and cod growth. Polar Biology 27:140-154.
Dalpadado, P. and H. R. Skjoldal. (1996). Abundance, maturity and growth of krill species *Thysanoessa inermis* and *T. longicaudata* in the Barents Sea. *Marine Ecology Progress Series* 144: 175-183.

Dalpadado, P., B. Bogstad, H. Gjøsæter, S. Mehl, and H. R. Skjoldal. 2002. Zooplankton-fish interactions in the Barents Sea. In: Large Marine Ecosystems. Blackwell Science Inc.

Dolgov, A. V, A. M. Sokolov, and V. S. Mamylov. 2002. Is impact of blue whiting on cod juveniles significant? In the Report of the Arctic Fisheries Working Group. ICES CM 2002/ACFM:18.

Dolgov, A. V. 2002. Some peculiarities of saithe feeding in the Barents Sea in 1999-2001. In the Report of the Arctic Fisheries Working Group. ICES CM 2002/ACFM:18.

Drobysheva S, Nesterova V, Zhukova N (2003) Abundance dynamics of the Barents Sea euphausiids and their importance as a component of cod food supply. WD4, ICES Arctic Fisheries Working Group, Pasaia, Spain 23 April – 2 May 2003. 11pp

Folkow, L. P., T. Haug, K. T. Nilssen, and E. S. Nordøy. 2000. Estimated food consumption of minke whales *Balaenoptera acutorostrata* in Northeast Atlantic waters in 1992-1995. NAMMCO Sci. Publ. 2.

Gjøsæter, H, Loeng H (1987) Growth of the Barents Sea capelin, Mallotus villosus, in relation to climate. Environ. Biol. Fish. 20: 293-300

Gjøsæter, H. and B. Bogstad. 1998. Effects of the presence of herring (*Clupea harengus*) on the stock-recruitment relationship of Barents Sea capelin (*Mallotus villosus*). Fisheries Research, 38:57-71.

Gjøsæter, H., B. Bogstad, and S. Tjelmeland. 2002. Assessment methodology for Barents Sea capelin, *Mallotus villosus* (Müller). ICES Journal of Marine Science, 59:1086-1095.

Gjøsæter,H., P.Dalpadado, A.Hassel and H.R.Skjoldal. (2000). Growth of the Barents Sea capelin(*Mallotus villosus* Müller). In H.Gjøsæter, Dr.philos. thesis, Department of Fisheries and Marine Biology, University of Bergen, Norway. Paper IV.

Gudmundsdottir, A. and H. Vilhjálmsson 2002. Predicting total allowable catches for Icelandic capelin**,** 1978-2001. In ICES Marine Science Symposia, Vol. 216: 1105-1113.

Gundersen, A.C. and H. Gjøsæter. 1998. A comparison between abundance estimates of the Barents Sea capelin (*Mallotus villosus* Müller) at the larval, 0-group and 1-group stage, for the year classes 1981-1994. ICES Journal of Marine Science, 55: 95-101.

Hassel A. 2004. Økosystemet i Barentshavet - plankton. In Sjøtun K (ed.) Fisken og Havet, særnr. 2- 2004. Institute of Marine Research, Bergen, Norway. In Norwegian with English subtitles.

Heino, M., Belikov, S., Godø, O., Jacobsen, J.A., Mork, J., Sveinbjørnsson, S., Tangen, Ø., Timoshenko, N. and Varne, R. 2003a. Report of the Nordic Blue Whiting Network Meeting Bergen, 24.-26.3.2003. Working Document to The Northern Pelagic and Blue Whiting Fisheries Working Group, Copenhagen, 29 April-8 May 2003.

Heino, M., Engelhard, G., Godø, O. 2003b. Variations in the distribution of blue whiting in the Barents Sea: climatic influences or year class effects? ICES CM 2003/Q:03

Helland-Hansen B, Nansen F (1909) The Norwegian Sea. FiskDir. Skr. Ser. HavUnders 2: 1-360

Holst, J. C. 1996. Long-term trends in the growth of the Norwegian spring spawning herring (*Clupea harengus* L.). Dr.scient thesis, University of Bergen, Norway.

Holst, J.C., B. Couperus, Á. Guðmundsdóttir, C. Hammer, J. A. Jacobsen, A. Krysov, W. Melle, Ø. Tangen, and H. Vilhjálmsson. 2001. Report on surveys of the distribution, abundance and migrations of the Norwegian spring-spawning herring, other pelagic fish and the environment of the Norwegian Sea and adjacent waters in late winter, spring and summer of 2001. ICES CM 2001/D:07, 55 pp.

Hurrell, J.W., Kushnir, Y., Ottersen, G., and Visbeck, M. (eds.) 2003. *The North Atlantic Oscillation: Climate Significance and Environmental Impact,* Geophysical Monograph Series, 134, 279pp.

ICES (2003a). Report of the Arctic Fisheries Working Group. Pasaia, Spain, 23 April - 2 May 2003. ICES CM 2003/ACFM:22.

ICES (2003b). Report of the Northern Pelagic and Blue Whitting Working Group. Copenhagen, 29 April - 8 May 2003. ICES CM 2003/ACFM:23.

ICES 1991/Assess:17. Report of the Atlanto-Scandian Herring and Capelin Working Group. Copenhagen, 8-12 April 1991. ICES C.M. 1991/Assess:17, 62 pp.

ICES 1993/Assess:6. Report of the Atlanto-Scandian Herring and Capelin Working Group. Copenhagen, 19-23 October 1992. ICES C.M. 1993/Assess:6, 74 pp.

ICES 1995/Assess:7. Report of the Blue Whiting Assessment Working Group, Vigo, Spain 8 - 14 September 1994. ICES C.M. 1995/Assess:7.

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

ICES 1998/ACFM:18 – (Report of the Northern Pelagic and Blue Whiting Fisheries Working Group, Copenhagen, Denmark, 28 April - 6 May 1998) reference from the last line of 6.3.2.

ICES 1999/ACFM:7. Report of the Joint ICES/NAFO Working Group on harp and hooded seals. Tromsø, Norway, 29 September-2 October 1998. ICES CM 1999/ACFM:7, 36 pp.

ICES 2000/ACFM:16. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES Headquarters 26 April - 4 May 2000. ICES CM 2000/ACFM:16, 307 pp.

ICES 2002/ACFM:18. Report of the Arctic Fisheries Working Group. ICES Headquarters, 16-25 April 2002. ICES CM 2002/ACFM:18.

ICES 2002/ACFM:19. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. Vigo, Spain, 29 April–8 May 2002. ICES CM 2002/ACFM:19, 289 pp.

ICES 2002/CRR:255. Report from the ICES Advisory Committee on Fishery Management, 2002. Part 1. ICES 2002/CRR:255, 300 pp.

ICES 2002/D:07. Report of the planning group on surveys on pelagic fish in the Norwegian Sea. Bergen, Norway, 28-30 August 2002. ICES CM 2002/D:07.

ICES 2003/ACFM:15 – (Study Group on Precautionary Reference Points For Advice on Fishery Management).

ICES 2003/ACFM:22. Report of the Arctic Fisheries Working Group. San Sebastian, Spain, 23 April - 2 May 2003. 448 pp.

ICES 2003/ACFM:23. Report of the Northern Pelagic and Blue Whiting Fisheries Working Group. ICES Headquarters, 29. April – 8. May 2003. 229 pp.

ICES 2003/CRR:261. Report of the ICES Advisory Committee on Fishery Management, 2003. 975 pp.

ICES 2003/D:03. Report of the Working Group on Methods on Fish Stock Assessments. ICES Headquarters, 29

ICES 2003/D:10 Ref ACFM, AME (Planning Group on Surveys on Pelagic Fish in the Norwegian Sea) - see 3.1.1 line 6 and 3.2.3.3

ICES 2004/xxx Report of the Study Group on Assessment Methods Applicable to Assessment of Norwegian Spring-Spawning Herring and Blue Whiting Stocks [SGAMHBW]. IPIMAR, Lisboa, Portugal. 19-22 February, 2004

Ingvaldsen, R. (2003). The Atlantic in$\mathbf{F}_{low}$ to the Barents Sea. Dr. Scient. thesis, University of Bergen, Norway, pp. 106.

Ingvaldsen, R., H. Loeng, G. Ottersen, and B. Ådlandsvik. (in press). Climate variability in the Barents Sea during the 20th century with focus on the 1990s. ICES Marine Science Symposium.

Ingvaldsen, R., Loeng, H and Asplin, L. (2002). Variability in the Atlantic in$\mathbf{F}_{low}$ to the Barents Sea based on a one-year time series from moored current meters. Continental Shelf Research, 22, 505-19.

Ingvaldsen, R., Loeng, H, Ottersen, G, and Ådlandsvik, B. (2002). The Barents Sea climate during the 1990s. *ICES Marine Science Symposia, 219:160-168*.

Jakobsson, J., A. Gudmundsdottir, and G. Stefansson. 1993. Stock-related changes in biological parameters of the Icelandic summer-spawning herring. Fisheries Oceanography, 2:260-277.

Johansen, G. O., B. Bogstad, S. Mehl, and Ø. Ulltang. 2002. Consumption of juvenile herring (*Clupea harengus* L.) by Northeast Arctic cod (*Gadus morhua* L.) in the Barents Sea: a new approach to estimating consumption in piscivorous fish. In: G. O. Johansen. The predator-prey interaction between Northeast Arctic cod (*Gadus morhua* L.) and juvenile Norwegian spring-spawning herring (*Clupea harengus* L.). Dr. scient thesis, Department of Fisheries and Marine Biology, University of Bergen.

Lindstrøm, U., T. Haug, and I. Røttingen. 2002. Predation on herring, Clupea harengus, by minke whales, *Balaenoptera acutorostrata*, in the Barents Sea. ICES Journal of Marine Science, 59:58-70.

Loeng H, Bjørke H, Ottersen G (1995) Larval fish growth in the Barents Sea. Can. Spec. Publ. Fish. Aquat. Sci.691-698

Loeng H, Blindheim J, Ådlandsvik B, Ottersen G (1992) Climatic variability in the Norwegian and Barents Seas. ICES mar. Sci. Symp. 195: 52-61

Magnússon KG, Pálsson ÓK (1989) Trophic ecological relationships of Icelandic cod. Rapp P-v Réun Cons Int Explor Mer 188:206-224

Melle, W. and H. R. Skjoldal 1998. Reproduction, life cycles and distributions of *C. finmarchicus* and *C. hyperboreus* in relation to environmental conditions in the Barents Sea. In Melle, W: Dr. Scient. Thesis, Department of Fisheries and Marine Biology, University of Bergen Norway. Paper II, 32 pp.

Melle, W. and J.C. Holst, 2001. Klima, planktonproduksjon og vekst hos sild I Norskehavet. Fisken og havet, særnummer 2, 86-90 (in Norwegian).

Michalsen K, Ottersen G, Nakken O (1998) Growth of North-east arctic cod (Gadus morhua L.) in relation to ambient temperature. Ices J. Mar. Sci. 55: 863-877

Nilssen, K. T., O.-P. Pedersen, L. P. Folkow, and T. Haug. 2000. Food consumption estimates of Barents Sea harp seals. NAMMCO Scientific Publications, 2:9-27.

Ottersen G, Ådlandsvik B, Loeng H (2000) Predictability of Barents Sea temperature. Fisheries Oceanography 9: 121-135

Ottersen G, Helle K, Bogstad B (2002) Do abiotic mechanisms determine interannual variability in length-at-age of juvenile Arcto-Norwegian cod? Can J Fish Aquat Sci 59:57-65

Ottersen G, Loeng H (2000) Covariability in early growth and year-class strength of Barents Sea cod, haddock and herring: The environmental link. ICES J. Mar. sci. 57: 339-348

Ottersen G, Sundby S (1995) Effects of temperature, wind and spawning stock biomass on recruitment of Arcto-Norwegian cod. Fish. Oceanogr. 4: 278-292

Ottersen G. and H. Loeng. 2000. Covariability in early growth and year-class strength of Barents Sea cod, haddock and herring: The environmental link. ICES Journal of Marine Science, 57: 339-348.

Røttingen, I. 2000. A review of the process leading to the establishment of limit and precautionary reference points for the stock of Norwegian spring-spawning herring. ICES CM 2000/X:08.

Røttingen, I., P. Sandberg, B. Schultz, and I. Slotte. 2002. Potential sources of unaccounted mortality in the fishery for Norwegian spring spawning herring. ICES CM 2002/V:20. To 3-rd paragraph 3.2.1.

Schweder, T., H. J. Skaug, X. K. Dimakos, M. Langaas, and N. Øien. 1997. Abundance of northeastern Atlantic minke whales estimates for 1989 and 1995. Report of the International Whaling Commission, 47:453-483.

Schweder, T and Tjelmeland S, 2003. Age reading of herring - with minimum age instead of discards. WD to the ICES Northern pelagic and Blue Whiting WG 2003.ISVPA

Sjøtun, K. (Editor) 2004. Havets Miljø 2004. Fisken og Havet, særnr. 2- 2004. Institute of Marine Research, Bergen, Norway. In Norwegian with English subtitles.

Skagen, D. W. 2002. Programs for stochastic prediction and management simulation (STPR3 and LTEQ). Program description and instructions for use. Institute of Marine Research, Bergen. Unpublished.

Stiansen, J.E. 2003. A regression model for Barents Sea capelin recruitment incorporating climate, with one year prognosis possibility. Working document in: Report of the 2003 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock, Murmansk, 3-6 October 2003.

Stiansen, J.E., A. Aglen, B. Bogstad, S. Mehl and O. Nakken. 2003a. A regression model for recruitment of 3-year-old NEA cod based on capelin biomass, survey index and climate. Working document in: Report of the Arctic Fisheries Working Group, San Sebastian, Spain, 23 April-2 May 2003. ICES CM 2003/ACFM:22.

Stiansen, J.E., H. Loeng, E. Svendsen, L. Pettersson, J. Johannessen, T. Furevik, N.O. Handegaard and Olivier Frendo. (2002). Climate-fish interactions in Norwegian waters. Fisken og havet, 12-2002.

Stiansen, J.E., Loeng, H. and Ottersen, G., 2003b. Den nordatlantiske oscillasjon (NAO) og torskerekruttering. In: L. Asplin og E. Dahl (red.), *Havets miljø 2003*. Fisken og havet, særnr. 2-2003.

Toresen R, Østvedt O.J., (2000) Variation in abundance of Norwegian spring-spawning herring (*Clupea harengus*, Clupeidae) throughout the 20th century and the influence of climatic fluctuations. Fish and Fisheries 1: 231-256

Tretyak VL, Ozhigin VK, Yaragina NA, Ivshin VA. (1995). "Role of oceanographic conditions in Arcto-Norwegian cod recruitment dynamics." COPENHAGEN-DENMARK ICES.

Tveite, S. 2000. Suitability of a fixed station shrimp abundance survey in the Skagerrak-Norwegian Deep for stock assessments and associated research. J. Northw. Atl. Fish. Sci., 27:177-182.

Vasilyev D. 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.

Vasilyev D. 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

Vilhjálmsson, H. and E. Friðgeirsson 1976. A review of 0-group surveys in the Iceland-East Greenland area in the years 1970 - 1975. ICES Coop. Res. Rep. 54: 1-34.

Vilhjálmsson, H., 1994. The Icelandic capelin stock. Capelin *Mallotus villosus* (Müller) in the Iceland, Greenland, Jan Mayen area. Rit Fiskideildar, 13: 281 pp.

8.2 Working Documents

Belikov, S., Sokolov, A. WD. Russian research ob blue whiting in the Barents Sea in 2000-2003.

Bogstad B., Dolgolenko, I., Gjøsæter H., Prozorkevich, D., Tjelmeland S., and Ushakov N. WD Report from the 2003 joint Russian-Norwegian meeting to assess the Barents Sea capelin stock. Murmansk, October 4-6, 2003. 29 pp.

Gudmundsdottir, A. WD. Icelandic summer spawning herring. The fishing season 2003 - 2004.

Gudmundsdottir, A., Sveinbjörnsson, S. WG. The Icelandic fishery of norwegian spring spawners.

Heino, M. , Søiland, H., Nygaard, J. E., Oleynik, A., Alvarez, J., Tangen, Ø., O'Donnell, C. Mullins, E., Monstad, T., Macualay, G., Power, G., Ullgren, J., Oganin, I., Ratushnyy, S., Astakhov, A., Guzenko, V., Couperus, B., Ybema, S., Bol, R. and Dickey-Collas, M. WD a. International blue whiting spawning stock survey spring 2004.

Heino, M., Søiland, H., Nygaard, J. E., Alvarez, J., de Lange, J., Eriksen, K. B., Kristiansen, J., Meland, E., Tangen, Ø., Oleynik, A., Varne, R. and Wienerroither, R. WD b. Blue whiting survey during spring 2004.

Heino, M., Folmer, O., Gudmundsdottir, A., Jacobsen J.A., Krysov, A., Mork, J., Sveinbjornsson, S., Tangen, O., Varne, R. WD c. Report of the Nordic Blue Whiting Network Meeting. Reykjavik, 3.–5.11.2003

Heino, M., Belikov, S., Folmer, O., Jacobsen J.A., Mork, J., Oleynik, A., Sveinbjornsson, S., Tangen, O., Timoshenko, N., Varne, R. WD d. Report of the Nordic Blue Whiting Network Meeting. Copenhagen, 24.–26.2.2004.

O'Donnell, C., Mullins, E., Monstad, T., Macualay, G., Power, G. and Ullgren, J. WD .Blue Whiting Acoustic Survey Cruise Report. Marine Institute, Ireland.

Prozorkevich D. 2004. WD. Brief report on Russian investigations of capelin in February – March 2004.

Røttingen, B., and H. Gjøsæter. WD. Report on Norwegian capelin research and capelin fishery during winter 2003.

Stiansen, J. E., G. Ottersen, P. Dalpadado, H. Loeng, and R. Ingvaldsen. WD. The Barents Sea ecosystem, 2002-2003.

Schweder, T. and S. Tjelmeland. WD-2003. Age reading of herring – with minimum age instead of discard

Sveinbjörnsson,S., Krysov, A. and Meixide, M. WD. Some comments on the collection and compilation of national catch-at-age and weight-at age data for Blue whiting and Norwegian spring spawning herring.

Sveinbjörnsson,S. WD. Description of the Icelandic Blue whiting fishery in 2003 and short description of the fleet and CPUE

Timoshenko N., Pavlov.V. WD. Occurrence of blue whiting in the middle-atlantic ridge in December 2003

Tjelmeland, S. WD. Analysis of young fish and comparison of SeaStar and ISVPA – the 2002 assessment of Norwegian spring spawning herring.

Ushakov, N. G. WD. Peculiarity of capelin fishery during spring season 2003.

Vasilyev, D.A. WD. Description of the ISVPA (version 2004.1)

ANNEX I

Northern Pelagic and Blue Whiting Fisheries Working Group

ICES, Headquarters, 27 April – 4 May 2004

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Alexander Krysov	PINRO 6,Knipovich Street, 183763, Murmansk,Russia	+78152473424	+47 78910518	a_krysov@pinro.ru
Ane Iriondo	AZTI Txatxarramendi ugartea 48935 Sukarrieta Spain	+34 94 6029400	+34 94 6870006	airiondo@suk.azti.es
Asta Gudmundsdottir (Chair)	Marine Research Institute Skulagata 4 101 Reykjavik, Iceland	+354 5520240		asta@hafro.is
Dimitri Vasilyev	Russian Federal Research Institute of Fisheries and Oceanography	007 095 264 99 65	007 095 264 91 87	dvasilyev@vniro.ru
Dmitry Prozorkevich	PINRO 6,Knipovich Street, 183763, Murmansk,Russia	+78152472147	+47 78910518	dvp@pinro.ru
Frans van Beek	Netherlands Institute for Fisheries Research (RIVO)	+31 255 564671	+31 255 564646	fransa.vanbeek@wur.nl
Hjalmar Vilhjalmsson	Marine Research Institute Skulagata 4 101 Reykjavik, Iceland			hjalmar@hafro.is
Jan Arge Jacobsen	Faroese Fisheries Laboratory Nóatún P.O. Box 3051 FO-110 Tórshavn Faroe Islands Denmark	+298 315092$	+298 318264	janarge@frs.fo
Jens Chr. Holst	Institute of Marine Research, P.O. Box 1870, N-5187 Bergen, Norway	+47 55238411 +4748073791	+47 55238687	jensh@imr.no
Manuel Meixide	IEO Centro Oceanography de Vigo	+34 986 49 2111	+34 986 49 2351	manolo.meixide@vi.ieo.es
Mikko Heino	Institute of Marine Research, P.O. Box 1870, N-5187 Bergen, Norway	+47 55236962	+47 55238687	mikko@imr.no
Morten Vinther	Danish Institute for Fishery Research Charlottenlund Slot DK-2920 Charlottenlund Denmark			mv@dfu.min.dk
Nikolay Timoshenko	DM. Donskoy str. 5 Atlant NIRO Kaleningrad	+7 0112 225554	+7 0112 219997	timoshenko@atlant.baltnet.ru

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
	Russia			
Reidar Toresen	Institute of Marine Research P.O. Box 1870 Nordnes N-5817 Bergen Norway	+47 55 238420	+47 55 238687	reidar@imr.no
Sergei Belikov	PINRO 6,Knipovich Street, 183763, Murmansk,Russia	+78152473424	+47 78910518	belikov@pinro.ru
Sigurd Tjelmeland	Institute of Marine Research, P.O. Box 1870, N-5187 Bergen, Norway			sigurd@imr.no
Sveinn Sveinbjörnsson	Marine Research Institute Skúlagata 4 101 Reykjavík Iceland	+354 5520240		sveinn@hafro.is
Maurice Clarke	Marine Institute Parkmore Galway Ireland	+353 91 773900		Maurice.clarke@marine.ie

ANNEX II

```
DETAILS OF DATA FILLING-IN
--------------------------

  Filling-in for record : ( 55)   The Netherlands        3 IIa
Mean Weighted by Sampled Catches of:
  >>  (  3)  Iceland                3 IIa
  >>  ( 23)  Faroe Islands          3 IIa
  >>  (155)  Norway                 3 IIa
  >>  (183)  Russia                 3 IIa

  Filling-in for record : (126)   Germany                2 IIa
Mean Weighted by Sampled Catches of:
  >>  (  2)  Iceland                2 IIa
  >>  ( 22)  Faroe Islands          2 IIa
  >>  (154)  Norway                 2 IIa
  >>  (182)  Russia                 2 IIa

  Filling-in for record : (127)   Germany                3 IIa
Mean Weighted by Sampled Catches of:
  >>  (  3)  Iceland                3 IIa
  >>  ( 23)  Faroe Islands          3 IIa
  >>  (155)  Norway                 3 IIa
  >>  (183)  Russia                 3 IIa

  Filling-in for record : (205)   Denmark                1 IIa
Mean Weighted by Sampled Catches of:
  >>  (153)  Norway                 1 IIa
  >>  (181)  Russia                 1 IIa

  Filling-in for record : (206)   Denmark                2 IIa
Mean Weighted by Sampled Catches of:
  >>  (  2)  Iceland                2 IIa
  >>  ( 22)  Faroe Islands          2 IIa
  >>  (154)  Norway                 2 IIa
  >>  (182)  Russia                 2 IIa

  Filling-in for record : (208)   Denmark                4 IIa
Using Only
  >>  (184)  Russia                 4 IIa

  Filling-in for record : (258)   Sweden                 2 IIa
Mean Weighted by Sampled Catches of:
  >>  (  2)  Iceland                2 IIa
  >>  ( 22)  Faroe Islands          2 IIa
  >>  (154)  Norway                 2 IIa
  >>  (182)  Russia                 2 IIa

  Filling-in for record : (259)   Sweden                 3 IIa
Mean Weighted by Sampled Catches of:
  >>  (  3)  Iceland                3 IIa
  >>  ( 23)  Faroe Islands          3 IIa
  >>  (155)  Norway                 3 IIa
  >>  (183)  Russia                 3 IIa

  Filling-in for record : (185)   Russia                 1 IIb
Using Only
  >>  (177)  Russia                 1 I

  Filling-in for record : (186)   Russia                 2 IIb
Using Only
  >>  (177)  Russia                 1 I
```

```
  Filling-in for record : (263)   Sweden                 3 IIIa
Using Only
  >>  (211)  Denmark                3 IIIa

  Filling-in for record : ( 58)   The Netherlands        2 IVa
Using Only
  >>  (214)  Denmark                2 IVa

  Filling-in for record : (100)   Scotland               4 IVa

Using Only
  >>  (215)  Denmark                3 IVa

  Filling-in for record : (130)   Germany                2 IVa
Using Only
  >>  (214)  Denmark                2 IVa

  Filling-in for record : (131)   Germany                3 IVa
Using Only
  >>  (215)  Denmark                3 IVa

  Filling-in for record : (266)   Sweden                 2 IVa
Using Only
  >>  (214)  Denmark                2 IVa

  Filling-in for record : ( 62)   The Netherlands        2 IVb
Using Only
  >>  (214)  Denmark                2 IVa

  Filling-in for record : (217)   Denmark                1 IVb
Using Only
  >>  (213)  Denmark                1 IVa

  Filling-in for record : (219)   Denmark                3 IVb
Using Only
  >>  (215)  Denmark                3 IVa

  Filling-in for record : (  9)   Iceland                1 Vb
Using Only
  >>  ( 29)  Faroe Islands          1 Vb

  Filling-in for record : (103)   Scotland               3 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 11)  Iceland                3 Vb
  >>  ( 31)  Faroe Islands          3 Vb

  Filling-in for record : (134)   Germany                2 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 10)  Iceland                2 Vb
  >>  ( 30)  Faroe Islands          2 Vb

  Filling-in for record : (189)   Russia                 1 Vb
Using Only
  >>  ( 29)  Faroe Islands          1 Vb

  Filling-in for record : (191)   Russia                 3 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 11)  Iceland                3 Vb
  >>  ( 31)  Faroe Islands          3 Vb

  Filling-in for record : (192)   Russia                 4 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 12)  Iceland                4 Vb
  >>  ( 32)  Faroe Islands          4 Vb
```

```
  Filling-in for record : (222)   Denmark                 2 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 10)  Iceland                2 Vb
  >>  ( 30)  Faroe Islands          2 Vb

  Filling-in for record : (223)   Denmark                 3 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 11)  Iceland                3 Vb
  >>  ( 31)  Faroe Islands          3 Vb

  Filling-in for record : (224)   Denmark                 4 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 12)  Iceland                4 Vb
  >>  ( 32)  Faroe Islands          4 Vb

  Filling-in for record : (239)   France                  3 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 11)  Iceland                3 Vb
  >>  ( 31)  Faroe Islands          3 Vb

  Filling-in for record : (240)   France                  4 Vb
Mean Weighted by Sampled Catches of:
  >>  ( 12)  Iceland                4 Vb
  >>  ( 32)  Faroe Islands          4 Vb

  Filling-in for record : ( 69)   The Netherlands         1 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands          1 VIb
  >>  (165)  Norway                 1 VIb
  >>  (193)  Russia                 1 VIb

  Filling-in for record : (105)   Scotland                1 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands          1 VIb
  >>  (165)  Norway                 1 VIb
  >>  (193)  Russia                 1 VIb

  Filling-in for record : (106)   Scotland                2 VIa
Mean Weighted by Sampled Catches of:
  >>  ( 70)  The Netherlands        2 VIa
  >>  (162)  Norway                 2 VIa

  Filling-in for record : (108)   Scotland                4 VIa
Using Only
  >>  (163)  Norway                 3 VIa

  Filling-in for record : (227)   Denmark                 3 VIa
Using Only
  >>  (163)  Norway                 3 VIa

  Filling-in for record : (228)   Denmark                 4 VIa
Using Only
  >>  (163)  Norway                 3 VIa

  Filling-in for record : ( 13)   Iceland                 1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands          1 VIb
  >>  (165)  Norway                 1 VIb
  >>  (193)  Russia                 1 VIb

  Filling-in for record : ( 14)   Iceland                 2 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 38)  Faroe Islands          2 VIb
```

```
  >>  (166)  Norway                2 VIb
  >>  (194)  Russia                2 VIb

  Filling-in for record : ( 73)   The Netherlands        1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands         1 VIb
  >>  (165)  Norway                1 VIb
  >>  (193)  Russia                1 VIb

  Filling-in for record : (109)   Scotland               1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands         1 VIb
  >>  (165)  Norway                1 VIb
  >>  (193)  Russia                1 VIb

  Filling-in for record : (110)   Scotland               2 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 38)  Faroe Islands         2 VIb
  >>  (166)  Norway                2 VIb
  >>  (194)  Russia                2 VIb

  Filling-in for record : (141)   Germany                1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands         1 VIb
  >>  (165)  Norway                1 VIb
  >>  (193)  Russia                1 VIb

  Filling-in for record : (142)   Germany                2 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 38)  Faroe Islands         2 VIb
  >>  (166)  Norway                2 VIb
  >>  (194)  Russia                2 VIb

  Filling-in for record : (195)   Russia                 3 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 38)  Faroe Islands         2 VIb
  >>  (166)  Norway                2 VIb
  >>  (194)  Russia                2 VIb

  Filling-in for record : (241)   France                 1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands         1 VIb
  >>  (165)  Norway                1 VIb
  >>  (193)  Russia                1 VIb

  Filling-in for record : (113)   Scotland               1 VIIb
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands         1 VIIc
  >>  ( 77)  The Netherlands       1 VIIc
  >>  (173)  Norway                1 VIIbc

  Filling-in for record : (145)   Germany                1 VIIbc
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands         1 VIIc
  >>  ( 77)  The Netherlands       1 VIIc
  >>  (173)  Norway                1 VIIbc

  Filling-in for record : (245)   France                 1 VIIbc
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands         1 VIIc
  >>  ( 77)  The Netherlands       1 VIIc
  >>  (173)  Norway                1 VIIbc

  Filling-in for record : ( 78)   The Netherlands        2 VIIc
```

```
Mean Weighted by Sampled Catches of:

  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : (117)   Scotland              1 VIIc
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : ( 17)   Iceland               1 VIIgk+XII
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : (233)   Denmark               1 XII
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : (198)   Russia                2 VIIgk+XII
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : (249)   France                1 VIIg-k
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : ( 81)   The Netherlands       1 VIIh
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : ( 84)   The Netherlands       4 VIIh
Using Only
  >>  ( 95)  The Netherlands        3 VIIIabd

  Filling-in for record : ( 93)   The Netherlands       1 VIIIabd
Using Only
  >>  ( 95)  The Netherlands        3 VIIIabd

  Filling-in for record : ( 94)   The Netherlands       2 VIIIabd
Using Only
  >>  ( 95)  The Netherlands        3 VIIIabd

  Filling-in for record : (255)   France                3 VIIIabd
Using Only
  >>  ( 95)  The Netherlands        3 VIIIabd

  Filling-in for record : ( 85)   The Netherlands       1 VIIj
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII
```

```
  Filling-in for record : ( 87)   The Netherlands        3 VIIj
Using Only
  >>  ( 86)  The Netherlands        2 VIIj

  Filling-in for record : (121)   Scotland               1 VIIj
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : (149)   Germany                1 VIIj
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : ( 89)   The Netherlands        1 VIIk
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : (277)   Ireland                1 VIa

Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands          1 VIb
  >>  (165)  Norway                 1 VIb
  >>  (193)  Russia                 1 VIb

  Filling-in for record : (281)   Ireland                1 VIb
Mean Weighted by Sampled Catches of:
  >>  ( 37)  Faroe Islands          1 VIb
  >>  (165)  Norway                 1 VIb
  >>  (193)  Russia                 1 VIb

  Filling-in for record : (285)   Ireland                1 VIIb
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : (286)   Ireland                2 VIIb
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : (305)   Ireland                1 XII
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII

  Filling-in for record : (294)   Ireland                2 VIIg
Mean Weighted by Sampled Catches of:
  >>  ( 41)  Faroe Islands          1 VIIc
  >>  ( 77)  The Netherlands        1 VIIc
  >>  (173)  Norway                 1 VIIbc

  Filling-in for record : (297)   Ireland                1 VIIj
Mean Weighted by Sampled Catches of:
  >>  ( 49)  Faroe Islands          1 VIIgk+XII
  >>  (169)  Norway                 1 VIIgk
  >>  (197)  Russia                 1 VIIgk+XII
```

```
  Filling-in for record : (298)   Ireland                 2 VIIj
Using Only
  >>  ( 86)  The Netherlands       2 VIIj

  Filling-in for record : (300)   Ireland                 4 VIIj
Using Only
  >>  (301)  Ireland               1 VIIk

  Filling-in for record : (261)   Sweden                  1 IIIa
Using Only
  >>  (210)  Denmark               2 IIIa

  Filling-in for record : (262)   Sweden                  2 IIIa
Using Only
  >>  (211)  Denmark               3 IIIa

  Filling-in for record : (264)   Sweden                  4 IIIa
Using Only
  >>  (211)  Denmark               3 IIIa

  Filling-in for record : (267)   Sweden                  3 IVa
Using Only
  >>  (215)  Denmark               3 IVa

  Filling-in for record : (268)   Sweden                  4 IVa
Using Only
  >>  (215)  Denmark               3 IVa

  Filling-in for record : (309)   Faroe Islands-mix       1 IIIa
Using Only
  >>  (317)  Norway-mix            1 IIa

  Filling-in for record : (310)   Faroe Islands-mix       3 IIIa
Using Only
  >>  (323)  Norway-mix            3 IVa

  Filling-in for record : (311)   Faroe Islands-mix       4 IIIa
Using Only
  >>  (324)  Norway-mix            4 IVa

  Filling-in for record : (312)   Faroe Islands-mix       1 IVa
Using Only
  >>  (321)  Norway-mix            1 IVa

  Filling-in for record : (313)   Faroe Islands-mix       2 IVa
Using Only
  >>  (322)  Norway-mix            2 IVa

  Filling-in for record : (314)   Faroe Islands-mix       3 IVa
Using Only
  >>  (323)  Norway-mix            3 IVa

  Filling-in for record : (315)   Faroe Islands-mix       4 IVa
Using Only
  >>  (324)  Norway-mix            4 IVa

  Filling-in for record : (316)   Faroe Islands-mix       3 IVb
Using Only
  >>  (323)  Norway-mix            3 IVa

  Filling-in for record : (320)   Norway-mix              4 IIa
Using Only
  >>  (319)  Norway-mix            3 IIa
```

APPENDIX

Special opinion of Russian delegation

In order to give managers more information about different perception of stock size and fishery perspectives, Russian delegation conceders it to be important to present the results of short-term forecast, based on the results of stock assessment by means of ISVPA and agreed by the WG parameters on weight-at-age, natural mortality and maturity-at-age in prognostic years.

Blue whiting:

		2004					2005			2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
8493	5020	1	0.53	2365	6710	4680	0.0	0.000	0	7367	5305
						4626	0.1	0.053	241	7113	5089
						4574	0.2	0.106	471	6870	4883
						4522	0.3	0.159	691	6638	4687
						4471	0.4	0.212	902	6417	4500
					.	4420	0.5	0.265	1103	6205	4322
					.	4370	0.6	0.318	1295	6003	4152
					.	4321	0.7	0.371	1479	5810	3990
						4272	0.8	0.424	1656	5625	3835
						4224	0.9	0.477	1824	5448	3687
					.	4176	1.0	0.530	1986	5279	3546

In forecast: R=Rgm(1996-2002); weight and maturity = 2003 r.
Fbar: 3-7

Norwegian spring-spawning herring:

		2004					2005			2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
13374	**10768**	**1.54**	**0.101**	**825**	**12612**	**11089**	**0.0**	**0.000**	**0**	12211	11274
					.	**11074**	**0.1**	**0.007**	**66**	12139	11204
					.	**11059**	**0.2**	**0.014**	**132**	12067	11134
					.	**11044**	**0.3**	**0.022**	**197**	11996	11065
					.	**11030**	**0.4**	**0.029**	**261**	11925	10997
					.	**11015**	**0.5**	**0.036**	**325**	11855	10929
					.	**11000**	**0.6**	**0.043**	**389**	11785	10862
					.	**10986**	**0.7**	**0.050**	**452**	11716	10795
						10971	**0.8**	**0.057**	**514**	11648	10729
					.	**10956**	**0.9**	**0.065**	**576**	11580	10664
					.	**10942**	**1.0**	**0.072**	**638**	11513	10599
						10927	**1.1**	**0.079**	**699**	11446	10534
					.	**10913**	**1.2**	**0.086**	**759**	11380	10470
					.	**10898**	**1.3**	**0.093**	**819**	11314	10406
					.	**10884**	**1.4**	**0.100**	**879**	11249	10343
					.	**10869**	**1.5**	**0.108**	**938**	11184	10281
					.	**10855**	**1.6**	**0.115**	**996**	11120	10219
					.	**10840**	**1.7**	**0.122**	**1054**	11056	10157
					.	**10834**	**1.740**	**0.125**	**1077**	**11031**	**10133**
					.	**10826**	**1.8**	**0.129**	**1112**	10993	10096
					.	**10811**	**1.9**	**0.136**	**1169**	10931	10036
					.	**10797**	**2.0**	**0.144**	**1226**	10868	9976

Fbar: 5-14 weighted byabundance
Recruitment: GM 1950-2002 = 9794 millions

It seems expedient also to attract attention to the fact that for blue whiting stock assessment the model which gave marginally low stock estimates among the 4 models tested at the Working Group was chosen.

Russian delegation underlines also that shortened duration of the Working Group meeting restricts possibilities for comprehensive scientific discussions and propose to restore duration of the Working Group to 10 days.

Review of Northern Pelagic and Blue Whiting WG report 2004.

26-27 May, 2004 ICES, Copenhagen

Technical minutes

Participants:

Jan Horbowy,	sub-group chair,	Poland
Andrē Forest,	reviewer,	France
John Simmonds,	reviewer,	UK
Asta Gusmundsdotir,	WG chair,	Island

Terms of reference for NPBWWG

a) assess the status of and provide catch options for 2005 for the Norwegian spring-spawning herring stock
b) assess the status of and provide catch options for 2005 for the blue whiting stock;
c) assess the status of and provide catch options for the 2004–2005 season for the Icelandic summer-spawning herring stocks
d) assess the status of capelin in Subareas V and XIV and provide catch options for the summer/autumn 2004 and winter 2005 seasons
e) provide as detailed information as possible on the age/size composition in different segments of the blue whiting fishery
f) provide information on the species compositions in those fisheries that take appreciable amounts of blue whiting, and on the age/size composition by species of these catches [EC request for information on the industrial fisheries]
g) propose measures to reduce exploitation of blue whiting juveniles and evaluate the potential effect on the stock and the fisheries. The evaluation should include, but not be restricted to the effects of introducing a minimum size and closed areas/seasons;
h) continue the evaluation of candidates of harvest control rules for blue whiting
i) provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, 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 the assessment of the status of the stocks and for the projection should be clarified
j) comment on this meeting's assessments compared to the last assessment of the same stock, for stocks for which a full or update assessment is presented
k) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.

The WG has completed TOR a-e and i dealing with all the assessment of stocks, TOR f on blue whiting fisheries is completed. TOR g was carried and reported in last years WG report ICES CM2003/ACFM23.

Three TOR were not addressed,

f, was not completed due lack of time and incomplete age data,

h was not attempted due to shortage of appropriate software;

k. The two major stocks are currently under review of a study group to determine benchmark assessments once these are complete this will form the basis for further benchmark assessments.

Ecological Effects.

The WG provided a good overview of the influence of the environment on the development and distribution of stocks in this area. They provided model based estimates of recruitment. While most of the information used came from survey indices of abundance of recruits some additional information was obtained from environmental data. The WG should consider these models at the start of the meeting next year and decide if the proposed methods should be used in future estimates of recruitment.

Comments by Stock

Norwegian Spring Spawning herring

Data conformity

According to a request from last year review group information pertinent to the assessment of this stock are available on the ICES server and not only at a website in Norway.

Sop of Icelandic catch in area IIa is high at 1.49. Catch total was confirmed as correct. Could not be resolved at the group, the influence was determined to be negligible.

Maturity at age used in the assessment were seen to be inconsistent, in particular the ages 3 4 and 5 in year 1969 through 1973.

The WG indicated there were density dependent growth and maturity effects to be taken into account in the projections. However, year independent values are used in the assessment since 1993. This inconsistent use of data should be resolved

Mean weight at age in the period 1972 to 1992 show increase with age until 10 or 11 year then decreases are found. Could this be validated.

Assessments

As proposed by the WG the reviewers endorse the view that of the available assessments the Sea Star assessment is the best assessment for this stock.

Sea Star.

Error distribution assumptions (differing among data sets) are included in the model, these are not supported by tables or graphs in this year's report, these should be included each year so that it can be shown that the error distribution choice is appropriate.

It is suggested to include in the model also negative binomial error structure, which appears to work well with havy tailed survey data.

A standardised simple residual plot between observations and model estimates for all data should be provided. Some graphs for some surveys were included but a coherent residual plot is required.

Extensive range of different types of data are included in the model, It seems unlikely that all sources are equally informative, there is no information on weighting provided, Could this be provided in future and if possible different weighting of different data in the assessment explored. In particular the recruit indices may be informative in differing amounts, the wide span of ages from both catch and surveys have differing errors with age and it may be helpful to account for this with weighting.

There is a general tendency in figures produced for Sea Star to omit labels and units on the axes of graphs. Please ensure they are fully labelled to avoid confusion.

ISVPA

Its not possible to determine how survey catchability is dealt with within the ISVPA as used for this stock. In future could the age dependent or independent catchabilities be included.

Figure 3.5.3 shows a 'de trended' ISVPA fit. This is not explained in the report.

There are changes in the choice of model settings in comparison with those used in the previous assessment (minimisation of MDN except SSE for survey N5 in the 2003 assessment, compared to minimisation of MDN except AMD for surveys N3 and N4 in the 2004 assessment). The effect of these are not explained and the influence of these changes are not shown. This makes it difficult to judge the effect and importance of these changes and therefore the utility of the model.

General

ISVPA produces a rising selection function for catch at age from 1 to the older ages in the recent period. This is in contrast to the pattern from Sea Star which rises to 7 or 8 years and is domed or flatter for older herring. This difference is thought to be important for the assessment but is not discussed. The effect of the elevated part of the selection pattern (8-11 years) should be examined in future.

The surveys are documented intermittently by survey 'Name', or number, please ensure that the number is used on all descriptions tables and figures, so there is one consistent key to identify each survey.

The assessment is strongly dependent on the use of the 'feeding area survey'. A different treatment of this survey in ISVPA was the main cause of the difference in the 'ISVPA' and 'Sea Star' assessments. Although the fit was shown to be better in ISVPA with this change there was no discussion of why only this survey should be treated this way and why this might be the preferred method. Thus it was not possible to make a clear choice of which was the correct use. Under these circumstances the reviewers concluded that the method used last year for both ISVPA and Sea Star should be followed in preference to the new unexplained use taken this year by in ISVPA.

Projections

Short projections included maturity and weight at age that varied with year. It is good to see that this is being considered for projections for this stock but the values used were not fully documented in the table provided.

The mean weights at age in the projections seem inconsistent for ages, particularly for age 3. Its not expected that this will influence the SSB or the estimated catch used for management by much, however, the validity of these weights should be checked.

The short term predictions were rerun during the review and very small changes were found, these were include in the ACFM summary sheets. The new file is in the review group directory under 'Asta'.

In 2004 a TAC constraint was used for the projections. While the reviews support the use of this method, no explanation to support this choice was documented.

Capelin in the Icelandic-East Greenland – Jan Mayen Area

Data conformity

Its not clear from the report if the Capelin Acoustic Surveys are used as absolute or relative indices of abundance. If they are used as absolute in management, the Target Strength of Capelin used and its origin should be quoted. Perhaps validation of the survey against subsequent catch could be used to improve certainty with the method.

Assessments/ Projections

The assessment / projections rely on a constant time invariant natural mortality. Particularly of surveys from different times of year are to be used in management (as seems to the case recently) the validity of this assumption this needs to be considered.

Blue Whiting

Data conformity

This year the Norwegian survey of the spawning grounds alone was used in the assessment. The more extensive 4 ship survey was available. Unless there are reasons to believe that the additional data is incorrect it would be preferable to use the higher effort survey, maybe initially only from a standardised area for consistency. It is appreciated that it takes considerable work and organisation to get the survey data from such a survey combined in time for the WG.

Assessments

As proposed by the WG the reviewers endorse the view that of the available assessments the AMCI assessment is the best assessment for this stock.

The WG should be commended for trying 4 different packages for assessments for this stock. The broad correspondence between the results provides good support for the final assessment.

Comparing the assessments coming from the 4 models gave rise to some concerning patterns of residuals, particularly in ISVPA and SMS. Positive and Negative cohort dependent residuals were seen in both these models but in different directions in the different models for some of the older ages currently in the stock. If the causes of these effects could be established it may be possible to determine more easily which model is providing the better representation of the stock.

Projections

The methodology used for stochastic stock projections for this stock looks reasonable and the results do not look inconsistent. However, this software has not been validated against other software. It would be useful if this could be done before the next NPBWWG. One method would be to set variability to zero and to compare with deterministic software.

Icelandic summer spawning herring

Data conformity

The assessment relies heavily on the acoustic survey results. This survey is the result of several areas combined. When changes are occurring and there are both increases in numbers of juveniles and decreases in adults seen in these surveys it would be helpful to have a timeseries of area based values for comparison. This might allow such changes to be better supported.

Assessments

The reviews accepted the assessment of this stock.

There are some concerns that the assessment has a strong retrospective behaviour. This effect was reduced when fewer ages were used in the fit. This effect should be evaluated further. It may be due to ageing errors, increased variance of estimates with age and flat weighting in the assessment model (or something else). Nevertheless it should be investigated further.

Projections

Projections for 2 years ahead were provided. However, only one year ahead is needed as the stock is managed in year. Appropriate tables should be provided in the future.

The section on management advice was not fully completed. This made filling out the summary sheets more difficult

Norwegian spring-spawning herring

Input to the short term prediction

Landings in 2004 .825 million tonnes
Fbar age range: 5-14, Fbar is weighted with population numbers January 1
Spawning stock biomass in 2004 6.96595 million tonnes
Fbar in 2004, 0.166646
Basis for weight in stock prediction:condition factor
Basis for weight in catch prediction:condition factor
Part of year before spawning: .1

Age	Numbers (billion) 2004	Weight stock (kg) 2004	Weight stock (kg) 2005	Weight catch (kg)	Fraction mature 2004	Fraction mature 2005	Fraction mature 2006	Exploitation pattern
0	0.000	0.001	0.001	0.007	0.000	0.000	0.000	0.000
1	69.033	0.010	0.010	0.063	0.000	0.000	0.000	0.000
2	33.318	0.037	0.037	0.094	0.000	0.000	0.000	0.002
3	1.612	0.055	0.055	0.171	0.000	0.150	0.000	0.104
4	0.629	0.212	0.214	0.218	0.300	0.300	0.450	0.031
5	9.479	0.241	0.243	0.257	0.900	0.900	0.900	0.068
6	9.949	0.279	0.281	0.288	1.000	1.000	1.000	0.171
7	0.898	0.302	0.304	0.319	1.000	1.000	1.000	0.154
8	0.958	0.337	0.340	0.327	1.000	1.000	1.000	0.201
9	0.099	0.354	0.357	0.354	1.000	1.000	1.000	0.248
10	0.253	0.355	0.358	0.363	1.000	1.000	1.000	0.296
11	0.596	0.360	0.363	0.361	1.000	1.000	1.000	0.237
12	1.995	0.371	0.374	0.381	1.000	1.000	1.000	0.188
13	1.000	0.400	0.403	0.397	1.000	1.000	1.000	0.179
14	0.208	0.412	0.415	0.402	1.000	1.000	1.000	0.176
15	0.044	0.445	0.448	0.450	1.000	1.000	1.000	0.174
16	0.283	0.445	0.448	0.450	1.000	1.000	1.000	0.174

Short term prediction

SSB 2005	Fbar	Landings 2005	Biomass 2006	SSB 2006
6.317	0.084	0.605	8.702	6.593
6.307	0.101	0.721	8.585	6.483
6.296	0.118	0.835	8.470	6.374
6.291	0.125	0.884	8.421	6.327
6.286	0.134	0.947	8.357	6.267
6.275	0.151	1.057	8.246	6.162
6.265	0.168	1.166	8.137	6.059
6.254	0.185	1.273	8.029	5.958
6.244	0.202	1.378	7.923	5.859
6.233	0.218	1.482	7.818	5.762
6.223	0.235	1.584	7.716	5.666
6.212	0.252	1.684	7.614	5.572