Advisory Committee on Fishery Management ICES CM 2002/ACFM:20

REPORT OF THE

Northwestern Working Group

ICES Headquarters
29 April–8 May 2002

PARTS 1 and 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TECHNICAL MINUTES

North-Western Working Group (NWWG)

ACFM Meeting May 2002

Sub-group Chair: Dankert Skagen
Working Group Chair : Einar Hjörleifsson
Rapporteur/reviewer : Stuart Reeves
Reviewer : André Forest
Jesper Boje, Jakup Reinert
Vladimir Shibanov and Willy Vanhee

The WG chair introduced the report, noting that in retrospect it was sometimes quite hard to find-out what had been done and what had been changed in some assessments. There is an intention to improve on this next year by e.g. tabulating candidate values for recruitment estimation, and changes in assessment settings.

The chair followed with some comments about assessment approaches, and in particular the desirability of integrating the catch-at-age analysis, recruitment estimation, and short and medium term forecasts all into one step and thus removing the inconsistencies and potential for error that arises when these are all separate steps. This approach also allows for stochastic forecasts and much more explicit statements about the uncertainty associated with a particular assessment.

The WG has used a wide range of assessment approaches, but in some cases where e.g. an assessment is based on a statistical catch-at-age analysis it has still been necessary to use the terminal Fs to run a VPA to get the output which ICES requires. This is clearly undesirable.

When raised in plenary it was noted that as a minimum, and software developed for use in stock assessment should produce the required standard output tables. The Secretariat will prepare some text on this.

The Sub-group supported the idea that an assessment should be more than following a standard template and pushing all the right buttons, but rather that an assessment should actually involve finding-out what the data tell you. The ICES approach can limit the extent to which this is possible, a point which will be raised in plenary.

General comments

The sub-group appreciated the fact that the WG use a broad range of assessment models. However, use of more flexible models, e.g. BORMICON, AMCI, ADCAM etc. requires that much more detail needs to be provided in terms of model specification and diagnostics than for a 'standard XSA'. This is often not the case for the models used here, making it very difficult to review some of the assessments.

The WG should mention whether there is any information about the extent of discarding for all stocks. Even a statement like "Little discarding is thought to occur in this fishery" are better than nothing.

The WG should provide detailed output from catch forecasts, e.g. in the form of the pie charts used for Icelandic Saithe. This is essential for interpreting what is happening in a catch forecast.

In cases where alternative assessments have been attempted, the WG should consider carefully whether they should be included in the Report. If the assessment has not been used then it can be confusing to include the output. It also increases the size of the report.

Fs for short-term forecasts : The recent mean exploitation pattern should only be scaled to the point estimate in the most recent year in cases where there is a clear indication of a trend. Otherwise use the unscaled value, particularly in assessments which are uncertain or have retrospective problems. The WG have introduced the SPALY[1] approach which the SG considered a useful formulation.

[1] Same Procedure As Last Year

The wg should next year look into the use of *status quo* constraint in the forecasts, for all stocks.

Faroese Stocks

Both the Haddock and cod assessments discarded all commercial CPUE series and place considerable reliance on a single short time series of survey indices. This could potentially lead to unstable assessments, particularly at the very low level of shrinkage used in the XSA runs for these stocks. The WG should reconsider this approach.

Faroe Plateau cod

The plot of the catch-at-age data on log scale plot useful – In this case it highlights a problem with one recent small year class

The WG discarded all commercial CPUE data for this stock and just used one short survey series. The WG are uneasy about the way XSA weights different surveys & there is a recent history of poor estimation of recruitment for this stock hence choice of only survey series. There is an increasing scepticism about use of commercial CPUE series, however the Faroe series are standardised, so hopefully technology creep should be less of a problem.

WG encouraged to maintain commercial CPUE series even if not used, and look carefully at excluding commercial series.

Very weak shrinkage used (2.0) – not investigated but SPALY. The WG defended this as a way of placing more trust in one short survey when there is an anomaly in the catch at age data . The WG should consider the choice of shrinkage – weak shrinkage as used may contribute to instability & the problems experience when changing the plus group age. Also the WG are encouraged to investigate statistical catch at age models – e.g. ICA, AMCI – time permitting – as these may be more appropriate if the catch at age data aren't trusted.

The XSA output of stock numbers at age had been edited to show the overwritten values. This should NOT be done as it makes it very hard to check values etc. Any overwritten recruitments should be edited only in the summary table, but indicated by e.g. '*'

There is a contradiction in the use of survey as only fleet, but then throwing out XSA est. of 1999 year class

The forecast used an exploitation pattern scaled to 2001 point estimate of F– when in this case terminal F is likely to be poorly estimated, so unscaled F should have been used. WG Chair asked to prepare forecast with unscaled F as comparison.

This stock highlighted a general point about the provision of detailed forecast output and pie charts – these were not provided, when they are extremely useful for interpreting the results of catch forecasts..

Faroe bank cod

No comments (no assessment !)

Faroe Haddock

It was noted that time series plots are not the best way to present exploratory runs when the terminal estimates are the point of concern. In this case it led to the wrong conclusion that all approaches produce similar results, when in fact terminal F varied between 0.3 and 0.5. – The WG are encouraged to provide scatter plots of terminal SSB vs. mean F to summarise different exploratory runs.

Estimate of SSB & F highly uncertain – conflicting evidence in various sources of information. WG has selected what it considers to be the most reliable source of info, but other sources of information would have given a different picture.

The comments on fleet use for cod also apply here,, i.e. placing all trust in one short survey which is potentially misleading. The survey is considered reliable to age 5-6, but it is also used to tune at older ages – up to age 10 hence there are potential problems there.

In general a rather uncertain assessment . This was supported by the probability profile from exploratory statistical catch at age model.

The comment about use of scaled F as for cod, also applies here, but there is not much difference in this case, so no rerun was requested.

Faroe Saithe

There was some confusion about maturities, apparently raw data are smoothed using a GLM which incorporates a year-class strength effect – it is unclear how this can be estimated before there is an assessment ! The approach is probably OK but the explanation could be clearer.

The assumption of q dependent on population size for ages 3-4 is not supported by XSA diagnostics.

The WG could look at the internal consistency of tuning series by looking at correlation within cohorts in successive years & also between series.

The assessment is a shaky, but WG has done a good job with limited data.

There was much discussion about population inputs for the short-term forecast. This was eventually rerun with 1998 year-class estimated using long-term GM, and XSA estimate accepted for 1996 year-class. (It was considered that there was no real evidence that the 1998 year-class is as strong as was assumed and the XSA estimate of 1996 year-class not too bad.). The revised forecast also used an unscaled F in view of retrospective problem.

Well done for being the only stock to incorporate pie charts for the forecast results ! These are very useful and should be provided for all forecasts.

Reference points were discussed as there is some need for revision but no firm proposals were made in view of the need to also revise those of cod & haddock.

Icelandic Stocks

In plenary it was noted that the catch forecasts run for the Icelandic stocks routinely assumed a TAC constraint for the intermediate year. This sometimes implied a substantial reduction in F during that year. The WG is asked to evaluate whether these reductions in F have been achieved by TAC regulation in the past, and thus to review whether this practice is appropriate for future forecasts.

Icelandic Saithe

There is a real problem with lack of documentation of the method used, in terms of what was done and what the parameter values mean. Without this documentation, it is very difficult to review the assessment. This is not satisfactory. The comment does not refer to the method itself, but only to (the lack of) information provided about the assessment. The text for this assessment approach was contradictory in that it is first noted that including the survey data in the TSA produced very little differences in the results, abut lower down in the same section it is noted that adding the survey data to the TSA was a significant improvement. No comparison was provided so it was impossible for the reviewers to judge the relative merits of the two approaches. This is a very serious point as the assessment led to a substantial change in the perception of the stock, and it is not clear how much of this is due to the data and how much to the change of method.

The use of a recruitment estimate from another method (ADAPT here) to that used for the catch at age analysis (TSA) needs to have a very clear justification if it is to be acceptable. In this case, it makes little difference so it was not considered necessary to rerun the assessment.

Icelandic Cod

The WG have investigated a wide range of different methods for this stock. While the sub-group encourages this, they felt that such comparisons, shouldn't just involve looking at the interest parameters, but should also investigate why and how the results differ (if they do). This was lacking from these investigations.

Exploration of a range of models is good, but adequate testing and documentation is essential if such models are to be used as the basis of advice.

Comments about lack of documentation for TSA as for saithe.

The final method was selected after visual inspection of the retrospective performance of each. One reviewer noted that comparison of retrospectives is easier using Mohn's 'rho' statistic (as used by Bob, not as described in his 1999 (ICES JMS, **56**, 773-788) paper where the equations are wrong !) than by visual inspection.

The subgroup considered this assessment to represent the 'state of the art' to a certain extent, particularly in respect of the review process, and the extent to which the problems have been investigated and understood. The approach is also well explained in the WG report.

The short-term forecast for this stock assumes TAC constraint for 2002 which leads to a large reduction in F. The WG should review this assumption – see above.

Icelandic Haddock

Note that residual plot is provided for ADCAM fit (which was not used) but not for the XSA fit that was used. However, the SG noted that bubble plot used is a good way of summarising the residuals. Some indications of year effects 1999-2000 are apparent, but these do not appear to cause any severe retrospective problems – perhaps the assessment achieved the right balance between surveys & shrinkage.

ADCAM appears to be useful, but good documentation and testing is essential.

The reviewers appreciated the presentation of the combined assessment & projections including the confidence intervals

Redfish

It took a bloody long time for the SG to go through the *S. mentella* stuff. The WG are encouraged to provide a clearer and more concise summary next year.

Pelagic S. *mentella*

The WG should be careful with comparing an 'absolute' estimate from acoustic surveys with an absolute catch. A small change in the assumed target strength could give a completely different picture. However, there is a clear indication of a reduction in what is being measured, even if the reasons for this are not clear.

The WG encouraged to continue work on combined Acoustic/trawl index

Deep Sea S. *mentella*

Please not that if e.g. ASPIC runs are made which are exploratory, then the WG should make it clear that this is exploratory.

Given the possible problems with estimation of r, it maybe possible to estimate r externally for use in the model.

Catch projections : After some discussion the approach used to forecast catch as a basis for advice was changed to :

Catch(2003) = mean CPUE(1999-2001) * mean Effort (1999-2001)

This leads to a catch of 25526t. i.e. 25,500 + 4000t (Faroes) => 30,000t.

This approach picks up some of the recent reduction in effort.

Sebastes marinus

The SG accepted the BORMICON as exploratory, and this work is appreciated. However, Absolutely no information was provided by which the assessment could be evaluated.

The WG should consider Biological reference points based directly on the analytic assessment, but the existing values were retained at present.

In plenary, it was decided to recommend a 25% reduction in effort. Accordingly, the 2001 effort was used as a reference, and applied to the 1999-2001 CPUE.

Greenland cod

No comments as no assessment used

Greenland Halibut

No real comments – SPALY .

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1 INTRODUCTION

1.1 Participants

Einar Hjörleifsson (chair)	Iceland
Jesper Boje	Greenland
Höskuldur Björnsson	Iceland
Luis Rideao Crus	Faroe Islands
Fernando Gonzalez	Spain
Agnes C. Gundersen	Norway
Aage S. Høines	Norway
Sigurður Þór Jónsson	Iceland
Jean-Jacques Maguire	Faroe Islands
Sergei Melnikov	Russia
Lise Helen Ofstad	Faroe Islands
Hans Joachim Rätz	Germany
Jákup Reinert	Faroe Islands
Þorsteinn Sigurdsson	Iceland
Björn Ævarr Steinarsson	Iceland
Petur Steingrund	Faroe Islands
Christoph Stransky	Germany

1.2 Terms of Reference

The Northwestern Working Group [NWWG] (Chair: E. Hjorleifsson, Iceland) will meet at ICES Headquarters from 29 April to 8 May 2002 to:

a) assess the status of and provide catch options for 2003 for the stocks of redfish in Subareas V, XII, and XIV, Greenland halibut in Subareas V and XIV; cod in Subarea XIV, NAFO Subarea 1, and Division Va, saithe in Division Va, and haddock in Division Va;

b) for cod, haddock, and saithe in Division Vb that are under effort control, assess the status of and provide effort options and expected corresponding catches for 2003;

c) update survey and fishery information on the stocks of redfish in Subareas V, VI, XII, and XIV. In particular, update information on the development of the pelagic fishery for redfish with respect to seasonal and area distribution to allow NEAFC to further consider the appropriateness of area and seasonal closures;

d) consider further possibilities for the incorporation of biological interactions into the assessments of capelin, herring, and cod stocks in Division Va;

e) update information on the stock composition, distribution, and migration of the redfish stocks in Subareas V and XIV, and comment on the possible relationship between pelagic "deep sea" *Sebastes mentella* and the *Sebastes mentella* fished in demersal fisheries on the continental shelf and slope;

f) provide information on the horizontal and vertical distribution of pelagic redfish stock components in the Irminger Sea as well as seasonal and interannual changes in distribution;

g) provide specific information on possible deficiencies in the assessments, including at least: Major inadequacies in the data on catches, effort or discards; major inadequacies, if any, in research vessel surveys data, and major difficulties, if any, in model formulation; including inadequacies in available software. The Group should clarify the consequences from these deficiencies for a) assessment of the status of the stocks and b) for the projection;

h) for stocks for which a full analytical assessment is presented, comment on this meeting's assessments compared to the last assessment of the same stock;

i) consider the results presented in the reports of the WGMG and the SGPA with a view to applying these in the assessments;

j) review the draft Quality Handbook.

NWWG will report by 9 May 2002 for the attention of ACFM.

Request from NEAFC to ICES for scientific advice for 2002 and 2003

In addition to the ToR from ICES the NWWG addressed the NEAFC requests to ICES on the following issue:

1. Regarding redfish stocks:

a) Review the stock situation and its advice for pelagic redfish in the Irminger Sea for 2002 at the May 2002 ACFM meeting;
b) submit new information on stock identity of the components of redfish such as "pelagic deep-sea" *Sebastes mentella*, "oceanic" *Sebastes mentella* fished in the pelagic fisheries, and the "deep-sea" *Sebastes mentella* fished in demersal fisheries on the continental shelf and slope;
c) provide information on the horizontal and vertical distribution of pelagic redfish stock components and fisheries in the Irminger Sea and adjacent waters as well as seasonal and interannual changes in distribution. Information on the vertical distribution should allow NEAFC to further consider the appropriateness of separate management measures for different geographical areas/seasons.

1.3 General comments

The format of the report is similar to the last two years, with Tables and Figures located after all text for each stock. In the 1999 report some information not used directly in the assessment was omitted in order to make it more digestible for clients. Attempts to reduce the amount of documentation have not been made in the last three years reports, as clients of the report as well as ACFM have requested that it should contain sufficient data and diagnostics from analyses.

1.4 Stocks assessed by NWWG

The stocks dealt with by NWWG can be divided into two classes: those for which data are sufficient to allow an age-based analytical assessment, and those for which either the data amount is limited or for which the quality of the data is questionable, impeding analytical assessments. All gadoid stocks are in the first class except for Faroe Bank cod, where a short time-series and incomplete biological sampling of the landings inhibit analytical assessment, and cod in Greenland, where a ceased fishery prevents a VPA. In the second class are most of the redfish stocks, for which difficulties in age determination have prevented calculations of catch-at-age and, therefore, age-based analytical assessment. The Greenland halibut stock in Greenland, Iceland, and the Faroes shifted to this category last year, mainly due to unreliable determinations of age and maturity. One redfish stock, *S.marinus*, sits in the middle of these two extremes, being assessed by a length-based model (Bormicon).

1.5 Choices of stock size indices to be used in calibrations

Consistency between successive assessments of stock size is perceived as a virtue by most ICES assessment working groups. Over years, this has led to the adoption of standard XSA configurations that should be used as default with minimum changes from one year to the next. Given the workload of WG and ACFM, WGs have tended to tamper as little as possible with the settings and the series that are used in the assessment as frequent changes in these appear to be made on an *ad hoc* basis.

The recent assessments of North Sea and Icelandic cod point to the importance of periodically examining critically what indices should be used in the assessment. The main result of the in-depth examination for these two stocks had led to the exclusion of all five commercial fleets in the Icelandic cod assessment, and four of the five commercial fleets in the North Sea cod assessment, due to demonstrated or suspected increases in the commercial fleets' catchability coefficients and/or data errors as well as inability of assessment models to properly use indices from many fleets, giving surveys too little weight as they do not correlate as well with catch in numbers as the indices from the commercial fleets do. The omission of commercial CPUE series has resulted in considerably lower estimated stock sizes, consistent with perceived effects of unmodelled increase in catchability coefficient of the commercial fleets.

Given the rejections of commercial CPUE indices in the North Sea and Icelandic cod assessments and the expected increase in efficiency of commercial fleets, it would be tempting to systematically exclude **ALL** commercial CPUE indices from **ALL** ICES stock assessments, but this would be an unwise over-reaction. What is needed is a careful in-depth examination of ALL stock size indices used in each and every assessment to ensure that the indices do provide consistent measurements.

Although it is expected that fishing efficiency of commercial fleets will increase over time, the imposition of technical conservation measures has the contrary effect and it is not always clear what the net outcome will be. The commercial

CPUEs used in the Faroe saithe assessments have been carefully selected from a subset of vessels whose configurations have remained relatively unchanged over the years and have consistently provided reliable logbook information. The CPUE used for Greenland halibut has been modelled to take into account year, area, seasonal, and vessel characteristics, and even though the area fished has increased over the years, eliminating part of suspected changes in catchability. For the redfish stocks included in the mandate of the NWWG the commercial fleets' CPUE is a major source of information on changes in stock size. Regarding the stocks for which analytical assessment or long survey series are not available, trends in catchability coefficients are impossible to detect and results from "better known" species might have to be utilized (WP31).

1.6 Choices of stock assessment methods and/or software

For most of the stocks for which age based analytical assessments were carried out, the terminal fishing mortality was estimated by tuning aged catch data with selected fleet age disaggregated CPUE indices (commercial or survey indices) using two different methods. The adopted assessments of the Faroe cod and Faroe haddock were based on the conventional XSA methods. Terminal fishing mortality of Icelandic cod and Icelandic saithe have been modelled by a Time-series Analysis (TSA), this method having a relatively long history of usage in this Working Group. Terminal fishing mortality of Icelandic haddock was on the other hand not based on any special model but a number of models were run and results somewhere in the middle of the possible results were selected!!

The reader of the report will find that various other types of models were fitted to the Icelandic stocks, including forward-based catch-at-age analysis (Coleraine (WD29), ADCAM (WD33), STAM (WD22)) and the well established backward-based ADAPT - method. The principle of the latter model is the same as that of the conventional XSA, i.e. catch-at-age data are assumed to be without error. The principle of the former group of models is that catch-at-age and survey-indices are predicted from the model and "the best fit" is obtained by minimising the observed vs. the predicted values. This is the same procedure as that of AMCI (now used in WGNPBW) and the forward part of ICA. The advantage of using a forward calculation is that both short-term and medium-term projections are a natural extention of the assessment of the historical data series. One can thus bypass the tedious and often error prone procedure of going through 4 software packages (historical assessment, recruitment estimates, short-term prediction, and medium-term prediction), as is now the norm. Although members of the Working Group concluded that the results from any of these approaches and/or software packages could be used as the basis of the adoption of a final run, they were not used because of unfamiliarity of these methods/software packages to the ICES body at large. The results from two of the models where however used as a basis for short-term forward projection in the Icelandic haddock and saithe.

1.7 Comments on the WGMG and the quality handbook

The NWWG considered the report of the Methods Working Group (WGMG) (ToR i). Views varied on the proposed process for the certification of software (Section 7), particularly as it links with the quality of ACFM advice (Section 2.2). The first creation of the Methods Working Group in the early 1980s aimed at identifying which of the assessment methods available could be useful, standardising the assessment approaches, and providing guidelines on the use of existing software.

The overall philosophy could be described as the provision of assessment software that would be robust to both the data and the user. The current report of the WGMG suggests that this has not been an overwhelming success since for the 67 assessments for six stocks examined, 20 were in error by a factor of 2 or more. We agree with the MGMG (page 2) that "the prevailing inclination […] to seek solutions through a sophistication of models and methods" is unlikely to be successful and that the data needs to be improved. Unfortunately, under most existing fishery management systems, this may prove either very difficult or very expensive.

The software certification proposal of the current WGMG is in line with the overall philosophy described above. Although there is no disagreement that software should be certified, we consider it equally important to certify the assessor. It is more important to train assessors directly in analysing and interpreting the data available to them rather than teach them how to use a particular piece of software.

The software certification procedures and the quality handbook may make participation in ICES stock assessment working groups unattractive for highly qualified and innovative analysts who could make important contributions to the progress of ICES' work. Those highly qualified and innovative analysts that do come to assessment working groups cannot work as efficiently because of the software certification procedures and quality handbook.

Quality management procedures such as those proposed in the quality handbook manual seem appropriate for organisations that produce high volumes of standard items in a more or less automated way. The production of assessments and formulation of management advice may not be at the stage where it is possible to automate the process.

It relies more on the skills and dedication of the "artisan" involved in the work than on the procedures involved. This may require a different approach to quality management.

An important and often overlooked step is that output from stock assessment model should be easy to read by any statistical program or spreadsheet or even relational databases, while the output from many of the assessment programs used now is totally unacceptable in this context. Similar considerations apply to the input which is decades behind regarding sensitivity to extra spaces, tabs, or commas in input files.

The WG reports are consistently getting bigger and bigger. Reducing the font and going to A6 paper size is not an option because the eyesight of the average user is not improving. An alternative to the current approach of producing large WG reports would be to raise the status of individual working documents and publish them in a formal series as the technical documentation of the advice. Those documents would be authored by the relevant scientists and could count in the scientific production when assessing performance.

1.8 Precautionary reference points

No major evaluation of reference points has been made since 1999. The Working Group recognised that some existing reference points may in some cases be inappropriate (e.g. in Faroe saithe and Icelandic saithe). Given the management regime in effect in the Faroese demersal fisheries, the reference points for the three main species, cod, haddock, and saithe, should be re-evaluated at the same time. The catch rule for Icelandic cod is now under revision and it was considered that revision or establishment of reference points for Icelandic haddock and Icelandic saithe should await the result from that analysis. Until more appropriate reference points are identified and adopted, the existing ones could continue to be used, albeit with some flexibility in the formulation of management advice.

2 DEMERSAL STOCKS IN THE FAROE AREA (DIVISION VB AND SUB-DIVISION IIA4)

2.1 General Trends in Demersal Fisheries in the Faroe Area

The fishery at the Faroes is a multi-fleet and multi-species fishery. Figure 2.1.1 gives a summary of the 2002 assessments of the stocks of Faroe Plateau cod, Faroe haddock and Faroe saithe and Figure 2.1.2 shows the total yield of these stocks.

Fishing mortality on Faroe Plateau cod, Faroe haddock and Faroe Saithe has followed different trends for the three species since the early 1960s (Figure 2.1.1). Fishing mortality for cod and haddock declined steadily from 1961 to the early 1970s, but thereafter evolved differently. For cod, fishing mortality increased and has oscillated around a mean of about F = 0.50 since 1974, with a substantial decrease in the early 1990s when productivity was lower. For haddock F remained relatively low (F = 0.27) until the late 1990s when it appears to have increased to pre – 1973 values. For saithe, F increased regularly from 1961 to the late 1980s, reaching peak values in the early 1990s, but it appears to have decreased since. Over the whole time series, F for haddock is negatively correlated with time (r = 0.50), F for saithe is positively correlated with time (r = 0.70), and, as could be expected, the F for the two species are negatively correlated (r = 0.70). When combined in an overall index of exploitation (yield over SSB), the ratio is remarkably stable around 0.30 from 1961 to 1981 (Figure 2.1.2), but since then it has shown larger fluctuations, exceeding 0.55 in 1991. This index of overall exploitation has steadily increased in recent years from slightly less than in 1997 to about 0.42 in 2001.

The SSB for cod shows four cycles (Figure 2.1.3), the SSB for saithe two and half, and the SSB for haddock, three. The haddock SSB appears to lag that of cod by 2 years (r = 0.88). No such lags are clearly evident for saithe. When added together (Figure 2.1.4), the total SSB increases from 1961 to 1977, then it declined almost steadily until 1992, except for a brief increasing period from 1983 to 1985. SSB has shown an increasing trend since then.

Haddock shows the largest recruitment variability (Figure 2.1.5). There is a more than 50 fold difference between the smallest year class (1.8 million) and the largest one (95.6 millions). Cod shows the next largest variability with a 15 fold difference between the smallest year class (3.6 millions) and the largest one (54 millions). Saithe shows only a 7 fold difference between the smallest year class (8.4 millions) and the largest one (62 millions). The recruitment of cod does not show any particular feature other than the string of small year classes during most of the 1980s. Haddock shows sustained recruitment for the 1959 to 1976 year classes, but from 1977 to 1992, only the 1983-1985 year classes were of average size. All the other were much smaller than average. The 1993, 1994 and 1999 year classes are strong. Saithe recruitment increases regularly from the 1958 year class to the 1966 year class and then decreases similarly regularly until the 1975 year class. Recruitment patterns since then are not been so clearly cyclical.

During the 1980s the Faroese authorities have attempted to regulate the fishery and the investment in fishing vessels. In 1987 a system of fishing licenses was introduced. The fishery also has been regulated by technical means such as legislation on the mesh size, permanent and temporarily area closures, import ban on fishing vessels and a programme of buying back fishing licenses. Mesh size regulations and closed areas are still enforced.

In March 1994 the Faroese Parliament passed a law on the regulation of fisheries within the EEZ. This law introduced quotas for 5 demersal stocks including the Faroe Plateau and the Faroe Bank Cod, Faroe Haddock, Faroe Saithe and redfish. The quotas were allocated to each fleet category by percentage of the total quota and then equally divided between all vessels in each category.

The fishing year starts 1 September and ends 31 August the following year.

2.2 Faroe Plateau Cod

2.2.1 Trends in landings

The nominal landings of cod (1986-2001) from the Faroe Plateau by nations as officially reported to ICES, are given in Table 2.2.1.1. The relatively high recruitment in 1980-1983 allowed a good fishery for cod in the period 1983 to 1986 when landings some years reached almost 40 000 t. Landings decreased afterwards to only 6 000 tonnes in 1993, the lowest on record. In 1995 the officially reported landings increased to slightly above 19 000 t. Information from the fishing industry indicated misreporting in the order of 3 330 t (3 000t. gutted weight) for 1995 which were added to the officially reported landings in Table 2.2.1.2. Misreporting is not suspected to have been a problem afterwards. Landings increased spectacularly in 1996, to above 40 000 t, the highest value during the 1961 to 2000 time period. This increase is believed to be due to a combination of increased stock size, increased availability, and increased effective fishing effort as a result of the new management system introduced June 1, 1996. The catches remained high in 1997 (34 000 t), but decreased to 24 000 t in 1998 and 20 000 t in 1999. Catches increased slightly in 2000 (22 000 t), and reached 29 000 t in 2001.

In recent years, statistics for the Faroese fishery in that part of Subdivision IIa (Figure 2.2) which is within the Faroese EEZ, have become available. It is expected that these are taken from the Faroe Plateau area so they are included in the total used in the assessment in Table 2.2.1.2 under the row labelled "Used in the assessment". No information on the Faroese landings from IIa were available for 1993-1996, however. The French landings of Faroe Plateau cod in 1989 and 1990 as reported to the Faroese authorities are also included. Scottish catches 1991-1999 reported from the Faroe Bank (Vb2) were in the 2001 assessment moved to the Faroe Plateau (Vb1), by advice from the Faroese Coastal Guard (Table 2.2.1.2).

Since the introduction of the EEZ, the Faroe Plateau cod has almost entirely been exploited by the Faroese fishing fleets. Table 2.2.1.3 and Figure 2.2.1.1 show the landings for the most important fleet categories. In recent years, the longliners and the pair trawlers have usually taken most of the catches. Since autumn 1999, however, single trawlers > 400 HP have increased their share of the total catches considerably as a result of a special quota (in tonnes, not fishing days) allocated to them in shallow water (< 200 m) on a half year basis (September 1 and March 1).

2.2.2 Catch-at-age

Landings-at-age were updated to account for a change in the nominal landings for 1999-2000. Landings-at-age for 2001 are provided for the Faroese fishery in Table 2.2.2.1. Faroese landings from most of the fleet categories were sampled (see text table below). Landings-at-age for the fleets covered by the sampling scheme were calculated from the age composition in each fleet category and raised by their respective landings. The age composition of the combined Faroese landings was used to raise the foreign landings prior to 1998 when, the age composition of the corresponding Faroese fleets were used. Landings-at-age from 1961 to 2001 are shown in Table 2.2.2.2. Catch curves are shown in Fig. 2.2.1. They show atypical patterns in 1996 and to some extent in 2001 when there appears to be an increase over the previous year for ages where a decrease would normally have been expected. This could be due to catchability for longliners depending on fish growth (Fig. 2.2.6.1.5), causing atypical catch curves for longliners (Figure 2.2.6.1.4).

Fleet	Size	Samples	Length	Otoliths	Weights
Open boats		13	2,074	540	300
Longliners	<100 GRT	83	16,589	1,745	359
Longliners	>100 GRT	70	13,466	1,919	600
Jiggers		13	2,177	419	300
Sing. trawlers	<400 HP	16	3,107	360	240
Sing. trawlers	400-1000 HP	30	6,348	301	120
Sing. trawlers	>1000 HP	9	1,693	298	240
Pair trawlers	<1000 HP	19	3,974	480	420
Pair trawlers	>1000 HP	46	9,437	894	835
Total		286	56,791	6,416	3,114

Samples from commercial fleets in 2001.

2.2.3 Mean weight-at-age

Mean weight-at-age data for 1961-2001 are provided for the Faroese fishery in Table 2.2.3.1. These were calculated using the length/weight relationship based on individual length/weight measurements of samples from the landings. The sum-of-products-check for 2001 showed a discrepancy of less than 1 %.

Figure 2.2.3.1 shows the mean weight-at-age for 1961 to 2001. From 1991 to 1995 weights at age increased, they remained stable in 1996 and decreased during 1997-1998. Since 1998 they have increased again.

2.2.4 Maturity-at-age

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) are given in Table 2.2.4.1 (1961 - 2001) and shown in Figure 2.2.4.1 (1983 - 2002). The average maturity at age for 1983 to 1996 were used in years prior to 1983. Full maturity is generally reached at age 5 or 6, but considerable changes have been observed in the proportion mature for younger ages between years. In the 2001 assessment, the maturity of the youngest ages was revised (see ICES 2001). No revision was done this year.

2.2.5 Groundfish surveys

The spring groundfish surveys in Faroese waters with the research vessel *Magnus Heinason* were initiated in 1983. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the period was shortened by dropping the first cruise and one third of the 1991-stations were used as fixed stations. Since 1993 all stations are fixed stations. The standard abundance estimates is the stratified mean catch per hour in numbers at age calculated using smoothed age/length keys.

The overall mean catch (kg) of cod per unit effort (trawl hour) 1983-2002 is given in Figure 2.2.5.1. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased in 1999 and 2000, but increased again in 2001 and 2002. Normally the stratified mean catch per trawl hour increases for the first 4-5 years of life of a year class, and decreases afterwards. From 1994 to 1995, however, there was an increase for all year classes, possibly because of increased availability. A more normal pattern was observed from 1996-2000. Due to serious uncertainties as to the integrity of the data in the data base, only total kg/hour and information from aged fish were available in the current assessment. The database is being re-constructed, but the work was not completed to the current assessment.

In 1996, a new summer (august-september) groundfish survey was initiated, having 200 fixed stations distributed within the 500 m contour of the Faroe Plateau. Half of the stations were the same as in the spring survey. This series was ready to use in the current assessement, as it got the highest priority in the reconstruction of the database. The overall mean catch (kg) of cod per unit effort (trawl hour) 1996-2001 is shown in Figure 2.2.5.1, and catch curves in Figure 2.2.5.2. The catch curves show that the fish are fully recruited to the survey gear at an age of 3 or 4.

The abundance index was calculated as the stratified mean number of cod at age. The age length key was based on otolith samples pooled for all stations since there seemed to be a homogenious size at age by strata and depth. Due to incomplete otolith samples for the younges age groups, all cod less than 15 cm were considered being 0 years and between 15-34 cm 1 year. Since the age lengt key was the same for all strata, a mean length distribution was calculated by stratum and the overall length distribution was calculated as the mean length distribution for all strata weighted by stratum area. Having this length distribution and the age length key, the number of fish at age per station was calculated, and scaled up to 200 stations.

2.2.6 Stock assessment

2.2.6.1 Tuning and estimates of fishing mortality

The two tuning series used in NWWG 1998, the single trawlers 400-1000 HP and longliners > 100 GRT both with fishing effort measured in days were replaced in NWWG 1999 by two tuning series based on logbook data for five longliners > 100 GRT and eight pair trawlers > 1000 HP. In these series, effort was measured in 1000 hooks for the longliners and trawl hours for the pair trawlers. Both tuning series are shown in Table 2.2.6.1.1 (age disaggregated) and Figure 2.2.6.1.1 (kg/1000 hooks and kg/hour). The two series show very similar trends for most of the years. Effort standardized catch curves are shown in Figure 2.2.6.1.3 (Cuba trawlers) and Figure 2.2.6.1.4 (longliners).

In the longliner series, fishing sets with information on cod catch, effort and fishing location and with catches of tusk and ling together less than 20% of the total catch were selected. In this way only the fishery directed towards cod (and haddock) was used. The longliner series was further scrutinised in NWWG 1999 by looking at the individual CPUEs for each ship. All outliers were caused by either small catch or small effort data. Given that the index is based on the sum of all records, this meant that the outliers had little influence on the overall results and therefore all ships could be used.

In the Cuba trawler series, fishing sets with information on cod catch, effort, and fishing location east of 7 degrees W on the Faroe Plateau were used (in order to standardise). In addition only “saithe hauls” were used, i.e. the catch of saithe was more than 70 %, and the sum of cod- and haddock-catch was less than 30 %. Thus the Cuba series is a bycatch series. The Cuba series was in NWWG 1999 further scrutinised by looking at the individual CPUE for each ship. As for the longliners all ships could be used.

In the current assessment, four XSA runs were considered, 1) same settings as last year, 2) Cuba trawlers only, 3) longliners only, 4) survey only (Fig. 2.2.6.1.9). The diagnostics for the commercial tuning series were poorer than the survey (Figure 2.2.6.1.7). Looking at the results, the longliner tuning series seemed to have an important deficiency, since the catchability was dependent on growth rate of cod (Figure 2.2.6.1.5). This suggests that cod preference for longline bait depends on natural food availability. When choosing between the Cuba trawlers and the survey, the working group had more confidence in the survey even if the time span of the survey (1996-2001) is short. In addition, the indices of the youngest age are thought to be more reliable in the survey than in the commercial fleet. Thus the WG adopted the survey tuning series as the basis for short term predictions. The survey is conducted in a much more systematic way than the Cuba trawler series and is not affected by commercial interests or changes in gear technology or gear operation. In addition the diagnostics for the survey was better compared to the Cuba trawlers. It should be noted that all four XSA runs essentially indicated the same development of the stock.

The results from the retrospective analysis of the XSA (Figure 2.2.6.1.8) show that there is a tendency to overestimate fishing mortality.

The estimated fishing mortalities are shown in Tables 2.2.6.1.3 and 2.2.6.1.5 and Figures 2.2.6.1.10 and 2.2.6.1.11. The average F for age groups 3 to 7 in 2001 is estimated at 0.71, considerably higher than $\mathbf{F}_{max}$ = 0.48. Figure 2.2.6.1.10 shows, that fishing mortalities were underestimated most years in last years assessment.

2.2.6.2 Stock estimates and recruitment

The stock size in numbers is given in Tables 2.2.6.1.4. A summary of the VPA, with recruitment, biomass and fishing mortality estimates is given in Table 2.2.6.1.5 and in Figure 2.2.6.1.11. A comparison between the survey CPUE and biomass of ages 3+ (Figure 2.2.6.2.1) suggests that the spring survey is a reasonable index of 3+ biomass. The stock-recruitment relationship is presented in Figure 2.2.6.2.2.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 20 200 t. It increased sharply to almost 90 000 t in 1996 and 1997 before declining to a level of about 40 000 t in 2000. The 1997 year class was in last years assessment considered to be above average strength, but in the current assessment, it is below average. The 1998 year class seems to be slightly above average strength and the 1999 year class is in the current assessment estimated to be as strong as the highest observed (1982 year class: 47 millions). In fact the RCT3 program (Table 2.2.6.1.6-7) estimated the 1999 year class to be even stronger as did the initial XSA run. The recruits from the 1999 year class were set to 47 millions and thus the fishing mortality of that year class was recalculated as was the stock numbers and biomass at age, spawning numbers and biomass at age, total biomass and spawning biomass, and the yield/SSB ratio.

ACFM recommended last year, that the plus group should be set at 8+ instead of 10+. This was tried but gave much higher estimates of stock size and lower fishing mortalities. The working group was unable to explain these differences but decided that age 9 should be used as the oldest age, and that the plus group should be omitted. Output from the ASPIC model (Table 2.2.6.1.9 and Fig. 2.2.6.1.12-13) give lower estimates of total biomass and fishing mortalities than the current assessment and suggests that the use of the 8+ may not give correct stock estimates.

2.2.7 Predictions of catch and biomass

2.2.7.1 Short-term prediction

In order to estimate the strength of the year classes 1999-2001, the RCT3 program was used. Table 2.2.6.1.6 shows the input values. The catch curve of the 1997 year class is atypical and shows that high numbers were caught at age 1, but much lower than expected at age 2 or 3. Thus, the ages 1 and 2 of this year class were not used in the prediction of the 1999-2001 year classes. The long time span (1963-2001) was used in order to reduce the influence of the poor recruitment in the period 1987-1991 on the VPA mean.

The input data for the short term prediction are given in Table 2.2.7.1.1. The estimate of year classes 2000-2001 was taken from the RCT3 run. The 2002 year class was estimated as the geometric mean for the period 1961-2001. The estimate of the 1999 year class in 2002 (age 3) was obtained by adjusting the number of 2 year old in 2000 for mortality in 2001 (Table 2.2.7.1.1). Estimates of stock size (ages 4+) were taken directly from the VPA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 1999-2001 rescaled to 2001 values. The rescaling was based on the ages 3-7. The weight at age for 2002-2004 was set to the average of the 1999-2001 values. This implies a reduction in the weights compared to 2001. The proportion mature in 2002 was set to the 2002 values from the groundfish survey, and for 2003-2004 to the average values for 2000-2002.

Table 2.2.7.1.2 shows that the landings in 2002 are expected to be 42 000 tonnes if the fishing mortality stays the same as in 2001. The spawning stock biomass is expected increase considerably (from 52 000 t in 2001 to 64 000 t in 2004). The VPA suggest that the 1999 year class is very strong, which also is supported by the age distribution (Figure 2.2.7.1.1) and the increase in survey CPUE (kg/hour) in 2002 (Figure 2.2.6.2.1). The stock size could be even larger if the individual weights remain as high as those observed in 2000-2001. There is, however, the possibility, that longliners could have concentrated the effort on this strong year class, giving too optimistic prediction.

2.2.7.2 Biological reference points

In 1998, ACFM set $\mathbf{B}_{lim}$ equal to the lowest observed SSB, about 21 000 t and proposed that $\mathbf{B}_{pa}$ be set at 40 000 t based on $\mathbf{B}_{pa}$=Blime1$^{.645\,\sigma}$, assuming a σ of about 0.40 to account for the relatively large uncertainties in the assessment. ACFM further proposed that $\mathbf{F}_{pa}$ be set at 0.35, more than twice $\mathbf{F}_{0.1}$, about equal to $\mathbf{F}_{max}$ and $\mathbf{F}_{med}$ and at the low end of the range of previously estimated $\mathbf{F}_{MSY}$, from 0.33 (Stefansson and Bell, WD prepared for the SGPAFM) to 0.56 (NWWG, 1997). In previous years, MBAL was considered to be 52 000 t. Over the period covered by the assessment, fishing mortality has been equal to or less than this proposed $\mathbf{F}_{pa}$ in only 6 of 40 years of available data. This suggest that $\mathbf{F}_{pa}$ = 0.35 may be overly conservative. The updated assessment indicates an $\mathbf{F}_{med}$ = 0.41, $\mathbf{F}_{0.1}$ = 0.27 and $\mathbf{F}_{max}$ = 0.48. $\mathbf{F}_{pa}$ could therefore be set in the order of $\mathbf{F}_{med}$ = 0.41.

Following the logic used to set $\mathbf{B}_{pa}$, $\mathbf{F}_{lim}$ was set at $\mathbf{F}_{lim}$=Fpae1$^{.645\sigma}$, that is, $\mathbf{F}_{lim}$=0.68. Should the $\mathbf{F}_{pa}$ be reviewed, $\mathbf{F}_{lim}$ could be adjusted accordingly.

The stock trajectory with respect to existing reference points is illustrated in Figure 2.2.7.2.1.

2.2.7.3 Medium-term prediction

Medium term 20 years prediction were done in the 2001 assessment (ICES 2001). It was not repeated this year.

2.2.7.4 Long-term prediction

The input data for the yield-per-recruit calculations (long-term predictions) are given in Table 2.2.7.4.1. The exploitation pattern (rescaled to 2001 values) and weight at age were set to the average values for 1961-2001. The proportion mature was set to the average for 1983-2002.

The output from the yield-per-recruit calculations is shown in Table 2.2.7.4.2. and in Figure 2.2.7.4.1. $\mathbf{F}_{0.1}$ was calculated as 0.27 and $\mathbf{F}_{max}$ as 0.48. The present average fishing mortality in 2001 of 0.71 is substantially above $\mathbf{F}_{max}$ and $\mathbf{F}_{med}$ = 0.41 (Figure 2.2.7.2.1).

2.2.8 Management considerations

The management system with individual transferable days introduced in 1996 had as an objective to decrease fishing mortality. The current assessment shows that instead, fishing mortality increased from 0.3 in 1995 to 0.7 in 1996. The WG report for 2000 describes the scope for changes in catchability and how they could account for such increases in fishing mortality and it also reports on an external review of the scientific basis for the initial allocation of fishing days and of the method to calculate probability profiles for expected fishing mortalities given the possible utilisation of the allocated fishing days (Pope 2000).

Given the recent history, however, fishing mortality in future years is expected to be above the proposed $\mathbf{F}_{pa}$ of F = 0.35 unless the number of days are reduced substantially.

For reference purpose, the day allocations are summarised in the text table below.

The number of days allocated to each fleet category are given in the table below:

Gear	Allocation	Optional change
LL<110	8861	There are 8861 days to be shared/chosen to be fished either by longlining (<100), jigging or trawling (<400hp)
ST<400	0	There are 8861 days to be shared/chosen to be fished either by longlining (<100), jigging or trawling (<400hp)
ST400–1000	0	No effort limitation, assumed to catch less than 4 % cod.
ST>1000	0	No effort limitation, assumed to catch less than 4 % cod.
PT>400	6839	
LL>110	2527	
OPEN	22444	
JIGGERS		There are 8861 days to be shared/chosen to be fished either by longlining (<100), jigging or trawling (<400hp)

In addition to the effort control, the fleets are supposed to be constrained to a pre-agreed species composition in the catch as indicated in the table below:

Groups of fleets	Fleet	Cod	Haddock	Saithe	Redfish
		%	%	%	%
Group 1	Single trawlers	4.0	1.75	13.0	90.5
Group 2	Pair trawlers	21.0	10.25	69.0	8.5
Group 3	Longliners > 100 GRT	23.0	28.0		
Group 4	Longliners and jiggers > 15 GRT	31.0	34.5	11.5	0.5
Group 5	Longliners and jiggers < 15 GRT	20.0	23.5	6.0	
Group 6	Others	1.0	2.0	0.5	0.5
		100	100	100	100

These restrictions do not take into account that several of these fleets are in fact involved in a multispecies fishery and that the actual species composition in the water is unlikely to be exactly the same as in catches under the regulation. The percentages are guidelines only and it is not expected they will result in discarding and misreporting. They are therefore unlikely to jeopardise one of the eventual potential benefits of an effort management system, an improvement in the quality of the information collected from the fisheries.

Management systems based on effort controls are expected to lead to overcapitalisation in the fishing fleets because vessel owners will want to maximise the catch they can harvest with the fishing effort allocation they have received. In the medium to long term, this process will lead to increased fishing efficiency of the fleets and it will be necessary to decrease the total number of fishing days available to be allocated in order not to exert excessive fishing mortality. In extreme cases, effort controls can lead to the fishery being open only for a few days per year as was the case for the Pacific halibut fishery a few years ago, and remains the case for some Pacific herring fisheries off the Coast of British Columbia.

In order to constrain fishing mortality within reasonable limits, it will therefore be necessary to adjust the number of days periodically. For this purpose, there is a need for a mechanism to monitor changes in efficiency, and detailed information on the activities of the fleets, on the physical characteristics of the boats and their equipment should therefore be collected. In the case of Faroe Plateau cod, the results of medium term simulations presented in ICES 2001 suggest that fishing mortality should be decreased by 25%.

If the intent of fishery management is to control fishing mortality within some limits, it is important that control be exerted on all fleet components generating fishing mortality. In the Faroes, the main tool to control fishing mortality on cod, haddock and saithe is the effort management system and area closures. Single trawlers larger than 400 HP are limited by fishing area and any possible reduction of fishing days would not affect them. As long as they catch less than

4% cod (as is assumed), the mortality they generate may not be problematic. However, since 1999 they have been allocated cod and haddock quotas, and in theory the additional fishing pressure they generate should be compensated by a reduction in the total number of days allocated to other fleets. Although discarding is not believed to be a serious problem in the Faroes, management by catch quotas provides for incentives for such behavior.

There are clear indications that environmental conditions (food availability) are determining cod production (Steingrund and Gaard, in prep.). When productivity is high, as has been the case in 2000 and 2001, high fishing mortalities may not a problem, but when productivity is low, fishing mortalities may have to be reduced in order to avoid potential stock collapse. Having a lower fishing mortality should not decrease yield over the long run, but the size of the fish had been larger, thus giving possibility to get higher export value for the fish products.

2.2.9 Comment on the assessment

New or changed things compared to last years report: The two tuning series used last year (Cuba trawlers and longliners) were not used in this assessment, but only the groundfish summer survey. The face value of the recruitment of the 1999 year class from the initial XSA run, or the RCT3 estimate, was not used, but the highest observed (1982 year class). Thus corresponding fishing mortality was recalculated as well as the stock numbers and biomass at age, spawning stock numbers and biomass at age, total stock biomass and spawning stock biomass, and the yield/SSB ratio.

The short term prediction (Table 2.2.7.1.2) is very dependent on poorly estimated or assumed year classes. The majority of the predicted biomass in 2003 would come from the 1999-2001 year classes, which are either poorly estimated (1999 year class) or assumed to be of average strength (1999 and 2000 year classes). This is a general problem with predictions where no, or very limited information of year class strength is available.

The most important change compared to last years assessment is the perception of recruitment. In last years assessment the recruitment of the 1997, 1998, and 1999 year classes was estimated at 20, 30, and 15 millions, respectively. In the current assessment the figures are changed to 12, 21 and 47 millions, respectively. These revised figures have changed the short time prediction considerably. Although the SSB trend from this year’s assessment is very close to that from last year’s assessment, the perception of the fishing mortalities in the period 1996-2000 is different because the selection pattern obtained by using the survey in calibration is different from that obtained when using the CPUE series for the Cuba trawlers and the longliners.

Given the high fishing mortality, the perception of recruitment determines the perception of the stock size and future predictions. There are clear indications that environmental factors (food availability) determine cod production and recruitment in the Faroese area (Steingrund and Gaard, in prep.). The 1999 year class, that in current assessment is estimated the highest observed, requires favorable environmental conditions in order to dominate the fishery in the near future. If the environmental conditions should be poor in the coming years, the stock size and catches could be lower than predicted in this report.

2.3 Faroe Bank Cod

2.3.1 Trends in landings and effort

Total nominal landings of the Faroe Bank cod from 1986 to 2001 as officially reported to ICES are given in Table 2.3.1.1 and since 1965 in Figure 2.3.1.1. Landings have been highly irregular from 1965 to the mid 1980s, reflecting the opportunistic nature of the fishery on the Bank, with peak landings exceeding slightly 5 000 t in 1973. The evolution of landings has been smoother since 1987, declining from about 3 500 t in 1987 to only 330 t in 1992 before increasing to 3 600 t in 1997. In 2001, 1 800t were reported from the Faroe Bank. Most of the Faroese catch has been taken by pair trawlers and longliners (Table 2.3.1.2).

The decreasing trend in the cod landings from Faroe Bank lead ACFM in 1990 to advise the Faroese authorities to close the Bank to all fishing. This advice was followed for depths shallower than 200 meters. In 1992 and 1993 longliners and jiggers were allowed to participate in an experimental fishery inside the 200 meter depth contour. For the quota year 1 September 1995 to 31 August 1996 a fixed quota of 1 050 t was set. The new management regime with fishing days was introduced on 1 June 1996 allowing longliners and jiggers to fish inside the 200 m contour. The trawlers are allowed to fish outside the 200 contour.

2.3.2 Stock assessment

Biological samples have been taken from commercial landings since 1974 (the 2001 sampling intensity is shown in the text table below) and from the groundfish survey since 1983. In 2000, an attempt was made to assess the stock using XSA with catch at age for 1992-1999, using the spring groundfish survey as a tuning series (1995-1999) but the WG and ACFM concluded that it could only be taken as indicative due to scarce catch-at-age data. No attempt was made to update the XSA in 2001 nor this year given the poor sampling for age composition particularly for trawl landings. The Working Group considered it unwise to calculate an indicative XSA that could be misleading given the poor sampling of an important gear sector.

Sampling from commercial fleets in 2001 is as follows :

Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2001.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	<100 GRT	2	405	60	0
Longliners	>100 GRT	20	3,891	58	59
Jiggers		2	347	120	120
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	0	0	0	0
Sing. trawlers	>1000 HP	0	0	0	0
Pair trawlers	<1000 HP	1	251	0	0
Total		25	4,836	238	179

The Faroese groundfish surveys cover the Faroe Bank and cod is mainly taken within the 200 m depth contour. The catches of cod per trawl hour in depths shallower than 200 meter are shown in Figure 2.3.2.1. The CPUE was low during 1988 to 1995, varying between 246 and 637 kg/tow since 1996.The 2002 value (443.9) is slightly lower than the 2001 one (537.3)

The length distributions in the 1983-2002 surveys illustrated in Figure 2.3.2.2 show substantially higher numbers in 1996-2002 compared to previous years. They also show, that the 1996 year class is extremely weak, since no fish in the size range 40-65 cm in 1998 (2 years old) are observed. In 1999 and especially in 2001 the proportion of small fish is large compared to other years, indicating good recruitment.

Figure 2.3.2.3 shows a positive correlation between the survey index and the landings in the same year. The relatively high survey index in the spring of 2002 suggests that landings in 2002 could be in the order of 2000 tons or more. The ratio of landings to the survey cpue index provides an exploitation ratio (Figure 2.3.2.4), which can be used as a proxy to relative changes in fishing mortality. The results suggest that fishing mortality has decreased over time and is now close to the lowest observed.

A stock-production model was fitted to landings and the cpue from the survey using ASPIC. The software requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/$\mathbf{B}_{MSY}$ ratio and *q*, catchability coefficients. There was insufficient time to verify the stability of ASPIC to different starting guesses of these parameters, but a retrospective analysis, using progressively shorter time series of data suggest that the results are reasonably stable. The parameter estimates from ASPIC were: MSY = 2672t, $\mathbf{B}_{MSY}$ = 6843t, $\mathbf{F}_{MSY}$ = 0.3905. The 2002 biomass is estimated to be almost twice $\mathbf{B}_{MSY}$ (1.944). However, the resulting estimated fishing mortality rate since 1996 is unrealistically low, and therefore it casts doubts on the other results of ASPIC suggesting that the biomass may be overestimated. The results are presented in table 2.3.2.5 and figures 2.3.2.6, 2.3.2.7 for information.

2.3.2.1 Comment on the assessment

An XSA was attempted in the 2000 assessment but not in the current one. The NWWG concludes that the poor sampling for age composition, particularly for the trawler landings whose catch is not separated into Faroe Bank or Faroe Plateau during the same trips. Therefore, XSA is not considered useful until reliable coverage of the total catch at age can be obtained. Similar to 2001, XSA was not attempted in 2002.The ASPIC general production model shows some promise, but further work is needed before it can be used to provide advice.

2.3.3 Reference points

There are no analytical basis to suggest reference points based on XSA or an accepted general production analysis.

2.3.4 Management considerations

The landing estimates are uncertain because since 1996 vessels are allowed to fish both on the Plateau and on Faroe Bank during the same trip, rendering landings from both areas uncertain. Given the relative size of the two fisheries, this is a bigger problem for Faroe Bank cod than for Faroe Plateau cod, but the magnitude remains unquantified for both. The ability to provide advice depends on the reliability of input data. If the cod landings from Faroe Bank are not known, it is difficult to provide advice on landings. If the fishery management agency intends to manage the two fisheries to protect the productive capacity of each individual unit, then it is necessary to regulate the catch removed from each stock. Simple measures should make it possible to identify if the catch is originating from the Bank or from the Plateau e.g. by storing in different section of the hold.

2.4 Faroe Haddock

2.4.1 Landings and trends in the fishery

Nominal landings of haddock from the Faroe Plateau increased from a low of 10,000 t in 1982 to 14,000 t in 1987, but later decreased drastically to the lowest recorded at about 4,000 t in 1993; a slight increase to about 4,600 t was noted for 1995 but in 1996 and 1997 catches almost doubled each year to about 9,200 t and 16,700 t, respectively. In 1998 landings increased further to more than 19,000 t but decreased again in 1999-2001 to about 14,500 t (Table 2.4.1). Nominal landings for 1982–1992 from the Faroe Bank have varied between 500 and 1,600 t (on average 1,000 t), but dropped in 1993–1996 to 300-500 t. The closure of the fishery on the shallower parts of the Bank in 1990 and the introduction of a controlled fishery there since 1993, as described in Section 2.1, reduced the Faroese landings (Table 2.4.2) whereas Scottish landings remained relatively high in 1990-92. However, in the assessment only the fraction of the Scottish catches which have been reported to the Faroese authorities are included. In 1997 and 1998, landings on the bank increased abruptly to 1,300 and 3,000 t, but declined again to about 1,700t in 2001 and 2002. In some years, minor Faroese catches of haddock are taken in ICES Division IIa close to the boundary with Sub-Division Vb1 (labelled IIa4 in Figure 2.1.15 in ICES C.M., 1997). These catches are believed to be from the Faroe haddock stock and are consequently used in the assessment (Table 2.4.1).

Faroese vessels have taken almost the entire catch in recent years (Figure 2.4.1). Table 2.4.3 shows the Faroese landings since 1985 and the proportion taken by each fleet category. Pair trawlers and longliners took most of the catches in these years and within these two groups the relative importance of the larger vessels has increased. Due to poor catches and poor economic conditions, the effort of most fleets decreased in the early 1990s but from 1995 it has increased again (Table 2.1.4). In addition, the fishing ban on the cod spawning grounds before and during the spawning period of cod since 1992 (Section 2.1) has had a restrictive impact on the haddock fishery as well. The catch rates for most fleets declined drastically after the late 1980s, but from 1995 the CPUE for most fleets has increased considerably with some conflicting signals in recent years (Figure 2.4.9).

The 2001 monthly Faroese landings of haddock by fleet category from Subdivisions Vb1 and Vb2, are shown on Figure 2.4.2. The landings from the Plateau are high from late summer to the end of the spawning time in April and stay low during the summer time. On the Faroe Bank the monthly landings show a similar pattern although the landings in mid winter are small. In 2001, pair trawlers took the majority of the catch on the Faroe Bank followed by the longliners larger than 100 GRT on second place. On the Faroe Plateau the longliner landings are substantial; during the summer months most of the larger longliners fish in deeper waters and/or outside the Faroese EEZ but at this time the proportion taken by the smaller longliners is considerable. From the late 1980s haddock must be characterized as a by-catch only but this has changed for the major fleets since the middle of the 1990s, due to the recruitment of several large year classes.

2.4.2 Catch at age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. Data from the two areas are combined, as the fish are believed to belong to the same stock. The sampling intensity in 2001 is shown in the text table below. Compared to 2000, number of samples and of individual weightings was higher in 2000 whereas the number of age readings and of length measurements was somewhat lower.

No. of samples:	411
No. of length measurements:	61690
No. of individual weight measurements:	3538
No. of aged fish:	6182

Samples from each fleet category were disaggregated by season and then raised by the catch proportions to give the 2000 catch at age in numbers for each fleet (Table 2.4.4). Catches of some minor fleets have been included under the others heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by UK and France trawlers were assumed to have the same age composition as Faroese otter board trawlers larger than 1,000 HP. The Norwegian longliners were assumed to have the same age distribution as the Faroese longliners greater than 100 GRT. The most recent data were revised according to the final catch figures. The resulting total catch at age in numbers is given in Tables 2. 4.4 and 2.4.5 and in Figure 2.4.3 the LN (catch at age in numbers) is shown for the whole period of analytical assessments.

The standard procedure for this stock to include all fish age 10 and older into a plus group was questioned last year by ACFM and the WG. The catch at age was inspected this year in a Separable VPA and although in some years there are some large residuals for the youngest and oldest age groups it was concluded that there were no obvious reason to change the default age range. Moreover, these age groups should be better estimated this year due to a larger age range in the tuning series used in the XSA.

In general the catch at age matrix in recent years appears consistent except for the year class from 1996. The number at age 3 in 1999 is relatively high but at age 4 and older this year class turns out to be small. It was not possible to solve this out except for the fact that most of the catch in 1999 was taken by the smaller longliner fleet below 100 GRT in the last 4 months of the year indicating a possible depletion of local aggregations of 3 years old haddock. This is not the whole explanation since also the mean weight at age for this year class is developing atypical for age 2 and 3; in the summer groundfish survey used for tuning age 3 in 1999 also is unbelievable high. There could therefore be some problems in the age readings and/or calculation of catch at age for this year class possible due to poor sampling and an erroneous smoothing of the ALK. This will be further investigated before the next meeting of the WG but since the year class is a small one this problem will most likely only affect the final assessment to a small degree.

2.4.3 Weight at age

Mean weight-at-age data are provided for the Faroese fishery (Table 2.4.6). Figure 2.4.4 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. After a decrease from a high level in the middle of the 1990s for all age groups in the most recent years, the weights have increased again for all ages except for the youngest ages.

2.4.4 Maturity at age

Maturity-at-age data were available from the Faroese Spring Groundfish Surveys 1982–2002. The surveys are carried out in February-March, so the maturity at age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages should be relatively easy. In order to reduce eventual year-to-year effects due to possible inadequate sampling and at the same time allow for trends in the series, a 3-year running average has been used by the WG in the assessment. For the years prior to 1982, average maturity at age from the surveys 1982–1995 was adopted (Table 2.4.7 and Figure 2.4.5).

2.4.5 Assessment

2.4.5.1 Tuning and estimates of fishing mortality

Although several commercial catch per unit effort series are available, only two commercial series (see below) were used for tuning of the assessments in 2000 and 2001. Two annual groundfish surveys are conducted in Vb1, one carried out in February-March since 1982 (100 stations per year down to 500 m depth), and the other in August-September since 1996 (200 stations per year down to 500 m depth). Due to problems with the database, it has not been possible to update the survey indices (stratified mean number at age) since 1999 and a major revision of the data in the database prior to 1999 is necessary before the existing data can be relied upon. This work is ongoing and has been given a very high priority since the last WG meeting. But since this is a very demanding work only the short summer survey series is available this year (see under section 2.2). However, biomass estimates (kg/hour) are available for both series. It is expected that the spring survey series back to 1994will be available for next years assessment; before 1994 the technical equipment was very different from now both regarding sampling and recordings of data onboard the research vessel and regarding format of data files and database making the revision of the earliest data difficult. Since lack of reliable survey indices has a major impact on the estimation of recent and future recruiting year classes which again deteriorates the current estimate of stock status and the short term predictions, it is regarded as a major step forward that the summer survey now is available.

In tuning of this stock it has been standard to combine all available series in one tuning files. Recently it has been brought up that this is not a wise thing to do, and in general the use of commercial cpue series has been questioned (see f.ex. Section 2.4.9). Therefore the WG decided to make several runs using different combinations of series and with each series separately. Also different shrinkages were applied. Retrospective runs for many of these exercises are shown in Figure 2.4.6, and ranges of results are given below in the text as well as in Table 2.4.8 and in Figure 2.4.7. Since the main difference the runs is the recruitment estimates, the WG decided to present detailed XSA diagnostics and VPA results from the run with the summer survey only using catchability independent of stock size for all ages (in recent years this has been dependent on stock size for ages younger than 3) and a shrinkage of 2.0 as has been usual for this stock in recent years (except last year when shrinkage was set at0.5) (Table 2.4.10). Figure 2.4.8 shows the log catchability residuals for ages 2-8; age 9 was very noisy and left out. Age 1 was included in the tuning although it is not in the commercial catch at age matrix. The importance of this survey as indicator of stock abundance at age is reflected in Figure 2.4.8B, where the LN (stratified mean catch at age in numbers) for all year classes in the series is shown.

The two commercial series used for tuning of last years VPA (and which have been used this year in evaluations of the performance of the summer survey) consist of a longliner series consisting of the logbook data from 5 selected longliners larger than 100 GRT (directed effort measured as number of hooks) and a trawler series consisting of logbook data (catch at age in numbers and corresponding effort in number of trawl hours) from a homogenous group of pair trawlers larger than 1 000 HP which have been engaged in a mixed saithe, cod and haddock fishery since the middle of the 1980s (Table 2.4.9). Basically the series are the same as used last year (updated), and descriptions and analysis of them have been given in former reports of this WG and will not be repeated here.

Plots of age aggregated cpue’s (kg/hour) for the two commercial series and for the two surveys are given in Figures 2.4.9A and 2.4 9B showing some conflicts in recent years. The two survey series are however very consistent.

The fishing mortalities from the final XSA run are given in Table 2.4.11 and in Figure 2.4.10. According to this the fishing mortality has shown an overall decline since the early 1960s and it has been estimated to be below or at the natural mortality of 0.2 in several years from the late 1970s. Since 1993 it has been increasing again and in 1998 and 1999 it was estimated above 0.5, but decreased in 2000 and 2001 to 0.32 and 0.38, respectively. In comparisons all the runs with different fleets and different shrinkages gave fishing mortalities in the range of 0.3 to 0.5 (Table 2.4.8)

2.4.5.2 Stock estimates and recruitment

Compared to recent assessments, last years assessment changed the perception of stock size (and fishing mortality) considerably; this year’s assessment is consistent with the view presented in the 2001 assessment. The stock size in numbers is given in Table 2.4.11 and a summary of the “VPA” with the biomass estimates is given in Table 2.4.13 and Figure 2.4.810. According to this assessment, the spawning stock biomass decreased from 66 000 t in 1987 to 22 000 t in 1994, increased to 85 000 t in 1997 but have since decreased to about 53 000 t in 2000. In 2001 it increased again to 58 000 t. The decline in the spawning stock began in the late 1970s due to very poor recruitment in those years. The stabilization at relatively high SSB’s in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since then was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights at age in the stock. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the outstandingly large 1993 year class and the well above average 1994 year class. The most recent increase in the spawning stock is due to new strong year classes entering the fishery. Last year there were considerable doubts about the sizes of these incoming year classes, especially the 1998 year class, which came out very high from the XSA. Due to the lack of reliable recruitment indices it was decided to replace it with the geometric mean of the 1980-2000 recruitments at age 2. This years XSA shows that this decision was rather conservative but it also gives a very high estimate for the most recent year class at age 2, i.e. the 1999 year class. Since recruitment indices now are available from the summer survey, it was decided to use them in a Rct3-analysis to come up with another estimate of this year class. Although the summer series is very short (6 years), the correlation between it and the converged VPA was high, and it was decided to use the point value from the Rct3 (Table 2.4.11-13) in stead of the XSA value; the number at age 2 in 2001 was therefore reduced from above 90 millions to 44 millions. All other values in this year (Total biomass, Spawning stock biomass, fishing mortality, Y/SSB) were adjusted accordingly (Tables 2.4.11-13). In comparison, all the different runs presented in Table 2.4.8 gives the range 47-120 millions for this year class at age 2. The present approach could therefore seem to be rather conservative but seems more reliable than the one last year.

2.4.6 Prediction of catch and biomass

2.4.6.1 Input data

2.4.6.1.1 Short-term prediction

The input data for the short-term predictions are given in Table 2.4.14-15. The year classes up to 1998 inclusive are from the final VPA, the 1999-2000 year classes at age 2 are estimated using Rct3 and the 2001-2002 year classes are the geometric mean of the 2 year olds in 1980-2002. Age 3 in 2002 is estimated from the Rct3 age 2 value and calculated forward using standard XSA equations. Input to and result of the Rct 3 analysis are given in Tables 2.4.16-17.

The exploitation pattern used in the prediction was derived from averaging the 1999–2001 fishing mortality matrices from the final VPA and then rescaling the averages to 2001. Since the smallest on record year class from 1991 comes out from the VPA with very high fishing mortalities at age 6 and 7 and this will have a large impact on prediction of future biomasses and catches, this year class was omitted from the averaging. The same exploitation pattern was used for all three years.

The mean weight at age for ages 2-10 in 2002 was calculated as the average weight at age in 1999-2001. Inspecting the growth of the different year classes it was decided to replace the value for age 6 in 2002 with the value for age 6 in 2001. The 2002 mean weights at age were also applied for 2002 and 2003. The same weights at age were used for the catch and for the stock as was done in the assessment.

The maturity ogives for 2002-2004 are based on samples from the Faroese Groundfish Spring Surveys and estimated as the average of the smoothed 2000-2002 values.

2.4.6.1.2 Long-term Prediction

The input data for the long-term yield and spawning stock biomass (yield per recruit calculations) are listed in Table 2.4.18. Mean weights-at-age (stock and catch) are averages for the 1977–2001 period. The maturity ogives are averages for the years 1982-2001. The exploitation pattern was derived from the fishing mortality matrix from the final VPA as average F-values for the long time period, rescaled to the 2001 F_{bar} (age3-7).

2.4.6.2 Biological reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 2.4.18 and Figure 2.4.10. F_{max} and $F_{0.1}$ are indicated here as 0.51 and 0.19, respectively. From Figure 2.4.11, showing the recruit/spawning stock relationship, and from Table 2.4.19, F_{low}, F_{med} and F_{high} were calculated to be 0.05, 0.24 and 0.81, respectively.

In previous assessments of this stock the Minimum Biological Acceptable Limit (MBAL) was set at 40 000 t because the occurrence of good recruitment is considerably higher when the spawning stock biomass is above this value (Figure 2.4.11). Therefore, this is an appropriate value for a limit reference point and thus, B_{lim} is set by ACFM at 40 000 t. In the 1998 assessment, the B_{pa} was calculated as the value lying 2 standard deviations above B_{lim}, that is 65 000 t. By examining among other things the SSB-R plot, ACFM instead proposed B_{pa} = 55 000 t. The reference point F_{pa} was proposed by ACFM as the F_{med} value 0.25. The F_{lim} is defined to be two standard deviations above F_{pa} and was set by ACFM at 0.40. By inspecting the VPA results for the whole series, the NWWG felt this proposal to make sense, as the recruitment in the last two decades has been very low with occasional big year classes. However, if recruitment returns to the levels seen in the 1960s and 1970s, when the stock apparently could withstand high fishing mortalities, this proposal might be too conservative, and there are some indications of such a trend.

The history of the haddock fishery in relation to the four reference points can be seen in Figure 2.4.12. In the period 1961-69 the fishing mortality was above F_{lim} and the spawning stock biomass was below B_{pa}. Then the fishing mortality decreased and the stock biomass increased resulting in the stock/fishery was within or close to biological safe limits in most of the 1970s and 1980s. In 1989 the stock went below Bpa and continued to decrease below B_{lim} in 1991. This decrease in SSB continued until the lowest observed SSB was reached in 1994. The biomass has since increased, mainly due to the outstanding high 1993 year class and the well above long term average 1994 year class and has since been above or close to. The fishing mortality has however been above F_{pa} since 1996, was even above F_{lim} in 1998 and 1999 and is now estimated just below Flim.

2.4.6.3 Projections of catch and biomass

2.4.6.3.1 Short-term prediction

In the light of the performance of the new management system, it is not unrealistic to assume the same fishing mortalities in 2002 as in 2001 because the fleet is the same and so is the number of fishing days per fleet. The catch in 2002 is then predicted to be about 21 000 t and continuing with this fishing mortality will result in a 2003 catch of 18 000 t. The SSB will in this case decrease from 63 000 t in 2002 to 57 000 t in 2003, and 50 000 t in 2004. The results of the short-term prediction are shown in Table 2.4.20. This prediction should be interpreted cautiously given the apparent poor estimation of recruitment and the changes in estimations of recent terminal fishing mortalities. If stock size and landings in 2000 (and 2001) are compared, the predicted 2002 landings seem too high.

The overall cpue from the survey supports the development of the SSB in recent years (Figure 2.4.9). However, this series is more optimistic regarding the two latest years than the current assessment.

2.4.7 Medium term projections

Medium term projections were made last year and not repeated in this assessment.

2.4.8 Managements considerations

Stock and yield are highly variable due to fluctuations in recruitment, especially when fishing mortality is high. Although the stock with present favorable environmental conditions appears to be able to produce enough recruits to stay above B_{pa} this is not expected to sustain with fishing mortality continuously above the F_{pa}; from the short term prediction this year the stock is predicted to decrease below B_{pa} in the short term .In order to gain yield in the long term and to stabilize yield, fishing mortality should be lowered from recent high levels to below F_{pa}; juvenile and young fish area closures should be introduced for all gears capable of catching these fishes.

2.4.9 Comments on the assessment

This year assessment indices from commercial fleets were not used for tuning of the VPA. This decision was based on retrospective patterns statistic diagnostics from the XSA and the fact that these series do not have good information on some ages, especially the youngest. Also the results from the working group on Icelandic cod in autumn 2000 and a recent study by Guðmundsson and Jónsson (Working document no. 31) revealing marked trend in catchabilty in cpue series from commercial fleets were taking into account. Indices from commercial fleets are still very valuable even if they are not used directly for tuning of the VPA and they are as such an important source of information on the state of the stock. They gave the same main message in the assessment as the survey but in a situation where they would show opposite trends it would demand thorough investigation of both the survey and the cpue indices.

Even if the summer survey series is very short it gives very valuable information on recruitment and those the present assessment is thought to be more reliable than in recent years. However, for comparison many results and retrospective patterns are presented in the report from runs with other fleets and different fleet combinations.The Aspic software was applied on this stock using the yearly kg/tow from both surveys as indices of stock size (Table 2.4.13). The results are comparable to the accepted VPA.

Compared to the predicted values last year regarding recruitment, exploitable biomass (ag2+), spawning stock biomass and fishing mortality for 2001, this years estimate for 2001 of recruitment is 366% higher, exploitable biomass is 162% higher, spawning stock biomass is 142% and fishing mortality 20% lower.The main reason for these discrepancies is the poor estimation of recruitment to this stock. The use of the new summer survey series in the tuning of the VPA and in prediction of future recruitment has – even if it is very short – is believed to make this years assessment and predictions more reliable. When some more years are added to the summer survey series and when the spring survey will be available the consistency of the stock assessments between years is expected to improve considerably.

2.5 Faroe Saithe

2.5.1 Landings and trends in the fishery

Nominal landings of saithe from the Faroese grounds (Division Vb) have been highly variable since 1960 ranging from 10 000 t to 60 000 t over that period. In 1990 record high landings of about 60 000 t were taken. Thereafter landings declined steadily to 20 000 t in 1996. Since then landings have increased to 39 000 t in 2000 and to 51 800 tonnes in 2001 (Table 2.5.1.1, Figure 2.5.1.1).

With the introduction of the 200 miles EEZ in 1977, saithe has mainly been fished by Faroese vessels. The principal fleet consists of large pair trawlers (>1000 HP), which have a directed fishery for saithe, accounting for about 60% of the reported landings in 1993-2001 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) have a more mixed fishery and they account for about 20% of the total landings of saithe in 1993-2001. During the last decade the proportion of saithe in the catches has generally increased for larger pair trawlers and larger single trawlers (>1000 HP) but decreased for the smaller pair trawlers and jiggers. Other vessels only have small catches of saithe as by-catch.

The CPUE derived from the Cuba pair trawlers, with effort in hours fished, is not affected by the problem with fishing days because the effort comes from logbooks rather than from the landing slips and also because of direct contact with captains of the boats involved. The effort for Cuba Beta pair trawlers, witch is used as tuning fleet, increased by about 5% in 2001.

Catches used in the assessment are presented in Table 2.5.1.1. These include foreign catches that have been reported to the Faroese Authorities but not officially reported to ICES. Catches in that part of Subdivision IIa which lies immediately north of the Faroes have also been included.

2.5.2 Catch at age

Catch at age is based on length and otolith samples from Faroese landings of jiggers, small and large single and pair trawlers, and landing statistic by fleet provided by the Faroese Authorities. Catch at age was calculated for each fleet by four-month periods, before the numbers were combined. Catch at age was thereafter raised by the foreign catches. The catch-at-age data for previous years were also revised according to the final catch statistics (Tables 2.5.2.1 and 2.5.2.2). The sampling intensity in 2001 was similar to that in 2000:

Fleet	***Samples***	***Lengths***	***Otoliths***	***Weights***
Jiggers	8	1608	180	180
Single trawlers 1000 – 1499 HP	2	374	60	60
Single trawlers 1500 - 1999 HP	8	1430	300	300
Single trawlers > 2000 HP	10	2134	90	60
Pair trawlers 400 – 699 HP	2	396	60	60
Pair trawlers 700 – 999 HP	21	4737	420	360
Pair trawlers 1000 – 1499 HP	128	27104	3237	3177
Total	**179**	**37783**	**4347**	**4197**

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2001. For example, the mean weights at age 5 varied between about 1.6 kg and 3.3 kg while at age 7 it varied between 2.6 kg and 5.3 kg (Table 2.5.3.1 and Figure 2.5.3.1). Mean weights at age were generally high during 1980-86 and dropped in the period 1987-1991. The mean weights increased again in the period 1992-96 but have shown a general decreased since. The SOP for 2001 was 100%.

2.5.4 Maturity at age

Maturity at age data is available from 1983 onward. Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. A model was used, described in the 1993 Working Group report (ICES C.M.1993/Assess:18), for predicting maturity at age in order to alleviate some of the problems involved with the sampling data. The basic model used was a GLM with a Logit link function describing maturity at age as a function of age, year class strength, mean weight at age and a year effect. This model was applied to predict the entire maturity at age for 1983-2001 (Table 2.5.4.1 and Figure 2.5.4.1).

2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

The results of a summer survey initiated in 1996 were investigated as a possible index of stock size to calibrate XSA. The survey showed relatively good internal consistency up to age 10 vs age 11. Total mortality estimates (5+/6+, 6+/7+, 7+/8+) all showed very low total mortality over the period 1998 to 2001 suggesting that availability to the survey may have increased during that time. Survey population estimates at age 3, 4 and 5 were particularly large.

Various settings were investigated in the XSA, but using the default with ages 3 to 9 was presented for discussion. The standard errors of the log q residuals were high for ages 5 to 9, there was a marked trend in residuals and the Working Group concluded that the survey results used could not be considered a reliable index of stock size at this time. Reliable survey results would be particularly useful to estimate recruitment and the Working Group recommends that the survey data be further investigated, e.g. by excluding particularly large sets from the calculation of population estimates.

One tuning series has been used in the XSA since 2000. The series was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the Cuba Logbook series. The series extends back to 1985 and consists of data from 8 pair trawlers greater than 1000 HP (Cuba trawlers) which specialize in fishing on saithe and account for 5 000-8 000 t of saithe each year. In the Cuba Logbook series, information for each haul was supplied and only those hauls where saithe contributed more than 50% of the total catches of cod, haddock and saithe were used (Table 2.5.5.1).

The final XSA run in the current assessment was made with the same parameters as in 2001. The CPUE series used are shown in table 2.5.5.1. The XSA diagnostics are in Table 2.5.5.2 and the output from the XSA is presented in Tables 2.5.5.3-5. The values of S.E. (log q) are high, but for the principal year classes they appear reasonable. The log catchability residuals from the XSA tuning for age groups 3 and 5-11 (Figure 2.5.5.1) show more negative values in the first eight years than in the last nine years of the 17 years time series.

Retrospective analysis of the average fishing mortality for age groups 4-8 years (Figure 2.5.5.2) shows a tendency to overestimate F. This implies that biomass was correspondingly underestimated (Figure 2.5.5.3).

The fishing mortalities for 1961-2001 are presented in Table 2.5.5.3 and in Figure 2.5.5.4. The average fishing mortality for age groups 4-8 was 0.36 in 2001.

2.5.5.2 Stock estimates and recruitment

Recruitment in the 1980s was above or close to average (28 millions). The strongest year class since 1986 was produced in the 1990s and the average for that decade is about 39 million (Figure 2.5.5.5). Even though recruitment had been above average in the 1960s and 1970s, SSB declined from nearly 112 000 t in 1985 to 71 000 t in 1991 as a result of high fishing mortality yielding the highest (1990) and third highest (1996) landings of the whole 1961-2001 period. The historically low SSB persisted in 1992-1995 (Table 2.5.5.5 and Figure 2.5.5.6). The SSB has increased since 1996 with the maturation of the 1992, 1994 and 1996 year classes. SSB was estimated to be 137 000 t in 2001, which is an increase of 13 000 t compared to 2000, and well above the average SSB (94 000 t) in the 1980s. The relation between stock and recruitment is showed in Figure 2.5.5.7.

2.5.6 Prediction of catch and biomass

2.5.6.1 Input data

Input data for prediction with management options are presented in Table 2.5.6.1 and input data for the yield per recruit calculations are given in Table 2.5.6.2.

The size of the 1996 and 1998 year classes from the calibration were both higher than the highest observed. Both the survey and the commercial cpues indicate that these year classes are very abundant. Their sizes were reset to approximately the highest observed (1983 year class at age 3 in 1986 = 61 000) and the fishing mortality in 2001 on those year classes was adjusted accordingly.

Population numbers for the short term prediction up to the 1998 year class are from the final VPA run whereas values for the 1999-2001 year classes are the geometric mean of the 1977 to 1998 year classes. Mean weights for the stock and for the catches are the same for 2002-2004, the arithmetic mean for 1999-2001. In the long term prediction (yield per recruit) mean weights for 1961-2001 were used.

In the short term prediction the fitted proportion mature values from the model for 2002 were used for that year and for 2003 and 2004 the average of fitted values for 2000-2002 was used. In the long term prediction the average of fitted values for 1983-2002 was used.

For all three years in the short term prediction the average exploitation pattern in the final VPA for 1999-2001, rescaled to Fbar (ages 4-8) in 2001, was used. In the long term prediction the exploitation pattern was set equal to the average of exploitation patterns for 1961-2001.

2.5.6.2 Biological reference points

Yield per recruit and spawning stock biomass per recruit curves are presented in Figure 2.5.6.1. Compared to the 2001 average fishing mortality of 0.38 in age groups 4-8, $\mathbf{F}_{max}$ is 0.42, $\mathbf{F}_{0.1}$ is 0.16 , $\mathbf{F}_{med}$ is 0.35 and $\mathbf{F}_{high}$ is 0.82 (Table 2.5.6.3, Figure 2.5.6.1 and Figure 2.5.6.2).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 4-8	Yield/R	SSB/R
Average Current	0.378	1.499	3.439
$\mathbf{F}_{max}$	0.422	1.501	3.091
$\mathbf{F}_{0.1}$	0.161	1.337	7.106
$\mathbf{F}_{med}$	0.346	1.495	3.739

ACFM set $\mathbf{F}_{lim}$ = 0.40 and $\mathbf{F}_{pa}$ = 0.28 (May 1998), and $\mathbf{B}_{lim}$ = 60 000 t and $\mathbf{B}_{pa}$ = 85 000 t (May 1999). The current assessment (Table 2.5.5.5 and Figure 2.5.5.4) shows that fishing mortality has averaged 0.32 over the time period, that F has been above $\mathbf{F}_{lim}$ in 12 out of 41 years (29%) and consistently above $\mathbf{F}_{pa}$ since the early 1980s. There does appear, however, to have some relationship between fishing mortality and SSB with lower SSBs associated with higher fishing mortality (Figure 2.5.6.3). When fishing mortality and SSB are plotted versus time (Figure 2.5.5.4 and 2.5.5.6), initially, both F and SSB increase at the same time. SSB peaks in 1972 and subsequently decreases until 1981 while fishing mortality continues to increase. The brief increase in SSB in the early 1980s occurred at F in the order of 0.40. The 1983 to 1985 year classes were all relatively strong. Yet they did not result in substantial increases in SSB, because of high fishing mortality. Medium term simulations done during the 2001 NWWG meeting showed either stable SSB or slightly decreasing SSBs at F status quo (0.41) with a negligible probability that SSB would fall below $\mathbf{B}_{lim}$. Therefore, fishing mortalities in the order of 0.40 do not appear associated with a high probability of stock collapse. Given the history of the stock and the possible influence of changes in productivity on Faroese stocks, the average fishing mortality over the time period (F = 0.32) could be considered as an appropriate $\mathbf{F}_{pa}$, with $\mathbf{F}_{lim}$ derived using the usual formula of $\mathbf{F}_{lim}$ = Fpae1$^{.645xs}$ where s could be 0.30, implying $\mathbf{F}_{lim}$ = 0.53.

The stock and recruitment relationship for Faroe saithe (Figure 2.5.5.7) shows a pattern somewhere in-between types 2a and 3a identified by the SGPA, i.e. generally increasing recruitment as SSB decreases with some smaller recruitment at the lowest SSB. Given this pattern, it is not possible to identify with any certainty the SSB below which recruitment becomes impaired. Using the lowest SSB as $\mathbf{B}_{lim}$ would probably be overly conservative while using it as $\mathbf{B}_{pa}$ may be somewhat risky. Given the difficulties in identifying the biomass where recruitment becomes impaired, the equilibrium SSB corresponding to $\mathbf{F}_{pa}$ above could be used as $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$ could be calculated using the usual formula $\mathbf{B}_{lim}$ = Bpae1$^{.645xs}$ where s could be 0.30.

Although the WG recognises that the existing biological reference points are not appropriate, there was insufficient time to do the complete set of analyses necessary to make firm proposals for new reference points. In addition, given the management regime in effect in the Faroese demersal fisheries, the reference points for the three main species, cod, haddock and saithe, should be re-evaluated at the same time. Until more appropriate reference points are identified and adopted, the existing ones could continue to be used, albeit with some flexibility in the formulation of management advice.

The history of the stock/fishery in relation to the four reference points can be seen in Figure 2.5.6.3.

2.5.6.3 Projection of catch and biomass

Results from predictions with management option are presented in Table 2.5.6.4 and Figure 2.5.6.1. Catches at status quo F would be 54 000 t in 2002 and 57 000 t in 2003. The spawning stock biomass would increase from 141 000 t in 2002 to 144 000 t in 2003, substantially above $\mathbf{B}_{pa}$ in both years.

Results from the yield per recruit estimates are shown in Table 2.5.6.3 and Figure 2.5.6.1.

A projection of catch in number by year classes in 2002 and weight composition in SSB by year classes in 2003 is presented in Figure 2.5.6.4. The catch in 2002 is predicted to rely on the three most recent year classes (76%) that all may be poorly estimated. In 2003 the 1996 and 1997 year classes are expected to contribute almost half the SSB. This may be a reminder that one has to be cautious regarding the reliability of the short term prediction, because of the uncertain estimate of the 1997 and 1998 year classes.

2.5.7 Management considerations

The spawning stock biomass has increased to above $\mathbf{B}_{pa}$ and is expected to remain above $\mathbf{B}_{pa}$ at status quo fishing mortality, due to good recruitment in the short term.

2.5.8 Comments on the assessment

The XSA settings and tuning fleets are the same as last year.

There still is no independent recruitment index to predict recruits in the first year in the short term prediction. Attempts have been made to establish a programme for echo sounding and biological sampling of age group 0-2. However this needs to be developed further and consequently no results are available at this stage. It has been suggested by NWWG that an attempt should be tried to analyse the correlation between survey index and stock in number from VPA, principally ages 2 and 3.

The question of migration has been brought up previously. Although tagging data indicates that saithe migrate between management areas, and some indications are seen in the assessment as well, no attempts have been made to quantify the migration rate of saithe. An analysis of saithe otoliths using otolith elemental fingerprinting (OEF) between management areas in the North Atlantic is initiated by Iceland, which hopefully will add valuables information of saithe stocks in the north Atlantic and migrations between management units.

The 2002 assessment has been calibrated in a way very similar to the 2001 assessment. The results indicate that biomass is higher than was estimated in the 2001 assessment (2001 SSB = 125 000t compared with 89 000t) and that fishing mortality is lower. In the 2001 assessment, recent year classes were assumed to be equal to a geometric mean of recent year classes. In the 2002 assessment, the estimates from the XSA calibration, adjusted down to the highest previously observed, were used.

Table 2.2.1.1 Faroe Plateau (Subdivision VB1) COD. Nominal landings (tonnes) by countries, 1986-2001, as officially reported to ICES.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	8	30	10	-	-	-	-	-	-	-	-	-	-
Faroe Islands	34,492	21,303	22,272	20,535	12,232	8,203	5,938	5,744	8,724	19,079	39,406	33,556	23,308
France	4	17	17	-	-	- [1]	3 [2]	1 [2]	-	2 [2]	1 [2]	-	- [*]
Germany	8	12	5	7	24	16	12	+	2 [2]	2	+	+	-
Norway	83	21	163	285	124	89	39	57	36	38	507	410	405
Greenland	-	-	-	-	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	8	-	-	-	1	74	186	56	43	126	61 [2]	27 [2]
UK (Scotland)	-	-	-	-	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	34,595	21,391	22,467	20,827	12,380	8,309	6,066	5,988	8,818	19,164	40,040	34,027	23,740

	1999	2000	2001 [*]
Denmark	-		
Faroe Islands	19,156		
France [1)]	- [*]		
Germany	39	2	9 [2]
Norway	450	374 [*]	544
Greenland			
UK (Engl. and Wales)	51 [2]	18 [2]	
UK (Scotland)	-		
United Kingdom			338 [2]
Total	19,696	394	891

[*] Preliminary
[1)] Included in Vb2.
[2)] Reported as Vb.

Table 2.2.1.2 Faroe Plateau (Subdivision VB1) COD. Nominal catch (tonnes) 1986-2000, as used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Officially reported	34,595	21,391	22,467	20,827	12,380	8,309	6,066	5,988	8,818	19,164	40,040	34,027	23,740
Faroese catches in IIA within Faroe area jurisdiction			715	1,229	1,090	351	154						
Expected misreporting/discard										3330			
French catches as reported to Faroese authorities				12	17								
Catches reported as Vb2:													
UK (E/W/NI)					-	-	+	1	1	-	-	-	-
UK (Scotland)					205	90	176	118	227	551	382	277	265
Used in the assessment	34,595	21,391	23,182	22,068	13,487	8,750	6,396	6,107	9,046	23,045	40,422	34,304	24,005

	1999	2000	2001 [*]
Officially reported	19,696	394	891
Faroese catches in Vb1		21,793 [*]	28,099 [*]
Expected misreporting/discard			
Catches reported as Vb2:			
UK (E/W/NI)	-	-	-
UK (Scotland)	210	245	-
Used in the assessment	19,906	22,432	28,990

[*)] Preliminary

Table 2.2.1.3 Faroe Plateau (sub-division Vb1) COD. The landings of faroese fleets (in percents) of total catch.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Total Round.weig
1986	9.5	15.1	5.1	1.3	2.9	6.2	8.5	29.6	14.9	5.1	0.4	1.3	34,492
1987	9.9	14.8	6.2	0.5	2.9	6.7	8.0	26.0	14.5	9.9	0.5	0.1	21,303
1988	2.6	13.8	4.9	2.6	7.5	7.4	6.8	25.3	15.6	12.7	0.6	0.2	22,272
1989	4.4	29.0	5.7	3.2	9.3	5.7	5.5	10.5	8.3	17.7	0.7	0.0	20,535
1990	3.9	35.5	4.8	1.4	8.2	3.7	4.3	7.1	10.5	19.6	0.6	0.2	12,232
1991	4.3	31.6	7.1	2.0	8.0	3.4	4.7	8.3	12.9	17.2	0.6	0.1	8,203
1992	2.6	26.0	6.9	0.0	7.0	2.2	3.6	12.0	20.8	13.4	5.0	0.4	5,938
1993	2.2	16.0	15.4	0.0	9.0	4.1	3.6	14.2	21.7	12.6	0.8	0.4	5,744
1994	3.1	13.4	9.6	0.5	19.2	2.7	5.3	8.3	23.7	13.7	0.5	0.1	8,724
1995	4.2	17.9	6.5	0.3	24.9	4.1	4.7	6.4	12.3	18.5	0.1	0.0	19,079
1996	4.0	19.0	4.0	0.0	20.0	3.0	2.0	8.0	19.0	21.0	0.0	0.0	39,406
1997	3.1	28.4	4.4	0.5	9.8	5.1	2.9	4.8	11.3	29.7	0.0	0.1	33,556
1998	2.4	31.2	6.0	1.3	6.5	6.3	5.5	3.1	8.6	29.1	0.1	0.0	23,308
1999	2.7	24.0	5.4	2.3	5.4	5.2	11.8	6.4	14.5	21.9	0.4	0.1	19,156
2000	2.3	19.3	9.1	0.9	10.5	9.6	12.7	5.7	13.9	15.7	0.1	0.1	21,793
2001	3.7	28.3	7.4	0.2	15.6	6.4	6.4	5.2	9.2	17.8	0.0	0.0	28,099

Table 2.2.2.1 Faroe Plateau COD. Catch in numbers at age for each fleet in 2000. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats	LL < 100 G	Gill netters	Jiggers	ST 0-399H	ST 400-10(	ST > 1000	PT < 1000	PT > 1000	LL > 100 G	Others	Foreign	Catch-at-age
2	231	1643	5	665	95	135	81	100	168	758	0	142	4024
3	165	1000	6	539	308	298	206	297	393	549	0	104	3867
4	95	617	2	363	203	161	96	116	163	289	0	55	2161
5	19	102	0	77	35	22	21	16	33	45	0	8	378
6	6	125	0	71	42	23	15	7	18	59	0	11	377
7	21	243	0	138	39	29	34	14	46	149	0	28	739
8	13	152	1	57	18	12	33	7	21	114	0	21	449
9	0	6	0	11	0	0	2	0	1	15	0	3	37
10+	0	0	0	0	0	0	1	0	0	4	0	0	5
Sum	550	3888	14	1921	740	680	489	557	843	1982	0	372	12037
Round.wei(	1026	7955	47	4376	2074	1807	1786	1450	2584	5001	1	891	28990

Others include industrial bottom trawlers and longlining for Atlantic salmon and halibut.

Table 2.2.2.2 Faroe Plateau COD. Catch in numbers at age 1961-2001.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND18
At 6/05/2002 10:36

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

YEAR,	1961,
AGE	
2,	3093,
3,	2686,
4,	1331,
5,	1066,
6,	232,
7,	372,
8,	78,
9,	29,
0 TOTALNUM,	8887,
TONSLAND,	21598,
SOPCOF %,	91,

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	4424,	4110,	2033,	852,	1337,	1609,	1529,	878,	402,	328,
3,	2500,	3958,	3021,	3230,	970,	2690,	3322,	3106,	1163,	757,
4,	1255,	1280,	2300,	2564,	2080,	860,	2663,	3300,	2172,	821,
5,	855,	662,	630,	1416,	1339,	1706,	945,	1538,	1685,	1287,
6,	481,	284,	350,	363,	606,	847,	1226,	477,	752,	1451,
7,	93,	204,	158,	155,	197,	309,	452,	713,	244,	510,
8,	94,	48,	79,	48,	104,	64,	105,	203,	300,	114,
9,	22,	30,	41,	63,	33,	27,	11,	92,	44,	179,
0 TOTALNUM,	9724,	10576,	8612,	8691,	6666,	8112,	10253,	10307,	6762,	5447,
TONSLAND,	20967,	22215,	21078,	24212,	20418,	23562,	29930,	32371,	24183,	23010,
SOPCOF %,	94,	96,	98,	113,	109,	102,	106,	109,	99,	123,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	875,	723,	2161,	2584,	1497,	425,	555,	575,	1129,	646,
3,	1176,	3124,	1266,	5689,	4158,	3282,	1219,	1732,	2263,	4137,
4,	810,	1590,	1811,	2157,	3799,	6844,	2643,	1673,	1461,	1981,
5,	596,	707,	934,	2211,	1380,	3718,	3216,	1601,	895,	947,
6,	1021,	384,	563,	813,	1427,	788,	1041,	1906,	807,	582,
7,	596,	312,	452,	295,	617,	1160,	268,	493,	832,	487,
8,	154,	227,	149,	190,	273,	239,	201,	134,	339,	527,
9,	25,	120,	141,	118,	120,	134,	66,	87,	42,	123,
0 TOTALNUM,	5253,	7187,	7477,	14057,	13271,	16590,	9209,	8201,	7768,	9430,
TONSLAND,	18727,	22228,	24581,	36775,	39799,	34927,	26585,	23112,	20513,	22963,
SOPCOF %,	125,	105,	104,	100,	103,	70,	102,	101,	107,	107,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	1139,	2149,	4396,	998,	210,	257,	509,	2237,	243,	192,
3,	1965,	5771,	5234,	9484,	3586,	1362,	2122,	2151,	2849,	451,
4,	3073,	2760,	3487,	3795,	8462,	2611,	1945,	2187,	1481,	2152,
5,	1286,	2746,	1461,	1669,	2373,	3083,	1484,	1121,	852,	622,
6,	471,	1204,	912,	770,	907,	812,	2178,	1026,	404,	303,
7,	314,	510,	314,	872,	236,	224,	492,	997,	294,	142,
8,	169,	157,	82,	309,	147,	68,	168,	220,	291,	93,
9,	254,	104,	34,	65,	47,	69,	33,	61,	50,	53,
0 TOTALNUM,	8671,	15401,	15920,	17962,	15968,	8486,	8931,	10000,	6464,	4008,
TONSLAND,	21489,	38133,	36979,	39484,	34595,	21391,	23182,	22068,	13487,	8750,
SOPCOF %,	104,	99,	99,	97,	97,	98,	102,	98,	101,	109,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	205,	120,	573,	2615,	351,	200,	455,	1288,	2230,	4024,
3,	455,	802,	788,	2716,	5164,	1278,	745,	1080,	2812,	3867,
4,	466,	603,	1062,	2008,	4608,	6710,	1558,	869,	834,	2161,
5,	911,	222,	532,	1012,	1542,	3731,	5140,	1204,	455,	378,
6,	293,	329,	125,	465,	1526,	657,	1529,	2420,	719,	377,
7,	132,	96,	176,	118,	596,	639,	159,	477,	863,	739,
8,	53,	33,	39,	175,	147,	170,	118,	65,	111,	449,
9,	30,	22,	23,	44,	347,	51,	28,	19,	8,	37,
0 TOTALNUM,	2545,	2227,	3318,	9153,	14281,	13436,	9732,	7422,	8032,	12032,
TONSLAND,	6396,	6107,	9046,	23045,	40422,	34304,	24005,	19906,	22432,	28990,
SOPCOF %,	108,	107,	103,	103,	100,	104,	104,	102,	104,	101,

Table 2.2.3.1 Faroe Plateau (sub-divisionVb1) COD. Catch weight at age 1961-2001.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND18

At 6/05/2002 10:36

Table 2 Catch weights at age (kg)

YEAR	1961
AGE	
2	1.0800
3	2.2200
4	3.4500
5	4.6900
6	5.5200
7	7.0900
8	9.9100
9	8.0300
0 SOPCOFAC	.9068

Table 2 Catch weights at age (kg)

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
2	1.0000	1.0400	.9700	.9200	.9800	.9600	.8800	1.0900	.9600	.8100
3	2.2700	1.9400	1.8300	1.4500	1.7700	1.9300	1.7200	1.8000	2.2300	1.8000
4	3.3500	3.5100	3.1500	2.5700	2.7500	3.1300	3.0700	2.8500	2.6900	2.9800
5	4.5800	4.6000	4.3300	3.7800	3.5100	4.0400	4.1200	3.6700	3.9400	3.5800
6	4.9300	5.5000	6.0800	5.6900	4.8000	4.7800	4.6500	4.8900	5.1400	3.9400
7	9.0800	6.7800	7.0000	7.3100	6.3200	6.2500	5.5000	5.0500	6.4600	4.8700
8	6.5900	8.7100	6.2500	7.9300	7.5100	7.0000	7.6700	7.4100	10.3100	6.4800
9	6.6600	11.7200	6.1900	8.0900	10.3400	11.0100	10.9500	8.6600	7.3900	6.3700
0 SOPCOFAC	.9444	.9573	.9824	1.1262	1.0905	1.0224	1.0598	1.0851	.9943	1.2264

Table 2 Catch weights at age (kg)

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
2	.6600	1.1100	1.0800	.7900	.9400	.8700	1.1120	.8970	.9270	1.0800
3	1.6100	2.0000	2.2200	1.7900	1.7200	1.7900	1.3850	1.6820	1.4320	1.4700
4	2.5800	3.4100	3.4400	2.9800	2.8400	2.5300	2.1400	2.2110	2.2200	2.1800
5	3.2600	3.8900	4.8000	4.2600	3.7000	3.6800	3.1250	3.0520	3.1050	3.2100
6	4.2900	5.1000	5.1800	5.4600	5.2600	4.6500	4.3630	3.6420	3.5390	3.7000
7	4.9500	5.1000	5.8800	6.2500	6.4300	5.3400	5.9270	4.7190	4.3920	4.2400
8	6.4800	6.1200	6.1400	7.5100	6.3900	6.2300	6.3480	7.2720	6.1000	4.4300
9	6.9000	8.6600	8.6300	7.3900	8.5500	8.3800	8.7150	8.3680	7.6030	6.6900
0 SOPCOFAC	1.2481	1.0485	1.0432	1.0033	1.0285	.7026	1.0228	1.0055	1.0680	1.0674

Table 2 Catch weights at age (kg)

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
2	1.2300	1.3380	1.1950	.9050	1.0990	1.0930	1.0610	1.0100	.9450	.7790
3	1.4130	1.9500	1.8880	1.6580	1.4590	1.5170	1.7490	1.5970	1.3000	1.2710
4	2.1380	2.4030	2.9800	2.6260	2.0460	2.1600	2.3000	2.2000	1.9590	1.5700
5	3.1070	3.1070	3.6790	3.4000	2.9360	2.7660	2.9140	2.9340	2.5310	2.5240
6	4.0120	4.1100	4.4700	3.7520	3.7860	3.9080	3.1090	3.4680	3.2730	3.1850
7	5.4420	5.0200	5.4880	4.2200	4.6990	5.4610	3.9760	3.7500	4.6520	4.0860
8	5.5630	5.6010	6.4660	4.7390	5.8930	6.3410	4.8960	4.6820	4.7580	5.6560
9	5.2160	8.0130	6.6280	6.5110	9.7000	8.5090	7.0870	6.1400	6.7040	5.9730
0 SOPCOFAC	1.0428	.9901	.9872	.9695	.9715	.9755	1.0153	.9810	1.0064	1.0857

Table 2 Catch weights at age (kg)

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
2	.9890	1.1550	1.1940	1.2180	1.0160	.9010	1.0040	1.0500	1.4160	1.1640
3	1.3640	1.7040	1.8430	1.9860	1.7370	1.3410	1.4170	1.5860	2.1700	2.0760
4	1.7790	2.4210	2.6130	2.6220	2.7450	1.9580	1.8020	2.3500	3.1870	3.0530
5	2.3120	3.1320	3.6540	3.9250	3.8000	3.0120	2.2800	2.7740	3.7950	3.9760
6	3.4770	3.7230	4.5840	5.1800	4.4550	4.1580	3.4780	3.2140	4.0480	4.3940
7	4.5450	4.9710	4.9760	6.0790	4.9780	4.4910	5.4330	5.4960	4.5770	4.8710
8	6.2750	6.1590	7.1460	6.2410	5.2700	5.3120	5.8510	8.2760	8.1820	5.5630
9	7.6190	7.6140	8.5640	7.7820	5.5930	6.1720	7.9700	9.1290	11.8950	7.2770
0 SOPCOFAC	1.0770	1.0652	1.0303	1.0299	1.0026	1.0367	1.0376	1.0178	1.0429	1.0054

Table 2.2.4.1 Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2001. From 1961-1982 the average from 1983-1996 is used.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND18

At 6/05/2002 10:36

Table 5 Proportion mature at age

YEAR,	1961,
AGE	
2,	.1700,
3,	.6400,
4,	.8700,
5,	.9500,
6,	1.0000,
7,	1.0000,
8,	1.0000,
9,	1.0000,

Table 5 Proportion mature at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,
3,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,
4,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,
5,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,
3,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,
4,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,
5,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.1700,	.0300,	.0700,	.0000,	.0000,	.0000,	.0600,	.0500,	.0000,	.0000,
3,	.6400,	.7100,	.9600,	.5000,	.3800,	.6700,	.7200,	.5400,	.6800,	.7200,
4,	.8700,	.9300,	.9800,	.9600,	.9300,	.9100,	.9000,	.9800,	.9000,	.8600,
5,	.9500,	.9400,	.9700,	.9600,	1.0000,	1.0000,	.9700,	1.0000,	.9900,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,	1.0000,	1.0000,	.9800,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	.9400,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.0600,	.0300,	.0500,	.0800,	.0400,	.0700,	.0000,	.0200,	.0200,	.0700,
3,	.5000,	.7300,	.8900,	.5300,	.4400,	.7500,	.7400,	.4300,	.3900,	.4700,
4,	.8200,	.7800,	.9800,	.5500,	.7500,	.9500,	.9300,	.8800,	.7000,	.8600,
5,	.9800,	.9100,	.9900,	.7400,	.8700,	.9800,	.9900,	.9800,	.9200,	.9400,
6,	1.0000,	.9900,	1.0000,	.9700,	.9400,	1.0000,	1.0000,	1.0000,	.9900,	1.0000,
7,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.2.6.1.1 Faroe Plateau (Subdivision Vb1) COD. Summer survey tuning series (number of individuals per 200 stations).

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1) SURVEY4.TXT
101
SUMMER SURVEY
1996 2001
1 1 0.6 0.7
2 8
 200  819.4 5940.2  3637.4  1357.7  674.8  242.2  57.6
 200  548.7 1853.3  6359.6  1597.1  177.4  144.6  35.4
 200  555.1  572.4  1160.5  3668.8  978.2   52.5  38.3
 200  400   1341.7   818.7   796.7 1363.9  267    42.3
 200 1343   1129.8   701.5   317.7  435.7  610.6  35.5
 200 3536.4 2460    1501.2   420.8  241.2  290.5 242.7
```

Table 2.2.6.1.2 Faroe Plateau (sub-division Vb1) COD. Final XSA run.

```
Lowestoft VPA Version 3.1
 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_IND18
CPUE data from file SURVEY4.TXT

 Catch data for  41 years. 1961 to 2001. Ages  2 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2001,   2,     8,   .600,   .700

 Time series weights :

      Tapered time weighting not applied

 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    6

 Terminal population estimation :

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

      S.E. of the mean to which the estimates  are shrunk =   2.000

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

      Prior weighting not applied


 Tuning converged after   46 iterations

 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  1996,  1997,  1998,  1999,  2000,  2001

      2,  .034,  .042,  .079,  .121,  .126,  .086
      3,  .191,  .166,  .216,  .272,  .419,  .333
      4,  .450,  .407,  .313,  .420,  .350,  .670
      5,  .797,  .826,  .634,  .426,  .406,  .263
      6,  .906, 1.005, 1.030,  .712,  .489,  .708
      7, 1.158, 1.400,  .718, 1.161,  .601, 1.571
      8,  .954, 1.432, 1.170,  .742,  .976,  .743
      9,  .862, 1.127, 1.024,  .574,  .181, 1.118

 XSA population numbers (Thousands)

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

 1996 ,    1.17E+04, 3.28E+04, 1.40E+04, 3.10E+03, 2.83E+03, 9.60E+02, 2.64E+02, 6.64E+02,
1997 ,    5.40E+03, 9.24E+03, 2.22E+04, 7.33E+03, 1.15E+03, 9.37E+02, 2.47E+02, 8.34E+01,
 1998 ,    6.62E+03, 4.24E+03, 6.41E+03, 1.21E+04, 2.63E+03, 3.43E+02, 1.89E+02, 4.83E+01,
 1999 ,    1.25E+04, 5.01E+03, 2.80E+03, 3.84E+03, 5.25E+03, 7.68E+02, 1.37E+02, 4.81E+01,
 2000 ,    2.09E+04, 9.08E+03, 3.12E+03, 1.51E+03, 2.05E+03, 2.11E+03, 1.97E+02, 5.34E+01,
 2001 ,    5.42E+04, 1.51E+04, 4.89E+03, 1.80E+03, 8.21E+02, 1.03E+03, 9.47E+02, 6.08E+01,

 Estimated population abundance at 1st Jan 2002

    ,     0.00E+00, 4.07E+04, 8.85E+03, 2.05E+03, 1.13E+03, 3.31E+02, 1.76E+02, 3.69E+02,

 Taper weighted geometric mean of the VPA populations:

    ,     1.52E+04, 1.09E+04, 6.71E+03, 3.65E+03, 1.81E+03, 8.44E+02, 3.46E+02, 1.41E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .5894,    .5487,    .5502,    .5511,    .5680,    .5738,    .6368,    .7766,

 Log catchability residuals.
```

Table 2.2.6.1.2 (Cont'd)

Fleet : SUMMER SURVEY

Age	1996	1997	1998	1999	2000	2001
2	.04	.41	.24	-.69	.01	.00
3	.00	.08	-.28	.44	-.23	-.01
4	.03	.10	-.42	.13	-.18	.34
5	.68	.00	.21	-.30	-.30	-.29
6	.03	-.34	.56	-.01	-.36	.11
7	.25	-.08	-.53	.57	.03	.63
8	-.03	-.14	.04	.18	-.20	.00

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

Age	2	3	4	5	6	7	8
Mean Log q	-7.8389	-6.7511	-6.2550	-6.1599	-6.0451	-6.0451	-6.0451
S.E(Log q)	.3771	.2584	.2654	.3946	.3359	.4654	.1382

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.17	-.672	7.56	.80	6	.47	-7.84
3	1.02	-.120	6.70	.89	6	.29	-6.75
4	.98	.141	6.31	.91	6	.29	-6.25
5	.84	.820	6.49	.87	6	.34	-6.16
6	.91	.423	6.19	.83	6	.33	-6.05
7	.76	.954	6.12	.79	6	.33	-5.90
8	1.03	-.306	6.09	.96	6	.15	-6.07

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	40597.	.407	.000	.00	1	.957	.086
F shrinkage mean	43491.	2.00				.043	.080

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
40718.	.40	.01	2	.036	.086

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	8787.	.242	.010	.04	2	.979	.335
F shrinkage mean	12099.	2.00				.021	.254

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8846.	.24	.03	3	.139	.333

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	2019.	.193	.277	1.43	3	.978	.677
F shrinkage mean	4093.	2.00				.022	.391

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2050.	.19	.23	4	1.193	.670

Table 2.2.6.1.2 (Cont'd)

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

Year class = 1996

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	1152.,	.178,	.176,	.99,	4,	.986,	.260
F shrinkage mean ,	395.,	2.00,,,,				.014,	.623

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1135.,	.18,	.16,	5,	.924,	.263

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

Year class = 1995

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	333.,	.171,	.115,	.67,	5,	.978,	.705
F shrinkage mean ,	260.,	2.00,,,,				.022,	.837

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
331.,	.17,	.10,	6,	.593,	.708

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

Year class = 1994

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	167.,	.170,	.178,	1.05,	6,	.938,	1.611
F shrinkage mean ,	378.,	2.00,,,,				.062,	1.019

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
176.,	.20,	.18,	7,	.883,	1.571

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

Year class = 1993

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	375.,	.201,	.022,	.11,	6,	.972,	.734
F shrinkage mean ,	213.,	2.00,,,,				.028,	1.067

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
369.,	.20,	.04,	7,	.214,	.743

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

Year class = 1992

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	15.,	.247,	.138,	.56,	5,	.872,	1.170
F shrinkage mean ,	27.,	2.00,,,,				.128,	.799

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
16.,	.33,	.15,	6,	.447,	1.118

Table 2.2.6.1.3 Faroe Plateau (sub-division Vb1) COD. Fishing mortality at age.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND18

At 6/05/2002 10:36

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,
AGE	
2,	.3346,
3,	.5141,
4,	.4986,
5,	.5737,
6,	.4863,
7,	.9566,
8,	.8116,
9,	.6715,
0 FBAR 3- 7,	.6059,

Table 8 Fishing mortality (F) at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	.2701,	.2534,	.1086,	.1209,	.0829,	.0789,	.1010,	.1099,	.0530,	.0309,
3,	.4982,	.4138,	.2997,	.2518,	.1969,	.2389,	.2318,	.3063,	.2081,	.1337,
4,	.4838,	.5172,	.4523,	.4498,	.2552,	.2687,	.3949,	.3806,	.3654,	.2225,
5,	.7076,	.5124,	.5229,	.5622,	.4499,	.3442,	.5339,	.4180,	.3409,	.3845,
6,	.5569,	.5405,	.5659,	.6604,	.5016,	.5779,	.4472,	.5709,	.3709,	.5572,
7,	.3662,	.4879,	.6677,	.5305,	.9680,	.5203,	.7132,	.5118,	.6559,	.4651,
8,	.6826,	.3269,	.3531,	.4345,	.8520,	1.0438,	.3331,	.8457,	.4208,	.7528,
9,	.5641,	.4806,	.5164,	.5318,	.6106,	.5556,	.4882,	.5499,	.4339,	.4800,
0 FBAR 3- 7,	.5226,	.4944,	.5017,	.4909,	.4743,	.3900,	.4642,	.4375,	.3882,	.3526,

Table 8 Fishing mortality (F) at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	.0464,	.0657,	.0816,	.0774,	.0933,	.0481,	.0588,	.0433,	.0544,	.0523,
3,	.1476,	.2322,	.1568,	.3193,	.1723,	.3036,	.1896,	.2622,	.2391,	.2877,
4,	.2070,	.3048,	.2046,	.4359,	.3665,	.4748,	.4291,	.4308,	.3695,	.3408,
5,	.2497,	.2813,	.2953,	.4134,	.5568,	.7532,	.4289,	.5049,	.4337,	.4368,
6,	.6058,	.2526,	.3797,	.4544,	.5167,	.7333,	.4850,	.4906,	.5181,	.5643,
7,	.4686,	.3722,	.5330,	.3504,	.7619,	1.1138,	.5968,	.4480,	.4119,	.6939,
8,	.2464,	.3259,	.3052,	.4485,	.6429,	.7776,	.5674,	.6902,	.6437,	.5014,
9,	.3578,	.3091,	.3457,	.4235,	.5738,	.7783,	.5054,	.5170,	.4790,	.5115,
0 FBAR 3- 7,	.3358,	.2886,	.3139,	.3947,	.4748,	.6757,	.4259,	.4273,	.3945,	.4647,

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.0585,	.0991,	.1071,	.0655,	.0244,	.0280,	.0645,	.1637,	.0768,	.0325,
3,	.2226,	.4669,	.3707,	.3537,	.3524,	.2175,	.3369,	.4213,	.3239,	.1997,
4,	.3601,	.5583,	.5783,	.5065,	.6207,	.4712,	.5512,	.7016,	.5809,	.4352,
5,	.3886,	.6408,	.6604,	.6121,	.7005,	.4826,	.5410,	.7291,	.6615,	.5176,
6,	.4046,	.7833,	.4530,	.9220,	.8220,	.5519,	.7662,	.9318,	.6395,	.5230,
7,	.6925,	1.0775,	.4758,	1.1060,	.8368,	.4855,	.7875,	1.0324,	.7736,	.4853,
8,	.5525,	.9413,	.4787,	1.3184,	.5385,	.6174,	.8497,	1.0621,	1.0341,	.5998,
9,	.4833,	.8084,	.5336,	.9026,	.7104,	.5259,	.7058,	.9010,	.7451,	.5162,
0 FBAR 3- 7,	.4137,	.7053,	.5077,	.7001,	.6665,	.4417,	.5966,	.7632,	.5959,	.4322,

Table 8 Fishing mortality (F) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	FBAR 99-**
AGE											
2,	.0201,	.0131,	.0254,	.0696,	.0338,	.0418,	.0790,	.1207,	.1256,	.0976,	.1146,
3,	.1003,	.1019,	.1121,	.1612,	.1911,	.1658,	.2158,	.2721,	.4188,	.3333,	.3414,
4,	.3270,	.1873,	.1906,	.4609,	.4502,	.4068,	.3127,	.4202,	.3495,	.6698,	.4798,
5,	.3312,	.2549,	.2511,	.2802,	.7968,	.8263,	.6342,	.4255,	.4064,	.2635,	.3651,
6,	.4945,	.1902,	.2228,	.3634,	.9056,	1.0052,	1.0304,	.7118,	.4892,	.7082,	.6364,
7,	.4551,	.2957,	.1472,	.3393,	1.1583,	1.4005,	.7176,	1.1607,	.6015,	1.5706,	1.1109,
8,	.3351,	.1936,	.1872,	.2139,	.9536,	1.4316,	1.1697,	.7425,	.9757,	.7426,	.8203,
9,	.3912,	.2254,	.2007,	.3336,	.8619,	1.1266,	1.0239,	.5741,	.1809,	1.1177,	.6243,
0 FBAR 3- 7,	.3416,	.2060,	.1848,	.3210,	.7004,	.7609,	.5822,	.5981,	.4531,	.7091,	

Table 2.2.6.1.4 Faroe Plateau (sub-division Vb1) COD. Stock number at age.

```
Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)              COD_IND18
    At  6/05/2002  10:36
                   Terminal Fs derived using XSA (With F shrinkage)
```

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

YEAR,	1961,
AGE	
2,	12019,
3,	7385,
4,	3747,
5,	2699,
6,	666,
7,	668,
8,	155,
9,	66,
0 TOTAL,	27403,

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	20654,	20290,	21834,	8269,	18566,	23451,	17582,	9325,	8608,	11928,
3,	7042,	12907,	12893,	16037,	5999,	13990,	17744,	13012,	6840,	6684,
4,	3616,	3503,	6986,	7823,	10207,	4034,	9020,	11522,	7843,	4548,
5,	1863,	1825,	1710,	3639,	4085,	6475,	2525,	4976,	6447,	4456,
6,	1245,	752,	895,	830,	1698,	2133,	3757,	1212,	2682,	3754,
7,	335,	584,	358,	416,	351,	842,	980,	1967,	561,	1516,
8,	210,	190,	294,	151,	200,	109,	410,	393,	965,	238,
9,	56,	87,	112,	169,	80,	70,	31,	240,	138,	519,
0 TOTAL,	35021,	40138,	45083,	37333,	41186,	51104,	52050,	42647,	34085,	33643,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	21320,	12573,	30480,	38320,	18575,	9995,	10749,	14999,	23587,	14003,
3,	9469,	16664,	9640,	23000,	29036,	13853,	7799,	8298,	11760,	18290,
4,	4788,	6689,	10817,	6747,	13683,	20010,	8373,	5282,	5227,	7580,
5,	2981,	3187,	4037,	7217,	3572,	7765,	10190,	4463,	2811,	2957,
6,	2483,	1901,	1969,	2460,	3908,	1676,	2994,	5433,	2206,	1492,
7,	1760,	1109,	1209,	1103,	1279,	1909,	659,	1509,	2724,	1076,
8,	779,	902,	626,	581,	636,	489,	513,	297,	789,	1477,
9,	92,	499,	533,	378,	304,	274,	184,	238,	122,	340,
0 TOTAL,	43673,	43524,	59312,	79806,	70993,	55971,	41459,	40519,	49224,	47214,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	22139,	25185,	47829,	17400,	9638,	10300,	9008,	16373,	3632,	6646,
3,	10881,	17096,	18675,	35182,	13343,	7701,	8200,	6914,	11381,	2754,
4,	11231,	7130,	8775,	10554,	20223,	7680,	5073,	4794,	3715,	6740,
5,	4414,	6415,	3340,	4029,	5207,	8900,	3925,	2393,	1946,	1701,
6,	1564,	2450,	2767,	1413,	1789,	2116,	4497,	1871,	945,	822,
7,	695,	855,	917,	1440,	460,	644,	998,	1711,	603,	408,
8,	440,	285,	238,	466,	390,	163,	324,	372,	499,	228,
9,	732,	207,	91,	121,	102,	186,	72,	114,	105,	145,
0 TOTAL,	52096,	59622,	82632,	70605,	51152,	37690,	32097,	34541,	22826,	19444,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	GMST 61-99	AMST 61-99
AGE													
2,	11399,	10161,	25258,	42962,	11678,	5403,	6622,	12518,	20881,	47829,	0,	14546,	16956,
3,	5267,	9147,	8210,	20161,	32809,	9243,	4243,	5010,	9083,	15078,	35518,	10888,	12681,
4,	1847,	3901,	6763,	6009,	14049,	22189,	6411,	2799,	3125,	4892,	8846,	6897,	7998,
5,	3571,	1090,	2648,	4576,	3103,	7333,	12095,	3839,	1506,	1804,	2050,	3806,	4369,
6,	830,	2099,	692,	1687,	2831,	1145,	2627,	5252,	2054,	821,	1135,	1839,	2142,
7,	399,	414,	1421,	453,	960,	937,	343,	768,	2110,	1031,	331,	820,	957,
8,	206,	207,	252,	1004,	264,	247,	189,	137,	197,	947,	176,	342,	418,
9,	102,	120,	140,	171,	664,	83,	48,	48,	53,	61,	369,	148,	200,
0 TOTAL,	23621,	27141,	45385,	77024,	66357,	46580,	32579,	30371,	39009,	72463,	48425,		

Table 2.2.6.1.5 Faroe Plateau (sub-division Vb1) COD. Summary table.

```
Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_IND18
,

    At  6/05/2002  10:36

        Table 16    Summary     (without SOP correction)

                   Terminal Fs derived using XSA (With F shrinkage)

,            RECRUITS,    TOTALBIO,    TOTSPBIO,    LANDINGS,   YIELD/SSB,  FBAR  3- 7,
 ,             Age 2
    1961,         12019,       65428,       46439,       21598,       .4651,       .6059,
    1962,         20654,       68225,       43326,       20967,       .4839,       .5226,
    1963,         20290,       77602,       49054,       22215,       .4529,       .4944,
    1964,         21834,       84666,       55362,       21078,       .3807,       .5017,
    1965,          8269,       75043,       57057,       24212,       .4244,       .4909,
    1966,         18566,       83919,       60629,       20418,       .3368,       .4743,
    1967,         23451,      105289,       73934,       23562,       .3187,       .3900,
    1968,         17582,      110433,       82484,       29930,       .3629,       .4642,
    1969,          9325,      105537,       83487,       32371,       .3877,       .4375,
    1970,          8608,       98398,       82035,       24183,       .2948,       .3882,
    1971,         11928,       78218,       63308,       23010,       .3635,       .3526,
    1972,         21320,       76439,       57180,       18727,       .3275,       .3358,
    1973,         12573,      107683,       80516,       22228,       .2761,       .2886,
    1974,         30480,      136664,       95831,       24581,       .2565,       .3139,
    1975,         38320,      149775,      105677,       36775,       .3480,       .3947,
    1976,         18575,      154920,      116737,       39799,       .3409,       .4748,
    1977,          9995,      136019,      111864,       34927,       .3122,       .6757,
    1978,         10749,       94341,       76610,       26585,       .3470,       .4259,
    1979,         14999,       83773,       65382,       23112,       .3535,       .4273,
    1980,         23587,       84545,       58390,       20513,       .3513,       .3945,
    1981,         14003,       86921,       62066,       22963,       .3700,       .4647,
    1982,         22139,       96655,       64710,       21489,       .3321,       .4137,
    1983,         25185,      121712,       76963,       38133,       .4955,       .7053,
    1984,         47829,      150394,       94937,       36979,       .3895,       .5077,
    1985,         17400,      129867,       83298,       39484,       .4740,       .7001,
    1986,          9638,       98947,       73164,       34595,       .4728,       .6665,
    1987,         10300,       78551,       61945,       21391,       .3453,       .4417,
    1988,          9008,       67051,       52541,       23182,       .4412,       .5966,
    1989,         16373,       60489,       39489,       22068,       .5588,       .7632,
    1990,          3632,       39409,       30285,       13487,       .4453,       .5959,
    1991,          6646,       29996,       22358,        8750,       .3914,       .4322,
    1992,         11399,       36770,       21824,        6396,       .2931,       .3416,
    1993,         10161,       52251,       34196,        6107,       .1786,       .2060,
    1994,         25258,       85883,       54977,        9046,       .1645,       .1848,
    1995,         42962,      145180,       66197,       23045,       .3481,       .3210,
    1996,         11678,      141706,       86473,       40422,       .4675,       .7004,
    1997,          5403,       93591,       83351,       34304,       .4116,       .7609,
    1998,          6622,       64284,       54988,       24005,       .4365,       .5822,
    1999,         12518,       60990,       42578,       19906,       .4675,       .5981,
    2000,         20881,       85169,       40642,       22432,       .5519,       .4531,
    2001,         47829,      123424,       52537,       28990,       .5518,       .7091,

 Arith.
   Mean   ,       17805,       93321,       64996,       24585,       .3847,       .4878,
0 Units,   (Thousands),    (Tonnes),    (Tonnes),    (Tonnes),
```

Table 2.2.6.1.6 Faroe Plateau (sub-division Vb1) COD. Input to the RCT3 program.

```
FAROE PLATEAU COD: SUMMER GROUNDFISH SURVEY AND 0-GROUP SURVEY DATA
4 39 2
'Yrclass'   'VPA'     'Ogrpsurv'   'SS1y'      'SS2y'      'SS3y'
1963         8269        -11         -11         -11         -11
1964        18566        -11         -11         -11         -11
1965        23451        -11         -11         -11         -11
1966        17582        -11         -11         -11         -11
1967         9325        -11         -11         -11         -11
1968         8608        -11         -11         -11         -11
1969        11928        -11         -11         -11         -11
1970        21320        -11         -11         -11         -11
1971        12573        -11         -11         -11         -11
1972        30480        -11         -11         -11         -11
1973        38320        -11         -11         -11         -11
1974        18575        -11         -11         -11         -11
1975         9995        -11         -11         -11         -11
1976        10749        -11         -11         -11         -11
1977        14999        -11         -11         -11         -11
1978        23587        -11         -11         -11         -11
1979        14003        -11         -11         -11         -11
1980        22139        -11         -11         -11         -11
1981        25185        -11         -11         -11         -11
1982        47829        -11         -11         -11         -11
1983        17400        -11         -11         -11         -11
1984         9638        -11         -11         -11         -11
1985        10300        -11         -11         -11         -11
1986         9008        -11         -11         -11         -11
1987        16373        -11         -11         -11         -11
1988         3632        -11         -11         -11         -11
1989         6646         78         -11         -11         -11
1990        11399        523         -11         -11         -11
1991        10161         17         -11         -11         -11
1992        25258        120         -11         -11         -11
1993        42962       1193         -11         -11        5940
1994        11678        664         -11         819        1853
1995         5403         59          40         549         572
1996         6622        380          75         555        1342
1997        12518       1196         -11         -11        1130
1998        20881       8676         118        1343        2460
1999          -11       6202         397        3536         -11
2000          -11       2661         179         -11         -11
2001          -11       2760         -11         -11         -11
```

Table 2.2.6.1.7 Faroe Plateau (subdivision Vb1) COD. Output from the RCT3 program.

```
Analysis by RCT3 ver3.1 of data from file :

 cod9rct3.txt

 FAROE PLATEAU COD: SUMMER GROUNDFISH SURVEY AND 0-GROUP SURVEY DATA

 Data for    4 surveys over   39 years :  1963 - 2001

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

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

 Forecast/Hindcast variance correction used.

 Yearclass =   1999
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Ogrpsu     .73   5.17   1.22   .252     10   8.73   11.51    1.627     .042
 SS1y      1.53   2.56    .53   .791      3   5.99   11.74    2.357     .020
 SS2y      1.46   -.51    .12   .976      4   8.17   11.42     .402     .690
 SS3y
                                         VPA Mean =    9.38     .672     .247

 Yearclass =   2000
          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Ogrpsu     .72   5.17   1.22   .253     10   7.89   10.87    1.551     .138
 SS1y      1.54   2.55    .54   .791      3   5.19   10.52    1.578     .133
 SS2y
 SS3y

                                         VPA Mean =    9.38     .674     .729

 Yearclass =   2001

          I-----------Regression----------I  I-----------Prediction---------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error   Weights

 Ogrpsu     .72   5.17   1.22   .256     10   7.92   10.86    1.572     .157
 SS1y
 SS2y
 SS3y

                                         VPA Mean =    9.38     .678     .843

 Year     Weighted      Log      Int      Ext      Var      VPA       Log
 Class     Average      WAP      Std      Std     Ratio               VPA
          Prediction            Error    Error

 1999       55522     10.92      .33      .51      2.34
 2000       16948      9.74      .58      .42       .53
 2001       15004      9.62      .62      .54       .75
```

Table 2.2.6.1.8 Faroe Plateau (subdivision Vb1) COD. Output from the ASPIC run.

```
Faroe Plateau Cod RV                                                                                 Page 1
                                                                                    05 May 2002 at 15:09.03
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82)                               FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center                      ASPIC User's Manual
        101 Pivers Island Road; Beaufort, North Carolina  28516  USA                    is available gratis
                                                                                           from the author.
Ref:    Prager, M. H.  1994.  A suite of extensions to a nonequilibrium
        surplus-production model.  Fishery Bulletin 92: 374-389.


CONTROL PARAMETERS USED (FROM INPUT FILE)
------------------------------------------------------------------------------------------------------------
Number of years analyzed:                      41          Number of bootstrap trials:                     0
Number of data series:                          1          Lower bound on MSY:                     5.000E+02
Objective function computed:            in effort          Upper bound on MSY:                     1.000E+05
Relative conv. criterion (simplex):     1.000E-08          Lower bound on r:                       7.000E-02
Relative conv. criterion (restart):     3.000E-08          Upper bound on r:                       2.500E+00
Relative conv. criterion (effort):      1.000E-04          Random number seed:                       2010417
Maximum F allowed in fitting:               8.000          Monte Carlo search mode, trials:         0      0


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                               code  0
------------------------------------------------------------------------------------------------------------
Normal convergence.


GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS
------------------------------------------------------------------------------------------------------------
                                                   Weighted          Weighted     Current   Suggested  R-squared
Loss component number and title                         SSE    N          MSE      weight      weight    in CPUE

Loss(-1)  SSE in yield                            0.000E+00
Loss( 0)  Penalty for B1R > 2                     0.000E+00    1          N/A   1.000E-01         N/A
Loss( 1)  Survey CPUE                             6.916E+00   19    4.068E-01   1.000E+00   1.000E+00      0.345
TOTAL OBJECTIVE FUNCTION:                    6.91616191E+00

Number of restarts required for convergence:             22
Est. B-ratio coverage index (0 worst, 2 best):       0.8159          < These two measures are defined in Prager
Est. B-ratio nearness index (0 worst, 1 best):       1.0000          <     et al. (1996), Trans. A.F.S. 125:729


MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------
Parameter                                          Estimate    Starting guess   Estimated  User guess

B1R       Starting biomass ratio, year 1961       4.278E-01         1.000E+00           1           1
MSY       Maximum sustainable yield               3.277E+04         3.000E+04           1           1
r         Intrinsic rate of increase              7.675E-01         8.000E-01           1           1
........  Catchability coefficients by fishery:
q( 1)     Survey CPUE                             5.700E-03         1.000E-02           1           1


MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------
Parameter                                          Estimate           Formula       Related quantity

MSY       Maximum sustainable yield               3.277E+04              Kr/4
K         Maximum stock biomass                   1.708E+05
B_MSY     Stock biomass at MSY                   8.539E+04               K/2
F_MSY     Fishing mortality at MSY               3.838E-01               r/2

F(0.1)    Management benchmark                    3.454E-01         0.9*F_MSY
Y(0.1)    Equilibrium yield at F(0.1)             3.244E+04          0.99*MSY

B-ratio   Ratio of B(2002) to B_MSY              1.047E+00
F-ratio   Ratio of F(2001) to F_MSY              8.623E-01
F01-mult  Ratio of F(0.1) to F(2001)              1.044E+00
Y-ratio   Proportion of MSY avail in 2002         9.978E-01          2*Br-Br^2    Ye(2002) = 3.270E+04

........  Fishing effort at MSY in units of each fishery:
F_MSY( 1)  Survey CPUE                           6.732E+01          r/2q( 1)      f(0.1) = 6.059E+01
```

Table 2.2.6.1.8 (Cont'd)

Faroe Plateau Cod RV

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to $\mathbf{F}_{MSY}$	Ratio of biomass to $\mathbf{B}_{MSY}$
1	1961	0.587	3.653E+04	3.682E+04	2.160E+04	2.160E+04	2.217E+04	1.528E+00	4.278E-01
2	1962	0.552	3.710E+04	3.796E+04	2.097E+04	2.097E+04	2.266E+04	1.439E+00	4.345E-01
3	1963	0.565	3.879E+04	3.931E+04	2.222E+04	2.222E+04	2.322E+04	1.473E+00	4.543E-01
4	1964	0.510	3.980E+04	4.130E+04	2.108E+04	2.108E+04	2.403E+04	1.330E+00	4.661E-01
5	1965	0.563	4.275E+04	4.300E+04	2.421E+04	2.421E+04	2.469E+04	1.467E+00	5.007E-01
6	1966	0.444	4.323E+04	4.595E+04	2.042E+04	2.042E+04	2.577E+04	1.158E+00	5.063E-01
7	1967	0.467	4.858E+04	5.049E+04	2.356E+04	2.356E+04	2.729E+04	1.216E+00	5.689E-01
8	1968	0.587	5.231E+04	5.102E+04	2.993E+04	2.993E+04	2.746E+04	1.529E+00	6.126E-01
9	1969	0.697	4.984E+04	4.644E+04	3.237E+04	3.237E+04	2.593E+04	1.817E+00	5.837E-01
10	1970	0.552	4.340E+04	4.383E+04	2.418E+04	2.418E+04	2.500E+04	1.438E+00	5.083E-01
11	1971	0.505	4.422E+04	4.557E+04	2.301E+04	2.301E+04	2.564E+04	1.316E+00	5.179E-01
12	1972	0.365	4.685E+04	5.129E+04	1.873E+04	1.873E+04	2.751E+04	9.514E-01	5.487E-01
13	1973	0.374	5.564E+04	5.948E+04	2.223E+04	2.223E+04	2.973E+04	9.738E-01	6.516E-01
14	1974	0.369	6.315E+04	6.654E+04	2.458E+04	2.458E+04	3.116E+04	9.626E-01	7.395E-01
15	1975	0.551	6.972E+04	6.675E+04	3.678E+04	3.678E+04	3.120E+04	1.436E+00	8.165E-01
16	1976	0.679	6.414E+04	5.862E+04	3.980E+04	3.980E+04	2.951E+04	1.769E+00	7.512E-01
17	1977	0.704	5.385E+04	4.964E+04	3.493E+04	3.493E+04	2.700E+04	1.833E+00	6.307E-01
18	1978	0.585	4.593E+04	4.541E+04	2.659E+04	2.659E+04	2.559E+04	1.525E+00	5.379E-01
19	1979	0.498	4.493E+04	4.637E+04	2.311E+04	2.311E+04	2.592E+04	1.299E+00	5.262E-01
20	1980	0.400	4.774E+04	5.130E+04	2.051E+04	2.051E+04	2.753E+04	1.042E+00	5.591E-01
21	1981	0.396	5.476E+04	5.805E+04	2.296E+04	2.296E+04	2.940E+04	1.031E+00	6.413E-01
22	1982	0.325	6.119E+04	6.610E+04	2.149E+04	2.149E+04	3.106E+04	8.472E-01	7.166E-01
23	1983	0.568	7.076E+04	6.709E+04	3.813E+04	3.813E+04	3.125E+04	1.481E+00	8.287E-01
24	1984	0.615	6.388E+04	6.010E+04	3.698E+04	3.698E+04	2.988E+04	1.603E+00	7.481E-01
25	1985	0.788	5.677E+04	5.011E+04	3.948E+04	3.948E+04	2.712E+04	2.053E+00	6.649E-01
26	1986	0.912	4.441E+04	3.792E+04	3.460E+04	3.460E+04	2.259E+04	2.377E+00	5.200E-01
27	1987	0.678	3.240E+04	3.155E+04	2.139E+04	2.139E+04	1.974E+04	1.767E+00	3.795E-01
28	1988	0.828	3.075E+04	2.801E+04	2.318E+04	2.318E+04	1.796E+04	2.157E+00	3.601E-01
29	1989	1.033	2.553E+04	2.137E+04	2.207E+04	2.207E+04	1.433E+04	2.691E+00	2.990E-01
30	1990	0.801	1.779E+04	1.684E+04	1.349E+04	1.349E+04	1.165E+04	2.087E+00	2.083E-01
31	1991	0.497	1.595E+04	1.760E+04	8.750E+03	8.750E+03	1.211E+04	1.295E+00	1.868E-01
32	1992	0.270	1.932E+04	2.372E+04	6.396E+03	6.396E+03	1.565E+04	7.025E-01	2.262E-01
33	1993	0.170	2.857E+04	3.602E+04	6.107E+03	6.107E+03	2.172E+04	4.418E-01	3.346E-01
34	1994	0.169	4.419E+04	5.351E+04	9.046E+03	9.046E+03	2.807E+04	4.405E-01	5.175E-01
35	1995	0.342	6.321E+04	6.746E+04	2.305E+04	2.305E+04	3.130E+04	8.902E-01	7.402E-01
36	1996	0.608	7.146E+04	6.648E+04	4.042E+04	4.042E+04	3.113E+04	1.585E+00	8.369E-01
37	1997	0.574	6.217E+04	5.980E+04	3.430E+04	3.430E+04	2.982E+04	1.495E+00	7.280E-01
38	1998	0.395	5.768E+04	6.079E+04	2.401E+04	2.401E+04	3.004E+04	1.029E+00	6.755E-01
39	1999	0.286	6.371E+04	6.971E+04	1.991E+04	1.991E+04	3.161E+04	7.441E-01	7.461E-01
40	2000	0.278	7.542E+04	8.072E+04	2.243E+04	2.243E+04	3.263E+04	7.241E-01	8.832E-01
41	2001	0.331	8.562E+04	8.761E+04	2.899E+04	2.899E+04	3.274E+04	8.623E-01	1.003E+00
42	2002		8.937E+04						1.047E+00

Table 2.2.6.1.8 (Cont'd)

Faroe Plateau Cod RV
Page 3

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) Survey CPUE

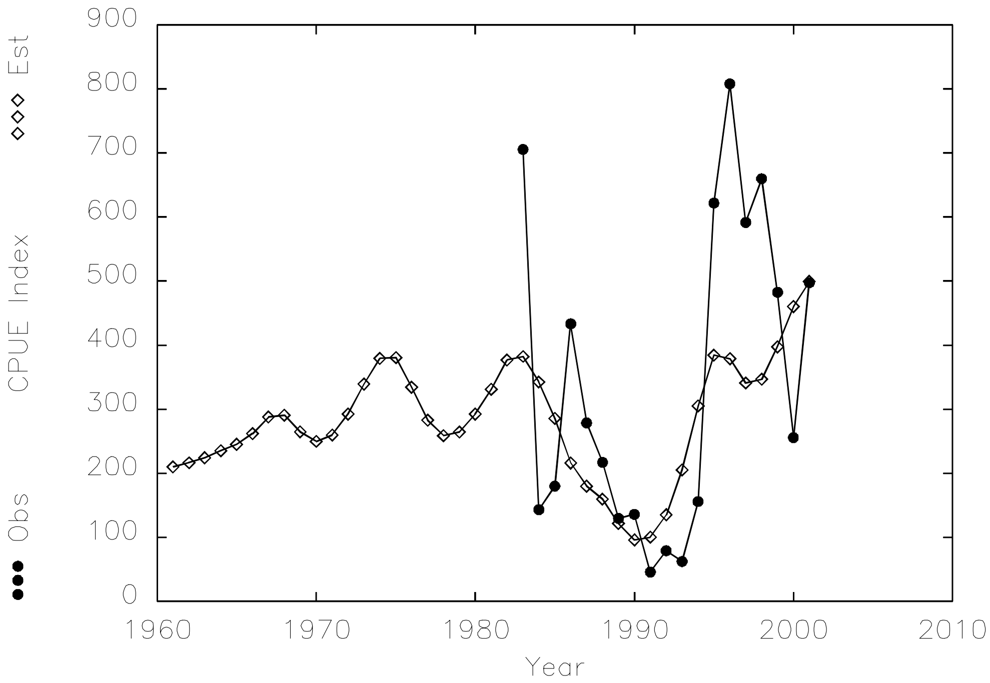
Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1961	*	2.099E+02	0.5866	2.160E+04	2.160E+04	0.00000	0.000E+00
2	1962	*	2.164E+02	0.5523	2.097E+04	2.097E+04	0.00000	0.000E+00
3	1963	*	2.241E+02	0.5652	2.222E+04	2.222E+04	0.00000	0.000E+00
4	1964	*	2.354E+02	0.5103	2.108E+04	2.108E+04	0.00000	0.000E+00
5	1965	*	2.451E+02	0.5631	2.421E+04	2.421E+04	0.00000	0.000E+00
6	1966	*	2.619E+02	0.4444	2.042E+04	2.042E+04	0.00000	0.000E+00
7	1967	*	2.878E+02	0.4666	2.356E+04	2.356E+04	0.00000	0.000E+00
8	1968	*	2.908E+02	0.5866	2.993E+04	2.993E+04	0.00000	0.000E+00
9	1969	*	2.647E+02	0.6971	3.237E+04	3.237E+04	0.00000	0.000E+00
10	1970	*	2.498E+02	0.5518	2.418E+04	2.418E+04	0.00000	0.000E+00
11	1971	*	2.598E+02	0.5049	2.301E+04	2.301E+04	0.00000	0.000E+00
12	1972	*	2.924E+02	0.3651	1.873E+04	1.873E+04	0.00000	0.000E+00
13	1973	*	3.391E+02	0.3737	2.223E+04	2.223E+04	0.00000	0.000E+00
14	1974	*	3.793E+02	0.3694	2.458E+04	2.458E+04	0.00000	0.000E+00
15	1975	*	3.805E+02	0.5509	3.678E+04	3.678E+04	0.00000	0.000E+00
16	1976	*	3.342E+02	0.6789	3.980E+04	3.980E+04	0.00000	0.000E+00
17	1977	*	2.830E+02	0.7036	3.493E+04	3.493E+04	0.00000	0.000E+00
18	1978	*	2.589E+02	0.5854	2.659E+04	2.659E+04	0.00000	0.000E+00
19	1979	*	2.643E+02	0.4984	2.311E+04	2.311E+04	0.00000	0.000E+00
20	1980	*	2.925E+02	0.3998	2.051E+04	2.051E+04	0.00000	0.000E+00
21	1981	*	3.309E+02	0.3955	2.296E+04	2.296E+04	0.00000	0.000E+00
22	1982	*	3.768E+02	0.3251	2.149E+04	2.149E+04	0.00000	0.000E+00
23	1983	7.052E+02	3.824E+02	0.5684	3.813E+04	3.813E+04	-0.61184	0.000E+00
24	1984	1.433E+02	3.426E+02	0.6153	3.698E+04	3.698E+04	0.87180	0.000E+00
25	1985	1.799E+02	2.856E+02	0.7880	3.948E+04	3.948E+04	0.46229	0.000E+00
26	1986	4.332E+02	2.162E+02	0.9123	3.460E+04	3.460E+04	-0.69513	0.000E+00
27	1987	2.786E+02	1.799E+02	0.6780	2.139E+04	2.139E+04	-0.43762	0.000E+00
28	1988	2.170E+02	1.597E+02	0.8277	2.318E+04	2.318E+04	-0.30678	0.000E+00
29	1989	1.297E+02	1.218E+02	1.0328	2.207E+04	2.207E+04	-0.06283	0.000E+00
30	1990	1.360E+02	9.601E+01	0.8007	1.349E+04	1.349E+04	-0.34804	0.000E+00
31	1991	4.586E+01	1.003E+02	0.4970	8.750E+03	8.750E+03	0.78305	0.000E+00
32	1992	7.913E+01	1.352E+02	0.2696	6.396E+03	6.396E+03	0.53595	0.000E+00
33	1993	6.239E+01	2.053E+02	0.1695	6.107E+03	6.107E+03	1.19123	0.000E+00
34	1994	1.559E+02	3.050E+02	0.1690	9.046E+03	9.046E+03	0.67093	0.000E+00
35	1995	6.216E+02	3.845E+02	0.3416	2.305E+04	2.305E+04	-0.48020	0.000E+00
36	1996	8.077E+02	3.789E+02	0.6081	4.042E+04	4.042E+04	-0.75681	0.000E+00
37	1997	5.915E+02	3.409E+02	0.5737	3.430E+04	3.430E+04	-0.55113	0.000E+00
38	1998	6.597E+02	3.465E+02	0.3949	2.401E+04	2.401E+04	-0.64391	0.000E+00
39	1999	4.825E+02	3.974E+02	0.2856	1.991E+04	1.991E+04	-0.19406	0.000E+00
40	2000	2.557E+02	4.601E+02	0.2779	2.243E+04	2.243E+04	0.58750	0.000E+00
41	2001	4.975E+02	4.994E+02	0.3309	2.899E+04	2.899E+04	0.00370	0.000E+00

* Asterisk indicates missing value(s).

Table 2.2.6.1.8 (Cont'd)

```
Faroe Plateau Cod RV
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1
                   -2       -1.5       -1       -0.5        0        0.5        1        1.5        2
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -------------------------------------------------------------------------------------
1961     0.0000                                             |
1962     0.0000                                             |
1963     0.0000                                             |
1964     0.0000                                             |
1965     0.0000                                             |
1966     0.0000                                             |
1967     0.0000                                             |
1968     0.0000                                             |
1969     0.0000                                             |
1970     0.0000                                             |
1971     0.0000                                             |
1972     0.0000                                             |
1973     0.0000                                             |
1974     0.0000                                             |
1975     0.0000                                             |
1976     0.0000                                             |
1977     0.0000                                             |
1978     0.0000                                             |
1979     0.0000                                             |
1980     0.0000                                             |
1981     0.0000                                             |
1982     0.0000                                             |
1983    -0.6118                                 ============|
1984     0.8718                                             |=================
1985     0.4623                                             |=========
1986    -0.6951                               ==============|
1987    -0.4376                                    =========|
1988    -0.3068                                       ======|
1989    -0.0628                                            =|
1990    -0.3480                                      =======|
1991     0.7830                                             |================
1992     0.5359                                             |===========
1993     1.1912                                             |========================
1994     0.6709                                             |=============
1995    -0.4802                                   ==========|
1996    -0.7568                              ===============|
1997    -0.5511                                  ===========|
1998    -0.6439                                =============|
1999    -0.1941                                         ====|
2000     0.5875                                             |============
2001     0.0037                                             |
                   -------------------------------------------------------------------------------------
```


Obs
Est
CPUE Index
900
800
700
600
500
400
300
200
100
0
1960
1970
1980
1990
2000
2010
Year

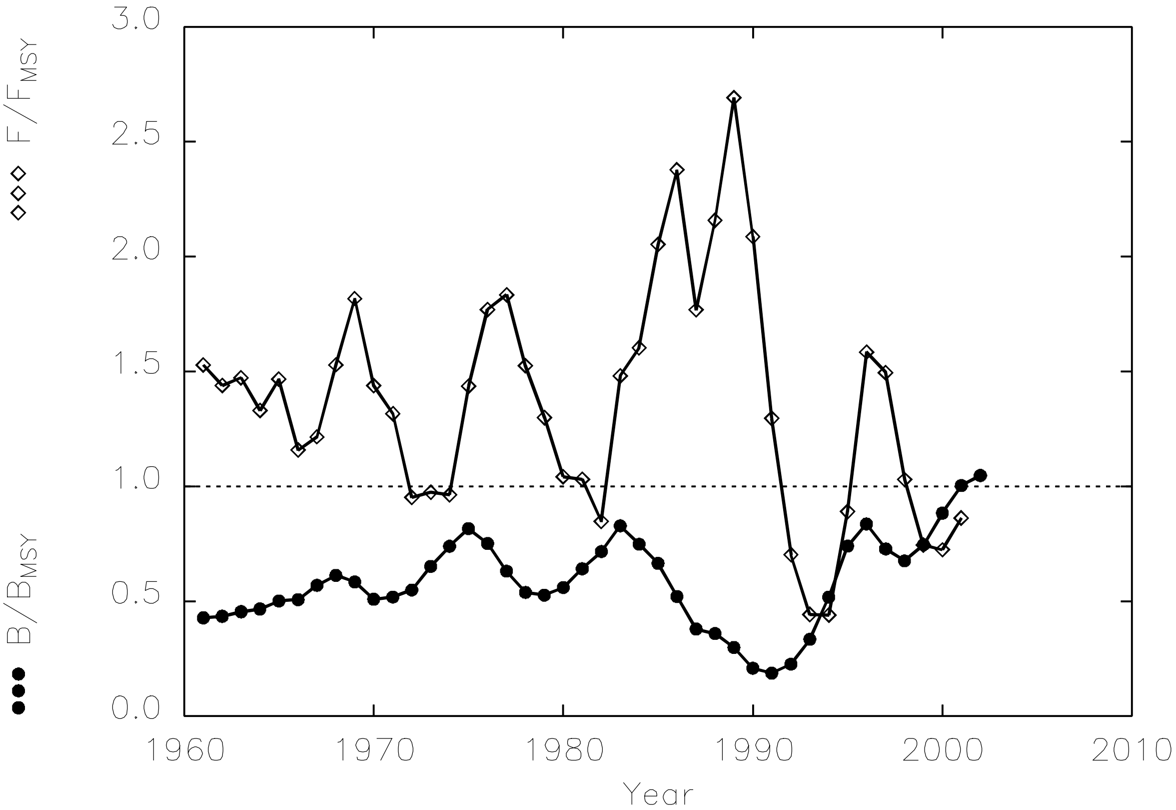

F/F$_{MSY}$
B/B$_{MSY}$
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1960
1970
1980
1990
2000
2010
Year

Table 2.2.7.1.1 Faroe Plateau (sub-division Vb1) COD. Input to management option table.

	Stock size	Recruitment	
	2002	2003	2004
Age 2	16948	15004	15107
Age 3	35518		
Age 4	8846		
Age 5	2050		
Age 6	1135		
Age 7	331		
Age 8	176		
Age 9	369		

35518 = 47829 (the highest observed) adjusted to one year later. 15004 from RCT3.
15107 = geometric mean 1961-2001.

	Exploitation pattern			Weight-at-age			Proportion Mature		
	2002	2003	2004	2002	2003	2004	2002	2003	2004
	Fbar99-01	Fbar99-01	Fbar99-01	av99-01	av99-01	av99-01	2001	av99-01	av99-01
	resc.to 01	resc.to 01	resc.to 01						
Age 2	0.1338	0.1338	0.1338	1.2100	1.2100	1.2100	0.040	0.043	0.043
Age 3	0.4126	0.4126	0.4126	1.9440	1.9440	1.9440	0.380	0.413	0.413
Age 4	0.5798	0.5798	0.5798	2.8633	2.8633	2.8633	0.770	0.777	0.777
Age 5	0.4412	0.4412	0.4412	3.5150	3.5150	3.5150	0.960	0.940	0.940
Age 6	0.7691	0.7691	0.7691	3.8853	3.8853	3.8853	0.930	0.973	0.973
Age 7	1.3425	1.3425	1.3425	4.9813	4.9813	4.9813	0.970	0.990	0.990
Age 8	0.9913	0.9913	0.9913	7.3407	7.3407	7.3407	1.000	1.000	1.000
Age 9	0.7545	0.7545	0.7545	9.4347	9.4347	9.4347	1.000	1.000	1.000

Table 2.2.7.1.2 Faroe Plateau (sub-division Vb1) COD. Management option table.

MFDP version 1
Run: Spred1
Index file 4/5-2002
Time and date: 16:40 06/05/02
Fbar age range: 3-7

2002				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
132921	63953	1.0000	0.7090	41920

2003					2004	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
118488	73982	0.0000	0.0000	0	146451	104878
.	73982	0.1000	0.0709	5063	140603	99679
.	73982	0.2000	0.1418	9856	135076	94775
.	73982	0.3000	0.2127	14397	129849	90149
.	73982	0.4000	0.2836	18699	124903	85782
.	73982	0.5000	0.3545	22779	120221	81658
.	73982	0.6000	0.4254	26648	115788	77761
.	73982	0.7000	0.4963	30319	111586	74078
.	73982	0.8000	0.5672	33805	107604	70596
.	73982	0.9000	0.6381	37114	103828	67301
.	73982	1.0000	0.7090	40259	100246	64184
.	73982	1.1000	0.7799	43248	96846	61233
.	73982	1.2000	0.8508	46089	93618	58438
.	73982	1.3000	0.9217	48792	90553	55791
.	73982	1.4000	0.9927	51363	87640	53283
.	73982	1.5000	1.0636	53810	84872	50905
.	73982	1.6000	1.1345	56140	82240	48651
.	73982	1.7000	1.2054	58360	79736	46513
.	73982	1.8000	1.2763	60474	77355	44485
.	73982	1.9000	1.3472	62490	75088	42560
.	73982	2.0000	1.4181	64411	72930	40734

Input units are thousands and kg - output in tonnes

Table 2.2.7.4.1 Faroe Plateau (subdivision Vb1) COD. Input data to yield per recruit calculations.

Input to Yield per recruit

ı	**Exploitatior pattern** Average 1961-2001 Resc. to 2001	**Weightatage** Average 1961-2001	**PropMature** Average 1983-2002
Age 2	0.12459	1.024	0.030
Age 3	0.38801	1.734	0.610
Age 4	0.60243	2.608	0.870
Age 5	0.71306	3.500	0.950
Age 6	0.84230	4.363	0.990
Age 7	0.99960	5.423	0.990
Age 8	0.95540	6.528	1.000
Age 9	0.83503	7.936	1.000

Proportion of M and F before spawning was set to 0. Weights in stock were set equal to weight in catch. Recruitment was set to 1.

Table 2.2.7.4.2 Faroe Plateau (sub-division Vb1) COD. Output data from yield per recruit calculations.

MFYPR version 1
Run: Yld1
Time and date: 16:25 06/05/02
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	4.4029	13.9913	2.9908	12.0815	2.9908	12.0815
0.1000	0.0709	0.1839	0.7092	3.9562	11.5600	2.5570	9.6865	2.5570	9.6865
0.2000	0.1418	0.3078	1.1070	3.6124	9.7728	2.2251	7.9322	2.2251	7.9322
0.3000	0.2127	0.3940	1.3251	3.3428	8.4361	1.9666	6.6256	1.9666	6.6256
0.4000	0.2836	0.4562	1.4400	3.1272	7.4183	1.7614	5.6354	1.7614	5.6354
0.5000	0.3545	0.5026	1.4957	2.9518	6.6293	1.5958	4.8718	1.5958	4.8718
0.6000	0.4254	0.5384	1.5180	2.8066	6.0066	1.4599	4.2727	1.4599	4.2727
0.7000	0.4963	0.5670	1.5216	2.6845	5.5068	1.3466	3.7948	1.3466	3.7948
0.8000	0.5673	0.5904	1.5150	2.5804	5.0989	1.2509	3.4074	1.2509	3.4074
0.9000	0.6382	0.6102	1.5030	2.4906	4.7609	1.1689	3.0886	1.1689	3.0886
1.0000	0.7091	0.6271	1.4885	2.4121	4.4768	1.0980	2.8226	1.0980	2.8226
1.1000	0.7800	0.6419	1.4729	2.3428	4.2350	1.0359	2.5978	1.0359	2.5978
1.2000	0.8509	0.6549	1.4573	2.2811	4.0268	0.9812	2.4057	0.9812	2.4057
1.3000	0.9218	0.6666	1.4419	2.2257	3.8456	0.9324	2.2397	0.9324	2.2397
1.4000	0.9927	0.6771	1.4272	2.1756	3.6863	0.8887	2.0950	0.8887	2.0950
1.5000	1.0636	0.6867	1.4130	2.1301	3.5453	0.8493	1.9677	0.8493	1.9677
1.6000	1.1345	0.6955	1.3996	2.0884	3.4194	0.8135	1.8550	0.8135	1.8550
1.7000	1.2054	0.7036	1.3869	2.0500	3.3062	0.7809	1.7544	0.7809	1.7544
1.8000	1.2763	0.7111	1.3748	2.0146	3.2039	0.7510	1.6641	0.7510	1.6641
1.9000	1.3472	0.7180	1.3633	1.9818	3.1109	0.7234	1.5826	0.7234	1.5826
2.0000	1.4181	0.7245	1.3525	1.9512	3.0259	0.6980	1.5086	0.6980	1.5086

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.7091
FMax	0.6758	0.4792
F0.1	0.3785	0.2684
F35%SPR	0.6084	0.4314
Flow	0.0567	0.0402
Fmed	0.5732	0.4064
Fhigh	1.7152	1.2162

Weights in kilograms

Table 2.3.1.1 Faroe Bank (sub-division Vb2)COD.Nominal catches(tonnes) by countries 1986-2001 as oficially reported to ICES.From 1992 the catches by Faroe Islands and Norway are used in the assessment.

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Faroe Islands	1,836	3,409	2,960	1,270	289	297	122	264	717	561	2,051	3,459	3,092
Norway	6	23	94	128	72	38	32	2	8	40	55	135 *	147
UK (E/W/NI)	-	-	-	-	-	-	+	1	1	-	- [2]	- [2]	-
UK (Scotland) [1]	63	47	37	14	205	90	176	118	227	551	382	277	265
United Kingdom													
Total	1,905	3,479	3,091	1,412	566	425	330	385	953	1,152	2,488	3,871	3,504
Used in assessment					361	335	154	266	725	601	2,106	3,594	3,239

	1999	2000	2,001
Faroe Islands	1,001		
Norway	88 *	49	200
UK (E/W/NI)	- [2]	[2]	
UK (Scotland)	210		
United Kingdom		- [2]	
Total	1,299	49	200
Used in assessment	1,089	1,243	1,813

*) Preliminary.
1) Includes Vb1
2) Included in Vb1

Table 2.3.1.2 Faroe Bank (sub-division Vb2) COD. Landings of Faroese fleets (in percents) of total Faroese catch (gutted weight)

Year	Open boat	LL<100	ST<400	Gillnet	Jiggers	ST<1000	ST>1000	PT<1000	PT>1000	LL>100	Ind.trwl	Others	Total, gut.w.
1992	0.0	8.0	0.0	0.0	16.0	7.0	7.0	11.0	40.0	11.0	0.0	0.0	100
1993	0.0	9.3	16.9	0.0	4.6	6.3	0.0	5.5	26.6	30.4	0.0	1.3	237
1994	0.5	8.8	31.2	2.6	5.1	8.1	6.4	2.8	20.0	12.6	1.6	0.5	645
1995	1.0	3.6	3.6	0.4	23.0	0.2	9.5	11.1	16.0	31.5	0.0	0.0	505
1996	2.3	1.2	3.2	0.1	24.3	5.0	1.6	23.9	36.7	1.5	0.0	0.1	1846
1997	0.4	1.9	0.4	1.5	11.4	4.5	3.4	16.9	38.4	21.2	0.0	0.0	3101
1998	0.1	3.8	0.5	1.3	5.7	3.1	10.1	12.8	32.4	29.8	0.3	0.0	2783
1999	0.4	10.5	0.1	1.7	17.9	1.8	3.0	0.1	0.9	63.6	0.0	0.1	901
2000	0.3	5.9	0.3	0.0	1.3	0.0	9.3	17.7	51.2	14.0	0.0	0.0	1062
2001	5.9	13.2	3.3	0.7	6.9	4.1	13.2	18	38.6	39.2	0.3	0	1453

Table 2.3.2.5 Faroe Bank (subdivision Vb2)COD. Results of the ASPIC model using the Spring research survey kg/tow as an index of biomass.

Faroe Bank Cod RV — Page 1

06 May 2002 at 15:35.10

ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82) — FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center
101 Pivers Island Road; Beaufort, North Carolina 28516 USA

ASPIC User's Manual is available gratis from the author.

Ref: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	37	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	5.000E+02
Objective function computed:	in effort	Upper bound on MSY:	1.000E+09
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	7.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	2.500E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	2010417
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 10000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) — code 0

Normal convergence.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	0.000E+00	1	N/A	1.000E-01	N/A	
Loss(1) Survey CPUE	4.376E+00	19	2.574E-01	1.000E+00	1.000E+00	0.605
TOTAL OBJECTIVE FUNCTION:	4.22890946E+00					

Number of restarts required for convergence:	61	
Est. B-ratio coverage index (0 worst, 2 best):	1.8097	< These two measures are defined in Prager
Est. B-ratio nearness index (0 worst, 1 best):	1.0000	< et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting biomass ratio, year 1965	7.265E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	2.672E+03	3.000E+03	1	1
r	Intrinsic rate of increase	7.809E-01	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Survey CPUE	3.739E-02	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	2.672E+03	Kr/4	
K	Maximum stock biomass	1.369E+04		
B_{MSY}	Stock biomass at MSY	6.843E+03	K/2	
F_{MSY}	Fishing mortality at MSY	3.905E-01	r/2	
F(0.1)	Management benchmark	3.514E-01	0.9*F_{MSY}	
Y(0.1)	Equilibrium yield at F(0.1)	2.645E+03	0.99*MSY	
B-ratio	Ratio of B(2002) to B_{MSY}	1.944E+00		
F-ratio	Ratio of F(2001) to F_{MSY}	1.953E-04		
F01-mult	Ratio of F(0.1) to F(2001)	4.609E+03		
Y-ratio	Proportion of MSY avail in 2002	1.090E-01	2*Br-Br^2	Ye(2002) = 2.911E+02
....	Fishing effort at MSY in units of each fishery:			
F_{MSY}(1)	Survey CPUE	1.044E+01	r/2q(1)	f(0.1) = 9.399E+00

Table 2.3.2.5 (Cont'd)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to $\mathbf{F}_{MSY}$	Ratio of biomass to $\mathbf{B}_{MSY}$
19	1983	0.523	4.528E+03	4.527E+03	2.367E+03	2.367E+03	2.366E+03	1.339E+00	6.617E-01
20	1984	0.480	4.527E+03	4.617E+03	2.216E+03	2.216E+03	2.389E+03	1.229E+00	6.615E-01
21	1985	0.680	4.700E+03	4.357E+03	2.961E+03	2.961E+03	2.317E+03	1.741E+00	6.868E-01
22	1986	0.448	4.056E+03	4.253E+03	1.905E+03	1.905E+03	2.288E+03	1.147E+00	5.927E-01
23	1987	0.946	4.439E+03	3.678E+03	3.479E+03	3.479E+03	2.091E+03	2.422E+00	6.488E-01
24	1988	1.518	3.052E+03	2.036E+03	3.091E+03	3.091E+03	1.339E+03	3.888E+00	4.460E-01
25	1989	1.702	1.300E+03	8.295E+02	1.412E+03	1.412E+03	6.055E+02	4.360E+00	1.900E-01
26	1990	0.720	4.934E+02	5.016E+02	3.610E+02	3.610E+02	3.773E+02	1.843E+00	7.210E-02
27	1991	0.613	5.097E+02	5.464E+02	3.350E+02	3.350E+02	4.096E+02	1.570E+00	7.449E-02
28	1992	0.199	5.844E+02	7.756E+02	1.540E+02	1.540E+02	5.705E+02	5.086E-01	8.540E-02
29	1993	0.204	1.001E+03	1.304E+03	2.660E+02	2.660E+02	9.195E+02	5.223E-01	1.463E-01
30	1994	0.376	1.654E+03	1.930E+03	7.250E+02	7.250E+02	1.293E+03	9.623E-01	2.418E-01
31	1995	0.218	2.222E+03	2.755E+03	6.010E+02	6.010E+02	1.712E+03	5.587E-01	3.247E-01
32	1996	0.000	3.334E+03	4.438E+03	2.000E+00	2.000E+00	2.316E+03	1.154E-03	4.872E-01
33	1997	0.000	5.648E+03	6.968E+03	3.000E+00	3.000E+00	2.638E+03	1.103E-03	8.254E-01
34	1998	0.000	8.283E+03	9.465E+03	3.000E+00	3.000E+00	2.255E+03	8.118E-04	1.210E+00
35	1999	0.000	1.054E+04	1.135E+04	1.000E+00	1.000E+00	1.502E+03	2.257E-04	1.540E+00
36	2000	0.000	1.204E+04	1.250E+04	1.000E+00	1.000E+00	8.416E+02	2.049E-04	1.759E+00
37	2001	0.000	1.288E+04	1.311E+04	1.000E+00	1.000E+00	4.266E+02	1.953E-04	1.882E+00
38	2002		1.330E+04						1.944E+00

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED)   Survey CPUE

Data type CC: CPUE-catch series   Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
19	1983	7.899E+01	1.693E+02	0.5228	2.367E+03	2.367E+03	0.76210	0.000E+00
20	1984	1.752E+02	1.726E+02	0.4800	2.216E+03	2.216E+03	-0.01503	0.000E+00
21	1985	1.735E+02	1.629E+02	0.6796	2.961E+03	2.961E+03	-0.06293	0.000E+00
22	1986	2.661E+02	1.590E+02	0.4480	1.905E+03	1.905E+03	-0.51500	0.000E+00
23	1987	1.640E+02	1.375E+02	0.9458	3.479E+03	3.479E+03	-0.17633	0.000E+00
24	1988	7.311E+01	7.612E+01	1.5182	3.091E+03	3.091E+03	0.04024	0.000E+00
25	1989	3.655E+01	3.101E+01	1.7023	1.412E+03	1.412E+03	-0.16447	0.000E+00
26	1990	2.324E+01	1.875E+01	0.7197	3.610E+02	3.610E+02	-0.21467	0.000E+00
27	1991	5.097E+01	2.043E+01	0.6131	3.350E+02	3.350E+02	-0.91441	0.000E+00
28	1992	2.843E+01	2.900E+01	0.1986	1.540E+02	1.540E+02	0.01959	0.000E+00
29	1993	2.576E+01	4.877E+01	0.2039	2.660E+02	2.660E+02	0.63836	0.000E+00
30	1994	4.468E+01	7.214E+01	0.3757	7.250E+02	7.250E+02	0.47912	0.000E+00
31	1995	9.532E+01	1.030E+02	0.2182	6.010E+02	6.010E+02	0.07747	0.000E+00
32	1996	3.803E+02	1.659E+02	0.0005	2.000E+00	2.000E+00	-0.82928	0.000E+00
33	1997	5.164E+02	2.605E+02	0.0004	3.000E+00	3.000E+00	-0.68410	0.000E+00
34	1998	6.377E+02	3.539E+02	0.0003	3.000E+00	3.000E+00	-0.58902	0.000E+00
35	1999	3.685E+02	4.243E+02	0.0001	1.000E+00	1.000E+00	0.14093	0.000E+00
36	2000	2.465E+02	4.674E+02	0.0001	1.000E+00	1.000E+00	0.63969	0.000E+00
37	2001	5.373E+02	4.903E+02	0.0001	1.000E+00	1.000E+00	-0.09150	0.000E+00

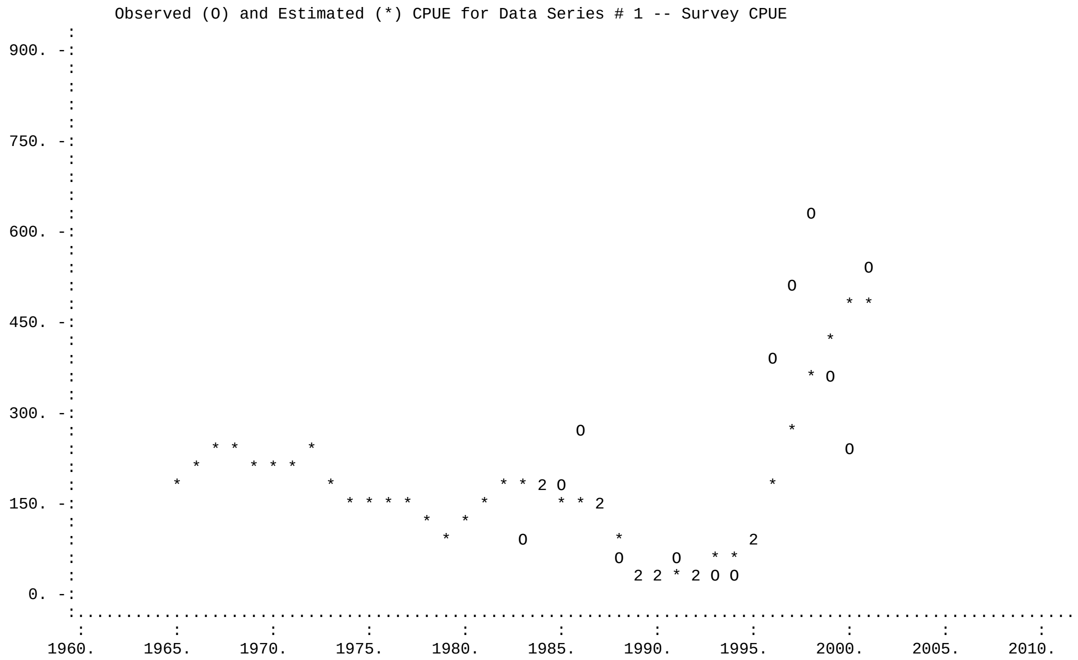
* Asterisk indicates missing value(s).

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    ------------------------------------------------------------------------------------
1983    0.7621                                             |==============================
1984   -0.0150                                            =|
1985   -0.0629                                          ===|
1986   -0.5150                        =====================|
1987   -0.1763                                      =======|
1988    0.0402                                             |==
1989   -0.1645                                      =======|
1990   -0.2147                                    =========|
1991   -0.9144        =====================================|
1992    0.0196                                             |=
1993    0.6384                                             |==========================
1994    0.4791                                             |===================
1995    0.0775                                             |===
1996   -0.8293            =================================|
1997   -0.6841                  ===========================|
1998   -0.5890                     ========================|
1999    0.1409                                             |======
2000    0.6397                                             |==========================
2001   -0.0915                                         ====|
                   ------------------------------------------------------------------------------------
```

Table 2.3.2.5 (Cont'd)

Faroe Bank Cod RV Page 5



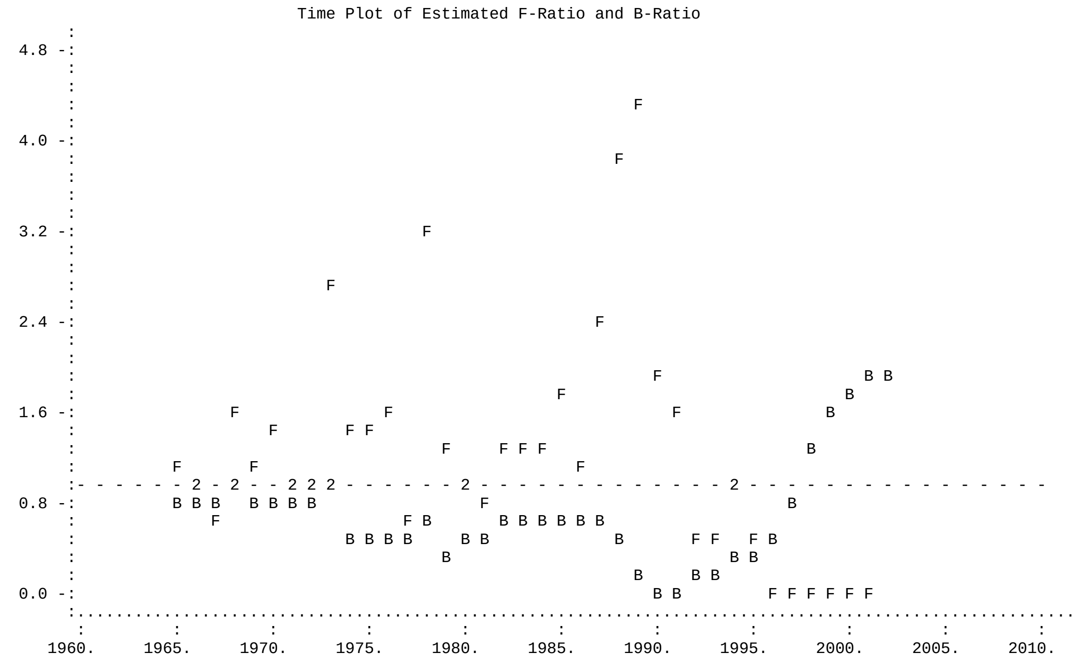


Table 2.4.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2001, as officially reported to ICES , and the total Working Group estimate in Vb.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Denmark	-	-	-	-	1	8	4	-	-	-
Faroe Islands	10,319	11,898	11,418	13,597	13,359	13,954	10,867	13,506	11,106	8,074
France[1]	2	2	20	23	8	22	14	-	-	-
Germany	1	+	+	+	1	1	-	+	+	+
Norway	12	12	10	21	22	13	54	111	94	125
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-
UK (Scotland)[3]	1	-	-	-	-	-	-	-	-	-
United Kingdom										
Total	10,335	11,912	11,448	13,641	13,391	14,000	10,939	13,617	11,207	8,199
Working Group estimate[4,5]	11,937	12,894	12,378	15,143	14,477	14,882	12,178	14,325	11,726	8,429

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001[2]
Faroe Islands	4,655	3,622	3,675	4,549	9,152	16,585	19,135	16,643		
France[1]	164	-					2[2,7]	0		
Germany	-	-		5	-	-				
Greenland								30[6]	22[6]	0[6]
Norway	71	28	22	28	45	45[2]	71[2]	411[2]	355[2]	259
UK (Engl. and Wales)	54	81	31	23	5	22[1]	30[1]	59[7]	19[7]	
UK (Scotland)[3]	-	-	-	-	…	…	…			
United Kingdom										152[6]
Total	4,944	3,731	3,728	4,605	9,202	16,652	19,238	17,143	396	411
Working Group estimate[4,5,8]	5,476	4,026	4,252	4,948	9,642	17,924	22,210	18,482	16,084	16,296

1) Including catches from Sub-division Vb2. Quantity unknown 1989-1991, 1993 and 1995-2001.

2) Provisional data

3)From 1983 to 1996 catches included in Sub-division Vb2.

4) Includes catches from Sub-division Vb2 and Division IIa in Faroese waters.

5)Includes French and Greenlandic catches from Division Vb, as reported to the Faroese coastal guard service

6) Reported as Division Vb, to the Faroese coastal guard service.

7) Reported as Division Vb.

8) Includes Faroese landings reported to the NWWG by the Faroese Fisheries Laboratory

Table 2.4.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries, 1982-2001, as officially reported to ICES, and the total Working Group estimate in Vb2.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Faroe Islands	1,533	967	925	1,474	1,050	832	1,160	659	325	217
France[1]	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-
UK (Scotland)[3]	48	13	+	25	26	45	15	30	725	287
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001[2]
Faroe Islands	338	185	353	303	338	1,133	2,810	1,110		
France[1]	-	-	-	-	-	-				
Norway	23	8	1	1[2]	40[2]	4[2]	60[2]	3[2]	48	64
UK (Engl. and Wales)	+	+	+	...[1]	…[1]	…[1]	…[1]	[1]	[1]	[1]
UK (Scotland)[3]	869	102	170	39	62	135[1]	102	193	[1]	[1]
Total	1,230	295	524	343	440	1,272	2,972	1,306	48	64
Working Group estimate 4)									1,648	1,750

1) Catches included in Sub-division Vb1.

2) Provisional data

3)From 1983 to 1996 includes also catches taken in Sub-division Vb1 (see Table 2.4.1)

4) Includes Faroese landings reported to the NWWG by the Faroese Fisheries Laboratory

Table 2.4.3 Total Faroese landings of haddock from Division Vb and the contribution (%) by each fleet category (metier). In the column to the right are the average haddock percentages of the total landings of all species by each fleet category. Total catch in this table may deviate from official landings.

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Haddock %
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	18
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	38
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	21
Otterboard trawlers < 400HP	1	2	2	2	1	1	2	2	8	8	7	6	3	2	2	4	2	11
Otter board trawlers 400-999HP	6	3	5	4	3	3	1	1	3	2	5	7	6	6	5	5	5	12
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	1
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	7
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	4
Nets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jigging	1	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	1	1
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	6

Table 2.4.4 Haddock in ICES Division Vb 2001

Catch at age in numbers by fleet category

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 400HP	Vb1 OB. trawl. 400-999HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese Pairtrawlers	Vb2 All Faroese Fleets	Vb Foreign Trawlers	Vb Foreign LLiners	Vb Total
1	0	0	18	0	0	0	0	0	1	20	2	0	2	0	1	23
2	187	2255	1074	31	154	48	51	100	202	3900	502	33	508	13	71	4492
3	79	1032	1027	67	147	136	130	184	153	2946	61	92	157	37	68	3208
4	44	509	707	66	124	153	153	251	111	2150	102	138	246	41	47	2484
5	1	17	61	2	4	8	9	20	7	133	16	23	39	2	4	176
6	5	43	152	8	15	21	32	85	18	374	33	30	74	6	10	463
7	14	171	363	36	54	62	97	200	56	1080	33	27	60	17	24	1181
8	28	309	452	67	86	50	83	173	69	1331	22	15	36	13	30	1410
9	1	4	7	0	0	0	1	2	1	16	0	0	1	0	0	17
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	1	5	0	0	0	0	0	0	0	6	0	0	0	0	0	7
12	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1
13	0	0	6	0	0	0	0	0	0	7	0	1	1	0	0	8
14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	369	4345	3866	297	595	479	556	1006	620	11965	772	369	1126	129	255	13475
Catch, t.	215	3760	4419	337	695	536	695	1344	663	12753	881	612	1493	144	291	14881

Notes: Numbers in 1000'

Catch, gutted weight in tonnes

Others includes netters, jiggers, other small categories and catches not otherwise accounted for

LLiners = Longliners OB.trawl. = Otterboard trawlers Pair Trawl. = Pair trawlers

Table 2.4.5

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2002 17:00

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

YEAR,	1961,
AGE	
2,	7932,
3,	7330,
4,	5134,
5,	1937,
6,	1305,
7,	838,
8,	236,
9,	59,
+gp,	0,
TOTALNUM,	24771,
TONSLAND,	20831,
SOPCOF %,	89,

AGE										
2,	9631,	13552,	2284,	1368,	1081,	1425,	5881,	2384,	1728,	717,
3,	13977,	8907,	7457,	4286,	3304,	2405,	4097,	7539,	4855,	4393,
4,	5233,	7403,	3899,	5133,	4804,	2599,	2812,	4567,	6581,	4727,
5,	2361,	2242,	2360,	1443,	2710,	1785,	1524,	1565,	1624,	3267,
6,	1407,	1539,	1120,	1209,	1112,	1426,	1526,	1485,	1383,	1292,
7,	868,	860,	728,	673,	740,	631,	923,	1224,	1099,	864,
8,	270,	257,	198,	1345,	180,	197,	230,	378,	326,	222,
9,	72,	75,	49,	43,	54,	52,	68,	114,	68,	147,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
TOTALNUM,	33819,	34835,	18095,	15500,	13985,	10520,	17061,	19256,	17664,	15629,
TONSLAND,	27151,	27571,	19490,	18479,	18766,	13381,	17852,	23272,	21361,	19393,
SOPCOF %,	90,	90,	101,	94,	109,	102,	103,	108,	103,	99,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	750,	3300,	5633,	7337,	4396,	255,	32,	1,	143,	74,
3,	3744,	8388,	2899,	7952,	7858,	4039,	1022,	1161,	58,	455,
4,	4179,	1236,	3970,	2097,	6798,	5168,	4248,	1754,	3724,	202,
5,	2706,	2786,	451,	1371,	1251,	4918,	4054,	3341,	2583,	2586,
6,	1171,	916,	976,	247,	1189,	2128,	1841,	1850,	2496,	1354,
7,	696,	1051,	466,	352,	298,	946,	717,	772,	1568,	1559,
8,	180,	150,	535,	237,	720,	443,	635,	212,	660,	608,
9,	113,	68,	68,	419,	258,	731,	243,	155,	99,	177,
+gp,	0,	11,	147,	187,	318,	855,	312,	74,	86,	36,
TOTALNUM,	13539,	17906,	15145,	20199,	23086,	19483,	13104,	9320,	11417,	7051,
TONSLAND,	16485,	17976,	14773,	20715,	26211,	25555,	19200,	12418,	15016,	12233,
SOPCOF %,	98,	98,	97,	117,	107,	98,	99,	104,	100,	109,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	539,	441,	1195,	985,	230,	283,	655,	63,	105,	77,
3,	934,	1969,	1561,	4553,	2549,	1718,	444,	1518,	1275,	1044,
4,	784,	383,	2462,	2196,	4452,	3565,	2463,	658,	1921,	1774,
5,	298,	422,	147,	1242,	1522,	2972,	3036,	2787,	768,	1248,
6,	2182,	93,	234,	169,	738,	1114,	2140,	2554,	1737,	651,
7,	973,	1444,	42,	91,	39,	529,	475,	1976,	1909,	1101,
8,	1166,	740,	861,	61,	130,	83,	151,	541,	885,	698,
9,	1283,	947,	388,	503,	71,	48,	18,	133,	270,	317,
+gp,	214,	795,	968,	973,	712,	334,	128,	81,	108,	32,
TOTALNUM,	8373,	7234,	7858,	10773,	10443,	10646,	9510,	10311,	8978,	6942,
TONSLAND,	11937,	12894,	12378,	15143,	14477,	14882,	12178,	14325,	11726,	8429,
SOPCOF %,	92,	106,	106,	106,	101,	102,	97,	100,	102,	106,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	40,	113,	277,	804,	326,	77,	106,	174,	1489,	4492,
3,	154,	298,	191,	452,	5234,	2913,	1055,	1142,	3112,	3208,
4,	776,	274,	307,	235,	1019,	10517,	5269,	942,	213,	2484,
5,	1120,	554,	153,	226,	179,	710,	9856,	4677,	693,	178,
6,	959,	538,	423,	132,	163,	116,	446,	6619,	2730,	463,
7,	335,	474,	427,	295,	161,	123,	99,	226,	2894,	1181,
8,	373,	131,	383,	290,	270,	93,	87,	26,	80,	1410,
9,	401,	201,	125,	262,	234,	220,	95,	20,	1,	17,
+gp,	162,	185,	301,	295,	394,	516,	502,	192,	72,	18,
TOTALNUM,	4320,	2768,	2587,	2991,	7980,	15285,	17515,	14018,	11284,	13451,
TONSLAND,	5476,	4026,	4252,	4948,	9642,	17924,	22210,	18482,	16084,	16296,
SOPCOF %,	106,	104,	100,	103,	100,	103,	101,	100,	104,	100,

Table 2.4.6

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2002 17:00

Table 2 Catch weights at age (kg)

YEAR,	1961,
AGE	
2,	.4700,
3,	.7300,
4,	1.1300,
5,	1.5500,
6,	1.9700,
7,	2.4100,
8,	2.7600,
9,	3.0700,
+gp,	3.5500,
SOPCOFAC,	.8938,

Table 2 Catch weights at age (kg)

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,
SOPCOFAC,	.9011,	.8964,	1.0131,	.9401,	1.0920,	1.0166,	1.0278,	1.0835,	1.0274,	.9874,

Table 2 Catch weights at age (kg)

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.3110,	.3570,	.3570,	.6430,	.4520,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.6330,	.7900,	.6720,	.7130,	.7250,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,	.9410,	.9570,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,
SOPCOFAC,	.9795,	.9776,	.9718,	1.1712,	1.0746,	.9784,	.9947,	1.0380,	1.0017,	1.0870,

Table 2 Catch weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.7000,	.4700,	.6810,	.5280,	.6080,	.6050,	.5010,	.5800,	.4380,	.5470,
3,	.8960,	.7400,	1.0110,	.8590,	.8870,	.8310,	.7810,	.7790,	.6990,	.6930,
4,	1.1500,	1.0100,	1.2550,	1.3910,	1.1750,	1.1260,	.9740,	.9230,	.9390,	.8840,
5,	1.4440,	1.3200,	1.8120,	1.7770,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,
6,	1.4980,	1.6600,	2.0610,	2.3260,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,
7,	1.8290,	2.0500,	2.0590,	2.4400,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,
8,	1.8870,	2.2600,	2.1370,	2.4010,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,
9,	1.9610,	2.5400,	2.3680,	2.5320,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,
+gp,	2.8560,	3.0400,	2.6860,	2.6860,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,
SOPCOFAC,	.9238,	1.0554,	1.0602,	1.0559,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,

Table 2 Catch weights at age (kg)

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.5250,	.7550,	.7540,	.6660,	.5340,	.5190,	.6220,	.5040,	.6610,	.6080,
3,	.7240,	.9820,	1.1030,	1.0540,	.8580,	.7710,	.8460,	.6240,	.9360,	.9400,
4,	.8170,	1.0270,	1.2540,	1.4890,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,
5,	1.0380,	1.1920,	1.4650,	1.7790,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,
6,	1.2490,	1.3780,	1.5930,	1.9400,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,
7,	1.4300,	1.6430,	1.8040,	2.1820,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,
8,	1.5640,	1.7960,	2.0490,	2.3570,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,
9,	1.6330,	1.9710,	2.2250,	2.4900,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,
+gp,	2.1260,	2.2400,	2.4230,	2.6780,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,
SOPCOFAC,	1.0554,	1.0361,	.9969,	1.0331,	1.0043,	1.0250,	1.0106,	.9975,	1.0362,	.9964,

Table 2.4.7

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2002 17:00

Table 5 Proportion mature at age

YEAR,	1961,
AGE	
2,	.0600,
3,	.4800,
4,	.9100,
5,	1.0000,
6,	1.0000,
7,	1.0000,
8,	1.0000,
9,	1.0000,
+gp,	1.0000,

Table 5 Proportion mature at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.0700,	.0800,	.0800,	.0300,	.0300,	.0500,	.0500,	.0200,	.0800,	.1600,
3,	.5200,	.6200,	.7600,	.6200,	.4300,	.3200,	.2400,	.2200,	.3700,	.5800,
4,	.8800,	.8900,	.9800,	.9600,	.9500,	.9100,	.8900,	.8700,	.9000,	.9300,
5,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9800,	.9800,	.9900,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.1800,	.1500,	.1200,	.1000,	.0600,	.0200,	.0100,	.0100,	.0200,	.0900,
3,	.6500,	.5300,	.5000,	.5500,	.5700,	.5500,	.4500,	.4100,	.3800,	.5400,
4,	.9100,	.9000,	.9200,	.9700,	.9500,	.9300,	.8900,	.8600,	.8700,	.9300,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.4.8

VPA results for Faroe haddock in 2002 using different fleets and combination of fleets for tuning

Fishing mortalities age 3-7

Years	Spaly shr .5	LL,PT,Surv shr .3	LL,PT,Surv shr .5	LL,PT,Surv shr .7	LL,PT,Surv shr 2.0	Surv shr .3	Surv shr .5	Surv shr .7	LL shr .5	PT shr .5	Average	Min	Max
1990	0.3002	0.2879	0.2909	0.2912	0.3506	0.2741	0.2749	0.2758	0.3084	0.2848	0.29388	0.2741	0.3506
1991	0.3075	0.2925	0.2959	0.2961	0.3562	0.2763	0.2778	0.2796	0.3098	0.279	0.29707	0.2763	0.3562
1992	0.2377	0.2252	0.2269	0.2264	0.2721	0.2122	0.2136	0.2153	0.2361	0.2052	0.22707	0.2052	0.2721
1993	0.2029	0.1959	0.1957	0.1938	0.2216	0.1892	0.1905	0.1916	0.201	0.1811	0.19633	0.1811	0.2216
1994	0.2164	0.212	0.2101	0.2067	0.2281	0.2083	0.2097	0.211	0.2158	0.2013	0.21194	0.2013	0.2281
1995	0.2356	0.2321	0.2322	0.2296	0.2461	0.2286	0.2301	0.231	0.2341	0.2253	0.23247	0.2253	0.2461
1996	0.3316	0.3311	0.3244	0.3178	0.3326	0.3304	0.3291	0.3224	0.3321	0.3272	0.32787	0.3178	0.3326
1997	0.3935	0.3991	0.3787	0.363	0.3677	0.4034	0.3971	0.3802	0.4	0.3933	0.3876	0.363	0.4034
1998	0.5872	0.5962	0.559	0.5389	0.5335	0.6069	0.5899	0.5586	0.6028	0.575	0.5748	0.5335	0.6069
1999	0.5916	0.6185	0.5436	0.5166	0.5464	0.6477	0.6139	0.5528	0.6305	0.5556	0.58172	0.5166	0.6477
2000	0.4202	0.4448	0.361	0.3414	0.3736	0.483	0.4281	0.3604	0.4677	0.3694	0.40496	0.3414	0.483
2001	0.3949	0.4348	0.3855	0.3781	0.426	0.4903	0.4464	0.4092	0.4621	0.3188	0.41461	0.3188	0.4903

VPA results for Faroe haddock in 2002 using different fleets and combination of fleets for tuning

Spawning stock biomass

Years	Spaly shr .5	LL,PT,Surv shr .3	LL,PT,Surv shr .5	LL,PT,Surv shr .7	LL,PT,Surv shr 2.0	Surv shr .3	Surv shr .5	Surv shr .7	LL shr .5	PT shr .5	Average	Min	Max
1990	40428	41820	41498	41496	36022	43531	43420	43302	39435	42429	41338.1	36022	43531
1991	31593	32896	32672	32738	27684	34452	34307	34133	31012	34121	32560.8	27684	34452
1992	24049	25298	25063	25116	20292	26770	26605	26401	23562	26433	24958.9	20292	26770
1993	20739	21955	21730	21800	17646	23388	23207	22993	20651	23549	21765.8	17646	23549
1994	19324	20531	20369	20468	16721	22026	21849	21664	19476	22819	20524.7	16721	22819
1995	24263	25227	25703	26115	22656	26323	26339	26690	24448	27974	25573.8	22656	27974
1996	49339	49499	53000	54690	51232	49466	50510	53564	48810	51640	51175	48810	54690
1997	71674	71412	77354	79839	75769	70802	73194	78897	70321	74361	74362.3	70321	79839
1998	67116	66150	73776	76818	72839	64534	68052	75522	64785	69111	69870.3	64534	76818
1999	46925	45596	53676	57203	53765	43650	47364	55069	44194	48849	49629.1	43650	57203
2000	35976	34325	42690	46143	43124	32245	35973	43963	33112	39561	38711.2	32245	46143
2001	44180	41889	48273	50055	43213	39623	40793	47648	41164	50685	44752.3	39623	50685

VPA results for Faroe haddock in 2002 using different fleets and combination of fleets for tuning

Recruitment at age 2

Years	Spaly shr .5	LL,PT,Surv shr .3	LL,PT,Surv shr .5	LL,PT,Surv shr .7	LL,PT,Surv shr 2.0	Surv shr .3	Surv shr .5	Surv shr .7	LL shr .5	PT shr .5	Average	Min	Max
1990	8932	9180	9002	8969	8312	9449	9300	9046	9054	9686	9093	8312	9686
1991	2885	2928	2918	2918	2727	2963	2955	2971	2910	2963	2913.8	2727	2971
1992	2662	2647	2692	2757	2735	2641	2646	2682	2650	2650	2676.2	2641	2757
1993	1820	1819	1823	1829	1846	1818	1819	1823	1819	1821	1823.7	1818	1846
1994	6330	6285	6396	6465	6402	6258	6285	6360	6284	6354	6341.9	6258	6465
1995	79841	79258	86534	89465	86845	78388	81091	88670	78821	80531	82944.4	78388	89465
1996	39082	37978	41845	43219	41224	36233	38793	41938	36505	40564	39738.1	36233	43219
1997	7332	7275	7626	7781	7537	7063	7334	7697	6983	8199	7482.7	6983	8199
1998	3063	2965	2991	3006	2971	2901	2861	2878	2995	3250	2988.1	2861	3250
1999	18294	17596	17097	16669	15403	17880	16918	16455	18854	22172	17733.8	15403	22172
2000	20245	18198	17824	17072	15058	17866	17120	16610	19853	20751	18059.7	15058	20751
2001	106833	118880	86441	68619	47887	117169	83011	67063	104309	112956	91316.8	47887	118880

Table 2.4.9

Haddock in the Faroe Ground (Fishing Area Vb)
103
5LL_01: 5lline>100GRT cod-had rev 2001 (Catch: Numbers*1000) (Effort: 1000 hooks)
1990 2001
1 1 0.0 1.0
4 8

20090	126.710	58.614	125.417	152.570	74.992
16593	129.226	110.919	62.998	110.919	66.228
16421	46.103	107.745	93.759	47.139	35.224
17702	33.698	75.974	82.101	76.587	12.254
14797	37.480	17.569	39.823	41.385	35.528
16814	18.490	22.972	15.408	28.855	30.256
26212	121.333	22.515	20.639	14.072	34.711
36201	1661.236	142.178	26.191	30.400	19.175
38602	838.633	1953.830	107.787	21.032	26.815
32667	127.022	784.727	1119.309	41.403	5.279
38070	31.447	99.119	452.137	557.579	10.093
36146	258.073	22.164	55.365	132.468	165.004

CUBA_01: Pair trawlers > 1000 HP (Catch: Thousands) (Effort: Trawl-hours)
1990 2001
1 1 0.0 1.0
5 7

6532	15.603	42.909	50.432
6892	49.092	28.172	35.424
6560	36.655	51.317	17.749
8299	28.069	37.996	41.762
13871	18.049	75.014	72.194
16215	30.072	16.403	45.564
15087	15.613	13.383	13.383
24406	77.593	4.619	10.161
27274	1074.649	38.843	8.239
28131	428.992	506.231	17.914
21208	77.675	384.309	338.275
21887	21.629	69.735	215.637

SUMMER SURVEY
1996 2001
1 1 0.6 0.7
1 8

200	13437.69	68536.90	61942.72	1089.00	195.27	268.26	223.03	387.00
200	386.18	15494.51	28220.30	48488.59	845.37	173.32	79.23	157.68
200	17894.07	2026.20	3494.10	14944.97	19198.77	290.63	89.47	72.41
200	20671.12	16303.90	6263.69	1606.53	9075.80	10240.79	210.10	7.65
200	162660.00	18907.03	8597.62	425.81	1338.06	4749.13	5801.99	80.13
200	94011.65	102494.50	11830.83	4393.10	173.69	630.37	2621.33	3211.11

Table 2.4.10

```
Lowestoft VPA Version 3.1

   7/05/2002  16:58

 Extended Survivors Analysis

 FAROE HADDOCK (ICES DIVISION Vb)                 HAD_IND

 CPUE data from file tuna_02.dat

 Catch data for  41 years. 1961 to 2001. Ages  2 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2001,   1,     8,   .600,   .700


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    6


 Terminal population estimation :

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

      S.E. of the mean to which the estimates  are shrunk =   2.000

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

      Prior weighting not applied


 Tuning converged after   40 iterations


 Regression weights
       ,  .954,  .976,  .990,  .997, 1.000, 1.000


 Fishing mortalities



    Age,  1996,  1997,  1998,  1999,  2000,  2001

      2,  .008,  .011,  .042,  .012,  .100,  .056
      3,  .077,  .089,  .198,  .828,  .296,  .325
      4,  .362,  .220,  .229,  .273,  .348,  .410
      5,  .412,  .464,  .331,  .328,  .332,  .552
      6,  .344,  .518,  .603,  .389,  .324,  .388
      7,  .346,  .475, 1.227,  .718,  .293,  .226
      8,  .381,  .344,  .746, 1.487,  .605,  .226
      9,  .371,  .618,  .719,  .373,  .175,  .243


XSA population numbers (Thousands)

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

 1996 ,    4.67E+04, 7.76E+04, 3.71E+03, 5.85E+02, 6.19E+02, 6.09E+02, 9.42E+02, 8.34E+02,
 1997 ,    8.00E+03, 3.79E+04, 5.88E+04, 2.11E+03, 3.17E+02, 3.59E+02, 3.53E+02, 5.27E+02,
 1998 ,    2.85E+03, 6.48E+03, 2.84E+04, 3.86E+04, 1.09E+03, 1.55E+02, 1.83E+02, 2.05E+02,
 1999 ,    1.66E+04, 2.24E+03, 4.35E+03, 1.85E+04, 2.27E+04, 4.88E+02, 3.71E+01, 7.10E+01,
 2000 ,    1.72E+04, 1.34E+04, 8.02E+02, 2.71E+03, 1.09E+04, 1.26E+04, 1.95E+02, 6.87E+00,
 2001 ,    9.11E+04, 1.28E+04, 8.16E+03, 4.64E+02, 1.59E+03, 6.46E+03, 7.69E+03, 8.71E+01,

 Estimated population abundance at 1st Jan 2002

    ,     0.00E+00, 7.05E+04, 7.55E+03, 4.44E+03, 2.19E+02, 8.84E+02, 4.22E+03, 5.02E+03,

 Taper weighted geometric mean of the VPA populations:

    ,     1.24E+04, 8.31E+03, 5.49E+03, 3.48E+03, 2.57E+03, 1.58E+03, 7.57E+02, 3.30E+02,

 Standard error of the weighted Log(VPA populations) :

    ,       1.3061,   1.1958,   1.3177,   1.3777,   1.2678,   1.3289,   1.4806,   1.6498,
```

Table 2.4.10 (cont.)

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1996	1997	1998	1999	2000	2001
2	.22	.50	-.49	-.18	-.01	-.02
3	-.27	-.33	-.58	1.47	-.35	.04
4	-.47	.47	.02	-.30	.11	.16
5	-.24	-.03	.10	.09	.10	-.04
6	.00	.34	-.32	.07	-.01	-.07
7	-.17	-.59	.86	.23	.02	-.15
8	-.03	.03	.17	-.01	.11	-.12

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

Age	2	3	4	5	6	7	8
Mean Log q	-4.9969	-5.0734	-5.6850	-5.7566	-5.7771	-5.7771	-5.7771
S.E(Log q)	.3356	.7536	.3367	.1324	.2132	.4892	.1068

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.92	.701	5.39	.95	6	.32	-5.00
3	1.64	-1.672	2.25	.64	6	1.05	-5.07
4	.91	1.080	5.99	.97	6	.30	-5.69
5	.95	2.198	5.88	1.00	6	.09	-5.76
6	1.02	-.298	5.74	.98	6	.24	-5.78
7	1.09	-.644	5.62	.92	6	.57	-5.74
8	1.04	-1.558	5.74	1.00	6	.09	-5.75

Terminal year survivor and F summaries :

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

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	69320.	.363	.000	.00	1	.966	.057
F shrinkage mean	115625.	2.00				.034	.035

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
70523.	.36	.09	2	.263	.056

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

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	7518.	.332	.021	.06	2	.960	.326
F shrinkage mean	8313.	2.00				.040	.300

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7548.	.33	.02	3	.062	.325

Table 2.4.10 (cont.)

```
Age  4   Catchability constant w.r.t. time and dependent on age
 Year class = 1997
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      4387.,   .248,       .135,    .54,   3,  .974,     .414
   F shrinkage mean  ,      6730.,   2.00,,,,                         .026,     .288
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4435.,       .25,      .12,    4,    .467,   .410

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

 Year class = 1996
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       216.,   .207,       .167,    .81,   4,  .978,     .557
   F shrinkage mean  ,       353.,   2.00,,,,                         .022,     .376
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       219.,       .21,      .15,    5,    .713,   .552

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

 Year class = 1995
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       886.,   .168,       .119,    .71,   5,  .987,     .387
   F shrinkage mean  ,       761.,   2.00,,,,                         .013,     .439
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       884.,       .17,      .11,    6,    .631,   .388

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

 Year class = 1994
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      4287.,   .163,       .051,    .31,   6,  .987,     .223
   F shrinkage mean  ,      1252.,   2.00,,,,                         .013,     .617
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4219.,       .16,      .07,    7,    .454,   .226

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

 Year class = 1993
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      5107.,   .164,       .074,    .45,   6,  .988,     .223

   F shrinkage mean  ,      1212.,   2.00,,,,                         .012,     .719
 Weighted prediction :
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      5020.,       .16,      .09,    7,    .567,   .226

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

 Year class = 1992
 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        57.,   .197,       .099,    .50,   5,  .969,     .240


   F shrinkage mean  ,        35.,   2.00,,,,                         .031,     .363

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       56.,       .20,      .09,    6,    .474,   .243
```

Table 2.4.11

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2002 17:00

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,
AGE	
2,	.1875,
3,	.4162,
4,	.4209,
5,	.4387,
6,	.5879,
7,	.9483,
8,	.8742,
9,	.6600,
+gp,	.6600,
FBAR 3- 7,	.5624,

Table 8 Fishing mortality (F) at age

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	.3232,	.3801,	.0876,	.0691,	.0609,	.0641,	.1261,	.0860,	.0552,	.0527,
3,	.5866,	.5639,	.3723,	.2354,	.2370,	.1873,	.2647,	.2364,	.2529,	.1937,
4,	.5980,	.7261,	.5193,	.4767,	.4515,	.2971,	.3483,	.5320,	.3345,	.4187,
5,	.3480,	.5591,	.5369,	.3678,	.5006,	.2997,	.2847,	.3330,	.3639,	.2756,
6,	.6706,	.4026,	.6107,	.5882,	.5421,	.5406,	.4540,	.4975,	.5559,	.5560,
7,	1.0499,	1.2493,	.3375,	.9618,	.9128,	.6906,	.8367,	.8276,	.8740,	.8378,
8,	.9736,	1.1139,	1.2027,	2.3618,	.7509,	.6634,	.5851,	1.0631,	.5429,	.4224,
9,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5060,
+gp,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5060,
FBAR 3- 7,	.6506,	.7002,	.4753,	.5260,	.5288,	.4030,	.4377,	.4853,	.4762,	.4564,

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	.0253,	.1672,	.1267,	.1230,	.0908,	.0108,	.0010,	.0004,	.0325,	.0237,
3,	.4228,	.4309,	.2172,	.2650,	.1879,	.1128,	.0547,	.0457,	.0285,	.1374,
4,	.2855,	.2385,	.3730,	.2412,	.3810,	.1815,	.1666,	.1255,	.2025,	.1315,
5,	.4520,	.3134,	.1279,	.2116,	.2216,	.5274,	.2116,	.1913,	.2750,	.2112,
6,	.1495,	.2695,	.1714,	.0957,	.2871,	.7247,	.3820,	.1408,	.2136,	.2265,
7,	.6721,	.1946,	.2134,	.0859,	.1601,	.3904,	.5761,	.2722,	.1702,	.2005,
8,	.4059,	.2907,	.1433,	.1599,	.2539,	.3788,	.4968,	.3304,	.3955,	.0920,
9,	.3957,	.2627,	.2068,	.1595,	.2621,	.4438,	.3690,	.2130,	.2527,	.1731,
+gp,	.3957,	.2627,	.2068,	.1595,	.2621,	.4438,	.3690,	.2130,	.2527,	.1731,
FBAR 3- 7,	.3964,	.2894,	.2206,	.1799,	.2476,	.3874,	.2782,	.1551,	.1780,	.1814,

Table 8 Fishing mortality (F) at age

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	.0384,	.0252,	.0330,	.0281,	.0097,	.0338,	.0394,	.0050,	.0130,	.0285,
3,	.4619,	.1917,	.1168,	.1695,	.0943,	.0928,	.0681,	.1206,	.1317,	.1732,
4,	.3710,	.3482,	.3898,	.2394,	.2493,	.1851,	.1868,	.1364,	.2209,	.2733,
5,	.2919,	.3500,	.2172,	.3477,	.2601,	.2625,	.2376,	.3338,	.2336,	.2183,
6,	.2776,	.1384,	.3338,	.4166,	.3592,	.3086,	.3065,	.3223,	.3590,	.3180,
7,	.2524,	.2992,	.0854,	.2085,	.1574,	.4754,	.2086,	.5183,	.4265,	.4070,
8,	.2267,	.3103,	.2931,	.1721,	.5184,	.5855,	.2385,	.3896,	.4645,	.2712,
9,	.2855,	.2908,	.2653,	.2784,	.3107,	.3658,	.2368,	.3422,	.3430,	.2993,
+gp,	.2855,	.2908,	.2653,	.2784,	.3107,	.3658,	.2368,	.3422,	.3430,	.2993,
FBAR 3- 7,	.3310,	.2655,	.2286,	.2763,	.2241,	.2649,	.2015,	.2863,	.2743,	.2780,

Table 8 Fishing mortality (F) at age

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
2,	.0160,	.0704,	.0486,	.0093,	.0078,	.0107,	.0419,	.0117,	.1003,	.1190,
3,	.0731,	.1587,	.1632,	.1046,	.0775,	.0887,	.1984,	.8280,	.2964,	.3254,
4,	.1884,	.1802,	.2439,	.3099,	.3619,	.2203,	.2294,	.2735,	.3476,	.4100,
5,	.2775,	.1994,	.1446,	.2855,	.4125,	.4638,	.3314,	.3279,	.3321,	.5521,
6,	.2600,	.2078,	.2304,	.1791,	.3440,	.5177,	.6029,	.3891,	.3239,	.3878,
7,	.2683,	.1976,	.2535,	.2494,	.3455,	.4754,	1.2274,	.7176,	.2931,	.2258,
8,	.2330,	.1590,	.2428,	.2736,	.3807,	.3442,	.7463,	1.4866,	.6047,	.2265,
9,	.2467,	.1896,	.2241,	.2609,	.3713,	.6181,	.7186,	.3731,	.1753,	.2429,
+gp,	.2467,	.1896,	.2241,	.2609,	.3713,	.6181,	.7186,	.3731,	.1753,	.2429,
FBAR 3- 7,	.2135,	.1887,	.2071,	.2257,	.3083,	.3532,	.5179,	.5072,	.3186,	.3802,

Table 2.4.12

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2002 17:00

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,
AGE	
2,	51279,
3,	23796,
4,	16517,
5,	6028,
6,	3245,
7,	1512,
8,	448,
9,	135,
+gp,	0,
TOTAL,	102958,

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

YEAR,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,
AGE										
2,	38537,	47362,	30110,	22644,	20206,	25356,	54842,	31968,	35581,	15450,
3,	34806,	22837,	26515,	22586,	17302,	15565,	19470,	39580,	24016,	27568,
4,	12850,	15850,	10638,	14961,	14613,	11176,	10567,	12234,	25584,	15270,
5,	8877,	5786,	6278,	5182,	7605,	7618,	6798,	6107,	5884,	14991,
6,	3182,	5132,	2708,	3005,	2937,	3774,	4622,	4187,	3584,	3348,
7,	1476,	1332,	2809,	1204,	1366,	1398,	1800,	2403,	2084,	1683,
8,	480,	423,	313,	1641,	377,	449,	574,	638,	860,	712,
9,	153,	148,	114,	77,	127,	146,	189,	262,	180,	409,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
TOTAL,	100361,	98871,	79485,	71299,	64532,	65481,	98862,	97379,	97774,	79431,

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

YEAR,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE										
2,	33175,	23690,	52332,	70044,	55961,	26187,	35091,	2783,	4943,	3490,
3,	12001,	26483,	16410,	37749,	50708,	41839,	21209,	28701,	2277,	3917,
4,	18596,	6437,	14092,	10812,	23711,	34406,	30601,	16440,	22448,	1812,
5,	8224,	11444,	4152,	7946,	6955,	13262,	23493,	21210,	11873,	15009,
6,	9318,	4285,	6848,	2991,	5265,	4562,	6408,	15567,	14342,	7383,
7,	1572,	6569,	2680,	4724,	2226,	3235,	1810,	3581,	11071,	9484,
8,	596,	657,	4427,	1772,	3549,	1553,	1792,	833,	2233,	7645,
9,	382,	325,	402,	3141,	1236,	2254,	870,	893,	490,	1231,
+gp,	0,	52,	865,	1396,	1515,	2613,	1109,	424,	423,	249,
TOTAL,	83864,	79943,	102210,	140575,	151126,	129911,	122383,	90431,	70100,	50222,

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

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
2,	15829,	19599,	40732,	39319,	26410,	9422,	18755,	14022,	8976,	3033,
3,	2790,	12472,	15648,	32267,	31300,	21415,	7458,	14763,	11423,	7254,
4,	2796,	1440,	8430,	11399,	22298,	23320,	15978,	5704,	10713,	8199,
5,	1301,	1579,	832,	4674,	7345,	14228,	15867,	10853,	4075,	7033,
6,	9949,	795,	911,	548,	2703,	4637,	8960,	10244,	6364,	2641,
7,	4820,	6171,	567,	534,	296,	1545,	2788,	5399,	6076,	3639,
8,	6354,	3066,	3746,	426,	355,	207,	786,	1853,	2632,	3247,
9,	5709,	4147,	1840,	2288,	294,	173,	94,	507,	1028,	1355,
+gp,	946,	3459,	4564,	4398,	2927,	1196,	667,	307,	408,	136,
TOTAL,	50494,	52729,	77269,	95853,	93929,	76142,	71355,	63652,	51696,	36537,

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

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE											
2,	2785,	1837,	6449,	95646,	46666,	8000,	2855,	16570,	17236,	44235,	0,
3,	2414,	2244,	1401,	5029,	77581,	37912,	6480,	2241,	13409,	12764,	32152,
4,	4994,	1837,	1568,	975,	3709,	58782,	28404,	4351,	802,	8163,	7548,
5,	5108,	3387,	1256,	1006,	585,	2114,	38610,	18488,	2710,	464,	4435,
6,	4629,	3168,	2272,	890,	619,	317,	1089,	22693,	10905,	1592,	219,
7,	1573,	2922,	2107,	1477,	609,	359,	155,	488,	12591,	6458,	884,
8,	1983,	985,	1964,	1339,	942,	353,	183,	37,	195,	7690,	4219,
9,	2027,	1286,	688,	1261,	834,	527,	205,	71,	7,	87,	5020,
+gp,	814,	1178,	1648,	1411,	1393,	1222,	1068,	676,	493,	92,	115,
TOTAL,	26327,	18844,	19352,	109034,	132938,	109588,	79048,	65616,	58346,	128409,	92963,

Table 2.4.13

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND ,

At 7/05/2002 17:00

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 7,
1961,	51279,	81164,	47797,	20831,	.4358,	.5624,
1962,	38537,	83420,	51875,	27151,	.5234,	.6506,
1963,	47362,	80753,	49547,	27571,	.5565,	.7002,
1964,	30110,	68577,	44128,	19490,	.4417,	.4753,
1965,	22644,	65655,	45555,	18479,	.4056,	.5260,
1966,	20206,	60934,	43953,	18766,	.4270,	.5288,
1967,	25356,	60206,	41959,	13381,	.3189,	.4030,
1968,	54842,	78074,	45379,	17852,	.3934,	.4377,
1969,	31968,	83813,	53421,	23272,	.4356,	.4853,
1970,	35581,	87296,	59858,	21361,	.3569,	.4762,
1971,	15450,	81750,	62906,	19393,	.3083,	.4564,
1972,	33175,	83077,	61974,	16485,	.2660,	.3964,
1973,	23690,	82750,	61576,	17976,	.2919,	.2894,
1974,	52332,	95411,	64629,	14773,	.2286,	.2206,
1975,	70044,	121777,	75402,	20715,	.2747,	.1799,
1976,	55961,	135597,	89213,	26211,	.2938,	.2476,
1977,	26187,	121022,	96362,	25555,	.2652,	.3874,
1978,	35091,	120549,	97210,	19200,	.1975,	.2782,
1979,	2783,	97662,	85376,	12418,	.1455,	.1551,
1980,	4943,	87614,	81881,	15016,	.1834,	.1780,
1981,	3490,	78938,	75822,	12233,	.1613,	.1814,
1982,	15829,	68281,	56391,	11937,	.2117,	.3310,
1983,	19599,	63929,	51787,	12894,	.2490,	.2655,
1984,	40732,	83312,	53785,	12378,	.2301,	.2286,
1985,	39319,	93846,	62541,	15143,	.2421,	.2763,
1986,	26410,	98334,	65503,	14477,	.2210,	.2241,
1987,	9422,	87446,	67150,	14882,	.2216,	.2649,
1988,	18755,	77224,	61726,	12178,	.1973,	.2015,
1989,	14022,	69312,	51557,	14325,	.2778,	.2863,
1990,	8976,	53160,	43506,	11726,	.2695,	.2743,
1991,	3033,	38335,	34322,	8429,	.2456,	.2780,
1992,	2785,	28766,	26588,	5476,	.2060,	.2135,
1993,	1837,	25624,	23221,	4026,	.1734,	.1887,
1994,	6449,	27181,	21972,	4252,	.1935,	.2071,
1995,	95646,	87266,	27507,	4948,	.1799,	.2257,
1996,	46666,	109174,	56856,	9642,	.1696,	.3083,
1997,	8000,	106872,	85262,	17924,	.2102,	.3532,
1998,	2855,	92226,	83783,	22210,	.2651,	.5179,
1999,	16570,	73833,	63921,	18482,	.2891,	.5072,
2000,	17236,	72504,	53395,	16084,	.3012,	.3186,
2001,	44235,	86609,	55831,	16296,	.2919,	.3802,
Arith. Mean ,	27303,	80470,	58108,	15996,	.2819,	.3431,
Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 2.4.14 Management option tales. Input data. Faroe Haddock.

Table 2.4. **Management option tables INPUT DATA** **FAROE HADDOCK**

Stock size

The yearclasses up to 1998 included are derived from the final 2002 VPA.
The yearclasses 1999-2000 at age 2 are estimated using RCT3 on R at age 2 from the final VPA and 3 indices from the groundfish survey. The 1999 yc at age 3 is estimat from the rct3 age 2 value using M=0.2 in an Pope's cohort analysis.
The yearclasses 2001 and 2002 in 2003 and 2004 is estimated as the geometrical mean number of two years old fish 1986-02, i.e 1984-98 yc's from the final VPA , 1999-2000 from the RCT3.

Age	2002	2003	2004
2	23367	12440	12440
3	32152		
4	7548		
5	4405		
6	219		
7	884		
8	4219		
9	5020		
10+	115		

Year	age 2	Geomean(1980-2002)
1980	4943	
1981	3490	
1982	15829	
1983	19699	
1984	40732	
1985	39319	
1986	26410	
1987	9422	
1988	18756	12440
1989	14022	
1990	8976	
1991	3033	
1992	2786	
1993	1937	
1994	6449	
1995	95646	
1996	46666	
1997	8000	
1998	2865	
1999	16570	
2000	17236	
2001	44235	
2002	23367	
2003	12440	
2004	12440	

Proportion mature at age

Age	2002	2003	2004	2000	2001	2002	Avg(00-02)	2002 obs.
2	0.13	0.08	0.08	0.02	0.09	0.13	0.08	0.22
3	0.62	0.51	0.51	0.38	0.54	0.62	0.51	0.73
4	0.97	0.92	0.92	0.87	0.93	0.97	0.92	0.99
5	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00
6	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
7	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
8	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
9	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
10+	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The maturity at age 2003-2004 is estimated as the average of the maturity at age 2000-2002 (running 3-yrs average)

Catch/stock weights at age

Age	2002	2003	2004	1999	2000	2001	AVG(99-01)	
2	0.591	0.591	0.591	0.504	0.661	0.608	0.591	
3	0.833	0.833	0.833	0.624	0.936	0.94	0.833	
4	1.171	1.171	1.171	0.974	1.166	1.374	1.171	
5	1.494	1.494	1.494	1.22	1.483	1.779	1.494	
6	1.971	1.692	1.692	1.49	1.616	1.971	1.692	Age 6 in 2002 set at the same
7	2.156	2.156	2.156	2.456	1.893	2.119	2.156	value as age 6 in 2001
8	2.617	2.617	2.617	2.658	2.821	2.373	2.617	
9	3.032	3.032	3.032	2.598	3.749	2.75	3.032	
10+	3.372	3.372	3.372	2.953	3.196	3.966	3.372	

Weights has just be put at the average of the weights in 1999-01 and kept constant in all 3 years

Exploitation pattern

Age	2002	2003	2004	1999	2000	2001
2	0.0728	0.0728	0.0728	0.0117	0.1003	0.119
3	0.4570	0.4570	0.4570	0.828	0.2964	0.3254
4	0.3290	0.3290	0.3290	0.2735	0.3476	0.41
5	0.3821	0.3821	0.3821	0.3279	0.3321	0.5521
6	0.3470	0.3470	0.3470	0.3891	0.3239	0.3878
7	0.3898	0.3898	0.3898	0.7176	0.2931	0.2258
8	0.3930	0.3930	0.3930	1.4866	0.6047	0.2285
9	0.2495	0.2495	0.2495	0.3731	0.1753	0.2429
10+	0.2495	0.2495	0.2495	0.3731	0.1753	0.2429
Avg3-7	0.3802	0.3802	0.3802	0.5072	0.3186	0.3802

Average F for 1999-01 rescaled to 2001 values

2	0.0770	0.0728	
3	0.4833	0.4570	
4	0.3437	0.3290	
5	0.4040	0.3821	
6	0.3669	0.3470	
7	0.4122	0.3898	
8	0.4156	0.3930	
9	0.2638	0.2495	
10+	0.2638	0.2495	
Fbar(3-7)	0.4020	0.3802	0.3802

The exploitation pattern is estimated from the average fishing mortality matrix 1999-2001 from the final VPA in 2002, rescaled to the Fbar(3-7) in 2001.
F(age 2) in 2001 is estimated from the new N values as described above under stock size.

Table 2.4.15

Faroe haddock **Short term prediction** **Input**

MFDP version 1
Run: jr02
Time and date: 11:58 5/8/02
Fbar age range: 3-7

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	23357	0.2	0.13	0	0	0.5910	0.0728	0.5910
3	32152	0.2	0.62	0	0	0.8333	0.4570	0.8333
4	7548	0.2	0.97	0	0	1.1713	0.3250	1.1713
5	4435	0.2	1	0	0	1.4940	0.3821	1.4940
6	219	0.2	1	0	0	1.9710	0.3470	1.9710
7	884	0.2	1	0	0	2.1560	0.3898	2.1560
8	4219	0.2	1	0	0	2.6173	0.3930	2.6173
9	5020	0.2	1	0	0	3.0323	0.2495	3.0323
10	115	0.2	1	0	0	3.3717	0.2495	3.3717

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12440	0.2	0.08	0	0	0.5910	0.0728	0.5910
3	.	0.2	0.51	0	0	0.8333	0.4570	0.8333
4	.	0.2	0.92	0	0	1.1713	0.3250	1.1713
5	.	0.2	1	0	0	1.4940	0.3821	1.4940
6	.	0.2	1	0	0	1.6923	0.3470	1.6923
7	.	0.2	1	0	0	2.1560	0.3898	2.1560
8	.	0.2	1	0	0	2.6173	0.3930	2.6173
9	.	0.2	1	0	0	3.0323	0.2495	3.0323
10	.	0.2	1	0	0	3.3717	0.2495	3.3717

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12440	0.2	0.08	0	0	0.5910	0.0728	0.5910
3	.	0.2	0.51	0	0	0.8333	0.4579	0.8333
4	.	0.2	0.92	0	0	1.1713	0.3250	1.1713
5	.	0.2	1	0	0	1.4940	0.3821	1.4940
6	.	0.2	1	0	0	1.6923	0.3470	1.6923
7	.	0.2	1	0	0	2.1560	0.3898	2.1560
8	.	0.2	1	0	0	2.6173	0.3930	2.6173
9	.	0.2	1	0	0	3.0323	0.2495	3.0323
10	.	0.2	1	0	0	3.3717	0.2495	3.3717

Input units are thousands and kg - output in tonnes

Table 2.4.16

Faroe Haddock: VPA and groundfish summer survey data
3 23 2

'Yearclass'	'VPAage2'	'Survage1'	'Survage2'	'Survage3'
1978	4943	-11	-11	-11
1979	3490	-11	-11	-11
1980	15829	-11	-11	-11
1981	19599	-11	-11	-11
1982	40732	-11	-11	-11
1983	39319	-11	-11	-11
1984	26410	-11	-11	-11
1985	9422	-11	-11	-11
1986	18755	-11	-11	-11
1987	14022	-11	-11	-11
1988	8976	-11	-11	-11
1989	3033	-11	-11	-11
1990	2785	-11	-11	-11
1991	1837	-11	-11	-11
1992	6449	-11	-11	-11
1993	95646	-11	-11	61942.72
1994	46666	-11	68536.9	28220.3
1995	8000	13437.69	15494.51	3494.1
1996	2855	386.18	2026.2	6263.69
1997	16570	17894.07	16303.9	8597.62
1998	17236	20671.12	18907.03	11830.83
1999	-11	162660.0	102494.5	-11
2000	-11	94011.65	-11	-11

Table 2.4.17

Analysis by RCT3 ver3.1 of data from file :

rct3b02.dat

Faroe Haddock: VPA and groundfish summer survey data

Data for 3 surveys over 23 years : 1978 - 2000

Regression type = C

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

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

Forecast/Hindcast variance correction used.

Yearclass = 1997

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
Survag									
Survag	.82	1.44	.49	.944	3	9.70	9.42	.983	.490
Survag	1.35	-3.06	.95	.811	4	9.06	9.14	1.535	.201
					VPA Mean =		9.22	1.239	.309

Yearclass = 1998

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------				I	I-----------Prediction---------			I
Survag	.44	5.17	.47	.878	3	9.94	9.56	1.021	.199
Survag	.84	1.31	.40	.929	4	9.85	9.63	.635	.513
Survag	1.34	-2.91	.83	.789	5	9.38	9.68	1.181	.148
					VPA Mean =		9.23	1.213	.140

Table 2.4.17 (cont.)

Yearclass = 1999

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Survag	.47	4.97	.37	.887	4	12.00	10.61	.773	.314
Survag	.85	1.26	.33	.927	5	11.54	11.09	.583	.553
Survag									
					VPA Mean =		9.26	1.186	.133

Yearclass = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Survag	.47	4.97	.37	.888	4	11.45	10.35	.723	.734
Survag									
Survag									
					VPA Mean =		9.24	1.202	.266

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	10960	9.30	.69	.09	.02	16570	9.72
1998	14264	9.57	.45	.08	.03	17236	9.75
1999	44235	10.70	.43	.43	.98		
2000	23357	10.06	.62	.49	.63		

Tabel 2.4.18

Faroe haddock **Yield per Recruit** **Input data**

MFYPR version 1
Run: rein
Index file 06/05/2002
Time and date: 20:05 5/6/02
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.07	0	0	0.5570	0.0752	0.5570
3	0.2	0.49	0	0	0.8219	0.2536	0.8219
4	0.2	0.91	0	0	1.0936	0.3464	1.0936
5	0.2	1.00	0	0	1.4284	0.3549	1.4284
6	0.2	1	0	0	1.7488	0.4122	1.7488
7	0.2	1	0	0	2.0424	0.5340	2.0424
8	0.2	1	0	0	2.2560	0.5857	2.2560
9	0.2	1	0	0	2.4990	0.4418	2.4990
10	0.2	1	0	0	2.8241	0.4418	2.8241

Weights in kilograms

Table 2.4.19

Faroe haddock **Yield per Recruit** **Results**

MFYPR version 1
Run: rein
Time and date: 20:05 5/6/02
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.7253	4.1102	7.7985	4.1102	7.7985
0.1	0.038	0.1387	0.2445	4.8261	7.0098	3.4249	6.0878	3.4249	6.0878
0.2	0.076	0.2349	0.3894	4.3475	5.8687	2.9513	4.9514	2.9513	4.9514
0.3	0.1141	0.3059	0.4793	3.9951	5.0633	2.6038	4.1507	2.6038	4.1507
0.4	0.1521	0.3606	0.5369	3.7238	4.469	2.3374	3.561	2.3374	3.561
0.5	0.1901	0.4044	0.5748	3.5075	4.0148	2.1259	3.1111	2.1259	3.1111
0.6	0.2281	0.4402	0.5999	3.3304	3.6574	1.9535	2.7581	1.9535	2.7581
0.7	0.2662	0.4703	0.6167	3.1821	3.3695	1.8098	2.4745	1.8098	2.4745
0.8	0.3042	0.496	0.628	3.0557	3.1329	1.6879	2.2421	1.6879	2.2421
0.9	0.3422	0.5183	0.6354	2.9463	2.9351	1.583	2.0484	1.583	2.0484
1	0.3802	0.5378	0.6402	2.8504	2.7673	1.4915	1.8846	1.4915	1.8846
1.1	0.4182	0.5552	0.6431	2.7655	2.623	1.4109	1.7443	1.4109	1.7443
1.2	0.4563	0.5707	0.6447	2.6896	2.4976	1.3393	1.6228	1.3393	1.6228
1.3	0.4943	0.5847	0.6453	2.6213	2.3876	1.2751	1.5166	1.2751	1.5166
1.4	0.5323	0.5975	0.6453	2.5593	2.2903	1.2172	1.423	1.2172	1.423
1.5	0.5703	0.6091	0.6447	2.5027	2.2035	1.1647	1.3399	1.1647	1.3399
1.6	0.6084	0.6198	0.6438	2.4508	2.1256	1.1168	1.2656	1.1168	1.2656
1.7	0.6464	0.6297	0.6427	2.4031	2.0552	1.073	1.1988	1.073	1.1988
1.8	0.6844	0.6388	0.6414	2.3589	1.9913	1.0326	1.1384	1.0326	1.1384
1.9	0.7224	0.6474	0.6399	2.3178	1.9331	0.9954	1.0836	0.9954	1.0836
2	0.7604	0.6553	0.6384	2.2796	1.8797	0.9609	1.0336	0.9609	1.0336

Reference point	**F multiplier**	**Absolute F**
Fbar(3-7)	1	0.3802
FMax	1.3398	0.5094
F0.1	0.4889	0.1859
F35%SPR	0.6092	0.2316
Flow		
Fmed	0.5982	0.2275
Fhigh	2.1411	0.8141

Weights in kilograms

Table 2.4.20

Faroe haddock **Short Term Prediction** **Results**

MFDP version 1
Run: jr02
Index file 06/05/2002
Time and date: 11:58 5/8/02
Fbar age range: 3-7

2002

Biomass	SSB	FMult	FBar	Landings
85055	62598	1	0.3802	21097

2003					**2004**	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
72228	56642	0	0	0	80807	68520
.	56642	0.1	0.038	2030	78512	66316
.	56642	0.2	0.076	3993	76298	64190
.	56642	0.3	0.1141	5890	74161	62139
.	56642	0.4	0.1521	7724	72099	60160
.	56642	0.5	0.1901	9497	70110	58250
.	56642	0.6	0.2281	11211	68189	56407
.	56642	0.7	0.2661	12869	66336	54629
.	56642	0.8	0.3042	14472	64546	52912
.	56642	0.9	0.3422	16023	62819	51256
.	56642	1	0.3802	17523	61151	49657
.	56642	1.1	0.4182	18974	59541	48113
.	56642	1.2	0.4562	20377	57986	46623
.	56642	1.3	0.4943	21735	56485	45185
.	56642	1.4	0.5323	23050	55035	43796
.	56642	1.5	0.5703	24322	53634	42454
.	56642	1.6	0.6083	25553	52281	41159
.	56642	1.7	0.6463	26744	50974	39908
.	56642	1.8	0.6844	27898	49711	38700
.	56642	1.9	0.7224	29014	48491	37534
.	56642	2	0.7604	30096	47313	36407

Input units are thousands and kg - output in tonnes

Table 2.5.1.1 Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1988-2001, as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994
Denmark	94	-	2	-	-	-	-
Faroe Islands	44,402	43,624	59,821	53,321	35,979	32,719	32,406
France [3]	313	-	-	-	120	75	19
German Dem.Rep.	-	9	-	-	5	2	1
German Fed. Rep.	74	20	15	32		-	-
Netherlands	-	22	67	65	-	32	156
Norway	52	51	46	103	85	279	151
UK (Eng. & W.)	-	-	-	5	74	425	438
UK (Scotland)	92	9	33	79	98		
USSR/Russia [2]	-	-	30	-	12	-	-
Total	45,027	43,735	60,014	53,605	36,373	33,532	33,171
Working Group estimate [4,5]	45,285	44,477	61,628	54,858	36,487	33,543	33,182

Country	1995	1996	1997	1998	1999	2000 [1]	2001 [1]
Estonia	-	-	16	-	-	-	-
Faroe Islands	26,918	19,297	21,721	25,995	32,439		
France	10	12	9	17	-		
Germany	41	3	5	-	100	230	677
Greenland	-	-	-	-	-		
Norway	10	16	67	53	160	97	80
UK (Eng. & W.)	21	53	-	19	67	32	...
UK (Scotland)	200	580	460	337	441	534	...
United Kingdom							790
Russia	-	18	28	-	-	20	1
Irland							5
Total	27,200	19,979	22,306	26,421	33,207	913	1,553
Working Group estimate [4,5,6]	27,209	20,029	22,306	26,421	33,207	39,045	51,795

[1] Preliminary.

[2] As from 1991.

[3] Quantity unknown 1989-91.

[4] Includes catches from Sub-division Vb2 and Division IIa in Faroese waters.

[5] Includes French, Greenlandic, Russian catches from Division Vb, as reported to the Faroese coastal guard service.

[6] Includes Faroese, French, Greenlandic catches from Division Vb, as reported to the Faroese coastal guard service.

Table 2.5.1.2 Saithe in the Faroes (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category. Averages for 1985-2001 are given at the bottom.

Year	Open boats	Long-liners <100 GRT	Single trawl <400 HP	Gill-nets	Jiggers	Single trawl 400-1000 HP	Single trawl >1000 HP	Pair trawl <1000 HP	Pair trawl >1000HP	Long-liners >100 GRT	Indust-rial trawlers	Others	Total ungutted catch (tonnes)
1985	0.2	0.1	0.1	0.0	2.6	6.6	33.7	28.2	28.2	0.1	0.2	0.2	42598
1986	0.3	0.2	0.1	0.1	3.6	2.8	27.3	27.5	36.5	0.1	0.7	0.9	40107
1987	0.7	0.1	0.3	0.4	5.6	4.1	20.4	22.8	44.2	0.1	1.1	0.0	39627
1988	0.4	0.3	0.1	0.3	6.5	6.8	20.8	19.6	43.6	0.1	1.3	0.1	43940
1989	0.9	0.1	0.3	0.2	9.3	5.4	17.7	23.5	41.1	0.1	1.3	0.0	44547
1990	0.6	0.2	0.2	0.2	7.4	3.9	19.6	24.0	42.8	0.2	0.9	0.0	60740
1991	0.6	0.1	0.1	0.6	9.8	1.3	13.9	26.5	46.2	0.1	0.8	0.0	54290
1992	0.4	0.4	0.0	0.0	10.5	0.5	7.1	24.4	55.6	0.1	1.0	0.0	34934
1993	0.6	0.2	0.1	0.0	9.3	0.6	6.5	21.4	60.6	0.1	0.7	0.0	32313
1994	0.4	0.4	0.1	0.0	12.6	1.1	6.8	18.5	59.1	0.2	0.7	0.0	32405
1995	0.2	0.1	0.4	0.0	9.6	0.9	9.9	17.7	60.9	0.3	0.0	0.0	26915
1996	0.0	0.0	0.1	0.0	9.2	1.2	6.8	23.7	58.6	0.2	0.0	0.0	19262
1997	0.0	0.1	0.1	0.0	8.9	2.5	10.7	17.8	58.9	0.4	0.4	0.0	21713
1998	0.1	0.4	0.1	0.0	8.1	2.8	13.8	16.5	57.6	0.3	0.4	0.0	25993
1999	0.0	0.1	0.1	0.0	5.7	1.2	12.6	18.5	60.0	0.2	1.6	0.0	33057
2000	0.1	0.1	0.2	0.0	3.7	0.3	15.0	17.5	62.3	0.1	0.7	0.0	37450
2001	0.1	0.1	0.1	0.0	2.8	0.3	20.2	16.5	58.8	0.2	0.8	0.1	49395
Average	0.3	0.2	0.1	0.1	7.3	2.5	15.5	21.4	51.5	0.2	0.7	0.1	37605

Table 2.5.2.1 Saithe in the Faroes (Division Vb). Catch in number at age by fleet categories.

Age	Jiggers	ST>1000 Hk	PT<1000 Hk	PT>1000Hk	Others	Tot. Faroe	Foreign	Total
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	4	0	14	0	20	1	21
3	25	123	253	611	16	1094	32	1125
4	52	243	479	1438	35	2390	62	2452
5	181	848	1633	4946	121	8221	217	8438
6	51	355	339	1165	30	2064	91	2155
7	93	751	530	1855	52	3488	192	3681
8	44	369	176	748	21	1445	95	1539
9	44	353	136	618	18	1244	90	1334
10	9	93	20	127	4	269	24	293
11	6	35	5	29	1	81	9	90
12	1	5	1	15	0	23	1	24
13	1	7	1	8	0	18	2	19
14	0	4	1	6	0	12	1	13
15	0	0	0	0	0	0	0	0
Total No.	506	3189	3573	11579	301	20367	816	21183
Catch, t.	1355	9375	7660	27320	729	49395	2400	51795

Notes: Numbers in 1000'
Catch, ungutted weight in tonnes
Others includes longliners, small single trawlers, industrial trawlers and catches not otherwise accounted for

Table 2.5.2.2 Saithe in the Faroes (Division Vb). Catch numbers at age (Thousands).

```
Run title : FAROE SAITHE (ICES Division Vb)                 SAI_IND
    At  1/05/2002  14:12

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

YEAR	1961
AGE	
3	183
4	379
5	483
6	403
7	216
8	129
9	116
10	82
11	45
+gp	82
0 TOTALNUM	2118
TONSLAND	9592
SOPCOF %	108

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	562	614	684	996	488	595	614	1191	1445	2857
4	542	340	1908	850	1540	796	1689	2086	6577	3316
5	617	340	1506	1708	1201	1364	1116	2294	1558	5585
6	495	415	617	965	1686	792	1095	1414	1478	1005
7	286	406	572	510	806	1192	548	1118	899	828
8	131	202	424	407	377	473	655	589	730	469
9	129	174	179	306	294	217	254	580	316	326
10	113	158	150	201	205	190	128	239	241	164
11	71	94	100	156	156	97	89	115	86	100
+gp	105	274	174	285	225	140	187	190	132	100
0 TOTALNUM	3051	3017	6314	6384	6978	5856	6375	9816	13462	14750
TONSLAND	10454	12693	21893	22181	25563	21319	20387	27437	29110	32706
SOPCOF %	93	96	99	92	98	104	102	97	96	109

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	2714	2515	3504	2062	3178	1609	611	287	996	411
4	1774	6253	4126	3361	3217	2937	1743	933	877	1804
5	2588	7075	4011	3801	1720	2034	1736	1341	720	769
6	2742	3478	2784	1939	1250	1288	548	1033	673	932
7	1529	1634	1401	1045	877	767	373	584	726	908
8	1305	693	640	714	641	708	479	414	284	734
9	1017	550	368	302	468	498	466	247	212	343
10	743	403	340	192	223	338	473	473	171	192
11	330	215	197	193	141	272	407	368	196	92
+gp	210	186	265	298	287	330	535	691	786	1021
0 TOTALNUM	14952	23002	17636	13907	12002	10781	7371	6371	5641	7206
TONSLAND	42663	57431	47188	41576	33065	34835	28138	27246	25230	30103
SOPCOF %	100	120	113	116	107	104	100	102	99	96

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	387	2483	368	1224	1167	1581	866	451	294	1030
4	4076	1103	11067	3990	1997	5793	2950	5981	3833	5125
5	994	5052	2359	5583	4473	3827	9555	5300	10120	7452
6	1114	1343	4093	1182	3730	2785	2784	7136	9219	5544
7	380	575	875	1898	953	990	1300	793	5070	3487
8	417	339	273	273	1077	532	621	546	477	1630
9	296	273	161	103	245	333	363	185	123	405
10	105	98	52	38	104	81	159	83	61	238
11	88	98	65	26	67	43	27	55	60	128
+gp	902	540	253	275	158	97	60	39	79	118
0 TOTALNUM	8759	11904	19566	14592	13971	16062	18685	20569	29336	25157
TONSLAND	30964	39176	54665	44605	41716	40020	45285	44477	61628	54858
SOPCOF %	96	100	100	94	94	96	99	97	98	99

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
3	521	1316	690	398	297	344	163	321	812	1125
4	4067	2611	3961	1019	1087	832	1689	655	2832	2452
5	3667	4689	2663	3468	1146	2440	1934	3096	1485	8438
6	2679	1665	2368	1836	1449	1767	3475	2550	4372	2155
7	1373	858	746	1177	1156	1335	1379	4113	2227	3681
8	894	492	500	345	521	624	683	915	2727	1539
9	613	448	307	241	132	165	368	380	348	1334
10	123	245	303	192	77	71	77	146	186	293
11	63	54	150	104	64	29	32	23	56	90
+gp	108	52	49	117	82	100	73	69	25	56
0 TOTALNUM	14108	12430	11737	8897	6011	7707	9873	12268	15070	21163
TONSLAND	36487	33543	33182	27209	20029	22306	26421	33207	39045	51795
SOPCOF %	105	102	102	102	103	100	102	102	102	100

Table 2.5.3.1 Saithe in the Faroes (Division Vb). Catch weights at age (kg).

```
Run title : FAROE SAITHE (ICES Division Vb)              SAI_IND
    At  1/05/2002  14:12
```

Table 2 Catch weights at age (kg)

	YEAR	1961
	AGE	
	3	1.4300
	4	2.3020
	5	3.3480
	6	4.2870
	7	5.1280
	8	6.1550
	9	7.0600
	10	7.2650
	11	7.4970
	+gp	9.3399
0	SOPCOFAC	1.0779

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	3	1.2730	1.2800	1.1750	1.1810	1.3610	1.2730	1.3020	1.1880	1.2440	1.1010
	4	2.0450	2.1970	2.0550	2.1250	2.0260	1.7800	1.7370	1.6670	1.4450	1.3160
	5	3.2930	3.2120	3.2660	2.9410	3.0550	2.5340	2.0360	2.3020	2.2490	1.8180
	6	4.1910	4.5680	4.2550	4.0960	3.6580	3.5720	3.1200	2.8530	2.8530	2.9780
	7	5.1460	5.0560	5.0380	4.8780	4.5850	4.3680	4.0490	3.6730	3.5150	3.7020
	8	5.6550	5.9320	5.6940	5.9320	5.5200	5.3130	5.1830	5.0020	4.4180	4.2710
	9	6.4690	6.2590	6.6620	6.3210	6.8370	5.8120	6.2380	5.7140	5.4440	5.3880
	10	6.7060	8.0000	6.8370	7.2880	7.2650	6.5540	7.5200	6.4050	5.7330	5.9720
	11	7.1500	7.2650	7.6860	8.0740	7.6620	7.8060	8.0490	6.5540	6.6620	6.4900
	+gp	9.0237	8.8589	8.5591	8.9035	9.2233	8.1494	9.0925	8.0870	8.5844	8.0047
0	SOPCOFAC	.9342	.9590	.9933	.9220	.9769	1.0357	1.0194	.9663	.9634	1.0935

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	3	1.0430	1.0880	1.4300	1.1140	1.0880	1.2230	1.4930	1.2200	1.2300	1.3100
	4	1.4850	1.4610	1.5250	1.6580	1.6760	1.6410	2.3240	1.8800	2.1200	2.1300
	5	2.0550	1.5820	2.2070	2.2600	2.8780	2.6600	3.0680	2.6200	3.3200	3.0000
	6	2.8290	2.2490	2.5000	3.1200	3.0810	3.7900	3.7460	3.4000	4.2800	3.8100
	7	3.7910	3.6870	3.1200	3.5570	4.2870	4.2390	4.9130	4.1800	5.1600	4.7500
	8	4.1750	4.3850	4.6010	4.0960	4.3520	5.5970	4.3680	4.9500	6.4200	5.2500
	9	4.8080	5.1280	5.5590	5.1280	4.7900	5.3500	5.2760	5.6900	6.8700	5.9500
	10	5.2940	5.2760	5.7140	6.0940	5.9120	5.9120	5.8320	6.3800	7.0900	6.4300
	11	6.9480	6.7270	6.2590	7.1960	6.6190	6.8370	6.0530	7.0200	7.9300	7.0000
	+gp	7.5146	8.0307	8.0104	8.5982	7.8941	7.7085	7.5756	8.6262	9.2153	8.9618
0	SOPCOFAC	1.0043	1.2006	1.1296	1.1607	1.0680	1.0442	1.0049	1.0248	.9937	.9564

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	3	1.3370	1.2080	1.4310	1.4010	1.7180	1.6090	1.5000	1.3090	1.2230	1.2400
	4	1.8510	2.0290	1.9530	2.0320	1.9860	1.8350	1.9750	1.7350	1.6330	1.5680
	5	2.9510	2.9650	2.4700	2.9650	2.6180	2.3950	1.9780	1.9070	1.8300	1.8640
	6	3.5770	4.1430	3.8500	3.5960	3.2770	3.1820	2.9370	2.3730	2.0520	2.2110
	7	4.9270	4.7240	5.1770	5.3360	4.1860	4.0670	3.7980	3.8100	2.8660	2.6480
	8	6.2430	5.9010	6.3470	7.2020	5.5890	5.1490	4.4190	4.6670	4.4740	3.3800
	9	7.2320	6.8110	7.8250	6.9660	6.0500	5.5010	5.1150	5.5090	5.4240	4.8160
	10	7.2390	7.0510	6.7460	9.8620	6.1500	6.6260	6.7120	5.9720	6.4690	5.5160
	11	8.3460	7.2480	8.6360	10.6700	9.5360	6.3430	9.0400	6.9390	6.3430	6.4070
	+gp	10.0411	10.0547	10.0976	11.9501	10.2181	10.2439	9.3369	9.9364	8.2869	7.7285
0	SOPCOFAC	.9632	.9997	.9991	.9415	.9419	.9620	.9928	.9698	.9811	.9938

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	AGE										
	3	1.2640	1.4080	1.5030	1.4560	1.4320	1.4760	1.3880	1.3740	1.4770	1.3300
	4	1.6020	1.8600	1.9510	2.1770	1.8750	1.7830	1.7110	1.7120	1.6060	1.5900
	5	2.0690	2.3230	2.2670	2.4200	2.4960	2.0320	1.9540	1.9050	2.0770	1.7850
	6	2.5540	3.1310	2.9360	2.8950	3.2290	2.7780	2.4050	2.3960	2.3600	2.5860
	7	3.0570	3.7300	4.2140	3.6510	3.7440	3.5980	3.3000	2.8450	2.9770	3.0590
	8	4.0780	4.3940	4.9710	5.0640	4.9640	4.7660	4.2200	4.1240	3.4800	3.8710
	9	5.0120	5.2090	5.6570	5.4400	6.3750	5.9820	4.9990	5.2560	4.8510	4.3740
	10	6.7680	6.5400	5.9500	6.1670	6.7450	7.6580	6.3910	5.5260	5.2680	5.5650
	11	7.7540	8.4030	6.8910	7.0800	7.4660	7.8820	6.6650	6.9560	6.5230	6.7030
	+gp	8.2297	8.0501	9.1086	7.5392	7.9806	9.2453	8.4847	8.5237	5.9024	6.9076
0	SOPCOFAC	1.0506	1.0169	1.0240	1.0205	1.0319	.9994	1.0221	1.0187	1.0155	1.0018

Table 2.5.4.1 Saithe in the Faroes (Division Vb). Proportion mature at age.

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND
At 1/05/2002 14:12

Table 5 Proportion mature at age

YEAR	1961
AGE	
3	.0400
4	.2600
5	.5700
6	.8200
7	.9100
8	.9800
9	1.0000
10	1.0000
11	1.0000
+gp	1.0000

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 5 Proportion mature at age

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	.0400	.0800	.0900	.0900	.1200	.1100	.1000	.0900	.0800	.0800
4	.2600	.2900	.2800	.2900	.2800	.2600	.2800	.2400	.2300	.2200
5	.5700	.6600	.5600	.6600	.5900	.5500	.4600	.4500	.4300	.4400
6	.8200	.9000	.8800	.8600	.8200	.8100	.7800	.6900	.6300	.6600
7	.9100	.9500	.9700	.9700	.9300	.9200	.9000	.9000	.8100	.7800
8	.9800	.9900	.9900	1.0000	.9900	.9800	.9700	.9700	.9700	.9300
9	1.0000	1.0000	1.0000	1.0000	1.0000	.9900	.9900	.9900	.9900	.9900
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
AGE										
3	.0800	.0900	.1000	.1000	.0900	.1000	.0900	.0900	.0900	.1000
4	.2200	.2600	.2800	.3100	.2600	.2500	.2600	.2800	.2400	.2200
5	.4800	.5300	.5200	.5500	.5700	.4700	.5600	.5600	.4500	.4800
6	.7200	.8000	.7800	.7700	.8200	.7500	.7800	.8100	.6900	.6900
7	.8300	.9000	.9300	.8900	.9000	.8900	.9000	.9100	.8100	.8200
8	.9600	.9700	.9800	.9800	.9800	.9800	.9700	.9800	.9600	.9300
9	.9900	.9900	.9900	.9900	1.0000	1.0000	.9900	1.0000	.9900	.9900
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.5.5.1 Saithe in the Faroes (Division Vb). Effort (hours) and catch in number at age for commersial Cuba Logbook pair trawlers.

```
Faroe   Saithe (ICES Div.Vb) age3+5-11
102
Cuba    Logbookage3
1985    2001
1   1   0   1
3   3
3864    31
4175    65
7126    120
7314    66
7167    52
8177    23
8082    34
8600    11
8622    83
9601    81
11326   74
11594   41
15185   102
12747   22
14271   59
12542   143
13143   237
Cuba Logbook age5-11
1985    2001
1   1   0   1
5   11
3864    396     83      103     13      5   1   2
4175    342     245     68      72      18  6   3
7126    401     319     119     63      33  7   5
7314    876     308     125     52      35  8   1
7167    507     641     73      43      14  8   5
8177    741     717     394     36      10  4   4
8082    495     400     252     124     15  14  10
8600    277     234     117     68      59  11  6
8622    525     189     101     60      44  26  6
9601    372     349     112     78      51  47  22
11326   898     368     227     76      38  29  21
11594   217     224     274     210     101 26  14
15185   522     383     294     133     31  15  5
12747   349     606     257     128     72  14  5
14271   694     632     1026    249     109 36  6
12542   312     939     480     592     73  40  12
13143   1916    451     719     290     240 49  11
```

Table 2.5.5.2. Saithe in the Faroes (Division Vb). Diagnostics from XSA with Cuba Logbook tuning series.

```
Lowestoft VPA Version 3.1

    1/05/2002  14:11

 Extended Survivors Analysis

 FAROE SAITHE (ICES Division Vb)                SAI_IND

 CPUE data from file C:\Stovnsmeting\Ices2002\Koyringar\XsainnL\CUBALOG3_11.DAT

 Catch data for  41 years. 1961 to 2001. Ages  3 to  12.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 Cuba Logbook age3   1985  2001    3      3    .000   1.000
 Cuba Logbook age5-11    1985  2001    5     11    .000   1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 Catchability analysis :

      Catchability dependent on stock size for ages <    5

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


      Catchability independent of age for ages >=    9


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   5 years or the   3 oldest ages.

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

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

      Prior weighting not applied


 Tuning converged after   15 iterations

1


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


Fishing mortalities
    Age   1992   1993   1994   1995   1996   1997   1998   1999   2000   2001

      3   .030   .063   .044   .011   .013   .010   .010   .004   .018   .019
      4   .263   .204   .272   .085   .036   .047   .061   .052   .048   .071
      5   .597   .551   .331   .406   .131   .107   .146   .151   .161   .197
      6   .713   .602   .604   .400   .296   .305   .220   .293   .331   .370
      7   .580   .522   .602   .701   .476   .489   .415   .439   .451   .518
      8   .486   .421   .670   .628   .798   .514   .502   .539   .592   .655
      9   .577   .484   .509   .824   .524   .639   .661   .585   .404   .659
     10   .601   .479   .721   .708   .692   .603   .712   .606   .644   .716
     11   .666   .583   .616   .585   .544   .614   .608   .476   .494   .764
```

Table 2.5.5.2. (Continued)

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1992	1.97E+04	1.94E+04	9.02E+03	5.81E+03	3.45E+03	2.57E+03	1.55E+03	3.01E+02	1.43E+02
1993	2.39E+04	1.57E+04	1.22E+04	4.07E+03	2.33E+03	1.58E+03	1.29E+03	7.11E+02	1.35E+02
1994	1.76E+04	1.84E+04	1.05E+04	5.77E+03	1.82E+03	1.13E+03	8.50E+02	6.52E+02	3.60E+02
1995	4.14E+04	1.38E+04	1.15E+04	6.15E+03	2.58E+03	8.18E+02	4.75E+02	4.18E+02	2.60E+02
1996	2.49E+04	3.35E+04	1.03E+04	6.26E+03	3.37E+03	1.05E+03	3.57E+02	1.70E+02	1.69E+02
1997	3.90E+04	2.01E+04	2.65E+04	7.43E+03	3.81E+03	1.72E+03	3.86E+02	1.73E+02	6.99E+01
1998	1.75E+04	3.16E+04	1.57E+04	1.95E+04	4.49E+03	1.91E+03	8.41E+02	1.67E+02	7.76E+01
1999	8.19E+04	1.42E+04	2.43E+04	1.11E+04	1.28E+04	2.43E+03	9.49E+02	3.55E+02	6.71E+01
2000	4.93E+04	6.68E+04	1.10E+04	1.71E+04	6.78E+03	6.75E+03	1.16E+03	4.33E+02	1.59E+02
2001	6.47E+04	3.96E+04	5.21E+04	7.70E+03	1.01E+04	3.54E+03	3.06E+03	6.33E+02	1.86E+02

Estimated population abundance at 1st Jan 2002

0.00E+00	5.19E+04	3.02E+04	3.50E+04	4.35E+03	4.91E+03	1.51E+03	1.29E+03	2.54E+02

Taper weighted geometric mean of the VPA populations:

3.30E+04	2.48E+04	1.68E+04	8.85E+03	4.46E+03	1.93E+03	8.31E+02	3.37E+02	1.39E+02

Standard error of the weighted Log(VPA populations) :

.5192	.4974	.5397	.5177	.6194	.5948	.6037	.5229	.5410

Log catchability residuals.

Fleet : Cuba Logbook age3

Age	1985	1986	1987	1988	1989	1990	1991
3	.85	.61	.96	.27	.44	-.42	-.08
4	No data for this fleet at this age						
5	No data for this fleet at this age						
6	No data for this fleet at this age						
7	No data for this fleet at this age						
8	No data for this fleet at this age						
9	No data for this fleet at this age						
10	No data for this fleet at this age						
11	No data for this fleet at this age						

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	-1.33	.99	1.13	-.07	-.32	.03	-.86	-1.32	.45	.75
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	1.24	-.484	16.67	.29	17	.85	-15.46

Fleet : Cuba Logbook age5-11

Age	1985	1986	1987	1988	1989	1990	1991
3	No data for this fleet at this age						
4	No data for this fleet at this age						
5	.91	.81	.53	.18	-.20	.42	.52
6	-.05	.70	.44	.49	.03	.21	.28
7	.06	.00	.05	.03	-.44	-.01	-.07
8	-.48	.38	-.05	-.18	-.35	-.79	-.32
9	-.70	.63	.02	.18	-.71	-1.30	-.83
10	-1.67	.08	.24	-.58	-.49	-1.58	-.23
11	-.19	.04	.21	-.66	-.22	-.67	.07

Table 2.5.5.2. (Continued)

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	.34	.65	.26	.91	-.55	-.90	-.58	-.44	-.32	-.09
6	.18	.27	.43	.16	-.42	-.32	-.69	-.17	-.06	-.02
7	-.29	-.07	.20	.44	.24	-.08	-.23	.00	.01	.00
8	-.70	-.37	.23	.35	1.16	-.18	-.16	.18	.17	.08
9	-.25	-.41	.06	.32	1.43	-.05	.20	.34	-.21	.08
10	-.29	-.34	.33	.12	.88	.01	.20	.23	.28	.09
11	-.12	-.10	.12	.23	.21	-.18	-.11	.05	.02	-.16

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

Age	5	6	7	8	9	10	11
Mean Log q	-12.5081	-12.0288	-11.7869	-11.6707	-11.7077	-11.7077	-11.7077
S.E(Log q)	.5722	.3526	.2115	.4860	.6224	.5446	.2462

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	1.47	-1.004	13.82	.31	17	.84	-12.51
6	1.40	-1.454	13.20	.57	17	.47	-12.03
7	1.07	-.585	12.01	.89	17	.23	-11.79
8	1.23	-.740	12.61	.51	17	.61	-11.67
9	1.43	-.972	13.87	.33	17	.90	-11.71
10	1.23	-.583	13.09	.39	17	.69	-11.71
11	.85	1.378	10.74	.89	17	.20	-11.77

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	109776.	.963	.000	.00	1	.116	.009
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	24785.	.50				.444	.040
F shrinkage mean	90003.	.50				.440	.011

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51946.	.33	.71	3	2.137	.019

Age 4 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	47479.	.914	.000	.00	1	.128	.046
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	16797.	.54				.403	.124
F shrinkage mean	44165.	.50				.469	.049

Table 2.5.5.2. (Continued)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30206.	.34	.47	3	1.373	.071

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	9350.	.893	.000	.00	1	.134	.597
Cuba Logbook age5-11	32122.	.596	.000	.00	1	.317	.213
F shrinkage mean	50860.	.50				.549	.140

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
35037.	.35	.51	3	1.437	.197

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	1846.	.975	.000	.00	1	.051	.721
Cuba Logbook age5-11	3963.	.313	.129	.41	2	.597	.400
F shrinkage mean	5785.	.50				.352	.290

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4354.	.26	.19	4	.715	.370

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	5044.	.897	.000	.00	1	.028	.507
Cuba Logbook age5-11	4633.	.220	.091	.41	3	.710	.542
F shrinkage mean	5743.	.50				.262	.457

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4913.	.21	.08	5	.374	.518

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	1096.	.921	.000	.00	1	.019	.820
Cuba Logbook age5-11	1424.	.208	.100	.48	4	.657	.682
F shrinkage mean	1717.	.50				.323	.594

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1505.	.21	.08	6	.383	.655

Table 2.5.5.2. (Continued)

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	1210.	.923	.000	.00	1	.015	.692
Cuba Logbook age5-11	1131.	.213	.179	.84	5	.585	.726
F shrinkage mean	1581.	.50				.400	.567

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1295.	.24	.14	7	.597	.659

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	781.	.956	.000	.00	1	.008	.292
Cuba Logbook age5-11	228.	.222	.091	.41	6	.566	.771
F shrinkage mean	285.	.50				.426	.657

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
254.	.25	.09	8	.355	.716

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 9

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	191.	.997	.000	.00	1	.002	.355
Cuba Logbook age5-11	65.	.221	.080	.36	7	.650	.812
F shrinkage mean	83.	.50				.349	.683

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
71.	.23	.08	9	.342	.764

Table 2.5.5.3 Saithe in the Faroes (Division Vb). Fishing mortality (F) at age.

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 6/05/2002 12:10

Traditional vpa using screen input for terminal F with backwards extension

Table 8 Fishing mortality (F) at age

YEAR	1961
AGE	
3	.0226
4	.0556
5	.0993
6	.1213
7	.0928
8	.0847
9	.0964
10	.0907
11	.0906
+gp	.0906
0 FBAR 4- 8	.0907

YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
AGE										
3	.0466	.0307	.0477	.0495	.0250	.0248	.0321	.0329	.0480	.0887
4	.0862	.0359	.1259	.0771	.1006	.0518	.0909	.1450	.2544	.1479
5	.1206	.0715	.2193	.1586	.1486	.1215	.0953	.1715	.1536	.3565
6	.1399	.1113	.1791	.2131	.2319	.1382	.1354	.1679	.1593	.1402
7	.1186	.1629	.2204	.2205	.2771	.2552	.1338	.1993	.1531	.1258
8	.0748	.1150	.2553	.2411	.2518	.2600	.2172	.2079	.1935	.1115
9	.1142	.1345	.1414	.2960	.2749	.2249	.2168	.3039	.1643	.1239
10	.1282	.1993	.1643	.2331	.3309	.2873	.2006	.3254	.1991	.1202
11	.1057	.1496	.1870	.2567	.2859	.2574	.2116	.2790	.1856	.1186
+gp	.1057	.1496	.1870	.2567	.2859	.2574	.2116	.2790	.1856	.1186
0 FBAR 4- 8	.1080	.0993	.2000	.1821	.2020	.1653	.1345	.1783	.1828	.1764

YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
AGE										
3	.0937	.1277	.2296	.1510	.2059	.1484	.0840	.0376	.0931	.0138
4	.0730	.3223	.3174	.3592	.3702	.2979	.2374	.1781	.1542	.2424
5	.1648	.4563	.3535	.5426	.3152	.4241	.2885	.2898	.2029	.1965
6	.2972	.3470	.3264	.2885	.3430	.4130	.1918	.2785	.2310	.4375
7	.3268	.2903	.2288	.1952	.2046	.3661	.2003	.3210	.3222	.5550
8	.2975	.2411	.1761	.1745	.1762	.2532	.4109	.3565	.2550	.6296
9	.3726	.1968	.1948	.1177	.1657	.2018	.2634	.3859	.3121	.5557
10	.4546	.2472	.1795	.1475	.1195	.1731	.2997	.4659	.5066	.5173
11	.3749	.2284	.1834	.1466	.1538	.2094	.3247	.4028	.3579	.5675
+gp	.3749	.2284	.1834	.1466	.1538	.2094	.3247	.4028	.3579	.5675
0 FBAR 4- 8	.2318	.3314	.2804	.3120	.2818	.3509	.2658	.2848	.2331	.4122

YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
AGE										
3	.0287	.0699	.0159	.0634	.0213	.0371	.0220	.0178	.0160	.0473
4	.1841	.1066	.4962	.2378	.1396	.1397	.0901	.2070	.2055	.4164
5	.2042	.3640	.3464	.5039	.4563	.4293	.3581	.2311	.6384	.7696
6	.4819	.4656	.5674	.2925	.7600	.5777	.6440	.4974	.7924	.9046
7	.3200	.4946	.6360	.5666	.4063	.4633	.5900	.3796	.8127	.8168
8	.5384	.5269	.4641	.4154	.7481	.4182	.5988	.5325	.4141	.6802
9	.5662	.8384	.5150	.3185	.8228	.5476	.5650	.3560	.2163	.7530
10	.3270	.3695	.3678	.2171	.6168	.7266	.5538	.2398	.1896	.8321
11	.4772	.5783	.4489	.3170	.7292	.5641	.5725	.3761	.2733	.7551
+gp	.4772	.5783	.4489	.3170	.7292	.5641	.5725	.3761	.2733	.7551
0 FBAR 4- 8	.3457	.3916	.5020	.4032	.5021	.4056	.4562	.3695	.5726	.7175

YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR
AGE											99-**
3	.0299	.0631	.0446	.0108	.0134	.0099	.0104	.0058	.0184	.0203	.0148
4	.2651	.2052	.2725	.0858	.0367	.0471	.0612	.0525	.0642	.0709	.0625
5	.5979	.5541	.3329	.4069	.1313	.1081	.1472	.1522	.1614	.2752	.1963
6	.7121	.6047	.6094	.4038	.2966	.3057	.2210	.2939	.3322	.3701	.3321
7	.5927	.5232	.6063	.7106	.4814	.4900	.4159	.4404	.4519	.5175	.4699
8	.5068	.4384	.6696	.6360	.8182	.5233	.5026	.5398	.5924	.6550	.5957
9	.5945	.5173	.5424	.8210	.5380	.6752	.6811	.5855	.4052	.6587	.5498
10	.5415	.5059	.8143	.7937	.6886	.6301	.7956	.6411	.6450	.7158	.6673
11	.5476	.4872	.6754	.7502	.6816	.6095	.6598	.5888	.5475	.7644	.6336
+gp	.5476	.4872	.6754	.7502	.6816	.6095	.6598	.5888	.5475	.7644	
0 FBAR 4- 8	.5349	.4651	.4981	.4486	.3528	.2949	.2696	.2958	.3204	.3777	

Table 2.5.5.4 Saithe in the Faroes (Division Vb). Stock number at age (start of year) (Thousands).

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 6/05/2002 12:10

Traditional vpa using screen input for terminal F with backwards extension

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

	YEAR	1961
	AGE	
	3	9032
	4	7722
	5	5631
	6	3884
	7	2685
	8	1750
	9	1391
	10	1042
	11	572
	+gp	1043
0	TOTAL	34753

	YEAR	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971
	AGE										
	3	13619	22363	16181	22750	21787	26822	21451	40612	34010	37084
	4	7230	10643	17755	12630	17727	17397	21423	17008	32175	26541
	5	5980	5430	8407	12816	9574	13125	13525	16016	12045	20426
	6	4175	4340	4139	5528	8954	6756	9516	10067	11047	8458
	7	2816	2972	3179	2833	3657	5814	4818	6804	6968	7713
	8	2004	2048	2067	2088	1861	2269	3688	3451	4564	4895
	9	1316	1522	1495	1311	1343	1184	1433	2430	2295	3079
	10	1034	961	1090	1062	798	835	774	944	1468	1594
	11	779	745	645	757	689	470	513	519	558	985
	+gp	1153	2170	1122	1383	994	678	1078	857	857	985
0	TOTAL	40106	53195	56080	63158	67384	75351	78219	98707	105988	111760

	YEAR	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
	AGE										
	3	33414	23106	18771	16196	18780	12842	8357	8568	12347	33021
	4	27785	24909	16650	12215	11402	12515	9064	6291	6755	9210
	5	18742	21148	14775	9925	6983	6447	7607	5853	4310	4741
	6	11708	13013	10971	8495	4723	4171	3454	4667	3586	2881
	7	6019	7121	7530	6481	5212	2744	2260	2334	2892	2331
	8	5568	3554	4361	4905	4365	3478	1558	1514	1386	1716
	9	3585	3386	2287	2994	3372	2997	2210	846	868	880
	10	2227	2022	2277	1541	2179	2340	2005	1391	471	520
	11	1157	1157	1293	1558	1088	1583	1611	1217	715	232
	+gp	737	1001	1739	2405	2216	1921	2118	2284	2865	2577
0	TOTAL	110942	100418	80655	66714	60321	51037	40243	34964	36196	58108

	YEAR	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
	AGE										
	3	15097	40553	25707	21952	61019	47833	43918	28207	20463	24569
	4	26664	12011	30962	20715	16868	48904	37735	35175	22687	16488
	5	5918	18160	8839	15434	13370	12011	34818	28234	23415	15124
	6	3189	3950	10332	5118	7635	6936	6401	19927	18347	10124
	7	1523	1613	2030	4796	3128	2923	3187	2752	9921	6801
	8	1095	905	805	880	2228	1706	1506	1446	1542	3604
	9	748	523	438	414	476	863	919	677	695	834
	10	413	348	185	214	247	171	409	428	389	459
	11	254	244	197	105	141	109	68	192	276	263
	+gp	2602	1344	766	1111	333	246	150	136	363	243
0	TOTAL	57503	79651	80261	70740	105444	121703	129112	117176	98097	78508

	YEAR	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	GMST 61-99	AMST 61-99
	AGE													
	3	19477	23727	17432	41017	24654	38660	17419	61629	49131	61876	0	23343	26268
	4	19185	15476	18238	13649	33222	19917	31342	14115	50168	39492	49644	17235	19446
	5	8902	12050	10320	11370	10256	26219	15556	24136	10965	38519	30121	11601	13273
	6	5735	4008	5669	6057	6198	7364	19266	10993	16971	7639	23949	6778	7738
	7	3355	2304	1792	2523	3312	3772	4441	12646	6708	9967	4320	3755	4308
	8	2460	1518	1118	800	1015	1675	1892	2399	6665	3496	4864	2037	2351
	9	1494	1213	802	468	347	367	813	937	1145	3018	1487	1142	1417
	10	322	675	592	382	169	166	153	337	427	625	1279	646	888
	11	163	153	333	215	141	69	72	56	145	184	250	371	561
	+gp	280	148	109	242	181	239	165	169	65	114	113		
0	TOTAL	61373	61272	56405	76724	79495	98448	91118	127418	142390	164929	116026		

Table 2.5.5.5 Saithe in the Faroes (Division Vb). Summary table.

```
Run title : FAROE SAITHE (ICES Division Vb)                 SAI_IND

    At  6/05/2002  12:10

        Table 16    Summary     (without SOP correction)

        Traditional vpa using screen input for terminal F with backwards extension
```

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1961	9032	122159	84047	9592	.1141	.0907
1962	13619	126558	85825	10454	.1218	.1080
1963	22363	158306	100859	12693	.1258	.0993
1964	16181	160324	98419	21893	.2224	.2000
1965	22750	174701	107272	22181	.2068	.1821
1966	21787	184036	108806	25563	.2349	.2020
1967	26822	181502	104636	21319	.2037	.1653
1968	21451	189683	116011	20387	.1757	.1345
1969	40612	214702	123787	27437	.2216	.1783
1970	34010	224052	129102	29110	.2255	.1828
1971	37084	227929	139397	32706	.2346	.1764
1972	33414	236418	147387	42663	.2895	.2318
1973	23106	209953	136561	57431	.4206	.3314
1974	18771	203579	137545	47188	.3431	.2804
1975	16196	187008	137809	41576	.3017	.3120
1976	18780	169263	121855	33065	.2713	.2818
1977	12842	155791	113860	34835	.3059	.3509
1978	8357	136872	95808	28138	.2937	.2658
1979	8568	112662	83398	27246	.3267	.2848
1980	12347	124362	88748	25230	.2843	.2331
1981	33021	141447	76135	30103	.3954	.4122
1982	15097	149399	83124	30964	.3725	.3457
1983	40553	177826	95076	39176	.4120	.3916
1984	25707	188596	96837	54665	.5645	.5020
1985	21952	188340	111564	44605	.3998	.4032
1986	61019	233039	96773	41716	.4311	.5021
1987	47833	247305	94088	40020	.4253	.4056
1988	43918	256296	100564	45285	.4503	.4562
1989	28207	225295	99752	44477	.4459	.3695
1990	20463	188942	93390	61628	.6599	.5726
1991	24569	147192	70745	54858	.7754	.7175
1992	19477	121945	59424	36487	.6140	.5349
1993	23727	131210	62720	33543	.5348	.4651
1994	17432	126280	61503	33182	.5395	.4981
1995	41017	155996	64210	27209	.4238	.4486
1996	24654	166494	72321	20029	.2769	.3528
1997	38660	194087	81093	22306	.2751	.2949
1998	17419	184094	97096	26421	.2721	.2696
1999	61629	235655	112528	33207	.2951	.2958
2000	49131	268261	111274	39045	.3509	.3204
2001	61876	296315	124828	51795	.4149	.3777
Arith. Mean	27694	183509	100638	33693	.3476	.3226
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.5.6.1 Saithe in the Faroes (Division Vb). Prediction with management table: input data

MFDP version 1a
Run: man1
Time and date: 14:30 06/05/02
Fbar age range: 4-8

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29761	0.2	0.09	0	0	1.394	0.017	1.394
4	49644	0.2	0.25	0	0	1.636	0.071	1.636
5	30121	0.2	0.50	0	0	1.922	0.224	1.922
6	23949	0.2	0.73	0	0	2.447	0.379	2.447
7	4320	0.2	0.85	0	0	2.960	0.536	2.960
8	4864	0.2	0.96	0	0	3.825	0.679	3.825
9	1487	0.2	0.99	0	0	4.827	0.627	4.827
10	1279	0.2	1.00	0	0	5.453	0.761	5.453
11	250	0.2	1.00	0	0	6.727	0.722	6.727
12	113	0.2	1.00	0	0	7.111	0.722	7.111

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29761	0.2	0.09	0	0	1.394	0.017	1.394
4 .		0.2	0.25	0	0	1.636	0.071	1.636
5 .		0.2	0.50	0	0	1.922	0.224	1.922
6 .		0.2	0.73	0	0	2.447	0.379	2.447
7 .		0.2	0.85	0	0	2.960	0.536	2.960
8 .		0.2	0.96	0	0	3.825	0.679	3.825
9 .		0.2	0.99	0	0	4.827	0.627	4.827
10 .		0.2	1.00	0	0	5.453	0.761	5.453
11 .		0.2	1.00	0	0	6.727	0.722	6.727
12 .		0.2	1.00	0	0	7.111	0.722	7.111

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29761	0.2	0.09	0	0	1.394	0.017	1.394
4 .		0.2	0.25	0	0	1.636	0.071	1.636
5 .		0.2	0.50	0	0	1.922	0.224	1.922
6 .		0.2	0.73	0	0	2.447	0.379	2.447
7 .		0.2	0.85	0	0	2.960	0.536	2.960
8 .		0.2	0.96	0	0	3.825	0.679	3.825
9 .		0.2	0.99	0	0	4.827	0.627	4.827
10 .		0.2	1.00	0	0	5.453	0.761	5.453
11 .		0.2	1.00	0	0	6.727	0.722	6.727
12 .		0.2	1.00	0	0	7.111	0.722	7.111

Input units are thousands and kg - output in tonnes

Table 2.5.6.2 Saithe in the Faroes (Division Vb). Yield per recruit: input data.

MFYPR version 2a
Run: yrn1
Index file 6/5/2002
Time and date: 15:01 06/05/02
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.09	0	0	1.320	0.063	1.320
4	0.2	0.26	0	0	1.831	0.203	1.831
5	0.2	0.52	0	0	2.463	0.346	2.463
6	0.2	0.77	0	0	3.212	0.429	3.212
7	0.2	0.89	0	0	4.062	0.448	4.062
8	0.2	0.97	0	0	4.990	0.463	4.990
9	0.2	0.99	0	0	5.784	0.468	5.784
10	0.2	1.00	0	0	6.498	0.474	6.498
11	0.2	1.00	0	0	7.349	0.471	7.349
12	0.2	1.00	0	0	8.679	0.471	8.679

Weights in kilograms

Table 2.5.6.3 Saithe in the Faroes (Division Vb). Yield per recruit: summary table.

MFYPR version 2a
Run: yrn1
Time and date: 15:01 06/05/02
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.6360	3.4985	18.8792	3.4985	18.8792
0.1000	0.0378	0.1366	0.6314	4.8365	17.7856	2.8445	14.1091	2.8445	14.1091
0.2000	0.0755	0.2308	0.9832	4.3678	14.6423	2.4007	11.0408	2.4007	11.0408
0.3000	0.1133	0.3002	1.1891	4.0236	12.4702	2.0800	8.9389	2.0800	8.9389
0.4000	0.1511	0.3536	1.3135	3.7588	10.8964	1.8375	7.4309	1.8375	7.4309
0.5000	0.1889	0.3962	1.3901	3.5480	9.7130	1.6479	6.3094	1.6479	6.3094
0.6000	0.2266	0.4312	1.4376	3.3755	8.7963	1.4956	5.4509	1.4956	5.4509
0.7000	0.2644	0.4604	1.4668	3.2312	8.0683	1.3706	4.7779	1.3706	4.7779
0.8000	0.3022	0.4854	1.4844	3.1085	7.4780	1.2662	4.2396	1.2662	4.2396
0.9000	0.3400	0.5070	1.4943	3.0024	6.9907	1.1777	3.8014	1.1777	3.8014
1.0000	0.3777	0.5259	1.4993	2.9097	6.5821	1.1018	3.4393	1.1018	3.4393
1.1000	0.4155	0.5427	1.5009	2.8278	6.2349	1.0359	3.1362	1.0359	3.1362
1.2000	0.4533	0.5576	1.5003	2.7546	5.9362	0.9783	2.8795	0.9783	2.8795
1.3000	0.4911	0.5711	1.4982	2.6889	5.6765	0.9273	2.6597	0.9273	2.6597
1.4000	0.5288	0.5834	1.4951	2.6293	5.4486	0.8821	2.4700	0.8821	2.4700
1.5000	0.5666	0.5946	1.4914	2.5751	5.2470	0.8415	2.3047	0.8415	2.3047
1.6000	0.6044	0.6048	1.4872	2.5253	5.0672	0.8050	2.1596	0.8050	2.1596
1.7000	0.6422	0.6143	1.4829	2.4795	4.9058	0.7720	2.0315	0.7720	2.0315
1.8000	0.6799	0.6230	1.4784	2.4372	4.7601	0.7420	1.9176	0.7420	1.9176
1.9000	0.7177	0.6312	1.4739	2.3978	4.6277	0.7145	1.8157	0.7145	1.8157
2.0000	0.7555	0.6388	1.4694	2.3612	4.5069	0.6894	1.7242	0.6894	1.7242

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3777
FMax	1.1164	0.4217
F0.1	0.4262	0.161
F35%SPR	0.4706	0.1778
Flow	0.289	0.1092
Fmed	0.9161	0.346
Fhigh	2.1754	0.8217

Weights in kilograms

Table 2.5.6.4 Saithe in the Faroes (Division Vb). Prediction with management table.

MFDP version 1a
Run: man1
Index file 6/5/2002
Time and date: 14:30 06/05/02
Fbar age range: 4-8

2002

Biomass	SSB	FMult	FBar	Landings
287239	140665	1.0000	0.3777	54013

2003					2004	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
266959	143675	0.0000	0.0000	0	309186	192892
.	143675	0.1000	0.0378	6801	301599	186314
.	143675	0.2000	0.0755	13318	294338	180036
.	143675	0.3000	0.1133	19567	287385	174041
.	143675	0.4000	0.1511	25560	280726	168314
.	143675	0.5000	0.1889	31310	274346	162844
.	143675	0.6000	0.2266	36828	268231	157615
.	143675	0.7000	0.2644	42126	262369	152617
.	143675	0.8000	0.3022	47215	256747	147837
.	143675	0.9000	0.3400	52104	251353	143264
.	143675	1.0000	0.3777	56803	246176	138889
.	143675	1.1000	0.4155	61320	241207	134701
.	143675	1.2000	0.4533	65665	236434	130691
.	143675	1.3000	0.4911	69846	231850	126851
.	143675	1.4000	0.5288	73869	227444	123172
.	143675	1.5000	0.5666	77743	223209	119646
.	143675	1.6000	0.6044	81475	219136	116265
.	143675	1.7000	0.6422	85070	215218	113024
.	143675	1.8000	0.6799	88535	211447	109914
.	143675	1.9000	0.7177	91876	207818	106931
.	143675	2.0000	0.7555	95098	204323	104067

Input units are thousands and kg - output in tonnes

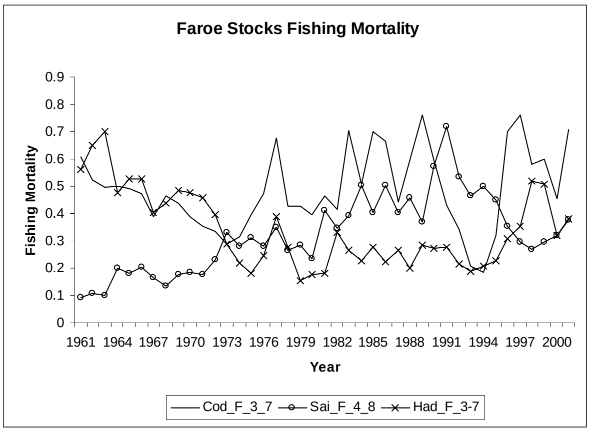


Figure 2.1.1: Faroe demersal stocks fishing mortality.

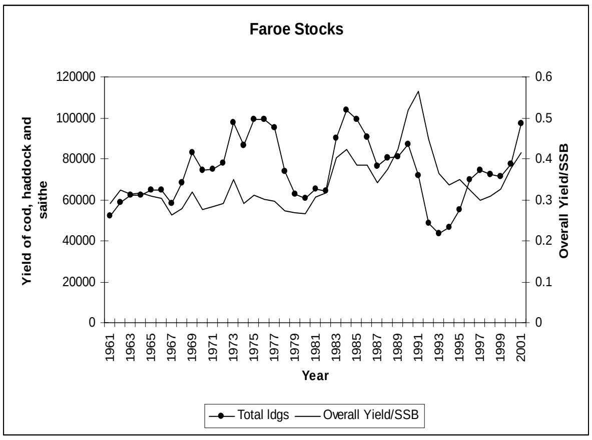


Figure 2.1.2: Faroe demersal stocks total landings and overall yield/SSB ratios

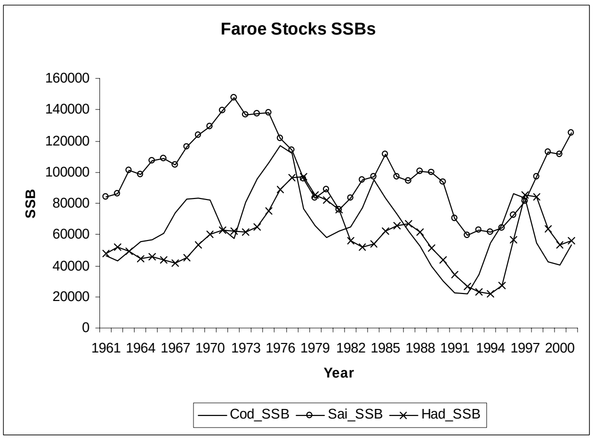


Figure 2.1.3: Faroe demersal stocks individual SSB trends.

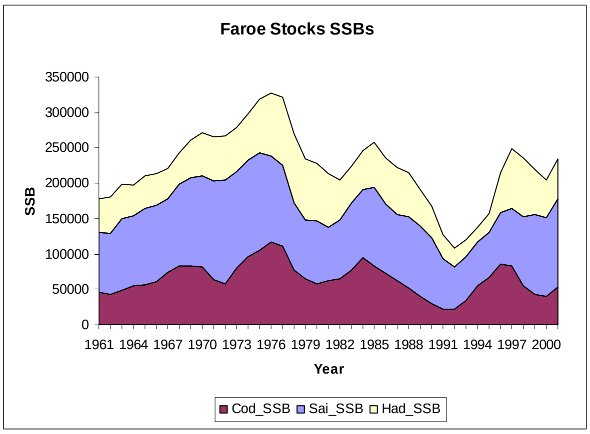


Figure 2.1.4: Faroe demersal stocks spawning stock biomasses.

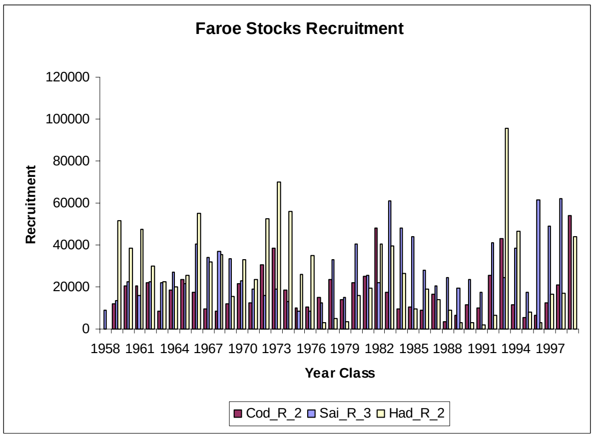


Figure 2.1.5: Faroe demersal stocks recruitment.

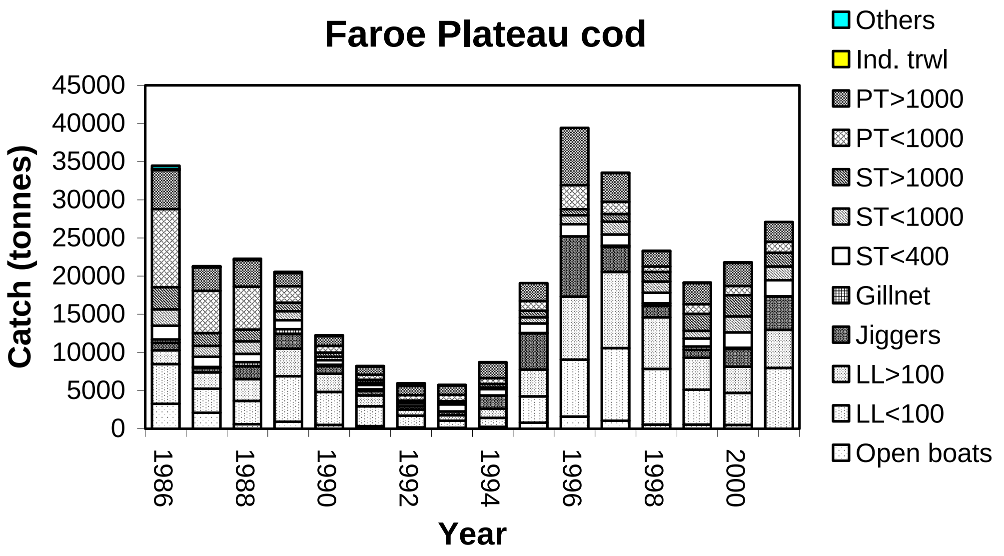


Figure 2.2.1.1 Faroe Plateau (subdivision VB1) COD. Catch landed by faroese fleets 1986-2001.

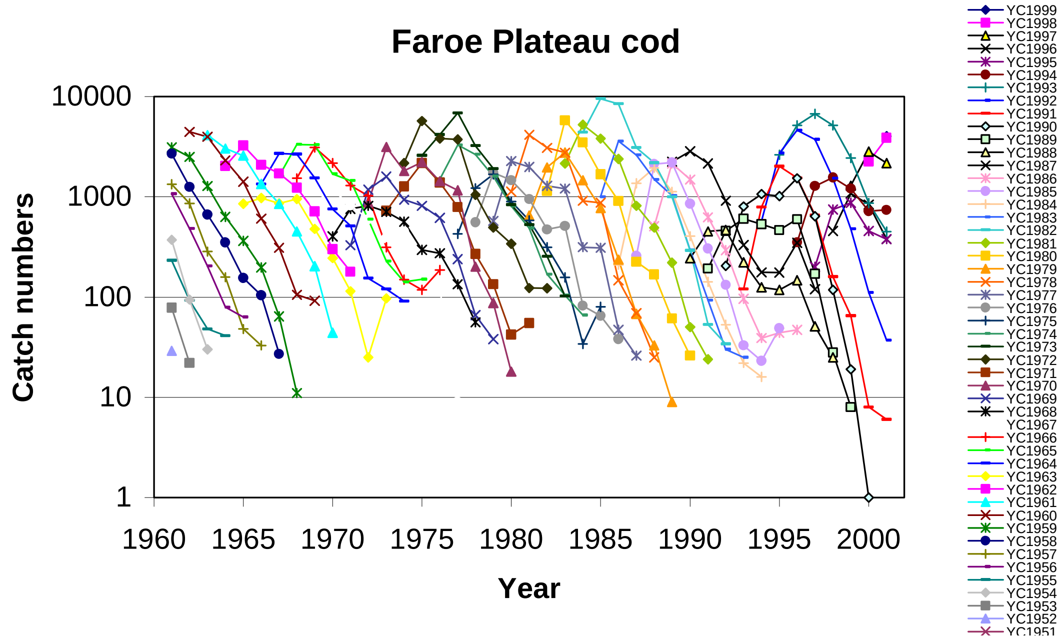


Figure 2.2.2.1 Faroe Plateau (subdivision VB1) COD. Catch curves obtained from the catch at age data.

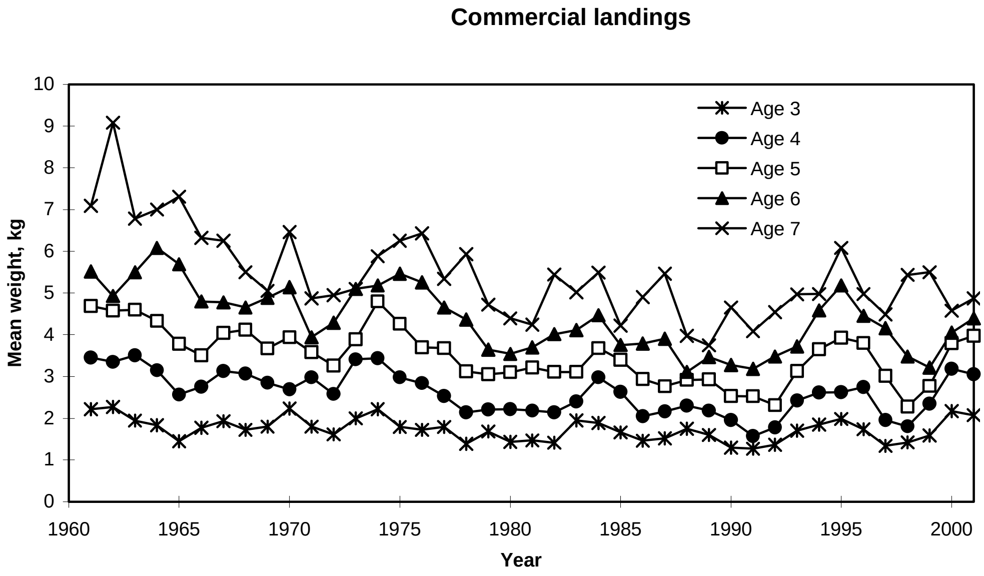


Figure 2.2.3.1 Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2001.

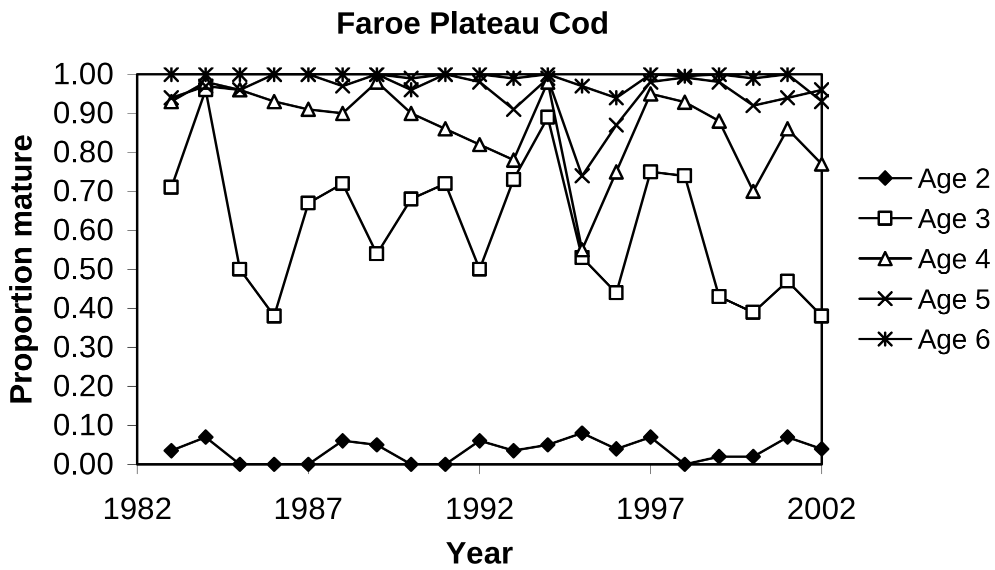


Figure 2.2.4.1 Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey.

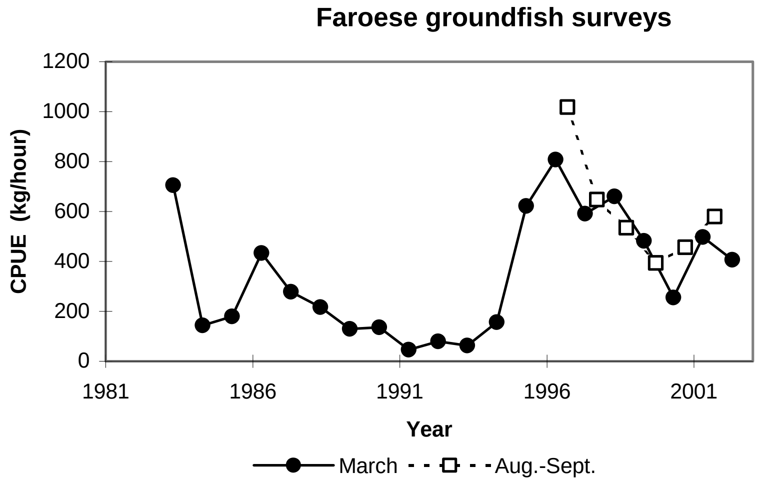


Figure 2.2.5.1 Faroe Plateau (sub-division VB1) COD. Catch per unit effort in the spring, and summer groundfish survey.

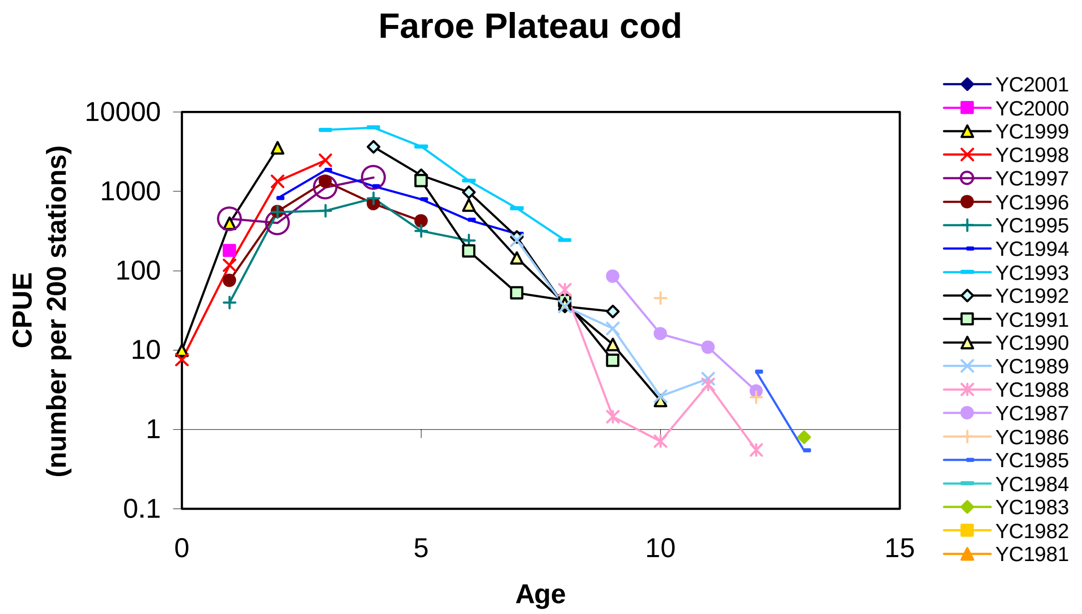


Figure 2.2.5.2 Faroe Plateau (sub-division VB1) COD. Catch curvey from the summer groundfish survey.

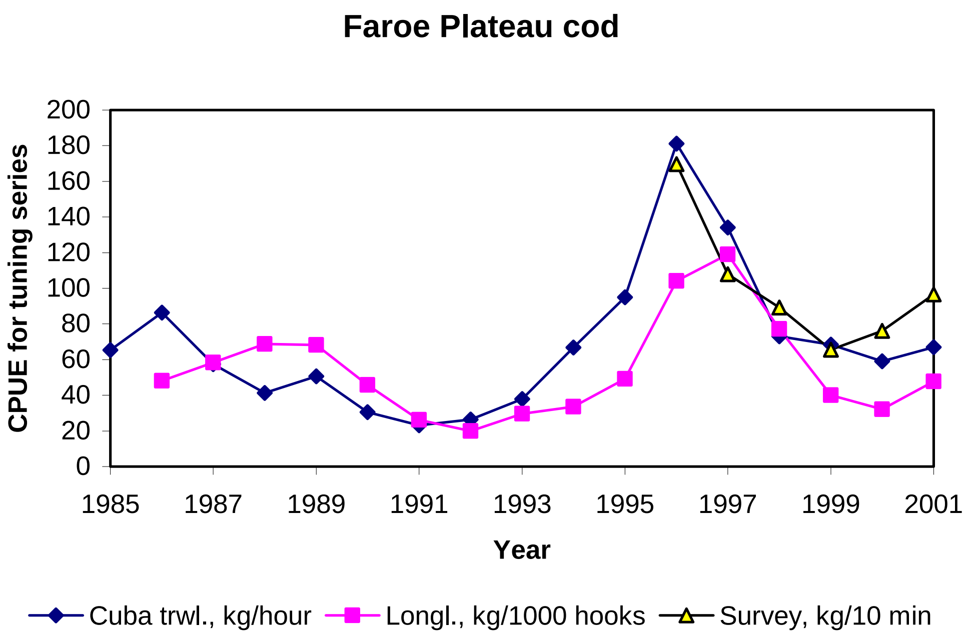


Figure 2.2.6.1.1 Faroe Plateau (subdivision VB1) COD. Catch per unit effort for Cuba trawlers, longliners and summer survey.

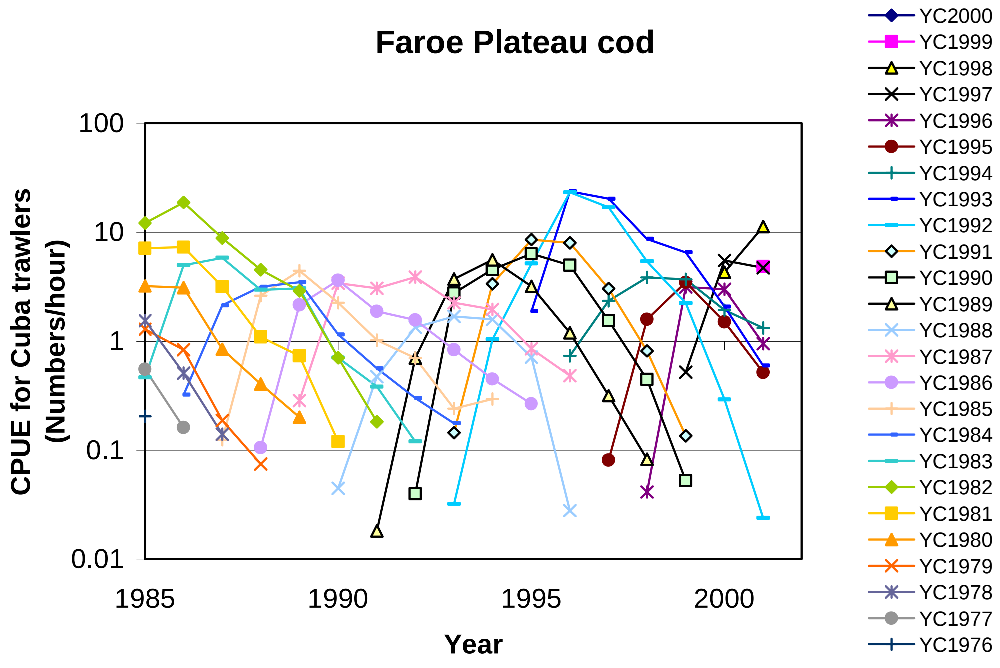


Figure 2.2.6.1.3 Faroe Plateau (subdivision VB1) COD. Catch per unit effort for Cuba trawlers segregated to age classes.

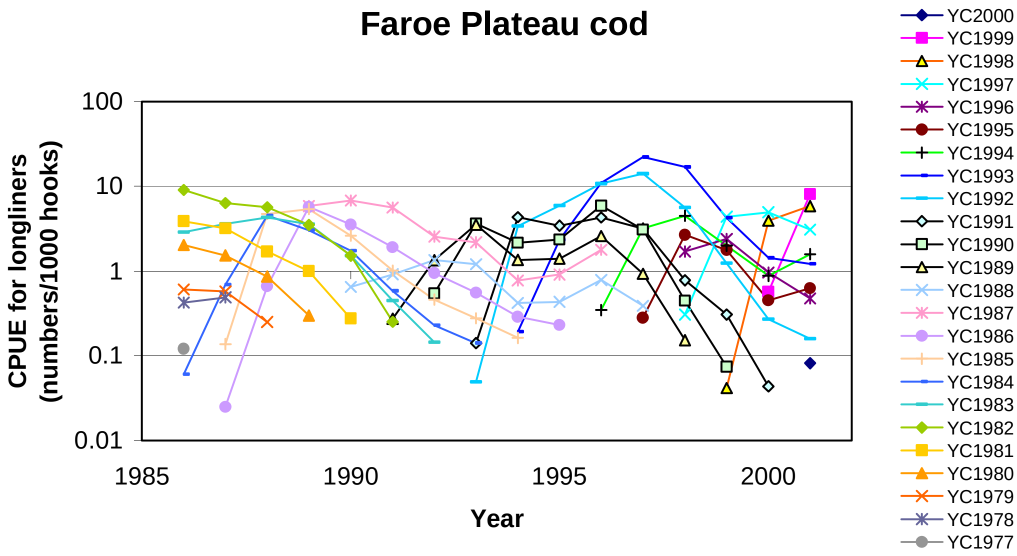


Figure 2.2.6.1.4 Faroe Plateau (sub-division VB1) COD. Catch per unit effort for longliners segregated to age classes.

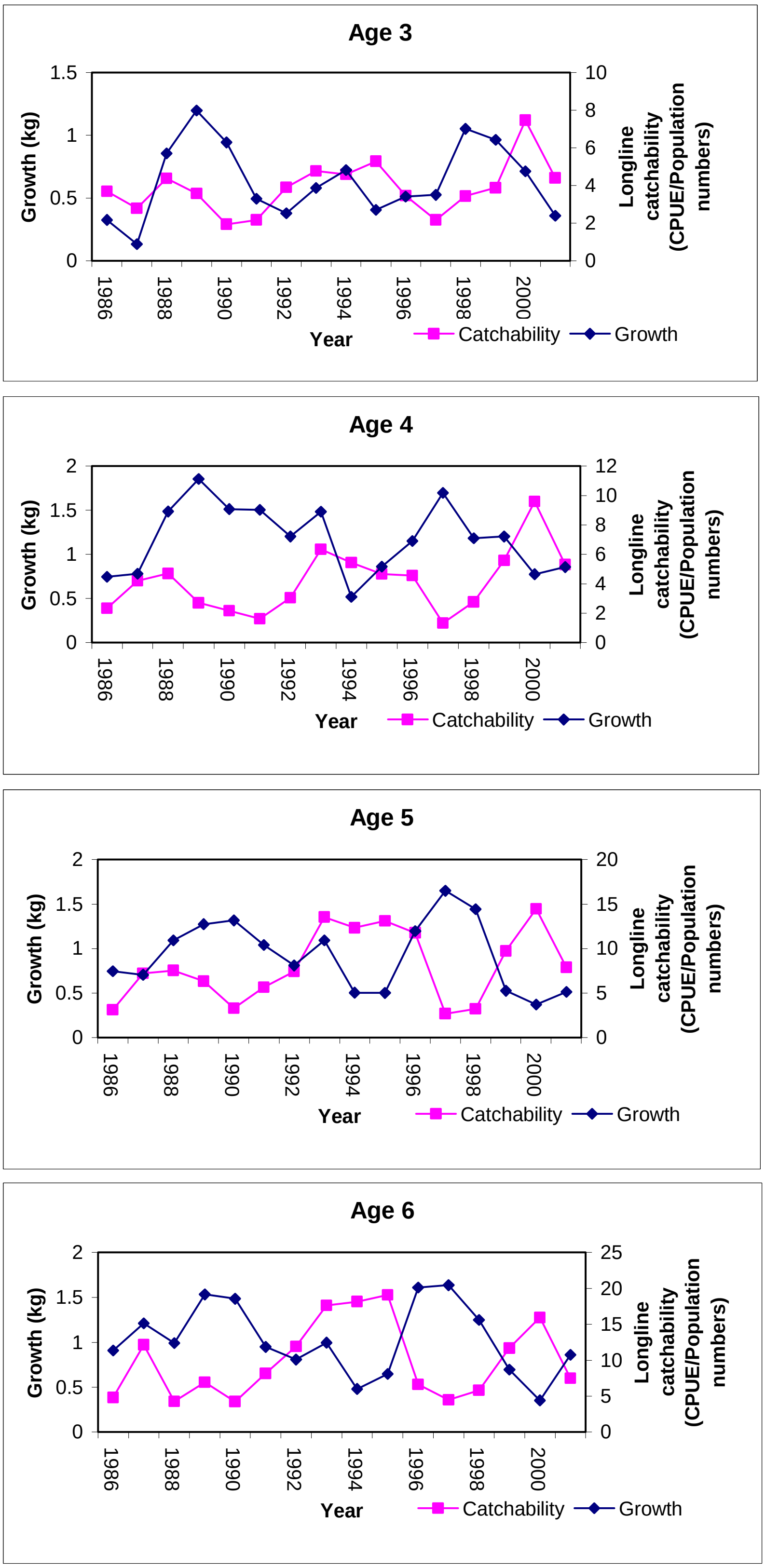
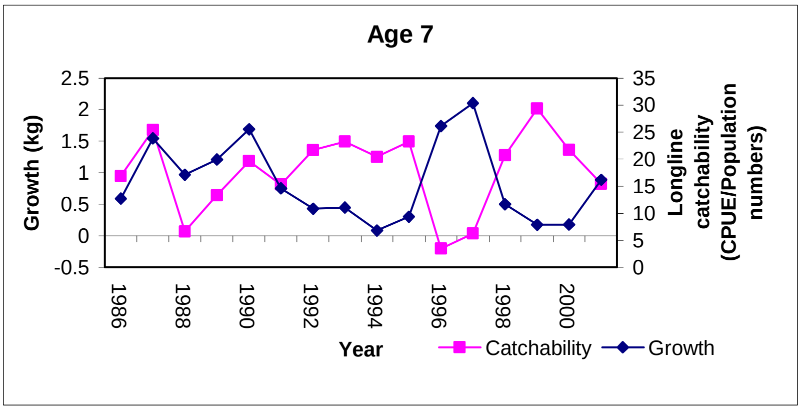
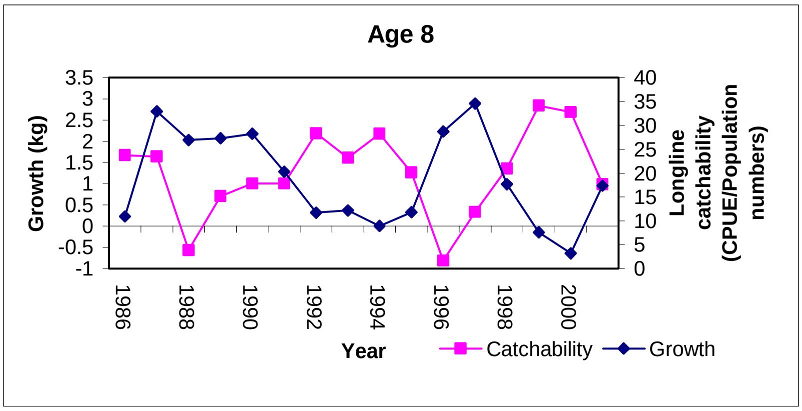


Figure 2.2.6.1.5 Faroe Plateau (sub-division VB1) COD. Growth versus catchability for longliners.





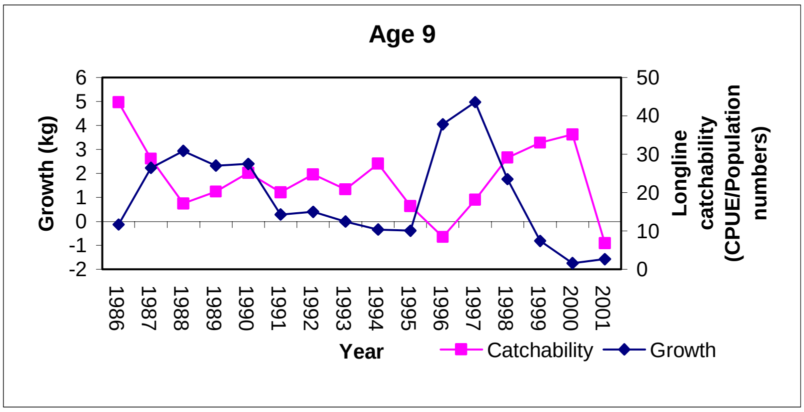


Figure 2.2.6.1.5 Faroe Plateau (sub-division VB1) COD. Growth versus catchability for longliners. (Continued).

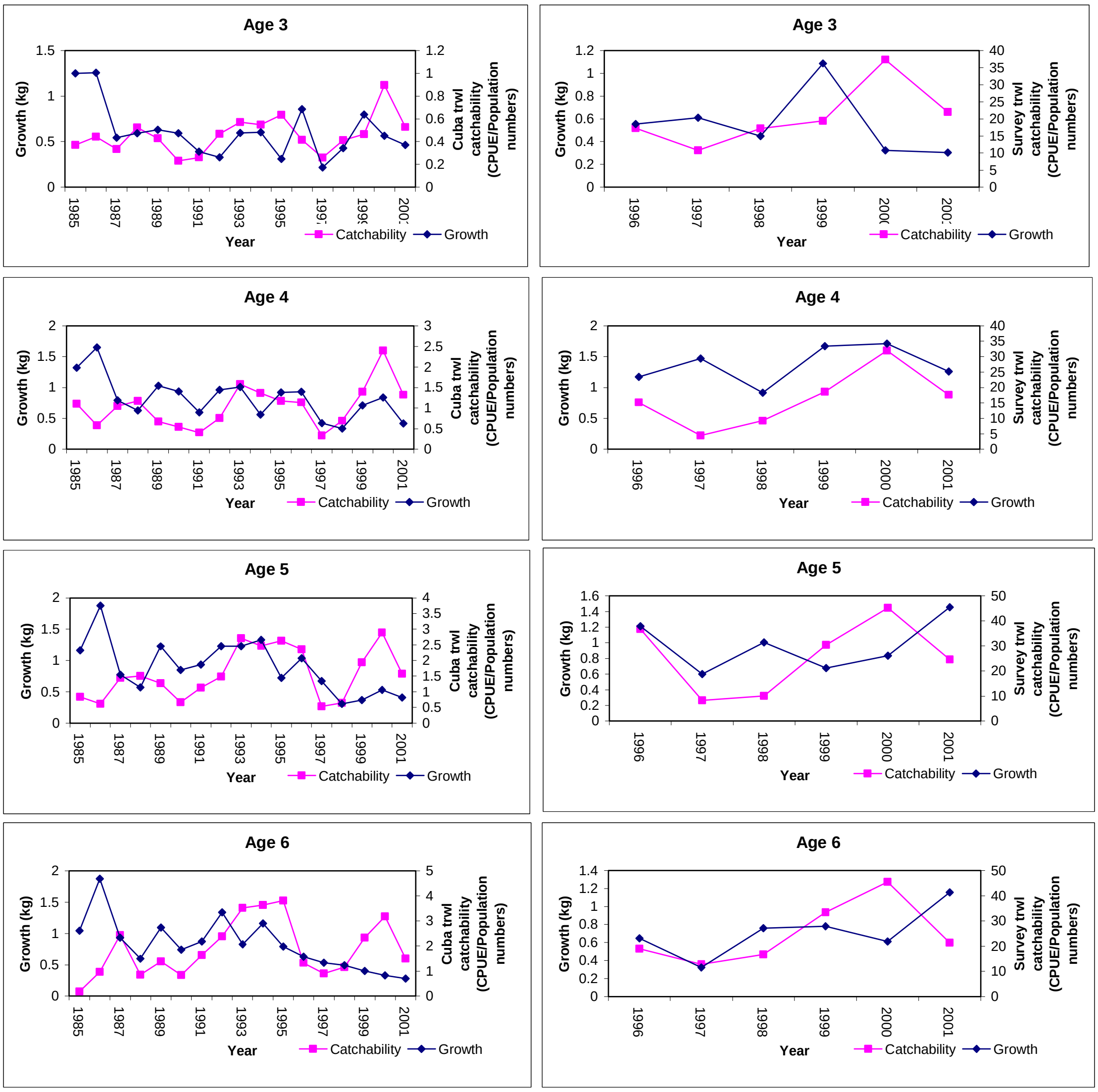


Figure 2.2.6.1.6 Faroe Plateau (sub-division VB1) COD. Growth versus catchability for Cuba trawlers (left) and summer survey (right).

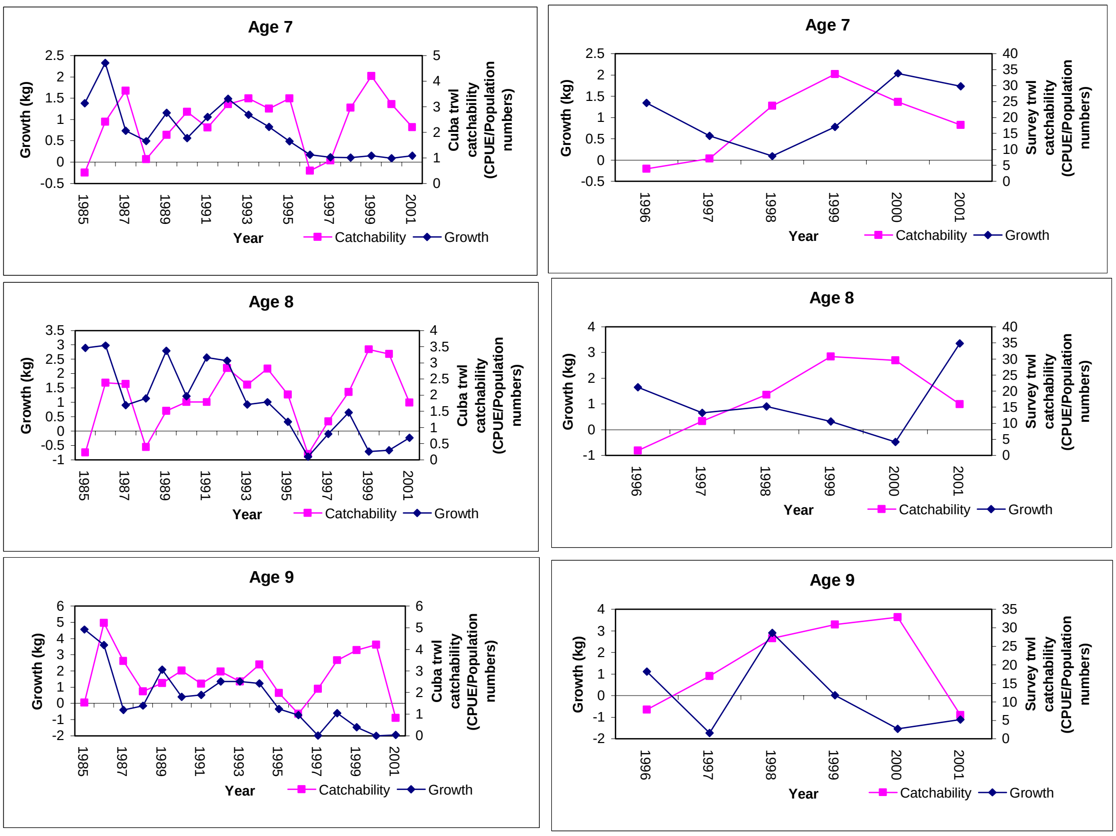


Figure 2.2.6.1.6 Faroe Plateau (sub-division VB1) COD. Growth versus catchability for Cuba trawlers (left) and summer survey (right). (Continued).

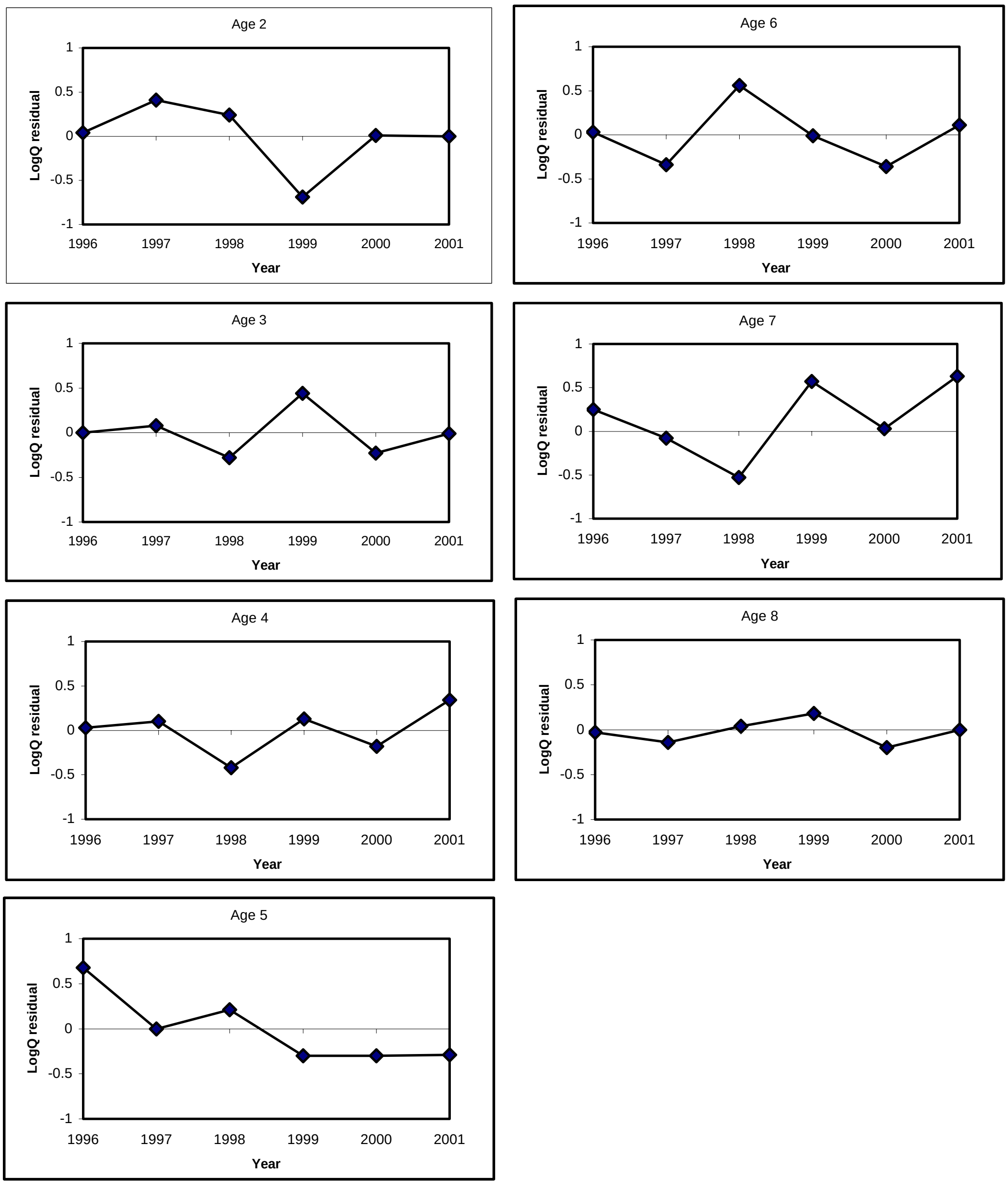


Figure 2.2.6.1.7 Faroe Plateau (sub-division VB1) COD. Log catchability residuals (summer survey).

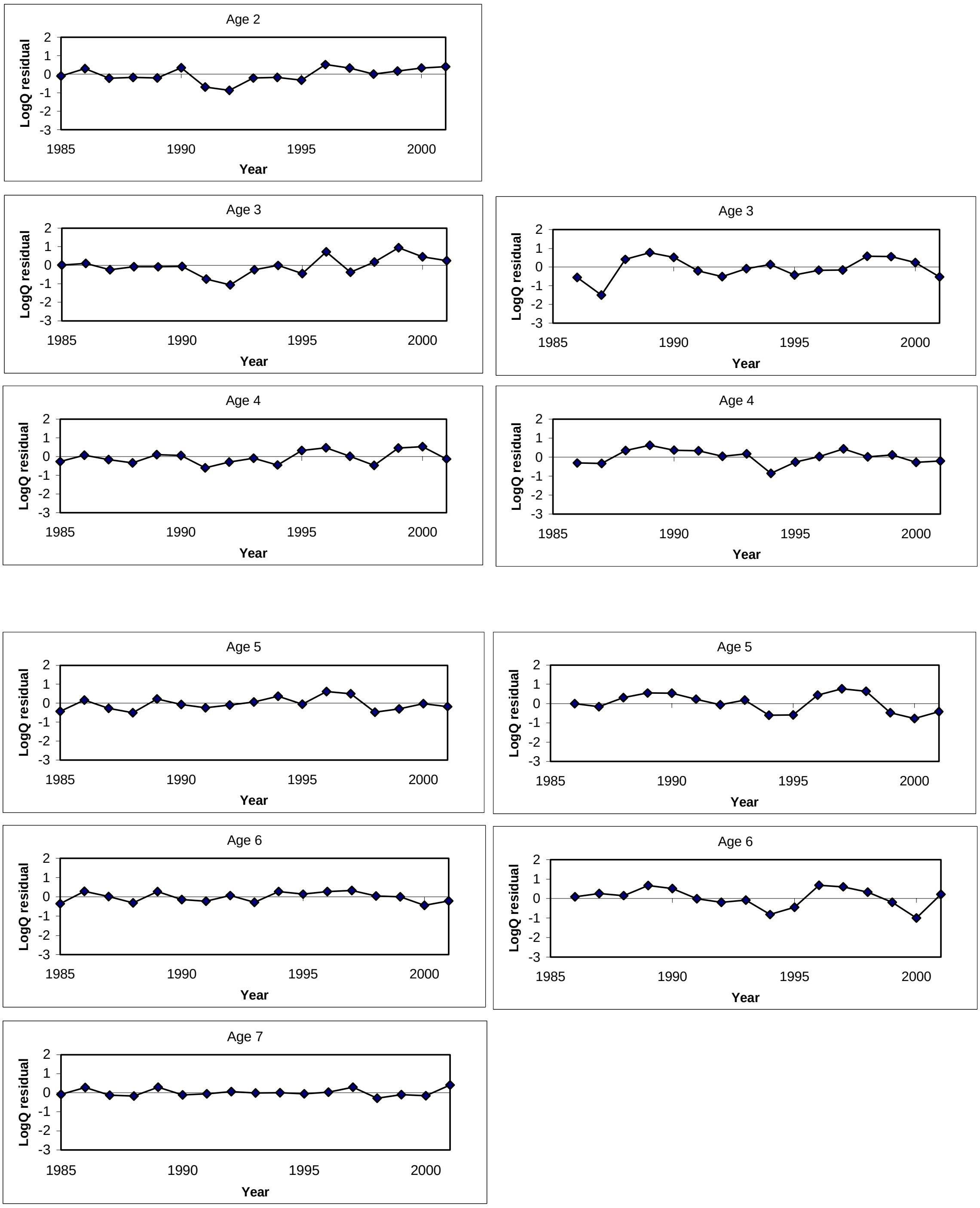
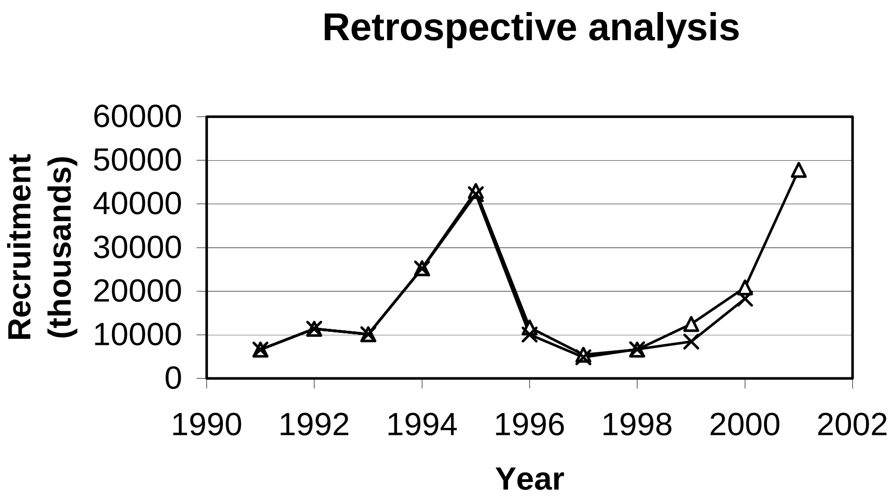


Figure 2.2.6.1.7 Faroe Plateau (subdivision VB1) COD. Log catchability residuals (Cuba trawlers (left) and longliners (right)). Continued.



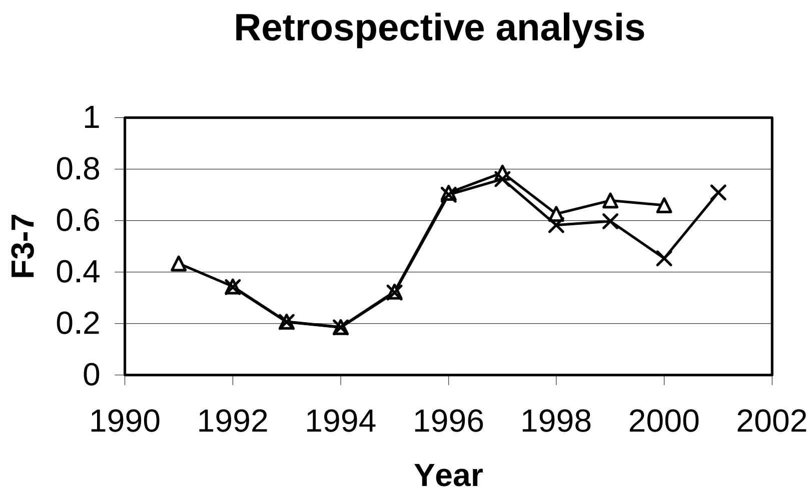
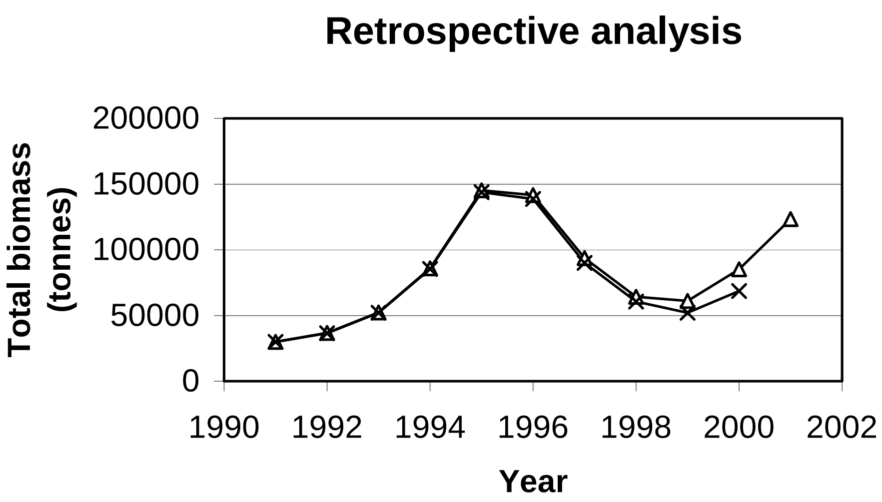


Figure 2.2.6.1.8 Faroe Plateau (subdivision VB1) COD. Results from retrospective analysis.



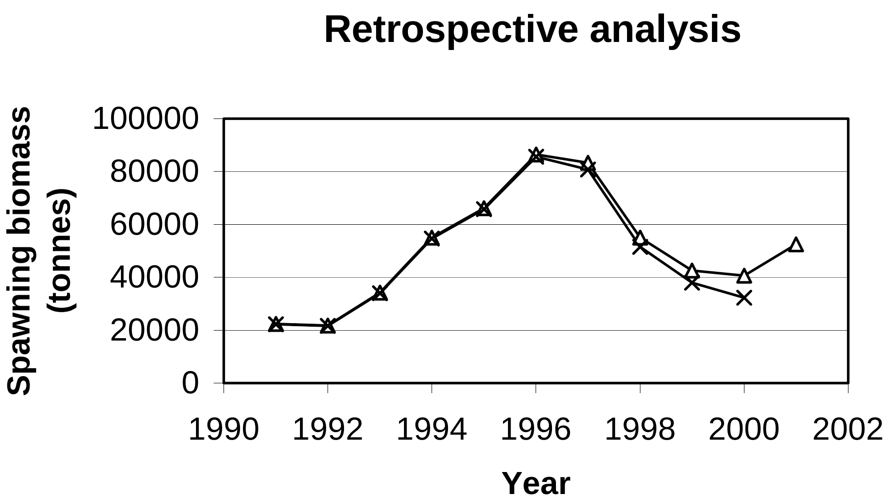
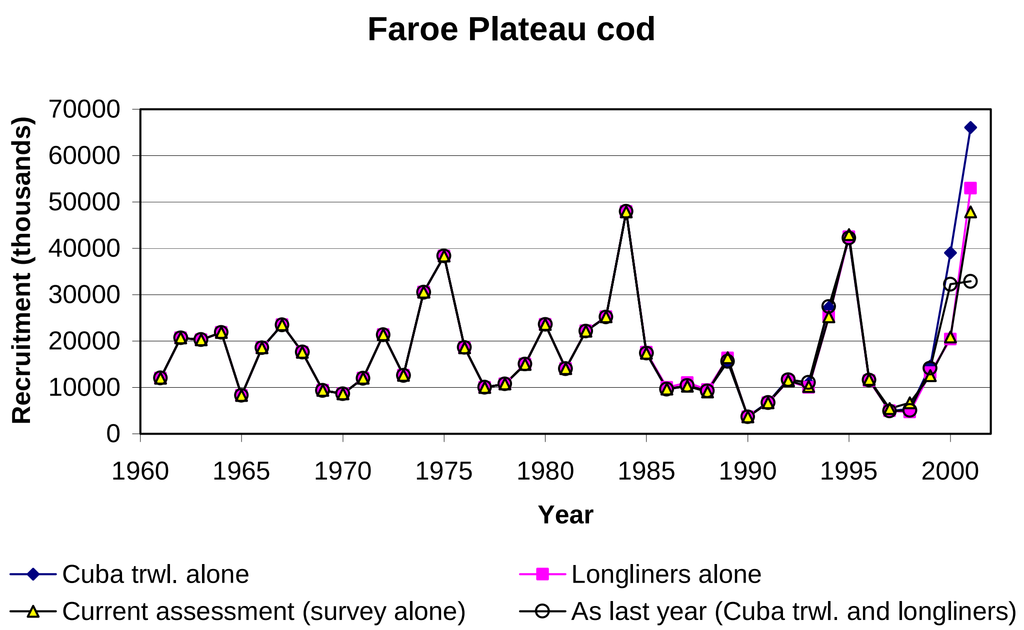


Figure 2.2.6.1.8 Faroe Plateau (subdivision VB1) COD. Results from retrospective analysis. (Continued).



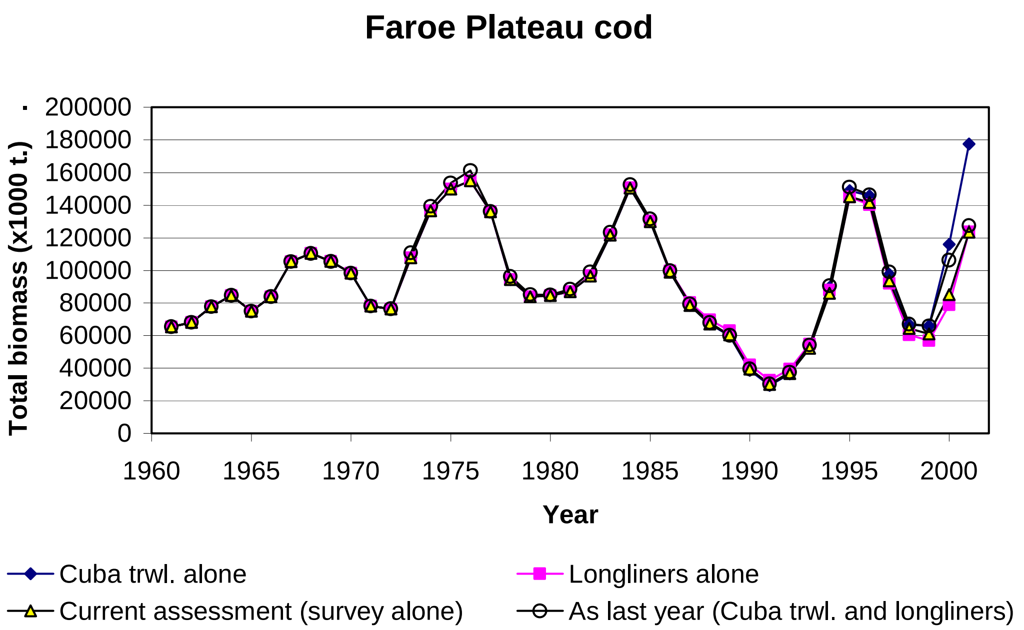
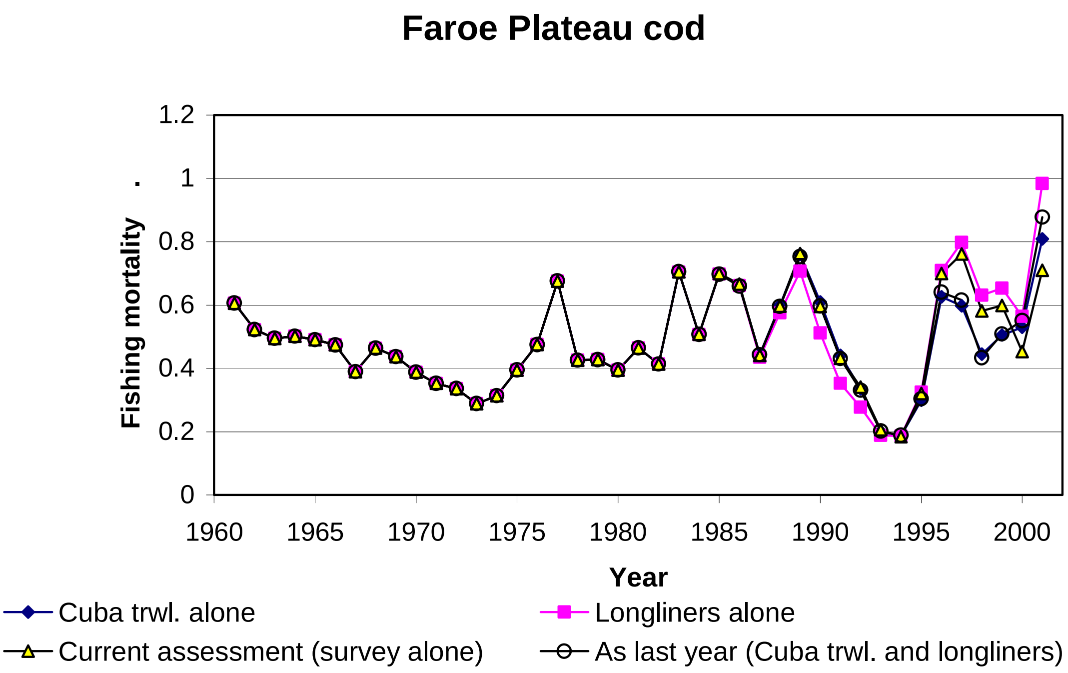


Figure 2.2.6.1.9 Faroe Plateau (sub-division VB1) COD. Results from different XSA runs.



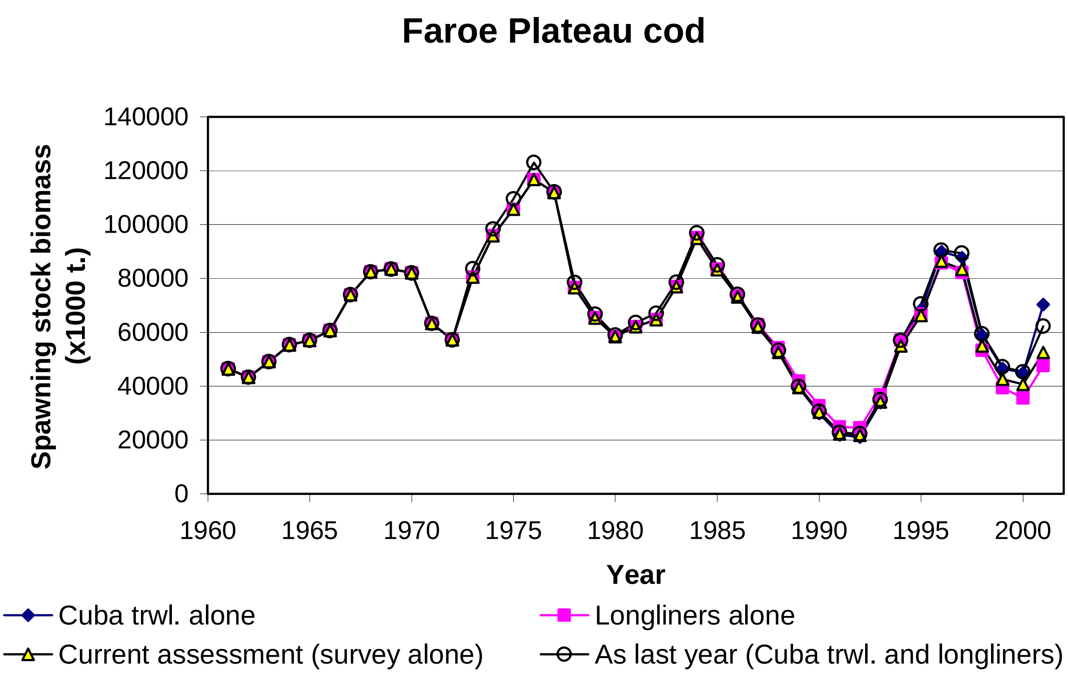


Figure 2.2.6.1.9 Faroe Plateau (su-division VB1) COD. Results from different XSA runs. (Continued).

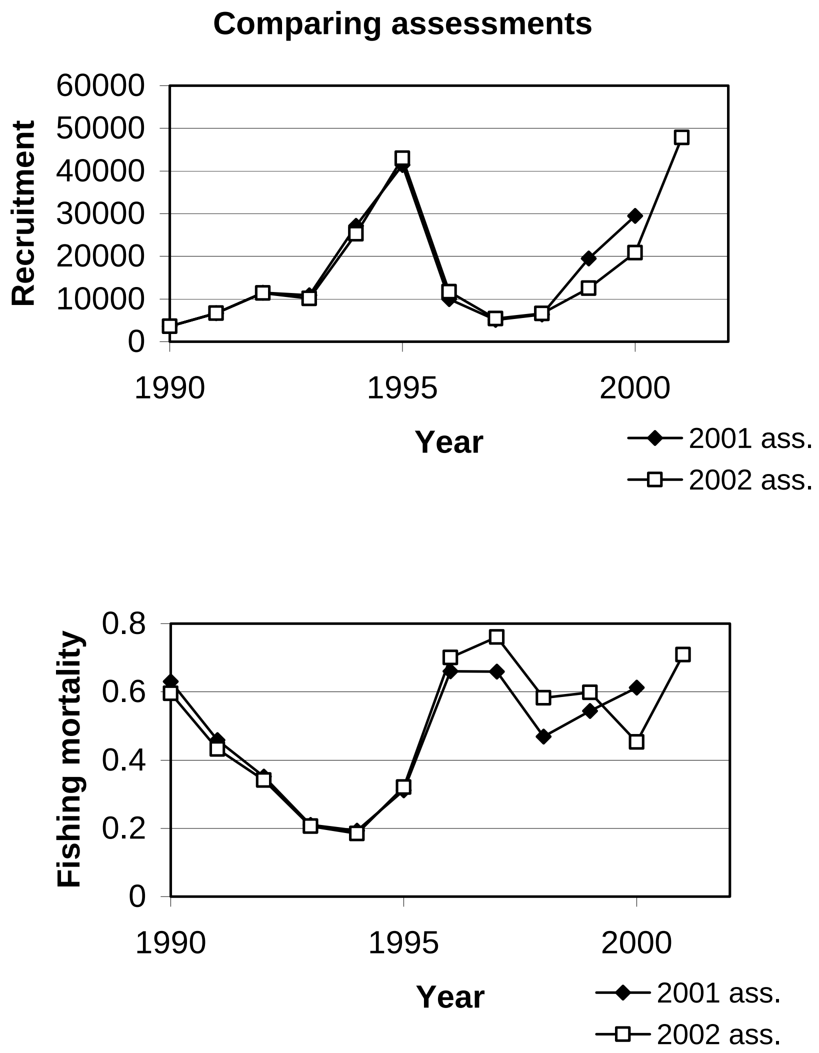
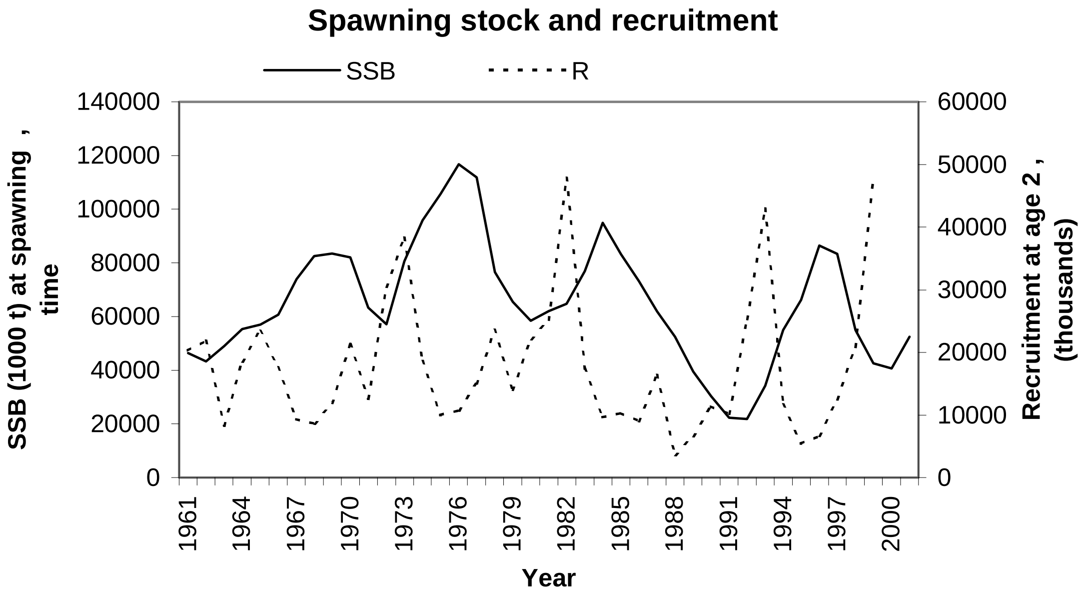


Figure 2.2.6.1.10 Faroe Plateau (subdivision VB1) COD. Current assessment compared with the assessment from last year.



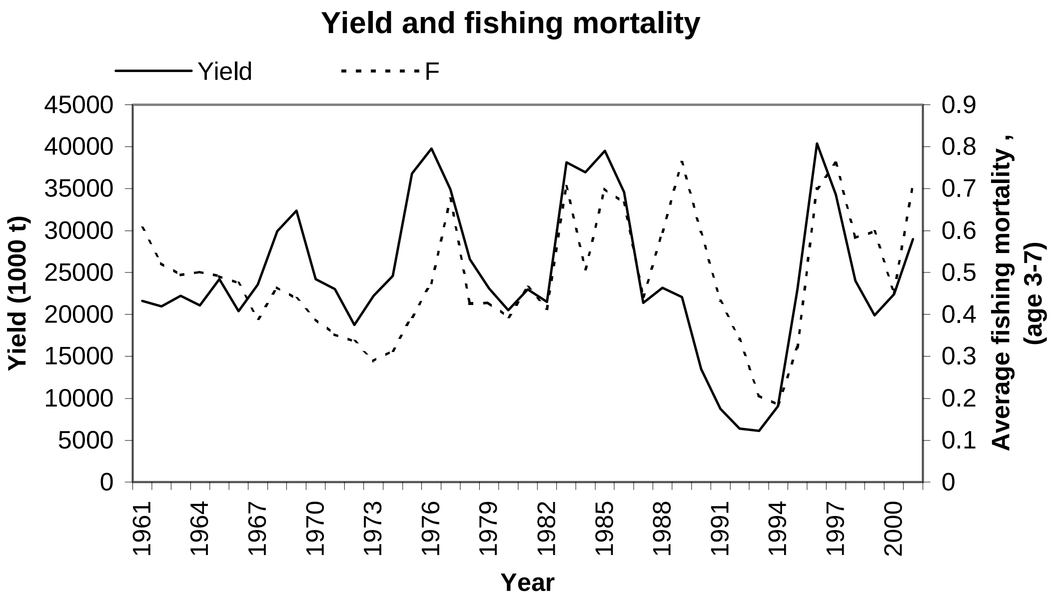


Figure 2.2.6.1.11 Faroe Plateau (subdivision VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment versus year.

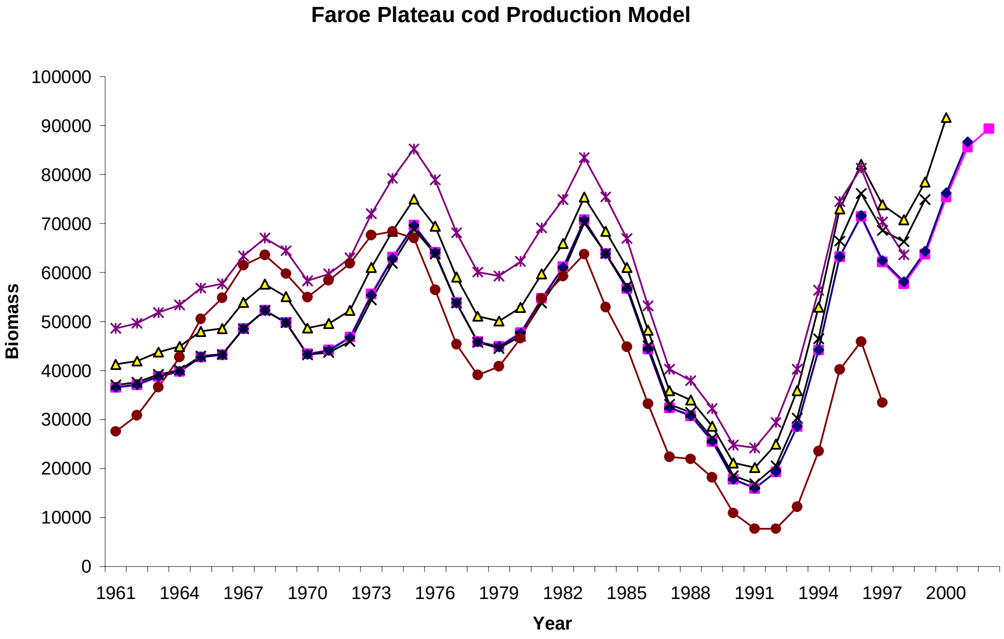


Figure 2.2.6.1.12 Faroe Plateau (subdivision VB1) COD. Biomass estimates (tonnes) obtained by the ASPIC model. Retrospective runs up to 1997-2001.

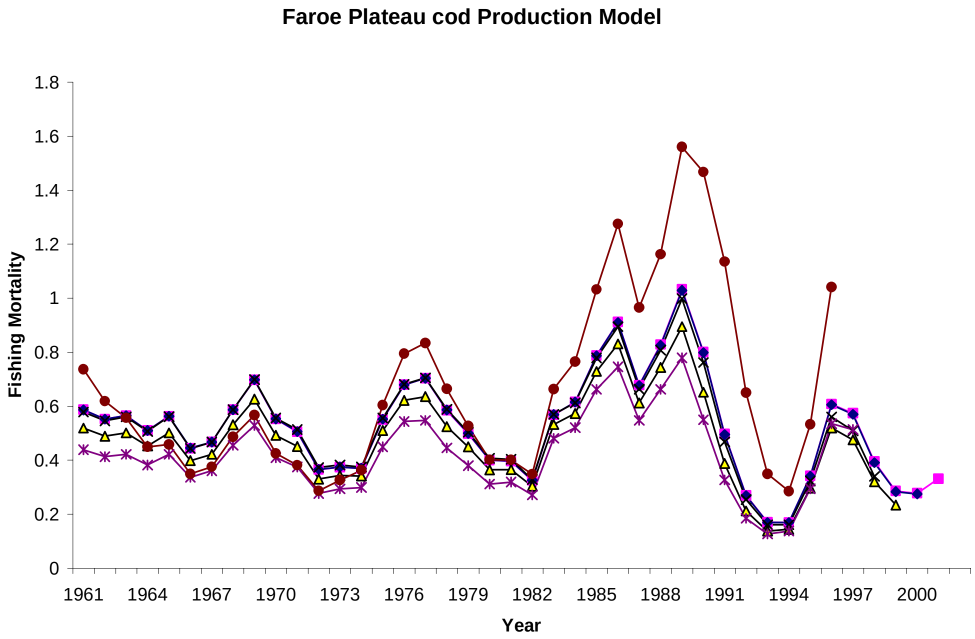


Figure 2.2.6.1.13 Faroe Plateau (subdivision VB1) COD. Fishing mortality estimates obtained by the ASPIC model. Retrospective runs up to 1997-2001.

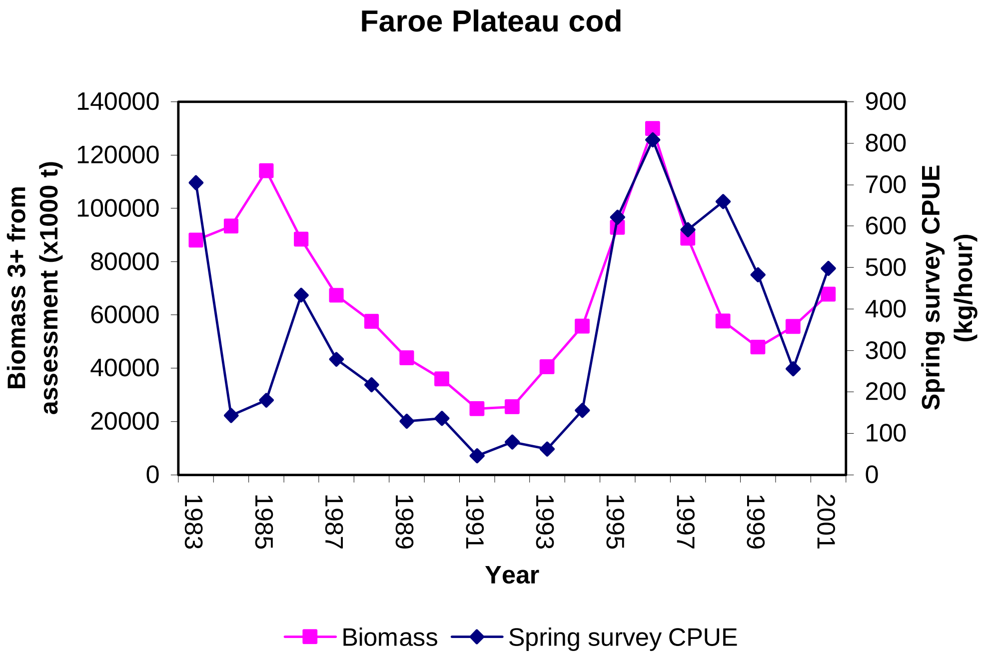


Figure 2.2.6.2.1 Faroe Plateau (subdivision VB1) COD. Biomass age 3 years and older from VPA compared with survey catch per unit effort.

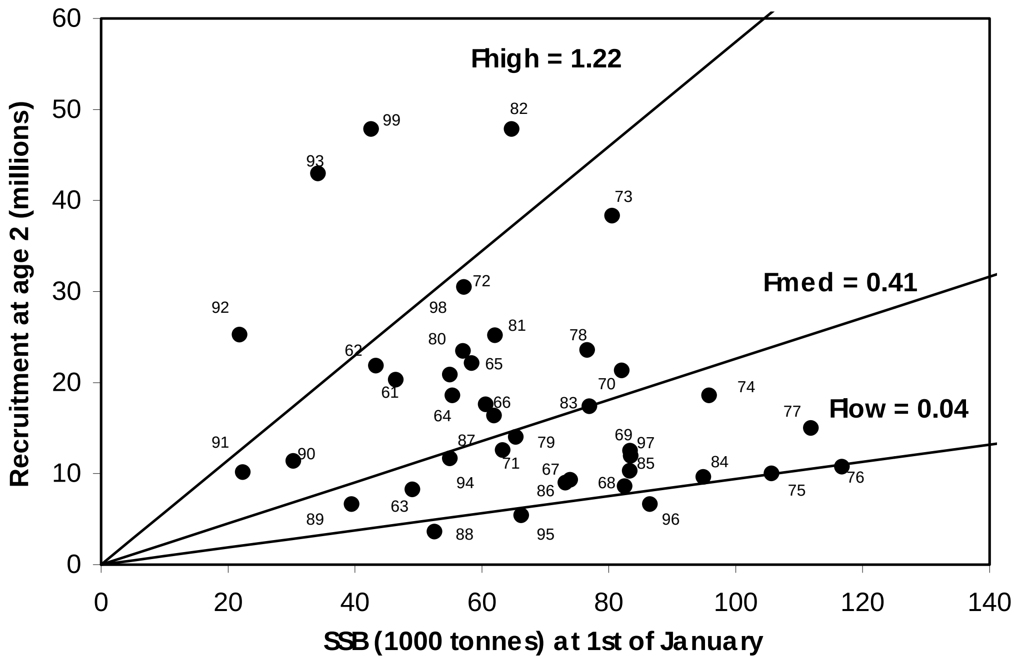


Figure 2.2.6.2.2 Faroe Plateau (subdivision VB1) COD. Spawning stock – recruitment relationship 1961-1999. Years are shown at each data point.

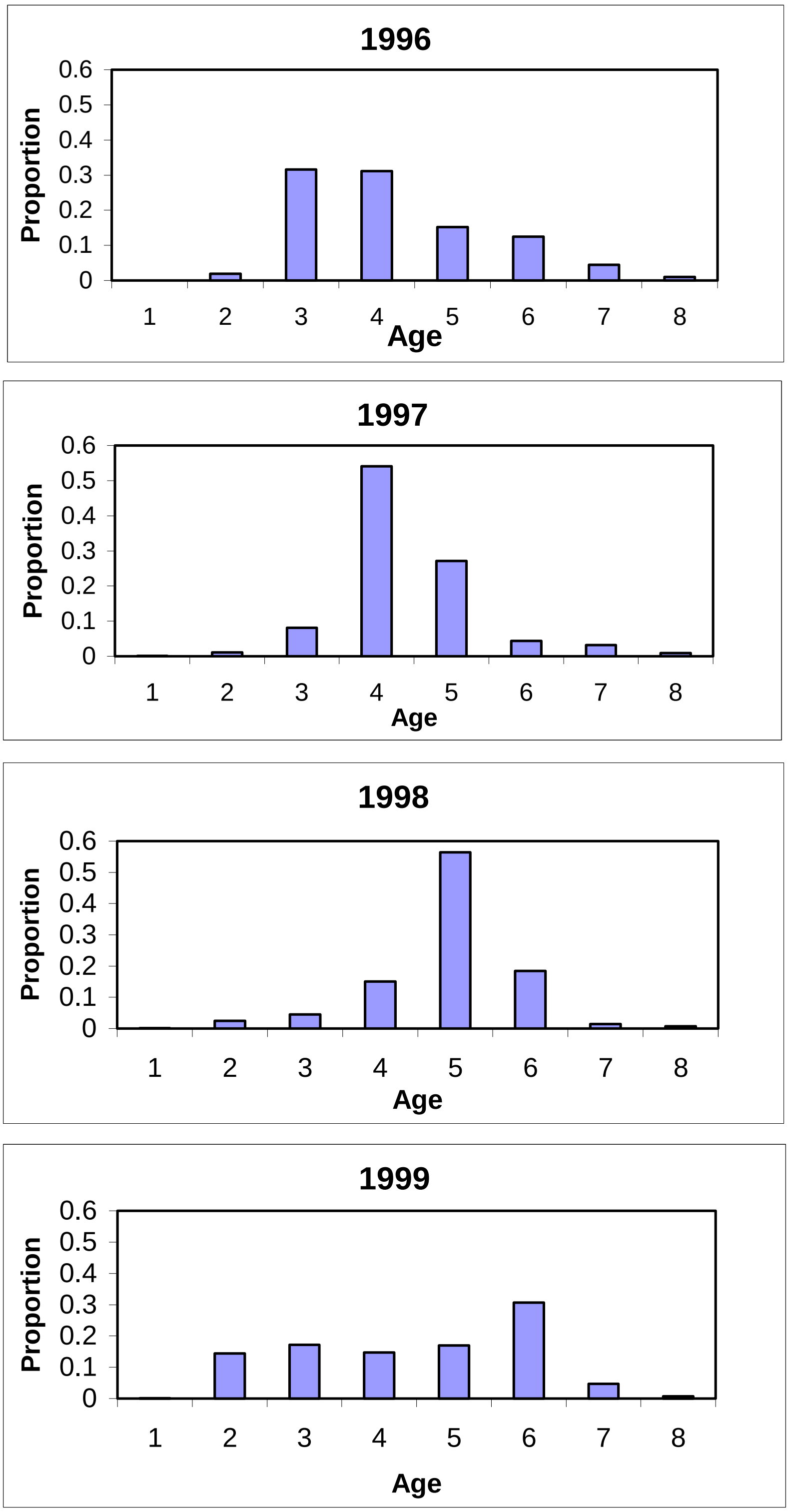


Figure 2.2.7.1.1 Faroe Plateau (subdivision VB1) COD. Frequency of age groups in otolith samples from the groundfish spring survey.

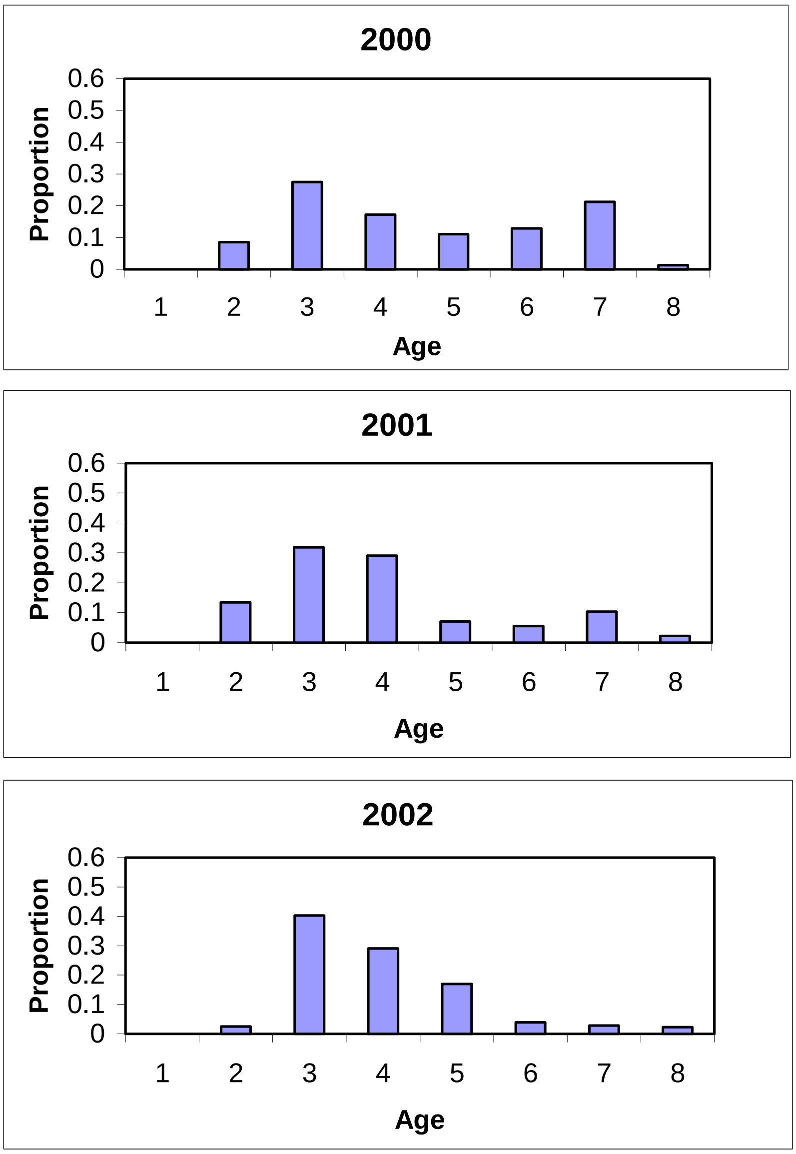


Figure 2.2.7.1.1 Faroe Plateau (subdivision VB1) COD. Frequency of age groups in otolith samples from the groundfish spring survey. (Continued).

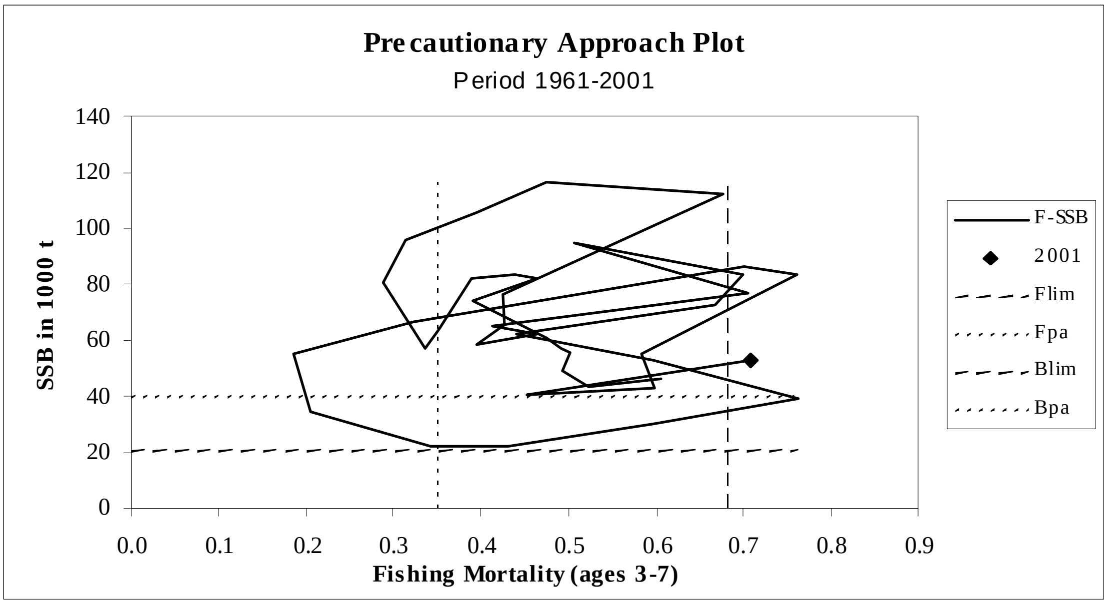
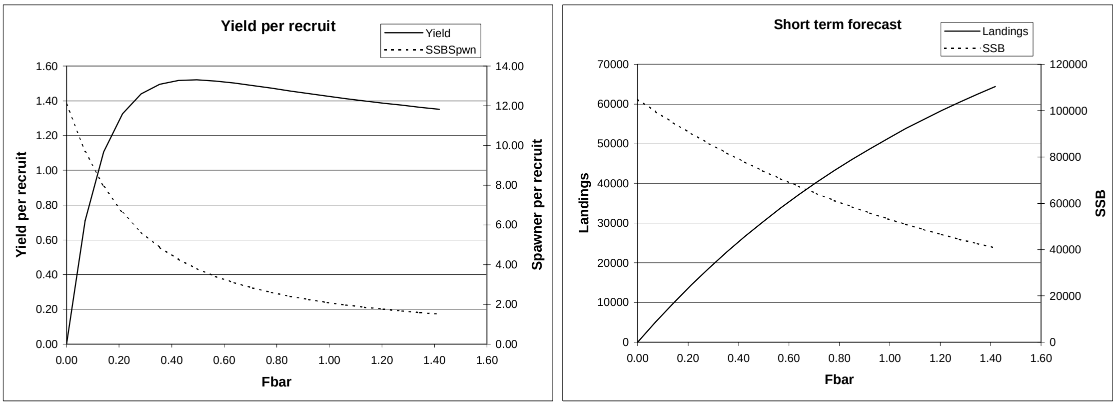


Figure 2.2.7.2.1 Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2001. Output from standard graph software.



MFYPR version 1
Run: Yld1
Time and date: 16:25 06/05/02

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.7091
FMax	0.6758	0.4792
F0.1	0.3785	0.2684
F35%SPR	0.6084	0.4314
Flow	0.0567	0.0402
Fmed	0.5732	0.4064
Fhigh	1.7152	1.2162

Weights in kilograms

MFDP version 1
Run: Spred1
Index file 4/5-2002
Time and date: 16:40 06/05/02
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.2.7.4.1 Faroe Plateau (sub-division VB1) COD. Yiels per recruit and spawning stock biomass (SSB) per recruit versus fishing mortality (left figure). Landings and SSB versus Fbar (3-7).

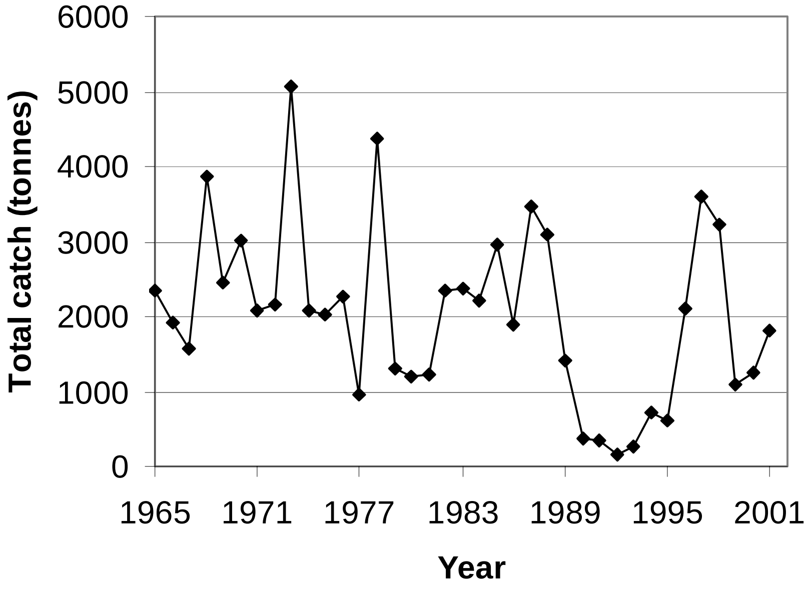


Figure 2.3.1.1 Faroe Bank (sub-division Vb2) COD. Reported landings 1965-2001. From 1992 only catches from Faroese and Norwegian vessels is considered to be taken on Faroe Bank.

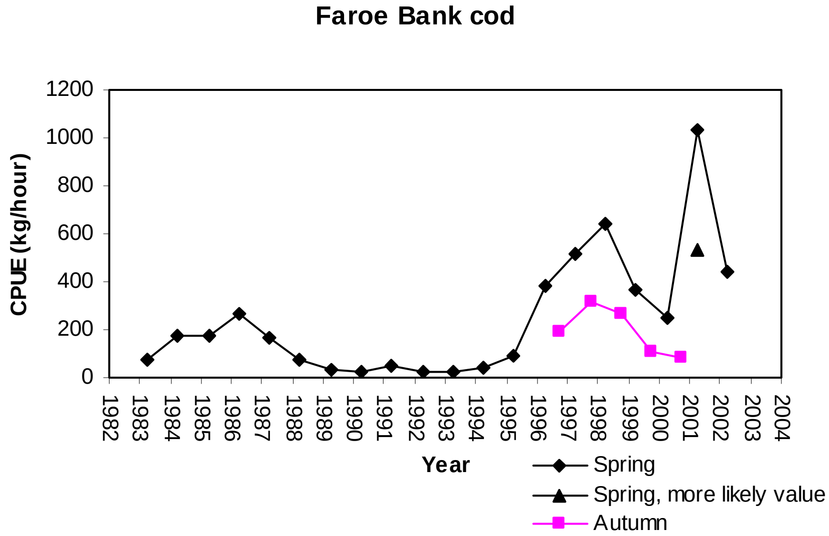


Figure 2.3.2.1 Faroe Bank (sub-division Vb2) COD. Catch per unit of effort in the spring groundfish survey (up to 2002) and autumn groundfish survey (up to 2001). If one large haul (14 tonnes) is replaced by 4 tonnes (more typical for that particular station) the CPUE drops from about 1000 kg/hour to about 500 kg/hour.

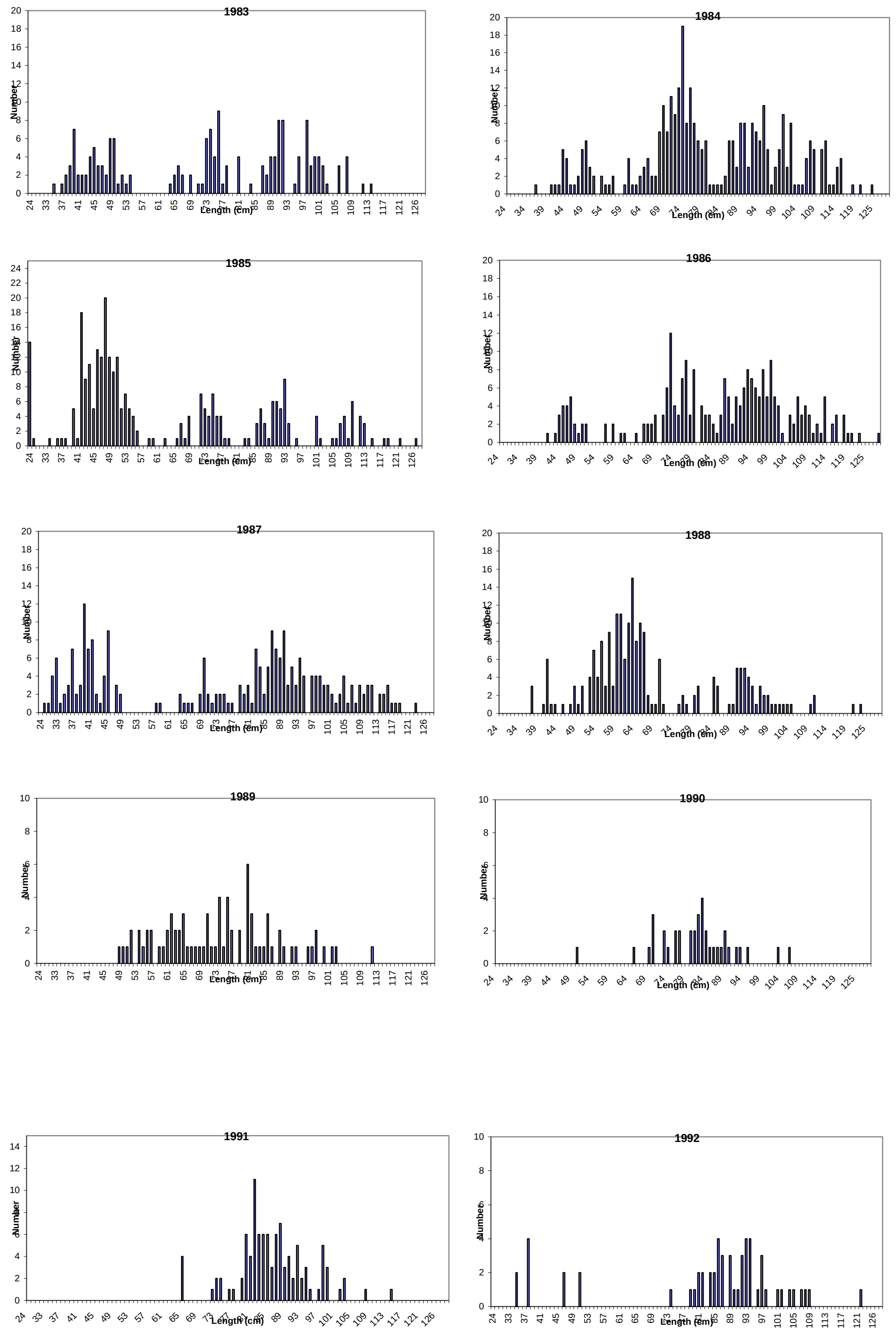


Figure 2.3.2.2 .Faroe Bank (sub-division Vb2) COD.Length distributions in the spring survey 1983-1999,2001,2002.

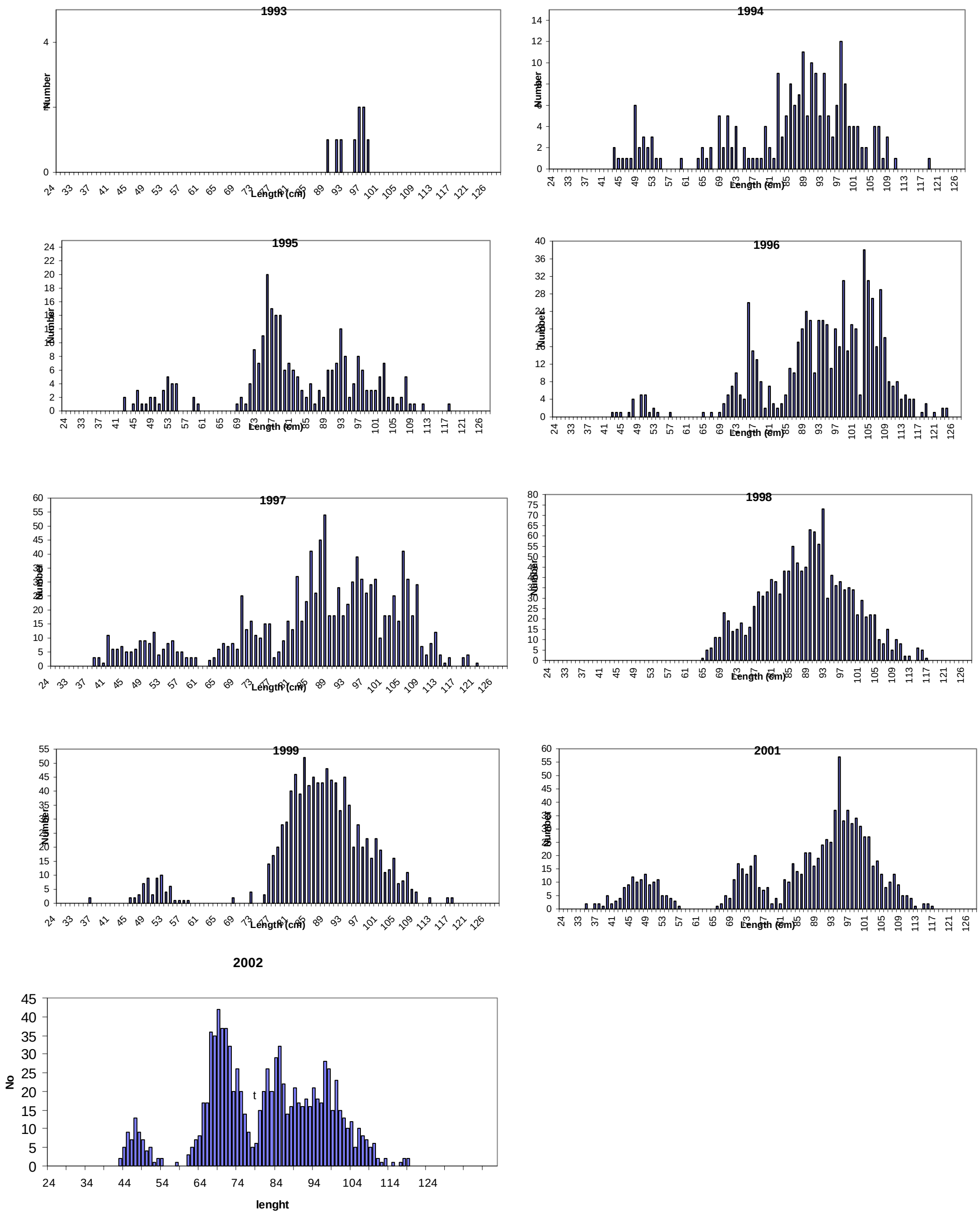


Figure2.3.2.2 (Continue)

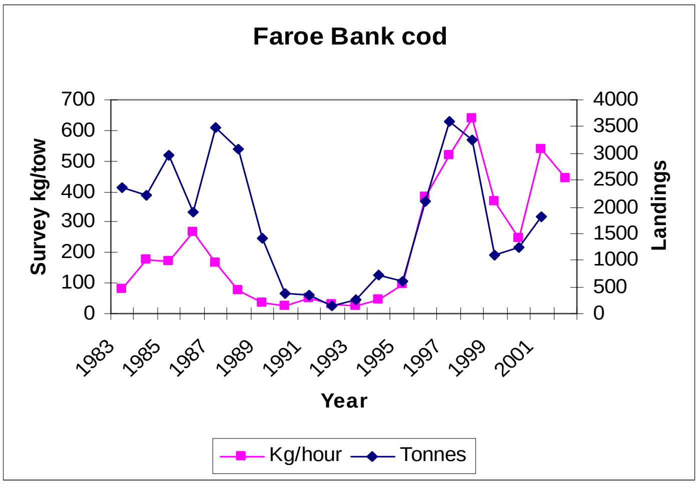


Figure 2.3.2.3 Faroe Bank (Subdivision Vb2) COD.CPUE in spring survey(2002) and landings (2001)

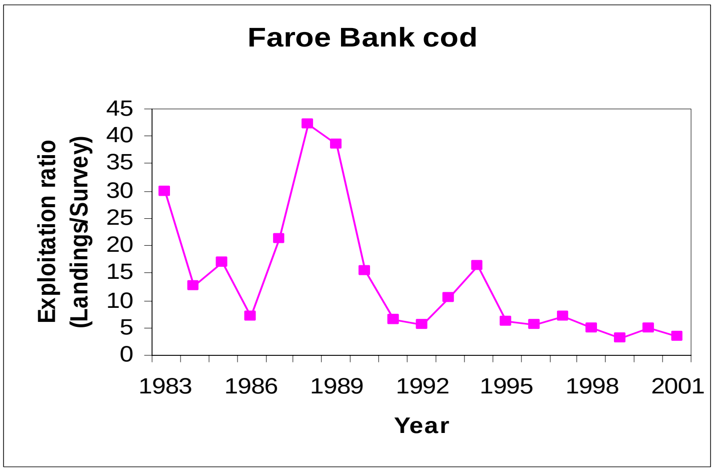


Figure 2.3.2.4 Faroe Bank (Sub-division Vb2) COD.Explotation ratio

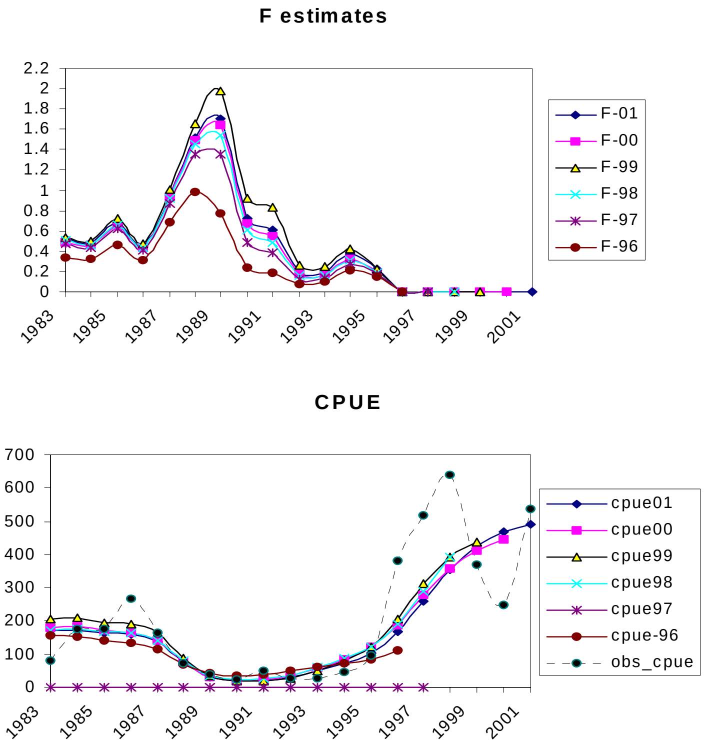


Figure 2.3.2.6 Retrospective analysis of F and CPUE (estimates and observed values)

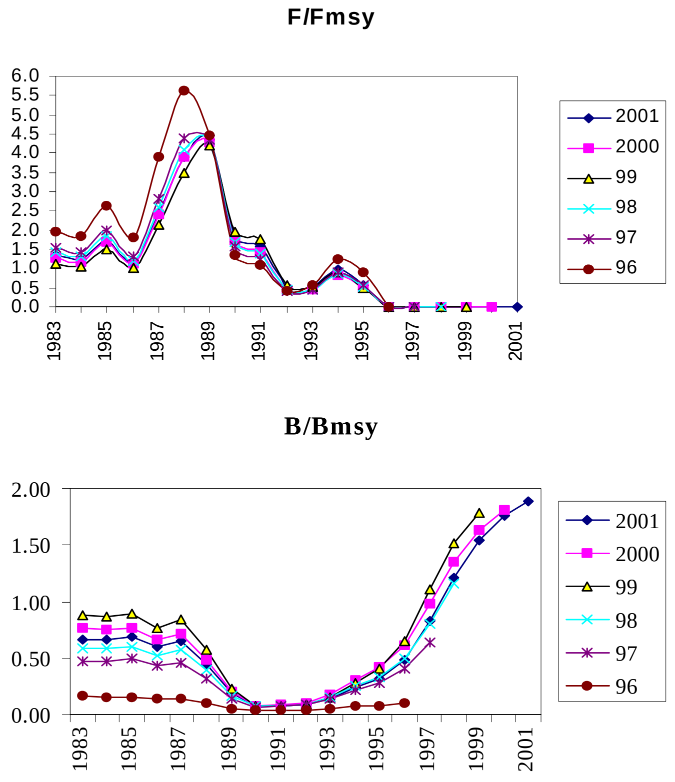


Figure 2.3.2.7 Retrospective analysis of F/$\mathbf{F}_{MSY}$ and B/$\mathbf{B}_{MSY}$ from ASPIC.

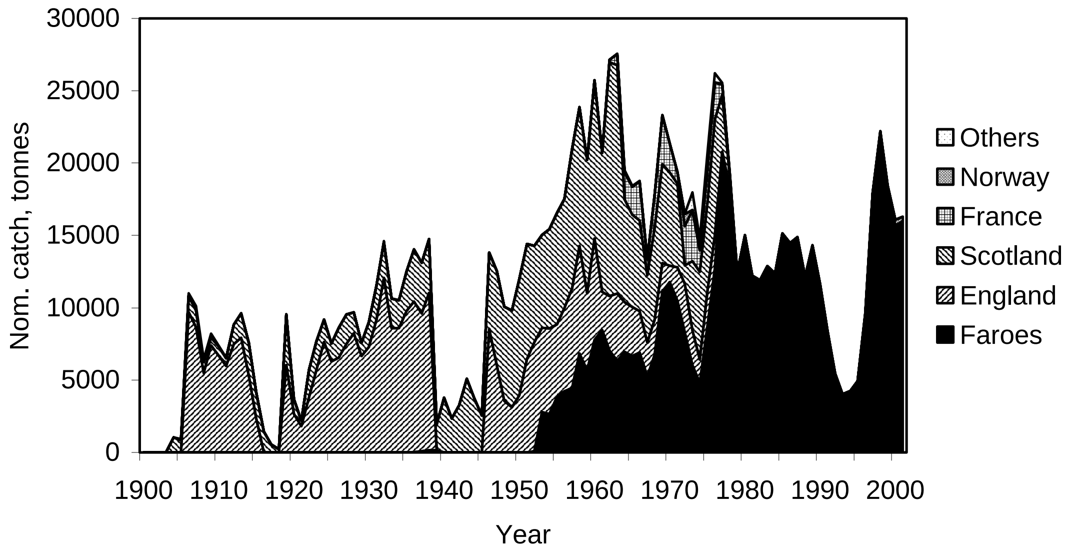


Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1903-2001.

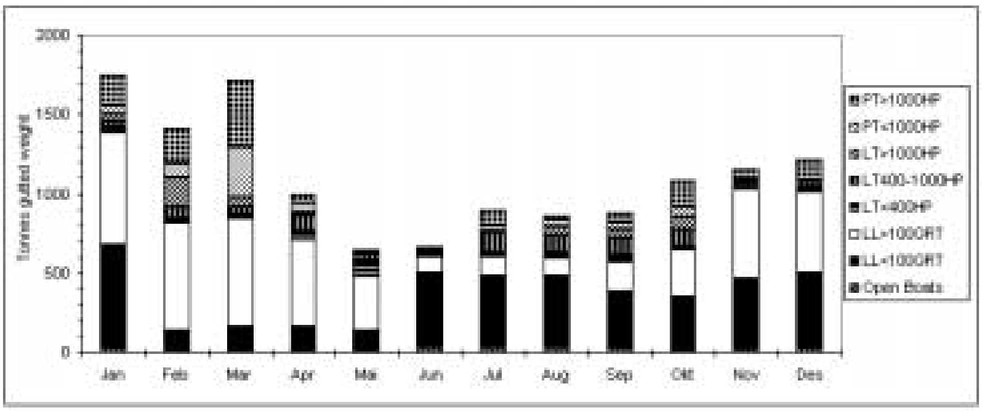


Figure 2.4.1.A. Faroese landings of haddock from Vb1 in 2001 by fleet. Tonnes ungutted weight.

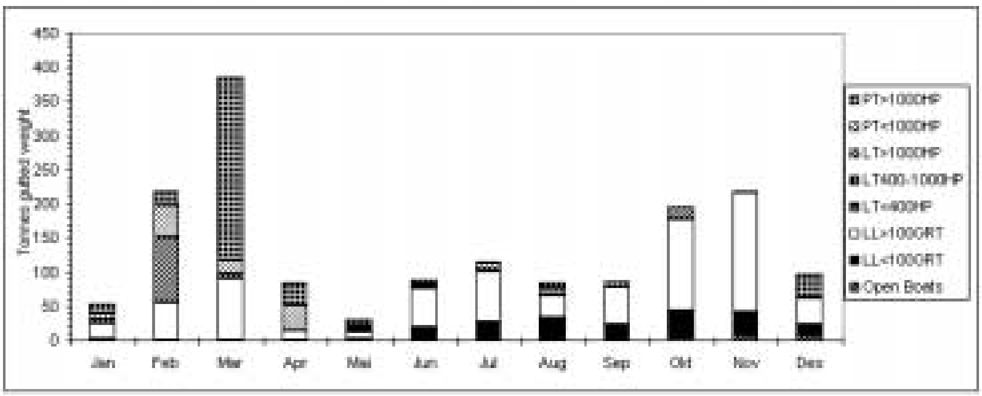


Figure 2.4.1.B. Faroese landings of haddock from Vb2 in 2001 by fleet. Tonnes ungutted weight.

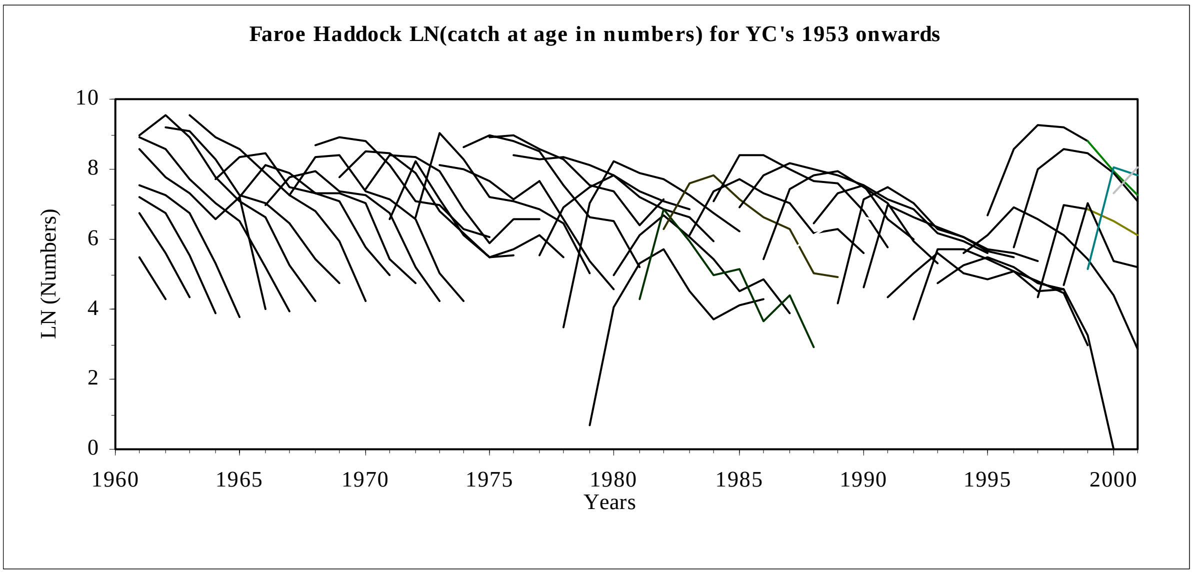


Figure 2.4.3

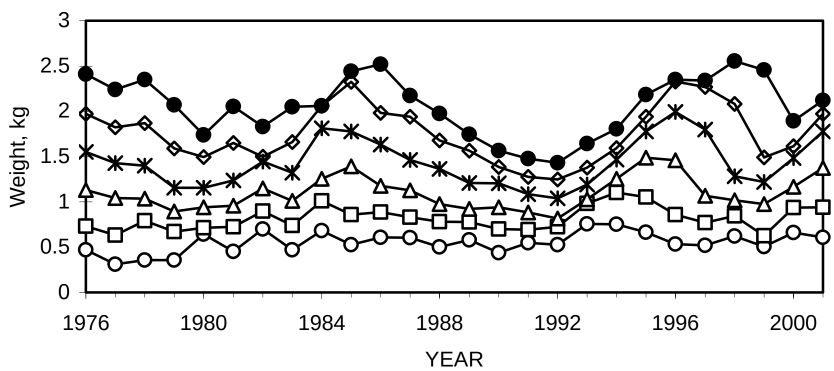
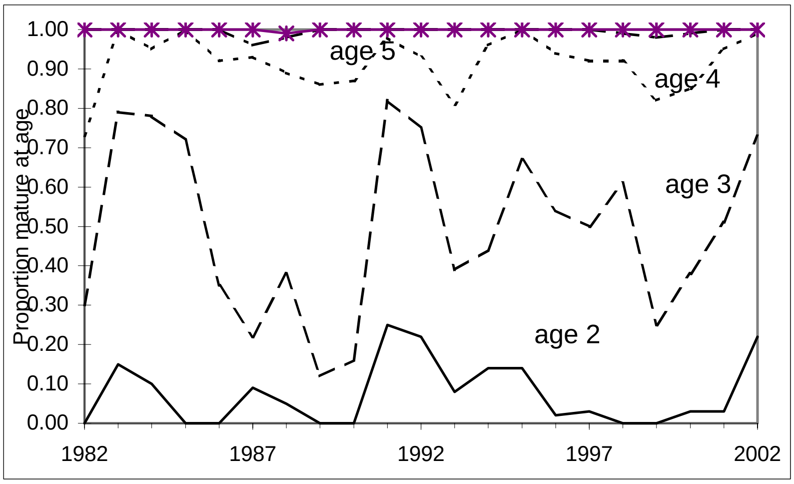
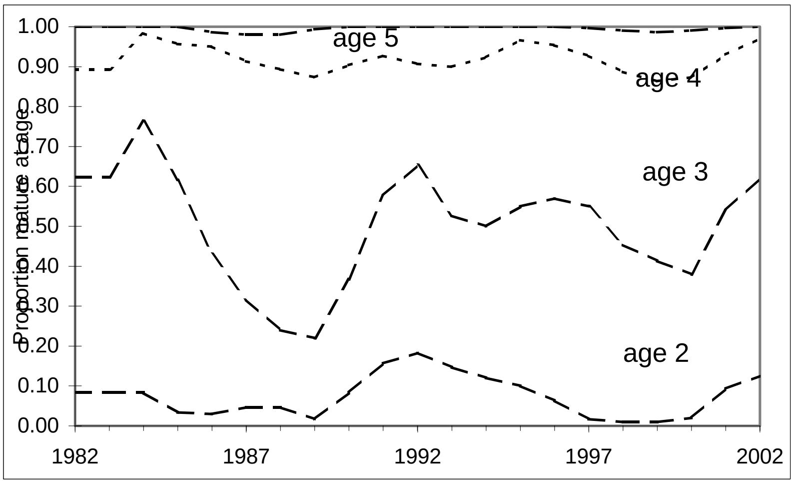


Figure 2.4.4 Faroe haddock 1976-2000. Mean weight at age for ages 2-7.



A: Faroe haddock. Maturity ogives. Observed values from the spring survey.

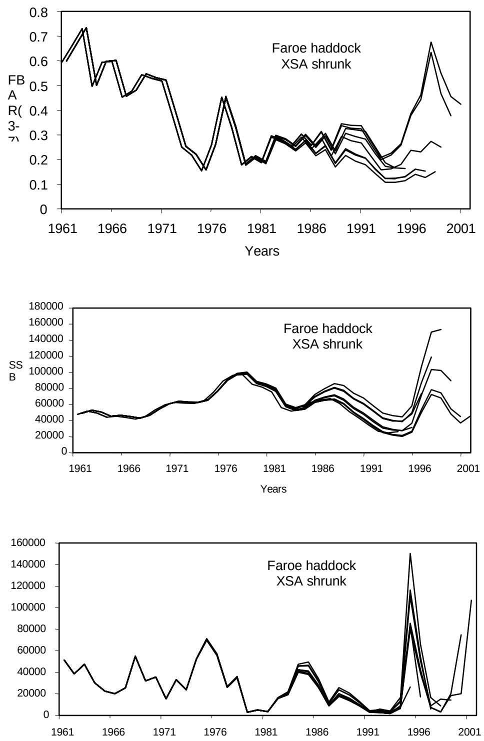


y.

B: Faroe haddock. Maturity ogives. Running 3 years average from the spring surve

Figure 2.4.5. Haddock in ICES Division Vb. Maturity at age.

Tuning with longliners > 100 GRT and CUBA pair trawlers > 1000 HP (SPALY) | **Tuning with longliners > 100 GRT**



Tuning with CUBA pairtrawlers > 1000 HP | **Tuning with summer survey**

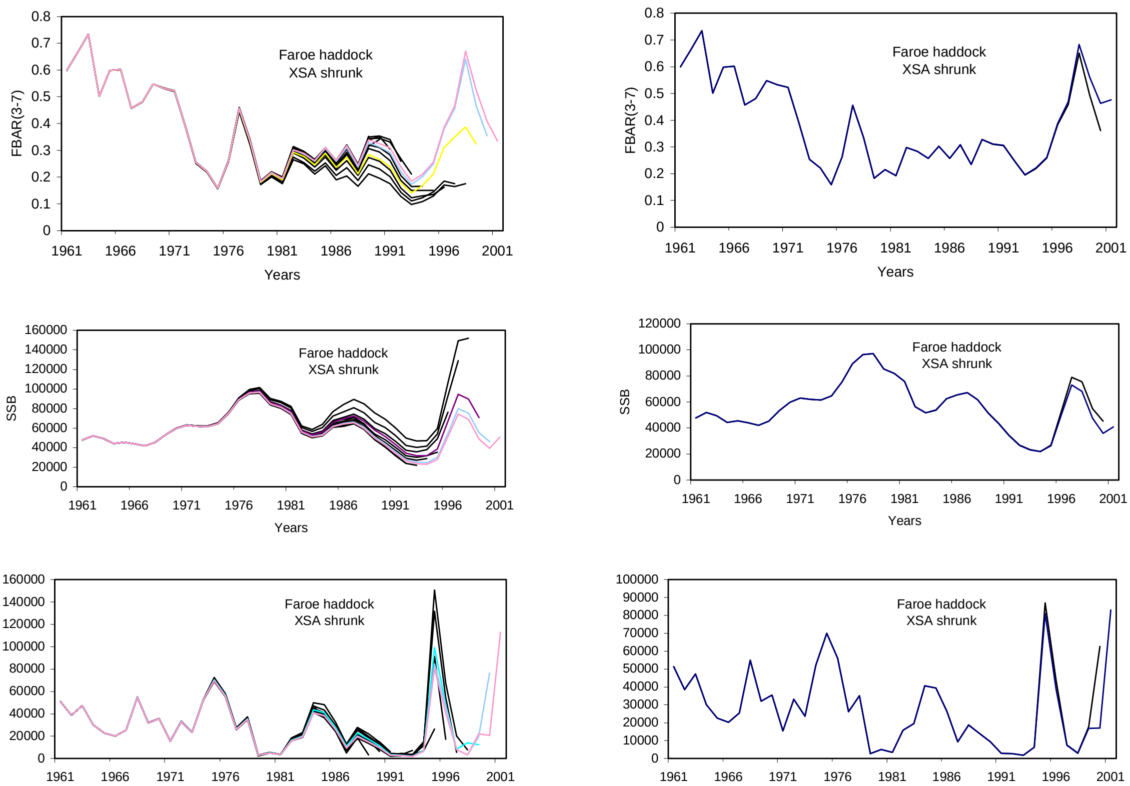
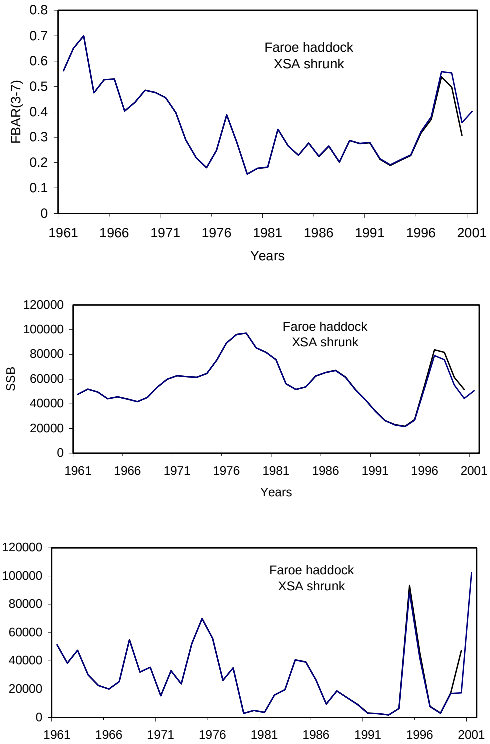
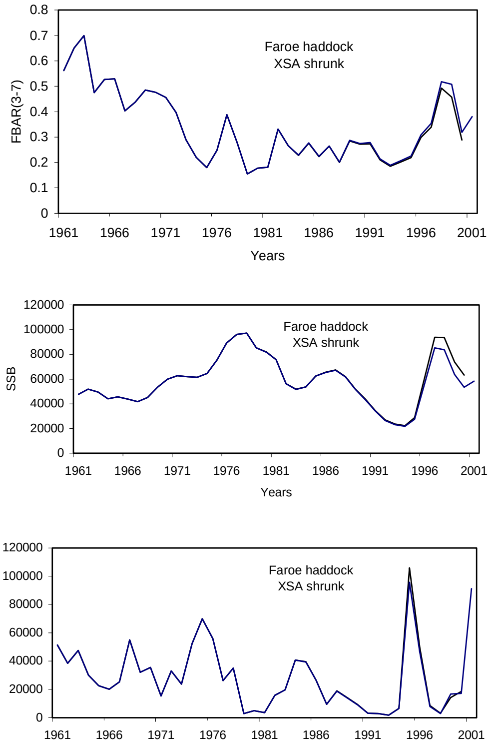


Figure 2.4.6 Retrospective analysis 2001 of different xsa's shrunk 0.5.

Tuning with summersurvey



Tuning with summer survey



Tuning with summersurvey, cuba trawlers and longliners>100GRT

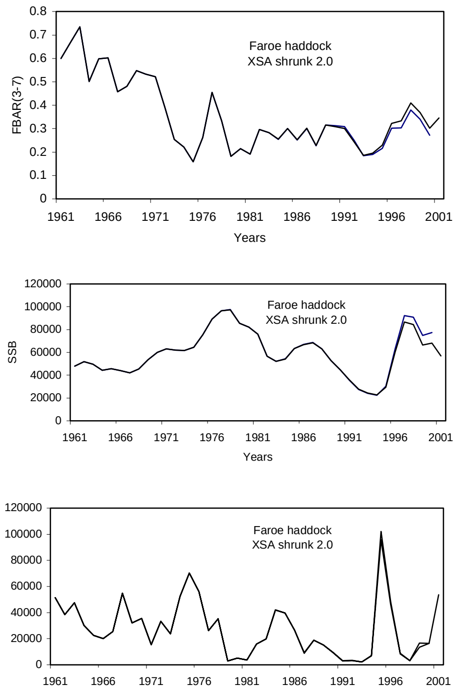


Figure 2.4.6 Retrospective analysis 2001 of different xsa’s (cont.). Upper left shrunk 0.7, upper wright shrunk 2.0, bottom shrunk 2.0.

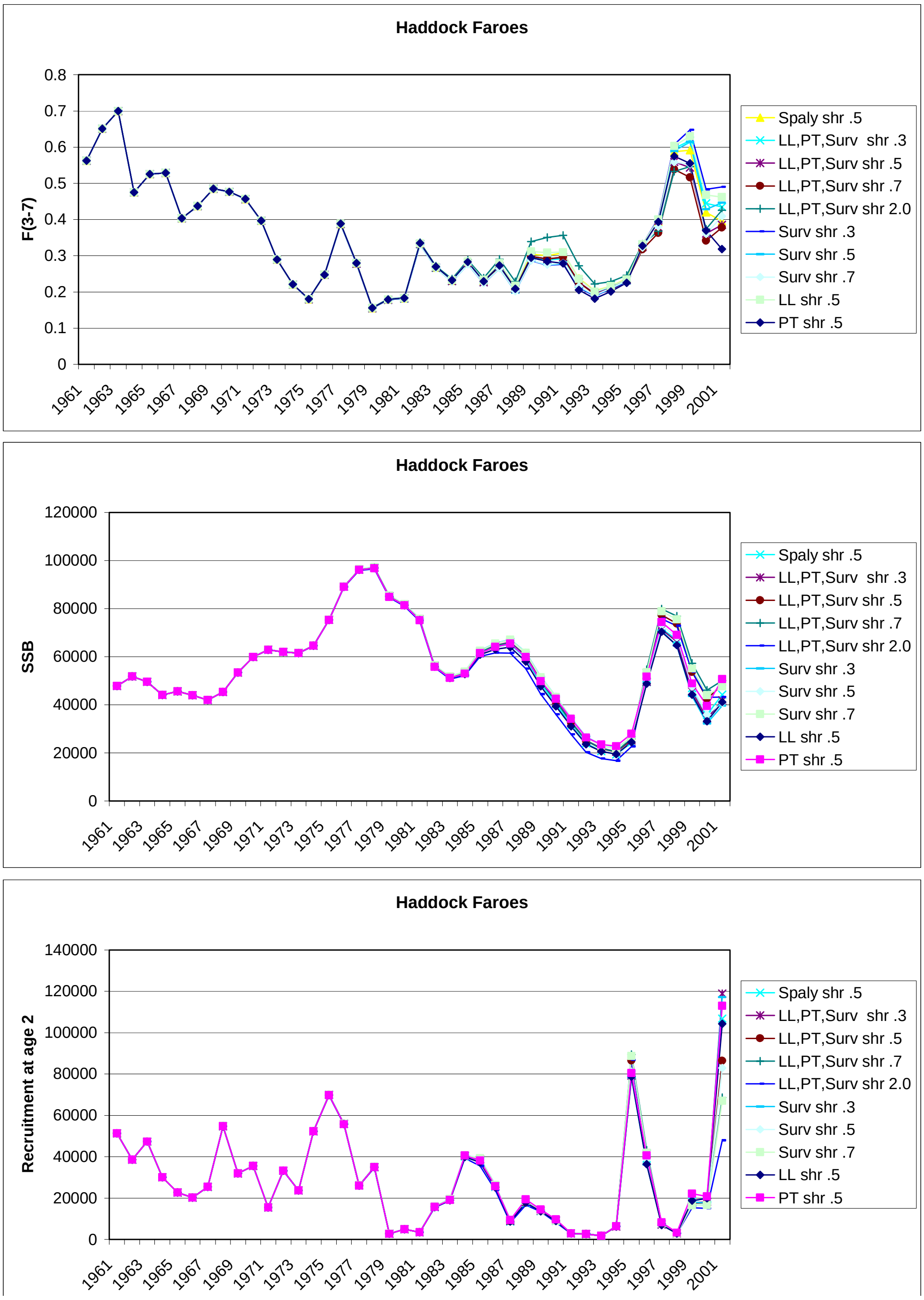


Figure 2.4.7 Retrospective performances of several XSA's tuned with different fleets and settings.

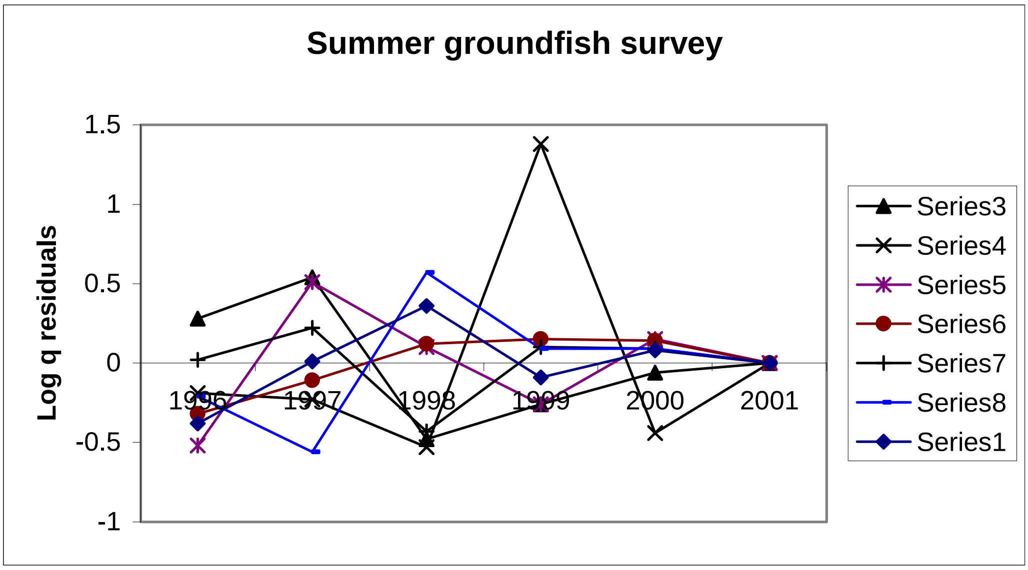


Figure 2.4.8 A. Log catchability residuals for ages 2-8. Age 2 the uppermost legends, age 3 the next etc.

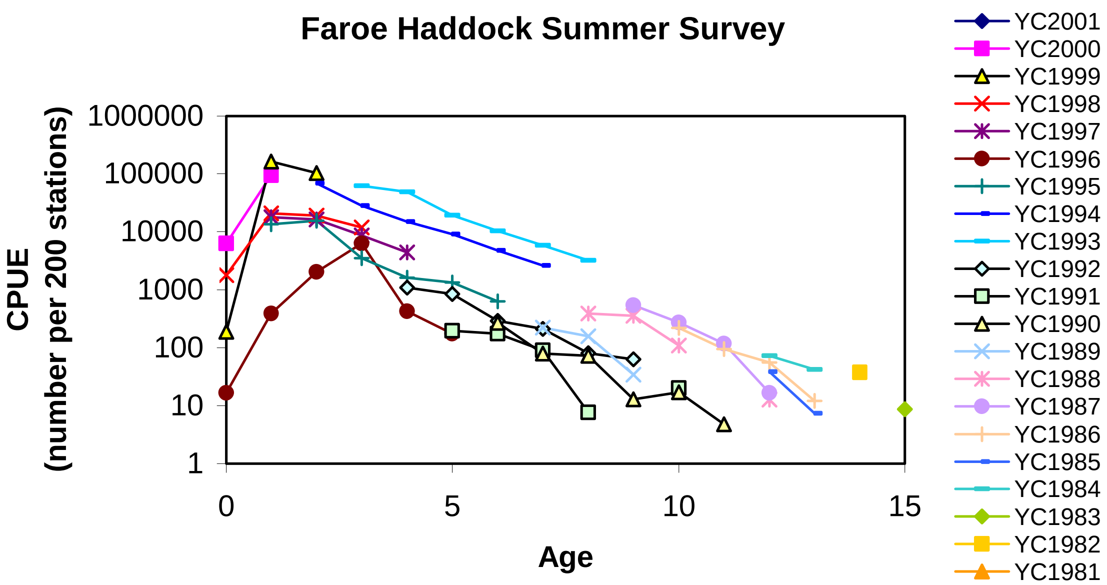


Figure 2.4.8 B. LN(stratified mean catch at age in numbers) for year classes from 1981 onwards in the summer survey series.

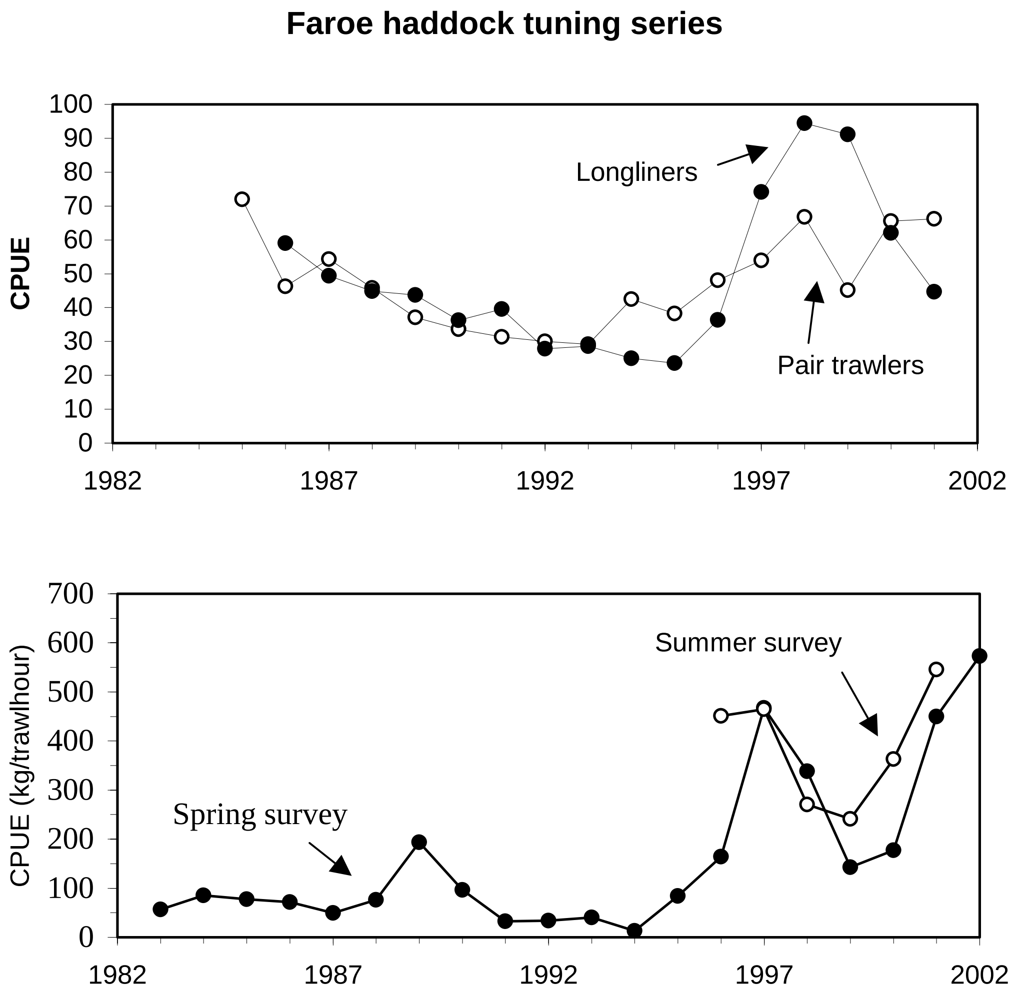


Figure 2.4.9 CPUE (kg/hour) of haddock in the commercial longliners and pair trawlers series and in the spring and summer survey series.

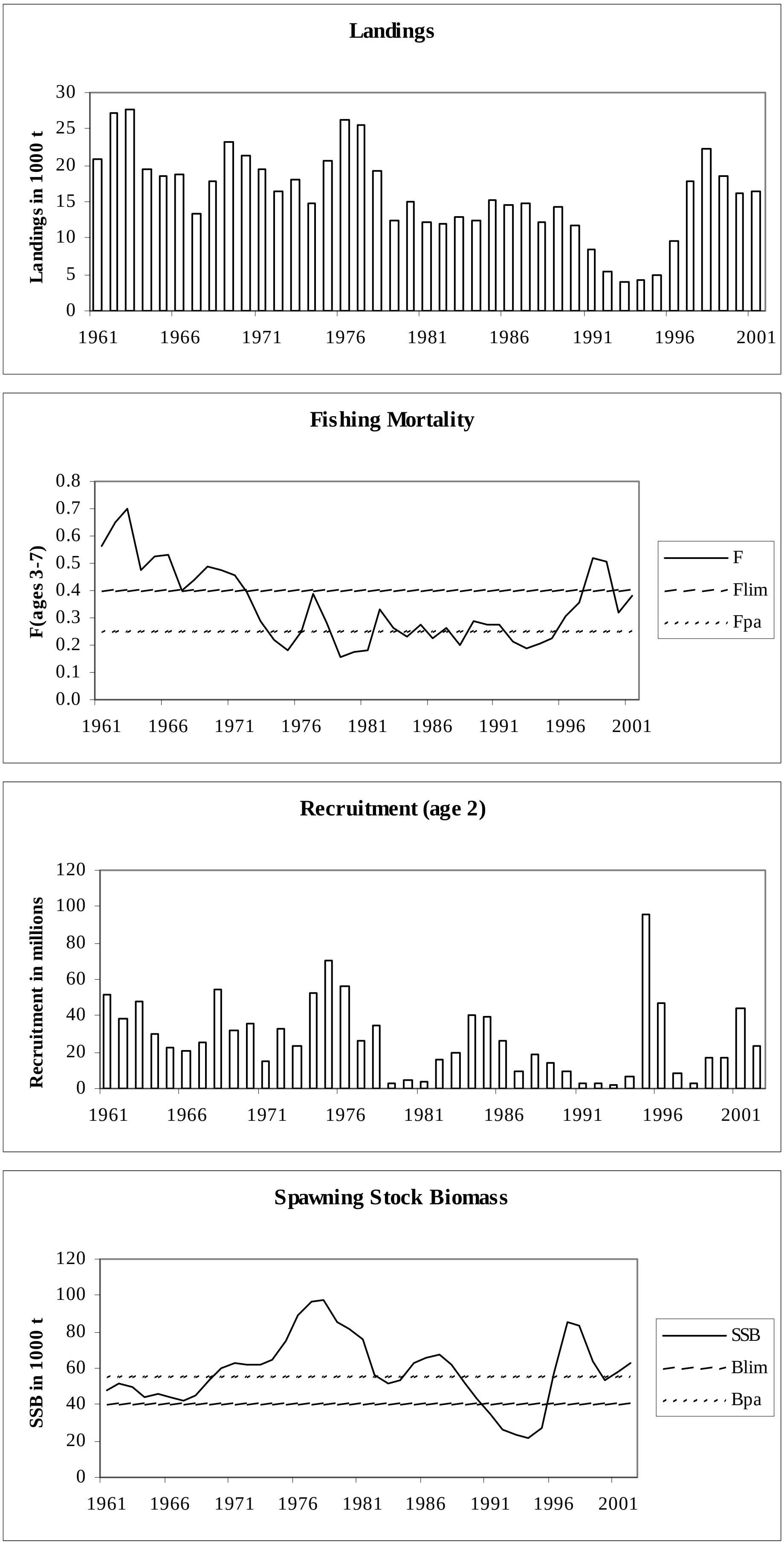
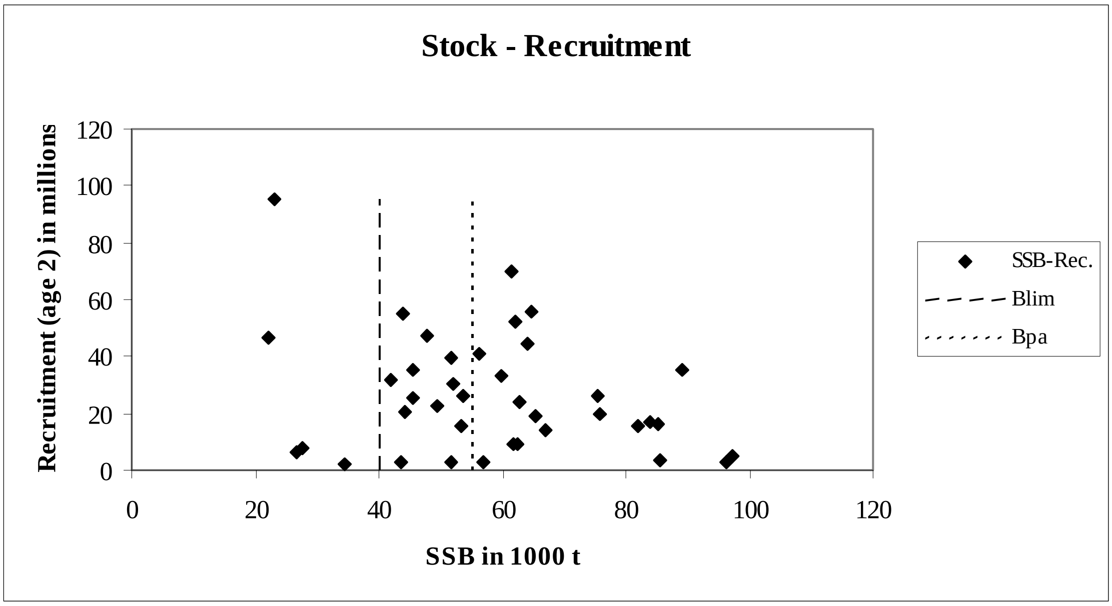
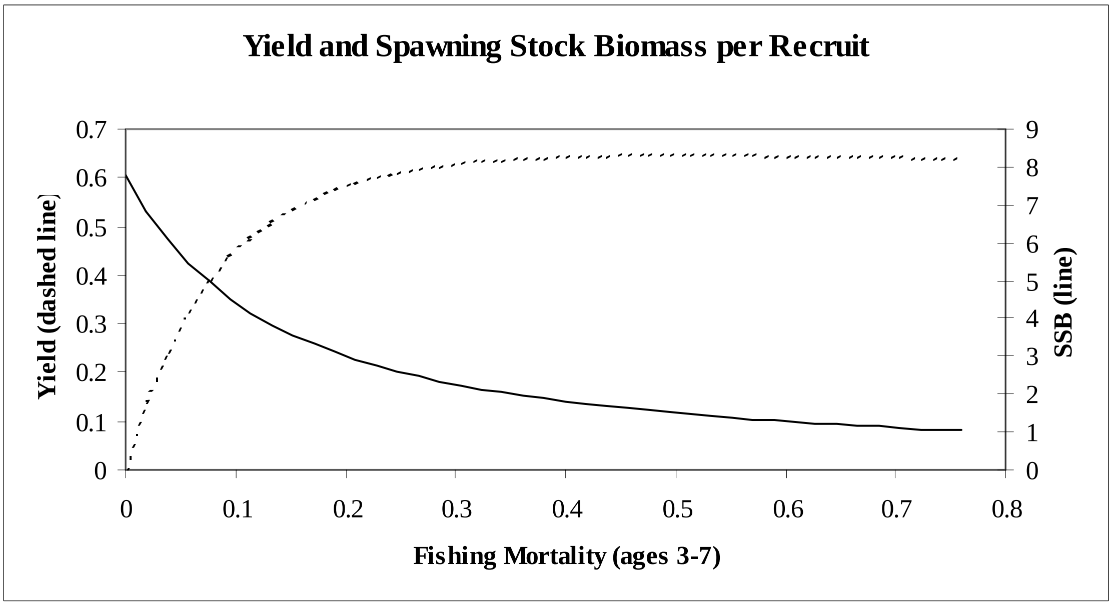


Figure 2.4.10 Faroe haddock 2002. Stock summary graph.





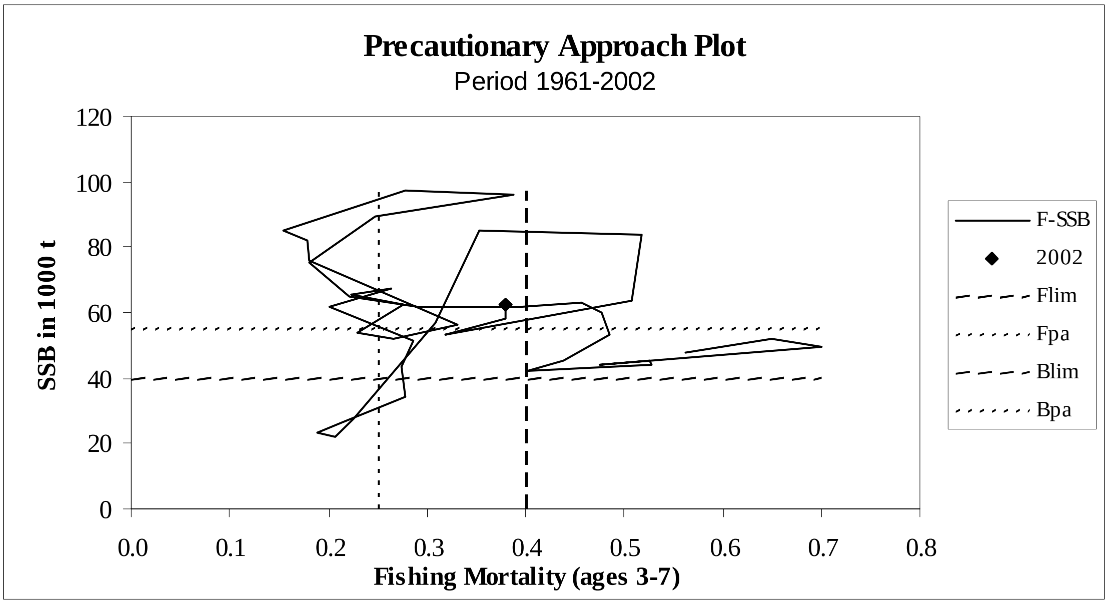


Figure 2.4.10 Faroe haddock 2002. Stock summary graph (cont.).

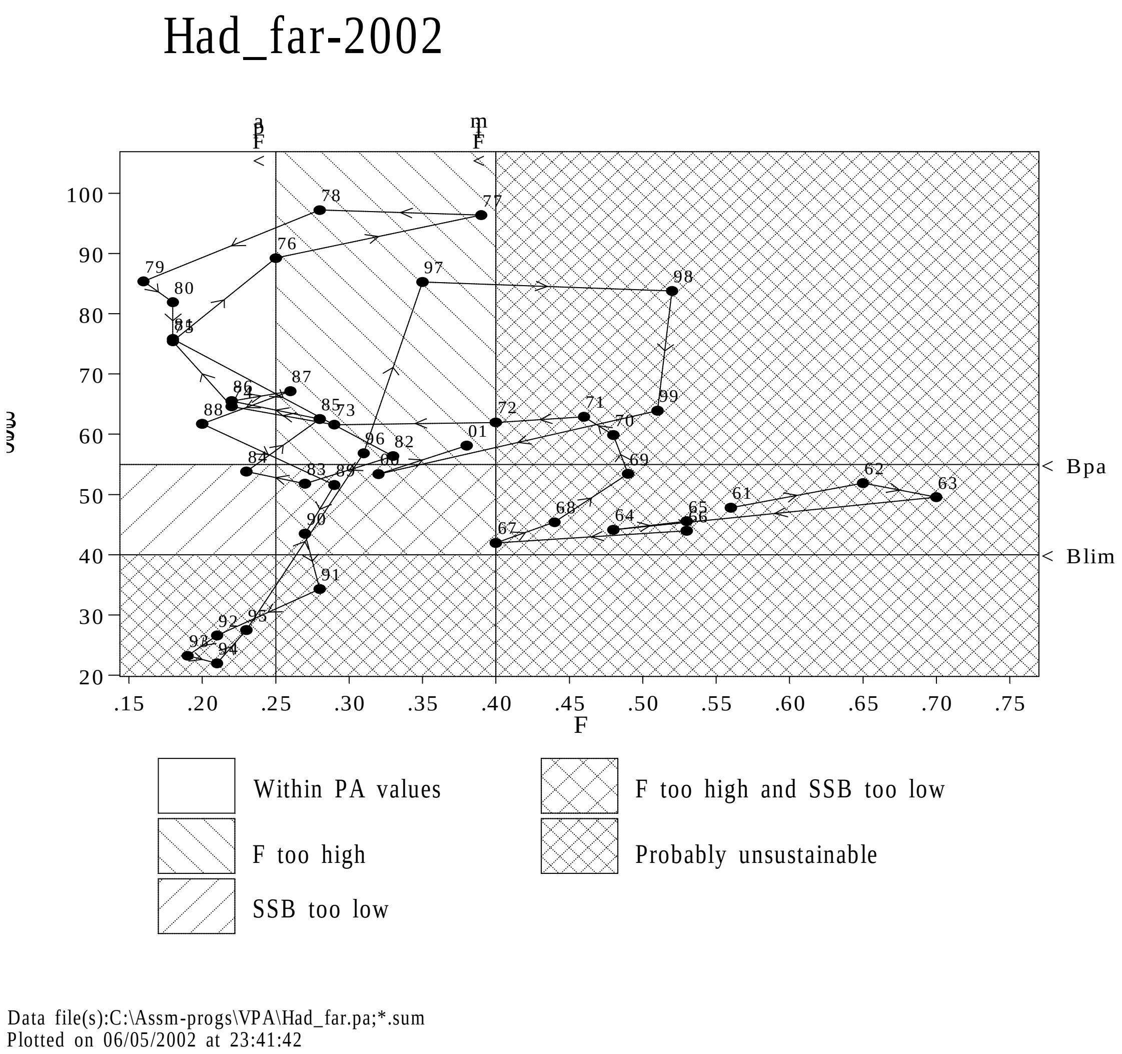
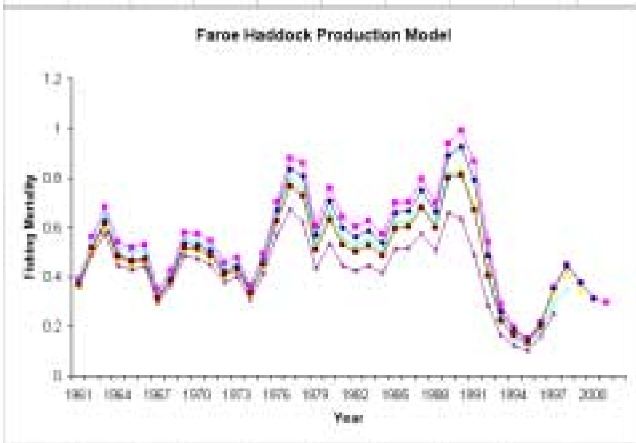
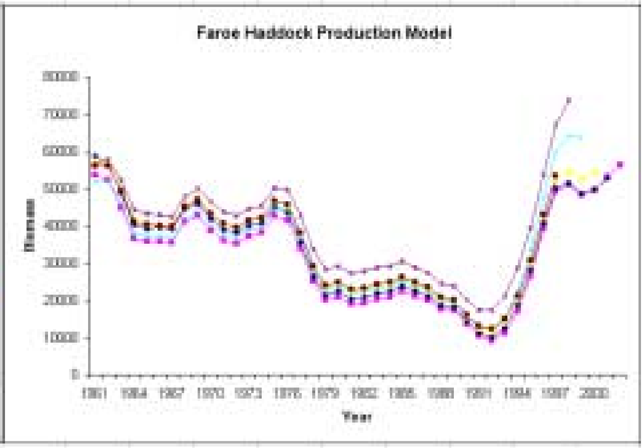


Figure 2.4.12 The history of Faroe haddock in relation to the adopted precautionary reference points.

Figure 2.4.13. Retrospective patterns from runs with an ASPIC model for Faroe Haddock.





This includes only the spring survey

Parameter	2001	2000	1999	1998	1997	1996
B1R	1.13	1.18	0.99	0.82	0.55	0.90
MSY	19750	19360	20270	22120	27440	21070
r	0.83	0.78	0.70	0.70	0.54	0.68
q(1)	0.00	0.00	0.00	0.00	0.00	0.00
MSY	19750	19360	20270	22120	27440	21070
K	95340	99300	116200	126600	204800	124700
Bmsy	47670	49650	58080	63300	102400	62360
Fmsy	0.41	0.39	0.35	0.35	0.27	0.34
F(0.1)	0.37	0.35	0.31	0.31	0.24	0.30
Y(0.1)	19550	19160	20070	21900	27160	20860
B-ratio	1.18	1.06	0.94	1.01	0.72	0.88
F-ratio	0.72	0.81	0.99	1.00	0.95	0.69
F0.1-mult	1.25	1.12	0.91	0.90	0.95	1.52
Y-ratio	0.97	1.00	1.00	1.00	0.92	0.96

	F2001	F2000	F1999	F1998	F1997	F1996
1961	0.383	0.362	0.364	0.4	0.364	0.372
1962	0.662	0.619	0.611	0.663	0.495	0.618
1963	0.683	0.625	0.607	0.658	0.574	0.613
1964	0.54	0.49	0.474	0.518	0.446	0.48
1965	0.518	0.47	0.495	0.499	0.429	0.461
1966	0.528	0.478	0.464	0.511	0.44	0.471
1967	0.35	0.319	0.311	0.341	0.297	0.315
1968	0.427	0.394	0.383	0.416	0.366	0.397
1969	0.576	0.533	0.514	0.554	0.495	0.519
1970	0.574	0.53	0.509	0.549	0.475	0.512
1971	0.646	0.604	0.463	0.621	0.449	0.486
1972	0.456	0.422	0.405	0.437	0.378	0.408
1973	0.477	0.445	0.428	0.468	0.4	0.43
1974	0.365	0.344	0.331	0.351	0.309	0.332
1975	0.494	0.47	0.45	0.469	0.415	0.448
1976	0.703	0.669	0.634	0.653	0.57	0.628
1977	0.879	0.834	0.777	0.797	0.676	0.767
1978	0.869	0.807	0.74	0.76	0.623	0.727
1979	0.607	0.568	0.519	0.533	0.432	0.509
1980	0.767	0.707	0.644	0.662	0.534	0.621
1981	0.641	0.597	0.541	0.557	0.447	0.53
1982	0.601	0.561	0.51	0.526	0.424	0.5
1983	0.635	0.594	0.534	0.546	0.446	0.524
1984	0.572	0.537	0.494	0.506	0.416	0.488
1985	0.687	0.656	0.606	0.619	0.512	0.598
1986	0.704	0.666	0.614	0.625	0.516	0.603
1987	0.794	0.751	0.691	0.7	0.575	0.677
1988	0.7	0.663	0.61	0.616	0.504	0.598
1989	0.94	0.89	0.816	0.817	0.667	0.798
1990	0.992	0.927	0.833	0.824	0.633	0.812
1991	0.880	0.791	0.691	0.67	0.469	0.671
1992	0.641	0.484	0.419	0.396	0.286	0.407
1993	0.289	0.261	0.231	0.213	0.163	0.228
1994	0.190	0.183	0.169	0.162	0.125	0.164
1995	0.151	0.144	0.136	0.122	0.106	0.136
1996	0.218	0.212	0.202	0.178	0.18	0.2
1997	0.368	0.362	0.334	0.29	0.254	
1998	0.449	0.444	0.414	0.346		
1999	0.377	0.376	0.346			
2000	0.312	0.314				
2001	0.298					
2002						

	B2001	B2000	B1999	B1998	B1997	B1996
1961	53680	58580	57510	51760	58540	55950
1962	62380	66610	60540	62340	67900	59960
1963	44910	48730	49890	46170	52170	48820
1964	36580	40220	41800	35160	44205	41150
1965	35670	39320	40640	37140	43340	40170
1966	35690	39360	40800	35960	43000	40080
1967	35400	39100	40230	36420	42340	39640
1968	40970	44690	45750	41540	47790	45160
1969	42570	45960	47370	43820	49970	46940
1970	38580	41740	43370	40060	46290	43080
1971	36010	39060	40720	37730	43740	40470
1972	35080	38040	39670	36700	42610	39420
1973	37180	40000	41630	38720	44500	41330
1974	39080	40740	42370	39660	46320	42200
1975	42680	44980	46770	44810	50170	46760
1976	41380	43360	45460	43890	49080	45700
1977	33910	35600	37610	36810	42670	38020
1978	25040	26520	28870	27940	33510	29130
1979	19980	21400	23510	22800	28030	23990
1980	20980	22270	24370	23730	29160	24930
1981	18880	20270	22360	21730	27150	22830
1982	19300	20730	22830	22170	27630	23300
1983	20380	21630	23930	23270	28720	24390
1984	20880	22520	24390	23750	29140	24850
1985	22380	23730	25740	25170	30400	26190
1986	21130	22380	24380	23820	28820	24730
1987	20010	21140	22920	22570	27320	23250
1988	17510	18630	20280	20040	24560	20690
1989	17220	18120	19630	19620	23810	20020
1990	13480	14300	15710	15750	19920	16070
1991	10340	11180	12810	12840	17230	12970
1992	9135	10160	11800	12340	17360	12170
1993	11160	12490	14420	15490	21080	14810
1994	16960	18690	20720	22600	28690	21080
1995	26420	28130	30240	33660	39690	30650
1996	39140	40580	42830	47790	53860	40020
1997	49080	50100	52860	59700	66980	52010
1998	50050	51520	54790	63800	73820	
1999	46350	48660	53730	63780		
2000	49600	49630	54400			
2001	53130	52780				
2002	50140					

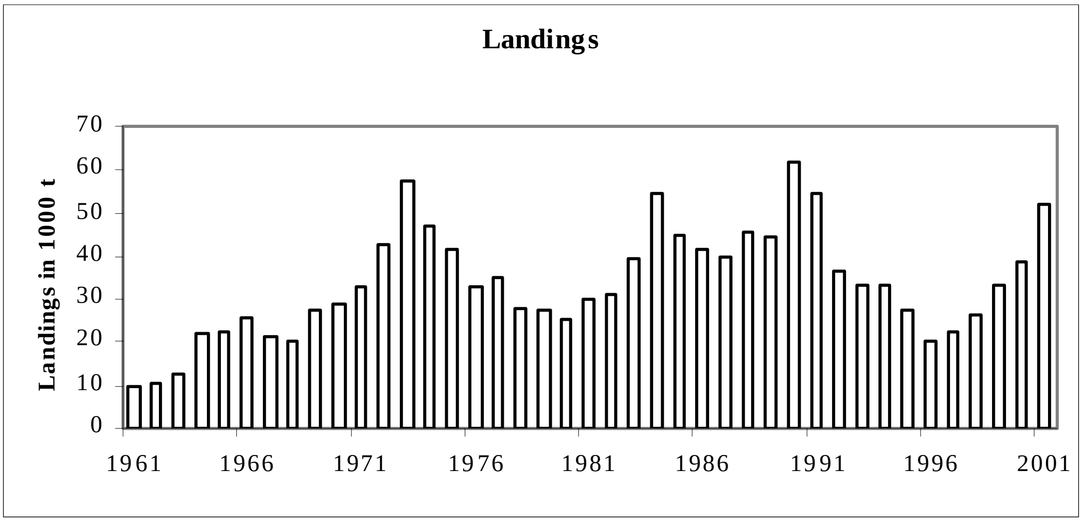


Figure 2.5.1.1 Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

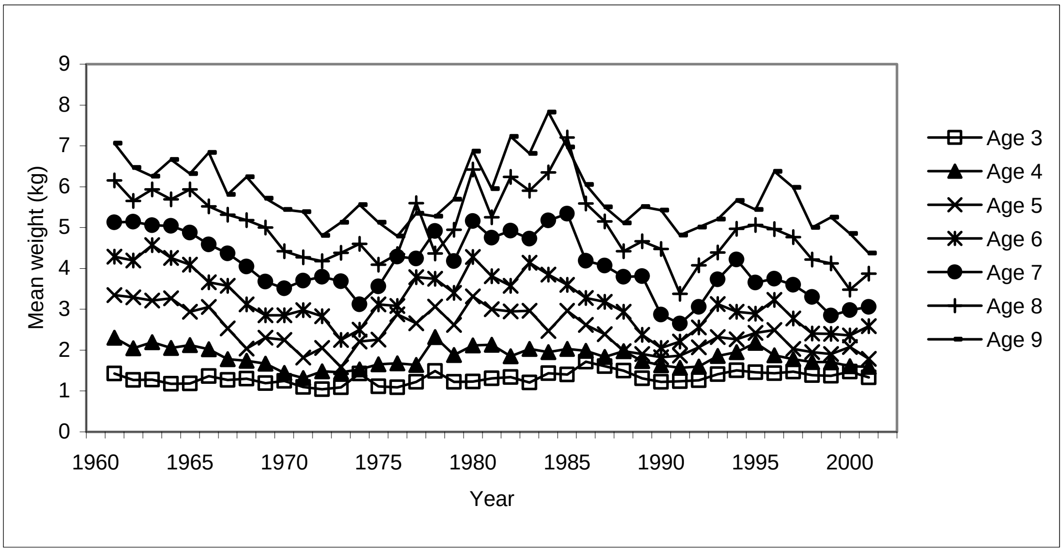
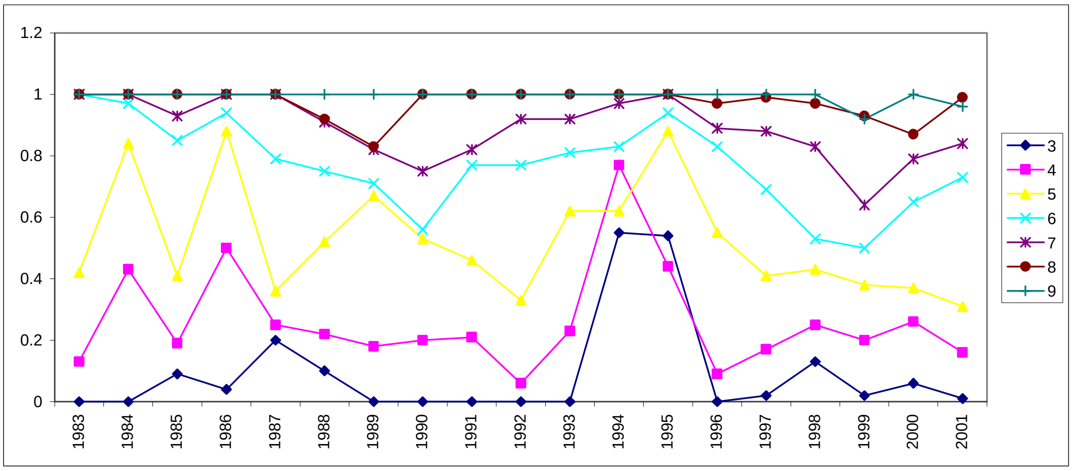


Figure 2.5.3.1 Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2001.



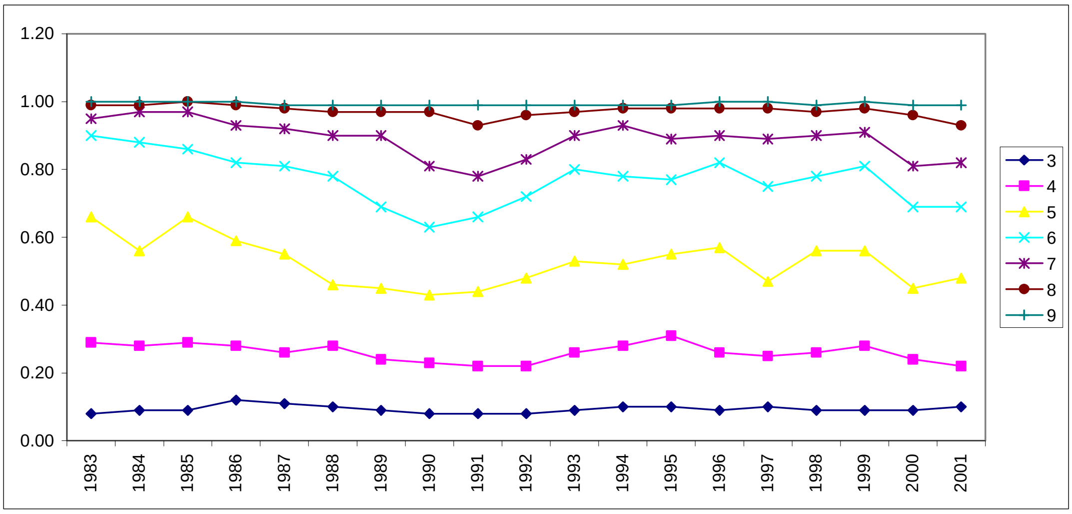


Figure 2.5.4.1 Saithe in the Faroes (Division Vb). Observed (upper figure) and fitted values (lower figure) proportion mature at age for the period 1983-2001.

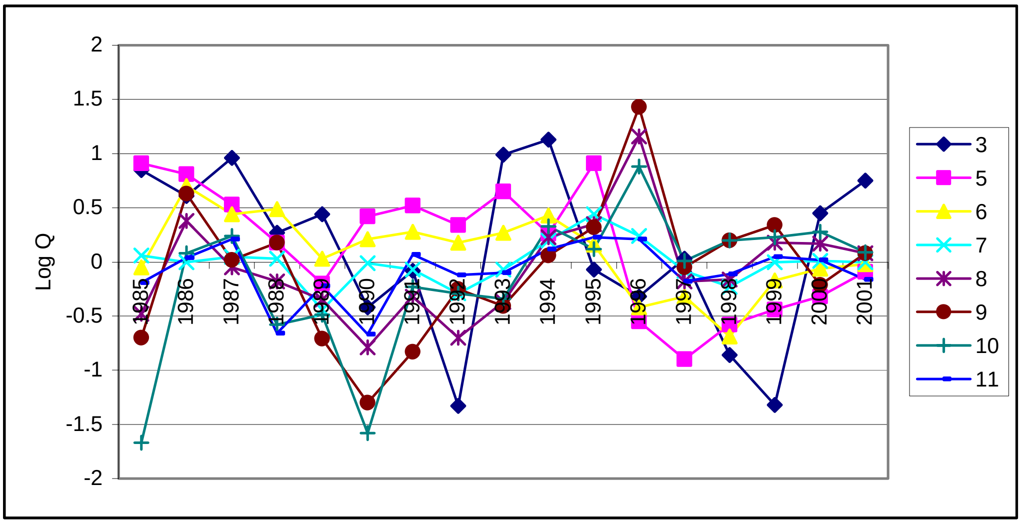


Figure 2.5.5.1 Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 and 5-11 from XSA.

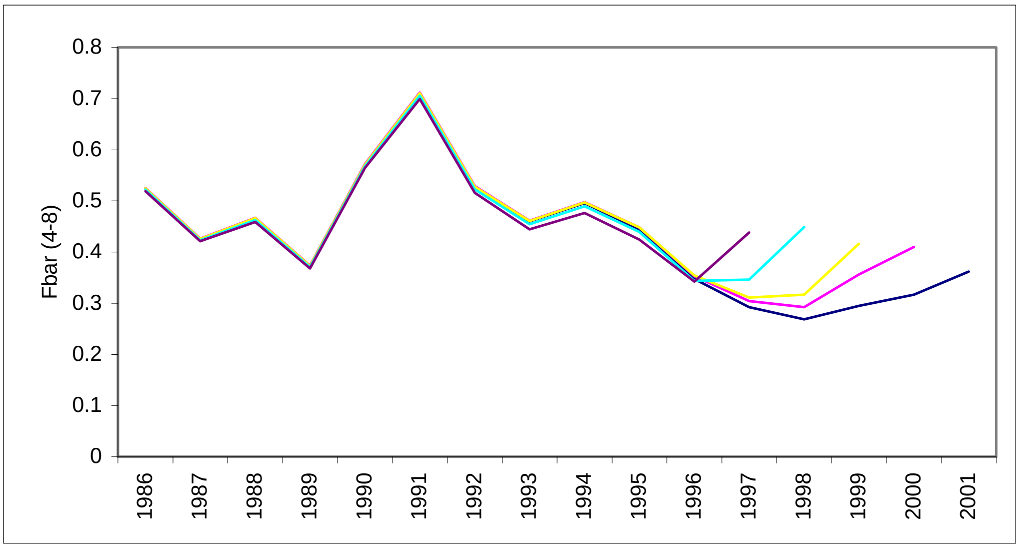


Figure 2.5.5.2 Saithe in the Faroes (Division Vb). Retrospective analysis of average fishingmortality of age groups 4-8 from XSA for the years 1996-2001.

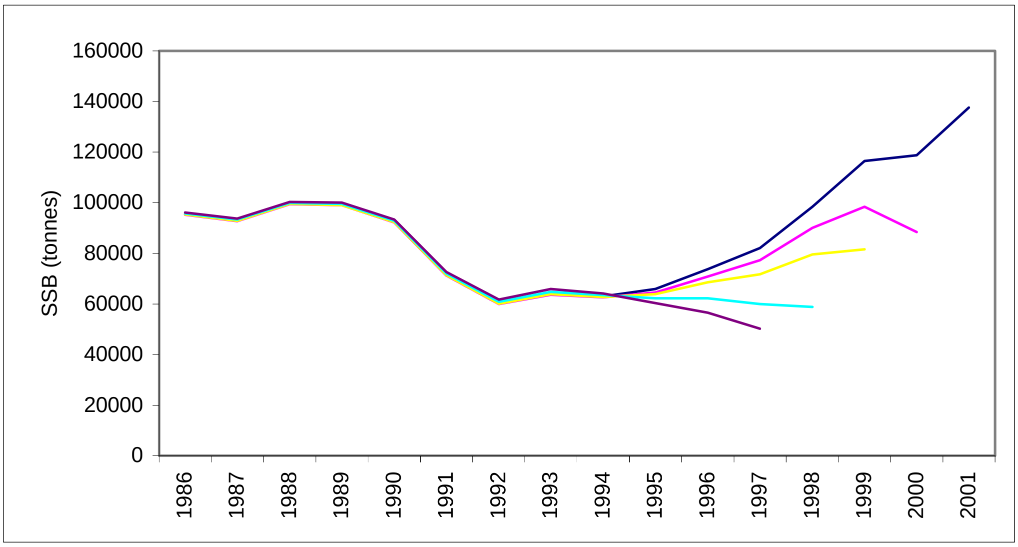


Figure 2.5.5.3 Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from XSA for the years 1996-2001.

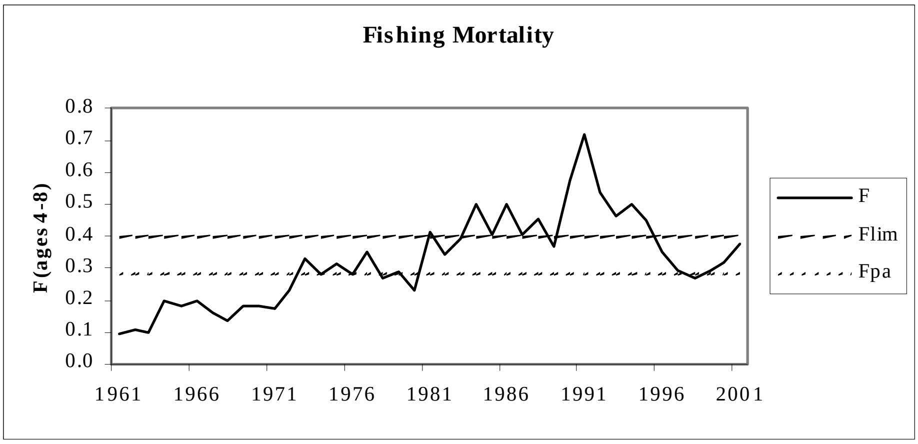


Figure 2.5.5.4 Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

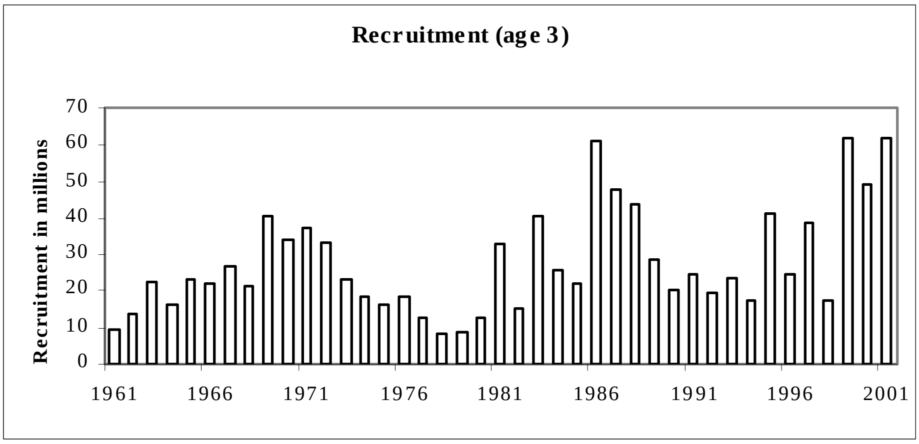


Figure2.5.5.5 Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

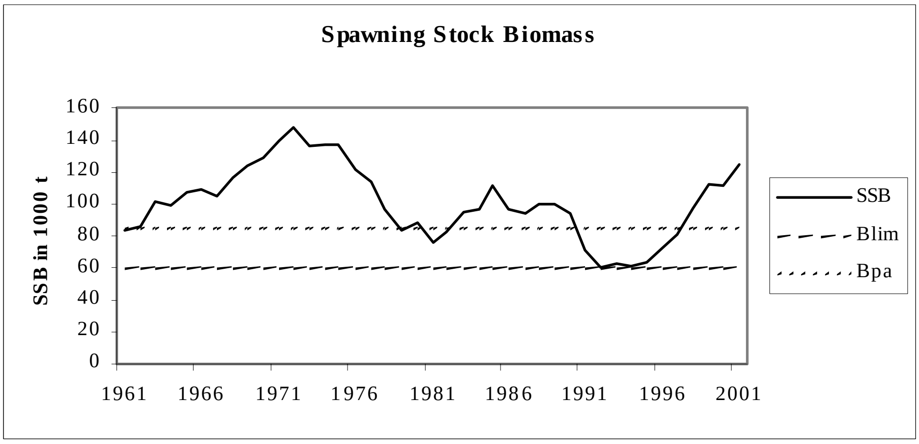


Figure 2.5.5.6 Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes).

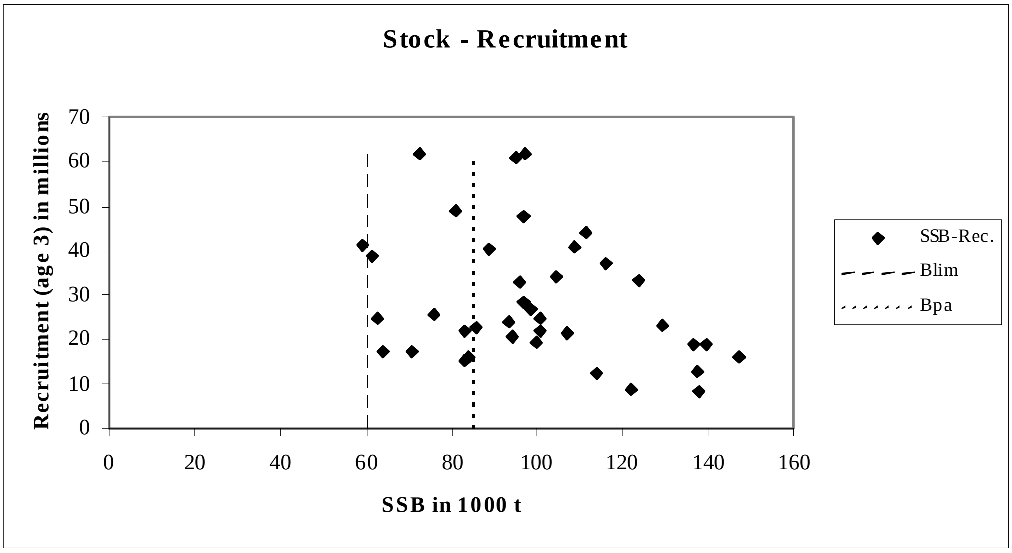
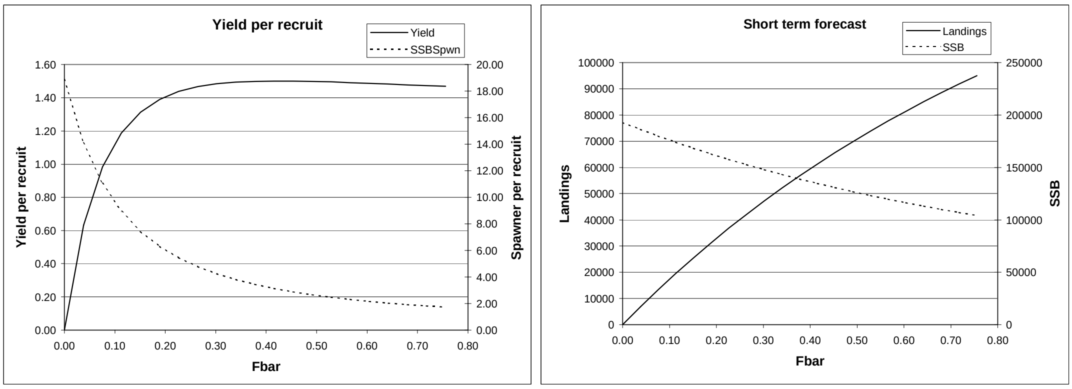


Figure 2.5.5.7 Saithe in the Faroes (Division Vb). Stock-Recruitment plot.



MFYPR version 2a
Run: yrn1
Time and date: 15:01 06/05/02

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3777
FMax	1.1164	0.4217
F0.1	0.4262	0.1610
F35%SPR	0.4706	0.1778
Flow	0.2890	0.1092
Fmed	0.9161	0.3460
Fhigh	2.1754	0.8217

Weights in kilograms

MFDP version 1a
Run: man1
Index file 6/5/2002
Time and date: 14:30 06/05/02
Fbar age range: 4-8

Input units are thousands and kg - output in tonnes

Figure 2.5.6.1 Saithe in the Faroes (Division Vb). Fish stock summary.

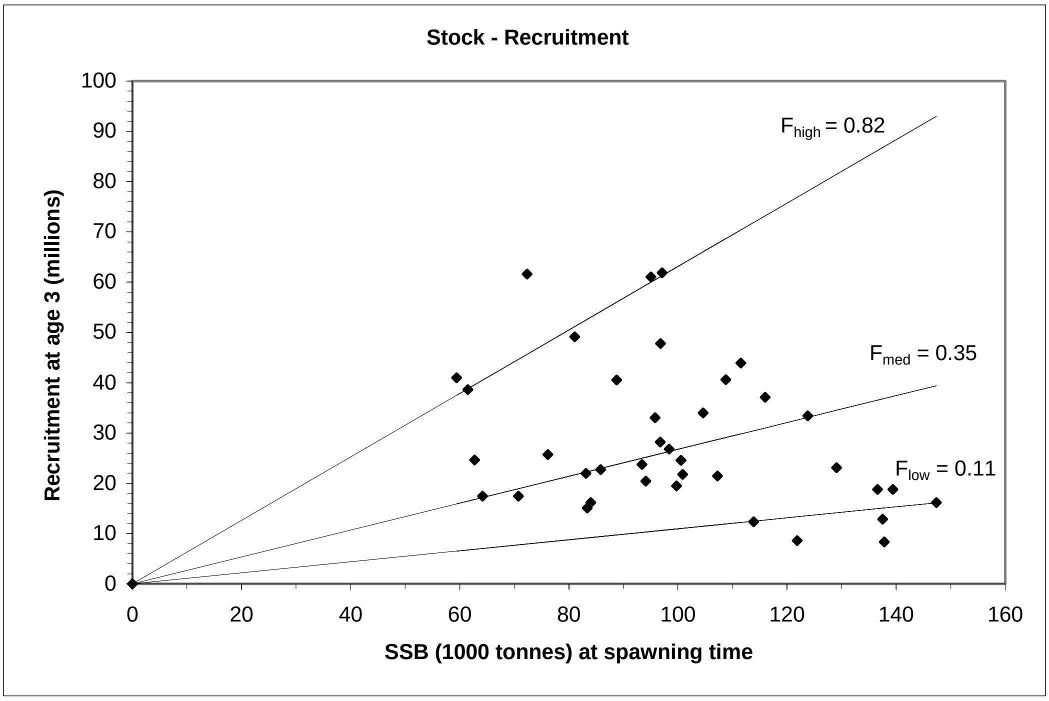


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

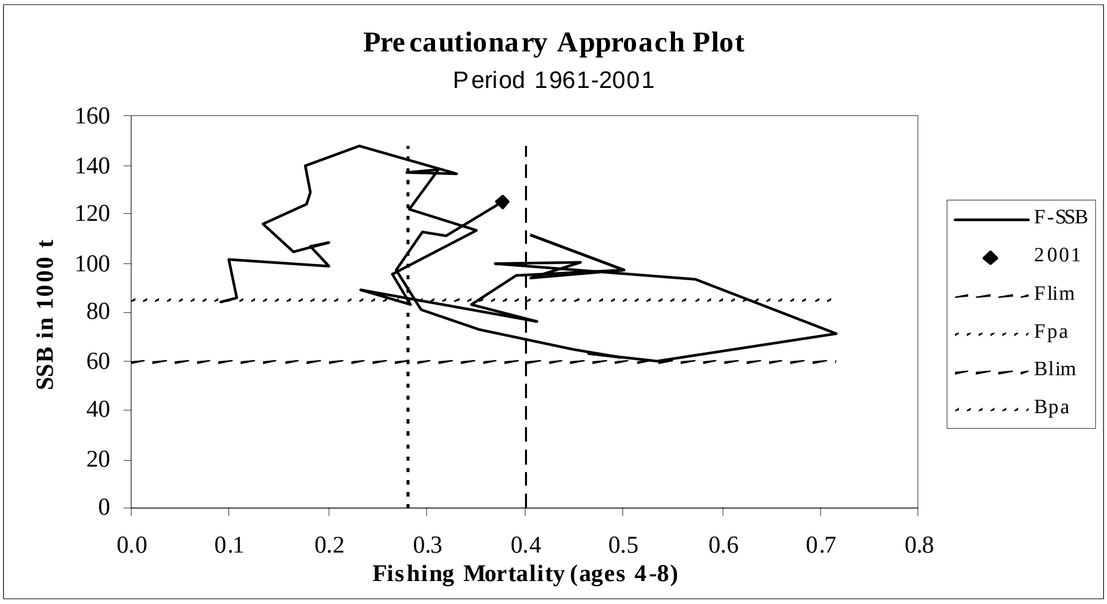


Figure 2.5.6.3 Saithe in the Faroes (Division Vb). The history of the stock/fishery in relation to the four reference points.

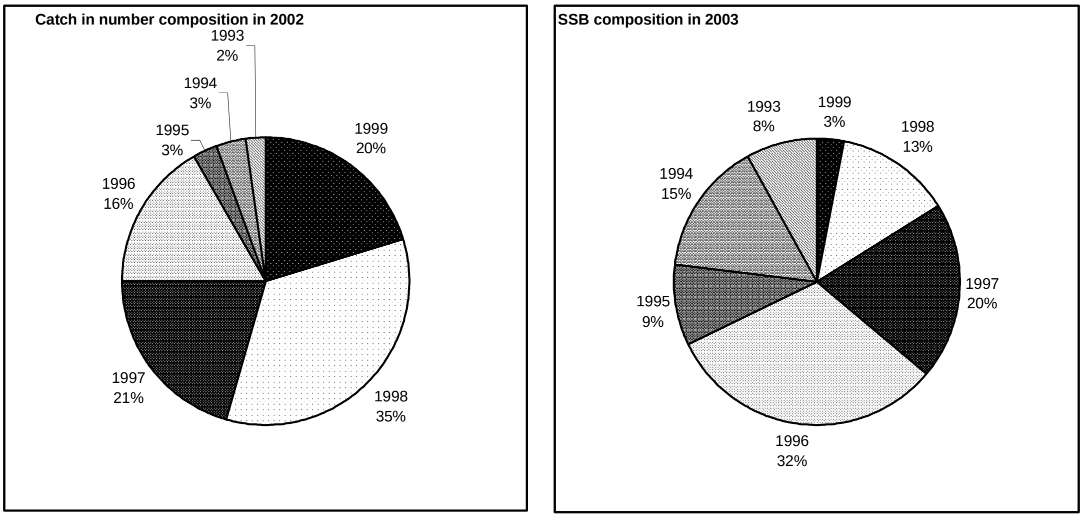


Figure 2.5.6.4 Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2002 (left figure) and the composition in SSB in 2003 by year classes (right figure).

3 DEMERSAL STOCKS AT ICELAND (DIVISION VA)

3.1 Regulation of Demersal Fisheries

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect young juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. In addition a system was implemented whereby fishing can be forbidden immediately in areas where the number of small fish in the catches exceeds a certain percentage (25% < 55 cm for cod and saithe and 25% < 48 cm for haddock). These areas have usually been closed for two weeks and can be extended in time and space if necessary.

A system of transferable boat quotas was introduced in 1984. The agreed quotas were based on the Marine Research Institute's TAC recommendations, taking some socio-economic effects into account. Until 1990, the quota year corresponded to the calendar year but at present the quota, or fishing year, starts on September 1 and ends on August 31 of the following year. This was done to meet the needs of the fishing industry.

Adoption of a Harvest Control Rule for the Icelandic cod stock in 1995

In May 1995, the Icelandic government adopted a Harvest Control Rule (HCR) for the Icelandic cod fishery, based on work carried out by a government appointed group of fisheries scientists and economists (Anon., 1994; Baldursson *et al.,* 1996; Daníelsson *et al.,* 1997). The group investigated the consequences of various long-term harvesting strategies for cod by using risk analysis, taking into account biological and economic interactions between cod and its major prey, capelin and shrimp. The group showed that a harvest rate of 25% of the average fishable (4+) biomass of cod at the start and the end of assessment year with a minimum of 155 thousand tonnes TAC would lead to a low probability of stock collapse, defined as SSB going below 100 thousand tonnes. The government implemented this catch-rule as a Harvest Control Rule in the next five fishing years.

Amendments adopted in June 2000

The assessment of the Icelandic cod stock in the year 2000 showed that the fishable biomass in 2000 had been overestimated by 180 thousand tonnes in the preceding assessment. Based on the 2000 assessment the HCR for the quota year 2000/2001 resulted in a recommended catch of 203 thousand tonnes. This reduction in catch between two consecutive years, which was largely driven by the downward revision in stock estimates, highlighted to the managers the uncertainty in stock assessments and the undesirability of tying a catch rule directly to point estimators in stock assessment. In June 2000 the Icelandic government therefore asked the MRI to explore whether an upper limit of between-year changes in TAC (catch-stabilizer) would jeopardise the original aim of the long-term harvesting strategy imposed by the HCR, with the addition of excluding the 155 thousand tonnes TAC floor.

Under the given time constraint only limited studies were possible. The basic approach taken was the same as that done previously by the working group (Stefánsson *et al.* 1997a; 1997b) and the work was carried out by one of its member. In addition to simulating cod, capelin and shrimp the analysis included two seal species and three species of baleen whales. The same criterion was used for the definition of stock collapse i.e SSB going below 100 thousand tonnes. No density dependent growth in the cod stock was assumed and only limited options of catch developments of whales and seals were explored, but different assumptions will affect the mean catch figures of cod. Fifteen percent CV in stock estimates was assumed. The general conclusion of all base-case trials showed limited sensitivity of introduction of a range of catch-stabilizers (10-60 thous tons). However, when various catch-stabilisers were applied under a regime of drastic reduction in recruitment (half the normal recruitment per SSB), the effects became clear; the lower the stabiliser was fixed, the greater probability of SSB collapse. It appeared that when catch-stabiliser applied was 25 thous tonnes or less, the risk increased significantly, while catch-stabiliser, allowing 30 thous tonnes or higher interannual changes in catches performed far better. In light of these provisional trials, the 30 thous tonnes catch-stabiliser was considered a safe approach.

On the basis of these results the Icelandic government adopted a modification to the HCR by including a 30 thousand tonnes catch-stabiliser and abandoning the minimum catch floor of 155 thousand tonnes. This resulted in a TAC of 220 thousand tonnes for the fishing year 2000/2001 instead of 203 thousand tonnes and 190 thousand tonnes for the fishing year 2001/2002 instead of 155 thousand tonnes if no stabiliser would have been in effect.

At the time of the catch-rule amendment, because of time constrains, detailed alternative simulations were not possible. A working group was set up by the Ministry of Fisheries in 2001 with the objectives to analyse the experience of using the catch rule and try out alternative approaches taking into account obvious shortcomings of the current harvest control rule and use state of the art knowledge for further development. This working group is supposed to deliver preliminary report before the start of the next fishing year 1 September 2002.

3.2 Saithe in Icelandic waters

3.2.1 Trends in landings

Saithe landings from Icelandic grounds (Division Va) have declined from a peak of 103 Kt in 1991 to close to 30 Kt in the last 4-5 years (Table 3.2.1.1). The Icelandic landings in the quota year September 2000/August 2001 amounted to 31 395 t, or a little more than the national TAC of 30Kt for the same period.

Landings of saithe in the fishing years 2000/2001 and 2001/2002 and in calendar years 2001 and 2002 show that the fishery proceeds at a steady rate, higher catches in the current years than last year are explained by a strike in 2001 (Figure 3.2.1.1).

According to fishermen it has become increasingly difficult to avoid saithe on the fishing grounds when operating in a quota system. At the end of 2001 the ministry of fisheries raised the saithe TAC for fishing year 2001/2002 from 30Kt to 37Kt.

3.2.2 Fleets and fishing grounds

More than three quarters of the catches in 2001 were taken by bottom trawl, 14% in gillnets, 5% on hooks and 2% in Danish seine (Figure 3.2.2.1). The proportion of the catch taken in gillnets has declined from almost a third of the total in 1994 and 1995, while the bottom trawl share has increased. Landings of hook and Danish seine catches were fairly stable in the period 1993-2001.

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast (Figure 3.2.7.3) but the gillnet fishery is concentrated on spawning grounds south and southwest of Iceland.

3.2.3 Catch at age

Compared to last years prognosis considerably higher numbers were caught of age groups 3-5 than expected but for other age groups estimated numbers in C@A agree with the prognosis made in last years assessment (Figure 3.2.3.1).

Data from samples from most gear types were used to calculate the catch in numbers at age for the total landings in 2001, with the sampling level indicated in the text table below, and used as input for the assessment (Table 3.2.3.1).

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	4 514	25	1 158	27	3 224
Jiggers	1 503	5	204	11	1 230
Danish seine	745	2	100	4	701
Bottom trawl	24 211	98	4 646	156	23 398
Other gear	867	-	-	-	-
Faroese jiggers	125	-	-	-	-
Total	31 965	130	6 108	198	28 553

Gillnet catches were split according to a gear-specific age-length key, the rest of the catches were split according to a key based on all samples from commercial gear except those from gill nets. The length weight relationship used was $W = 0.02498 \cdot L^{2.75674}$ for all fleets. Minor revisions were made to the catch at age matrix to account for slightly adjusted landings in 2000 (Table 3.2.3.1 and Figures 3.2.2.2 and 3.2.2.3).

3.2.4 Mean weight at age

Mean weights at age in the landings are computed on the basis of samples of otoliths and lengths along with length distributions and length-weight relationships. The mean weights at age are computed for the same categories as the catch numbers at age and are then weighted together across the fleets. The 1992 year class has had lower than average mean weight as age group 4-9 (Figure 3.2.4.1 and Table 3.2.4.1). Age groups 3-5 have lower mean weight at age in

2001 than the same age groups the year before, while those for age groups 6 and 7 were higher. Weights at age in landings were also used as weight at age in the stock.

3.2.5 Maturity at age

As has been pointed out in earlier reports of this working group, the maturity at age data for saithe can be misleading due to the nature of the fishery and of the species, and inadequate sampling. A GLM model, described in the 1993 Working Group report (ICES. C.M.1993/Assess:18), has been used to explain maturity at age as a function of age and year class strength. This model was used to predict maturity at age for 1980-2001 (Table 3.2.5.1). The maturity at age prior to 1980 is from ICES C.M. 1979/G:6.

3.2.6 Migration of saithe

According to available data approximately 115 thousand saithe were tagged in the NE-Atlantic last century, most of them in the Barents Sea with total returns just under 20 thousand (S. T. Jonsson 1996). At Iceland 6 000 saithe were tagged in 1964-65, the recapture rate being 50% (Jones and Jonsson, 1971). Based on recaptures by area approximately 1 in 500 of tagged saithe released outside Icelandic waters were recaptured in Icelandic waters and 1 in 300 released in Icelandic waters were recaptured in distant waters (S. T. Jonsson 1996). For comparison, cod long term average rate of emigration from Icelandic waters is 1 in 2000 tagged fish (J. Jonsson 1996), a rate almost an order of maginitude lower. Taken at face value, this leads to the conclusion that there is not a significant difference in the rates of semi-trans-Atlantic migrations of saithe east and west. Since there are more saithe in distant waters than on Icelandic grounds the latter might on average be on the receiving end of a NE-Atlantic saithe migratory budget.

Other evidence of saithe migrations exist, albeit of a more circumstantial nature. Sudden changes in average length or weight at age and reciprocal fluctuation in catch numbers at age in different areas of the NE-Atlantic have been interpreted as signs of migrations between saithe stocks (Reinsch 1976, Jakobsen and Olsen 1987, S.T. Jonsson 1996). Since mean weight at age decrease along an approximately NW-SE-NE gradient, migration of e.g. northeast arctic saithe to Icelandic waters will, theoretically, be detectable as a reduction in size at age (Figure 3.2.4.1). Catch curves from some year classes, from different areas show some reciprocal variations. Inspection of the data based on the above indicate that the most likely years and ages for immigration are as follows: Age 10 in 1986, age 7 in 1991, age 9 in 1993 and the 1992 year class as age 7 saithe in 1999 and 8 in 2000.

A tagging program was started in Icelandic waters in 2000. More than 1 700 mostly juvenile saithe, caught with hooks at the nearshore nursery areas were tagged in 2000. The program continued in 2001 when approx. 3 000 saithe were tagged, at the same localities and some new ones. Recapture rates to date have reached more than 5% for saithe released in 2000 (Figure 3.2.6.1), mostly from saithe of approx. 50 cm or more at tagging. The fish tagged in 2000 were mostly from age groups 2 and 3 and therefore less than 50 cm so they are not expected to enter the fishery until autumn 2001. It is planned to continue these taggings for monitoring saithe migrations.

3.2.7 Stock Assessment

3.2.7.1 Tuning input

3.2.7.1.1 Commercial fleets

CPUE data based on Icelandic trawler log books are available from 1970 and from 1988 for the gillnet fleet. To begin with the logbooks were kept on a voluntary basis by skippers of a few vessels, but since 1991 it has been mandatory to keep logbooks, both for the trawling and the gillnets fleets.

With reduced stock size in the 1990s a continuous shift, from effort directed at saithe towards mixed fisheries, has been observed. Traditional analyses using CPUE data from commercial fleets have been based on the criteria of using tows where more than certain percent (50-70) of the catch was saithe. For saithe, big schools of fish are occasionally encountered but the number of schools might decrease with reduced stocksize. To bypass this problem CPUE from all tows and gillnet settings from the most important fishing areas for saithe was calculated. In the 2000 assessment tuning time series analysis (TSA) was tuned with CPUE from the trawler fleet in the period January – May. As fishermen have complained about the way fleets based on logbook information to tune the assessment are set up, when they claim to be avoiding saithe, other commercial fleet alternatives have been studied.

GLM and RAW fleets were set up for Gudmundssons catchability study prior to NWWG2002 (WD31)

- GLM: a 'glm'-index, or the year effect from a multiplicative/general linear model including also fishing vessel, month and location (as statistical square of 1° longitude by 1/2° latitude) of capture.
- RAW: a 'raw'-index, or the annual mean CPUE of the data used as input for the model for the 'glm'-index.

Data from 1985-2001 were chosen as this is covered by the Icelandic GroundFish Survey (IGFS), logbooks and catches. The fishery is year-round, here separate indices are calculated for the periods January-May and June-December. Only one region is used here although in previous exercises using these data the Icelandic shelf has sometimes been split in north and south regions. All vessels operating with a bottom trawl for groundfish reporting to the MRI logbook database were included, both stern trawlers and smaller boats.

'glm'-indices

The 'glm'-indices used in this study were derived in generally the same way as in Stefánsson (1997, 1988) using the multiplicative modelling approach of Gavaris (1980).

The choice of sets, in which the species studied was more than 50% of the catch, for inclusion in the analysis is admittedly *ad hoc*, but this percentage has been used earlier when indices of this type have been used in Icelandic assessments and experience indicates that the results are not very sensitive to the choice of percentage. However the approach has to be modified if all catches, including zeros, are to be included in the analysis.

'raw'-indices

Annual arithmetic averages of the data used as input to the model above were calculated and are used directly as an index of biomass.

It has also been proposed that a set of vessels be chosen, with the criterion of 'not being restricted by quota' when fishing for saithe. A new fleet was set up with this in mind, where each year, the 10 trawlers, who reported the highest saithe catches for a given year, were chosen. CPUE was found for this fleet and others previously considered by NWWG and is shown for all fleets together (Figure 3.2.7.1) where it is apparent that all trawl fleets indices increase from 2000 to 2001 but the gillnet fleets go down. The fleet of top 10 trawlers was studied with respect to measure of central tendency chosen to calculate the index (WD28) The main fishing areas of trawlers remained more or less unchanged in 1993-2001, although saithe is only caught intermittently by trawlers north of Iceland and the area where trawl hauls where saithe are more than half the catch has increased slightly from a low in 1998 (Figure 3.2.7.2).

The problem with commercial tuning fleets is twofold. Fleets based on commercial CPUE age-disaggregated for tuning XSA or TSA have the serious drawback of being auto-correlated with catch in numbers, since it is not possible to age-disaggregate them independently. Further, under a restrictive quota, as for the saithe in recent years, it is probable that some avoidance effect may make a tuning fleet such as the one used in the 2000 assessment of saithe in Va biassed downwards. Use of a biomass index from commercial fleets is a much more attractive alternative, but for that programs different from XSA have to be used, or the TSA modified. As no commercial index has been agreed upon and because of the dangers of catchability changes (see ICES CM 2001/Assess:20, WD31) the use of commercial fleet tuning data in assessment was put off until further studies have been made.

3.2.7.1.2 Survey

Survey indices for saithe around Iceland are highly variable but have now been studied in more detail to be studied in more detail for the purpose of using them in assessment.

In this assessment indices of stratified mean abundance by age group in the IGFS (Icelandic GroundFish Survey) have been greater consideration than previously (Table 3.2.7.1). Length distributions from the survey show distinct peaks for 2-4 year old saithe that can to some extent be tracked from one year to the next (3.2.7.3). The distribution area of saithe in the survey is similar to the major fishing grounds, even showing a parallel in 1993 between distribution in survey and fleet (Figures 3.2.7.4). Catch curves for saithe in the IGFS show that a Z of 0.6 is possibly not far from the truth (Figure 3.2.7.5) and the Shepherd Nicholson model fitted to the survey gives CV=0.6 for ages 2-9 but 0.32 with ages 4 to 8. Residuals from model are shown in Figure 3.2.7.6.

The stratified indices for saithe could not be used for tuning without some doctoring, i.e. the most extreme outlier has been set at the second highest observation. By using medians of age group numbers and multiplying them with the proportion of positive stations, that nuisance might be avoided. Extreme hauls of saithe on the IGFS are rare and it is disappointing to let that prevent us from using information that could be of help in assessment. Although saithe is among the species with the highest CV in IGFS (Figure 3.2.7.6.), it should be kept in mind that it is possibly 'better to be vaguely right than definitely wrong'. We now tune three models with a survey fleet, that is independent of the catch at age, although somewhat noisy.

3.2.7.2 Estimates of fishing mortality

As has usually be done prior NWWG-meetings, time series analysis (TSA) (Gudmundsson 1994, WD30-32) and XSA were used in preliminary assessment runs of the stock. This year APAPT(tive framework) was also used prior to the meeting (Gavaris 1988, Rivard and Gavaris 2000). TSA run with the same settings as last year gave estimates of $F_{4\text{-}9}$ in 2000 of 0.37 and spawning stock biomass (SSB) of 86 Kt at the start of 2001 as compared to $F_{4\text{-}9,2000}$ of 0.36 and SSB of 84 Kt estimated in spring 2001.

XSA runs with survey and commercial fleet all had more or less poor diagnostics and it was decided present only one run for comparison with TSA and ADAPT, with emphasis on ADAPT and XSA performance in predicting recruitment, when the two were tuned with the IGFS saithe indices. In the text table below a the range of XSA results for summary statistics in the terminal year can be observed, for commercial and survey XSA tunings, with different fleets, for different seasons and for different number of tuned age groups, but settings otherwise similar to those in previous XSAs of this stock (starting with 11 'commercial' and ending with 5 different survey tunings):

	R3	FSB (B4+)	F4-9
glm	52	275	0.157
top10u50	46	269	0.158
glmjundes	47	249	0.167
umean	47	243	0.184
glmjanmay	45	233	0.200
umeanjundes	43	223	0.189
umeanjanmay	44	221	0.221
glmjanmay5_10	38	190	0.239
umeanjanmay5_1(	39	187	0.262
top10u50t1	36	165	0.300
top10u50t2	36	163	0.304
smoothsmb	36	139	0.396
smb123	33	134	0.349
smb	32	134	0.342
smb234	29	133	0.348
.smb345	27	129	0.353

In the ADAPT and XSA comparison the programs were run with settings as close to identical as they permit. Both were run with zero catches for ages younger than those present in the C@A, age range 2-12 in ADAPT, 1-12 in XSA. No plus group was used. As tuning indices we chose age groups in which no zeros occur in the IGFS index matrix, i.e. ages 2-9, which had to be shifted to the end of the previous year in XSA, but were set at the beginning of the year in ADAPT, in order to tune with the most recent survey. Proportional catchability was assumed for all age groups in both models. In ADAPT population weighted mean $F_{8\text{-}11}$ was used for calculating the oldest age group. In XSA, tapering was not applied since the IGFS is a standardized survey, which has changed relatively little since it started in 1985. TSA used IGFS data differently, the average of indices at age 3-5 were used as a 'recruitment index' for a year class at age 4, ages 6-8 were used to calibrate the model with C@A.

Retrospective plots of TSA B4+ and F4-9 are shown in Figure 3.2.7.7 and 3.2.7.8, and of N3 from ADAPT and XSA are shown in Figures 3.2.7.9 and 3.2.7.10. Fishable biomass (4+) for the three survey tunings are shown in Figure 3.2.7.11 and an overview of results final results of the three models and a SPALY TSA run are given in the text table below:

	$B_{4+,2002}$ (Kt)	$F_{4\text{-}9,2001}$	$N_{4,2002}$ (millions)	$N_{3,2002}$ (millions)
TSA (SPALY)	127	0.345	21	N/A
TSA (survey)	143	0.334	15	N/A
ADAPT	155	0.36	17	37 (bootstrap bias corrected)
XSA	158	0.33	17	46

Time series analysis were run by Guðmundur Guðmundsson of MRI and Seðlabanki Íslands, the following is his commentary to the saithe TSA runs this year:

'For saithe the variances from the survey are much higher than for cod and haddock and results from a joint analysis with catch-at-age data tend to differ little from results obtained from analysis of catch-at-age data alone.

The best retrospective analyses are obtained by using a linear trend between constant values in the three first and last years as a recruitment index. This is, however, not a very satisfactory arrangement and liable to produce biased results if the trend comes to a halt or changes course. We have found that a fairly accurate recruitment index (at 4 years) is obtained by the average over 3-5 years indices from respective cohort in the survey. Estimates of catchable biomass in 2001 are about 10,000 tonnes higher with this index than the trend. It is highly significant compared with the trend according to the likelihood function. The retrospective analyses in the last years are satisfactory, but actually worse than with the trend further back.

CPUE indices for saithe from trawlers have much lower transitory variations than the survey, but appear to have changed systematically over the time period included here so that the variations represented by λ and δ_{8t} are not negligible. Estimates obtained from trawl indices without these terms produce much higher values of catchable biomass than other estimates' (WD30).

On the basis of the above, i.e. that adding a survey index to TSA was a significant improvement and the relatively slight differences between the three survey runs it was decided to keep TSA as the adopted method for the stock, but tune it with survey in the final run. Contrary to what was stated ICES CM 2001/Assess:20 we have now shown that useful indices of recruitment are available for saithe from the IGFS survey. Therefore TSA calibrated with the IGFS is chosen as the final assessment run (WD30) and first estimate of saithe year class strength year class 1998 are based on ADAPT, which performed better than XSA in retrospective prediction of N3.

Continuing the precedence from last years assessment, saithe migration was estimated. The same migration events as in the 2001 assessment were included and estimated again. The years and ages were selected by studying anomalies in length and weight at age data as well as by comparison of Icelandic catch at age data with C@A for Faroese and Norwegian saithe (see also section 3.2.6). The years and age groups chosen were the ones for which the largest discrepancies in catch at age data had been detected in TSA runs. The strength of the migrations was estimated in TSA. The estimates of migrations were (in units of millions): $N_{10,86} = 2.3$, $N_{7,91}=7.6$, $N_{9,93}=4.1$, $N_{7,99}=2.0$, $N_{8,00}=1.9$

It has been observed that Icelandic saithe shows density dependent growth which causes larger year classes to grow slower. Distinguishing between slower growth and migration can at times be tricky as slower growth delays recruitment to the fishery. Even though slower growth is the cause of anomalies in catch at age data, modelling it as migrations is probably better than ignoring them.

Table 3.2.7.2 shows the estimated stock size and fishing mortalities from the selected TSA run along with estimated standard errors. The estimated standard errors are underestimates of the real standard errors. This applies in particular to results using commercial fleet data as these data are strongly correlated with the catch-at-age data. ADAPT results are given in table 3.2.7.3 for comparison. Fishing mortality and stock in numbers from a VPA accounting for migration are given in Tables 3.2.7.4 and 3.2.7.5.

3.2.7.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.7.12 and given in Table 3.2.7.6. After a decline from 1970-1977, the spawning stock biomass averaged between 160-180 Kt in 1978-1989 and increased to about 190 Kt in 1990. Since 1992 the spawning stock biomass has declined to a minimum in 1999-2000 of slightly above 80Kt , which is the lowest SSB recorded. Spawning stock biomass at the beginning of 2002 is estimated at 106Kt.

Estimates of recruitment at age 3 are plotted in Figure 3.2.7.12. The 1983-1985 year classes are all well above the 1962-1998 long-term average of 41 million 3 year old recruits. The 1984 year class was among the highest on record at 78 million recruits. All year classes after 1985 are below the long term arithmetic average. The average size of the 1986-1995 year classes is estimated at only 20 million recruits, which is below the lower quartile of the historic series of recruitment. Recruitment has improved somewhat recently, year classes 1996-1999 are all estimated above the 20 million 3 year olds used a first estimates of recruitment in the 2000 and 2001 assessments (Figure 3.2.7.12). The scatter of SSB and recruitment is shown in Figure 3.2.7.13.

3.2.8 Prediction of catch and biomass

3.2.8.1 Input data

Predicted catch in 2002 is based the quota for the fishing year 2001/2002 which was changed to 37Kt at the end of the year . As the fishery has not escalated (Figure 3.2.1) no overshoot is added. The input data for the catch projections is shown in Table 3.2.9.

Year classes 1999-2001 were set at 30 million 3 year olds, the median recruitment in the period 1962-2001.

For catch predictions and stock biomass calculations, the mean weight at ages 4-9 were predicted using multiple regression analysis where the mean weight at age was predicted by the mean weight of the year class in the previous year and the year class strength. Since the regression analysis showed significant relationships only for the above age groups, the mean weights at age for other age groups were averaged over the 1999-2001 period.

For the short-term predictions, maturity at age was predicted as described in Section 3.2.5. The selection pattern was based on average fishing mortality for 1999-2001, with F8+ set at the average for age groups 8-14. This average was scaled to the reference F of 2001. Median recruitment for year classes 1959-1998 was used for 3 year olds in 2002-2004. Short term prediction based on these inputs is given in Table 3.2.10

For long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the average of the fishing mortalities during 1985-2001 from the TSA survey run. Averages over 1985-2001 for maturity and mean weight at age for all age groups were used, along with a natural mortality of 0.2 (Table 3.2.11).

Standard plots for short and long term predictions are shown in figure 3.2.11.

3.2.8.2 Biological reference points

The ACFM has set $\mathbf{B}_{pa}$ at 150 Kt, $\mathbf{B}_{lim}$ tentatively at 90 Kt, and $\mathbf{F}_{pa}$ at 0.3. $\mathbf{F}_{lim}$ has not been set for this stock. The stock is well below $\mathbf{B}_{pa}$ but more than 15Kt above $\mathbf{B}_{lim}$ to according to this assessment. The $\mathbf{B}_{lim}$ reference point is based on the lowest observed SSB but it seems that these spawners are capable of producing at least more recruits than the lower quartile, or the recent low average. The reference points for this stock might need revision. The standard PA-plot is shown in figure 3.2.8.2.

3.2.8.3 Medium term projections

Medium term projections were made last year by the working group (ICES CM 2001/Assess:20).

3.2.9 Management considerations

A further reduction in fishing mortality, of at least 10% is advisable. Reducing fishing increases the probability of lowering fishing mortality to $\mathbf{F}_{pa}$, and if improved recruitment is observed for incoming year classes so will the likelihood of the SSB reaching $\mathbf{B}_{pa}$.

3.2.10 Comments on the assessment

In last year's assessment TSA was run on catch at age only, with linear trend in recruitment estimated. This year information from IGFS survey was added to the TSA.

The assessment is uncertain, but shows positive signs. Data not used in the assessment (Figure 3.2.7.1) suggest that the rate of increase in stock size from 1999-2000 to the present might be an underestimate.

Year classes 1996-1999 were set at 20 million 3 year olds in last years assessment compared to 24, 28 and 22 million in the current assessment. Year class 2000 was set at 30 million 3 year olds, although the ADAPT bootstrap bias corrected estimate is 37 million.

Age group 9 in 2001 belongs to the 1992 year class for which migration was estimated in 2000, 2001 and is estimated again in this assessment. That migration has been split on two years, as 7 year olds in 1999 and 8 year olds in 2000. Catch at age 9 in 2991did not exceed prognosis as catches of this year class did the 2 previous years (Figure 3.2.3.1).

ADAPT and XSA performance in estimating N3 was compared with results from retrospective runs indicating that ADAPT performed slightly better. An ADAPT estimate for year class 1999 was used in this assessment.

Three assessment methods were used this year with similar results. ADAPT might be used in the future for estimating recruitment, and possibly be used as the primary assessment tool.

Length-weight relationships are kept the same for both fleets and from year to year in the interest of consistency, a change in the relationship might occur in conjunction with adding weight information to the assessment.

The stock was overestimated until in the 1997 assessment but has been more stable in more recent assessments. It recovering from the lowest observed level at present. The reference F values have been at or above $\mathbf{F}_{med}$ for the whole time series in the assessment, and were higher than $\mathbf{F}_{max}$ in 1993-1995. Recruitment in recent years (the 1986 and more recent year classes) has been below the long term average but year classes 1996-1999 are all estimated higher than 20 million used in projections 2000 and 2001.

Tag returns and stock assessment data indicate migration between saithe stock units in NE-Atlantic, and indications from catch at age have been described (Reinch 1977, Jakobsen & Olsen 1987). Little is known about their magnitude and frequency. Better understanding of saithe biology, e.g. behaviour, recruitment and migrations, is needed. A few new studies on saithe have recently been initiated. The tagging program mention in section 3.2.6 will continue at least in 2001 and 2002, with the addition of electronic tags in 2002. A nordic project setting out to test a hypothesis of migration of the 1984 and 1992 year classes of saithe from east to west in the NA-Atlantic by analysis of otolith chemistry from four saithe stocks managed by Iceland, Faroe Islands and Norway (and EU and Russia) is under way.

3.3 Icelandic cod (Division Va)

3.3.1 Trends in landing

In the period 1978–1981 landings of cod increased from 320 000 t to 469 000 t due to immigration of the strong 1973 year class from Greenland waters combined with an increase in fishing effort. Catches then declined rapidly to only 280 000 t in 1983. Although cod catches have been regulated by quotas since 1984, catches increased to 392 000 t in 1987 due to the recruitment of the 1983 and 1984 year classes to the fishable stock in those years (Table 3.3.1 and Fig. 3.3.1).

During the period 1988-1996 all year classes entering the fishable stock were well below average, or even poor, resulting in a continuous decline in the landings. The 1995 catch of only 170 000 t is the lowest catch level since 1942. In the years 1993 - 1995 a marked reduction in effort against cod was observed (Table 3.3.2 and Figure 3.3.9.A) with the adoption of the HCR. The largest reduction was by the trawlers who diverted their effort to other species and other areas.

From 1995 catches increased continuously to 1999 when the estimated landings were 260 000 tonnes but decreased to 235 000 tonnes in the year 2000 and 2001.

3.3.1.1 Catch in number at age and sampling intensity

The fleet fishing for cod at Iceland operates throughout the year. The fishing vessels are of different sizes but can however be grouped into three main categories: 1) Multi-gear boats; < 300 GRT, 2) Small boats; < 20 GRT, 3)Trawlers; > 300 GRT.

The trawlers operate throughout the year outside the 12 mile limits. They follow the spawning and feeding migration patterns of cod and fish on spawning grounds off the south west and south-coasts during the spawning season but move to the feeding areas off the northwest coast during the summer time. During the autumn, this fleet is more spread out. The multi-gear boats operate mainly using gillnet during the spawning season in winter and spring along the south-west coasts but in recent years this fleet has also used gillnet in late autumn. In the years 1995 to 1998 this fleet increased the mesh size in their nets from 7 to 9 inches but reduced the mesh size back to 8 inches in 1999 and the use of 7 and 8 inches mesh size has been increasing again in the last 2 years (Figure 3.3.3). Part of this fleet uses longlines during autumn and early winter. During summer some of these boats trawl along the coast out to the 3 mile limit. Others fish with Danish seines close to the shore. Most of the smaller boats operate with handlines, mainly in shallow waters during the summer and autumn period.

The data samples comprising the age-length keys for 2001 are given in the following table: The number of samples in gillnets in January-May can be explained by inclusion of gillnet surveys in the numbers.

Gear	Season	Area	Nos. le measured	Nos. le. samples	Nos. weighted	Nos. aged	Nos. age samples
Bottom trawl	Jan-May	North	62622	267	1096	2789	57
Bottom trawl	Jan-May	South	13909	79	1028	1099	21
Danish Seine	Jan-May	North	42	1	0	0	0
Danish Seine	Jan-May	South	3807	25	250	248	5
Handlines	Jan-May	North	924	7	299	346	7
Handlines	Jan-May	South	522	4	150	199	4
Longline	Jan-May	North	9067	41	386	631	12
Longline	Jan-May	South	11820	66	740	999	21
Gillnet	Jan-May	North	2245	15	150	147	3
Gillnet	Jan-May	South	31070	238	1139	1217	25
Bottom trawl	Jun-Dec	North	82486	379	1594	3601	73
Bottom trawl	Jun-Dec	South	7553	40	598	636	13
Danish Seine	Jun-Dec	North	5101	27	50	50	1
Danish Seine	Jun-Dec	South	4512	25	200	200	4
Handlines	Jun-Dec	North	603	4	150	199	4
Handlines	Jun-Dec	South	0	0	0	0	0
Longline	Jun-Dec	North	15665	73	350	641	13
Longline	Jun-Dec	South	2079	12	300	297	6
Gillnet	Jun-Dec	North	2010	11	100	100	2
Gillnet	Jun-Dec	South	3045	18	298	288	6
Total			**259082**	**1332**	**8878**	**13687**	**277**

Catch in number at age is calculated by splitting the landings by 5 fleets("metiers"), 2 areas and 2 seasons. The gears are long lines, bottom trawl, gillnets, hand lines and Danish seine, seasons January-May (spawning season) and June-December and regions North and South. Historically, there have been some changes in fleet definitions and thus there does not currently exist a fully consistent set of catch-at-age data on a per-fleet basis.

The sampling effort in each cell (Gear-Season-Area) in the year 2001 is shown in the table above.

In some cases samples are not available for a cell or are to few to give reliable keys. In those cases otholith samples from "related" cells are used. Notably hand lines are included with long lines in the same area and season.

In recent years emphasis has been put on relating the sampling scheme to the landings database automatically, calling for samples when certain amount has been landed in each cell, calculated daily ("real time proportional sampling scheme").

The total catch-at-age data is given in Table 3.3.3 and Figure 3.3.4. The Shephard Nicholson model gives a CV of 0.2 for age groups 4-10. It should be noted that much higher proportions of the older age groups are taken during the first part of the year and this fishing mortality affects estimation of the spawning stock at spawning time. Since the catch-at-age data have historically only been available for January to May, and not by shorter periods, it is assumed that 60% of the those catches were taken during January to March, i.e., before spawning time (Table 3.3.4). Natural mortality before spawning is assumed to be one fourth of the annual natural mortality.

3.3.2 Mean weight at age

3.3.2.1 Mean weight at age in the landings

Mean weight at age in the landings is calculated with the catch in numbers. Before 1993 weighting of cod was relatively uncommon so length-weight relationships were based on little data. Since 1994 weighting has been much more extensive but currently all fishes sampled for otolith are weighted and length-weight relationships can be calculated from current data. The weights are shown in table 3.3.5 and figure 3.3.7.

Mean weight at age have been shown to correlate well with the size of the capelin stock and capelin stock size has for some time been used as a predictor of weights in the landings. In 1981-1982 weights were low following collapse of the capelin stock and were also relatively low in 1990-1991 when the capelin stock was small. The weights were very high in 1994 to 1998 but have been low in 1999 and 2000, lower than the predicted from the capelin stock size. In 2001 about 15% increase in mean weight at age was observed for age groups 3-5, the weights for age groups 6-10 were about same as in 2000 and about 15% decrease was observed for older fish.

Mean weights at age are not available on an annual basis for catches taken before 1973, and hence the average for the years 1973 - 1991 is used as the constant (in time) mean weight at age for earlier years.

3.3.2.2 Mean weight at age in the stock

Weights at age in the landings have been used without modification to compute stock biomasses, with the exception of the spawning stock biomass (see below).

Data collected in the Icelandic groundfish survey (IGFS) have the potential for providing better estimates of mean weights at age in the stock. As the survey takes place early in the year with small meshes in the trawl codend mean weights in the survey multiplied by number in stock would give a much better measure of “real stock size”. A problem with using survey weights for calculation of stock biomass is that they are only available back to 1985 and weighting of mean weight at age from areas with different growth rates is sensitive to catchability and annual differences in spatial distribution.

The calculated annual mean weights at age in the IGFS show similar pattern as the weights in landings although survey weights for ages 3 to 5 are always considerably lower than weights from the catches from the same period.

3.3.2.3 Mean weight at age in the spawning stock

Weight at age data from the commercial catch period January-May have been used for estimation of mean weights at age in the spawning stock. It is assumed that catches in different gears and areas appropriately reflect stock composition with regard to mean weight at age. Weights in the SSB have decreased in 1999 and 2000 after being very high in 1996 to 1998. In 2001 an increase was observed for age groups 3-9 and decrease in older fish. The peak in 1996 to 1998 could be related to selection of the commercial fleets who were using large mesh size in gillnets in this period (Figure 3.3.3). Mean weights in the spawning stock are shown in table 3.3.6 and figure 3.3.8.

3.3.3 Maturity at age

Maturity at age is based on samples from the commercial fleets in January-May (ICES 1992/Assess:14) (Table 3.3.7 and Figure 3.3.6). It has been pointed out that using data collected throughout the year may bias the proportion mature in various ways (Stefánsson, 1992). The approach taken is, therefore, to compute the proportion mature at the time of spawning, by considering only the first part of the year (January-May), but aggregating across gears and regions. Maturity at age increased substantially from 1982-1995 to relatively high values and decreased again in 1996-2000 but a sharp increase was observed for age groups 3-7 in 2001.

Maturity at age data are not available on an annual basis for catches taken prior to 1973 and, hence, the average for the years 1973–1991 is used as a constant (in time) maturity at age for the years prior to 1973.

3.3.4 Stock Assessment

Recent assessment and reviews

The 2000 ICES assessment showed that the stock had been seriously overestimated in recent years. In May-June 2000 the MRI asked a group of external experts to review and reanalyse the assessment. The group was chaired by Prof. John Pope. Various alternative assessment models were used: XSA (John Pope), Coleraine (Árni Magnússon/Ray Hilborn), Cagean like model (Pat Sullivan), TSA (Guðmundur Guðmundsson) as well as some unconventional methods such as Bormicon (Höskuldur Björnsson). The group met twice, first in May/June 2000 and again in late autumn.

At the spring meeting, several different tuning sets and assumptions were explored. The outcome of the final runs of the various assessment models are shown in Figure 3.3.4. The main conclusion was that the ICES assessment (XSA using a number of cpue tuning series from the survey and the commercial fleets) gave a higher estimate of biomass than most of the assessments done by the reviewing body. Variations in catchability and selection patterns in recent years were identified. The reviewing body did however not suggest in their June meeting that the assessment should be rejected and concluded that the MRI/Working group methodology and procedures were sound.

In the autumn 2000 the reviewing group met in Reykjavík to discuss the results of the review with Icelandic scientists. Various aspects of assessments, data sets and assumptions were discussed. The main critique on the ICES assessment was the use of multiple fleets and area split survey indices in XSA, letting XSA select the weights of different fleets. For future assessment it was suggested that a combined survey index should be used and that XSA should be run on only one tuning series at a time. It was also pointed out that XSA is unable to compensate for changes in efficiency of the commercial fleets (except for down weighting) and there is potential danger of overweighing the commercial cpue indices as they are often highly correlated with catch at age data. The reviewing group also recommended the usage of various alternative assessment models.

The 2001 assessment showed that there had been overestimation in biomass in recent years. In 2001 the results from XSA using one survey fleet for calibration was adopted as a final run by ICES. TSA and various other assessment models tried for at MRI gave all very similar results. In spring 2001 the minister of fisheries asked a group of external experts lead by Dr. Andrew Rosenberg to review the recent years assessments with emphasis on uncertainty in assessments. The group has not delivered a final report yet, but in a presentation at a public hearing on the cod assessment held by the Ministry of Fisheries in November 2001, Dr. Rosenberg presented a preliminary results of the group. Those as well as analysis by MRI scientists presented at the meeting showed that the assessment of Icelandic cod in recent years were partly data driven and partly a result of model mispecification. It was concluded that the overestimation in recent years should be taken into account in future management consideration.

Current assessment

In coherence with above and the results of a recent study done Gudmundsson and Jónsson (Working document No. 31), showing substantial linear trend in catchability in cpue form commercial fleets, only survey indices were used for calibration of assessment models in this years assessment. Six different assessment models were run: **XSA** and **TSA** as last year, **AD-CAM**-Statistical Catch at Age model written in AD-Model Builder developed at the MRI (Working Document no. 33), **STAM-**Statistical Catch at Age Model written in Excel developed at the MRI (Working Document no. 22), **Coleraine**-a general statistical catch at age model developed at the University of Washington (Working Document no. 29), **ADAPT**-an adaptive framework developed at Department of Fisheries an Ocean in New Brunswick, Canada.

3.3.4.1 Tuning data

Survey indices

A conventional Cochran type method was used for calculating survey indices. The stratas used follow depth contours. The Cochran indices were calculated separately for two areas: Northern area and Southern area and then combined. For all models used except for the TSA the indices were combined by simple summation (Table 3.3.8 and figure 3.3.11) but for the TSA tuning the two area indices a weighted geometric mean was calculated (Table3.3.9). The total biomass index from the survey is presented in figure 3.3.10. The Shephard Nicholson model gives a CV of 0.24 for age groups 2-9 for the survey indices.

Figure 3.3.13 shows plots of survey index for cod vs. the index of the same year class in the survey one year later. This type of plot should show good relationship if the survey is consistent, except when fishing effort varies much. The best relationship is between ages 3 and 4, age groups that are fully recruited to the survey but age 3 does usually have low fishing mortality.

To use the latest information available for tuning, the 2002 survey indices were moved three months back in time i.e. to end of December 2001 for the age groups 4-9. The same applies to abundance indices for the other survey years. No shift in time needs to be applied to age groups 3 and 2.

3.3.4.2 Estimates of fishing mortality

Six different assessment models were run all using the same datasets, catch in number at age, Table 3.3.3, and survey indices, Table 3.3.8, expect for TSA using weighted geometric mean of North and South areas indices, Table 3.3.9.

XSA tuning

Firstly the default run from last years assessment was run on the updated data sets. The resulting tuning diagnostic and terminal F's are presented in Table 3.3.10, resulting retrospective analysis in Figure 3.3.16 and Figure 3.3.17 and the log catchability residuals in Figure 3.3.8. The estimated terminal reference F (average of age groups 5-10) is **0.81.**

TSA

The results of the TSA run are presented in Table. 3.3.11. The test statistics from standardised residuals of prediction errors of catches and survey indices seem satisfactory. (Table 3.3.11 and Figure 3.3.18). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.81**.

AD-CAM

The input parameters, estimated fishing mortality rates and stock in numbers are presented in Table 3.3.12 along with the resulting residuals**.** The residuals plot are presented in Figure 3.3.18 a the corresponding retrospective pattern in Figures 3.3.16-17. The terminal reference fishing mortality is estimated **0.82.**

STAM

The estimated parameters and results of the STAM run are presented in Table. 3.3.13 as well as the residuals of prediction errors of catches and survey indices seem satisfactory. (See also Figure 3.3.18 for plot of the residuals). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.83.**

Coleraine

The estimated parameters and results of the Coleraine run are presented in Table. 3.3.14 as well as the residuals of prediction errors of catches and survey indices. (See also Figure 3.3.18 for plot of the residuals). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.67.**

ADAPT

The estimated parameters and results of the ADAPT run are presented in Table 3.3.15 as well as the residuals of prediction errors of catches and survey indices seem satisfactory. (See also Figure 3.3.18 for plot of the residuals). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **1.0**

The selection of a final run

In Table 3.3.16 and Figures 3.3.19 and Figure 3.3.20 a summary of the resulting terminal fishing mortalities and estimated stock in numbers in 2002 from the six different models are presented. The resulting terminal reference fishing mortalities from the XSA, TSA, AD-CAM and STAM are very similar or in the range of 0.81-0.83. Those four models also show very similar fishing mortality pattern. ADAPT gives the highest value for the reference fishing mortalities, 1.0, and

Coleraine the lowest estimate, 0.67. The relatively low differences between the results of the various models in the estimated stock size in numbers at the beginning of the year 2002 are mainly in the younger age groups. In this assessment these year classes are estimated by the RCT3 recruitment model.

Comparison of the retrospective results from the various models (Figures 3.3.16-17) show that the most consistent patterns are observed using the AD-CAM model looking at both the reference fishing mortalities and the fishable biomass (4+). The retrospective pattern from the TSA runs do show the second best consistency and the other models do show somewhat more inconsistent pattern and the other models. The NWWG concluded that the AD-CAM modelling approach is the most appropriate since it provides stock and recruitment estimates within the same statistical framework including probability profiles. Medium term projection are also a natural extension of this type of model approach. However, as the AD-CAM model has not yet been published or gone through a recognised reviewing process, the group adopted the TSA run as a point estimate for forward projections.

The resulting fishing mortalities from the final TSA run are given in Table 3.3.17 and in Figure 3.3.21. The fishing mortality increased to a peak in 1988, decreased in 1989 but then rose to another peak in 1993. Due to restriction of the cod quota effort dropped markedly in 1994 and 1995. In recent years fishing mortality has again shown an increasing trend.

3.3.4.3 Stock and recruitment estimates

The resulting stock size in numbers and stock in weight from the final VPA are given in Tables 3.3.18 & 3.3.20. In the stock in numbers table, the recruitment in the most recent years (year classes 1997–2001 as 3-year-olds in 2000-2004) was estimated using RCT3 as described in Section 3.3.7.1.

3.3.5 Biological and technical interactions

Several important biological interactions in the ecosystem around Iceland are connected to the cod stock. The single most important interaction is the cod-capelin connection (Pálsson, 1981) and this has been studied in some detail (Magnússon and Pálsson, 1989 and 1991a and Steinarsson and Stefánsson, 1991). Another important interaction is between cod and shrimp. This has been studied by Magnússon and Pálsson (1991b) and Stefánsson *et al.* (1994). The cod-capelin interaction is used in the short-term prediction in Section 3.3.7.1 based on the results in Steinarsson and Stefánsson (1996).

Various factors affect the natural mortality of cod and several of these factors could change in magnitude in the future. The cod is a cannibal and the mortality through cannibalism has been estimated in Björnsson (WD 26,1998). Cannibalism occurs mainly on prerecruits and immature fish. Further, the minke whale, the harbour seal and the grey seal are apex predators, all of which consume cod to varying degrees. Most of these M values will affect cod at an early age, before recruitment to the fishery.

It has been illustrated that not only may cetaceans have a considerable impact on future yields from cod in Division Va (Stefánsson *et al.*, 1995), but seals may have an even greater impact (Stefánsson *et al.*, 1997). These results imply that predictions which do not take into account the possible effects of marine mammals may be too optimistic in terms of long-term yields. It is therefore desirable to include marine mammals as a part of future natural mortality for the cod stock.

A number of fleets operate in Division Va. The primary gears are described in Section 3.3.2. Earlier work by this group included the separation of catches into finer seasonal and areal splits, but this has not been taken further at this meeting.

A numerical description of interactions between fisheries and species requires data on landings as well as catches in numbers at age of each species by gear type, region and season.

3.3.6 Prediction of catch and biomass

3.3.6.1 Input data to the short-term prediction

For short-term predictions, it is essential to take into account potential changes in mean weights at age due to environmental conditions. It has been shown that cod growth is to some extent correlated to size the of the capelin stock. Table 3.3.21 gives the size of the capelin stock biomass since 1979. Regressions based on the capelin stock size are used to predict the mean weights at age for age groups 4-8 in the catches and ages 5-8 in the spawning stock for the year 2002. For the year 2003 onwards, the average capelin stock size over the years 1979–2002 is used for prediction. (Table 3.3.25). In the most recent period maturity at age has been decreasing but a marked increase was observed in 2001. For the short-term predictions the average for the years 1999–2001 has been used for the years 2002-2004. The exploitation pattern used for the short-term predictions was taken as the average of the years 1999–2001 from the VPA . The combined Cochran survey indices, age groups 1-4 and recruitment estimates from the VPA, for the year classes 1985-1996, were used for recruitment prediction. It was considered more appropriate to use relatively short time span considering the relative low recruitment in recent years compared to the long term average The input for the RCT3 is given in Table 3.3.23. The size of the year classes 1997–2001 has been estimated using RCT3, with the output as given in Table 3.3.24. Th recruitment estimates from the various other models give similar estimates, see Table 3.3.16.

3.3.6.2 Short term prediction results

Input data to the short term prediction and results from projections up to the year 2004 with different management options are presented in Table 3.3.25 and Figure 3.3.23.

Based on the reported landings for the first month of 2001/2002 fishing year and an assumption of the use of amended harvest control rule for the coming fishing year the expected catch in 2002 will be 190,000 t corresponding to F=0.59. The buffer of the amended catch control rule (with an upper limit of between year changes in TACs of 30 thous. tonnes) will not be applied and the resulting TAC in the 2002/2003 fishing year is 183,000 tonnes. The SSB will increase slightly in 2003 and the resulting a reference fishing mortality is about 0.45.

3.3.6.3 Input data to the long-term prediction

For long-term predictions, fluctuating environmental conditions can be ignored, but it is essential to take into account potential changes due to density-dependent growth. These have been investigated for this stock (Steinarsson and Stefánsson, 1991 and ICES 1991/Assess:7) where no signs of density-dependent growth were found. However, the results in Schopka (1994) contain indications of some density dependence of growth and this will affect the long-term results at low fishing mortalities. This is not taken into account in typical yield-per-recruit calculations. Effect of catch on mean weight at age by selection of the largest individuals of incoming year classes is also an important effect not taken into account.

Naturally, any stock-recruitment relationship will affect yield-potential calculations and this is not taken into account in the yield-per-recruit calculations.

Average exploitation pattern, mean weight at age and maturity at age over the years 1982–2001 has been used as input (Table 3.3.26).

3.3.6.4 Long-term prediction results and biological reference points

The biological reference values for $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are 0.32 and 0.15 respectively. Yield per recruit at the $\mathbf{F}_{max}$- level is 1.78 kg. (Figure 3.3.25 Table 3.3.27).

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.26. When using the period 1955–1997, the reference points $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ are about 0.54 and 0.87, respectively.

The inclusion of the stock recruitment relationship has a major effect on long-term predictions. From Figure 3.3.26 it is seen that below-median recruitment occurs more frequently when the SSB is below-median than when the SSB is above the median. The increased probability of poor recruitment at low SSB levels is of major concern.

3.3.7 Medium term simulation

The AD-model builder Catch at age model (ADCAM described in working paper 33) does stock estimation, recruitment estimates and prognosis all at once. The settings used for the cod were .

- Catch in numbers 1955-2001, age 1-14.
- Fishing mortality nonparametric. Estimated for every year and age
- Recruiment was estimated from a Ricker SSB-recruitment model taking age variety in the spawning stock (Shannon index) into accound (Working paper 33). Trend in Rmax was estimated and CV of the residuals was allowed to vary with spawning stock size. The trend is estimated separately for the early and late part of the period and assumed to stop in 1996.
- CV in commercial catch data and survey indices as function of age estimated.

- Fishing mortality of each age group evolve as random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variablility in F) is specified to be larger than the measurement error but for the younger ages but the measurement error is specified to dominate in the older age groups.
- Future simulations were done with the amended harvest control law, assuming lognormally distributed assessment error with autocorrelation of 0.2.

Results of the simulations are shown in Figure 3.3.27. The results indicate low probability that the catchable biomass (age 4+) will remain at the low level observed in the last decade. This is despite median recruitment being modelled as low in coming years. The variability in recruitment is relatively large since the model estimated negative relationship between CV in residuals from the SSB-recruitment relationship and SSB.

Not allowing the trend in Rmax gives a more optimistic picture of recruitment and stock development in coming years. Spawning stock size and Shannon index are highly correlated with time so incorporating time trend in Rmax does not give significant reduction in the negative log-likelihood function but the effects on estimated future recruitment are large as the Shannon index and the spawning stock can improve but time can not be reversed.

3.3.8 Management considerations

Catch quotas for the Icelandic cod stock have since 1994 been based on the 25% catch rule. This catch rule was based on extensive simulations and has been considered precautionary. Until year 2000 the Icelandic government followed the catch rule with minimal deviations although it has turned out that the TAC has exceeded the 25% rule due to overestimation of the stock. In 2000 the Icelandic government, after some limited studies by the MRI, changed the adopted 25% catch rule by limiting the allowed changes in TAC between years to 30 thousand tonnes. For the last 2 fishing years the 30 thousand tonnes catch-stabilizer has been effective resulting in a TAC of 220 thousand tonnes in fishing year 2000/2001 instead of 203 thousand tonnes and a TAC of 190 thousand tonnes in the fishing year 2001/2002 instead of 155 thousand tonnes if no stabilizer would have been in effect. The NWWG observed that 30 thousand tonnes stabilizer, if used from the time that the initial 25% catch rule was adopted in 1994, would not have prevented the overexploitation of the stock in recent years.

Based on the current assessment and harvest control rule the resulting TAC for the next fishing year is 183 thousand tonnes. The 30 thousand tonnes catch-stabilizer will not be effective.

The catch control rule is now in reviewing process by a group scientists appointed by the Ministry of Fisheries. This group is suposed to deliver a preliminar report in June of this year.

The AD-CAM model described in working document no. 33 was used for short term projections using the amended catch control rule. The results are presented in Figure 3.3.24A and B show that the probability that the catchable biomass(4+) stock will be well above present level if the catch control rule will followed next few coming years.

At present fishing mortality is high (F5-10 in the year 2002 about 0.6) and age 5 and younger fish account for more than 70% of the fishable biomass(4+). This will be reflected in the age composition of the catches in 2003, age group 6 and younger will represent about 80% of the landings. The age composition of the spawning stock is highly skewed. Spawners at age 5 and younger will constitute to about 60% of the spawning stock biomass in 2003 and fishes older than ten years old less than 4%. Given the relatively high proportions of younger fish in both the fishable as well as in the spawning stock biomass a lower fishing mortalities than resulting from the catch control rule should be considered.

3.3.9 Comments on the assessment

The current assessment is now more consistent with previous years assessment compared to recent years assessments were substantial overestimation was observed. As in previous year assessment indices from commercial fleets were not used for the calibration of the assessment models used. This decision was based on retrospective patterns, the results from the working group on Icelandic cod in autumn 2000 and a recent study by Guðmundsson and Jónsson (Working document no. 31) revealing marked trend in catchabilty in cpue series from commercial fleets. Indices from commercial fleets are still used even if they are not used directly in tuning and they are as such an important source of information on the state of the stock. They usually give the same main message as the survey and a situation where they would show opposite trends would demand thorough investigation of the survey and the cpue indices.

The fishable biomass 4+ in 2001 was estimated 577 thousand tonnes in last years assessment compared to 640 thousand tonnes in the current assessment. This difference of 63 thousand tonnes, or 11%, is well within the error a limit of last years point estimate. The observed increase in the mean weight at age for the age groups 4-8, compared to last years prediction, accounts for about 2/3 of the discrepancies and the rest by relatively small difference in the estimated stock in number in 2001. The SSB is now estimated to have been 311 thousand tonnes at spawning season and spawning time in the year 2001. The last years estimate was markedly lower or only 219 thousand tonnes. The sharp increase in observed maturity at age in 2001 for age groups 3-7 does account for the bulk of this increase but some increase in mean weight at age was also observed for age groups less than 10 in the SSB. The year classes 1997-2000 were estimated 185, 170, 185 and 175 receptively in last years assessment compared to 180,165,176, 210 in the current assessment.

The main causes of the overestimation of this stock in the years 1998-2000 is now considered to be the use of combination of commercial cpue and survey indices for calibration of stock assessment models and high availability of cod in the years 1997 and 1998. The causes for the anticipated increase changes in availability in these years are still not quite understood. Many factors have been mentioned such as: hydrographical changes, capelin availability, increased availability with reduced effort (disturbance), increased natural mortality, emigration, increased discards etc. Some of those theories have been analysed but no analytical results are available. As those effects still remain unexplained the point estimate in this years assessment is not corrected for possible changes in parameters of this kind.

3.4 Icelandic haddock

3.4.1 Introductory comment

Haddock (*Melanogrammus aeglefinus*) in Icelandic waters is only connected with other haddock stocks in that 0-group and occasionally young fish found in E-Greenland waters originate from the Icelandic stock. The species is distributed all around the Icelandic coast, principally in the relatively warm waters off the west and south coast, on fairly shallow grounds. It is also found off the North coast and in warm periods a large part of the immature haddock can be found in that area.

Icelandic haddock was assessed at the North-Western Working Group in 1970 and 1976 but otherwise assessments were conducted by the Marine Research Institute in Iceland until in 1999 when it was again assessed by the North-Western Working Group.

3.4.2 Trends in landings and fisheries

During the sixties haddock landings rose to a record level of around 100 000 tonnes for several years (Figure 3.4.2.1) After that, landings have been between 40 000 and 65 000 tonnes. Historically landings by foreign fleets accounted for up to half of the total landed catch. Since 1976 fisheries by foreign nations have been negligible except a small catch by the Faroese. Haddock landings are subject to fluctuations, reflecting variability in stock biomass and recruitment, which is very variable.

The landings in 2001 are estimated as 39600 tonnes decreasing from 42 200 tonnes in 2000 In last year the forecasted landings for the year 2001 were 40000 tonnes, very close to the current estimate.

In 2001, 56% of landings were by demersal trawl, 8% by Danish seine, 31% by long line and 5% by gillnets, similar to 2000. The share of longline in the fishery increased between 1998 and 1999 and has been similar since then. This increase was due to increased longline effort where cod is probably the main target species.

3.4.3 Catch at age

Catch at age for 2001 for the Icelandic fishery is provided in Table 3.4.3.1. Catch at age is calculated by 3 fleets and two time intervals. The time intervals are January-May and June-December and the fleets are gill nets, long line and bottom trawl. Hand lines are included with the long line fleet. Danish seine (as well as minor units such as pelagic trawl and other gears which are dragged or hauled) are included in the trawl feet. The Faroese catch that is caught by long line is included in that category. Numbers sampled in 2001 are given in the table below.

Gear	Total landings	Number length measured	Number aged
Longline	12400	26118	2740
Gillnets	1900	2982	489
Danish Seine	3300	3752	307
Trawl	22100	68145	5121
Total	39700	100997	8657

Figure 3.4.3.1 shows the catch in number plotted on log scale. The curves indicate that total mortality is high or close to 1 for the oldest haddock. The 1976 year class is shown for comparison but the fishing mortality was low around 1980. Figure 3.4.3.1 indicates that CV in these data is low. Shephard Nicholson model gives a CV of 20% for age groups 2-8.

3.4.4 Weight and maturity at age

Mean weight at age in the catch is shown in Table 3.4.4.1

Mean weight at age in the stock for 1981–2001 is given in Table 3.4.4.2. Those data are calculated from the Icelandic groundfish survey. Weights for 1985–1992 were calculated using a length-weight relationship which is the mean from the years 1993–2000. Weights from 1993 onwards are based on weighting of fish in the groundfish survey each year. Stock weights prior to 1985 have been taken to be the mean of 1985-2002 weights.

Both stock and catch weights have been relatively low since 1990 compared to the eighties. Since 1990 the weights have not shown any apparent trend but it seems like the large year classes (1990 and 1995) grow slower.

Maturity at age data are given in Table 3.4.4.3. They show high maturity at age in recent years compared to earlier years. Maturity at age data from 1985 onwards are taken from the groundfish survey but maturity at age in catches January - May is used 1980 to 1984.

3.4.5 Survey and cpue data

Haddock is one of the most abundant fishes in the Icelandic groundfish survey, being caught in large number at age 1 and becoming fully recruited at age 2 or 3. Age disaggregated indices from the survey are given in Table 3.4.5.1.

The index of total biomass from the survey is shown in Figure 3.4.5.1. It was at record low in 2000 but has increased since then due to good recruitment and is in the year 2002 the highest since the series started.

Running the Shephard Nicholson model on the survey gives CV of 25% for ages 1 to 7 but 38% if ages 8 and 9 are included. The consistency of the survey indices can also be seen in Figure 3.4.5.2 where the abundance indices of a year class are plotted against the abundance indices of the same year class one year later showing some outliers in the 2001-2002 comparison. In Figure 3.4.5.3 survey indices are plotted against VPA estimates with regression lines based on all data until 1999 and r^2 in the fit of these lines included. The figure shows that the survey indices are good indices of stock size and the relationship between survey index and number in stock is close to linear for all age groups.

CPUE from the commercial fleet is shown in Figure 3.4.5.4. The figure is calculated from records where more than 50% of the catch is haddock. The CPUE for the trawl fishery increased by 15% between 2000 and 2001 while the CPUE for the other gear types is identical in 2001 to what is was in 2000.

3.4.6 Stock Assessment

3.4.6.1 Tuning input

Last years assessment was based on using the groundfish survey ages 2-9 for tuning. This year the same settings were used. The tuning data for the XSA run are shown in Table 3.4.6.1.

3.4.6.2 Tuning and estimation of fishing mortality

The XSA run used for the assessment uses survey indices from age 1985-2001, ages 2-9 for tuning. Shrinkage was set to 2 years and 2 ages with SE = 0.5. Varying the shrinkage did not affect the results much. Catchability of all age groups was independent of stock size.

Results from the XSA run are given in Table 3.4.6.2 and summary plots in Figure 3.4.6.1. The resulting mean F in 2001 for age groups 4–7 from the final run was 0.75. The plot of yield and fishing mortality (Figure 3.4.6.1) indicates that fishing mortality increased substantially in 1986 before falling slightly the following year and has been stable since but increasing in the recent years. Figure 3.4.8.5 shows the development of biomass 3+.

Retrospective pattern from the final run is shown in Figure 3.4.6.2. The retrospective patterns show good consistency with a slight tendency to underestimate the stock in recent years.

Looking at the composition of the stock in the beginning of 2002 the most important year classes are the recruiting year classes (1998 and younger) but the large 1995 year class is only 5.5% of the catchable biomass(3+).

In addition to the standard XSA runs a number of other models and settings were tested. The results are summarized in the table below.

	$F_{4\text{-}7}$ – 2001	SSB	Biomass 3+ 2001
Default XSA run. Survey indices 2-9	0.75	53.1	89.0
XSA using survey indices from age 1-9.	0.74	50.3	91.7
XSA using survey indices and glm indices from bottomtrawl in the 2nd half of the year.	0.64	58.3	97.1
TSA (age 3-9)	0.72		91.4
ADAPT using survey indices from age 1-9	0.81		89.6
ADCAM using survey indices from age 1-9.	0.73		91.0

As may be seen all the models using the survey indices only give similar results while the run incorporating the CPUE from the bottom trawl fleets gives lower fishing mortality as has been the case in recent years.

The AD-model builder Catch at age model (ADCAM described in working paper 33) does stock estimation, recruitment estimates and prognosis all at once. The settings used for the haddock were.

- Fishing mortality was estimated for every year and age.

- Recruitment was assumed to be lognormally distributed around a fixed mean with the CV of the lognormal distribution estimated. Autocorrelation of the residuals (0.15) was included

- CV of commercial catch data and of survey indices as function of age estimated.

- Fishing mortality of each age group was random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variablility in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to dominate in the older age groups.

Residuals from the model are plotted in Figure 3.4.6.3 showing mainly positive residuals in 2002 but negative in 2000 and 2001. The usual pattern seems to be that each year the residuals of all agegroups have the same sign and the model estimates correlation of the residuals of adjacent agegroups in the survey to be 0.5. Residuals from XSA (Table 3.4.6.2) show the same pattern.

3.4.7 Recruitment estimates

As stated earlier year classes 1998 - 2000 are very strong and are going to dominate the catches for a number of years. Therefore short term predictions are more driven by recruitment estimates than the XSA results. Recruitment of this stock is highly variable (σ = 0.75 on log scale) and survey indices reasonable measure of stock size (Figure 3.5.4.3). There seems though to be a marked increase in the catchability of the survey between the years 2000- 2001 and 2002 as demonstrated by the XSA residuals, so the recruitment estimates for year classes 1999 and 2000 from these surveys are unusually contradicting.

RTC3 input and results are shown in Tables 3.4.7.1 and 3.4.7.2. Looking at the 2000 year class the VPA mean is 48 million, 1 year estimate 115 million, 2 year estimate 214 million and weighed estimate 133 million. VPA mean has low weight but has considerable effect on the results due to the geometric mean. A number of other methods and settings were used to estimate recruitment and the results are shown in table below.

Looking at the results in table below the estimates for the 1999 year class range from 106 to 123 million and for the 2000 year class from 133 to 165 million fishes. Looking at the posterior profiles in Figure 3.4.7.1 the range 130 to 165 million for the 2000 year class corresponds to 20 and 60 percentiles and 106 and 130 million for the 1999 year class at age 2 correspond to 25 and 80 percentiles. On basis of this comparison the maximum likelihood values from the

ADCAM model were selected for recruitment estimates noting that they were somewhere in the middle of probable values.

Recruitment (million 2 year old.)									
Year class	RTC3	RTC3 no shrinkage	Adapt	Std. XSA	ADCAM	XSA from age 1	Survey 2001	Survey 2002	Used values
1998	83		99	94	98	101			
1999	106	117	114	123	112	117	102	164	112
2000	133	166	165		155		115	214	155
2001	35	35	33		27			32	29

3.4.8 Prediction of catch and biomass

3.4.8.1 Input data

The input data for the prediction are shown in Table 3.4.8.1

For the short-term catch prediction and stock biomass calculations, the mean weight at age 3–8 in the catches in 2002 were predicted using regression analysis, where the mean weight at age was predicted by the mean weight of the same year class in the previous year. For the years 2003 to 2005 the mean for the years 1999 – 2001 was used. For age groups 2, the mean of the years 1999–2001 was used.

For the stock weights survey weights for the year 2002 were used for that year but for the year 2003 mean weight at age was predicted by mean weight of the same year class in the survey in 2002. For 2004 and 2005 the mean of the weights in 2000-2002 was used.

The exploitation pattern was taken as the mean exploitation pattern from 1997–2001.

Recruitment for year classes 1999 – 2001 was taken from the ADCAM model (table above). Recruitment for year classes 2002 and 2003 was taken to be the geometric mean of recruitment from 1980–1999.

A TAC constraint of 45 000 tonnes was applied to the prediction for the year 2002 based on the landings in the first 4 months of 2002 and the proportion landed in the first 4 months in the year 2000. (In 2001 there was a strike in April).

In addition to the standard prognosis the ADCAM program was used for prediction using the 45 kT constraint for the year 2002 and the proposed $\mathbf{F}_{pa}$ of 0.47 for the following years. Assessment error was assumed to be lognormal with 10% CV and no autocorrelation. Weights in stock and catch were the mean of last 3 years.

For the long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the mean relative fishing mortality from 1980-2001. Mean weight at age in the stock and the maturity ogive are means from 1980-2001. Mean weight at age in the catch is the mean from 1980-2001. Input data for long term yield per recruit are given in Table 3.4.8.2.

3.4.8.2 Biological reference points

The yield per recruit is shown in Table 3.4.8.3. and Figure 3.4.8.1

Compared to the estimated fishing mortality of $F_{4\text{–}7} = 0.75$ for 2001, $\mathbf{F}_{max} = 0.45$ and $\mathbf{F}_{0.1} = 0.18$. These values are lower than last year as yield per recruit was run using plus group this year but not last year.

Yield per recruit at $\mathbf{F}_{max}$ corresponds to 0.88 kg. (Table 3.4.8.3). Mean weights as in the most recent years would give lower yield per recruit.

A plot of spawning stock biomass and recruitment from 1981-2000 is shown in Figure 3.4.8.2 and a plot of recruitment vs. spawning stock in Figure 3.4.8.3.

In the year 2000 the working group proposed provisional $\mathbf{F}_{pa}$ set to the $\mathbf{F}_{med}$ value of 0.47 and since no further work has been done since then on reference points for this stock that value will be used for $\mathbf{F}_{pa}$ this year. Since 1986 $F_{4–7}$ has exceeded $\mathbf{F}_{max}$ and for only 4 years since 1960 has $F_{4–7}$ been lower than $\mathbf{F}_{pa}$.

3.4.8.3 Projection of catch and biomass

At the beginning of 2002, the biomass of age 3+ is predicted to be 120 000 tonnes with a spawning stock of 69 000 t. (Tables 3.4.8.4 and 3.4.8.5 and Figure 3.4.8.4).

With a catch of 45 000 t in 2002, fishing mortality is estimated to be 0.57, the biomass of age 3+ is predicted to be 168 000 tonnes in the beginning of the year 2003 and the spawning stock biomass 98 000 tonnes.

The short term deterministic predictions indicate that in for wide range of fishing mortalities the biomass of the stock is going to increase in coming years due to good recruitment. In those predictions the catch in the year 2002 is estimated to be 45,000 tonnes. This catch will lead to considerable lowering of fishing mortality compared to 2001. The results from the ADCAM model (Figure 3.4.8.5) confirm that the stock biomass and catch are going to increase in the next years but reduce after 2004 when the small 2001 year class starts entering the catch.

3.4.9 Management considerations

For more than a decade fishing mortality on haddock has been high with $F_{4–7}$ between 0.6 and 0.8 since 1986. The advice in 2001 was based on $\mathbf{F}_{med}$ and if followed would have meant substantial reduction in fishing mortality while the real outcome was that the fishing mortality reduced only a little.

The short term predictions do not show much advantage in reducing fishing mortality. It must though be born in mind that a number of factors, like discard, hidden mortality due to mesh penetration and reduction of mean weight at age by removal of the largest individuals of each age group not included in these predictions.

Discard and hidden mortality due to mesh penetration has been a point of concern in this stock (Pálsson 2002). Some preliminary information on discard are available indicating substantial discard in some years but no direct information on the harm caused by mesh penetration are available. The discards have been estimated by Pálsson (2002) based on comparison of length distributions from sea and harbour sampling. The table below is a summary from Pálsson (2002) indicating a large reduction in discards in recent years from very high levels in 1994 – 1997. This reduction is partly due to bad recruitment from the 1996 and 1997 year classes. Preliminary results for the year show some increase from the year 2000 but the estimate is though much less than for 1994-1997. Most discard is observed when catchable biomass is low and recruiting year classes are large. Possible explanation for relatively little discard in 2001 in spite of good recruitment and small catchable biomass is that large part of the recruiting year classes 1999-2000 is growing up off the north coast, in areas where fishing effort is small.

year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Discard tonnes	1481	1499	364	3349	3858	2414	4236	8397	4577	6160	2501	1349	1930

The short term predictions do not take any of these factors into account nor do they include possible effect of much fishing effort on weight at age in the catches and in the stock. The predictions are therefore not valid when fishing effort differs considerably from recent years, they will most likely underestimate the stock if effort is reduced but overestimate if effort is increased. For similar effort the predictions should be reasonably accurate.

The assessment results show that the 1996 and 1997 year classes are small, specially the 1996 year class. The 1998 to 2000 year classes are on the other hand above average. In the fishing year 2002-2003 most of the catches will be from year classes 1998 to 2000. As the 2000 year class is potentially very large and will mostly be below landing size, limiting fishing effort in the next fishing year is important.

3.4.10 Comments on the assessment

The current assessment was done using only groundfish survey indices for tuning. .

Fishing mortality on haddock increased after 1985 (Figure 3.4.6.2.) The high fishing mortality was at least partly due to an overestimation of the stock biomass through the use of catch weights that are 20–25% higher than survey weights which have been used in the assessment since 1999.

The assessment presented here gives $F_{4–7}$ = 0.75 in 2001. As mentioned earlier assessment including commercial CPUE give lower mortality ($F_{4–7}$ = 0.65 in 2001). In spite of this high fishing mortality the stock size is going to increase in coming years due to good recruitment.

This year's assessment gives a more optimistic view of the stock than last years assessment. At the beginning of 2002, the biomass of age 3+ is predicted to be 120 000 tonnes with a spawning stock of 69 000 t. (Table 3.4.8.4) while forecast from last year for the year 2002 were 104 000 tonnes for the biomass (3+) and 56 000 tonnes for the spawning stock biomass. Of this discrepancy 2500 tonnes can be explained by less than anticipated catch but the rest by higher estimate of number in stock, mostly of year classes 1998 and 1999. This change in estimate is driven the results from the survey 2002.

In this year's assessment a number of different models were used and the range of results investigated. The point estimates selected for prognosis come from XSA for the older groups and ADCAM for the younger groups. The most important part was though that no special model was used and the selection was based on the results of all the models used.

Table 3.2.1.1 Nominal catch (tonnes) of SAITHE in Division Va by countries, 1982-2001, as officially reported to ICES

Country	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	201	224	269	158	218	217	268	369
Faroe Islands	3,582	2,138	2,044	1,778	783	2,139	2,596	2,246
France	23	-	-	-	-	-	-	-
Iceland	65,124	55,904	60,406	55,135	63,867	78,175	74,383	79,810
Norway	1	+	-	1	-	-	-	-
UK (Engl. and Wales)	-	-	-	29	-	-	-	-
Total	70,913	60,249	64,703	59,086	66,854	82,518	79,235	82,425
WG estimate	-	-	-	-	66,376[2)]	-	-	

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	190	236	195	104	30	-	-	-	-
Faroe Islands	2,905	2,690	1,570	1,562	975	1,161	803	716	997
France	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	1	1	1	-	3
Iceland	95,032	99,390	77,832	69,982	63,333	47,466	39,297	36,548	30,531
Norway	-	-	-	-	-	1	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
Total	98,127	102,316	79,597	71,648	64,339	48,629	40,101	37,264	31,531
WG estimate		102,737[3)]	-	-	-	-	-		

Country	1999[)]	2000[)]	2001[1]
Belgium	-		
Faroe Islands	700	228	128
France	-		
Germany	2		
Iceland	30560	32898	31837
Norway	6		
UK (Engl. and Wales)	2		
Total	31270	33126	31965
WG estimate			

1) Provisional.
2) Additional catch of 1,508 t. by Faroe Islands included.
3) Additional catch of 451 t by. Iceland included.

Table 3.2.3.1 Saithe in division Va. Catch in numbers (millions) 1962--2001.

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  Virtual Population Analysis : Catch in numbers, millions
 Ufsi LongRun 2002- TSA+survey
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Age	1962	1963	1964	1965	1966	1967	1968
3	1.534	6.134	3.041	2.003	0.940	1.116	0.836
4	4.999	2.314	11.712	4.825	2.090	3.400	2.605
5	3.861	2.518	3.586	7.589	3.283	5.591	3.563
6	3.744	2.902	2.301	2.158	4.117	4.326	6.318
7	1.019	1.869	1.185	1.324	1.285	4.931	3.207
8	0.419	0.797	0.559	0.642	0.739	1.200	3.008
9	0.280	0.329	0.237	0.353	0.390	0.550	0.621
10	0.245	0.271	0.145	0.164	0.235	0.330	0.343
11	0.143	0.254	0.107	0.102	0.133	0.169	0.215
12	0.083	0.193	0.092	0.085	0.069	0.073	0.103
13	0.028	0.075	0.059	0.081	0.102	0.104	0.079
14	0.015	0.022	0.033	0.052	0.073	0.065	0.041
Juvenile	10.643	11.600	17.761	13.148	7.091	10.967	8.923
Adult	5.727	6.078	5.296	6.230	6.365	10.888	12.016
Sum 3- 3	1.534	6.134	3.041	2.003	0.940	1.116	0.836
Sum 4-14	14.836	11.544	20.016	17.375	12.516	20.739	20.103
Total	16.370	17.678	23.057	19.378	13.456	21.855	20.939

Age	1969	1970	1971	1972	1973	1974	1975
3	1.572	0.287	0.476	0.565	0.219	1.269	0.526
4	4.395	5.622	3.031	3.786	1.768	3.404	2.997
5	5.706	4.999	10.221	6.524	5.155	2.348	2.479
6	6.518	6.126	6.736	8.646	7.077	3.164	1.829
7	9.136	6.178	6.694	4.178	7.372	3.452	3.496
8	2.796	5.934	5.045	3.320	2.616	3.384	2.994
9	1.843	1.689	4.272	2.098	1.635	1.303	1.434
10	0.461	1.191	0.959	1.421	0.871	0.824	0.710
11	0.100	0.299	0.887	0.361	0.412	0.351	0.325
12	0.110	0.171	0.349	0.328	0.231	0.141	0.176
13	0.032	0.092	0.096	0.079	0.080	0.043	0.100
14	0.044	0.070	0.063	0.068	0.022	0.013	0.036
Juvenile	14.100	12.839	14.702	12.979	9.742	8.111	6.584
Adult	18.613	19.819	24.127	18.395	17.716	11.585	10.518
Sum 3- 3	1.572	0.287	0.476	0.565	0.219	1.269	0.526
Sum 4-14	31.141	32.371	38.353	30.809	27.239	18.427	16.576
Total	32.713	32.658	38.829	31.374	27.458	19.696	17.102

Age	1976	1977	1978	1979	1980	1981	1982
3	0.329	0.059	0.548	0.480	0.275	0.203	0.508
4	3.234	2.099	1.145	3.764	2.540	1.325	1.092
5	3.045	2.858	2.435	1.991	5.214	3.503	2.804
6	2.530	1.801	1.556	3.616	2.596	5.404	4.845
7	2.154	1.036	1.275	1.566	2.169	1.457	4.293
8	2.367	1.068	0.961	0.718	1.341	1.415	1.215
9	1.530	1.528	0.537	0.292	0.387	0.578	0.975
10	1.064	0.958	0.575	0.669	0.262	0.242	0.306
11	0.295	0.538	0.476	0.589	0.155	0.061	0.059
12	0.191	0.166	0.279	0.489	0.112	0.154	0.035
13	0.094	0.071	0.139	0.150	0.064	0.135	0.048
14	0.068	0.012	0.091	0.072	0.033	0.128	0.046
Juvenile	7.008	5.014	4.249	7.129	6.979	6.136	6.186
Adult	9.893	7.180	5.768	7.267	8.169	8.469	10.040
Sum 3- 3	0.329	0.059	0.548	0.480	0.275	0.203	0.508
Sum 4-14	16.572	12.135	9.469	13.916	14.873	14.402	15.718
Total	16.901	12.194	10.017	14.396	15.148	14.605	16.226

Age	1983	1984	1985	1986	1987	1988	1989
3	0.107	0.053	0.376	3.108	0.956	1.318	0.315
4	1.750	0.657	4.014	1.400	5.135	5.067	4.313
5	1.065	0.800	3.366	4.170	4.428	6.619	8.471
6	2.455	1.825	1.958	2.665	5.409	3.678	7.309
7	4.454	2.184	1.536	1.550	2.915	2.859	1.794
8	2.311	3.610	1.172	1.116	1.348	1.775	1.928
9	0.501	0.844	0.747	0.628	0.661	0.845	0.848
10	0.251	0.376	0.479	1.549	0.496	0.226	0.270
11	0.038	0.291	0.074	0.216	0.498	0.270	0.191
12	0.012	0.135	0.023	0.051	0.058	0.107	0.135
13	0.002	0.185	0.072	0.030	0.027	0.024	0.076
14	0.004	0.226	0.071	0.014	0.048	0.001	0.010
Juvenile	4.254	2.536	6.455	8.061	11.027	13.228	15.731
Adult	8.696	8.650	7.433	8.436	10.952	9.561	9.929
Sum 3- 3	0.107	0.053	0.376	3.108	0.956	1.318	0.315

Sum 4-14	12.843	11.133	13.512	13.389	21.023	21.471	25.345
Total	12.950	11.186	13.888	16.497	21.979	22.789	25.660

Age	1990	1991	1992	1993	1994	1995	1996
3	0.143	0.198	0.242	0.657	0.702	1.573	1.102
4	1.692	0.874	2.928	1.083	2.955	1.853	2.608
5	5.471	3.613	3.844	2.841	1.770	2.661	1.868
6	10.112	6.844	4.355	2.252	2.603	1.807	1.649
7	6.174	10.772	3.884	2.247	1.377	2.370	0.835
8	1.816	3.223	4.046	2.314	1.243	0.905	1.233
9	1.087	0.858	1.290	3.671	1.263	0.574	0.385
10	0.380	0.838	0.350	0.830	2.009	0.482	0.267
11	0.151	0.228	0.196	0.223	0.454	0.521	0.210
12	0.055	0.040	0.056	0.188	0.158	0.106	0.232
13	0.076	0.006	0.054	0.081	0.188	0.035	0.141
14	0.037	0.005	0.015	0.012	0.082	0.013	0.074
Juvenile	14.894	12.700	8.635	5.194	4.846	5.152	4.560
Adult	12.300	14.799	12.625	11.205	9.958	7.748	6.044
Sum 3- 3	0.143	0.198	0.242	0.657	0.702	1.573	1.102
Sum 4-14	27.051	27.301	21.018	15.742	14.102	11.327	9.502
Total	27.194	27.499	21.260	16.399	14.804	12.900	10.604

Age	1997	1998	1999	2000	2001
3	0.603	0.183	0.989	0.850	1.223
4	2.960	1.289	0.732	2.383	2.619
5	2.766	1.767	1.564	0.896	2.184
6	1.651	1.545	2.176	1.511	0.591
7	1.178	1.114	1.934	1.612	0.977
8	0.599	0.658	0.669	1.806	0.943
9	0.454	0.351	0.324	0.335	0.819
10	0.125	0.265	0.140	0.173	0.186
11	0.095	0.120	0.072	0.057	0.094
12	0.114	0.081	0.025	0.033	0.028
13	0.077	0.085	0.028	0.017	0.028
14	0.043	0.085	0.022	0.007	0.013
Juvenile	4.868	2.734	3.302	3.779	3.835
Adult	5.797	4.809	5.373	5.901	5.870
Sum 3- 3	0.603	0.183	0.989	0.850	1.223
Sum 4-14	10.062	7.360	7.686	8.830	8.482
Total	10.665	7.543	8.675	9.680	9.705

Table 3.2.4.1 Saithe in Division Va. Mean weight at age in the catches and in the stock.

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Virtual Population Analysis : Weight at age in the catches, in grams
Ufsi LongRun 2002- TSA+survey

Age	1976	1977	1978	1979	1980	1981	1982
3	1120	1120	1120	1116	1428	1585	1547
4	1760	1760	1760	1760	1983	2037	2194
5	2730	2730	2730	2731	2667	2696	3015
6	4290	4290	4290	4294	3689	3525	3183
7	5540	5540	5540	5539	5409	4541	5114
8	7270	7270	7270	7268	6321	6247	6202
9	8420	8420	8420	8415	7213	6991	7256
10	9410	9410	9410	9410	8565	8202	7922
11	10000	10000	10000	10001	9147	9537	8924
12	10560	10560	10560	10563	9617	9089	10134
13	11870	11870	11870	11873	10066	9351	9447
14	13120	13120	13120	13115	11041	10225	10535

Age	1983	1984	1985	1986	1987	1988	1989
3	1530	1653	1609	1450	1516	1261	1403
4	2221	2432	2172	2190	1715	2017	2021
5	3171	3330	3169	2959	2670	2513	2194
6	4270	4681	3922	4402	3839	3476	3047
7	4107	5466	4697	5488	5081	4719	4505
8	5984	4973	6411	6406	6185	5932	5889
9	7565	7407	6492	7570	7330	7523	7172
10	8673	8179	8346	6487	8025	8439	8852
11	8801	8770	9401	9616	7974	8748	10170
12	9039	8831	10335	10462	9615	9559	10392
13	11138	11010	11027	11747	12246	10824	12522
14	9818	11127	10644	11902	11656	14099	11923

Age	1990	1991	1992	1993	1994	1995	1996
3	1647	1224	1269	1381	1444	1370	1229
4	1983	1939	1909	2143	1836	1977	1755
5	2566	2432	2578	2742	2649	2769	2670
6	3021	3160	3288	3636	3512	3722	3802
7	4077	3634	4150	4398	4906	4621	4902
8	5744	4967	4865	5421	5539	5854	5681
9	7038	6629	6168	5319	6818	6416	7182
10	7564	7704	7926	7006	6374	7356	7734
11	8854	9061	8349	8070	8341	6815	9256
12	10645	9117	9029	10048	9770	8312	8322
13	11674	10922	11574	9106	10528	9119	10501
14	11431	11342	9466	11591	11257	11910	11894

Age	1997	1998	1999	2000	2001	2002
3	1325	1347	1279	1367	1280	1309
4	1936	1972	2106	1929	1882	1939
5	2409	2943	2752	2751	2599	2645
6	3906	3419	3497	3274	3697	3559
7	5032	4850	3831	4171	4420	4729
8	6171	5962	5819	4447	5538	5614
9	7202	6933	7072	6790	7985	7849
10	7883	7781	8078	8216	9059	8093
11	8856	8695	8865	9369	9942	9098
12	9649	9564	10550	9817	10632	10103
13	9621	10164	10823	10932	10988	10796
14	10877	10379	11300	12204	11784	11497

Table 3.2.5.1 Saithe in Division Va. Sexual maturity at age from model, used as input to VPA.

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Marine Research Institute Wed May  8 12:37:06 2002
  Virtual Population Analysis : Sexual maturity at age in the catches
 Ufsi LongRun 2002- TSA+survey
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Age	1976	1977	1978	1979	1980	1981	1982
3	0.000	0.000	0.000	0.000	0.090	0.100	0.090
4	0.060	0.060	0.060	0.060	0.240	0.300	0.330
5	0.270	0.270	0.270	0.270	0.360	0.380	0.450
6	0.630	0.630	0.630	0.630	0.680	0.560	0.580
7	0.810	0.810	0.810	0.810	0.780	0.800	0.710
8	0.970	0.970	0.970	0.970	0.900	0.890	0.900
9	1.000	1.000	1.000	1.000	0.950	0.950	0.950
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

Age	1983	1984	1985	1986	1987	1988	1989
3	0.080	0.060	0.080	0.040	0.020	0.050	0.080
4	0.320	0.280	0.230	0.270	0.150	0.080	0.200
5	0.500	0.480	0.430	0.370	0.420	0.260	0.150
6	0.650	0.690	0.680	0.630	0.570	0.630	0.450
7	0.730	0.790	0.810	0.800	0.770	0.720	0.760
8	0.850	0.860	0.890	0.910	0.900	0.880	0.850
9	0.950	0.920	0.930	0.950	0.960	0.950	0.940
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

Age	1990	1991	1992	1993	1994	1995	1996
3	0.100	0.090	0.110	0.100	0.100	0.090	0.090
4	0.280	0.320	0.300	0.350	0.330	0.340	0.300
5	0.330	0.440	0.490	0.460	0.520	0.490	0.510
6	0.290	0.530	0.640	0.680	0.660	0.710	0.690
7	0.610	0.450	0.680	0.770	0.810	0.790	0.820
8	0.880	0.780	0.640	0.830	0.890	0.900	0.890
9	0.930	0.940	0.890	0.800	0.920	0.950	0.950
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

Age	1997	1998	1999	2000	2001	2002
3	0.110	0.120	0.090	0.090	0.140	0.140
4	0.310	0.350	0.380	0.320	0.420	0.420
5	0.460	0.470	0.520	0.540	0.590	0.590
6	0.700	0.660	0.670	0.710	0.760	0.760
7	0.810	0.820	0.790	0.800	0.860	0.860
8	0.910	0.910	0.910	0.890	0.930	0.930
9	0.950	0.960	0.960	0.960	0.970	0.970
10	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
12	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
14	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.2.7.1 Saithe in Division Va. IGFS indices of numbers at age used for tuning TSA, ADAPT and XSA

smb	2	3	4	5	6	7	8	9
1985	0.61	0.59	3.09	5.25	1.77	1.07	0.51	1.38
1986	2.33	2.45	2.11	2.14	1.44	0.62	0.28	0.19
1987	0.39	11.57	12.99	6.49	4	3.1	0.8	0.36
1988	0.31	0.49	2.72	2.78	1.68	0.94	0.4	0.07
1989	1.43	3.96	5.05	6.57	2.49	1.77	0.91	0.4
1990	0.35	1.69	4.86	6.4	12.33	3.3	1.21	0.64
1991	0.22	1.4	1.72	2.22	1.13	2.5	0.3	0.02
1992	0.14	0.9	5.73	5.52	2.79	2.68	1.91	0.28
1993	1.55	11.04	2	6.8	2.42	2.26	1.03	4.05
1994	0.82	0.72	1.89	1.74	1.97	0.58	1.02	1.35
1995	0.49	1.99	1.12	0.51	0.28	0.34	0.1	0.15
1996	0.11	0.49	3.72	1.12	1.01	0.61	1.01	0.06
1997	0.33	0.91	4.67	3.92	0.95	0.4	0.16	0.1
1998	0.11	1.63	2.3	2.53	1.27	0.72	0.3	0.08
1999	0.75	3.75	1.01	1.4	1.89	0.64	0.17	0.02
2000	0.34	1.75	2.51	0.62	0.88	0.55	0.45	0.08
2001	0.9	1.91	2.61	1.6	0.21	0.23	0.39	0.14
2002	1.05	2.07	2.47	2.54	1.91	0.4	0.46	0.32

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Table 3.2.7.2 Saithe in Division Va. Output from TSA run with starting values for N4 from a recruitment index (average index for year classes as 3, 4, and 5 yearolds in IGFS and IGFS I@A 5-8 as tuning fleet.

Icelandic saithe

Estimation with catch-at-age data 1985-2001
and survey data, 3-8 years 1985-2002
(ages 3-5 used as survey index for 4 years age)

STOCK

	4	5	6	7	8	9	10	11	BIOM
1985	36774.	20305.	9826.	5618.	3759.	4633.	1415.	277.	262.2
1986	26627.	26490.	14021.	6287.	3265.	2069.	3663.	785.	298.3
1987	56396.	20305.	18096.	8889.	3674.	1739.	1092.	1867.	324.7
1988	61657.	41327.	13304.	10213.	4622.	1820.	829.	530.	373.8
1989	45500.	45806.	27537.	7808.	5529.	2221.	826.	406.	368.2
1990	25569.	33236.	30149.	16428.	4459.	2819.	1076.	403.	354.9
1991	16155.	19119.	21778.	19040.	8098.	2074.	1307.	502.	284.3
1992	22751.	11994.	12191.	11671.	6739.	3601.	915.	552.	229.8
1993	11918.	15923.	7434.	6417.	5784.	9005.	1686.	424.	218.8
1994	15416.	8740.	10287.	4099.	3144.	2683.	4030.	749.	175.4
1995	14339.	10032.	5547.	5948.	2086.	1403.	1115.	1649.	145.0
1996	13502.	9721.	6137.	2990.	2851.	931.	631.	502.	120.1
1997	19220.	8791.	6241.	3549.	1605.	1308.	417.	283.	125.8
1998	12010.	12836.	5257.	3554.	1843.	788.	639.	203.	119.8
1999	5976.	8692.	8579.	6173.	1875.	901.	359.	293.	113.0
2000	18816.	4254.	5710.	5074.	4755.	937.	443.	176.	120.7
2001	23979.	13227.	2727.	3311.	2687.	2322.	457.	216.	137.8
2002	15282.	17311.	8807.	1658.	1817.	1366.	1151.	224.	142.6

STANDARD DEVIATION OF STOCK ESTIMATES

2001	4523.	2132.	390.	400.	323.	250.	66.	35.	15.9
2002	8995.	3759.	1622.	293.	303.	243.	195.	45.	24.0

FISHING MORTALITY RATES

	4	5	6	7	8	9	10	11	FGBAR	FBAR
1985	0.125	0.172	0.245	0.343	0.397	0.046	0.392	0.350	0.179	0.221
1986	0.067	0.181	0.256	0.335	0.430	0.439	0.474	0.452	0.241	0.284
1987	0.110	0.224	0.365	0.453	0.503	0.540	0.523	0.498	0.321	0.366
1988	0.096	0.206	0.332	0.412	0.529	0.587	0.515	0.529	0.307	0.360
1989	0.110	0.218	0.314	0.356	0.474	0.525	0.517	0.529	0.296	0.333
1990	0.087	0.221	0.395	0.507	0.566	0.568	0.561	0.567	0.328	0.391
1991	0.089	0.249	0.424	0.763	0.610	0.618	0.661	0.654	0.373	0.459
1992	0.151	0.278	0.440	0.502	0.780	0.556	0.567	0.604	0.399	0.451
1993	0.110	0.236	0.386	0.503	0.566	0.602	0.609	0.614	0.346	0.400
1994	0.180	0.253	0.346	0.466	0.580	0.655	0.670	0.642	0.375	0.413
1995	0.187	0.274	0.415	0.533	0.600	0.591	0.591	0.580	0.399	0.433
1996	0.193	0.242	0.346	0.422	0.574	0.598	0.594	0.585	0.364	0.396
1997	0.197	0.288	0.363	0.454	0.505	0.513	0.514	0.539	0.367	0.387
1998	0.123	0.203	0.357	0.438	0.515	0.583	0.576	0.565	0.325	0.370
1999	0.138	0.220	0.325	0.419	0.494	0.509	0.515	0.500	0.318	0.351
2000	0.151	0.243	0.345	0.435	0.517	0.516	0.520	0.520	0.337	0.368
2001	0.126	0.206	0.296	0.398	0.476	0.501	0.514	0.513	0.300	0.334

Table 3.2.7.2 (Cont'd)

STANDARD DEVIATIONS OF LOG(F)

2001	0.26	0.14	0.14	0.14	0.15	0.15	0.15	0.15	0.129

Standardised catch prediction errors

1986	-0.68	-0.83	-1.08	0.04	0.81	-0.32	1.55	-0.60
1987	0.65	2.13	1.21	1.37	2.00	1.31	1.67	-0.86
1988	-0.12	0.53	0.93	-1.70	0.18	2.01	-1.40	1.20
1989	0.96	1.14	1.11	-2.00	-0.65	-0.48	-0.98	0.77
1990	-1.02	0.77	2.08	2.05	1.82	0.19	-0.39	-0.02
1991	-1.35	0.97	2.09	1.81	0.40	0.44	1.49	0.31
1992	-0.90	1.96	1.94	-0.23	-1.47	-0.73	-0.30	-0.83
1993	-0.28	-1.34	-0.14	-0.82	0.32	0.11	1.22	1.10
1994	-0.50	0.72	-0.72	-1.26	-1.09	0.59	0.81	1.09
1995	1.16	-1.38	0.73	0.71	-0.20	-1.51	-0.76	-1.80
1996	-0.09	-0.88	-1.65	-1.79	0.13	-0.63	-0.49	-0.33
1997	0.71	-0.59	-0.57	-0.43	0.06	-1.39	-1.47	-0.90
1998	-0.05	-1.95	-2.07	-0.44	0.10	1.68	0.59	1.58
1999	-0.10	-0.21	0.27	-0.01	-0.46	-0.49	-0.16	-1.63
2000	0.26	-0.06	0.07	0.07	0.45	-0.18	0.27	-0.47
2001	0.63	-0.88	-1.62	-0.74	0.06	-0.32	0.56	0.62

γ_3 = 0.996 γ_4 = -1.586

CORRELATION WITHIN COHORTS 0.00

CORRELATION WITHIN AGES AND YEARS 0.39 0.08

Table 3.2.7.3 Saithe in Division Va. Output from ADAPT tuned with IGFS I@A 2-9, catchability proportional f. all age groups, surv. 11 & 12 fixed at face values from exploratory runs. Bootstrapped values at end of run based on 1000 replications.

FRIDAY, MAY 3, 2002 1:51:58.810 PM

APL Ver. 2.0.00

ADAPT_W Ver. 2.1

Workspace size = 6000000

c@a

	2	3	4	5	6	7	8	9	10	11	12
1985.00	0	376	4014	3366	1958	1536	1172	747	479	74	23
1986.00	0	3108	1400	4170	2665	1550	1116	628	1549	216	51
1987.00	0	956	5135	4428	5409	2915	1348	661	496	498	58
1988.00	0	1318	5067	6619	3678	2859	1775	845	226	270	107
1989.00	0	315	4313	8471	7309	1794	1928	848	270	191	135
1990.00	0	143	1692	5471	10112	6174	1816	1087	380	151	55
1991.00	0	198	874	3613	6844	10772	3223	858	838	228	40
1992.00	0	242	2928	3844	4355	3884	4046	1290	350	196	56
1993.00	0	657	1083	2841	2252	2247	2314	3671	830	223	188
1994.00	0	702	2955	1770	2603	1377	1243	1263	2009	454	158
1995.00	0	1573	1853	2661	1807	2370	905	574	482	521	106
1996.00	0	1102	2608	1868	1649	835	1233	385	267	210	232
1997.00	0	603	2960	2766	1651	1178	599	454	125	95	114
1998.00	0	183	1289	1767	1545	1114	658	351	265	120	81
1999.00	0	989	732	1564	2176	1934	669	324	140	72	25
2000.00	0	850	2383	896	1511	1612	1806	335	173	57	33
2001.00	0	1223	2619	2184	591	977	943	819	186	94	28
2002.00											

smb

	2	3	4	5	6	7	8	9
1985.20	0.61	0.59	3.09	5.25	1.77	1.07	0.51	1.38
1986.20	2.33	2.45	2.11	2.14	1.44	0.62	0.28	0.19
1987.20	0.39	11.57	12.99	6.49	4.00	3.10	0.80	0.36
1988.20	0.31	0.49	2.72	2.78	1.68	0.94	0.40	0.07
1989.20	1.43	3.96	5.05	6.57	2.49	1.77	0.91	0.40
1990.20	0.35	1.69	4.86	6.40	12.33	3.30	1.21	0.64
1991.20	0.22	1.40	1.72	2.22	1.13	2.50	0.30	0.02
1992.20	0.14	0.90	5.73	5.52	2.79	2.68	1.91	0.28
1993.20	1.55	11.04	2.00	6.80	2.42	2.26	1.03	4.05
1994.20	0.82	0.72	1.89	1.74	1.97	0.58	1.02	1.35
1995.20	0.49	1.99	1.12	0.51	0.28	0.34	0.10	0.15
1996.20	0.11	0.49	3.72	1.12	1.01	0.61	1.01	0.06
1997.20	0.33	0.91	4.67	3.92	0.95	0.40	0.16	0.10
1998.20	0.11	1.63	2.30	2.53	1.27	0.72	0.30	0.08
1999.20	0.75	3.75	1.01	1.40	1.89	0.64	0.17	0.02
2000.20	0.34	1.75	2.51	0.62	0.88	0.55	0.45	0.08
2001.20	0.90	1.91	2.61	1.60	0.21	0.23	0.39	0.14
2002.00	1.05	2.07	2.47	2.54	1.91	0.40	0.46	0.32

VPA setup

Plus Group : No plus group

Table 3.2.7.3 (Cont'd)

Population

	2	3	4	5	6	7	8	9	10	11	12
2002.00	40000	40000	20000	20000	10000	10000	5000	5000	2000	(100)	(50)

F ratios

	2	3	4	5	6	7	8	9	10	11	12
1985.00							1.00	1.00	1.00	1.00	(1.00)
1986.00							1.00	1.00	1.00	1.00	(1.00)
1987.00							1.00	1.00	1.00	1.00	(1.00)
1988.00							1.00	1.00	1.00	1.00	(1.00)
1989.00							1.00	1.00	1.00	1.00	(1.00)
1990.00							1.00	1.00	1.00	1.00	(1.00)
1991.00							1.00	1.00	1.00	1.00	(1.00)
1992.00							1.00	1.00	1.00	1.00	(1.00)
1993.00							1.00	1.00	1.00	1.00	(1.00)
1994.00							1.00	1.00	1.00	1.00	(1.00)
1995.00							1.00	1.00	1.00	1.00	(1.00)
1996.00							1.00	1.00	1.00	1.00	(1.00)
1997.00							1.00	1.00	1.00	1.00	(1.00)
1998.00							1.00	1.00	1.00	1.00	(1.00)
1999.00							1.00	1.00	1.00	1.00	(1.00)
2000.00							1.00	1.00	1.00	1.00	(1.00)
2001.00							1.00	1.00	1.00	1.00	(1.00)

Natural Mortality

	2	3	4	5	6	7	8	9	10	11	12
1985.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1986.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1987.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1988.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1989.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1990.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1991.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1992.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1993.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1994.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1995.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1996.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1997.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1998.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
1999.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2000.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)
2001.00	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)	(0.20)

Virtual Population Analysis using initial values

Population Numbers

	2	3	4	5	6	7	8	9	10	11	12
1985.00	88917	34605	38711	20387	9538	5587	4356	4167	1024	232	89
1986.00	132694	72799	27992	28075	13661	6048	3195	2514	2740	410	124
1987.00	68499	108641	56798	21655	19230	8787	3559	1616	1494	865	144
1988.00	38319	56082	88084	41871	13746	10888	4580	1707	732	778	266
1989.00	25832	31373	44726	67545	28321	7951	6346	2161	644	396	395
1990.00	33308	21149	25401	32730	47668	16621	4897	3466	1010	286	154
1991.00	18480	27270	17187	19270	21871	29933	8079	2383	1863	487	99
1992.00	24327	15130	22148	13282	12526	11767	14857	3731	1182	776	195
1993.00	20586	19918	12169	15495	7424	6352	6152	8530	1898	654	459
1994.00	41633	16854	15714	8986	10130	4058	3188	2965	3702	812	335
1995.00	43762	34086	13165	10207	5765	5955	2088	1497	1298	1243	261
1996.00	29291	35829	26487	9110	5966	3099	2755	900	712	631	552
1997.00	31883	23982	28340	19335	5778	3404	1787	1154	393	344	328
1998.00	31878	26104	19090	20534	13338	3249	1731	926	538	210	196
1999.00	41890	26100	21206	14467	15218	9528	1661	828	444	204	65
2000.00	31483	34297	20476	16702	10435	10500	6061	762	388	238	103
2001.00	48856	25776	27312	14617	12866	7182	7145	3342	324	163	144
2002.00	40000	40000	20000	20000	10000	10000	5000	5000	2000	100	50

Table 3.2.7.3 (Cont'd)

Fishing Mortality

	2	3	4	5	6	7	8	9	10	11	12
1985.00	0.000	0.012	0.121	0.200	0.256	0.359	0.350	0.219	0.714	0.430	0.334
1986.00	0.000	0.048	0.057	0.178	0.241	0.330	0.482	0.320	0.952	0.850	0.599
1987.00	0.000	0.010	0.105	0.254	0.369	0.451	0.535	0.592	0.452	0.981	0.582
1988.00	0.000	0.026	0.065	0.191	0.347	0.340	0.551	0.775	0.413	0.478	0.580
1989.00	0.000	0.011	0.112	0.149	0.333	0.285	0.405	0.560	0.613	0.745	0.468
1990.00	0.000	0.007	0.076	0.203	0.265	0.521	0.520	0.421	0.530	0.856	0.496
1991.00	0.000	0.008	0.058	0.231	0.420	0.501	0.573	0.501	0.675	0.714	0.580
1992.00	0.000	0.018	0.157	0.382	0.479	0.449	0.355	0.476	0.392	0.324	0.378
1993.00	0.000	0.037	0.103	0.225	0.404	0.490	0.530	0.635	0.649	0.467	0.593
1994.00	0.000	0.047	0.232	0.244	0.331	0.464	0.556	0.626	0.892	0.935	0.721
1995.00	0.000	0.052	0.168	0.337	0.421	0.571	0.641	0.543	0.521	0.612	0.586
1996.00	0.000	0.035	0.115	0.255	0.361	0.350	0.670	0.629	0.528	0.453	0.615
1997.00	0.000	0.028	0.122	0.171	0.376	0.476	0.457	0.562	0.428	0.361	0.478
1998.00	0.000	0.008	0.077	0.100	0.136	0.471	0.537	0.535	0.768	0.972	0.600
1999.00	0.000	0.043	0.039	0.127	0.171	0.252	0.580	0.558	0.424	0.487	0.546
2000.00	0.000	0.028	0.137	0.061	0.174	0.185	0.395	0.654	0.667	0.305	0.433
2001.00	0.000	0.054	0.112	0.180	0.052	0.162	0.157	0.313	0.976	0.983	0.241

… minimizations …

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LAMBDA       1.00000E-3
RSS          6.99502E1
NPHI         6.99502E1
```

Parameters

1.12177E1	1.06344E1	9.85315E0	9.75598E0	9.05605E0	7.82873E0
7.45301E0	7.56547E0	6.23652E0	-1.11689E1	-9.63770E0	-8.90196E0
-8.68208E0	-8.75475E0	-8.71827E0	-8.77539E0	-9.01050E0	

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

Estimated VPA (biased)

Population Numbers

	2	3	4	5	6	7	8	9	10	11	12
1985.00	88893	34588	38700	20385	9537	5587	4356	4167	1024	232	89
1986.00	132592	72779	27978	28066	13659	6047	3195	2513	2739	410	124
1987.00	68334	108557	56781	21643	19223	8785	3559	1616	1494	865	144
1988.00	38233	55947	88016	41858	13737	10882	4579	1707	731	778	266
1989.00	25809	31303	44615	67489	28310	7943	6341	2160	644	396	395
1990.00	33065	21131	25344	32639	47622	16612	4891	3462	1010	285	154
1991.00	17929	27071	17171	19223	21797	29895	8072	2378	1859	486	99
1992.00	24327	14679	21985	13270	12488	11707	14826	3725	1178	774	195
1993.00	20586	19918	11799	15362	7414	6321	6102	8505	1893	650	457
1994.00	34167	16854	15714	8684	10021	4049	3162	2924	3682	808	333
1995.00	31271	27974	13165	10207	5518	5866	2081	1476	1265	1226	258
1996.00	18388	25602	21483	9110	5966	2897	2682	895	695	604	538
1997.00	11519	15055	19967	15239	5778	3404	1622	1095	389	330	307
1998.00	28693	9431	11781	13681	9987	3249	1731	792	490	206	185
1999.00	36891	23492	7556	8484	9609	6785	1661	828	335	166	62
2000.00	30018	30204	18341	5526	5538	5911	3819	762	388	149	71
2001.00	50736	24577	23961	12869	3718	3178	3392	1515	324	163	71
2002.00	74436	41539	19018	17257	8570	2512	1725	1930	511	100	50

Fishing Mortality

	2	3	4	5	6	7	8	9	10	11	12
1985.00	0.000	0.012	0.121	0.200	0.256	0.359	0.350	0.219	0.714	0.430	0.334
1986.00	0.000	0.048	0.057	0.178	0.241	0.330	0.482	0.320	0.953	0.850	0.599
1987.00	0.000	0.010	0.105	0.255	0.369	0.452	0.535	0.592	0.452	0.981	0.582
1988.00	0.000	0.026	0.066	0.191	0.348	0.340	0.551	0.775	0.413	0.478	0.580
1989.00	0.000	0.011	0.113	0.149	0.333	0.285	0.405	0.561	0.613	0.746	0.469
1990.00	0.000	0.007	0.076	0.204	0.266	0.522	0.521	0.422	0.530	0.857	0.496
1991.00	0.000	0.008	0.058	0.231	0.422	0.501	0.573	0.502	0.677	0.715	0.581
1992.00	0.000	0.018	0.158	0.382	0.481	0.451	0.356	0.477	0.394	0.326	0.379
1993.00	0.000	0.037	0.107	0.227	0.405	0.493	0.536	0.637	0.651	0.471	0.596
1994.00	0.000	0.047	0.232	0.254	0.335	0.466	0.562	0.638	0.899	0.942	0.729
1995.00	0.000	0.064	0.168	0.337	0.444	0.583	0.644	0.553	0.539	0.624	0.596
1996.00	0.000	0.049	0.143	0.255	0.361	0.380	0.696	0.634	0.545	0.479	0.636
1997.00	0.000	0.045	0.178	0.223	0.376	0.476	0.517	0.603	0.435	0.379	0.522
1998.00	0.000	0.022	0.128	0.153	0.187	0.471	0.537	0.661	0.886	1.001	0.651
1999.00	0.000	0.048	0.113	0.226	0.286	0.375	0.580	0.558	0.610	0.644	0.581
2000.00	0.000	0.032	0.154	0.196	0.356	0.355	0.725	0.654	0.667	0.543	0.705
2001.00	0.000	0.056	0.128	0.207	0.192	0.411	0.364	0.887	0.976	0.983	0.566

Table 3.2.7.3 (Cont'd)

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

ORTHOGONALITY OFFSET......... 0.000170
MEAN SQUARE RESIDUALS 0.550789

Estimates for parameters (log scale)

Parameter	PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
S2,2002	1.12E1	7.66E-1	0.068	6.73E-3	0.001
S3,2002	1.06E1	5.43E-1	0.051	6.51E-3	0.001
S4,2002	9.85E0	4.58E-1	0.047	3.04E-3	0.000
S5,2002	9.76E0	4.24E-1	0.043	-1.62E-3	0.000
S6,2002	9.06E0	4.34E-1	0.048	-9.82E-3	-0.001
S7,2002	7.83E0	4.21E-1	0.054	-1.18E-2	-0.002
S8,2002	7.45E0	5.11E-1	0.069	-2.62E-2	-0.004
S9,2002	7.57E0	5.05E-1	0.067	-2.85E-2	-0.004
S10,2002	6.24E0	1.20E0	0.192	-3.48E-1	-0.056
q(ag2)	-1.12E1	1.89E-1	-0.017	-6.73E-3	0.001
q(ag3)	-9.64E0	1.84E-1	-0.019	-6.28E-3	0.001
q(ag4)	-8.90E0	1.81E-1	-0.020	-5.45E-3	0.001
q(ag5)	-8.68E0	1.80E-1	-0.021	-4.45E-3	0.001
q(ag6)	-8.75E0	1.80E-1	-0.021	-3.49E-3	0.000
q(ag7)	-8.72E0	1.79E-1	-0.021	-2.76E-3	0.000
q(ag8)	-8.78E0	1.80E-1	-0.021	-1.17E-3	0.000
q(ag9)	-9.01E0	1.83E-1	-0.020	3.55E-3	0.000

Parameters in linear scale

Parameter	PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
S2,2002	7.44E4	5.70E4	0.766	2.23E4	0.300
S3,2002	4.15E4	2.25E4	0.543	6.39E3	0.154
S4,2002	1.90E4	8.72E3	0.458	2.06E3	0.108
S5,2002	1.73E4	7.32E3	0.424	1.53E3	0.088
S6,2002	8.57E3	3.72E3	0.434	7.22E2	0.084
S7,2002	2.51E3	1.06E3	0.421	1.93E2	0.077
S8,2002	1.73E3	8.81E2	0.511	1.80E2	0.104
S9,2002	1.93E3	9.76E2	0.506	1.92E2	0.099
S10,2002	5.11E2	6.13E2	1.200	1.90E2	0.372
q(ag2)	1.41E-5	2.67E-6	0.189	1.58E-7	0.011
q(ag3)	6.52E-5	1.20E-5	0.184	6.90E-7	0.011
q(ag4)	1.36E-4	2.47E-5	0.181	1.49E-6	0.011
q(ag5)	1.70E-4	3.05E-5	0.180	1.99E-6	0.012
q(ag6)	1.58E-4	2.83E-5	0.180	1.99E-6	0.013
q(ag7)	1.64E-4	2.93E-5	0.179	2.18E-6	0.013
q(ag8)	1.54E-4	2.78E-5	0.180	2.33E-6	0.015
q(ag9)	1.22E-4	2.23E-5	0.183	2.47E-6	0.020

VPA using analytical bias adjusted parameters (linear scale)
Population Numbers

	2	3	4	5	6	7	8	9	10	11	12
1985.00	88890	34586	38698	20385	9537	5587	4355	4167	1024	232	89
1986.00	132579	72777	27977	28065	13659	6047	3195	2513	2739	410	124
1987.00	68315	108546	56779	21642	19222	8785	3559	1616	1494	865	144
1988.00	38223	55932	88007	41856	13736	10881	4579	1707	731	778	266
1989.00	25806	31295	44603	67482	28309	7943	6341	2160	644	396	395
1990.00	33032	21129	25337	32629	47616	16611	4890	3461	1010	285	154
1991.00	17872	27044	17169	19218	21789	29891	8071	2377	1859	486	99
1992.00	24327	14632	21963	13268	12483	11700	14822	3724	1178	773	195
1993.00	20586	19918	11762	15344	7413	6318	6097	8502	1893	650	457
1994.00	33196	16854	15714	8653	10006	4048	3159	2920	3679	808	332
1995.00	30488	27178	13165	10207	5492	5854	2080	1474	1262	1224	258
1996.00	17787	24962	20832	9110	5966	2876	2672	894	693	601	536
1997.00	10994	14562	19442	14706	5778	3404	1606	1087	388	328	304
1998.00	27084	9001	11378	13252	9551	3249	1731	778	484	206	184
1999.00	34110	22175	7204	8154	9258	6429	1661	828	323	160	62
2000.00	26951	27927	17262	5238	5269	5624	3528	762	388	140	67
2001.00	42937	22065	22097	11986	3482	2957	3157	1279	324	163	63
2002.00	52101	35154	16962	15731	7848	2319	1545	1739	321	100	50

Table 3.2.7.3 (Cont'd)

Fishing Mortality

	2	3	4	5	6	7	8	9	10	11	12
1985.00	0.000	0.012	0.121	0.200	0.256	0.359	0.350	0.219	0.714	0.430	0.334
1986.00	0.000	0.048	0.057	0.178	0.241	0.330	0.482	0.321	0.953	0.850	0.599
1987.00	0.000	0.010	0.105	0.255	0.369	0.452	0.535	0.592	0.452	0.981	0.582
1988.00	0.000	0.026	0.066	0.191	0.348	0.340	0.551	0.775	0.413	0.478	0.580
1989.00	0.000	0.011	0.113	0.149	0.333	0.285	0.405	0.561	0.613	0.746	0.469
1990.00	0.000	0.007	0.076	0.204	0.266	0.522	0.521	0.422	0.530	0.857	0.496
1991.00	0.000	0.008	0.058	0.231	0.422	0.501	0.573	0.502	0.677	0.716	0.581
1992.00	0.000	0.018	0.159	0.382	0.481	0.452	0.356	0.477	0.394	0.326	0.379
1993.00	0.000	0.037	0.107	0.228	0.405	0.493	0.536	0.638	0.651	0.471	0.597
1994.00	0.000	0.047	0.232	0.255	0.336	0.466	0.562	0.639	0.901	0.943	0.730
1995.00	0.000	0.066	0.168	0.337	0.447	0.584	0.644	0.555	0.541	0.625	0.597
1996.00	0.000	0.050	0.148	0.255	0.361	0.383	0.700	0.635	0.547	0.482	0.639
1997.00	0.000	0.047	0.183	0.232	0.376	0.476	0.524	0.609	0.435	0.382	0.528
1998.00	0.000	0.023	0.133	0.159	0.196	0.471	0.537	0.678	0.905	1.004	0.657
1999.00	0.000	0.050	0.119	0.237	0.298	0.400	0.580	0.558	0.640	0.674	0.585
2000.00	0.000	0.034	0.165	0.208	0.378	0.377	0.815	0.654	0.667	0.590	0.771
2001.00	0.000	0.063	0.140	0.224	0.207	0.449	0.397	1.182	0.976	0.983	0.658

BOOTSTRAP STATISTICS

Estimates for parameters (log scale)

Parameter	PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
S2,2002	1.12E1	7.06E-1	0.063	2.61E-2	0.002
S3,2002	1.06E1	4.97E-1	0.047	-1.12E-2	-0.001
S4,2002	9.85E0	4.20E-1	0.043	3.84E-3	0.000
S5,2002	9.76E0	4.01E-1	0.041	2.77E-3	0.000
S6,2002	9.06E0	4.15E-1	0.046	-1.37E-3	0.000
S7,2002	7.83E0	4.37E-1	0.056	-5.28E-3	-0.001
S8,2002	7.45E0	4.87E-1	0.065	-2.13E-2	-0.003
S9,2002	7.57E0	4.90E-1	0.065	-3.16E-2	-0.004
S10,2002	6.24E0	1.84E0	0.294	-4.37E-1	-0.070
q(ag2)	-1.12E1	1.86E-1	-0.017	-5.90E-3	0.001
q(ag3)	-9.64E0	1.75E-1	-0.018	-1.56E-2	0.002
q(ag4)	-8.90E0	1.76E-1	-0.020	-3.88E-3	0.000
q(ag5)	-8.68E0	1.67E-1	-0.019	3.25E-3	0.000
q(ag6)	-8.75E0	1.70E-1	-0.019	-1.00E-2	0.001
q(ag7)	-8.72E0	1.69E-1	-0.019	-3.43E-4	0.000
q(ag8)	-8.78E0	1.71E-1	-0.020	-2.63E-3	0.000
q(ag9)	-9.01E0	1.66E-1	-0.018	9.89E-4	0.000

Parameters in linear scale

Parameter	PAR. EST.	STD. ERR.	REL. ERR.	BIAS	REL. BIAS
S2,2002	7.44E4	7.95E4	1.068	2.28E4	0.307
S3,2002	4.15E4	2.38E4	0.572	4.80E3	0.116
S4,2002	1.90E4	9.12E3	0.479	1.82E3	0.096
S5,2002	1.73E4	7.99E3	0.463	1.51E3	0.087
S6,2002	8.57E3	3.74E3	0.437	7.13E2	0.083
S7,2002	2.51E3	1.15E3	0.458	2.21E2	0.088
S8,2002	1.73E3	8.69E2	0.504	1.58E2	0.092
S9,2002	1.93E3	1.00E3	0.521	1.64E2	0.085
S10,2002	5.11E2	5.98E2	1.170	1.60E2	0.312
q(ag2)	1.41E-5	2.64E-6	0.187	1.59E-7	0.011
q(ag3)	6.52E-5	1.14E-5	0.175	-2.10E-8	0.000
q(ag4)	1.36E-4	2.44E-5	0.179	1.60E-6	0.012
q(ag5)	1.70E-4	2.88E-5	0.170	2.93E-6	0.017
q(ag6)	1.58E-4	2.69E-5	0.171	6.87E-7	0.004
q(ag7)	1.64E-4	2.84E-5	0.173	2.30E-6	0.014
q(ag8)	1.54E-4	2.71E-5	0.176	1.88E-6	0.012
q(ag9)	1.22E-4	2.05E-5	0.168	1.81E-6	0.015

Bootstrap bias adjusted VPA

Table 3.2.7.3 (Cont'd)

Population Numbers

	2	3	4	5	6	7	8	9	10	11	12
1985.00	88891	34587	38699	20385	9537	5587	4356	4167	1024	232	89
1986.00	132584	72778	27978	28066	13659	6047	3195	2513	2739	410	124
1987.00	68326	108551	56780	21643	19222	8785	3559	1616	1494	865	144
1988.00	38229	55941	88010	41857	13736	10882	4579	1707	731	778	266
1989.00	25808	31300	44610	67485	28310	7943	6341	2160	644	396	395
1990.00	33041	21130	25341	32635	47618	16612	4890	3462	1010	285	154
1991.00	17913	27052	17171	19221	21794	29892	8071	2377	1859	486	99
1992.00	24327	14666	21969	13269	12486	11704	14824	3724	1178	773	195
1993.00	20586	19918	11789	15349	7414	6320	6100	8503	1893	650	457
1994.00	33391	16854	15714	8675	10010	4049	3161	2922	3680	808	333
1995.00	30610	27339	13165	10207	5511	5857	2081	1475	1264	1225	258
1996.00	17864	25061	20963	9110	5966	2891	2675	895	694	603	537
1997.00	10920	14626	19524	14813	5778	3404	1618	1089	388	329	306
1998.00	27107	8940	11430	13319	9639	3249	1731	788	486	206	184
1999.00	34148	22193	7154	8196	9312	6500	1661	828	332	162	62
2000.00	27305	27958	17277	5198	5303	5668	3586	762	388	146	68
2001.00	44872	22355	22123	11998	3449	2985	3193	1324	324	163	69
2002.00	51596	36738	17199	15752	7857	2291	1567	1767	351	100	50

Fishing Mortality

	2	3	4	5	6	7	8	9	10	11	12
1985.00	0.000	0.012	0.121	0.200	0.256	0.359	0.350	0.219	0.714	0.430	0.334
1986.00	0.000	0.048	0.057	0.178	0.241	0.330	0.482	0.321	0.953	0.850	0.599
1987.00	0.000	0.010	0.105	0.255	0.369	0.452	0.535	0.592	0.452	0.981	0.582
1988.00	0.000	0.026	0.066	0.191	0.348	0.340	0.551	0.775	0.413	0.478	0.580
1989.00	0.000	0.011	0.113	0.149	0.333	0.285	0.405	0.561	0.613	0.746	0.469
1990.00	0.000	0.007	0.076	0.204	0.266	0.522	0.521	0.422	0.530	0.857	0.496
1991.00	0.000	0.008	0.058	0.231	0.422	0.501	0.573	0.502	0.677	0.716	0.581
1992.00	0.000	0.018	0.159	0.382	0.481	0.452	0.356	0.477	0.394	0.326	0.379
1993.00	0.000	0.037	0.107	0.227	0.405	0.493	0.536	0.637	0.651	0.471	0.596
1994.00	0.000	0.047	0.232	0.254	0.336	0.466	0.562	0.638	0.900	0.942	0.730
1995.00	0.000	0.065	0.168	0.337	0.445	0.584	0.644	0.554	0.540	0.624	0.596
1996.00	0.000	0.049	0.146	0.255	0.361	0.381	0.698	0.635	0.546	0.480	0.638
1997.00	0.000	0.045	0.179	0.227	0.376	0.476	0.519	0.607	0.435	0.380	0.524
1998.00	0.000	0.021	0.129	0.154	0.190	0.471	0.537	0.663	0.896	1.002	0.653
1999.00	0.000	0.047	0.111	0.226	0.284	0.382	0.580	0.558	0.609	0.654	0.582
2000.00	0.000	0.030	0.149	0.189	0.350	0.346	0.725	0.654	0.667	0.529	0.711
2001.00	0.000	0.052	0.120	0.193	0.177	0.378	0.329	0.413	0.976	0.983	0.482

Table 3.2.7.4 Saithe in Division Va. Fishing mortality from a VPA run with F in 2001 from TSA calibrated with survey.

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Marine Research Institute Wed May  8 12:37:06 2002
  Virtual Population Analysis : Fishing mortality
 Ufsi LongRun 2002- TSA+survey
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Age	1962	1963	1964	1965	1966	1967	1968
3	0.056	0.084	0.063	0.024	0.015	0.018	0.016
4	0.273	0.112	0.227	0.134	0.031	0.068	0.054
5	0.312	0.215	0.254	0.226	0.127	0.109	0.095
6	0.475	0.409	0.311	0.239	0.184	0.244	0.173
7	0.276	0.464	0.291	0.297	0.219	0.348	0.288
8	0.216	0.361	0.244	0.253	0.269	0.326	0.372
9	0.167	0.263	0.172	0.239	0.241	0.328	0.280
10	0.164	0.242	0.177	0.173	0.248	0.330	0.351
11	0.144	0.255	0.142	0.182	0.207	0.284	0.372
12	0.170	0.294	0.138	0.160	0.180	0.167	0.281
13	0.211	0.228	0.137	0.173	0.293	0.449	0.275
14	0.172	0.255	0.148	0.172	0.232	0.308	0.320
W.Av 4- 9	0.315	0.237	0.243	0.195	0.097	0.149	0.138
Ave 4- 9	0.287	0.304	0.250	0.231	0.178	0.237	0.210

Age	1969	1970	1971	1972	1973	1974	1975
3	0.020	0.005	0.010	0.024	0.009	0.057	0.023
4	0.106	0.091	0.064	0.107	0.097	0.195	0.186
5	0.159	0.169	0.237	0.190	0.208	0.179	0.212
6	0.251	0.256	0.359	0.323	0.323	0.190	0.207
7	0.403	0.400	0.492	0.396	0.503	0.258	0.332
8	0.438	0.499	0.670	0.486	0.464	0.457	0.373
9	0.410	0.519	0.836	0.664	0.473	0.445	0.357
10	0.346	0.510	0.638	0.758	0.650	0.465	0.467
11	0.163	0.397	0.921	0.529	0.516	0.599	0.337
12	0.331	0.458	1.157	1.140	0.783	0.333	0.697
13	0.132	0.510	0.507	0.929	1.008	0.317	0.418
14	0.243	0.469	0.806	0.839	0.739	0.429	0.480
W.Av 4- 9	0.229	0.219	0.285	0.253	0.298	0.245	0.260
Ave 4- 9	0.295	0.322	0.443	0.361	0.345	0.287	0.278

Age	1976	1977	1978	1979	1980	1981	1982
3	0.012	0.003	0.012	0.012	0.011	0.012	0.026
4	0.188	0.096	0.074	0.109	0.079	0.066	0.079
5	0.292	0.252	0.154	0.178	0.217	0.148	0.195
6	0.348	0.281	0.212	0.357	0.369	0.366	0.313
7	0.400	0.234	0.329	0.342	0.378	0.366	0.558
8	0.393	0.354	0.353	0.312	0.553	0.454	0.594
9	0.332	0.477	0.303	0.172	0.276	0.493	0.659
10	0.492	0.359	0.331	0.763	0.229	0.278	0.531
11	0.360	0.498	0.304	0.670	0.394	0.076	0.101
12	0.339	0.353	0.525	0.586	0.252	0.871	0.057
13	1.060	0.203	0.566	0.603	0.137	0.546	0.755
14	0.563	0.353	0.431	0.655	0.253	0.443	0.361
W.Av 4- 9	0.295	0.213	0.172	0.191	0.203	0.214	0.292
Ave 4- 9	0.326	0.282	0.237	0.245	0.312	0.316	0.400

Age	1983	1984	1985	1986	1987	1988	1989
3	0.004	0.001	0.012	0.047	0.014	0.026	0.011
4	0.116	0.028	0.120	0.055	0.102	0.092	0.112
5	0.104	0.071	0.191	0.177	0.245	0.186	0.219
6	0.262	0.259	0.248	0.228	0.364	0.331	0.321
7	0.530	0.392	0.361	0.318	0.417	0.334	0.266
8	0.674	1.155	0.378	0.487	0.504	0.485	0.394
9	0.526	0.562	0.803	0.358	0.603	0.694	0.454
10	0.349	0.994	0.738	0.899	0.534	0.425	0.498
11	0.113	0.884	0.531	0.915	0.850	0.632	0.785
12	0.027	0.724	0.149	0.884	0.678	0.437	0.769
13	0.004	0.700	1.164	0.296	2.304	0.674	0.641
14	0.123	0.826	0.646	0.748	1.091	0.542	0.673
W.Av 4- 9	0.282	0.230	0.196	0.171	0.220	0.188	0.222
Ave 4- 9	0.369	0.411	0.350	0.270	0.373	0.354	0.295

Table 3.2.7.4 (Cont'd)

Age	1990	1991	1992	1993	1994	1995	1996
3	0.007	0.008	0.018	0.036	0.044	0.083	0.051
4	0.077	0.057	0.156	0.106	0.223	0.157	0.193
5	0.203	0.233	0.375	0.222	0.251	0.321	0.235
6	0.441	0.420	0.485	0.394	0.326	0.439	0.338
7	0.494	0.674	0.448	0.499	0.447	0.557	0.373
8	0.472	0.522	0.584	0.529	0.574	0.600	0.642
9	0.405	0.428	0.409	0.621	0.624	0.575	0.558
10	0.378	0.631	0.310	0.505	0.852	0.519	0.583
11	0.580	0.410	0.291	0.333	0.577	0.558	0.449
12	0.546	0.295	0.166	0.501	0.417	0.253	0.522
13	1.545	0.103	0.824	0.381	1.526	0.152	0.626
14	0.762	0.360	0.398	0.430	0.843	0.370	0.545
W.Av 4- 9	0.302	0.389	0.369	0.347	0.323	0.340	0.282
Ave 4- 9	0.348	0.389	0.409	0.395	0.408	0.442	0.390

Age	1997	1998	1999	2000	2001	1999-2001
3	0.045	0.028	0.047	0.031	0.032	0.037
4	0.189	0.127	0.150	0.154	0.126	0.143
5	0.322	0.165	0.223	0.276	0.206	0.235
6	0.337	0.300	0.313	0.348	0.296	0.319
7	0.430	0.400	0.438	0.404	0.398	0.414
8	0.503	0.457	0.446	0.496	0.440	0.461
9	0.520	0.630	0.429	0.422	0.440	0.430
10	0.353	0.663	0.558	0.429	0.440	0.476
11	0.423	0.681	0.376	0.466	0.440	0.427
12	0.472	0.788	0.287	0.296	0.440	0.341
13	0.327	0.790	0.706	0.323	0.440	0.490
14	0.394	0.730	0.482	0.379	0.440	0.434
W.Av 4- 9	0.288	0.225	0.295	0.279	0.213	0.237
Ave 4- 9	0.384	0.346	0.333	0.350	0.318	0.334

Table 3.2.7.5 Saithe in Division Va. Stock in numbers from a VPA run with F in 2001 from TSA calibrated with survey.

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Marine Research Institute Wed May  8 12:37:06 2002
  Virtual Population Analysis : Stock in numbers, millions
 Ufsi LongRun 2002- TSA+survey
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Age	1962	1963	1964	1965	1966	1967	1968
3	30.999	84.106	55.196	94.063	70.223	68.329	59.671
4	22.957	23.995	63.327	42.446	75.203	56.645	54.936
5	15.808	14.300	17.559	41.308	30.403	59.684	43.309
6	10.833	9.473	9.441	11.151	26.990	21.933	43.824
7	4.646	5.514	5.152	5.662	7.188	18.390	14.065
8	2.369	2.887	2.839	3.153	3.446	4.728	10.628
9	1.999	1.562	1.648	1.822	2.004	2.156	2.793
10	1.786	1.385	0.983	1.136	1.174	1.290	1.271
11	1.173	1.241	0.890	0.674	0.782	0.750	0.759
12	0.585	0.832	0.788	0.632	0.460	0.521	0.462
13	0.162	0.404	0.507	0.562	0.441	0.315	0.361
14	0.104	0.107	0.263	0.362	0.387	0.269	0.164
Juvenile	69.080	121.740	132.099	169.413	174.564	176.896	162.132
Adult	24.342	24.068	26.496	33.558	44.138	58.114	70.111
Sum 3- 3	30.999	84.106	55.196	94.063	70.223	68.329	59.671
Sum 4-14	62.422	61.701	103.399	108.909	148.479	166.681	172.572
Total	93.421	145.808	158.595	202.971	218.702	235.010	232.243

Age	1969	1970	1971	1972	1973	1974	1975
3	88.749	66.329	50.637	26.455	26.104	25.125	25.928
4	48.100	71.242	54.047	41.028	21.150	21.174	19.425
5	42.626	35.418	53.257	41.514	30.177	15.721	14.271
6	32.245	29.759	24.494	34.407	28.114	20.067	10.757
7	30.189	20.536	18.854	14.006	20.401	16.659	13.580
8	8.632	16.519	11.270	9.439	7.717	10.099	10.535
9	6.001	4.560	8.208	4.720	4.753	3.973	5.235
10	1.728	3.260	2.221	2.914	1.990	2.426	2.085
11	0.733	1.001	1.602	0.961	1.118	0.851	1.247
12	0.429	0.510	0.551	0.522	0.464	0.546	0.382
13	0.285	0.252	0.264	0.142	0.137	0.174	0.321
14	0.224	0.205	0.124	0.130	0.046	0.041	0.103
Juvenile	183.006	174.560	153.302	111.002	82.524	67.398	61.481
Adult	76.937	75.031	72.228	65.236	59.646	49.458	42.387
Sum 3- 3	88.749	66.329	50.637	26.455	26.104	25.125	25.928
Sum 4-14	171.193	183.261	174.893	149.783	116.066	91.731	77.941
Total	259.942	249.591	225.530	176.238	142.170	116.856	103.868

Age	1976	1977	1978	1979	1980	1981	1982
3	31.237	21.672	49.437	45.748	28.028	19.463	22.060
4	20.753	25.277	17.691	39.981	37.022	22.699	15.751
5	13.205	14.079	18.802	13.451	29.340	28.020	17.389
6	9.453	8.074	8.956	13.200	9.219	19.328	19.784
7	7.160	5.467	4.991	5.932	7.560	5.217	10.973
8	7.978	3.930	3.544	2.941	3.450	4.243	2.963
9	5.937	4.407	2.258	2.038	1.763	1.624	2.205
10	2.998	3.486	2.239	1.366	1.406	1.095	0.812
11	1.070	1.501	1.994	1.317	0.522	0.915	0.679
12	0.729	0.612	0.747	1.205	0.552	0.288	0.694
13	0.156	0.426	0.352	0.362	0.549	0.351	0.099
14	0.173	0.044	0.284	0.163	0.162	0.392	0.166
Juvenile	65.481	59.854	84.160	99.249	77.466	60.874	52.089
Adult	35.368	29.121	27.135	28.455	42.106	42.761	41.485
Sum 3- 3	31.237	21.672	49.437	45.748	28.028	19.463	22.060
Sum 4-14	69.612	67.303	61.858	81.955	91.544	84.172	71.515
Total	100.849	88.975	111.295	127.704	119.571	103.634	93.575

Age	1983	1984	1985	1986	1987	1988	1989
3	32.706	47.723	35.662	74.415	78.365	56.104	31.160
4	17.602	26.681	39.025	28.858	58.121	63.296	44.744
5	11.911	12.834	21.251	28.332	22.363	42.954	47.252
6	11.712	8.792	9.786	14.368	19.440	14.326	29.207
7	11.844	7.381	5.556	6.250	9.365	11.060	8.425
8	5.141	5.709	4.083	3.170	3.725	5.052	6.487
9	1.339	2.145	1.473	2.291	1.595	1.842	2.546
10	0.934	0.648	1.001	2.840	1.311	0.715	0.753
11	0.391	0.539	0.196	0.392	0.947	0.630	0.383
12	0.503	0.286	0.182	0.094	0.128	0.331	0.274
13	0.537	0.401	0.113	0.129	0.032	0.053	0.175
14	0.038	0.438	0.163	0.029	0.078	0.003	0.022
Juvenile	56.149	75.990	79.710	117.320	150.120	152.413	123.838
Adult	38.508	37.585	38.781	43.848	45.351	43.953	47.590

Table 3.2.7.5 (Cont'd)

Sum 3- 3	32.706	47.723	35.662	74.415	78.365	56.104	31.160
Sum 4-14	61.952	65.851	82.829	86.753	117.106	140.262	140.269
Total	94.657	113.575	118.491	161.168	195.471	196.366	171.428

Age	1990	1991	1992	1993	1994	1995	1996
3	21.431	27.512	14.774	20.555	17.877	21.694	24.263
4	25.227	17.417	22.346	11.878	16.236	14.002	16.342
5	32.744	19.127	13.471	15.657	8.748	10.634	9.795
6	31.063	21.883	12.409	7.578	10.262	5.570	6.315
7	17.346	23.964	11.777	6.257	4.184	6.063	2.940
8	5.284	8.670	9.997	6.160	3.110	2.190	2.843
9	3.581	2.699	4.212	8.665	2.971	1.434	0.984
10	1.324	1.956	1.440	2.291	3.812	1.303	0.660
11	0.375	0.743	0.852	0.864	1.132	1.331	0.635
12	0.143	0.172	0.404	0.522	0.507	0.521	0.624
13	0.104	0.068	0.105	0.280	0.259	0.274	0.331
14	0.076	0.018	0.050	0.038	0.157	0.046	0.193
Juvenile	89.094	73.125	47.959	41.319	36.030	37.585	41.167
Adult	49.603	51.103	43.877	39.425	33.224	27.477	24.757
Sum 3- 3	21.431	27.512	14.774	20.555	17.877	21.694	24.263
Sum 4-14	117.266	96.717	77.062	60.189	51.377	43.368	41.661
Total	138.697	124.228	91.836	80.745	69.254	65.062	65.924

Age	1997	1998	1999	2000	2001	2002
3	15.242	7.268	23.537	28.000	22.000	30.000
4	18.870	11.935	5.786	18.378	22.224	17.445
5	11.032	12.784	8.609	4.077	12.899	16.042
6	6.338	6.547	8.875	5.641	2.533	8.595
7	3.689	3.706	5.971	5.311	3.261	1.542
8	1.657	1.964	2.035	5.054	2.902	1.794
9	1.225	0.820	1.018	1.066	2.520	1.530
10	0.461	0.597	0.358	0.543	0.572	1.329
11	0.302	0.265	0.252	0.168	0.289	0.302
12	0.332	0.162	0.110	0.141	0.086	0.153
13	0.303	0.169	0.060	0.068	0.086	0.045
14	0.145	0.179	0.063	0.024	0.040	0.045
Juvenile	35.356	24.032	33.545	43.149	38.442	44.945
Adult	24.240	22.364	23.129	25.322	30.971	33.876
Sum 3- 3	15.242	7.268	23.537	28.000	22.000	30.000
Sum 4-14	44.354	39.128	33.137	40.471	47.413	48.821
Total	59.596	46.396	56.674	68.471	69.413	78.821

Table 3.2.7.6 Saithe in Division Va. Summary table from on a VPA run with F in 2001 from TSA calibrated with survey.

Year	Recruitment Age 3 thousands	SSB tonnes	Landings tonnes	Mean F Ages 4-9
1962	30999	131495	50000	0.287
1963	84106	132811	48000	0.304
1964	55196	134478	60000	0.250
1965	94063	161200	60000	0.231
1966	70223	207827	52000	0.179
1967	68329	272626	76000	0.237
1968	59671	340913	79000	0.210
1969	88749	393200	116000	0.295
1970	66329	396236	117000	0.322
1971	50637	378082	137000	0.443
1972	26455	332879	111000	0.361
1973	26104	313070	111000	0.345
1974	25125	287185	98000	0.287
1975	25928	262239	88000	0.278
1976	31237	226588	82000	0.326
1977	21672	184129	62000	0.282
1978	49437	163137	50000	0.238
1979	45748	159536	64000	0.245
1980	28028	165551	58347	0.312
1981	19463	164760	59001	0.316
1982	22060	168385	68933	0.400
1983	32706	161624	58266	0.369
1984	47723	164545	62716	0.411
1985	35662	147536	57101	0.350
1986	74415	179673	66376	0.271
1987	78365	174156	80531	0.373
1988	56104	165627	77247	0.354
1989	31160	171529	82425	0.294
1990	21431	182697	98127	0.349
1991	27512	184864	102737	0.389
1992	14774	169331	79597	0.410
1993	20555	167262	71648	0.395
1994	17877	142029	64339	0.408
1995	21694	109678	48629	0.442
1996	24263	96037	40101	0.390
1997	15242	89826	37264	0.384
1998	7268	84797	31531	0.347
1999	23537	83857	31290	0.333
2000	28000	87088	32430	0.350
2001	22000	105661	31965	0.318
Average	39746	191104	70040	0.327

Table 3.2.8.1 Saithe in Division Va. Prediction with management option - Input data.

"MFDP version 1"								
"Run: siggi2002stp"								
"Time and date: 14:01 8.5.2002"								
"Fbar age range: 4-9"								
""								
""								
2002								
"Age"	"N"	"M"	"Mat"	"PF"	"PM"	"SWt"	"Sel"	"CWt"
3	30	.2	.14	0	0	1309	.034	1309
4	17.445	.2	.28	0	0	1939	.138	1939
5	16.042	.2	.48	0	0	2645	.223	2645
6	8.595	.2	.68	0	0	3559	.322	3559
7	1.542	.2	.84	0	0	4729	.417	4729
8	1.794	.2	.92	0	0	5614	.467	5614
9	1.53	.2	.97	0	0	7849	.467	7849
10	1.329	.2	1	0	0	8093	.467	8093
11	.302	.2	1	0	0	9098	.467	9098
12	.153	.2	1	0	0	10103	.467	10103
13	.045	.2	1	0	0	10796	.467	10796
14	.045	.2	1	0	0	11497	.467	11497
""								
2003								
"Age"	"N"	"M"	"Mat"	"PF"	"PM"	"SWt"	"Sel"	"CWt"
3	30	.2	.14	0	0	1309	.034	1309
4	"."	.2	.28	0	0	1927	.138	1927
5	"."	.2	.48	0	0	2716	.223	2716
6	"."	.2	.68	0	0	3573	.322	3573
7	"."	.2	.84	0	0	4565	.417	4565
8	"."	.2	.92	0	0	5892	.467	5892
9	"."	.2	.97	0	0	7951	.467	7951
10	"."	.2	1	0	0	8093	.467	8093
11	"."	.2	1	0	0	9098	.467	9098
12	"."	.2	1	0	0	10103	.467	10103
13	"."	.2	1	0	0	10796	.467	10796
14	"."	.2	1	0	0	11497	.467	11497
""								
2004								
"Age"	"N"	"M"	"Mat"	"PF"	"PM"	"SWt"	"Sel"	"CWt"
3	30	.2	.14	0	0	1309	.034	1309
4	"."	.2	.28	0	0	1927	.138	1927
5	"."	.2	.48	0	0	2674	.223	2674
6	"."	.2	.68	0	0	3655	.322	3655
7	"."	.2	.84	0	0	4553	.417	4553
8	"."	.2	.92	0	0	5706	.467	5706
9	"."	.2	.97	0	0	6952	.467	6852
10	"."	.2	1	0	0	8093	.467	8093
11	"."	.2	1	0	0	9098	.467	9098
12	"."	.2	1	0	0	10103	.467	10103
13	"."	.2	1	0	0	10796	.467	10796
14	"."	.2	1	0	0	11497	.467	11497
""								
"Input units are millions and grams - output in tonnes"								

Table 3.2.8.2 Saithe in Division Va. Prediction with management option.

MFDP version 1
Run: siggi2002stp
SaiVa index-file for deterministic projection
Time and date: 14:01 8.5.2002
Fbar age range: 4-9

2002				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
191541	99229	1.0394	0.3524	37000

2003					2004	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
205743	105410	0.0000	0.0000	0	261890	146965
.	105410	0.1000	0.0339	4398	256915	143017
.	105410	0.2000	0.0678	8657	252097	139205
.	105410	0.3000	0.1017	12784	247429	135523
.	105410	0.4000	0.1356	16783	242907	131967
.	105410	0.5000	0.1695	20659	238525	128531
.	105410	0.6000	0.2034	24415	234279	125212
.	105410	0.7000	0.2373	28057	230162	122005
.	105410	0.8000	0.2712	31588	226172	118906
.	105410	0.9000	0.3051	35012	222302	115911
.	105410	1.0000	0.3390	38333	218550	113015
.	105410	1.1000	0.3729	41555	214910	110216
.	105410	1.2000	0.4068	44681	211379	107510
.	105410	1.3000	0.4407	47715	207953	104892
.	105410	1.4000	0.4746	50660	204629	102361
.	105410	1.5000	0.5085	53518	201402	99913
.	105410	1.6000	0.5424	56294	198270	97544
.	105410	1.7000	0.5763	58989	195229	95252
.	105410	1.8000	0.6102	61606	192277	93035
.	105410	1.9000	0.6441	64149	189409	90888
.	105410	2.0000	0.6780	66620	186623	88811

Input units are millions and grams - output in tonnes

Table 3.2.8.3 Saithe in Division Va. Long term prediction. Input data.

MFYPR version 1
Run: siggi2002ypr
SaiVa index-file for deterministic projection
Time and date: 12:57 8.5.2002
Fbar age range: 3-14

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.09	0	0	1377	0.03	1377
4	0.2	0.29	0	0	1970	0.13	1970
5	0.2	0.44	0	0	2669	0.24	2669
6	0.2	0.63	0	0	3566	0.35	3566
7	0.2	0.76	0	0	4558	0.43	4558
8	0.2	0.87	0	0	5696	0.50	5696
9	0.2	0.94	0	0	6920	0.53	6920
10	0.2	1	0	0	7814	0.55	7814
11	0.2	1	0	0	8846	0.55	8846
12	0.2	1	0	0	9754	0.46	9754
13	0.2	1	0	0	10842	0.75	10842
14	0.2	1	0	0	11509	0.58	11509

Weights in grams

Table 3.2.8.4. Saithe in Division Va. Long term prediction.

MFYPR version 1
Run: siggi2002ypr
Time and date: 12:57 8.5.2002
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn
0.0	0.000	0.000	0	5.517	26790	3.266	21752	3.266
0.1	0.043	0.129	792	4.875	20791	2.657	15888	2.657
0.2	0.085	0.214	1197	4.453	17132	2.264	12353	2.264
0.3	0.127	0.275	1419	4.149	14691	1.989	10027	1.989
0.4	0.170	0.322	1547	3.917	12955	1.783	8398	1.783
0.5	0.212	0.359	1622	3.733	11662	1.624	7203	1.624
0.6	0.255	0.390	1667	3.582	10662	1.496	6296	1.496
0.7	0.297	0.416	1693	3.454	9867	1.391	5587	1.391
0.8	0.340	0.438	1707	3.345	9220	1.303	5020	1.303
0.9	0.382	0.457	1715	3.250	8682	1.228	4557	1.228
1.0	0.425	0.474	1717	3.166	8227	1.163	4173	1.163
1.1	0.467	0.489	1716	3.092	7838	1.107	3850	1.107
1.2	0.510	0.503	1713	3.024	7500	1.057	3575	1.057
1.3	0.552	0.516	1709	2.963	7204	1.013	3338	1.013
1.4	0.595	0.527	1704	2.908	6942	0.973	3132	0.973
1.5	0.637	0.537	1699	2.857	6708	0.937	2952	0.937
1.6	0.679	0.547	1693	2.810	6498	0.905	2792	0.905
1.7	0.722	0.556	1687	2.766	6308	0.875	2650	0.875
1.8	0.764	0.564	1681	2.725	6136	0.848	2523	0.848
1.9	0.807	0.572	1674	2.687	5978	0.823	2408	0.823
2.0	0.849	0.580	1668	2.652	5833	0.800	2304	0.800

Referenc	F	Absolute F
Fbar(3-	1.0000	0.4246
$\mathbf{F}_{max}$	-1.0000	0
$\mathbf{F}_{0.1}$	-1	0
F35%SP	0.4623	0.1963

Weights

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1988- 2001 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994
Belgium	365	309	260	548	222	145	136
Faroe Islands	1,966	2,012	1,782	1,323	883	664	
Germany	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-
Iceland	375,741	353,985	333,348	306,697	266,662	251,170	177,919
Norway	4	3	-	-	-	-	-
UK	-	-	-	-	-	-	-
Total	378,076	356,309	335,390	308,568	267,767	251,979	178,809
WG estimate	-	-	-	-	-	-	-

Country	1995	1996	1997	1998	1999	2000	2001 [1]
Belgium	-	-	-	-	-	-	-
Faroe Islands	739	599	408	1,078	1,247	1,176	1129
Germany	-	-	-	9	21	15	
Greenland	-	-	-	-	25	-	
Iceland	168,685	181,052	202,745	241,545	258,658	234,362	233,969
Norway	-	7	-	-	85	101	
UK	-	-	-	-	16		
Total	169,424	181,658	203,153	242,632	260,052	235,687	
WG estimate	-	-	-	-	-	-	235,098

1) Provisional.

Table 3.3.2 Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-2001 (with 1991 as 100%). Data are based on logbooks which have been mandatory in the fisheries since 1991.

Bottom trawl:

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	175142	234946	100	745	100
1992	131504	228196	97	576	77
1993	114587	182882	78	627	84
1994	66186	83975	36	788	106
1995	60580	71202	30	851	114
1996	66867	66867	28	1000	134
1997	81202	74841	32	1085	146
1998	109947	86098	37	1277	171
1999	124381	120408	51	1033	138
2000	103289	126270	54	818	110
2001	101500	113789	48	892	120

Gillnet:

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	58948	1060	100	56	100
1992	59712	984	93	61	109
1993	56701	1008	95	56	101
1994	39192	718	68	55	98
1995	32309	437	41	74	133
1996	41764	492	46	85	153
1997	46742	483	46	97	174
1998	51554	721	68	71	127
1999	47648	781	74	61	104
2000	47989	842	79	57	102
2001	53943	1124	106	48	86

Longline:

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	44711	2006	100	22	100
1992	42301	2016	100	21	94
1993	47263	2224	111	21	95
1994	36426	1652	82	22	99
1995	44588	1724	86	26	116
1996	39770	1478	74	27	121
1997	31276	824	41	38	170
1998	37243	972	48	38	173
1999	53380	1570	78	34	155
2000	50085	1727	86	29	132
2001	47092	1811	90	26	118

Table 3.3.3 Cod at Iceland. Catch in numbers by year and age (millions).

year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	3.285	20.812	24.462	28.351	14.012	7.666	11.517	1.912	0.327	0.094	0.043	0.011
1983	3.554	10.91	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.75	31.552999	19.42	15.326	8.082	7.336	2.68	0.512	0.538	0.195	0.09	0.036
1985	6.457	24.552	35.391998	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.33	26.643999	30.839001	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.04
1987	11.002	62.130001	27.191999	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323002	55.895	18.663	6.399	5.877	1.345	0.455	0.305	0.157	0.114	0.025
1989	2.605	27.983	50.058998	31.455	6.01	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179001	44.534	17.037001	2.573	0.609	0.322	0.118	0.05	0.015	0.02
1991	8.554	25.131001	15.491	21.514	25.038	6.364	0.903	0.243	0.125	0.063	0.011	0.012
1992	12.217	21.708	26.524	11.413	10.073	8.304	2.006	0.257	0.046	0.032	0.012	0.008
1993	20.5	33.077999	15.195	13.281	3.583	2.785	2.707	1.181	0.18	0.034	0.011	0.013
1994	6.16	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.77	9.103	16.829	13.066	4.115	1.596	0.313	0.184	0.156	0.141	0.029	0.008
1996	5.356	14.886	7.372	12.307	9.43	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.441999	17.298	6.711	7.379	5.958	1.147	0.493	0.126	0.028	0.037	0.021
1998	3.548	7.707	25.393999	20.167	5.893	3.856	2.951	0.5	0.196	0.055	0.033	0.013
1999	2.525	19.554001	15.226	24.622	12.966	2.795	1.489	0.748	0.14	0.046	0.01	0.005
2000	10.493	6.581	29.08	11.227	11.39	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.332	25.027	9.306	19.461	5.617	3.927	2.016	0.444	0.202	0.118	0.013	0.009

Table 3.3.4 Cod at Iceland. Division Va. Proportion of fishing and natural mortality before spawning

F	M
0.085	0.250
0.180	0.250
0.248	0.250
0.296	0.250
0.382	0.250
0.437	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250

Table 3.3.5 Cod at Iceland. Division Va. Mean weight at age in the landings(g).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	1006	1550	2246	3104	4258	5386	6682	9141	11963	14226	17287	16590
1983	1095	1599	2275	3021	4096	5481	7049	8128	11009	13972	15882	18498
1984	1288	1725	2596	3581	4371	5798	7456	9851	11052	14338	15273	16660
1985	1407	1971	2576	3650	4976	6372	8207	10320	12197	14683	16175	19050
1986	1459	1961	2844	3593	4635	6155	7503	9084	10356	15283	14540	15017
1987	1316	1956	2686	3894	4716	6257	7368	9243	10697	10622	15894	12592
1988	1438	1805	2576	3519	4930	6001	7144	8822	9977	11732	14156	13042
1989	1186	1813	2590	3915	5210	6892	8035	9831	11986	10003	12611	16045
1990	1290	1704	2383	3034	4624	6521	8888	10592	10993	14570	15732	17290
1991	1309	1899	2475	3159	3792	5680	7242	9804	9754	14344	14172	20200
1992	1289	1768	2469	3292	4394	5582	6830	8127	12679	13410	15715	11267
1993	1392	1887	2772	3762	4930	6054	7450	8641	10901	12517	14742	16874
1994	1443	2063	2562	3659	5117	6262	7719	8896	10847	12874	14742	17470
1995	1348	1959	2920	3625	5176	6416	7916	10273	11022	11407	13098	15182
1996	1457	1930	3132	4141	4922	6009	7406	9772	10539	13503	13689	16194
1997	1484	1877	2878	4028	5402	6386	7344	8537	10797	11533	10428	12788
1998	1230	1788	2477	3588	5013	7293	7843	9283	10976	15352	17718	16068
1999	1241	1716	2426	3443	4720	6352	8730	9946	11088	12535	14995	15151
2000	1308	1782	2330	3252	4690	5894	7809	9203	10240	11172	13172	17442
2001	1499	2050	2649	3413	4766	6508	7520	9055	8796	9526	11210	13874

Table 3.3.6 Cod at Iceland. Division Va. Mean weight at age in the spawning stock(g)

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	996	1626	2095	3006	4339	5571	6801	9259	11550	13445	17138	16554
1983	891	1472	2139	2918	4130	5553	7007	7770	10817	13176	14175	18543
1984	1002	1479	2257	3476	4480	5887	7660	9920	11035	14531	15378	16394
1985	1131	1597	2285	3524	5010	6195	7800	9225	11336	13277	15325	18932
1986	1182	1762	2681	3562	4824	6457	7843	9419	10674	13660	13812	18479
1987	1289	1811	2735	4202	5110	6497	7802	10220	11197	10620	15893	16514
1988	1218	1604	2499	3566	5161	6238	7302	8647	10184	11504	14159	10952
1989	1012	1542	2423	3743	5298	6910	7725	9397	11953	9529	12195	14270
1990	813	1330	2132	3187	4691	6627	8915	10362	12093	15453	15337	17257
1991	1122	1776	2233	3044	3891	5897	7657	10573	11230	14340	14172	20200
1992	876	1389	2174	3185	4481	5587	6775	8225	11702	13474	15436	11267
1993	1037	1570	2518	3611	4872	6150	7538	8840	11088	12002	14402	18383
1994	1193	1748	2382	3684	5175	6210	7676	8814	10842	12595	14402	17470
1995	1066	1826	2735	3497	4741	6126	7582	9887	10829	11307	13098	15182
1996	1264	1627	2600	3829	4605	5792	7550	9433	11293	12984	13821	16194
1997	1221	1613	2595	3807	5434	6440	7629	8606	10486	11774	10943	15225
1998	1260	2018	2335	3529	5321	7731	8173	9397	10995	15274	17387	15069
1999	1068	1459	2231	3181	4743	6577	8561	10081	11200	12567	14995	15151
2000	1025	1498	2159	3236	4655	5957	7881	9458	10231	11736	13172	17442
2001	1121	1621	2417	3234	4854	6546	7935	9196	9086	9899	10351	13874

Table 3.3.7 Cod at Iceland. Division Va. Maturity at age in the stock at spawning time.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	0.02	0.05	0.13	0.23	0.54	0.85	0.96	0.97	1.00	1.00	1.00	1.00
1983	0.00	0.09	0.17	0.34	0.51	0.72	0.86	0.98	0.98	1.00	1.00	1.00
1984	0.00	0.04	0.19	0.42	0.66	0.78	0.86	0.95	0.97	0.95	1.00	1.00
1985	0.03	0.06	0.20	0.55	0.77	0.90	0.94	1.00	1.00	1.00	1.00	1.00
1986	0.01	0.05	0.24	0.54	0.76	0.89	0.98	0.96	0.99	1.00	1.00	1.00
1987	0.02	0.05	0.24	0.59	0.81	0.94	0.95	1.00	0.98	1.00	1.00	1.00
1988	0.04	0.02	0.21	0.48	0.69	0.83	0.93	0.95	0.97	0.82	1.00	1.00
1989	0.00	0.05	0.23	0.55	0.82	0.86	0.89	0.99	1.00	0.90	0.86	1.00
1990	0.00	0.08	0.30	0.63	0.82	0.91	0.95	0.99	1.00	1.00	1.00	1.00
1991	0.00	0.06	0.21	0.54	0.78	0.89	0.95	0.84	1.00	1.00	1.00	1.00
1992	0.07	0.23	0.56	0.71	0.91	0.96	0.98	1.00	1.00	1.00	1.00	1.00
1993	0.08	0.25	0.47	0.71	0.94	0.98	0.97	0.97	1.00	1.00	1.00	1.00
1994	0.10	0.28	0.57	0.80	0.90	0.92	1.00	0.85	0.99	1.00	1.00	1.00
1995	0.04	0.39	0.73	0.85	0.85	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.08	0.10	0.51	0.74	0.86	0.91	0.84	1.00	1.00	0.99	0.97	1.00
1997	0.07	0.31	0.50	0.74	0.88	0.92	0.97	0.93	1.00	0.91	1.00	1.00
1998	0.03	0.26	0.48	0.65	0.83	0.94	0.99	0.93	1.00	1.00	1.00	1.00
1999	0.05	0.30	0.55	0.72	0.83	0.93	0.97	0.99	1.00	1.00	0.84	1.00
2000	0.04	0.18	0.44	0.64	0.80	0.92	0.98	0.98	1.00	1.00	1.00	1.00
2001	0.13	0.41	0.61	0.79	0.92	0.90	0.97	0.99	1.00	1.00	1.00	1.00

Table 3.3.8 CPUE from bottom trawl survey 1985-2002. Sum of North and South (stratified mean) areas indices.

Year/age	1	2	3	4	5	6	7	8	9
1985	16.54	112.29	35.39	48.19	64.82	22.97	15.3	5.05	3.4
1986	15.1	61.03	95.72	22.49	21.54	27.48	7.18	2.8	0.94
1987	3.65	28.94	104.03	83.46	21.73	13	13.15	2.82	1
1988	3.45	7.48	72.71	104.93	70.98	8.56	6.51	7.04	0.68
1989	4.09	17.25	22.36	80.13	74.62	39.41	4.88	1.73	1.43
1990	5.57	12.09	26.71	14.29	27.92	35.3	16.78	1.77	0.59
1991	3.95	16.31	18.19	30.72	15.8	19.27	22.72	4.93	0.95
1992	0.72	17.46	33.84	19.08	16.63	6.9	6.37	5.78	1.49
1993	3.58	4.77	35.07	39.28	13.92	10.87	2.49	2.1	1.43
1994	13.76	16.02	8.85	27.06	23.21	6.22	4.08	0.81	0.53
1995	1.17	29.3	26.16	9.36	24.68	18.61	3.95	1.82	0.35
1996	3.63	5.36	41.94	28.26	12.55	14.39	13.73	3.69	0.97
1997	1.21	22.39	13.71	56.53	29.77	9.68	8.48	6.32	0.49
1998	7.98	5.47	29.78	15.95	61.45	28.15	6.54	5.46	3.34
1999	7.38	34.29	7.1	42.32	13.18	24.36	11.42	2.38	1.34
2000	18.81	28.53	55.62	7.18	30.82	8.53	8.41	4.26	0.5
2001	12.09	24.05	37	38.32	5.11	15.8	3.42	2.05	0.82
2002	0.91	38.67	41.23	40.27	36.31	7.12	8.34	1.49	0.74

Table 3.3.9 CPUE from bottom trawl survey 1985-2001 as used in the TSA runs. Weighted geometric mean of North and South (stratified mean) areas indices.

Year/age	3	4	5	6	7	8	9
1985	10194	17940	19807	9678	4247	2033	1450
1986	25776	8929	8998	10578	2972	861	402
1987	28528	30647	7163	5354	4111	1191	383
1988	18205	38415	26208	3789	2034	1789	287
1989	5163	29516	28150	16648	2006	650	438
1990	8065	3869	12159	16302	6186	741	266
1991	4833	11444	6426	9030	10353	2077	397
1992	11199	8270	6643	2902	2849	2725	639
1993	14173	17635	6459	4770	946	910	590
1994	4071	12707	9497	2786	1314	296	241
1995	9201	4489	10885	8189	1621	678	153
1996	14537	12390	5417	6939	5907	1458	467
1997	5101	20437	11214	4045	3212	2100	215
1998	8590	5603	17600	10281	2462	2007	1538
1999	2165	14238	5266	11516	5083	1187	529
2000	14457	3115	12745	3985	3545	2144	251
2001	13086	15931	2242	6714	1360	817	407
2002	12296	18074	17092	3608	3093	712	312

Table 3.3.10 XSA Tuning diagnostic. Total stratfied mean survey indices.

Lowestoft VPA Version 3.1

16/04/2002 21:02

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1972-2001"

CPUE data from file codvarnt.dat

Catch data for 31 years. 1971 to 2001. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SMB. Tot	1984	2001	3	8	0.99	1
SMB. Tot a3 on a3	1985	2001	3	3	0.17	0.25

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 5

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

Catchability independent of age for ages >= 11

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

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

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

Prior weighting not applied

Tuning converged after 15 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.08	0.167	0.095	0.076	0.036	0.023	0.025	0.053	0.064	0.074
4	0.379	0.323	0.303	0.199	0.144	0.148	0.137	0.188	0.188	0.216
5	0.635	0.501	0.325	0.358	0.245	0.247	0.359	0.437	0.472	0.443
6	0.894	0.781	0.453	0.373	0.486	0.369	0.511	0.716	0.681	0.679
7	1.1	0.808	0.651	0.533	0.508	0.612	0.651	0.741	0.895	0.907
8	1.023	1.13	0.76	0.522	0.6	0.716	0.774	0.759	0.893	0.94
9	0.617	1.237	0.799	0.425	0.579	0.763	1.001	0.801	0.793	0.972
10	0.528	0.951	0.822	0.615	0.562	0.83	0.94	0.762	0.846	0.903
11	0.396	0.904	0.625	0.651	0.559	0.818	0.99	0.762	0.881	0.865
12	0.708	0.576	0.67	0.751	0.629	0.411	1.122	0.664	1.337	1.046
13	0.263	0.567	0.702	1.172	0.761	0.94	1.319	0.616	0.799	0.923
14	0.477	0.759	0.709	0.803	0.634	0.758	1.106	0.707	0.979	0.944
F5-10	0.800	0.901	0.635	0.471	0.497	0.590	0.706	0.703	0.763	0.807

1

XSA population numbers (Thousands)

Table 3.3.10 (Cont'd)

YEAR	AGE 3	4	5	6	7	8	9	10	11	12
1992	1.75E+05	7.60E+04	6.24E+04	2.13E+04	1.67E+04	1.43E+04	4.82E+03	6.92E+02	1.56E+02	6.97E+01
1993	1.47E+05	1.32E+05	4.26E+04	2.71E+04	7.15E+03	4.55E+03	4.21E+03	2.13E+03	3.34E+02	8.58E+01
1994	7.51E+04	1.02E+05	7.84E+04	2.11E+04	1.01E+04	2.61E+03	1.20E+03	1.00E+03	6.73E+02	1.11E+02
1995	1.62E+05	5.59E+04	6.18E+04	4.64E+04	1.10E+04	4.33E+03	9.99E+02	4.43E+02	3.60E+02	2.95E+02
1996	1.67E+05	1.23E+05	3.75E+04	3.54E+04	2.62E+04	5.29E+03	2.10E+03	5.34E+02	1.96E+02	1.54E+02
1997	8.32E+04	1.32E+05	8.72E+04	2.40E+04	1.78E+04	1.29E+04	2.38E+03	9.66E+02	2.49E+02	9.18E+01
1998	1.58E+05	6.65E+04	9.31E+04	5.57E+04	1.36E+04	7.91E+03	5.16E+03	9.07E+02	3.45E+02	9.01E+01
1999	5.45E+04	1.26E+05	4.75E+04	5.32E+04	2.74E+04	5.81E+03	2.99E+03	1.55E+03	2.90E+02	1.05E+02
2000	1.86E+05	4.24E+04	8.54E+04	2.51E+04	2.13E+04	1.07E+04	2.23E+03	1.10E+03	5.93E+02	1.11E+02
2001	1.76E+05	1.43E+05	2.87E+04	4.36E+04	1.04E+04	7.12E+03	3.58E+03	8.25E+02	3.86E+02	2.01E+02

Estimated population abundance at 1st Jan 2002

0.00E+00	1.34E+05	9.41E+04	1.51E+04	1.81E+04	3.44E+03	2.28E+03	1.11E+03	2.74E+02	1.33E+02

Taper weighted geometric mean of the VPA populations:

1.63E+05	1.26E+05	8.19E+04	4.64E+04	2.21E+04	9.59E+03	3.72E+03	1.45E+03	5.34E+02	1.99E+02

Standard error of the weighted Log(VPA populations) :

0.4456	0.4423	0.4481	0.4484	0.5408	0.6477	0.7589	0.8238	0.7381	0.6831

YEAR	AGE 13	14
1992	4.30E+01	2.33E+01
1993	2.81E+01	2.70E+01
1994	3.95E+01	1.31E+01
1995	4.64E+01	1.60E+01
1996	1.14E+02	1.18E+01
1997	6.71E+01	4.37E+01
1998	4.98E+01	2.15E+01
1999	2.40E+01	1.09E+01
2000	4.42E+01	1.06E+01
2001	2.38E+01	1.63E+01

Estimated population abundance at 1st Jan 2002

5.79E+01	7.76E+00

Taper weighted geometric mean of the VPA populations:

7.23E+01	2.49E+01

Standard error of the weighted Log(VPA populations) :

0.6977	1.1018

1

Log catchability residuals.

Fleet : SMB. Tot

Age	1984	1985	1986	1987	1988	1989	1990	1991
3	0.29	-0.26	-0.22	0.1	0.43	-0.02	0.04	0.02
4	0.13	-0.06	-0.14	-0.08	0.05	-0.1	0.18	-0.18
5	0.23	0.03	0.07	-0.51	0.26	-0.15	0.1	-0.2
6	0.58	-0.27	0.07	0.25	-0.15	0.1	0.14	-0.14
7	0.24	-0.25	-0.14	0.61	0.07	-0.25	-0.15	-0.1
8	0.66	-0.37	0	-0.23	0.75	0.22	0.29	-0.22

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	-0.05	-0.07	-0.15	-0.2	0.21	0.05	0.07	-0.03	-0.14	-0.05
4	0.06	-0.18	0.11	0.17	-0.06	0.38	-0.02	-0.03	-0.19	-0.02
5	0.02	-0.29	0.02	0.03	0.02	0.25	0.15	-0.15	-0.08	0.18
6	-0.23	-0.09	-0.2	0.18	0.08	0.09	-0.05	-0.11	-0.29	0.05
7	0.04	-0.36	-0.06	0.45	0.1	0.44	-0.08	-0.11	-0.43	-0.03
8	-0.13	0.13	-0.1	0.18	-0.62	0.52	0.15	-0.54	-0.52	-0.17

Table 3.3.10 (Cont'd)

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

Age	5	6	7	8
Mean Log q	-7.8443	-7.7344	-7.7237	-7.8657
S.E(Log q)	0.2025	0.2172	0.2825	0.4006

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.67	3.43	9.39	0.87	18	0.18	-8.15
4	0.7	3.74	9.05	0.91	18	0.16	-7.95

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.92	0.831	8.12	0.86	18	0.19	-7.84
6	0.87	1.29	8.11	0.86	18	0.19	-7.73
7	0.95	0.338	7.82	0.76	18	0.28	-7.72
8	0.92	0.455	7.95	0.64	18	0.38	-7.87
1							

Fleet : SMB. Tot a3 on a3

Age	1984	1985	1986	1987	1988	1989	1990	1991
3	99.99	0.06	-0.12	0.11	0.38	0.3	-0.04	-0.03
4	No data for this fleet at this age							
5	No data for this fleet at this age							
6	No data for this fleet at this age							
7	No data for this fleet at this age							
8	No data for this fleet at this age							

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	-0.15	0.06	-0.2	-0.25	0.03	-0.02	-0.14	-0.03	0.12	-0.1
4	No data for this fleet at this age									
5	No data for this fleet at this age									
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.67	3.626	9.53	0.89	17	0.17	-8.38
1							

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1998

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	127925	0.3	0	0	1	0.347	0.077
SMB. Tot a3 on a3	121430	0.3	0	0	1	0.347	0.081
P shrinkage mean	125534	0.44				0.172	0.079
F shrinkage mean	211704	0.5				0.134	0.047

Table 3.3.10 (Cont'd)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
134001	0.18	0.11	4	0.631	0.074

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Age 4 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	87235	0.212	0.061	0.29	2	0.5	0.231
SMB. Tot a3 on a3	106017	0.3	0	0	1	0.242	0.194
P shrinkage mean	81912	0.45				0.143	0.244
F shrinkage mean	120724	0.5				0.115	0.172

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
94080	0.15	0.07	5	0.436	0.216

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	15068	0.174	0.111	0.64	3	0.66	0.444
SMB. Tot a3 on a3	14649	0.3	0	0	1	0.198	0.454
F shrinkage mean	15867	0.5				0.142	0.426

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
15094	0.15	0.07	5	0.441	0.443

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	18209	0.157	0.033	0.21	4	0.685	0.677
SMB. Tot a3 on a3	15757	0.3	0	0	1	0.131	0.75
F shrinkage mean	19573	0.5				0.184	0.642

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18107	0.15	0.04	6	0.241	0.679

Table 3.3.10 (Cont'd)

Age 7 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	3150	0.154	0.059	0.38	5	0.672	0.961
SMB. Tot a3 on a3	3380	0.3	0	0	1	0.078	0.918
F shrinkage mean	4383	0.5				0.25	0.77

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3440	0.16	0.08	7	0.47	0.907

1

Age 8 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	1997	0.175	0.112	0.64	6	0.593	1.022
SMB. Tot a3 on a3	2355	0.3	0	0	1	0.045	0.92
F shrinkage mean	2812	0.5				0.361	0.817

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2277	0.21	0.11	8	0.505	0.94

Age 9 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	929	0.155	0.11	0.71	6	0.43	1.086
SMB. Tot a3 on a3	867	0.3	0	0	1	0.041	1.132
F shrinkage mean	1305	0.5				0.529	0.874

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1109	0.27	0.11	8	0.413	0.972

Age 10 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	240	0.148	0.113	0.76	6	0.327	0.984
SMB. Tot a3 on a3	225	0.3	0	0	1	0.032	1.025
F shrinkage mean	296	0.5				0.641	0.858

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
274	0.32	0.09	8	0.262	0.903

Table 3.3.10 (Cont'd)

Age 11 Catchability constant w.r.t. time and dependent on age

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	160	0.156	0.075	0.48	6	0.167	0.761
SMB. Tot a3 on a3	141	0.3	0	0	1	0.012	0.832
F shrinkage mean	128	0.5				0.82	0.887

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
133	0.41	0.08	8	0.19	0.865

1

Age 12 Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	68	0.148	0.099	0.67	6	0.071	0.943
SMB. Tot a3 on a3	50	0.3	0	0	1	0.006	1.146
F shrinkage mean	57	0.5				0.923	1.053

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
58	0.46	0.06	8	0.128	1.046

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	7	0.157	0.185	1.18	6	0.026	0.983
SMB. Tot a3 on a3	8	0.3	0	0	1	0.002	0.938
F shrinkage mean	8	0.5				0.972	0.921

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8	0.49	0.04	8	0.09	0.923

1

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	5	0.177	0.054	0.3	6	0.021	0.931
SMB. Tot a3 on a3	5	0.3	0	0	1	0.001	0.969
F shrinkage mean	5	0.5				0.978	0.944

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5	0.49	0.01	8	0.02	0.944

Table 3.3.11 Cod at Iceland. Division Va. TSA-results

Input data and estimated parameters:

Data: Catch at age 1971–2001 and spring trawl survey indices (weighted geometric of North and South) 1985–2002.

Estimated stock in numbers and total biomass:

Year/age	4	5	6	7	8	9	10	11	BIOM(4-11)
1984	184720.	76888.	40368.	18416.	13787.	4983.	987.	983.	881.0
1985	109545.	122883.	44927.	19635.	7855.	4696.	1711.	339.	904.5
1986	108324.	66760.	67388.	20841.	7917.	2928.	1648.	588.	832.8
1987	253886.	69652.	31494.	26644.	7028.	2512.	923.	528.	1008.6
1988	234614.	151967.	33204.	11705.	8312.	2058.	740.	273.	1063.3
1989	133789.	152446.	74948.	12023.	3459.	1844.	472.	176.	1038.9
1990	65268.	83394.	102917.	33051.	4568.	1174.	637.	162.	823.8
1991	102522.	42346.	43269.	43854.	12126.	1585.	404.	219.	688.9
1992	76913.	60815.	20143.	15827.	13972.	3997.	506.	125.	533.0
1993	133636.	42950.	26020.	6694.	4482.	4286.	1422.	177.	575.4
1994	100060.	79838.	20718.	9947.	2235.	1231.	1089.	360.	574.8
1995	56026.	61266.	46731.	10598.	4345.	868.	477.	426.	557.3
1996	121872.	37534.	35298.	25410.	5192.	2064.	409.	221.	676.8
1997	130327.	86410.	23464.	17910.	12313.	2332.	932.	183.	790.3
1998	65621.	91479.	54872.	12988.	8116.	5028.	895.	353.	716.7
1999	127062.	46405.	52830.	26632.	5412.	2889.	1562.	286.	716.5
2000	41422.	85002.	24378.	21153.	10183.	2028.	1085.	597.	542.3
2001	149672.	27855.	43937.	9936.	7199.	3453.	710.	381.	660.5
2002	139556.	99890.	14599.	18045.	3374.	2328.	1085.	222.	729.1

Standard deviation of stock estimate:

2001	11957.	2087.	2749.	677.	659.	353.	90.	68.	35.1
2002	17335.	9625.	1494.	1900.	419.	395.	225.	51.	52.2

Estimated fishing mortality rates:

Year/age	4	5	6	7	8	9	10	11	FGBAR	FBAR
1984	0.207	0.337	0.519	0.652	0.877	0.868	0.864	0.874	0.649	0.686
1985	0.294	0.401	0.568	0.706	0.787	0.845	0.868	0.868	0.673	0.696
1986	0.241	0.543	0.728	0.887	0.947	0.948	0.935	0.943	0.816	0.831
1987	0.310	0.538	0.784	0.964	1.028	1.022	1.017	1.022	0.870	0.892
1988	0.231	0.505	0.813	1.018	1.266	1.237	1.206	1.212	0.961	1.007
1989	0.261	0.447	0.615	0.757	0.878	0.860	0.865	0.885	0.717	0.737
1990	0.231	0.451	0.651	0.802	0.858	0.865	0.866	0.874	0.730	0.749
1991	0.322	0.542	0.777	0.920	0.903	0.936	0.960	0.943	0.824	0.840
1992	0.380	0.649	0.897	1.026	0.962	0.834	0.851	0.872	0.861	0.870
1993	0.315	0.528	0.761	0.897	1.059	1.122	1.143	1.131	0.888	0.918
1994	0.270	0.336	0.470	0.628	0.746	0.747	0.739	0.749	0.587	0.611
1995	0.200	0.337	0.410	0.513	0.537	0.536	0.556	0.560	0.474	0.481
1996	0.142	0.270	0.446	0.522	0.595	0.594	0.607	0.606	0.488	0.506
1997	0.152	0.255	0.391	0.572	0.695	0.757	0.770	0.769	0.534	0.573
1998	0.147	0.343	0.522	0.672	0.785	0.910	0.883	0.860	0.651	0.686
1999	0.201	0.444	0.695	0.758	0.775	0.758	0.743	0.753	0.684	0.695
2000	0.197	0.460	0.697	0.862	0.876	0.846	0.840	0.844	0.746	0.763
2001	0.204	0.444	0.689	0.879	0.929	0.957	0.964	0.948	0.783	0.810

Standard deviations of log(F):

2001	0.11	0.09	0.08	0.08	0.10	0.12	0.13	0.13	0.074

Table 3.3.11 (Continued)

Standardized catch prediction errors:

Year/age	4	5	6	7	8	9	10	11
1985	1.54	1.00	1.03	-0.78	0.45	-1.24	1.02	0.79
1986	-0.30	1.12	1.55	1.02	0.06	1.15	-0.75	0.62
1987	1.29	1.26	-1.03	0.47	0.16	0.35	1.09	-0.27
1988	-1.59	0.72	1.93	-0.98	0.71	0.33	0.31	2.11
1989	-0.62	-1.01	-0.77	-0.17	-0.60	-2.39	-1.97	-0.83
1990	0.01	-1.73	-0.55	0.67	1.37	0.11	-0.04	0.92
1991	1.08	1.68	0.08	0.32	-0.56	0.45	0.63	0.32
1992	0.93	1.01	1.12	-0.64	-1.08	-1.10	-0.81	-1.46
1993	0.29	-1.23	-0.10	-0.78	-1.07	-0.43	2.22	1.89
1994	0.04	-0.35	-0.37	0.49	1.90	-0.71	-1.00	0.86
1995	-0.54	-1.71	-0.95	-0.57	-1.29	-1.31	-0.80	-0.62
1996	-0.30	-0.91	-1.24	0.16	0.04	0.46	1.86	0.00
1997	-0.70	0.77	0.17	-1.43	0.66	0.22	1.27	1.80
1998	-0.48	1.16	1.84	0.89	-1.46	1.04	0.61	0.47
1999	1.79	1.90	0.62	0.77	0.22	-1.61	-2.00	-1.44
2000	-0.50	1.09	0.89	-0.81	0.51	0.12	-0.67	-0.44
2001	0.36	0.04	-0.29	0.50	-0.95	0.09	0.60	-0.33
2002	-0.03	0.01	-0.01	0.01	0.05	0.03	0.03	0.01

Skewness and kurtosis:
1.013 -1.667

Correlation within cohorts aages and years: 0.23 0.36 -0.09

Standardized prediction errors of cpue:

Year/age	4	5	6	7	8	9
1985	1.72	0.16	1.25	0.30	1.16	0.82
1986	-0.55	-0.57	0.10	-1.08	-1.77	-0.49
1987	0.22	-0.75	-0.23	-0.47	0.08	0.00
1988	0.72	1.10	-0.28	-0.48	0.61	-0.37
1989	1.54	0.45	2.21	0.54	0.20	-0.08
1990	-0.95	-1.71	-0.05	1.00	0.56	0.73
1991	0.60	1.31	0.53	0.90	-0.16	1.02
1992	0.65	-1.08	-0.34	-1.27	-0.66	-0.53
1993	1.03	0.16	1.08	-1.12	-0.60	-1.03
1994	-1.10	-0.92	-0.47	-1.31	-0.95	-0.58
1995	-0.59	-1.29	0.62	-0.68	-0.40	0.03
1996	0.25	0.01	-0.60	1.27	1.95	1.09
1997	0.63	0.02	0.36	-2.06	-0.81	-2.14
1998	-0.51	-0.06	0.63	-0.24	-0.07	1.40
1999	0.95	-0.51	0.29	-0.18	0.15	-1.20
2000	-0.42	0.38	0.62	-1.48	0.06	-1.37
2001	0.02	-1.18	-0.11	-1.10	-1.84	-1.22
2002	0.50	0.74	2.51	0.31	0.95	-0.36

Skewness and kurtosis:
0.011 -0.473

Correlation within cohorts ages and years: -0.11 0.32 -0.13

Skewness and kurtosis are transformed to variables which folllow N(0;1) distribution if the resuduals are normally distributed.

Table 3.3.12 AD Model Builder -Statistical Catch at Age - ADMB-SCA - diagnostic and results.

Input data and estimated parameters:

Data: Catch at age 1971–2001 and spring trawl survey indices 1985–2002.

age	M	Survey Sigma	Survey lnQ	Survey Power	Meansel	Progsel	Sigma
1	0.2	0.331	-23.474	2.089	-1.000	-1.000	-1.000
2	0.2	0.264	-17.933	1.763	-1.000	-1.000	-1.000
3	0.2	0.221	-16.729	1.709	0.080	0.060	0.223
4	0.2	0.195	-14.625	1.572	0.306	0.219	0.188
5	0.2	0.181	-12.180	1.397	0.469	0.458	0.165
6	0.2	0.177	-7.650	1.000	0.593	0.741	0.151
7	0.2	0.182	-7.495	1.000	0.741	0.929	0.143
8	0.2	0.197	-7.457	1.000	0.868	0.962	0.141
9	0.2	0.224	-7.599	1.000	0.930	0.994	0.145
10	0.2	0.268	-7.564	1.000	1.016	1.000	0.154
11	0.2	-1.000	-1.000	-1.000	1.056	0.932	0.171
12	0.2	-1.000	-1.000	-1.000	1.132	0.906	0.197
13	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.237
14	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.295

Estimated fishing mortality rates:

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.072	0.077	0.083	0.079	0.075	0.044	0.042	0.044	0.051	0.056	0.059
4	0.310	0.400	0.327	0.304	0.178	0.145	0.144	0.149	0.183	0.211	0.231
5	0.545	0.574	0.542	0.313	0.381	0.275	0.258	0.366	0.419	0.445	0.434
6	0.808	0.865	0.746	0.563	0.384	0.458	0.447	0.518	0.725	0.712	0.708
7	0.907	1.029	0.854	0.723	0.509	0.512	0.604	0.661	0.730	0.954	0.951
8	0.852	1.001	1.063	0.847	0.566	0.619	0.673	0.755	0.772	0.886	0.954
9	0.784	0.779	1.043	0.953	0.508	0.596	0.718	0.831	0.821	0.855	0.953
10	0.840	0.769	0.826	0.842	0.685	0.693	0.767	0.820	0.838	0.866	0.911
11	0.797	0.766	0.775	0.746	0.725	0.739	0.771	0.792	0.782	0.787	0.787
12	1.073	1.129	1.101	1.065	0.618	0.608	0.636	0.720	0.780	0.831	0.837
13	0.842	0.846	0.879	0.890	0.885	0.881	0.860	0.838	0.834	0.835	0.837
14	0.842	0.846	0.879	0.890	0.885	0.881	0.860	0.838	0.834	0.835	0.837
F(5-10)	**0.789**	**0.836**	**0.846**	**0.707**	**0.506**	**0.526**	**0.578**	**0.659**	**0.717**	**0.786**	**0.818**

Table 3.3.12 (Continued)

Estimated stock in numbers:

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	109.739	165.733	143.102	72.332	144.357	183.501	79.320	148.775	56.990	182.550	167.284	186.451
4	99.192	83.627	125.688	107.788	54.714	109.618	143.815	62.260	116.566	44.342	141.388	129.090
5	44.112	59.538	45.890	74.215	65.136	37.495	77.660	101.962	43.902	79.503	29.397	91.865
6	46.058	20.941	27.456	21.852	44.450	36.422	23.312	49.131	57.904	23.638	41.725	15.602
7	39.423	16.807	7.216	10.657	10.188	24.779	18.858	12.210	23.959	22.961	9.494	16.835
8	12.430	13.034	4.918	2.515	4.234	5.013	12.153	8.443	5.160	9.451	7.240	3.004
9	1.614	4.340	3.920	1.391	0.883	1.968	2.210	5.079	3.248	1.953	3.191	2.282
10	0.415	0.603	1.630	1.131	0.439	0.435	0.888	0.882	1.812	1.170	0.680	1.007
11	0.252	0.147	0.229	0.584	0.399	0.181	0.178	0.337	0.318	0.642	0.403	0.224
12	0.075	0.093	0.056	0.086	0.227	0.158	0.071	0.067	0.125	0.119	0.239	0.150
13	0.030	0.021	0.025	0.015	0.024	0.100	0.071	0.031	0.027	0.047	0.042	0.085
14	0.036	0.023	0.016	0.014	0.010	0.012	0.038	0.038	0.024	0.018	0.023	0.023

Residuals:

Log(Cay-oberved/Cay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	0.09	0.31	-0.16	-0.26	-0.53	-0.21	0.22	0.10	0.68	0.21	0.13
4	-0.01	-0.04	0.07	-0.14	-0.07	-0.11	0.04	-0.15	0.04	-0.06	0.12
5	0.04	-0.07	0.05	0.10	-0.33	-0.06	-0.09	0.11	-0.14	0.08	-0.11
6	0.05	0.03	-0.05	0.25	0.02	0.10	-0.09	0.02	0.00	-0.21	0.01
7	-0.09	0.12	0.02	-0.08	0.02	-0.08	0.15	0.01	-0.06	-0.13	0.10
8	-0.04	0.00	0.03	-0.03	-0.15	0.11	-0.03	0.09	-0.06	-0.05	-0.05
9	-0.12	0.09	0.03	0.19	-0.33	-0.04	0.11	-0.07	0.14	-0.27	-0.03
10	0.02	-0.10	0.07	0.13	-0.17	-0.12	0.10	-0.13	0.33	-0.15	-0.07
11	0.01	0.06	-0.20	0.37	-0.19	0.13	-0.01	-0.33	0.41	0.00	-0.17
12	-0.10	0.13	-0.04	0.18	0.05	-0.10	0.24	-0.41	-0.01	-0.05	0.33
13	0.05	-0.31	0.15	0.51	-0.14	-0.26	-0.14	-0.07	-0.07	0.30	0.39
14	-0.08	-0.10	0.02	-0.15	-0.72	-0.17	-0.20	-0.14	0.15	-0.05	0.10

Year/age	1996	1997	1998	1999	2000	2001	2002
3	-0.28	-0.54	-0.49	0.06	0.18	0.26	-5.91
4	0.10	-0.06	-0.02	0.18	-0.14	-0.06	-6.78
5	-0.11	0.07	-0.11	0.09	0.13	-0.01	-7.10
6	0.01	-0.13	0.10	-0.06	0.03	0.00	-5.72
7	0.04	-0.06	0.08	0.07	-0.11	0.05	-5.97
8	0.02	0.09	-0.06	-0.01	0.13	-0.04	-4.28
9	0.03	0.10	0.11	-0.18	0.08	0.11	-4.03
10	0.04	0.12	0.09	-0.08	-0.07	0.18	-3.24
11	-0.11	0.30	0.13	-0.10	-0.01	0.00	-1.83
12	-0.01	-0.05	0.37	-0.16	0.15	-0.05	-1.50
13	0.02	-0.01	0.39	-0.12	-0.03	-0.24	-1.14
14	-0.05	0.02	-0.18	-0.26	-0.12	-0.10	-0.48

Table 3.3.12 (Continued)

Log(Uay-observed/Uay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.18	0.55	0.56	-0.19	0.28	-0.24	-0.27	-0.43	-0.38	0.43	-0.22
2	0.39	0.06	0.02	-0.08	0.10	0.03	-0.39	-0.07	-0.16	-0.17	0.01
3	0.22	-0.27	0.08	0.41	0.44	-0.01	-0.11	-0.19	0.09	-0.12	-0.22
4	0.34	-0.26	-0.30	0.16	0.52	-0.09	0.12	-0.05	0.00	-0.13	-0.17
5	0.19	-0.13	-0.01	-0.01	0.15	-0.21	0.20	-0.15	0.03	-0.20	0.06
6	0.29	0.03	0.02	-0.33	0.23	-0.14	0.07	-0.15	0.00	-0.35	-0.01
7	0.50	-0.17	0.05	0.18	-0.10	0.05	0.25	-0.13	-0.24	-0.18	-0.20
8	0.21	-0.23	-0.05	0.53	-0.02	-0.15	-0.16	-0.02	-0.04	-0.29	-0.12
9	0.47	-0.23	0.02	-0.05	0.38	0.13	0.26	-0.15	-0.06	-0.03	-0.05
10	0.47	0.07	-0.03	-0.06	0.07	0.26	0.30	-0.05	-0.36	-0.01	-0.02

Y/a	1996	1997	1998	1999	2000	2001	2002
1	-0.42	0.35	-0.09	0.01	0.70	-0.15	-0.31
2	-0.20	0.11	0.37	0.17	0.14	-0.21	-0.10
3	-0.17	0.14	-0.15	0.06	0.13	-0.13	-0.21
4	-0.17	0.10	0.15	0.15	-0.09	-0.24	-0.07
5	0.13	-0.03	0.34	0.00	0.03	-0.37	-0.05
6	-0.05	-0.01	0.32	0.06	-0.09	-0.05	0.10
7	0.14	-0.05	0.13	0.03	-0.18	-0.19	0.05
8	0.37	0.07	0.29	-0.03	-0.03	-0.43	0.02
9	0.11	-0.44	0.43	0.01	-0.31	-0.34	-0.19
10	-0.08	-0.31	0.44	-0.11	-0.28	-0.08	-0.22

Table 3.3.12 (Continued)

Summary:

year	F5.10	SSB	Cbio	Cbio4.	N3
1955	0.33	984	1531	2235	150920
1956	0.32	932	1387	1998	187269
1957	0.33	969	1342	1886	169072
1958	0.33	1132	1399	1952	213303
1959	0.35	908	1205	1735	300934
1960	0.37	802	1171	1758	150388
1961	0.36	666	899	1407	195572
1962	0.40	684	984	1481	135632
1963	0.47	586	864	1277	170562
1964	0.56	519	816	1194	280031
1965	0.60	405	704	1132	244505
1966	0.58	374	714	1214	272098
1967	0.59	452	785	1393	307274
1968	0.61	533	853	1515	170511
1969	0.56	601	905	1483	251041
1970	0.58	599	887	1412	187171
1971	0.63	446	732	1154	187775
1972	0.68	369	643	997	144585
1973	0.73	368	530	831	278941
1974	0.78	279	504	921	178792
1975	0.80	285	494	891	256607
1976	0.74	248	524	954	379858
1977	0.65	289	636	1309	136309
1978	0.52	352	724	1304	222249
1979	0.48	449	806	1391	243367
1980	0.52	488	869	1467	146743
1981	0.62	390	851	1304	143086
1982	0.73	230	596	951	131010
1983	0.73	191	497	787	223711
1984	0.67	197	502	894	145652
1985	0.69	229	518	919	132323
1986	0.78	224	497	835	316706
1987	0.85	213	507	996	270033
1988	0.88	164	502	1013	180930
1989	0.71	234	521	1012	89082
1990	0.73	294	497	846	129050
1991	0.79	189	399	684	109739
1992	0.84	204	327	549	165733
1993	0.85	190	307	580	143102
1994	0.71	225	296	591	72332
1995	0.51	292	315	557	144357
1996	0.53	245	371	656	183501
1997	0.58	318	422	795	79320
1998	0.66	261	424	717	148775
1999	0.72	276	402	714	56990
2000	0.79	201	338	539	182550
2001	0.82	289	340	639	167284
2002	0.60	254	354	685	186451
Mean	**0.62**	**417**	**681**	**1116**	**186734**

Table 3.3.13 Excel Statistical Catch at Age - STAM - diagnostic and results.

Input data and estimated parameters:

The fitting procedure was based on minimizing

$$SSR_C = \sum_{ay} \frac{\left[\ln\left(C_{ay}\right) - \ln\left(\hat{C}_{ay}\right)\right]^2}{2\sigma_a^2}$$

$$SSR_I = \sum_{ay} \frac{\left[\ln(I_{ay}) - \ln(\hat{I}_{ay})\right]^2}{2\rho_a^2}$$

$$SSR_T = a_C SSR_c + a_I SSR_I$$

The weighting factor (a_c and a_I) in each case was set to one. To reflect different accuracy by age in the estimation of catch-at-age and survey-index-at-age the residuals by age in the SSR_C and SSR_I were weighted according:

Age ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Catch (sigma)			0,32	0,22	0,16	0,13	0,12	0,11	0,12	0,14	0,17	0,24	0,36	0,60	0,60
Survey (rho)	0,39	0,30	0,24	0,22	0,20	0,21	0,22	0,26	0,32	0,43					

In order to force the model to fit the observed yield within each year an additional minimization factor (penalty factor) was set in:

$$SSR_Y = \sum_{y} \frac{\left[\ln\left(Y_y\right) - \ln\left(\hat{Y}_y\right)\right]^2}{2\sigma_a^2}$$

$$SSR_T = a_C SSR_c + a_I SSR_I + a_Y SSR_y$$

where the a_Y factor was set to 1000.

The input data were into the model where:

1) catch-in-number matrix was based on ages 3 to 14 for years 1985 to 2001, Ca for ages 1 and 2 were assuemd 0 (thus 204 input values).
2) aged survey indices for ages 1 to 9 for years 1985-2002 (162 input values).
3) auxillary data on the CV by age groups for Cay and Uay - data obtained from hoski@hafro.is (see intext table above).
4) auxillary data such as corresponding weight at age in the catch and in the survey and maturity at age in the catch.

The number of estimated parameters were:

1) 13 estimates of N_{a85} for a = 2, 3, … , 14
2) 18 estimates of N_{1y} for y = 1985, 1986, …. , 2002
3) 9 estimates of α_a for a=1, 2, …. , 9
4) 7 estimates of β_a for a = 1, 2, …. , 7. I.e. power model was used for age groups 1-7, simple linear model for age groups 8 and 9 was used (β=1). The judgement on where to use power model was based on residual plots.
5) 17 estimates of Fy for y = 1985, 1986, …. , 2001
6) estmates of a_{50} and a_{95}
or a total of 66 parameter estimates.

See WD-22

Table 3.3.13 (Continued)

Estimated fishing mortality rates:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.077	0.082	0.086	0.060	0.048	0.046	0.047	0.057	0.066	0.073	0.076
4	0.236	0.251	0.262	0.183	0.148	0.141	0.145	0.173	0.202	0.222	0.231
5	0.525	0.560	0.582	0.406	0.329	0.313	0.322	0.385	0.450	0.495	0.515
6	0.782	0.834	0.868	0.606	0.490	0.467	0.480	0.574	0.672	0.738	0.768
7	0.901	0.961	1.000	0.698	0.564	0.537	0.552	0.662	0.774	0.850	0.884
8	0.939	1.002	1.043	0.727	0.588	0.560	0.576	0.690	0.806	0.886	0.922
9	0.950	1.013	1.055	0.736	0.595	0.567	0.583	0.698	0.816	0.896	0.933
10	0.953	1.017	1.058	0.738	0.597	0.569	0.584	0.700	0.818	0.899	0.936
11	0.954	1.017	1.059	0.739	0.598	0.569	0.585	0.700	0.819	0.900	0.936
12	0.954	1.018	1.059	0.739	0.598	0.569	0.585	0.701	0.819	0.900	0.936
13	0.954	1.018	1.059	0.739	0.598	0.569	0.585	0.701	0.819	0.900	0.937
14	0.954	1.018	1.059	0.739	0.598	0.569	0.585	0.701	0.819	0.900	0.937
F5-10	**0.842**	**0.898**	**0.934**	**0.652**	**0.527**	**0.502**	**0.516**	**0.618**	**0.723**	**0.794**	**0.826**

Estimated stock in numbers:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	103.313	171.637	121.503	72.425	150.407	172.190	81.950	153.101	56.488	181.073	166.289	188.134
4	100.234	78.295	129.407	91.302	55.852	117.322	134.627	63.991	118.434	43.280	137.831	126.201
5	46.612	64.829	49.851	81.557	62.278	39.449	83.455	95.390	44.064	79.199	28.371	89.535
6	44.868	22.581	30.328	22.797	44.476	36.703	23.618	49.532	53.127	22.992	39.534	13.878
7	43.187	16.801	8.027	10.421	10.184	22.306	18.845	11.971	22.834	22.223	9.003	15.020
8	13.102	14.361	5.262	2.418	4.247	4.742	10.670	8.881	5.058	8.626	7.780	3.044
9	1.764	4.193	4.317	1.519	0.956	1.930	2.217	4.911	3.648	1.849	2.912	2.533
10	0.517	0.558	1.246	1.231	0.596	0.432	0.897	1.014	2.002	1.321	0.618	0.938
11	0.317	0.163	0.165	0.354	0.482	0.268	0.200	0.409	0.412	0.723	0.440	0.198
12	0.084	0.100	0.048	0.047	0.139	0.217	0.124	0.091	0.166	0.149	0.241	0.141
13	0.032	0.027	0.030	0.014	0.018	0.062	0.101	0.057	0.037	0.060	0.050	0.077
14	0.014	0.010	0.008	0.008	0.005	0.008	0.029	0.046	0.023	0.013	0.020	0.016

Table 3.3.13. (Continued)

Residuals:

Log(Uay-observed/Uay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
4	0.53	-0.40	-0.42	0.14	0.67	-0.14	0.06	-0.04	-0.08	0.08	-0.23
5	0.20	-0.05	-0.16	-0.25	0.11	-0.15	0.18	-0.27	-0.05	-0.28	0.19
6	0.21	0.03	0.01	-0.44	0.13	-0.24	0.05	-0.21	-0.08	-0.32	0.03
7	0.47	-0.29	0.08	0.27	-0.09	-0.09	-0.09	-0.20	-0.24	-0.06	-0.07
8	0.16	-0.26	-0.11	0.70	-0.01	-0.21	-0.21	-0.14	-0.15	-0.32	-0.08
9	0.65	-0.37	0.01	-0.14	0.47	0.10	0.34	-0.08	-0.15	-0.10	-0.05

Y/a	1996	1997	1998	1999	2000	2001	2002
4	-0.26	0.22	0.09	0.13	-0.11	-0.20	-0.02
5	0.20	-0.07	0.46	0.08	0.05	-0.20	0.03
6	-0.01	0.08	0.32	0.10	-0.02	0.00	0.36
7	0.22	-0.06	0.24	0.01	-0.27	-0.06	0.21
8	0.52	0.25	0.28	0.02	0.06	-0.56	0.06
9	0.27	-0.55	0.57	-0.04	-0.35	-0.31	-0.27

Log(CNay-observed/CNay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
4	0.45	-0.02	0.15	-0.06	0.30	0.09	0.27	0.31	0.20	0.56	0.27
5	-0.05	0.09	-0.04	-0.14	0.11	-0.01	-0.12	0.04	-0.28	-0.23	0.06
6	-0.07	0.00	-0.12	0.09	-0.12	0.00	-0.04	-0.03	-0.20	-0.31	-0.19
7	-0.08	0.07	0.14	-0.01	0.00	0.04	0.06	0.05	-0.27	-0.09	0.02
8	-0.08	0.03	0.05	0.31	0.01	0.09	-0.14	-0.01	-0.12	0.09	-0.08
9	-0.01	-0.11	-0.03	0.14	-0.29	-0.14	-0.10	-0.20	0.04	-0.19	-0.23

Y/a	1996	1997	1998	1999	2000	2001
4	0.06	0.00	-0.18	-0.01	-0.18	-0.03
5	-0.27	-0.19	-0.09	0.04	0.03	-0.11
6	-0.02	-0.20	0.02	0.03	0.02	0.00
7	0.11	0.01	0.10	0.14	-0.03	0.14
8	0.15	0.33	-0.05	0.08	0.19	-0.09
9	0.09	0.25	0.27	-0.23	0.09	0.22

Table 3.3.13 (Continued)

Summary:

Year	F5-10	SSB	Cbio	Bio4+	N3
1985	0.68	266	597	900	144
1986	0.82	255	576	831	348
1987	0.90	241	558	1034	283
1988	0.87	196	576	1067	167
1989	0.71	272	633	1017	90
1990	0.70	342	610	841	131
1991	0.84	230	488	709	103
1992	0.90	249	387	564	172
1993	0.93	230	358	614	122
1994	0.65	259	331	577	72
1995	0.53	326	373	553	150
1996	0.50	270	426	666	172
1997	0.52	356	474	787	82
1998	0.62	341	495	709	153
1999	0.72	312	457	692	56
2000	0.79	227	386	528	181
2001	0.83	297	367	621	166
2002	0.644	275	374	659	188
Mean	**0.73**	**275**	**470**	**743**	**155**

Table 3.3.14 COLERAINE - diagnostic and results

Input data and estimated parameters:

Data: Catch at age 1971–2001 and spring trawl survey indices 1985–2002.

StartYear	1971
EndYear	2002
Nsexes	1
Nages	14
Nmethods	1
NCPUEindex	1
Nsurveyindex	2
First_length	1
Length_class_increment	1
Number_of_length_classes	1

Likelihoods

CPUE		0	
Survey_Index		5.9201	798034
C@A_Commercial		-718.978	
C@A_survey		-425.017	0
C@L_Commercial		0	
C@L_no_sex_data_survey		0	0
C@L_data_survey		0	0
Prior_penalties	5.24864		

Parameters

R0	487109
h	0.9
Sex_specific	
M	0.2
Rinit	0.678161
uinit	0.296081
plusscale	1
Method_specific	
Sfullest	5.05383
log_varLest	0.656066
log_varRest	15

Method_specific_and_annual

errSfull	0	0	0	0	0	0	0	0	0	0	0	0
errvarL	0	0	0	0	0	0	0	0	0	0	0	0
errvarR	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0						
	0	0	0	0	0	0						
	0	0	0	0	0	0						

Table 3.3.14 (Continued)

CPUE_index_specific													
log_qCPUE	0												
CPUE_index_specific_and_annual													
qCPUEerr		0											
q		1	1	1	1	1	1	1	1	1	1	1	1
		1	1	1	1	1	1	1	1	1	1	1	1
		1	1	1	1	1	1	1	1	1			
Survey_index_specific													
log_qsurvey	-7.85753	-8.63											
surveySfull	4.43308	4.7											
log_surveyvarL	1.57308	1.9											
log_surveyvarR	15	15											
Recruitment_residuals													
log_InitialDev		-0.31	-0.17	-0.11	0.08	-0.16	0.21	0.39	0.13	0.05	-0.14	-0.07	-0.04
log_RecDev		0.84	0.05	0.55	1.00	-0.11	0.43	0.49	-0.14	-0.12	-0.37	0.19	-0.22
		-0.31	0.80	0.75	0.13	-0.70	-0.24	-0.51	0.06	-0.02	-0.79	0.14	0.33
		-0.68	0.01	-1.33	0.07	0.14	0.26	0.73	-0.65				
Priors													
Priortype_0(or_non_defined_value)=uniform,1=normal,2=lognormal													
	Phase	LB	UB	PriorType	mean	cv	initial_value						
R0_prior		1	100000	1.00E+06	0	0	0	480000					
h_prior		-1	0.2	1	0	0	0	0.9					
Sex_specific													
M_prior		-1	0.01	0.5	0	0	0	0.2					
Rinit_prior		3	0	2	0	0	0	0.68					
uinit_prior		3	0	1	0	0	0	0.3					
p_plusscale		-3	0	2	0	0	0	1					
Method_specific													
p_Sfullest		3	2	10	0	0	0	5.1					
p_Sfulldelta		-1	-5	5	0	0	0	0					
log_varLest_prior		3	-5	5	0	0	0	0.68					
log_varRest_prior		-1	-15	15	0	0	0	15					
Method_specific_and_annual													
errSfull_prior		-1	-15	15	0	0	0	0					
errvarL_prior		-1	-15	15	0	0	0	0					
errvarR_prior		-1	-15	15	0	0	0	0					
CPUE_index_specific													
log_qCPUE_prior		-1	-20	20	0	0	0	0					
CPUE_index_specific_and_annual													
qCPUEerr_prior		-1	-5	5	0	0	0	0					
Survey_index_specific													
log_qsurvey_prior		1	-15	0	0	0	0	-7.84					
	-1	-15	0	0	0	0	-8.6						
surveySfull_prior		3	2	10	0	0	0	4.5					
	-3	2	10	0	0	0	4.7						

Table 3.3.14 (Continued)

p_surveySfulldelta		-1	-5	5	0	0	0	0
	-1	-5	5	0	0	0	0	
log_surveyvarL_prior		3	-5	5	0	0	0	1.6
	-3	-5	5	0	0	0	1.9	
log_surveyvarR_prior		-1	-15	15	0	0	0	15
	-1	-15	15	0	0	0	15	
Recruitment_residuals								
p_log_InitialDev		3	-15	15	1	0	0.5	0
p_log_RecDev		2	-15	5	1	0	1	0

Estimated fishing mortality rates:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.055	0.058	0.057	0.040	0.035	0.034	0.033	0.039	0.047	0.052	0.056
4	0.308	0.330	0.322	0.219	0.190	0.182	0.174	0.210	0.258	0.291	0.316
5	0.648	0.703	0.684	0.436	0.372	0.356	0.339	0.416	0.527	0.604	0.668
6	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
7	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
8	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
9	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
10	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
11	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
12	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
13	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
14	0.651	0.706	0.686	0.437	0.374	0.357	0.340	0.417	0.529	0.607	0.671
F5-10	**0.650**	**0.706**	**0.686**	**0.437**	**0.373**	**0.357**	**0.340**	**0.417**	**0.528**	**0.606**	**0.671**

Estimated stock in numbers:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	98.294	173.609	152.522	67.484	158.722	196.783	71.811	140.291	38.905	165.770	172.962	193.270
4	99.779	76.197	134.160	118.039	53.105	125.511	155.805	56.939	110.591	30.438	129.093	134.267
5	38.286	59.906	44.821	79.685	77.811	36.027	85.780	107.370	37.927	70.374	18.817	78.208
6	45.461	16.494	24.513	18.796	42.655	44.309	20.837	50.479	58.790	18.761	32.545	8.288
7	43.000	19.559	6.739	10.265	10.054	24.274	25.611	12.255	27.619	29.053	8.666	14.316
8	20.980	18.499	7.991	2.822	5.490	5.721	14.030	15.063	6.705	13.649	13.420	3.812
9	3.258	9.026	7.558	3.346	1.509	3.124	3.307	8.252	8.241	3.314	6.305	5.903
10	1.824	1.402	3.688	3.165	1.790	0.859	1.806	1.945	4.515	4.073	1.531	2.773
11	1.514	0.785	0.573	1.544	1.693	1.019	0.496	1.062	1.064	2.231	1.881	0.673
12	0.460	0.651	0.321	0.240	0.826	0.963	0.589	0.292	0.581	0.526	1.031	0.828
13	0.305	0.198	0.266	0.134	0.128	0.470	0.557	0.346	0.160	0.287	0.243	0.453
14	0.501	0.347	0.223	0.205	0.181	0.176	0.374	0.547	0.489	0.321	0.281	0.230

Table 3.3.13 (Continued)

Residuals

Log(Uay-oserved/Uay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.44	0.47	-0.07	-0.75	-0.38	-0.26	-0.52	-1.26	-0.57	0.65	-0.90
2	0.42	0.24	0.12	-0.49	-0.22	0.06	-0.25	0.10	-0.45	0.00	0.30
3	-0.26	0.05	0.19	0.33	-0.06	0.00	-0.17	0.04	0.13	-0.34	-0.20
4	-0.24	-0.47	-0.20	-0.06	0.22	-0.27	-0.05	-0.10	-0.01	-0.16	-0.52
5	-0.01	-0.27	-0.04	-0.02	-0.05	-0.07	0.21	-0.04	0.01	0.04	0.03
6	0.14	0.16	0.02	-0.28	0.03	0.22	0.23	0.37	0.36	0.16	0.35
7	0.15	0.01	0.22	0.03	-0.20	0.19	0.45	0.12	0.18	0.35	0.24
8	-0.28	-0.52	-0.13	0.29	-0.65	-0.20	-0.36	0.08	-0.16	0.02	0.07
9	-0.65	-0.93	-0.75	-0.85	-0.66	-0.71	-0.14	-0.56	-0.49	-0.57	-0.28
10	-0.80	-1.04	-0.89	-1.33	-1.13	-0.73	-0.59	-0.56	-1.07	-0.64	-1.12

Y/a	1996	1997	1998	1999	2000	2001	2002
1	-0.42	-0.43	-0.16	-0.20	0.52	0.01	-1.33
2	-0.38	0.19	-0.10	0.36	0.03	0.06	0.04
3	0.07	-0.23	-0.29	-0.36	0.15	0.01	-0.11
4	-0.26	0.03	-0.40	-0.01	-0.59	-0.05	-0.15
5	0.13	-0.06	0.27	-0.15	-0.01	-0.18	0.24
6	0.06	0.23	0.25	0.03	0.02	0.40	0.86
7	0.62	-0.10	0.20	0.03	-0.43	0.19	0.47
8	0.75	0.20	-0.18	-0.12	-0.35	-0.75	0.07
9	0.02	-0.91	-0.07	-0.91	-1.08	-0.92	-1.06
10	-0.56	-1.20	-0.12	-1.03	-1.80	-0.73	-1.25

Table 3.3.13 (Continued)

Summary

Year	F5-10	Bio4+	N3
1971	0.48	1410	165
1972	0.49	1220	143
1973	0.63	944	311
1974	0.63	1050	177
1975	0.57	1010	285
1976	0.48	1120	421
1977	0.34	1550	143
1978	0.27	1580	243
1979	0.30	1720	265
1980	0.34	1830	149
1981	0.46	1480	152
1982	0.48	1190	120
1983	0.44	973	212
1984	0.40	1060	137
1985	0.44	1080	119
1986	0.59	944	349
1987	0.62	1120	337
1988	0.52	1220	182
1989	0.44	1220	77
1990	0.52	936	128
1991	0.65	783	98
1992	0.71	620	174
1993	0.69	650	153
1994	0.44	655	67
1995	0.37	624	159
1996	0.36	745	197
1997	0.34	896	72
1998	0.42	811	140
1999	0.53	780	39
2000	0.61	573	166
2001	0.67	619	173
2002	0.48	690	193

Table 3.3.15 ADAPTive famework - ADAPT - diagnostic and results.

Input parameters:

Estimated fishing mortality rates:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3	0.10	0.08	0.17	0.10	0.08	0.04	0.02	0.03	0.05	0.07	0.08
4	0.31	0.38	0.32	0.30	0.20	0.15	0.15	0.14	0.20	0.18	0.22
5	0.51	0.64	0.50	0.33	0.36	0.25	0.26	0.37	0.46	0.52	0.40
6	0.78	0.89	0.78	0.45	0.38	0.49	0.37	0.53	0.75	0.74	0.80
7	0.95	1.11	0.80	0.65	0.53	0.51	0.62	0.65	0.80	0.98	1.11
8	0.77	1.02	1.16	0.74	0.53	0.59	0.72	0.79	0.76	1.03	1.20
9	0.78	0.59	1.21	0.85	0.40	0.59	0.75	1.01	0.83	0.80	1.51
10	1.02	0.53	0.86	0.78	0.71	0.52	0.86	0.89	0.78	0.91	0.96
11	1.10	0.53	0.92	0.51	0.59	0.74	0.70	1.07	0.68	0.93	1.03
12	0.90	0.99	0.99	0.69	0.53	0.53	0.67	0.77	0.79	0.98	1.19
F(5-10)	**0.80**	**0.80**	**0.88**	**0.63**	**0.48**	**0.49**	**0.59**	**0.71**	**0.73**	**0.83**	**1.00**

Estimated stock in numbers:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	101.514	173.451	145.919	74.319	157.677	162.510	79.584	147.646	57.469	178.554	165.845	201.990
4	102.741	75.398	130.989	101.002	55.292	119.379	128.217	63.603	117.760	44.773	136.720	125.559
5	42.718	61.533	42.244	77.525	60.995	37.073	84.325	90.160	45.129	78.809	30.730	89.413
6	43.333	21.098	26.669	20.974	45.803	34.827	23.721	53.480	51.018	23.299	38.478	16.809
7	44.435	16.291	7.112	9.991	10.924	25.770	17.486	13.396	25.728	19.799	9.057	14.153
8	12.930	14.110	4.401	2.628	4.254	5.259	12.653	7.718	5.702	9.504	6.085	2.432
9	1.814	4.909	4.174	1.134	1.030	2.054	2.377	5.041	2.881	2.175	2.791	1.502
10	0.413	0.680	2.225	1.020	0.395	0.562	0.933	0.922	1.505	1.033	0.796	0.507
11	0.203	0.122	0.326	0.770	0.382	0.159	0.274	0.324	0.310	0.565	0.341	0.250
12	0.115	0.055	0.059	0.107	0.377	0.173	0.062	0.112	0.092	0.129	0.183	0.100

Residuals:

Summary:

Year	F5-10	Cbio4+	N3
1985	0.67	912	144
1986	0.78	846	336
1987	0.82	1030	280
1988	0.97	1056	168
1989	0.63	1025	83
1990	0.73	834	132
1991	0.80	700	102
1992	0.80	546	173
1993	0.88	581	146
1994	0.63	579	74
1995	0.48	557	158
1996	0.49	674	163
1997	0.59	783	80
1998	0.71	706	148
1999	0.73	690	57
2000	0.83	522	179
2001	1.00	609	166
2002		647	202
Mean	**0.74**	**739**	**155**

Table 3.3.16 Comparison of the results from the various methods.

Estimated fishing mortality rate in 2001:

Age	XSA	TSA	STAM	ADMB-SCA	Coleraine	ADAPT
3	0.07		0.08	0.06	0.06	0.08
4	0.22	0.20	0.23	0.23	0.32	0.22
5	0.44	0.44	0.52	0.43	0.67	0.40
6	0.68	0.69	0.77	0.71	0.67	0.80
7	0.91	0.88	0.88	0.95	0.67	1.11
8	0.94	0.93	0.92	0.95	0.67	1.20
9	0.97	0.96	0.93	0.95	0.67	1.51
10	0.90	0.96	0.94	0.91	0.67	0.96
11	0.86	0.95	0.94	0.79	0.67	1.03
12	1.05	0.95	0.94	0.84	0.67	1.19
13	0.92	0.95	0.94	0.84	0.67	1.19
14	0.94	0.95	0.94	0.84	0.67	1.19
F(5-10)	**0.81**	**0.81**	**0.83**	**0.82**	**0.67**	**1.00**

Bio4+,2001	654	661	603	640	619	609
Bio4-11,2002	**708**	**729**	**659**	**685**	**690**	**647**

Estimated stock in numbers in 2002:

Age	XSA	TSA	STAM	ADMB-SCA	Coleraine	ADAPT
3			188.134	186.451	193.270	201.990
4	134.001	139.556	126.201	129.090	134.267	125.559
5	94.08	99.890	89.535	91.865	78.208	89.413
6	15.094	14.599	13.878	15.602	8.288	16.809
7	18.107	18.045	15.020	16.835	14.316	14.153
8	3.44	3.374	3.044	3.004	3.812	2.432
9	2.277	2.328	2.533	2.282	5.903	1.502
10	1.109	1.085	0.938	1.007	2.773	0.507
11	0.274	0.222	0.198	0.224	0.673	0.250
12	0.133		0.141	0.150	0.828	0.100
13	0.058		0.077	0.085	0.453	
14	0.008		0.016	0.023	0.230	

Recruitment:

Yearclass	RCT3	ADM-SCA	STAM	Coleraine	ADAPT	TSA-REC
1997	181	183	181	166	179	
1998	166	167	166	173	166	161
1999	176	186	188	193	202	160
2000	208	229	211	285		202
2001	82	75	60			63

Table 3.3.17 Cod at Iceland. Division Va. Resulting fishing mortality using final F from TSA using catch at age and spring trawl survey indices.

Marine Research Institute Thu Apr 25 06:41:12 2002
Virtual Population Analysis : Fishing mortality.

Age	1982	1983	1984	1985	1986	1987	1988
3	0.027	0.017	0.055	0.051	0.070	0.045	0.045
4	0.221	0.120	0.211	0.288	0.222	0.309	0.222
5	0.400	0.433	0.323	0.388	0.580	0.519	0.506
6	0.541	0.622	0.539	0.572	0.697	0.785	0.838
7	0.581	0.767	0.598	0.683	0.883	0.976	0.953
8	1.046	0.852	0.900	0.731	0.936	0.994	1.393
9	1.187	0.930	0.746	0.802	0.806	0.975	1.112
10	0.910	1.082	0.634	0.770	0.764	0.707	0.986
11	0.479	0.671	0.639	0.613	0.740	0.582	1.032
12	0.404	0.678	0.587	0.641	0.672	0.665	0.905
13	0.417	0.533	0.685	0.711	0.445	0.739	2.334
14	0.679	0.779	0.658	0.707	0.685	0.734	1.274
W.Av 5-10	0.582	0.609	0.479	0.486	0.689	0.697	0.629
Ave 5-10	0.777	0.781	0.623	0.658	0.778	0.826	0.965

Age	1989	1990	1991	1992	1993	1994	1995
3	0.035	0.050	0.098	0.081	0.168	0.096	0.077
4	0.265	0.231	0.312	0.380	0.324	0.304	0.200
5	0.485	0.445	0.507	0.635	0.502	0.326	0.360
6	0.601	0.640	0.776	0.893	0.780	0.454	0.374
7	0.727	0.785	0.949	1.099	0.807	0.651	0.535
8	0.875	0.816	0.786	1.024	1.126	0.759	0.524
9	0.819	0.786	0.779	0.618	1.232	0.799	0.427
10	0.546	0.836	0.870	0.530	0.948	0.821	0.616
11	0.665	0.624	0.963	0.390	0.902	0.625	0.651
12	0.975	0.771	0.829	0.710	0.561	0.670	0.749
13	0.575	0.438	0.378	0.360	0.571	0.666	1.155
14	0.716	0.691	0.763	0.522	0.843	0.716	0.719
W.Av 5-10	0.544	0.596	0.751	0.790	0.690	0.397	0.388
Ave 5-10	0.676	0.718	0.778	0.800	0.899	0.635	0.473

Age	1996	1997	1998	1999	2000	2001	1998-2001
3	0.036	0.023	0.026	0.053	0.066	0.079	0.056
4	0.145	0.149	0.137	0.190	0.189	0.221	0.185
5	0.247	0.249	0.361	0.436	0.477	0.444	0.429
6	0.488	0.372	0.512	0.716	0.673	0.689	0.648
7	0.509	0.616	0.656	0.740	0.891	0.879	0.792
8	0.602	0.715	0.780	0.769	0.888	0.929	0.842
9	0.581	0.765	0.993	0.815	0.816	0.957	0.895
10	0.564	0.831	0.941	0.750	0.879	0.964	0.884
11	0.563	0.817	0.989	0.768	0.849	0.948	0.888
12	0.629	0.417	1.110	0.666	1.345	0.948	1.017
13	0.758	0.930	1.322	0.607	0.803	0.948	0.920
14	0.619	0.752	1.071	0.721	0.938	0.953	0.921
W.Av 5-10	0.417	0.368	0.471	0.629	0.610	0.666	0.526
Ave 5-10	0.499	0.591	0.707	0.704	0.771	0.810	0.748

Table 3.3.18 Cod at Iceland. Division Va. Resulting Stock in numbers using final F from TSA using catch at age and spring trawl survey indices.

Marine Research Institute Thu Apr 25 06:41:12 2002
Virtual Population Analysis : Stock in numbers, millions

Age	1982	1983	1984	1985	1986	1987	1988
3	133.575	226.325	139.007	144.031	335.805	277.524	168.492
4	115.390	106.396	182.089	107.718	112.095	256.309	217.286
5	81.350	75.742	77.274	120.679	66.119	73.478	154.011
6	74.178	44.653	40.214	45.818	67.038	30.295	35.806
7	34.736	35.350	19.620	19.203	21.166	27.346	11.314
8	12.818	15.903	13.437	8.835	7.941	7.168	8.435
9	17.940	3.687	5.554	4.471	3.484	2.551	2.172
10	3.480	4.482	1.191	2.156	1.642	1.274	0.788
11	0.940	1.147	1.244	0.517	0.817	0.627	0.514
12	0.310	0.476	0.480	0.537	0.230	0.319	0.287
13	0.138	0.170	0.198	0.219	0.232	0.096	0.134
14	0.024	0.075	0.081	0.082	0.088	0.122	0.038
Juvenile	383.310	444.545	405.969	361.273	531.447	607.930	516.069
Adult	91.570	69.860	74.423	92.994	85.210	69.178	83.208
Sum 3- 3	133.575	226.325	139.007	144.031	335.805	277.524	168.492
Sum 4-14	341.305	288.080	341.384	310.235	280.852	399.584	430.785
Total	474.880	514.405	480.391	454.266	616.657	677.108	599.276

Age	1989	1990	1991	1992	1993	1994	1995
3	82.982	131.940	101.382	173.621	146.014	74.249	160.583
4	131.890	65.588	102.802	75.290	131.127	101.080	55.234
5	142.508	82.815	42.619	61.583	42.156	77.638	61.059
6	76.023	102.818	43.432	21.017	26.710	20.902	45.895
7	12.686	34.109	44.373	16.371	7.047	10.024	10.866
8	3.572	5.022	12.733	14.060	4.465	2.576	4.281
9	1.715	1.219	1.818	4.750	4.134	1.186	0.987
10	0.585	0.619	0.455	0.683	2.095	0.988	0.437
11	0.241	0.278	0.220	0.156	0.329	0.665	0.356
12	0.150	0.101	0.122	0.069	0.087	0.109	0.291
13	0.095	0.046	0.038	0.044	0.028	0.040	0.046
14	0.011	0.044	0.024	0.022	0.025	0.013	0.017
Juvenile	345.201	311.670	246.946	259.553	212.883	140.240	196.109
Adult	107.256	112.930	103.074	108.113	151.336	149.229	143.944
Sum 3- 3	82.982	131.940	101.382	173.621	146.014	74.249	160.583
Sum 4-14	369.475	292.659	248.638	194.045	218.204	215.220	179.469
Total	452.457	424.599	350.020	367.666	364.218	289.469	340.052

Age	1996	1997	1998	1999	2000	2001	2002
3	165.212	82.713	155.358	54.034	181.034	165.390	175.000
4	121.758	130.429	66.165	123.993	41.960	138.750	125.187
5	37.026	86.272	91.971	47.225	83.909	28.428	91.074
6	34.879	23.682	55.072	52.497	25.009	42.636	14.930
7	25.846	17.529	13.365	27.025	21.000	10.446	17.526
8	5.212	12.714	7.753	5.676	10.556	7.053	3.551
9	2.076	2.338	5.090	2.909	2.154	3.555	2.281
10	0.528	0.950	0.891	1.545	1.054	0.780	1.118
11	0.193	0.246	0.339	0.285	0.597	0.358	0.243
12	0.152	0.090	0.089	0.103	0.108	0.209	0.114
13	0.113	0.066	0.049	0.024	0.043	0.023	0.066
14	0.012	0.043	0.021	0.011	0.011	0.016	0.007
Juvenile	311.870	193.151	300.392	222.652	286.864	327.890	354.921
Adult	81.136	163.922	95.770	92.674	80.571	69.755	76.177
Sum 3- 3	165.212	82.713	155.358	54.034	181.034	165.390	175.000
Sum 4-14	227.794	274.360	240.804	261.292	186.401	232.255	256.098
Total	393.006	357.073	396.162	315.325	367.435	397.645	431.098

Table 3.3.19 Cod at Iceland. Division Va. Resulting SSB using final F from TSA using catch at age and spring trawl survey indices.

Marine Research Institute Thu Apr 25 06:41:12 2002
Virtual Population Analysis : SSB in 1000 x tons

Age	1982	1983	1984	1985	1986	1987	1988
3	2.917	0.000	0.000	4.166	1.877	6.780	7.584
4	8.747	12.670	10.555	9.011	9.747	19.211	6.371
5	18.924	23.102	28.990	48.126	35.627	40.003	66.523
6	40.895	34.834	47.189	71.051	100.356	56.151	45.213
7	62.440	53.319	43.624	54.566	52.824	73.973	26.630
8	36.502	41.484	39.718	34.163	28.874	27.026	22.627
9	62.993	13.516	24.330	21.231	17.356	11.320	8.247
10	19.197	19.366	7.881	13.102	9.834	8.836	3.829
11	8.215	8.439	9.326	4.166	5.759	4.950	2.965
12	3.271	4.322	4.755	5.000	2.165	2.348	1.672
13	1.845	1.773	2.089	2.271	2.463	1.020	0.595
14	0.277	0.906	0.928	1.051	1.115	1.347	0.213
Total	266.223	213.731	219.384	267.905	267.997	252.964	192.470

Age	1989	1990	1991	1992	1993	1994	1995
3	0.000	0.000	0.000	10.345	11.075	8.023	6.956
4	8.853	5.970	10.343	20.903	45.444	44.712	36.464
5	65.814	45.567	17.084	61.138	41.906	92.491	105.913
6	124.593	163.239	54.279	34.515	52.000	50.970	116.026
7	39.718	92.345	89.255	41.545	22.535	34.441	34.076
8	13.743	20.213	44.936	45.903	15.715	10.035	18.928
9	7.561	6.773	8.633	22.267	16.030	5.915	5.809
10	3.994	4.036	2.545	4.153	10.853	4.771	3.061
11	1.992	2.370	1.482	1.443	2.260	5.014	2.689
12	0.771	1.031	1.118	0.627	0.756	0.953	2.193
13	0.719	0.549	0.432	0.538	0.289	0.403	0.329
14	0.103	0.516	0.327	0.180	0.291	0.151	0.174
Total	267.861	342.610	230.434	243.557	219.154	257.880	332.619

Age	1996	1997	1998	1999	2000	2001
3	15.446	6.999	4.831	2.623	7.021	22.774
4	17.809	59.418	31.969	49.386	10.228	84.913
5	44.101	100.506	89.663	49.836	67.363	35.946
6	81.583	56.845	102.636	92.007	40.117	84.715
7	80.334	63.020	43.694	75.819	52.994	31.752
8	20.110	52.532	38.189	23.574	37.326	26.279
9	9.501	11.437	24.280	15.545	10.720	16.439
10	3.617	4.877	4.701	10.233	6.111	4.249
11	1.586	1.661	2.207	2.101	3.878	1.970
12	1.372	0.755	0.761	0.898	0.635	1.254
13	1.003	0.444	0.428	0.215	0.371	0.144
14	0.136	0.438	0.184	0.108	0.114	0.133
Total	276.599	358.932	343.542	322.345	236.878	310.569

Table 3.3.20 Cod at Iceland. Division Va. Resulting stock weight using final F from TSA using catch at age and spring trawl survey indices.

Marine Research Institute Thu Apr 25 06:41:12 2002
Virtual Population Analysis : Stock weight 1. Jan. in 1000 x tons
FINAL - TSA_Vegið_N+S

Age	1982	1983	1984	1985	1986	1987	1988
3	134.377	247.825	179.041	202.652	489.939	365.221	242.291
4	178.855	170.127	314.104	212.311	219.818	501.340	392.202
5	182.712	172.314	200.603	310.870	188.042	197.363	396.734
6	230.249	134.895	144.007	167.234	240.868	117.968	126.000
7	147.906	144.793	85.761	95.554	98.106	128.965	55.777
8	69.040	87.164	77.908	56.296	48.878	44.849	50.621
9	119.873	25.988	41.413	36.696	26.139	18.795	15.516
10	31.809	36.430	11.733	22.251	14.920	11.771	6.950
11	11.244	12.631	13.747	6.311	8.462	6.702	5.129
12	4.411	6.657	6.884	7.892	3.509	3.390	3.363
13	2.388	2.692	3.024	3.537	3.370	1.525	1.903
14	0.404	1.378	1.358	1.557	1.321	1.532	0.489
Juvenile	715.807	746.864	768.932	756.213	1002.751	1123.689	1028.443
Adult	397.460	296.031	310.652	366.949	340.622	275.734	268.531
Sum 3- 3	134.376	247.826	179.041	202.652	489.939	365.221	242.291
Sum 4-14	978.891	795.070	900.543	920.510	853.434	1034.201	1054.683
Total	1113.267	1042.896	1079.584	1123.162	1343.373	1399.422	1296.974

Age	1989	1990	1991	1992	1993	1994	1995
3	98.417	170.203	132.709	223.797	203.252	107.141	216.466
4	239.116	111.762	195.221	133.113	247.437	208.528	108.204
5	369.096	197.349	105.482	152.049	116.857	198.908	178.292
6	297.631	311.948	137.203	69.188	100.482	76.480	166.371
7	66.095	157.720	168.264	71.935	34.742	51.292	56.241
8	24.617	32.749	72.325	78.485	27.034	16.128	27.465
9	13.778	10.835	13.169	32.443	30.802	9.153	7.815
10	5.751	6.553	4.461	5.554	18.105	8.788	4.487
11	2.883	3.051	2.142	1.979	3.591	7.214	3.924
12	1.500	1.476	1.746	0.921	1.083	1.409	3.325
13	1.197	0.729	0.544	0.684	0.408	0.596	0.601
14	0.171	0.756	0.495	0.243	0.419	0.224	0.258
Juvenile	755.005	621.809	498.646	432.177	382.749	281.376	333.988
Adult	365.246	383.324	335.115	338.212	401.463	404.484	439.461
Sum 3- 3	98.417	170.203	132.709	223.797	203.252	107.141	216.466
Sum 4-14	1021.835	834.929	701.051	546.593	580.960	578.719	556.983
Total	1120.252	1005.132	833.761	770.390	784.212	685.860	773.449

Age	1996	1997	1998	1999	2000	2001	2002
3	240.715	122.746	191.090	67.056	236.793	247.920	236.075
4	234.992	244.816	118.302	212.772	74.773	284.437	240.108
5	115.966	248.291	227.811	114.568	195.508	75.305	249.088
6	144.434	95.393	197.599	180.747	81.330	145.518	53.912
7	127.215	94.690	66.997	127.560	98.488	49.786	81.235
8	31.317	81.192	56.542	36.054	62.215	45.901	21.902
9	15.371	17.168	39.924	25.393	16.820	26.735	18.291
10	5.155	8.114	8.269	15.364	9.702	7.058	10.509
11	2.035	2.654	3.719	3.155	6.116	3.152	2.444
12	2.054	1.038	1.365	1.294	1.207	1.994	1.259
13	1.544	0.692	0.861	0.360	0.572	0.258	0.872
14	0.192	0.554	0.345	0.161	0.187	0.221	0.113
Juvenile	619.767	408.163	547.203	431.318	486.501	627.970	651.691
Adult	301.223	509.184	365.623	353.164	297.210	260.316	264.118
Sum 3- 3	240.715	122.746	191.090	67.056	236.793	247.920	236.075
Sum 4-14	680.275	794.602	721.735	717.426	546.919	640.366	679.733
Total	920.989	917.348	912.825	784.482	783.711	888.286	915.808

Table 3.3.21 Cod at Iceland. Division Va. Capelin biomass ('000 tonnes) used for prediction of cod mean weights at age.

Year	Total Biomass
1979	3177
1980	2110
1981	1500
1982	1209
1983	2385
1984	3373
1985	3724
1986	4195
1987	3994
1988	3094
1989	2780
1990	2197
1991	2519
1992	3164
1993	3405
1994	3350
1995	3921
1996	4705
1997	4229
1998	3303
1999	3485
2000	3718
2001	3161
2002	3160
Average	3161

Table 3.3.22 Cod at Iceland. Division Va. Landings ('000 tonnes), average fishing mortality of age groups, recruitment (at age 3 in millions), spawning stock at spawning time ('000 tonnes) and total biomass ('000 tonnes).

Year	Landings	F5-10	SSB	Recruitment	Tot. Bio
1955	538	0.31	1261	260	
1956	481	0.26	1199	307	
1957	452	0.32	1145	153	
1958	509	0.32	1034	191	
1959	453	0.33	928	143	
1960	465	0.38	825	163	
1961	374	0.33	760	292	
1962	387	0.40	729	255	
1963	410	0.45	683	273	
1964	434	0.54	569	328	
1965	394	0.61	454	174	
1966	357	0.54	412	255	
1967	345	0.49	476	186	
1968	381	0.67	594	178	
1969	406	0.53	693	136	
1970	471	0.56	684	303	
1971	453	0.62	615	170	
1972	399	0.71	477	265	
1973	383	0.71	436	432	
1974	375	0.76	329	143	
1975	371	0.81	339	222	
1976	348	0.76	283	246	
1977	340	0.63	319	144	
1978	330	0.48	375	143	
1979	368	0.43	447	134	
1980	434	0.45	602	226	
1981	469	0.68	389	139	1432
1982	388	0.78	266	144	1113
1983	300	0.78	214	336	1043
1984	284	0.62	219	278	1080
1985	325	0.66	268	168	1123
1986	369	0.78	268	83	1343
1987	392	0.83	253	132	1399
1988	378	0.96	192	101	1297
1989	356	0.68	268	174	1120
1990	335	0.72	343	146	1005
1991	309	0.78	230	74	834
1992	268	0.80	244	161	770
1993	252	0.90	219	165	784
1994	179	0.64	258	83	686
1995	169	0.47	333	155	773
1996	182	0.50	277	54	921
1997	203	0.59	359	181	917
1998	243	0.71	344	165	913
1999	260	0.70	322	175	784
2000	236	0.77	237	210	784
2001	235	0.81	311	80	888
Average	**357**	**0.61**	**478**	**190**	**1001**

Table 3.3.23 Cod at Iceland. Division Va. Input file used for RCTR3

Iceland Cod: VPA and groundfish survey data,N+S

4 21 2

'Yearcl'	'VPAage3'	'Surv4'	'Surv3'	'Surv2'	'Surv1'
1981	-11	4819	-11	-11	-11
1982	-11	2249	3539	-11	-11
1983	-11	8346	9572	11229	-11
1984	-11	10493	10403	6103	1654
1985	168	8013	7271	2894	1510
1986	83	1429	2236	748	365
1987	132	3072	2671	1725	345
1988	101	1908	1819	1209	409
1989	174	3928	3384	1631	557
1990	146	2706	3507	1746	395
1991	74	936	885	477	72
1992	161	2826	2616	1602	358
1993	165	5653	4194	2930	1376
1994	83	1595	1371	536	117
1995	155	4232	2978	2239	363
1996	54	718	710	547	121
1997	-11	3832	5562	3429	798
1998	-11	4027	3700	2853	738
1999	-11	-11	4123	2405	1881
2000	-11	-11	-11	3867	1209
2001	-11	-11	-11	-11	91

Table 3.3.24 Cod at Iceland. Division Va. Output from RCT3

```
Analysis by RCT3 ver3.1 of data from file :

 in_2002.dat

 Iceland Cod: VPA and groundfish survey data,N+S

 Data for    4 surveys over   21 years :  1981 - 2001

 Regression type = C
 Tapered time weighting not applied
 Survey weighting not applied

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

 Forecast/Hindcast variance correction used.

 Yearclass =   1997

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4      .58    .21    .16   .870     12   8.25    5.03     .183     .326
 Surv3      .66   -.36    .20   .813     12   8.62    5.34     .240     .226
 Surv2      .65    .11    .18   .844     12   8.14    5.41     .219     .272
 Surv1      .55   1.56    .32   .620     12   6.68    5.22     .379     .091

                                       VPA Mean =    4.77     .391     .085


 Yearclass =   1998

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4      .58    .21    .16   .870     12   8.30    5.05     .184     .314
 Surv3      .66   -.36    .20   .813     12   8.22    5.07     .229     .239
 Surv2      .65    .11    .18   .844     12   7.96    5.29     .213     .277
 Surv1      .55   1.56    .32   .620     12   6.61    5.18     .377     .088

                                       VPA Mean =    4.77     .391     .082


 Yearclass =   1999

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3      .66   -.36    .20   .813     12   8.32    5.15     .231     .346
 Surv2      .65    .11    .18   .844     12   7.79    5.18     .208     .426
 Surv1      .55   1.56    .32   .620     12   7.54    5.69     .416     .107

                                       VPA Mean =    4.77     .391     .121


 Yearclass =   2000

         I-----------Regression----------I  I-----------Prediction---------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series          cept   Error           Pts  Value   Value    Error   Weights

 Surv4
 Surv3
 Surv2      .65    .11    .18   .844     12   8.26    5.49     .224     .607
 Surv1      .55   1.56    .32   .620     12   7.10    5.45     .394     .195

                                       VPA Mean =    4.77     .391     .198
```

Table 3.3.24 (Continued)

Yearclass = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv4									
Surv3									
Surv2									
Surv1	.55	1.56	.32	.620	12	4.52	4.04	.398	.491
					VPA Mean =		4.77	.391	.509

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	181	5.20	.11	.10	.82		
1998	166	5.11	.11	.07	.41		
1999	176	5.17	.14	.13	.88		
2000	208	5.34	.17	.20	1.33		
2001	82	4.41	.28	.37	1.72		

Table 3.3.25 Short term prediction (Management option table)

Calculation were done with a spreadsheet: codpr2002.xls

Input data:

Sexual maturity at spawning time:

age\year	2001	2002	2003	2004	2005	AV99-01	Av75-01	Av85-01
3	0.13	0.073	0.073	0.073	0.073	0.073	0.036	0.046
4	0.413	0.296	0.296	0.296	0.296	0.296	0.132	0.180
5	0.614	0.536	0.536	0.536	0.536	0.536	0.334	0.416
6	0.792	0.715	0.715	0.715	0.715	0.715	0.577	0.660
7	0.921	0.849	0.849	0.849	0.849	0.849	0.792	0.833
8	0.898	0.916	0.916	0.916	0.916	0.916	0.906	0.916
9	0.967	0.972	0.972	0.972	0.972	0.972	0.955	0.956
10	0.987	0.985	0.985	0.985	0.985	0.985	0.967	0.962
11	1	1.000	1.000	1.000	1.000	1.000	0.995	0.996
12	1	1.000	1.000	1.000	1.000	1.000	0.983	0.978
13	1	0.946	0.946	0.946	0.946	0.946	0.988	0.981
14	1	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Mean weights in the spawning stock (1/1 - 31/5 in catches each year)

age\year	2001	2002	2003	2004	2005	99-01
3	1.121	1.071	1.071	1.071	1.071	1.071
4	1.621	1.526	1.526	1.526	1.526	1.526
5	2.417	2.384	2.370	2.370	2.370	2.269
6	3.234	3.484	3.457	3.445	3.445	3.217
7	4.854	4.594	4.798	4.776	4.767	4.751
8	6.546	6.276	6.057	6.229	6.210	6.360
9	7.935	8.126	8.126	8.126	8.126	8.126
10	9.196	9.578	9.578	9.578	9.578	9.578
11	9.086	10.172	10.172	10.172	10.172	10.172
12	9.899	11.401	11.401	11.401	11.401	11.401
13	10.351	12.839	12.839	12.839	12.839	12.839
14	13.874	15.489	15.489	15.489	15.489	15.489

Table 3.3.25 (Continued)

Mean weights in the catch

age\year	2001	2002	2003	2004	2005	98-00
3	1.499	1.349	1.349	1.349	1.349	1.349
4	2.050	1.918	1.852	1.852	1.852	1.849
5	2.649	2.735	2.646	2.602	2.602	2.468
6	3.413	3.611	3.678	3.609	3.575	3.369
7	4.766	4.635	4.814	4.875	4.812	4.725
8	6.508	6.168	6.074	6.203	6.247	6.251
9	7.520	8.020	8.020	8.020	8.020	8.020
10	9.055	9.401	9.401	9.401	9.401	9.401
11	8.796	10.041	10.041	10.041	10.041	10.041
12	9.526	11.078	11.078	11.078	11.078	11.078
13	11.210	13.126	13.126	13.126	13.126	13.126
14	13.874	15.489	15.489	15.489	15.489	15.489

Selection pattern

Fishing mortality from a VPA:

age\year	1996	1997	1998	1999	2000	2001	99-01
3	0.036	0.023	0.026	0.053	0.066	0.079	0.066
4	0.145	0.149	0.137	0.19	0.189	0.221	0.200
5	0.247	0.249	0.361	0.436	0.477	0.444	0.452
6	0.488	0.372	0.512	0.716	0.673	0.689	0.693
7	0.509	0.616	0.656	0.74	0.891	0.879	0.837
8	0.602	0.715	0.78	0.769	0.888	0.929	0.862
9	0.581	0.765	0.993	0.815	0.816	0.957	0.863
10	0.564	0.831	0.941	0.75	0.879	0.964	0.864
11	0.563	0.817	0.989	0.768	0.849	0.948	0.855
12	0.629	0.417	1.11	0.666	1.345	0.948	0.986
13	0.758	0.93	1.322	0.607	0.803	0.948	0.786
14	0.619	0.752	1.071	0.721	0.938	0.948	0.869
Ave(5-10)	0.499	0.591	0.707	0.704	0.771	0.810	0.762

Natural Mortality

age\year	2001	2002	2003	2004	2005
3	0.20	0.20	0.20	0.20	0.20
4	0.20	0.20	0.20	0.20	0.20
5	0.20	0.20	0.20	0.20	0.20
6	0.20	0.20	0.20	0.20	0.20
7	0.20	0.20	0.20	0.20	0.20
8	0.20	0.20	0.20	0.20	0.20
9	0.20	0.20	0.20	0.20	0.20
10	0.20	0.20	0.20	0.20	0.20
11	0.20	0.20	0.20	0.20	0.20
12	0.20	0.20	0.20	0.20	0.20
13	0.20	0.20	0.20	0.20	0.20
14	0.20	0.20	0.20	0.20	0.20

Table 3.3.25 (Continued)

Given stock numbers

age\year	2002	2003	2004	2005
3	175.000	210.00	80.00	180.00
4	125.187			
5	91.074			
6	14.930			
7	17.526			
8	3.551			
9	2.281			
10	1.118			
11	0.243			
12	0.114			
13	0.066			
14	0.007			

Mortality proportions before spawning

F	M
0.085	0.250
0.180	0.250
0.248	0.250
0.296	0.250
0.382	0.250
0.437	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250

Table 3.3.25 (Continued)

Icelandic COD. Division Va.

Prognosis - Summery and plots

Catch, '000 tonnes

	1998	1999	2000	2001	2002	2003	2004	2005
Opt1	203	243	260	235	190	160	160	160
Opt2	203	243	260	235	190	183	219	237
Opt3	203	243	260	235	190	190	190	190
Opt4	203	243	260	235	190	220	220	220
Opt5	203	243	260	235	190	250	250	250

Average fishing mortality of 5-10 years old

	1998	1999	2000	2001	2002	2003	2004	2005
Opt1	0.707	0.704	0.771	0.810	0.591	0.385	0.292	0.229
Opt2	0.707	0.704	0.771	0.810	0.591	0.450	0.437	0.413
Opt3	0.707	0.704	0.771	0.810	0.591	0.470	0.375	0.307
Opt4	0.707	0.704	0.771	0.810	0.591	0.560	0.472	0.407
Opt5	0.707	0.704	0.771	0.810	0.591	0.657	0.588	0.539

Fishable stock, 4+ in '000 tonnes at the beginniq of the year

	1998	1999	2000	2001	2002	2003	2004	2005
Opt1	722	717	546	640	680	785	996	1030
Opt2	722	717	546	640	680	785	969	930
Opt3	722	717	546	640	680	785	960	956
Opt4	722	717	546	640	680	785	925	882
Opt5	722	717	546	640	680	785	889	808

Spawning stock in '000 at the time of spawning

	1998	1999	2000	2001	2002	2003	2004	2005
Opt1	343	322	237	311	285	362	477	595
Opt2	343	322	237	311	285	356	443	500
Opt3	343	322	237	311	285	355	445	532
Opt4	343	322	237	311	285	347	413	470
Opt5	343	322	237	311	285	340	382	409

Table 3.3.25 (Continued)

Icelandic COD. Division Va.

Prognosis - Summary table (nwwg2002)

2002				2003				2004				2005			
TAC	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*
190	680	285	0.591	160	785	362	0.385	160	996	477	0.292	160	1030	595	0.229
				183	785	356	0.450	219	969	443	0.437	237	930	500	0.413
				190	785	355	0.470	190	960	445	0.375	190	956	532	0.307
				220	785	347	0.560	220	925	413	0.472	220	882	470	0.407
				250	785	340	0.657	250	889	382	0.588	250	808	409	0.539

The shaded option corresponds to the harvest control rule.

Table 3.3.26 Cod at Iceland. Divsion Va. Yield per recruit input data

MFYPR version 1
Run: final
Cod Va (NWWG 2002)
Time and date: 11:50 03/05/2002
Fbar age range: 5-10

Age	M	Mat	PF	PM	SWt	Sel	CW
3	0.2	0.04	0.085	0.25	1.3243	0.083	1.3243
4	0.2	0.16	0.18	0.25	1.8402	0.321	1.8402
5	0.2	0.38	0.248	0.25	2.5931	0.596	2.5931
6	0.2	0.61	0.296	0.25	3.5337	0.868	3.5337
7	0.2	0.79	0.382	0.25	4.7369	1.056	4.7369
8	0.2	0.9	0.437	0.25	6.165	1.206	6.165
9	0.2	0.95	0.477	0.25	7.6071	1.171	7.6071
10	0.2	0.96	0.477	0.25	9.3275	1.102	9.3275
11	0.2	0.99	0.477	0.25	10.8935	1.003	10.8935
12	0.2	0.98	0.477	0.25	12.8801	1.032	12.8801
13	0.2	0.98	0.477	0.25	14.5616	1.063	14.5616
14	0.2	1	0.477	0.25	15.8647	1.074	15.8647

Weights in kilograms

Table 3.3.27 Cod at Iceland Division Va. Yield per recruit summary (Plus group included).

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average Current	1.000	1.610	1.186
$\mathbf{F}_{max}$	0.324	1.778	4.342
$\mathbf{F}_{0.1}$	0.154	1.623	8.829
$\mathbf{F}_{med}$	0.541	1.728	2.424

Table 3.4.2.1 Haddock in Division Va Landings by nation.

HADDOCK Va

Country	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	807	1010	1144	673	377	268	359	391
Faroe Islands	2116	2161	2029	1839	1982	1783	707	987
Iceland	40552	52152	47916	61033	67038	63889	47216	49553
Norway	13	11	23	15	28	3	3	+
UK								
Total	43488	55334	51112	63560	69425	65943	48285	50933

HADDOCK Va

Country	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	257	238	352	483	595	485	361	458
Faroe Islands	1289	1043	797	606	603	773	757	754
Iceland	47317	39479	53085	61792	66004	53516	46098	46932
Norway		1	+					
UK								
Total	48863	40761	54234	62881	67202	53774	47216	48144

HADDOCK Va

Country	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	248							
Faroe Islands	911	758	664	340	639	624	968	609
Iceland	58408	60061	56223	43245	40795	44557	41199	39038
Norway	1	+	4					
UK								
Total	59567	60819	56891	43585	41434	45481	42167	39647

Table 3.4.3.1 Haddock in division Va.

Marine Research Institute Tue Apr 9 11:38:25 2002
Virtual Population Analysis : Catch in numbers, millions

Age	1982	1983	1984	1985	1986	1987	1988
2	0.050	0.001	0.060	0.427	0.196	2.237	0.133
3	0.286	0.705	0.755	1.773	3.681	7.559	10.068
4	2.698	1.498	4.970	4.981	3.822	7.500	15.927
5	10.703	4.645	1.176	6.058	4.933	2.696	5.598
6	14.115	10.301	4.875	0.837	5.761	2.249	1.260
7	2.288	8.808	3.772	1.564	0.493	1.194	1.009
8	1.167	0.874	4.446	2.475	0.852	0.151	0.577
9	0.816	0.241	0.171	2.212	0.898	0.208	0.058
Juvenile	12.851	8.736	7.097	9.652	8.124	15.382	19.540
Adult	19.272	18.337	13.128	10.675	12.512	8.412	15.090
Sum 2- 2	0.050	0.001	0.060	0.427	0.196	2.237	0.133
Sum 3- 9	32.073	27.072	20.165	19.900	20.440	21.557	34.497
Total	32.123	27.073	20.225	20.327	20.636	23.794	34.630

Age	1989	1990	1991	1992	1993	1994	1995
2	0.078	0.446	2.461	2.726	0.218	0.280	2.357
3	2.603	2.603	1.282	7.343	11.617	3.030	6.327
4	23.077	7.994	3.942	4.181	12.642	27.025	5.667
5	9.703	23.803	6.711	4.158	3.167	10.722	23.357
6	3.118	6.654	13.650	3.989	1.786	1.550	5.605
7	0.541	0.857	2.956	5.936	1.504	0.756	0.610
8	0.507	0.167	0.398	1.314	2.263	0.404	0.263
9	0.144	0.071	0.052	0.132	0.379	0.700	0.210
Juvenile	16.344	11.221	9.468	14.024	16.227	16.507	14.717
Adult	23.427	31.374	21.984	15.755	17.349	27.960	29.679
Sum 2- 2	0.078	0.446	2.461	2.726	0.218	0.280	2.357
Sum 3- 9	39.693	42.149	28.991	27.053	33.358	44.187	42.039
Total	39.771	42.595	31.452	29.779	33.576	44.467	44.396

Age	1996	1997	1998	1999	2000	2001
2	1.467	1.375	0.207	1.077	2.351	2.212
3	8.982	3.690	8.109	1.455	6.496	11.298
4	7.076	11.127	5.984	16.897	2.335	7.124
5	4.751	4.885	8.390	4.844	13.817	1.497
6	13.963	2.540	2.420	4.982	2.052	6.212
7	2.446	4.981	1.502	0.942	1.789	0.698
8	0.228	0.692	1.884	0.588	0.364	0.484
9	0.087	0.052	0.207	0.514	0.197	0.104
Juvenile	15.344	9.926	9.154	10.140	11.138	13.527
Adult	23.656	19.416	19.549	21.159	18.263	16.102
Sum 2- 2	1.467	1.375	0.207	1.077	2.351	2.212
Sum 3- 9	37.533	27.967	28.496	30.222	27.050	27.417
Total	39.000	29.342	28.703	31.299	29.401	29.629

Table 3.4.4.1 Haddock in division Va

Marine Research Institute Tue Apr 9 11:38:25 2002
Virtual Population Analysis : Weight at age in the catches, in grams

Age	1982	1983	1984	1985	1986	1987	1988
2	330	655	980	599	867	446	468
3	819	958	1041	1002	1187	1048	808
4	1365	1436	1476	1783	1755	1629	1474
5	1649	1827	2105	2201	2377	2373	2230
6	2329	2355	2460	2727	2710	2984	2934
7	3012	2834	3028	3431	3591	3550	3545
8	3384	3569	3014	3783	3760	4483	3769
9	3965	4308	3807	4070	4135	4667	4574

Age	1989	1990	1991	1992	1993	1994	1995
2	745	357	409	320	420	568	457
3	856	716	868	856	756	720	874
4	1170	1039	1111	1253	1372	1058	1145
5	2010	1542	1546	1597	1870	1742	1366
6	2879	2403	2035	2088	2360	2380	2079
7	4109	3458	2849	2529	2888	2785	2853
8	4035	4186	3464	3133	2975	3447	3251
9	4706	4969	4642	4022	3442	3156	3899

Age	1996	1997	1998	1999	2000	2001	2002
2	387	450	689	616	518	542	0
3	841	829	777	866	951	933	0
4	1189	1192	1166	1096	1314	1451	0
5	1528	1663	1692	1638	1461	1759	0
6	1816	1934	2312	2205	2096	1836	0
7	2641	2360	2379	2681	2679	2309	0
8	3499	3059	2882	2863	3181	2966	0
9	3526	3010	3417	3229	3438	3123	0

Table 3.4.4.2 Haddock in division Va

Marine Research Institute Tue Apr 9 11:38:25 2002
Virtual Population Analysis : Weight at age in the stock, in grams

Age	1982	1983	1984	1985	1986	1987	1988
2	185	185	185	245	234	157	176
3	475	475	475	555	677	564	453
4	901	901	901	1158	1128	1211	969
5	1411	1411	1411	1629	1929	1825	1826
6	2004	2004	2004	2349	2371	2596	2679
7	2526	2526	2526	2736	3149	3020	3089
8	3201	3201	3201	3213	3241	3626	3464
9	3266	3266	3266	3302	3688	3818	3294

Age	1989	1990	1991	1992	1993	1994	1995
2	181	183	174	157	171	180	165
3	439	447	495	496	385	402	443
4	885	829	998	902	874	700	738
5	1502	1238	1397	1379	1492	1243	1053
6	2380	1962	1879	1926	1807	1689	1868
7	2987	2688	2490	2373	2617	2413	2624
8	3503	3080	3732	2932	2620	2697	3093
9	3194	3317	3642	3672	3346	3228	3160

Age	1996	1997	1998	1999	2000	2001	2002
2	180	172	202	203	179	190	172
3	456	424	404	481	552	490	475
4	855	808	741	721	893	1056	889
5	1040	1195	1223	1200	1165	1437	1460
6	1437	1425	1725	1965	1776	1509	1949
7	2171	1919	2001	2378	2620	2169	2137
8	3172	2331	2320	2797	2911	2756	1990
9	3221	3686	3030	2907	3137	3043	3709

Table 3.4.4.3 Haddock in division Va

Marine Research Institute Tue Apr 9 11:38:25 2002
Virtual Population Analysis : Sexual maturity at age in the stock and ssb

Age	1982	1983	1984	1985	1986	1987	1988
2	0.000	0.000	0.000	0.010	0.020	0.020	0.010
3	0.130	0.130	0.130	0.100	0.190	0.110	0.220
4	0.300	0.300	0.300	0.400	0.430	0.410	0.380
5	0.460	0.460	0.460	0.430	0.660	0.520	0.770
6	0.680	0.680	0.680	0.720	0.830	0.790	0.790
7	0.860	0.860	0.860	0.670	0.870	0.780	0.930
8	0.960	0.960	0.960	0.920	0.950	1.000	0.900
9	1.000	1.000	1.000	0.890	0.990	0.960	1.000

Age	1989	1990	1991	1992	1993	1994	1995
2	0.040	0.110	0.040	0.040	0.120	0.250	0.160
3	0.200	0.280	0.200	0.140	0.330	0.320	0.490
4	0.530	0.590	0.580	0.420	0.470	0.570	0.430
5	0.720	0.810	0.750	0.770	0.660	0.780	0.780
6	0.800	0.840	0.820	0.860	0.880	0.860	0.830
7	1.000	0.920	0.910	0.870	0.970	1.000	0.690
8	1.000	0.900	0.940	0.710	0.930	0.900	1.000
9	1.000	1.000	1.000	1.000	0.850	1.000	1.000

Age	1996	1997	1998	1999	2000	2001	2002
2	0.170	0.090	0.030	0.050	0.100	0.090	0.050
3	0.360	0.440	0.480	0.390	0.250	0.380	0.270
4	0.580	0.660	0.680	0.680	0.620	0.520	0.630
5	0.650	0.710	0.780	0.720	0.800	0.750	0.800
6	0.780	0.750	0.760	0.760	0.870	0.900	0.930
7	0.730	0.860	0.850	0.900	0.870	0.920	0.930
8	0.960	0.890	0.910	0.770	1.000	0.920	1.000
9	0.980	1.000	1.000	0.920	1.000	1.000	1.000

Table 3.4.5.1 Icelandic haddock. Age disaggregated survey indices.

year/age	1	2	3	4	5	6	7	8	9
1985	28.18	32.72	18.35	23.66	26.55	3.73	10.98	4.88	5.64
1986	123.99	108.52	59.09	12.81	16.39	13.21	0.98	2.77	1.26
1987	22.23	296.28	163.65	57.09	13.17	11.17	8.09	0.58	1.28
1988	15.77	40.71	184.79	88.88	22.87	1.36	2.25	1.87	0.18
1989	10.59	23.36	41.55	146.77	44.92	12.74	0.85	0.84	0.41
1990	70.5	31.88	27.28	39.12	91.83	30.88	3.44	0.9	0.23
1991	89.73	145.96	41.59	17.86	20.28	32.56	7.67	0.3	0.1
1992	18.11	211.44	138.55	35.63	16.57	13.15	15.94	2.21	0.18
1993	30.18	37.55	242.46	84.8	10.85	3.73	1.65	4.42	0.89
1994	56.54	60.33	39.17	130.8	33.84	5.48	2.12	1.24	3.15
1995	35.44	77.41	49.36	19.8	69.52	7.79	1.34	0.12	0.33
1996	91.76	67.55	119.69	37.57	19.76	41.43	6.17	0.65	0.15
1997	8.7	120.52	52.78	55.17	11.23	7.51	10.9	1.4	0.06
1998	23.81	18.28	102.62	27.53	23.52	4.78	3.56	4.78	0.35
1999	82.9	86.8	26.8	103.07	13.41	9.81	1.45	1.73	1.03
2000	62.67	92.12	45.91	8.78	25.42	3	1.64	0.41	0.15
2001	81.36	140.37	115.63	22.7	4.22	10.97	0.97	0.58	0
2002	21.72	297.95	202.34	114.99	23.66	3.6	7.13	0.32	0.35

Table 3.4.6.1 Haddock in division Va. Input data for tuning.

```
ICE HADDOCK Catch at age
102
2ara CPU
1985 2001
1 1 0.17 0.25
2 2
0.1 32.7
0.1 108.5
0.1 296.3
0.1 40.7
0.1 23.4
0.1 31.9
0.1 146.0
0.1 212.3
0.1 37.2
0.1 61.2
0.1 83.2
0.1 71.3
0.1 120.4
0.1 18.2
0.1 86.5
0.1 91.0
0.1 140.4

SUR CPU
1984 2001
1 1 0.99 1
2 8
0.1 18.4 23.7 26.6 3.7 11.0 4.9 5.6
0.1 59.1 12.8 16.4 13.2 1.0 2.8 1.3
0.1 163.6 57.1 13.2 11.2 8.1 0.6 1.3
0.1 184.8 88.9 22.9 1.4 2.2 1.9 0.2
0.1 41.6 146.8 44.9 12.7 0.8 0.8 0.4
0.1 27.3 39.1 91.8 30.9 3.4 0.9 0.2
0.1 41.6 17.8 20.3 32.5 7.7 0.3 0.1
0.1 138.7 35.6 16.6 13.2 15.9 2.2 0.2
0.1 252.9 88.8 11.3 3.9 1.7 4.5 0.9
0.1 40.6 162.8 46.1 7.2 2.9 1.4 4.1
0.1 48.8 20.7 68.4 8.1 1.4 0.1 0.4
0.1 118.4 34.3 18.7 40.4 6.2 0.6 0.1
0.1 49.6 54.6 10.4 7.0 11.2 1.4 0.1
0.1 110.4 28.4 23.4 4.6 3.5 4.6 0.3
0.1 25.8 98.2 12.9 9.6 1.4 1.7 1.0
0.1 45.5 8.6 24.7 2.9 1.6 0.4 0.2
0.1 115.2 22.2 4.1 10.6 0.9 0.6 0.0
0.1 202.3 115.0 23.7 3.6 7.1 0.3 0.4
```

Table 3.4.6.2 Haddock Va. Output from XSA.

```
Lowestoft VPA Version 3.1

   8/04/2002  17:48

 Extended Survivors Analysis

 Icelandic Haddock. Run 3.

 CPUE data from file hadvaef.dat

 Catch data for  21 years. 1981 to 2001. Ages  2 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                     ,    year, year,  age ,  age
 2ara CPU             ,   1985, 2001,   2,     2,  0.170,  0.250
 SUR CPU              ,   1984, 2001,   2,     8,  0.990,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    7


 Terminal population estimation :

      Survivor estimates shrunk towards the mean F
      of the final   2 years or the   2 oldest ages.

      S.E. of the mean to which the estimates  are shrunk =   0.500

      Minimum standard error for population
      estimates derived from each fleet =   0.300

      Prior weighting not applied


 Tuning converged after   17 iterations


 Regression weights
       , 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000, 1.000

 Fishing mortalities
    Age,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001

      2, 0.018, 0.006, 0.008, 0.038, 0.048, 0.016, 0.018, 0.027, 0.028, 0.020
      3, 0.137, 0.098, 0.116, 0.234, 0.197, 0.164, 0.128, 0.170, 0.224, 0.181
      4, 0.419, 0.369, 0.348, 0.331, 0.447, 0.400, 0.436, 0.425, 0.452, 0.410
      5, 0.704, 0.657, 0.619, 0.579, 0.515, 0.646, 0.602, 0.778, 0.753, 0.594
      6, 0.837, 0.768, 0.810, 0.793, 0.849, 0.579, 0.797, 0.914, 0.940, 0.959
      7, 0.797, 0.923, 0.911, 0.916, 1.037, 0.874, 0.836, 0.867, 1.064, 1.044
      8, 0.971, 0.838, 0.689, 0.999, 1.152, 0.992, 1.036, 0.980, 1.053, 0.986
      9, 0.937, 0.862, 0.684, 0.993, 1.182, 0.924, 0.968, 0.932, 1.141, 1.052


 XSA population numbers (Thousands)

                                    AGE
 YEAR            2        3        4        5        6        7        8        9

 1992     1.70E+05 6.35E+04 1.35E+04 9.09E+03 7.78E+03 1.19E+04 2.34E+03 2.40E+02
 1993     3.75E+04 1.37E+05 4.53E+04 7.27E+03 3.68E+03 2.76E+03 4.41E+03 7.25E+02
 1994     4.12E+04 3.05E+04 1.02E+05 2.57E+04 3.09E+03 1.40E+03 8.97E+02 1.56E+03
 1995     7.04E+04 3.35E+04 2.22E+04 5.88E+04 1.13E+04 1.12E+03 4.60E+02 3.69E+02
 1996     3.45E+04 5.55E+04 2.17E+04 1.31E+04 2.70E+04 4.19E+03 3.68E+02 1.39E+02
 1997     9.29E+04 2.69E+04 3.73E+04 1.13E+04 6.39E+03 9.45E+03 1.22E+03 9.53E+01
 1998     1.28E+04 7.48E+04 1.87E+04 2.05E+04 4.87E+03 2.93E+03 3.23E+03 3.69E+02
 1999     4.49E+04 1.03E+04 5.39E+04 9.90E+03 9.19E+03 1.80E+03 1.04E+03 9.37E+02
 2000     9.47E+04 3.58E+04 7.09E+03 2.89E+04 3.72E+03 3.02E+03 6.18E+02 3.20E+02
 2001     1.23E+05 7.54E+04 2.34E+04 3.69E+03 1.11E+04 1.19E+03 8.53E+02 1.77E+02
```

Table 3.4.6.2 (Cont'd)

```
Estimated population abundance at 1st Jan 2002

         0.00E+00 9.85E+04 5.15E+04 1.27E+04 1.67E+03 3.49E+03 3.43E+02 2.61E+02

Taper weighted geometric mean of the VPA populations:

   ,    4.72E+04,3.59E+04,2.61E+04, 1.64E+04, 8.35E+03, 3.18E+03, 1.25E+03, 3.92E+02,

Standard error of the weighted Log(VPA populations) :

   ,      0.7806,  0.7468,  0.7446,  0.8448,   0.8339,  0.8830,   0.9630,   1.0408,


Log catchability residuals.

Fleet : 2ara CPU

 Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991
    2 , 99.99, -0.48, -0.05,  0.33, -0.40, -0.37,  0.12,  0.36
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age

 Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
    2 , -0.02, -0.25,  0.16, -0.07,  0.49,  0.02,  0.12,  0.42, -0.28, -0.10
    3 , No data for this fleet at this age
    4 , No data for this fleet at this age
    5 , No data for this fleet at this age
    6 , No data for this fleet at this age
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age

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


   Age ,         2
Mean Log q,   -4.3210,
S.E(Log q),    0.2957,

Regression statistics :


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

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 2,    0.98,    0.162,      4.43,    0.86,     17,    0.30,   -4.32,

Fleet : SUR CPU

 Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991
    2 , -0.38,  0.06,  0.31, -0.19, -0.44, -0.28,  0.34,  0.28
    3 , -0.21, -0.32,  0.45,  0.12, -0.04, -0.12, -0.26,  0.57
    4 ,  0.05,  0.02,  0.43,  0.22,  0.10,  0.05, -0.16,  0.26
    5 ,  0.33,  0.08,  0.55, -0.88,  0.53,  0.47, -0.18,  0.26
    6 ,  0.89, -0.14,  0.96, -0.14, -0.43,  0.38,  0.00,  0.05
    7 , -0.05,  0.51,  0.60,  0.63, -0.01,  0.98, -0.99, -0.16
    8 ,  0.10, -0.30,  0.90,  0.53,  0.44,  0.25, -0.10, -0.28



 Age  ,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001
    2 ,  0.11, -0.22, -0.13,  0.25,  0.11, -0.11,  0.42, -0.26, -0.08,  0.22
    3 ,  0.27,  0.07, -0.47,  0.05, -0.03,  0.01,  0.19, -0.21, -0.46,  0.40
    4 ,  0.10,  0.25, -0.19,  0.02, -0.43, -0.21, -0.07, -0.49, -0.23,  0.28
    5 , -0.21,  0.58, -0.60,  0.14, -0.18, -0.33, -0.23, -0.52, -0.32,  0.50
    6 , -0.72,  0.50, -0.01,  0.16, -0.06, -0.05, -0.48, -0.87, -0.51,  0.48
    7 , -0.08,  0.35, -1.63,  0.39,  0.04,  0.26,  0.39, -0.53, -0.45, -0.23
    8 ,  0.12,  0.87, -0.02, -0.43, -0.05, -0.31, -0.04, -0.57, 99.99,  0.33

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

Table 3.4.6.2 (Cont'd)

```
   Age         2        3        4        5        6        7        8
 Mean Log q   -4.1030  -4.2021  -4.2696  -4.3409  -4.3776  -4.5113  -4.5113
 S.E(Log q)    0.2654   0.2991   0.2493   0.4447   0.5059   0.6261   0.4336


 Regression statistics :


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

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  2,    0.99,    0.162,      4.20,    0.89,     18,    0.27,   -4.10,
  3,    0.89,    1.230,      4.90,    0.89,     18,    0.26,   -4.20,
  4,    1.08,   -0.855,      3.80,    0.88,     18,    0.27,   -4.27,
  5,    1.09,   -0.591,      3.88,    0.74,     18,    0.49,   -4.34,
  6,    0.88,    0.834,      4.92,    0.75,     18,    0.45,   -4.38,
  7,    1.00,   -0.016,      4.50,    0.62,     18,    0.65,   -4.51,
  8,    0.95,    0.540,      4.57,    0.87,     17,    0.41,   -4.43,


 Terminal year survivor and F summaries :

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

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 2ara CPU           ,     88807.,  0.304,      0.000,   0.00,   1, 0.415,    0.022
 SUR CPU            ,    122297.,  0.300,      0.000,   0.00,   1, 0.428,    0.016

   F shrinkage mean  ,     72001.,   0.50,,,,                     0.157,    0.027

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     98526.,      0.20,     0.15,    3,   0.749,  0.020


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

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 2ara CPU           ,     39080.,  0.304,      0.000,   0.00,   1, 0.286,    0.232
 SUR CPU            ,     60260.,  0.215,      0.239,   1.11,   2, 0.583,    0.157

   F shrinkage mean  ,     46666.,   0.50,,,,                     0.131,    0.198

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     51487.,      0.17,     0.15,    4,   0.927,  0.181


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

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 2ara CPU           ,     19343.,  0.304,      0.000,   0.00,   1, 0.197,    0.288
 SUR CPU            ,     11435.,  0.176,      0.229,   1.30,   3, 0.662,    0.447

   F shrinkage mean  ,     11603.,   0.50,,,,                     0.141,    0.442

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     12709.,      0.15,     0.17,    5,   1.129,  0.410
```

Table 3.4.6.2 (Cont'd)

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

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU           ,       1875.,  0.304,      0.000,   0.00,   1, 0.157,    0.544
SUR CPU            ,       1817.,  0.168,      0.196,   1.17,   4, 0.644,    0.557

  F shrinkage mean  ,      1161.,   0.50,,,,                       0.199,    0.773

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1670.,      0.15,     0.15,    6,   0.983,  0.594


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

Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU           ,       3566.,  0.304,      0.000,   0.00,   1, 0.101,    0.946
SUR CPU            ,       3397.,  0.179,      0.183,   1.02,   5, 0.533,    0.976

  F shrinkage mean  ,      3621.,   0.50,,,,                       0.366,    0.937

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     3494.,      0.21,     0.11,    7,   0.528,  0.959


Age  7   Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU           ,        562.,  0.304,      0.000,   0.00,   1, 0.049,    0.753
SUR CPU            ,        277.,  0.231,      0.099,   0.43,   6, 0.395,    1.187

  F shrinkage mean  ,       382.,   0.50,,,,                       0.555,    0.976

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      343.,      0.29,     0.10,    8,   0.351,  1.044


Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1993

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU           ,        244.,  0.304,      0.000,   0.00,   1, 0.022,    1.029
SUR CPU            ,        285.,  0.286,      0.150,   0.52,   7, 0.423,    0.931

  F shrinkage mean  ,       244.,   0.50,,,,                       0.554,    1.028

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      261.,      0.30,     0.09,    9,   0.309,  0.986
```

Table 3.4.6.2 (Cont'd)

```
Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

Year class = 1992

Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
2ara CPU            ,       59.,  0.304,     0.000,   0.00,    1, 0.014,    0.954
SUR CPU             ,       36.,  0.211,     0.091,   0.43,    6, 0.107,    1.290

  F shrinkage mean  ,       52.,   0.50,,,,                       0.879,    1.027

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       50.,      0.44,     0.12,    8,   0.272,  1.052
```

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

Table 8   Fishing mortality (F) at age

Year Age	1981
2	0.0001
3	0.0194
4	0.1046
5	0.3041
6	0.8136
7	0.8630
8	0.7745
9	0.8273
FBAR 4- 7	0.5213

Table 8   Fishing mortality (F) at age

Year-age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	0.0013	0.0000	0.0033	0.0114	0.0024	0.0148	0.0031	0.0032	0.0223	0.0345
3	0.0404	0.0228	0.0344	0.1284	0.1282	0.1218	0.0856	0.0768	0.1418	0.0824
4	0.1336	0.3061	0.2217	0.3310	0.4473	0.4163	0.4053	0.2880	0.3560	0.3310
5	0.3458	0.3577	0.4207	0.4613	0.6437	0.6655	0.6362	0.4650	0.5457	0.5771
6	0.4482	0.6648	0.8011	0.6064	1.1417	0.6993	0.7759	0.9288	0.6848	0.7100
7	0.8745	0.5638	0.5487	0.6562	0.9160	0.7760	0.8092	0.9544	0.7218	0.7627
8	1.1679	1.0557	0.6290	0.8815	0.9601	0.8229	1.1782	1.4471	0.9217	0.9169
9	1.0329	0.8181	0.5939	0.7597	0.9857	0.6552	0.9142	1.1564	0.8120	0.8572
0FBAR4-7	0.4505	0.4731	0.4981	0.5137	0.7872	0.6393	0.6566	0.6591	0.5771	0.5952

Run title : Icelandic Haddock. Run 3.

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Terminal Fs derived using XSA (With F shrinkage)
Fishing mortality (F) at age

Year-Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	FBAR99-**
2	0.0178	0.0065	0.0075	0.0377	0.0481	0.0165	0.0181	0.0269	0.0278	0.0201	0.0249
3	0.1368	0.0984	0.1164	0.2344	0.1969	0.1643	0.1276	0.1703	0.2241	0.1811	0.1918
4	0.4190	0.3686	0.3480	0.3314	0.4475	0.3995	0.4363	0.4250	0.4523	0.4103	0.4292
5	0.7042	0.6568	0.6194	0.5787	0.5147	0.6461	0.6020	0.7783	0.7528	0.5939	0.7083
6	0.8368	0.7685	0.8099	0.7935	0.8491	0.5789	0.7972	0.9135	0.9400	0.9588	0.9374
7	0.7968	0.9233	0.9110	0.9156	1.0371	0.8741	0.8356	0.8668	1.0638	1.0445	0.9917
8	0.9706	0.8378	0.6889	0.9991	1.1520	0.9922	1.0364	0.9796	1.0526	0.9861	1.0061
9	0.9372	0.8618	0.6840	0.9930	1.1816	0.9237	0.9679	0.9319	1.1414	1.0524	1.0419
FBAR4-7	0.6892	0.6793	0.6721	0.6548	0.7121	0.6247	0.6678	0.7459	0.8022	0.7519	

Table 3.4.6.2 (Cont'd)

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Terminal Fs derived using XSA (With F shrinkage)

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

AGE

Year	1981	1982	1983	1984	1985	1986
Age						
2	9753	42216	30162	19932	41756	89227
3	29682	7984	34518	24694	16265	33800
4	54866	23834	6278	27623	19534	11712
5	71496	40460	17073	3785	18119	11486
6	11953	43189	23442	9775	2034	9353
7	5420	4338	22588	9872	3592	908
8	3711	1872	1481	10524	4669	1526
9	332	1400	477	422	4593	1583
TOTAL	187211	165294	136019	106626	110562	159596

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

year	1987	1988	1989	1990	1991	1992	1993	1994	1995
age									
2	168086	47662	26664	22362	80236	170306	37456	41187	70431
3	72876	135593	38902	21760	17905	63465	136968	30469	33468
4	24343	52826	101905	29495	15460	13500	45316	101629	22204
5	6131	13144	28839	62551	16915	9091	7269	25663	58753
6	4941	2580	5696	14832	29675	7777	3681	3086	11309
7	2445	2010	972	1842	6122	11945	2758	1397	1124
8	298	921	733	306	733	2338	4408	897	460
9	478	107	232	141	100	240	725	1562	369
TOTAL	279597	254843	203942	153290	167146	278660	238582	205890	198119

Run title : Icelandic Haddock. Run 3.

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Terminal Fs derived using XSA (With F shrinkage)

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

	1996	1997	1998	1999	2000	2001	2002	GMST81-99	AMST81-99
2	34505	92926	12774	44861	94659	122785	0	43230	56974
3	55531	26923	74837	10271	35755	75373	98526	34544	45574
4	21676	37338	18704	53934	7093	23396	51487	28161	35904
5	13052	11345	20502	9899	28868	3694	12709	17162	23451
6	26969	6387	4868	9194	3722	11133	1670	8587	12144
7	4188	9446	2931	1796	3019	1190	3494	3359	5037
8	368	1215	3227	1041	618	853	343	1329	2144
9	139	95	369	937	320	177	261	414	753
TOTAL	156428	185675	138211	131933	174053	238601	168489		

Table 3.4.6.2 (Cont'd)

Run title : Icelandic Haddock. Run 3.

At 11/04/2002 11:32

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1981	9753	216822	103616	63580	0.6136	0.5213
1982	42216	198240	111800	69325	0.6201	0.4505
1983	30162	162056	102033	65943	0.6463	0.4731
1984	19932	125235	79931	48285	0.6041	0.4981
1985	41756	116169	60071	50933	0.8479	0.5137
1986	89227	114951	56443	48863	0.8657	0.7872
1987	168086	131273	41677	40801	0.9790	0.6393
1988	47662	161666	65989	54236	0.8219	0.6566
1989	26664	175174	99652	62979	0.6320	0.6591
1990	22362	151173	110642	67200	0.6074	0.5771
1991	80236	135986	91532	54732	0.5980	0.5952
1992	170306	133987	63532	47212	0.7431	0.6892
1993	37456	137434	69600	48844	0.7018	0.6793
1994	41187	135751	83282	59345	0.7126	0.6721
1995	70431	131693	86912	61131	0.7034	0.6548
1996	34505	113318	68381	56958	0.8330	0.7121
1997	92926	101537	61286	44053	0.7188	0.6247
1998	12774	94613	62142	41434	0.6668	0.6678
1999	44861	92783	59698	45481	0.7619	0.7459
2000	94659	93968	52895	42167	0.7972	0.8022
2001	122785	112554	53165	39647	0.7457	0.7519
Arith. Mean	61902	135066	75442	53007	0.7248	0.6367
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 3.4.7.1 Haddock in division Va. Input file for RCT3

```
. Iceland Haddock: VPA and groundfish survey data
3 24 2
'Yearcl' 'VPAage2' 'Surv3' 'Surv2' 'Surv1'
1978   37   -11   -11   -11
1979   10   -11   -11   -11
1980   42   -11   -11   -11
1981   30   -11   -11   -11
1982   20   184   -11   -11
1983   41   591   327   -11
1984   88  1636  1085   282
1985  166  1848  2963  1240
1986   47   416   407   222
1987   26   273   234   158
1988   22   416   319   106
1989   79  1386  1460   705
1990  169  2425  2114   897
1991   37   392   376   181
1992   41   494   603   302
1993   70  1197   774   565
1994   34   528   676   354
1995   92  1026  1205   918
1996   13   268   183    87
1997   45   459   868   238
1998  -11  1156   921   829
1999  -11  2023  1404   627
2000  -11   -11  2980   814
2001  -11   -11   -11   213
```

Table 3.4.7.2 Haddock in division Va. Output from the RTC3 model.

```
Analysis by RCT3 ver3.1 of data from file :
 rinki.inp
 Iceland    Haddock:    VPA    and    groundfish    survey    data
 Data for    3 surveys over   24 years :  1978 - 2001

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

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

 Forecast/Hindcast variance correction used.
 Yearclass =   1998
          I-----------Regression----------I  I-----------Prediction--------I

 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error  Weights

 Surv3     1.06  -2.94    .29   .868     16   7.05    4.50     .342     .313
 Surv2      .96  -2.33    .28   .876     15   6.83    4.23     .324     .350
 Surv1      .94  -1.51    .31   .858     14   6.72    4.80     .373     .264

                                        VPA Mean =    3.89     .712     .072
 Yearclass =   1999
          I-----------Regression----------I  I-----------Prediction--------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error  Weights

 Surv3     1.07  -3.03    .29   .867     16   7.61    5.10     .377     .278
 Surv2      .97  -2.40    .28   .877     15   7.25    4.63     .339     .344
 Surv1      .93  -1.50    .30   .862     14   6.44    4.52     .363     .300

                                        VPA Mean =    3.89     .713     .078

 Yearclass =   2000
          I-----------Regression----------I  I-----------Prediction--------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error  Weights

 Surv3
 Surv2      .98  -2.48    .28   .879     15   8.00    5.37     .388     .421
 Surv1      .93  -1.49    .30   .866     14   6.70    4.75     .374     .454

                                        VPA Mean =    3.88     .715     .124
 Yearclass =   2001
          I-----------Regression----------I  I-----------Prediction--------I
 Survey/  Slope  Inter-   Std  Rsquare  No.  Index Predicted   Std     WAP
 Series           cept   Error          Pts  Value   Value    Error  Weights

 Surv3
 Surv2
 Surv1      .93  -1.47    .30   .871     14   5.37    3.49     .359     .800
                                        VPA Mean =    3.87     .717     .200


 Year     Weighted      Log      Int      Ext      Var      VPA       Log
 Class     Average      WAP      Std      Std     Ratio               VPA
          Prediction             Error    Error

 1998          84       4.44     .19      .15       .65
 1999         106       4.67     .20      .19       .90
 2000         134       4.90     .25      .34      1.83
 2001          35       3.57     .32      .15       .22
```

Table 3.4.8.1 Haddock Va. Input data for short term prediction.

Sexual maturity at spawning time:

age\year	2001	2002	2003	2004	2005
2	0,091	0,047	0,081	0,081	0,081
3	0,377	0,286	0,308	0,308	0,308
4	0,522	0,633	0,596	0,596	0,596
5	0,753	0,800	0,787	0,787	0,787
6	0,895	0,934	0,899	0,899	0,899
7	0,916	0,928	0,906	0,906	0,906
8	0,918	1,000	0,973	0,973	0,973
9	1,000	1,000	1,000	1,000	1,000

Mean weights in the fishable stock and SSB

age\year	2001	2002	2003	2004	2005
2	0,190	0,172	0,180	0,180	0,180
3	0,490	0,475	0,438	0,505	0,505
4	1,056	0,889	0,882	0,944	0,944
5	1,437	1,460	1,317	1,352	1,352
6	1,509	1,949	1,924	1,741	1,741
7	2,169	2,137	2,514	2,306	2,306
8	2,765	2,815	2,765	2,557	2,557
9	3,025	3,025	3,146	3,420	3,420

Mean weights in tha catch

age\year	2001	2002	2003	2004	2005
2	0,542	0,577	0,577	0,559	0,559
3	0,933	0,868	0,873	0,917	0,917
4	1,451	1,366	1,274	1,287	1,287
5	1,759	1,932	1,836	1,619	1,619
6	1,836	2,276	2,469	2,046	2,046
7	2,309	2,370	2,731	2,556	2,556
8	2,966	2,877	2,917	3,003	3,003
9	3,123	3,322	3,223	3,263	3,263

Selection pattern from a VPA;

age\year	1996	1997	1998	1999	2000	2001	97-2001	Used
2	0,069	0,027	0,027	0,036	0,035	0,029	0,031	0,031
3	0,280	0,266	0,194	0,229	0,280	0,241	0,243	0,243
4	0,634	0,644	0,660	0,572	0,564	0,545	0,594	0,594
5	0,726	1,037	0,909	1,046	0,940	0,790	0,942	0,942
6	1,197	0,923	1,196	1,227	1,172	1,276	1,166	1,166
7	1,443	1,396	1,235	1,155	1,324	1,389	1,299	1,318
8	1,536	1,532	1,539	1,259	1,285	1,312	1,375	1,318
9	1,392	1,284	1,324	1,213	1,260	1,325	1,280	1,318
Ave(4-7)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Table 3.4.8.1 (Cont'd)

Given stock numbers

age\year	2002	2003	2004	2005
2	155,000	29,00	48,00	48,00
3	90,000			
4	51,487			
5	12,709			
6	1,670			
7	3,494			
8	0,343			
9	0,261			

Table 3.4.8.2 Haddock in division Va. Input to yield per recruit.

MFYPR version 1
Run: had-iceg
Icelandic Haddock.
Time and date: 17:39 07/05/02
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	.2	.068	0	0	.1852	.0162	.54175
3	.2	.2605	0	0	.4794	.1265	.8853
4	.2	.491	0	0	.90845	.36525	1.3237
5	.2	.6725	0	0	1.4003	.57945	1.8088
6	.2	.79	0	0	1.96775	.78455	2.3461
7	.2	.8635	0	0	2.51275	.83915	2.97555
8	.2	.921	0	0	3.1646	.97075	3.43515
9	.2	.9795	0	0	3.2482	.86475	3.90525

Weights in kilograms

Table 3.4.8.3 Haddock in division Va. Output from yield per recruit.

MFYPR version 2a
Run: had-iceg
Time and date: 19:55 07/05/02
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNos Jan	SSBJan	SpwnNos Spwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	9.1405	3.2229	7.6094	3.2229	7.6094
0.1000	0.0752	0.2003	0.5388	4.5198	6.1126	2.2847	4.7141	2.2847	4.7141
0.2000	0.1504	0.3022	0.7389	4.0148	4.6597	1.8245	3.3531	1.8245	3.3531
0.3000	0.2255	0.3653	0.8234	3.7030	3.8149	1.5499	2.5795	1.5499	2.5795
0.4000	0.3007	0.4091	0.8598	3.4872	3.2653	1.3663	2.0884	1.3663	2.0884
0.5000	0.3759	0.4419	0.8741	3.3265	2.8802	1.2340	1.7524	1.2340	1.7524
0.6000	0.4511	0.4677	0.8776	3.2005	2.5953	1.1335	1.5099	1.1335	1.5099
0.7000	0.5262	0.4887	0.8758	3.0979	2.3760	1.0539	1.3275	1.0539	1.3275
0.8000	0.6014	0.5064	0.8712	3.0121	2.2017	0.9891	1.1857	0.9891	1.1857
0.9000	0.6766	0.5215	0.8653	2.9387	2.0597	0.9351	1.0726	0.9351	1.0726
1.0000	0.7518	0.5347	0.8589	2.8749	1.9414	0.8891	0.9804	0.8891	0.9804
1.1000	0.8269	0.5464	0.8524	2.8185	1.8412	0.8494	0.9038	0.8494	0.9038
1.2000	0.9021	0.5569	0.8459	2.7683	1.7551	0.8146	0.8391	0.8146	0.8391
1.3000	0.9773	0.5663	0.8397	2.7230	1.6802	0.7839	0.7839	0.7839	0.7839
1.4000	1.0525	0.5749	0.8336	2.6819	1.6144	0.7565	0.7361	0.7565	0.7361
1.5000	1.1276	0.5827	0.8279	2.6443	1.5559	0.7318	0.6943	0.7318	0.6943
1.6000	1.2028	0.5900	0.8224	2.6097	1.5036	0.7094	0.6575	0.7094	0.6575
1.7000	1.2780	0.5967	0.8172	2.5777	1.4565	0.6890	0.6248	0.6890	0.6248
1.8000	1.3532	0.6029	0.8123	2.5480	1.4138	0.6703	0.5956	0.6703	0.5956
1.9000	1.4283	0.6088	0.8075	2.5202	1.3748	0.6532	0.5692	0.6532	0.5692
2.0000	1.5035	0.6142	0.8031	2.4943	1.3391	0.6372	0.5454	0.6372	0.5454

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.7518
$\mathbf{F}_{max}$	0.6045	0.4544
$\mathbf{F}_{0.1}$	0.2384	0.1792
F35%SPR	0.2865	0.2154

Weights in kilograms

Table 3.4.8.4 Haddock in division Va. Output from short term prediction.

MFDP version 1
Run: had-iceg
hadrun3MFDP Index file 7.5.2002
Time and date: 17:50 07/05/02
Fbar age range: 4-7

2002				
Biomass	SSB	FMult	FBar	Landings
146214	69021	0.7633	0.5738	45000

2003					2004	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
173552	98237	0.0000	0.0000	0	247517	171783
.	98237	0.1000	0.0752	10111	238304	164336
.	98237	0.2000	0.1504	19692	229581	157309
.	98237	0.3000	0.2255	28775	221317	150676
.	98237	0.4000	0.3007	37392	213483	144411
.	98237	0.5000	0.3759	45571	206052	138490
.	98237	0.6000	0.4511	53340	199000	132892
.	98237	0.7000	0.5262	60723	192304	127595
.	98237	0.8000	0.6014	67744	185941	122580
.	98237	0.9000	0.6766	74425	179891	117831
.	98237	1.0000	0.7518	80786	174136	113330
.	98237	1.1000	0.8269	86845	168659	109062
.	98237	1.2000	0.9021	92622	163442	105013
.	98237	1.3000	0.9773	98131	158471	101169
.	98237	1.4000	1.0525	103390	153731	97519
.	98237	1.5000	1.1276	108411	149209	94049
.	98237	1.6000	1.2028	113209	144892	90750
.	98237	1.7000	1.2780	117796	140769	87611
.	98237	1.8000	1.3532	122184	136829	84623
.	98237	1.9000	1.4283	126384	133062	81778
.	98237	2.0000	1.5035	130406	129457	79066

Input units are thousands and kg - output in tonnes

Table 3.4.8.5 Haddock in division Va. Output from short term prediction.

Catch, '000 tonnes

	1998	1999	2000	2001	2002	2003	2004	2005
$F_{0.1}$	41	46	42	40	45	22	32	38
F_{pa}	41	46	42	40	45	55	66	65
F2001	41	46	42	40	45	81	82	68
1.25F2001	41	46	42	40	45	95	88	66
*Y2001*1.5*	41	46	42	40	45	60	60	60

Average fishing mortality of 4-7 years old

	1998	1999	2000	2001	2002	2003	2004	2005
$F_{0.1}$	0,666	0,746	0,803	0,752	0,574	0,169	0,169	0,169
F_{pa}	0,666	0,746	0,803	0,752	0,574	0,470	0,470	0,470
F2001	0,666	0,746	0,803	0,752	0,574	0,750	0,750	0,750
1.25F2001	0,666	0,746	0,803	0,752	0,574	0,940	0,940	0,940
*Y2001*1.5*	0,666	0,746	0,803	0,752	0,574	0,519	0,432	0,423

Fishable stock, 3+ in '000 tonnes at the beginning of the year

	1998	1999	2000	2001	2002	2003	2004	2005
$F_{0.1}$	91	83	76	88	120	168	219	234
F_{pa}	91	83	76	88	120	168	189	170
F2001	91	83	76	88	120	168	166	130
1.25F2001	91	83	76	88	120	168	152	111
*Y2001*1.5*	91	83	76	88	120	168	184	171

Spawning stock in '000 tonnes at the beginning of the year

	1998	1999	2000	2001	2002	2003	2004	2005
$F_{0.1}$	62	59	52	53	69	98	156	184
F_{pa}	62	59	52	53	69	98	132	129
F2001	62	59	52	53	69	98	114	95
1.25F2001	62	59	52	53	69	98	103	79
*Y2001*1.5*	62	59	52	53	69	98	128	130

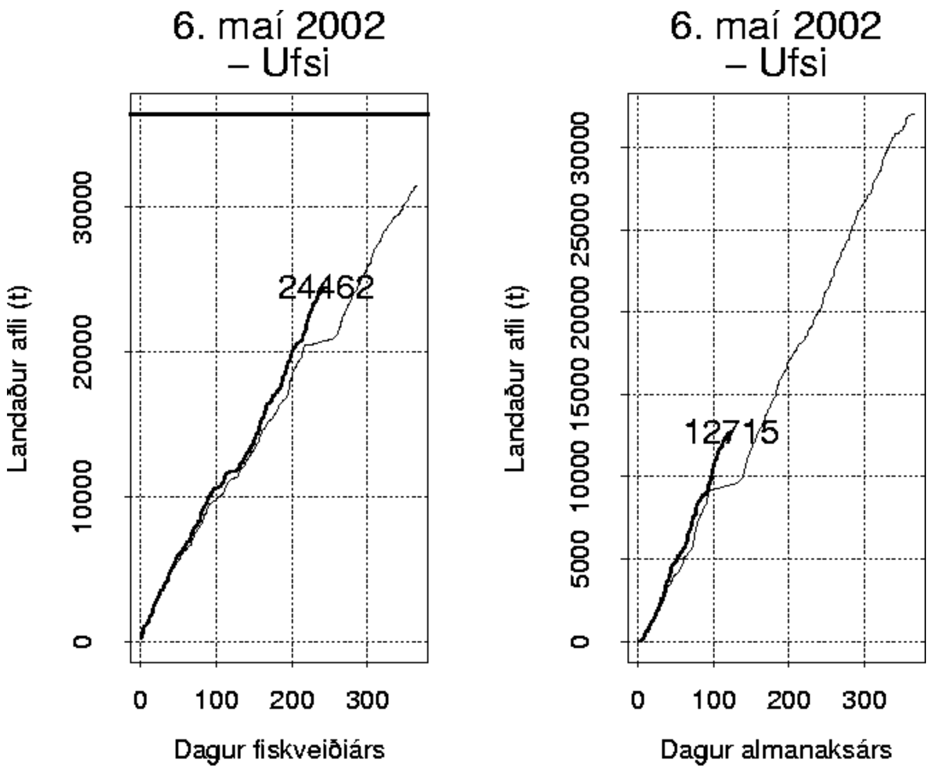


Figure 3.2.1.1 Saithe in Va. Cumulative landings (tonnes) of saithe in Icelandic waters by qouta year on left and calendar year on right. Broad line shows current year (quota year 2001/2002 and calendar year 2002), thin line previous year (2000/2001 and 2001, respectively). Preliminary figures for landings to date in respective years shown in tons at the end of the broad curves. Updated weekly at www.hafro.is/~sigurdur/Landings.

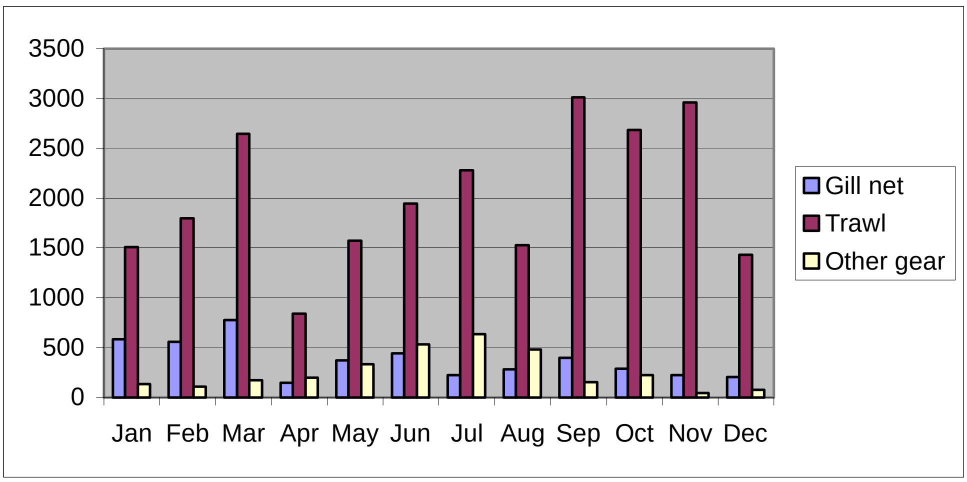


Figure 3.2.2.1 Saithe in division Va. Landings in 2001 by gear type.

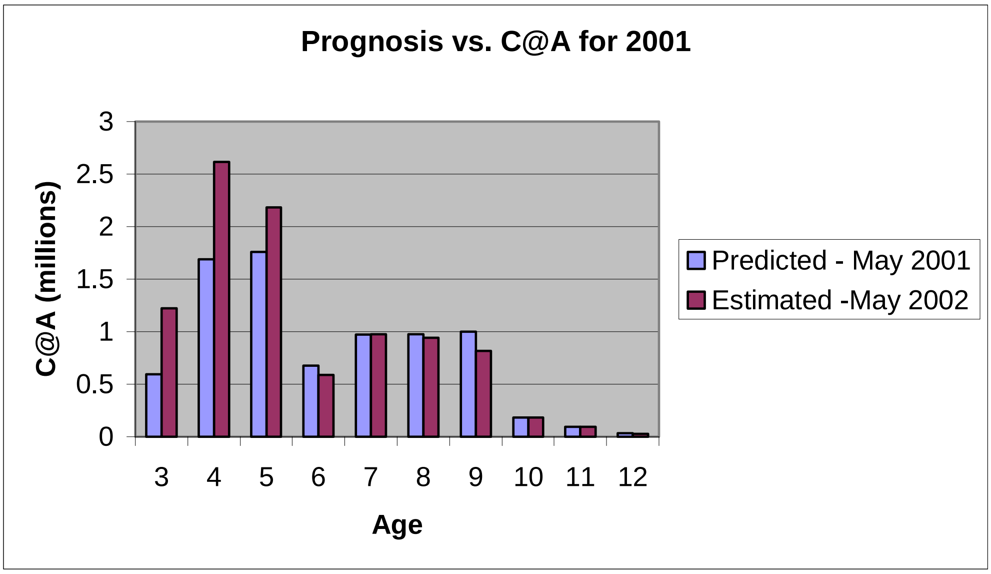


Figure 3.2.3.1 Saithe in division Va. Prognosis in May 2001 and estimate in April age distribution in 2000 landings in numbers.

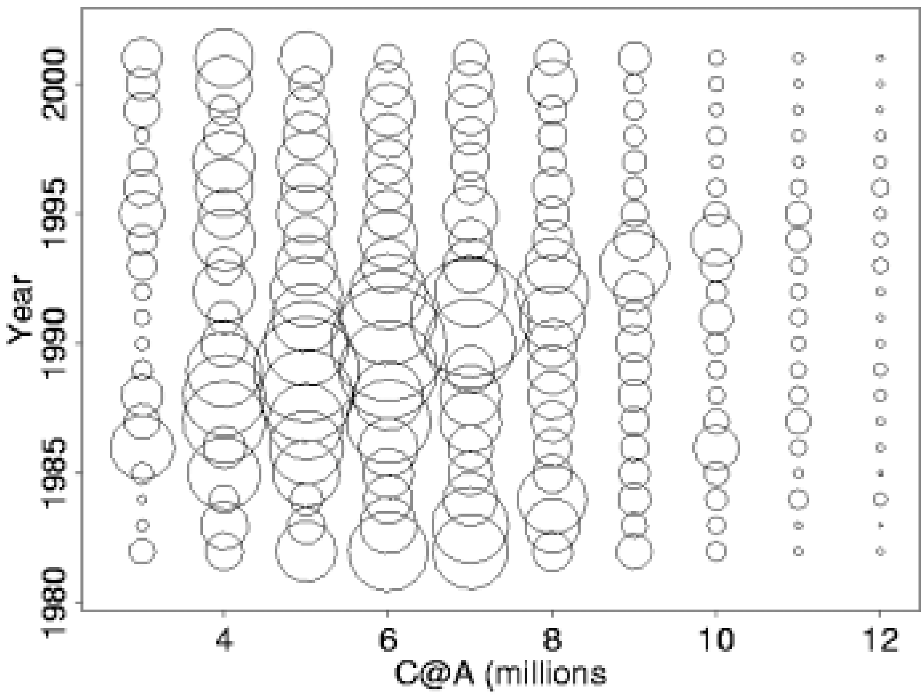


Figure 3.2.3.2 Saithe in Va. Catch at age 1980-2001 for age groups 3-12 as bubbles with area proportional to numbers.

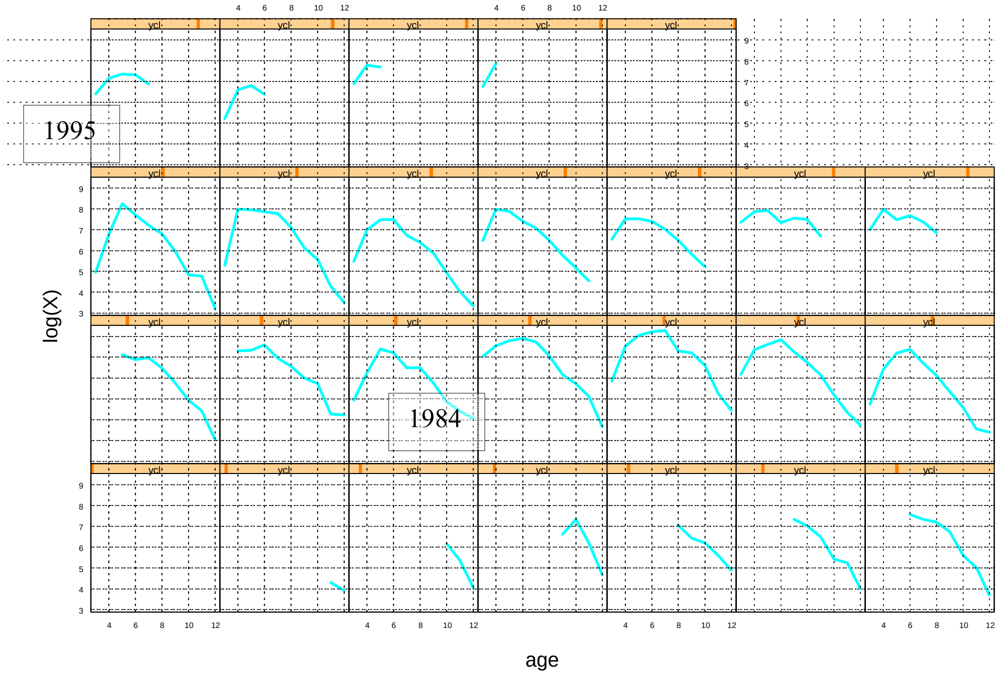


Figure 3.2.3.3 Saithe in Va. Catch at age 1985-2001 for age groups 3-12 as catch curves for year classes 1973 in lower left corner to 1998 in upper right (both with only one observation). Year class 1984 was strong, 1995 is weak.

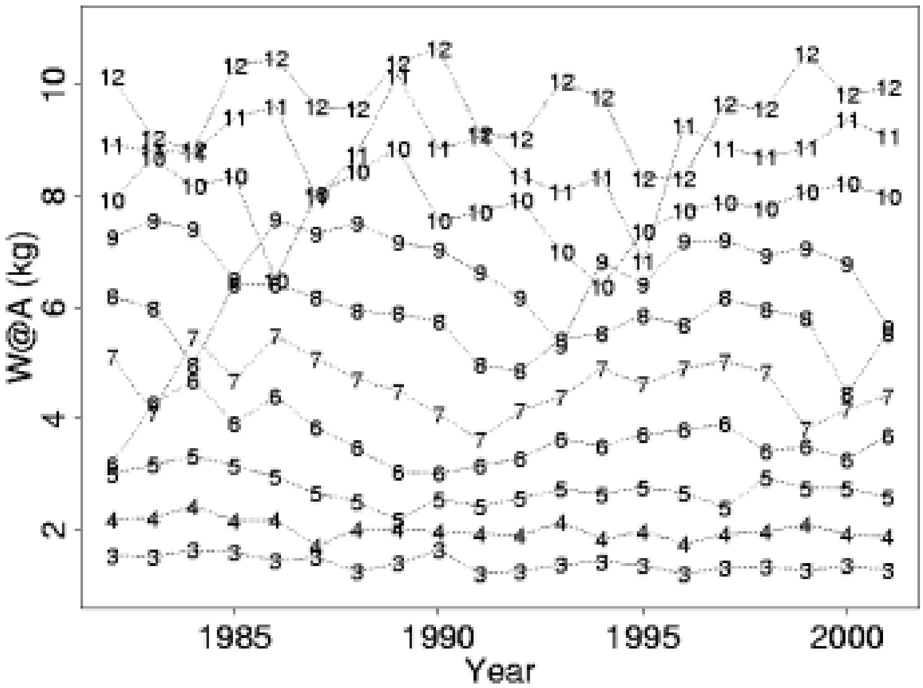


Figure 3.2.4.1 Saithe in Va. Mean weight at age in the catches 1981-2000 for age groups 3-10.

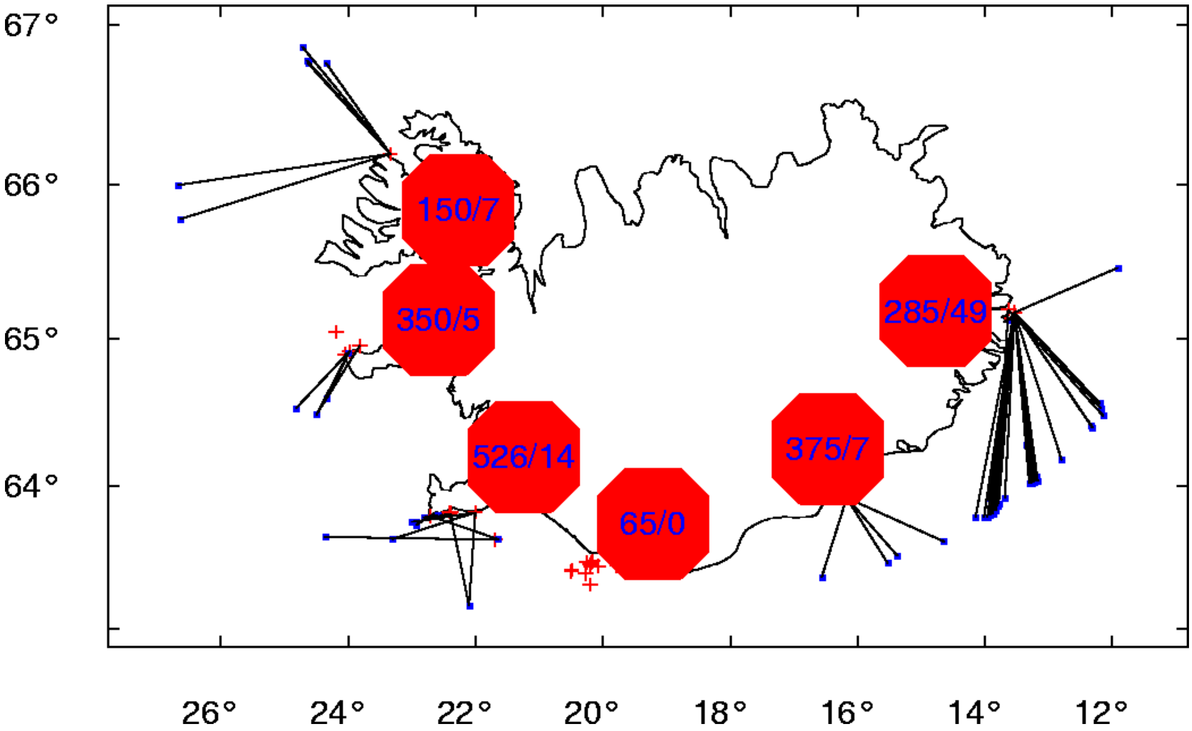


Figure 3.2.6.1 Saithe in Va. Preliminary results from nearshore taggings of saithe in June-July 2000 as of autumn 2001. Straight lines connect tagging site (red crosses) and position of recovery (blue boxes). Numbers tagged and recaptured are given in circles for each tagging area (tagged/recovered).

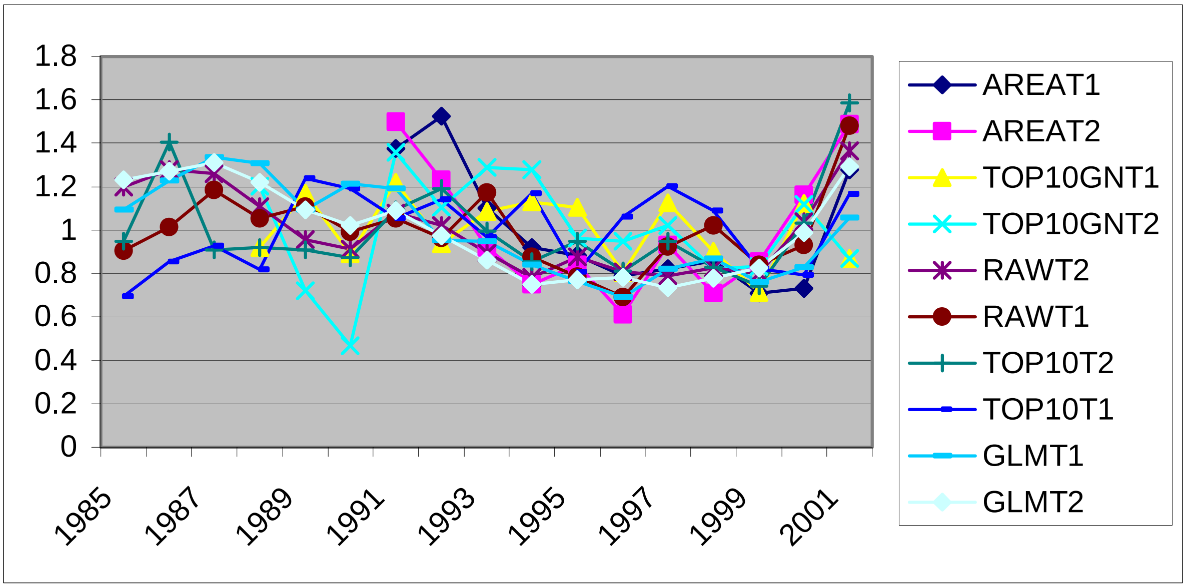


Figure 3.2.7.1 Saithe in Va. Indices of CPUE from various, mostly trawler, fleets.

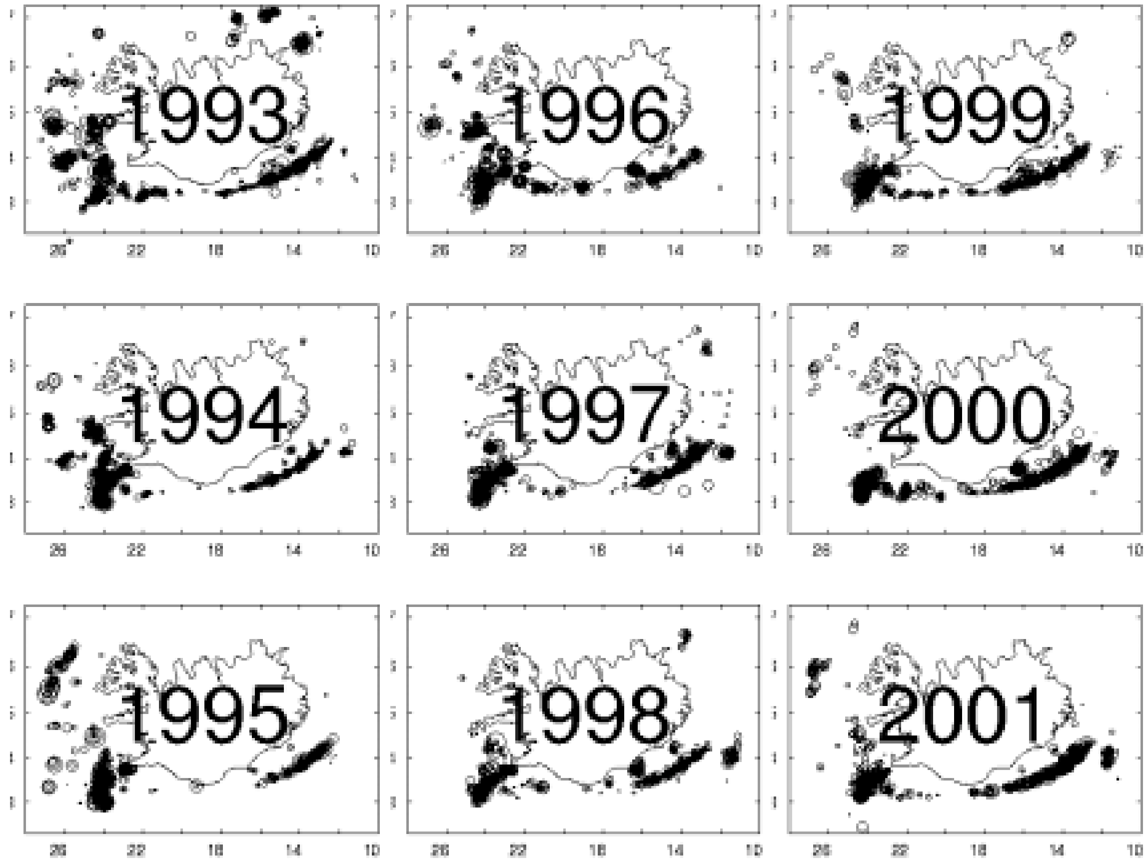


Figure 3.2.7.2 Saithe in Va. Trawl sets with saithe more than 50% of catch for 10 top trawlers in 1993-2001. Circle area proportional to saithe catch scaled to the maximum for period shown.

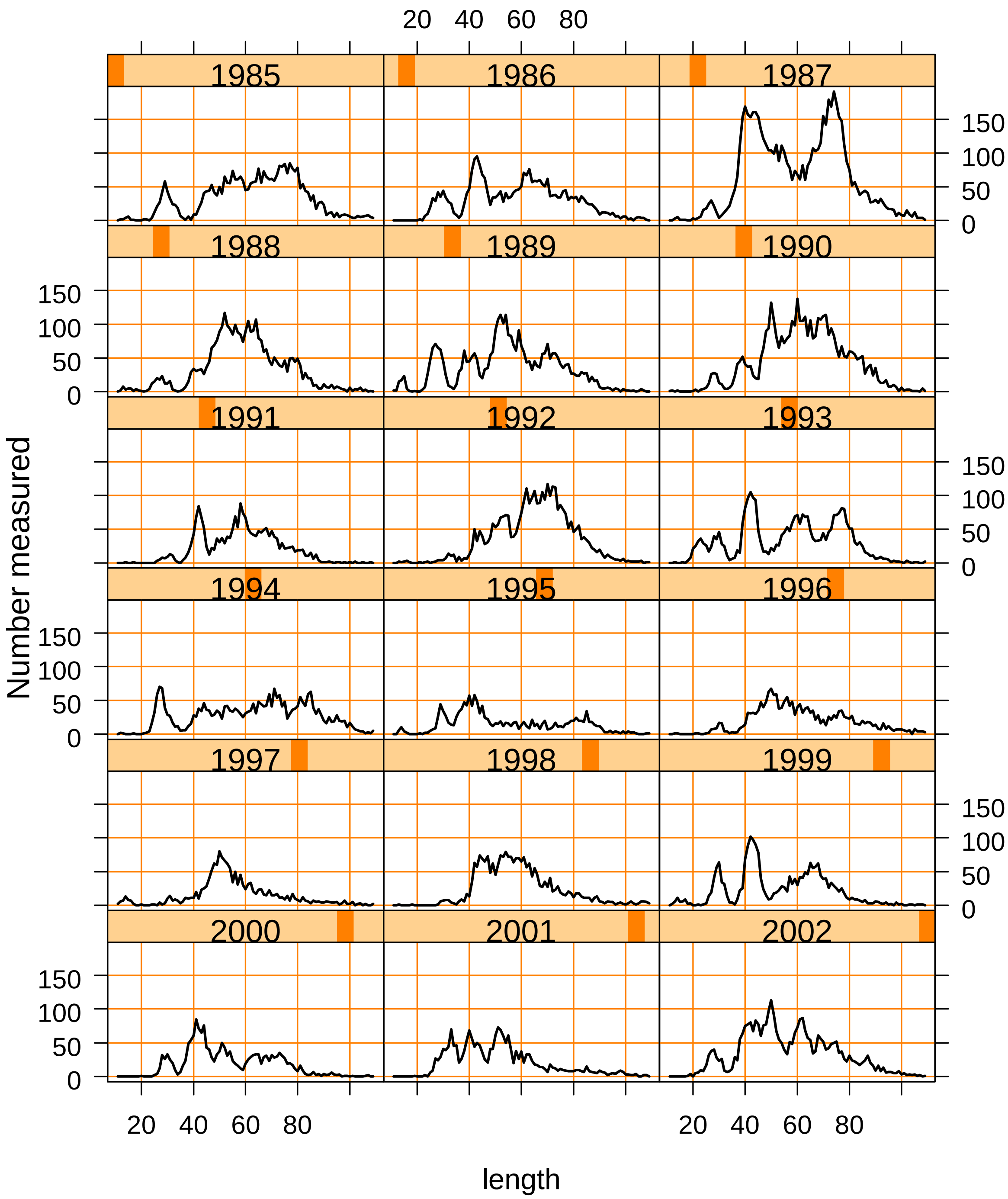


Figure 3.2.7.3 Saithe in Va. Length distributions in IGFS. Note that unscaled length measurements are shown.

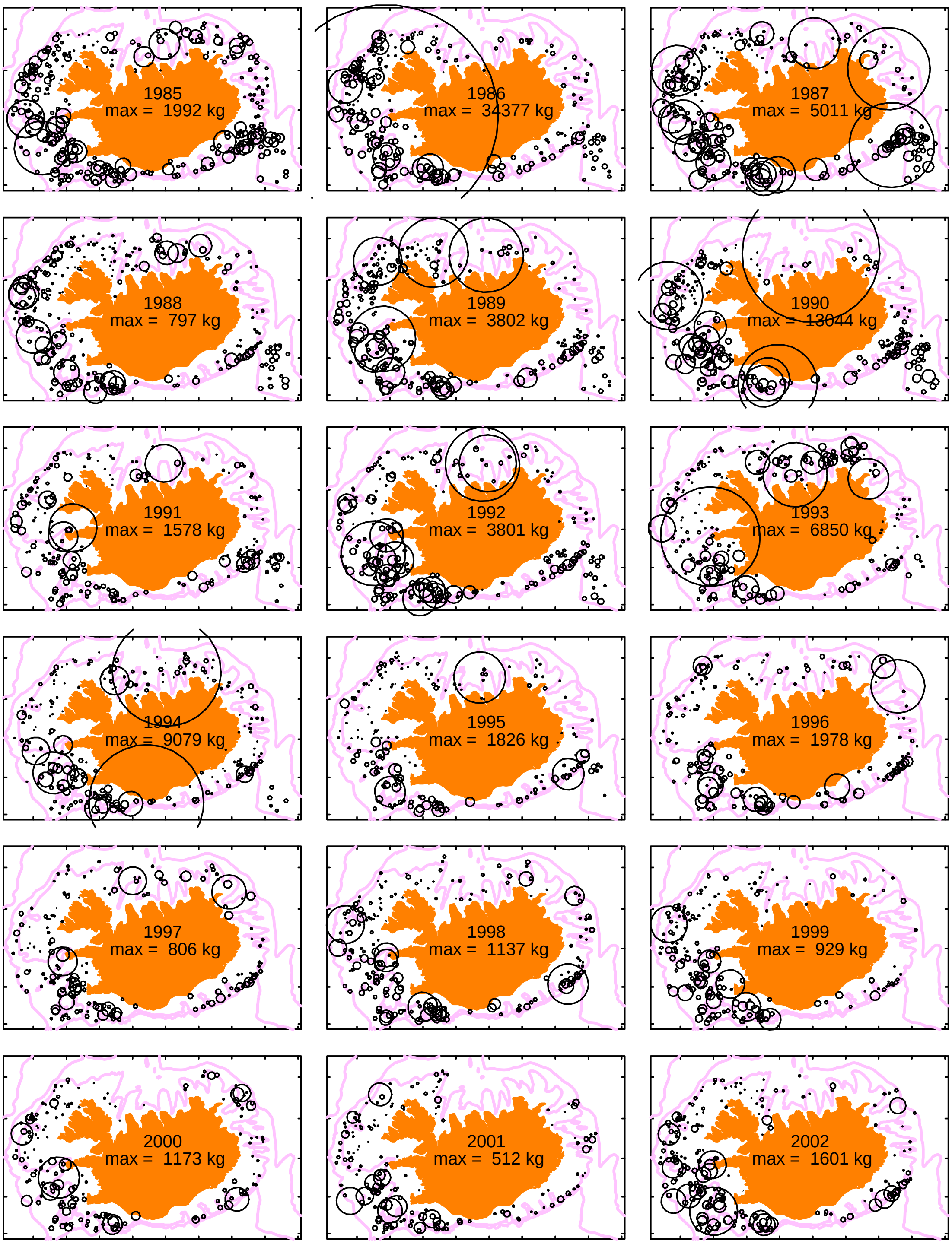


Figure 3.2.7.4 Saithe in Va. Geographic distribution of abundance in IGFS. Only stations, where saithe was found, are shown..

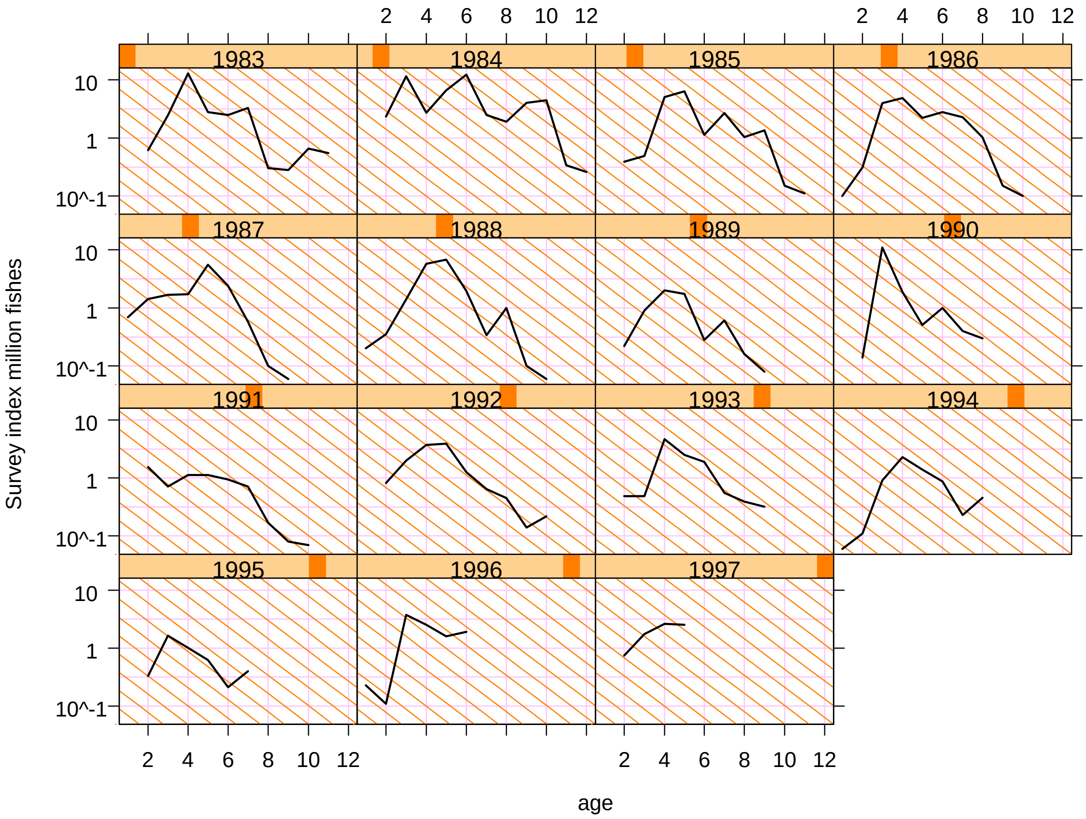


Figure 3.2.7.5 Saithe in Va. Saithe in division Va. Catch curves of IGFS indices for year classes 1983-1997. Grey lines show Z = 0.6.

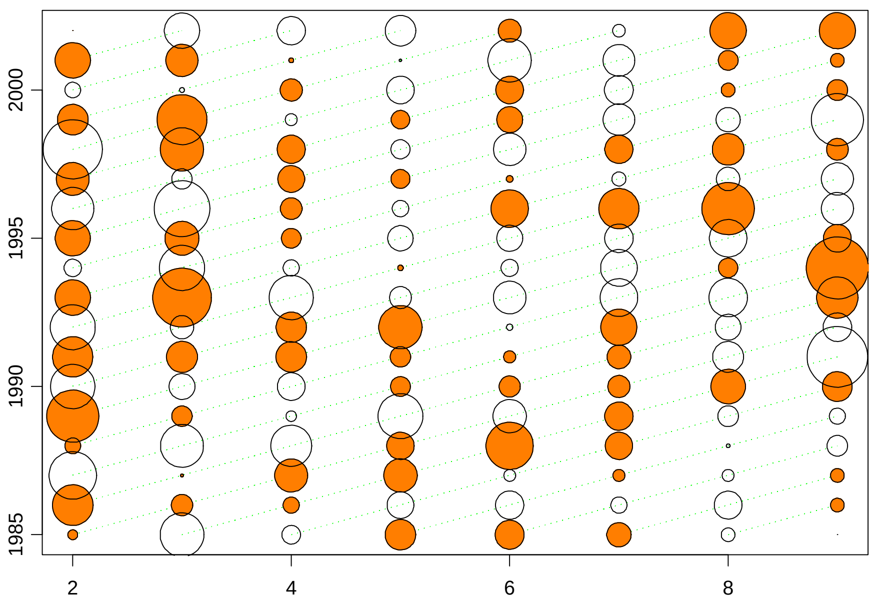


Figure 3.2.7.6 Saithe in Va. Residuals from Shephard Nicholson model for saithe indices from IGFS. Larges circle correponds to 0.5, filled circles are positve, open negative.

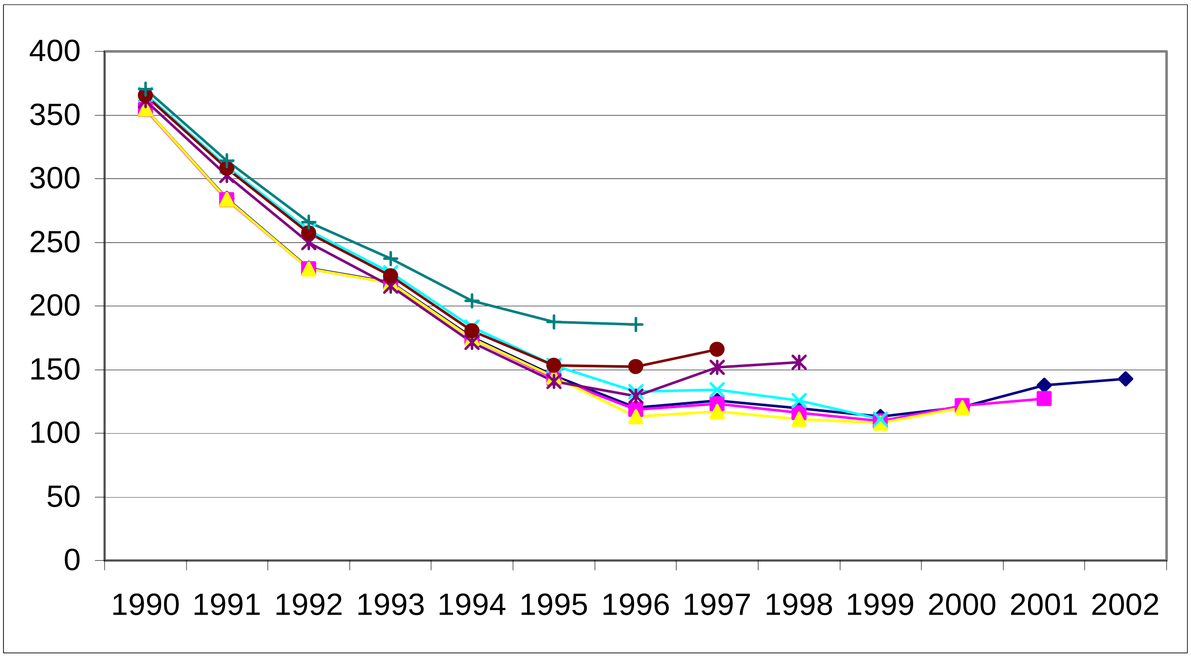


Figure 3.2.7.7 Saithe in Va. Retrospective analysis of TSA biomass (B4+), tuned with IGFS for ages 5-8 and and index for N4 based on year class averages index at age 3, 4 and 5.

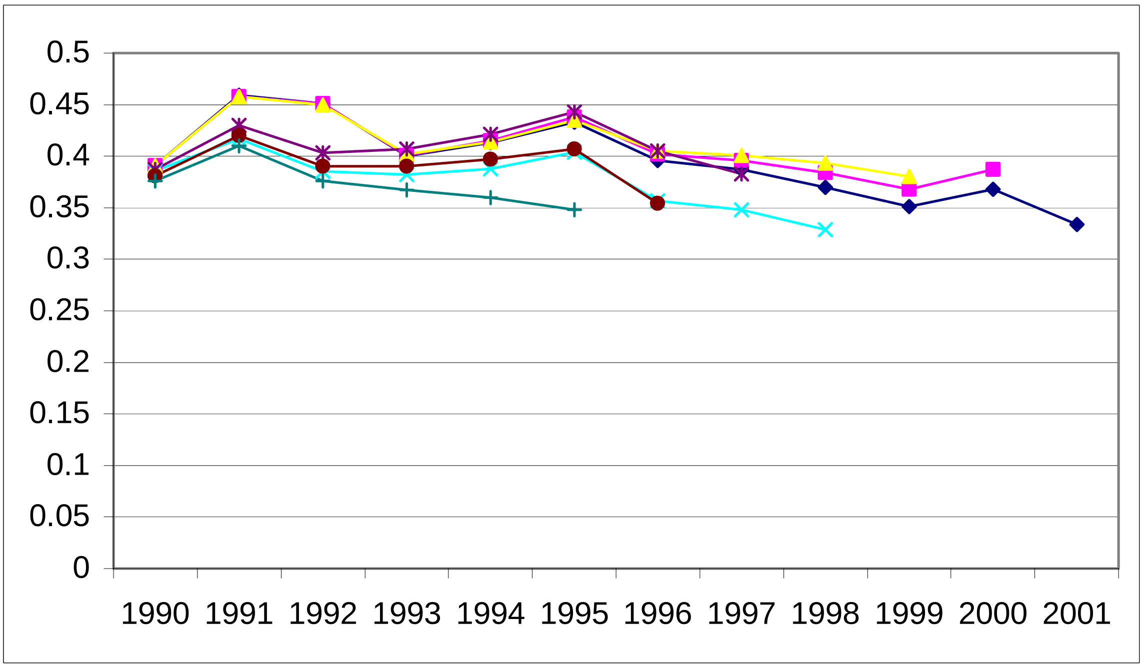


Figure 3.2.7.8 Saithe in Va. Retrospective analysis of TSA F4-9, tuned with IGFS for ages 5-8 and index for N4 based on year class averages index at age 3, 4 and 5.

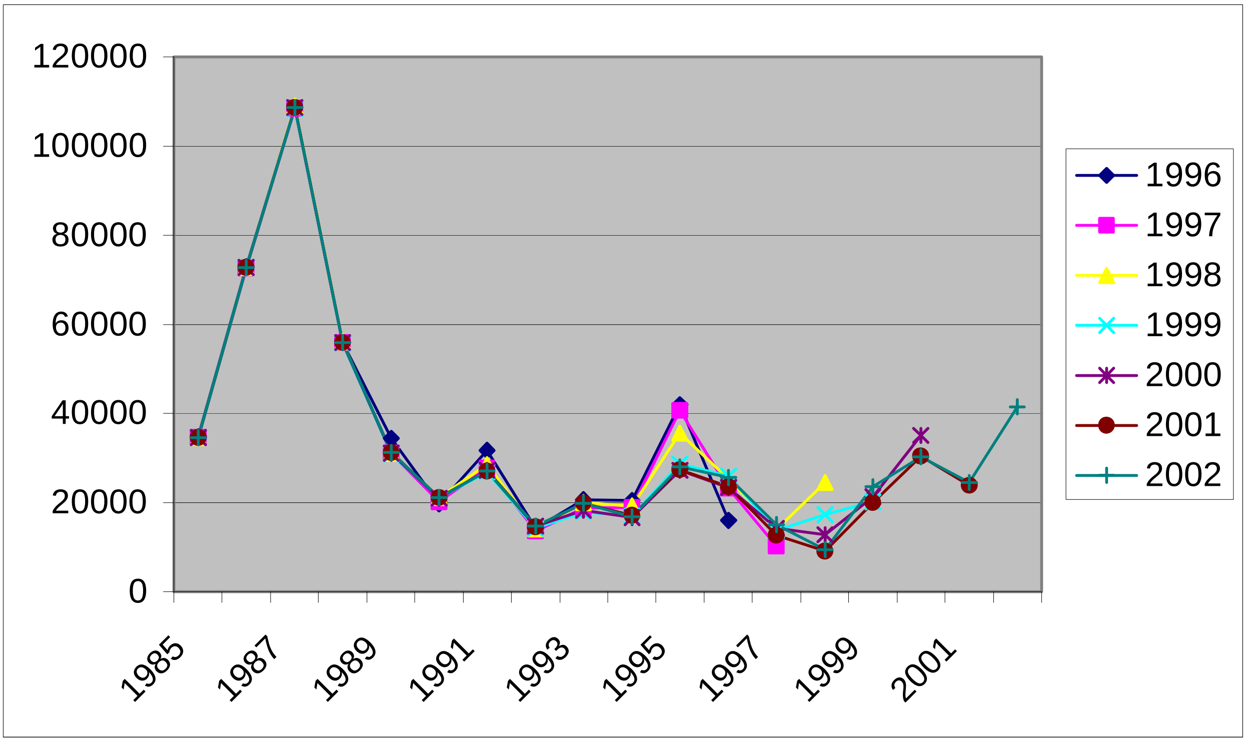


Figure 3.2.7.9 Saithe in Va. Retrospective analysis of R as 3 year olds from ADAPT tuned with IGFS.

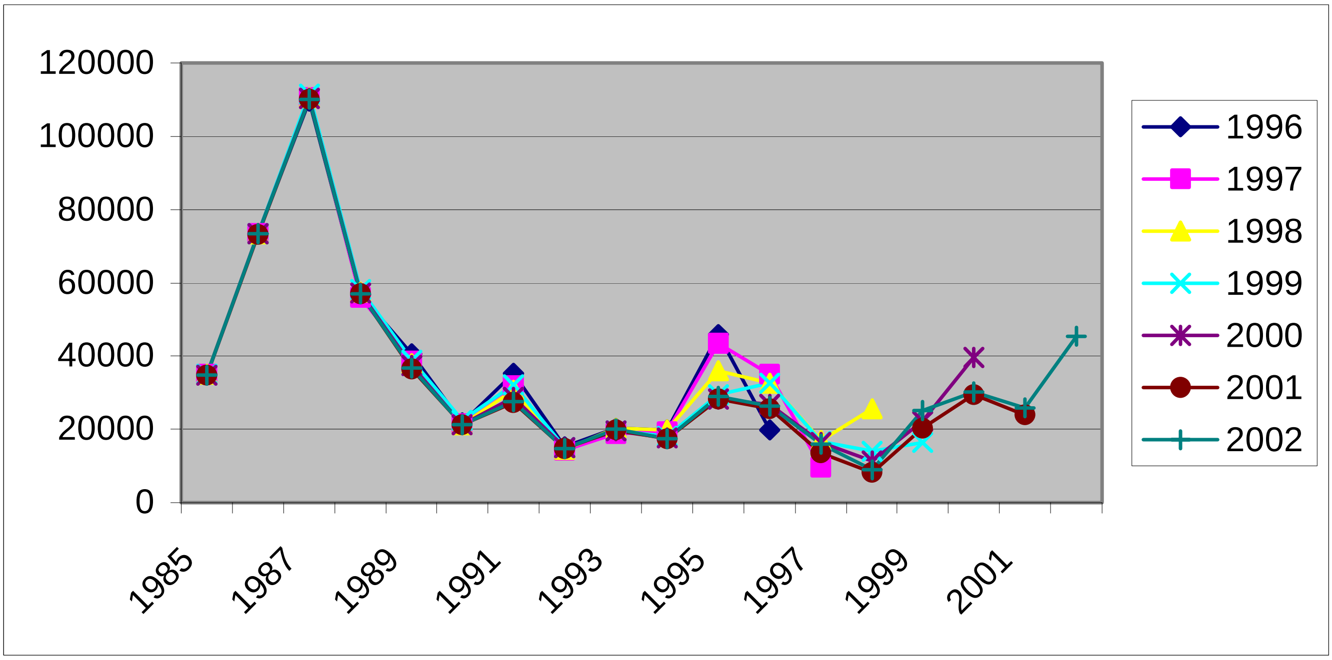


Figure 3.2.7.10 Saithe in Va. Retrospective analysis of R as 3 year olds from XSA tuned with IGFS.

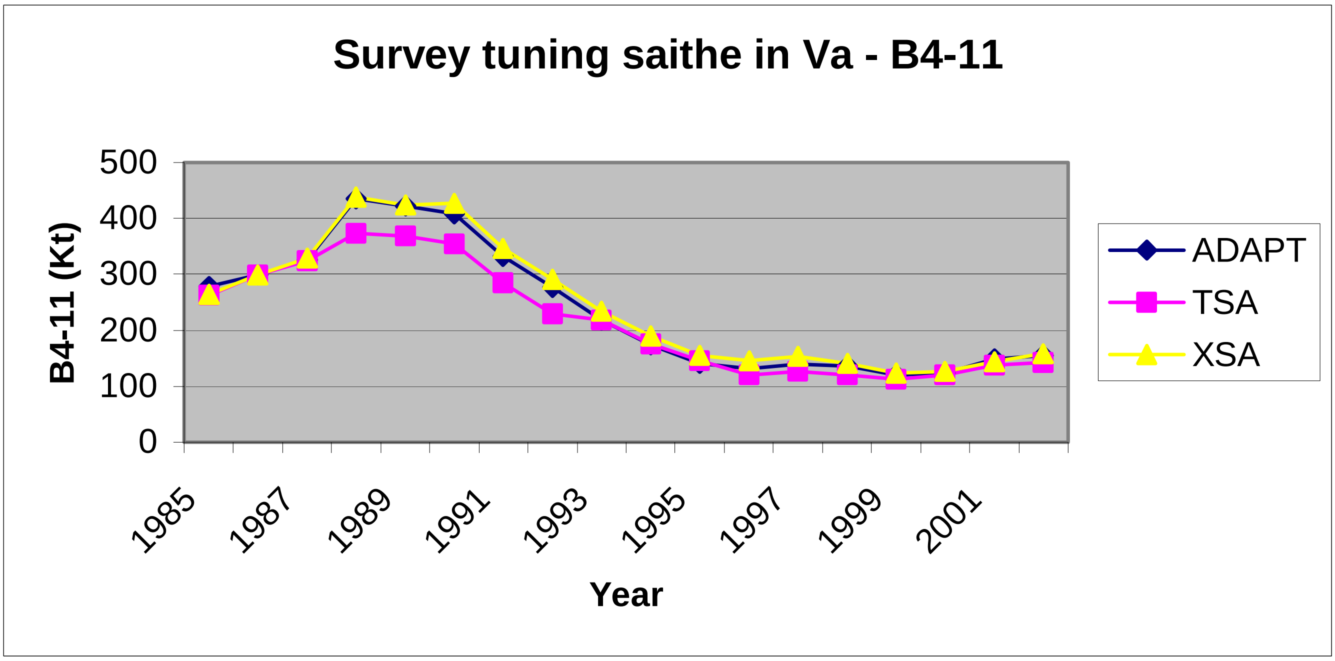


Figure 3.2.7.11 Saithe in Va. Fishable biomass (4+) from ADAPT, TSA and XSA, all tuned with IGFS survey. Discrepancy from 1988 to 1993 due to migration estimation in TSA for the strong 1984 year class.

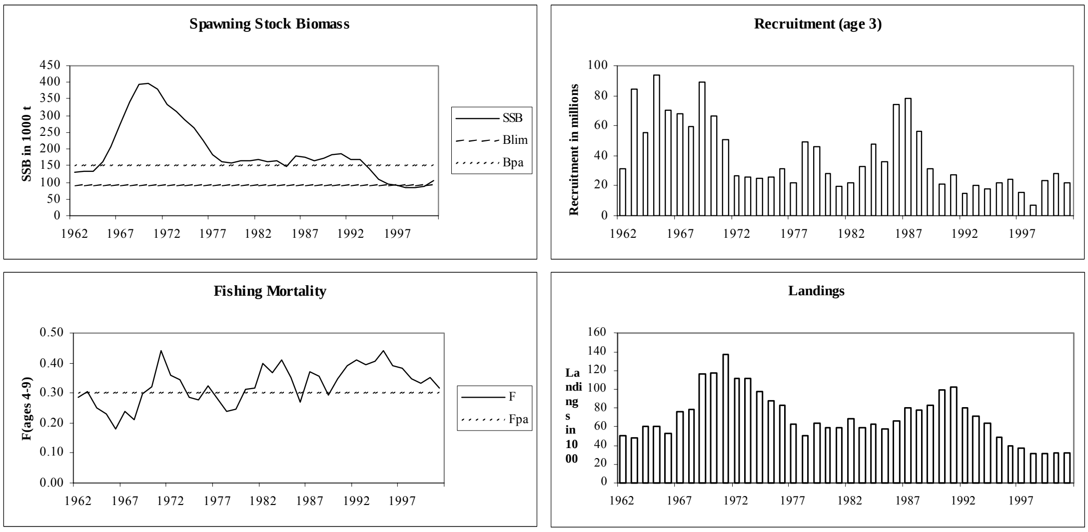


Figure 3.2.7.12 Saithe in Va. Fish stock summary.

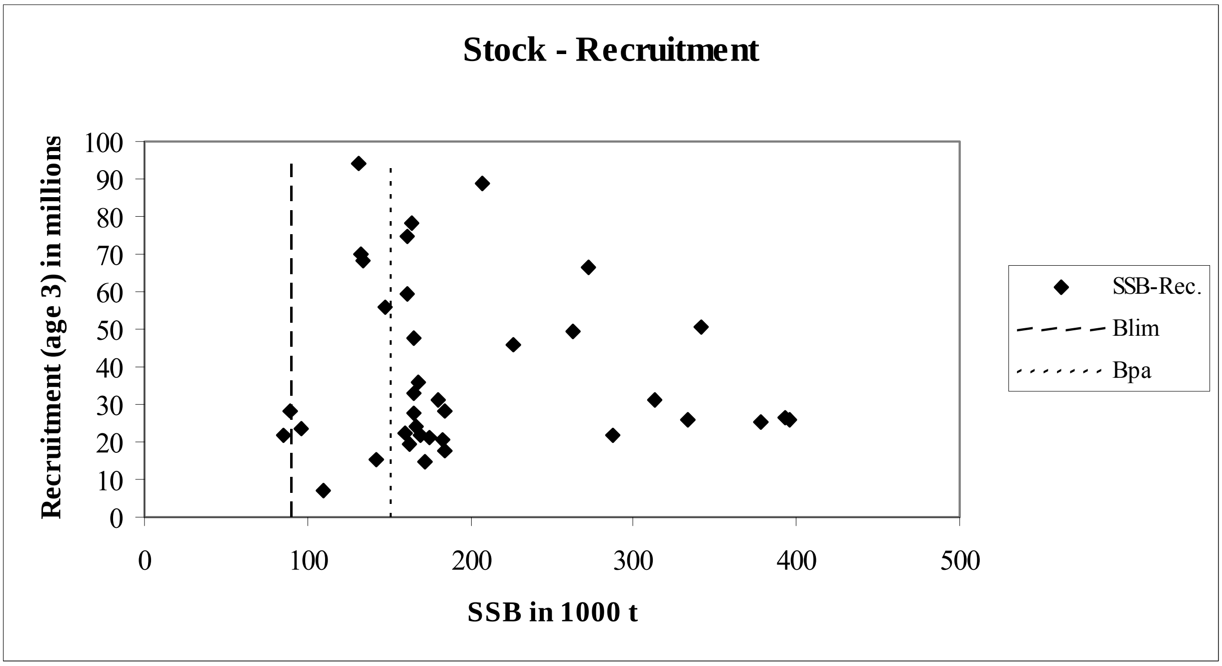
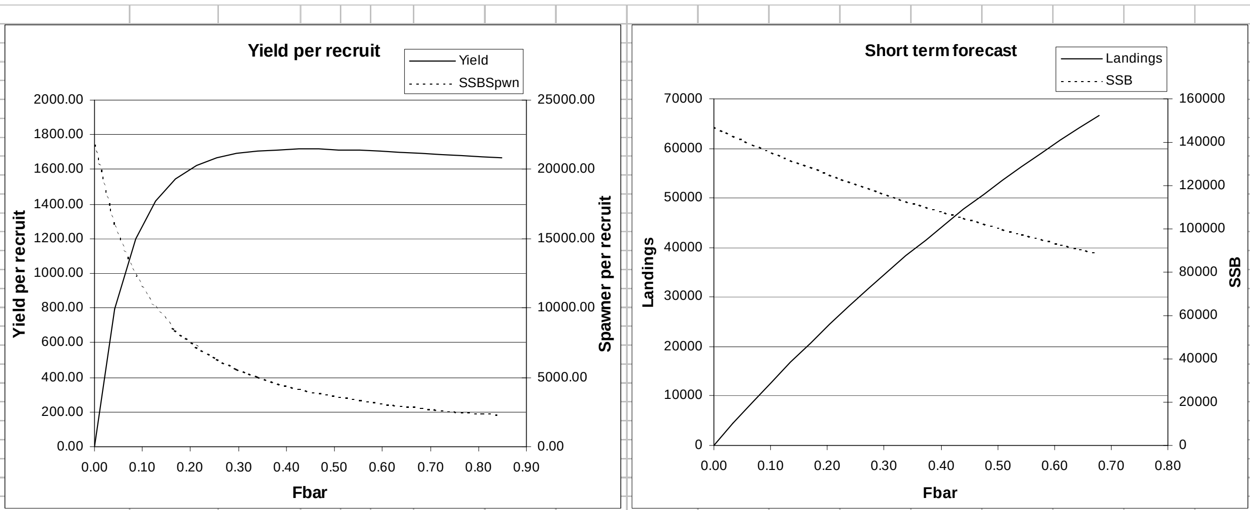


Figure 3.2.7.13 Saithe in Va. Stock and recruitment.



MFYPR version 1
Run: siggi2002ypr
Time and date: 12:57 8.5.2002

Reference point	F multiplier	Absolute F
Fbar(3-14)	1.0000	0.4246
FMax	-1.0000	
F0.1	-1.0000	
F35%SPR	0.4623	0.1963

Weights in grams

MFDP version 1
Run: siggi2002stp
SaiVa index-file for deterministic projection
Time and date: 14:01 8.5.2002
Fbar age range: 4-9

Input units are millions and grams - output in tonnes

Figure 3.2.8.1 Saithe in Va. Yield per recruit and deterministic projection.

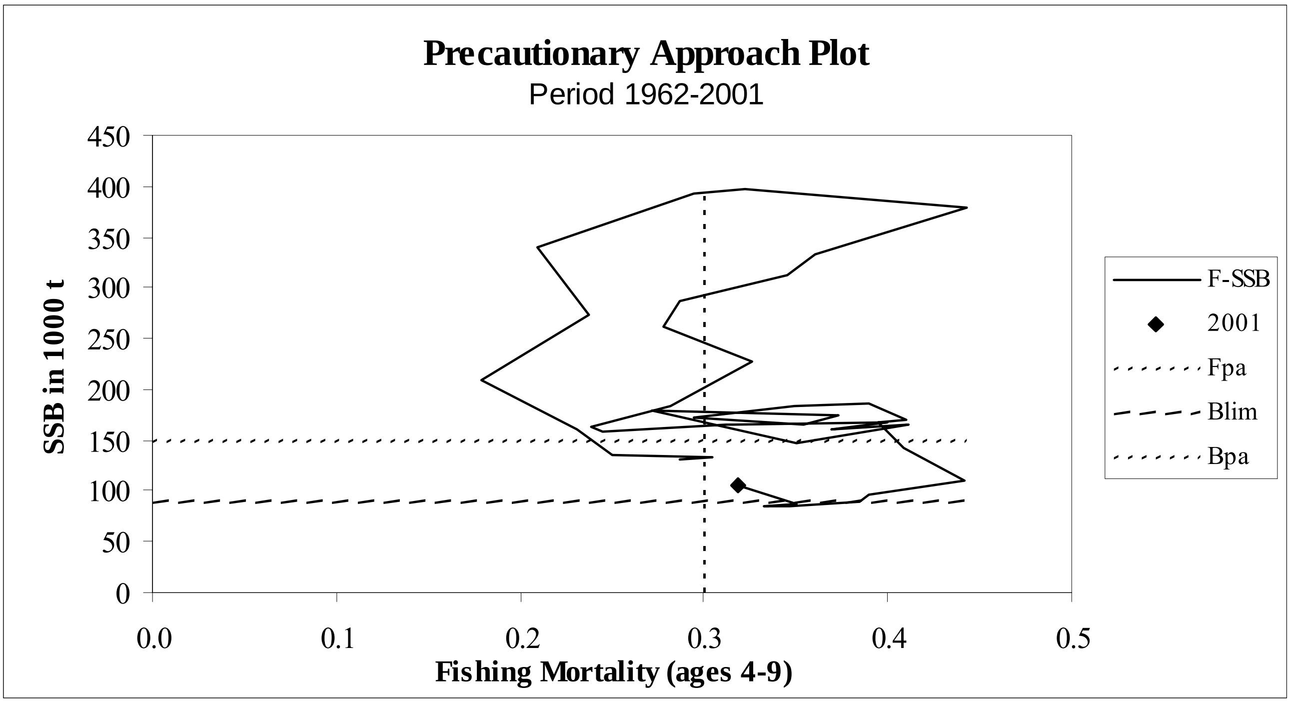


Figure 3.2.8.2 Saithe in Va. Pa-plot.

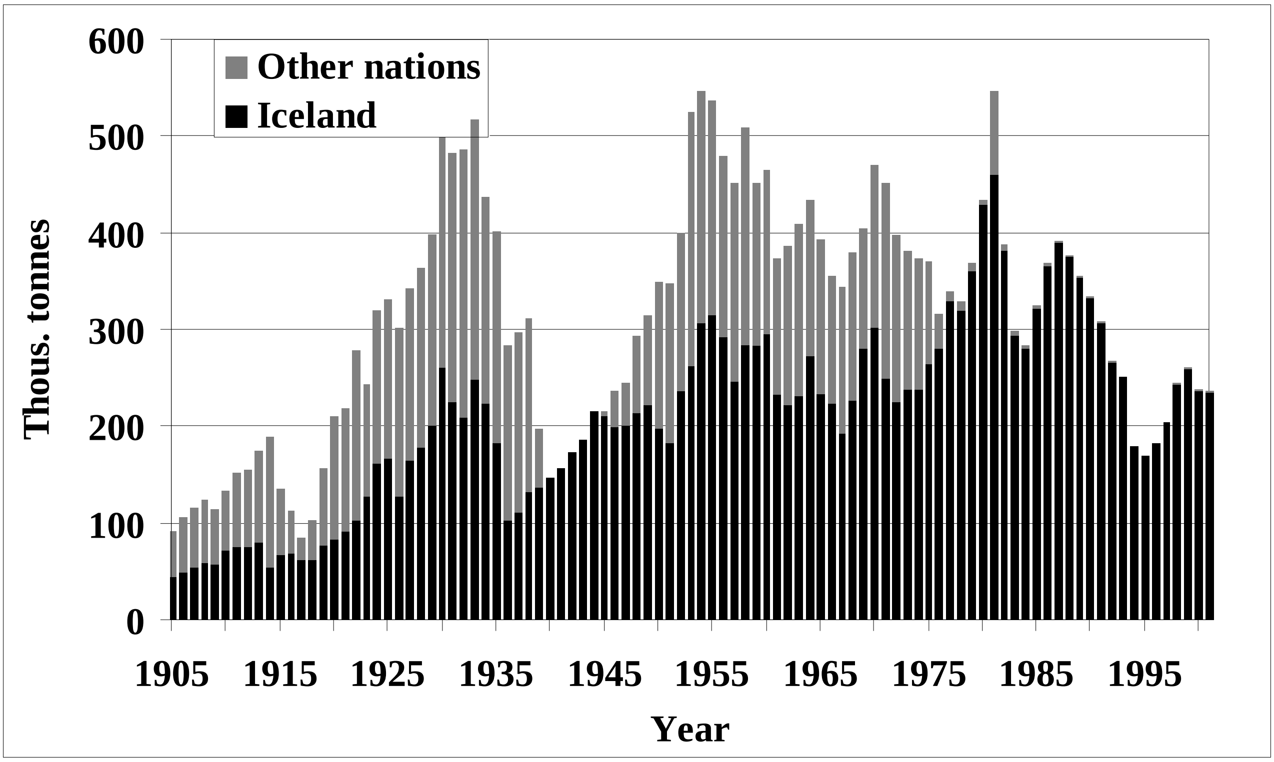
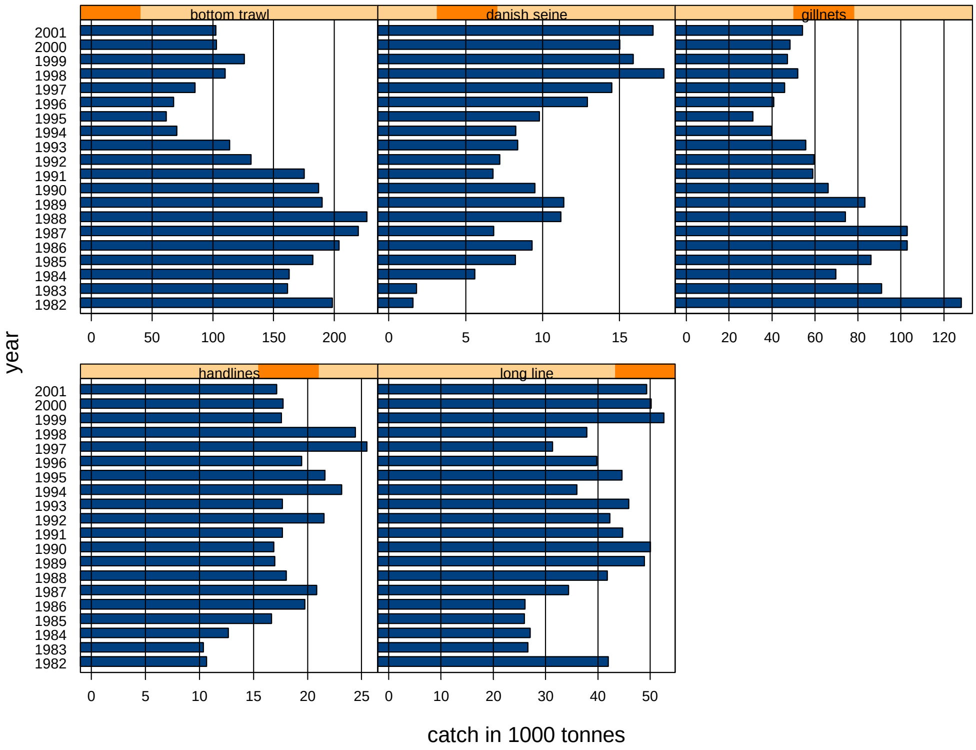


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.



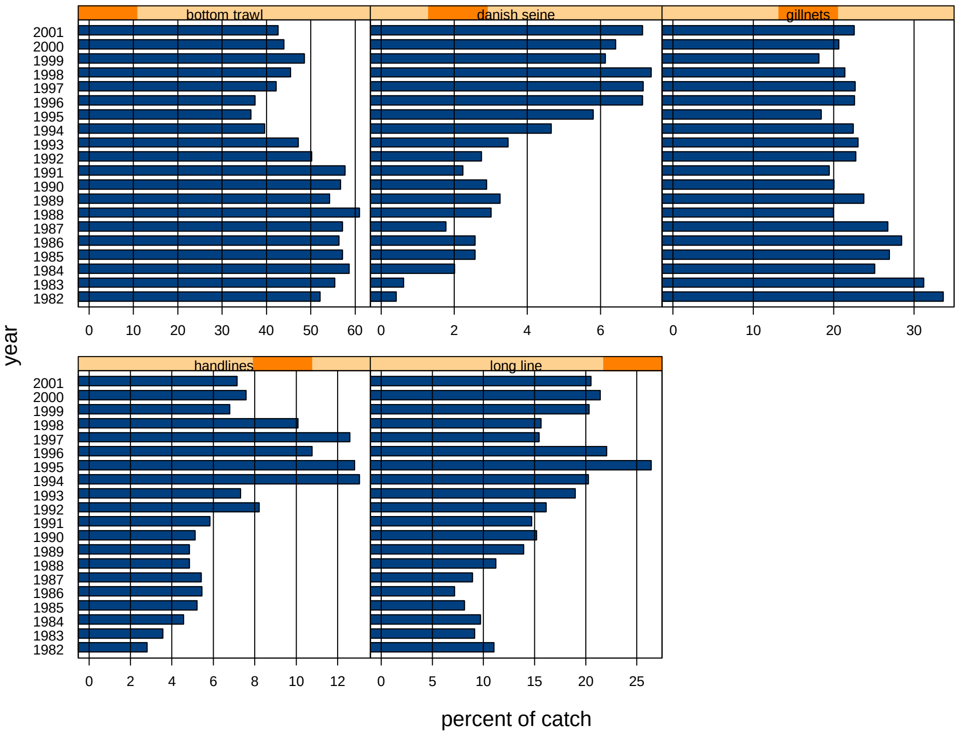


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes sand lower in percentages.

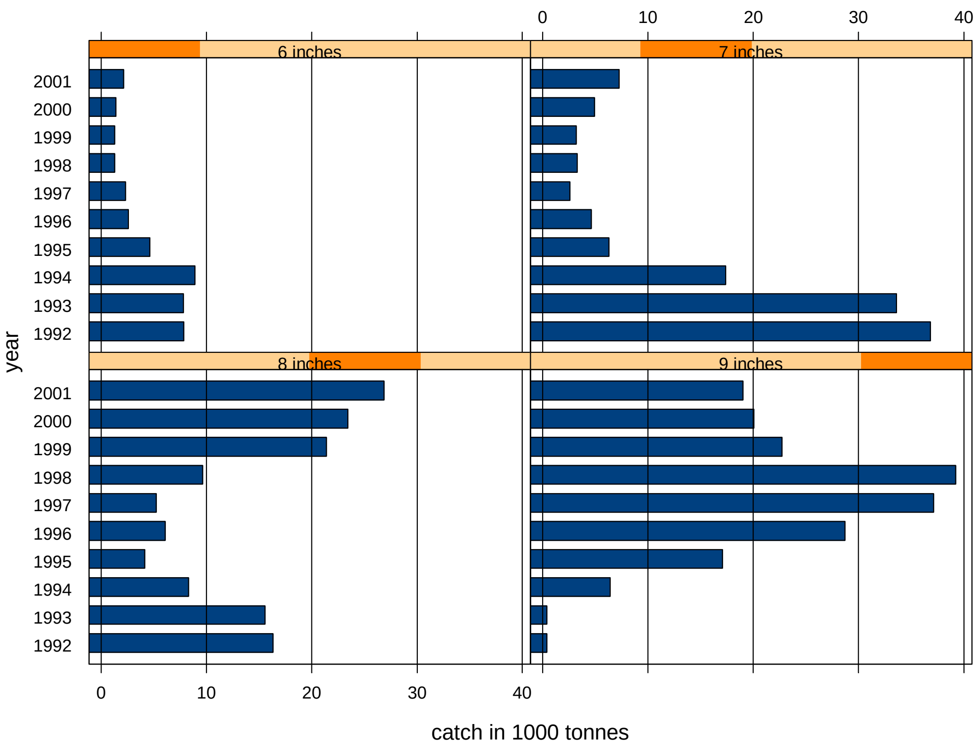


Figure 3.3.3 Cod in division Va. Gillnet landings by mesh size and year.

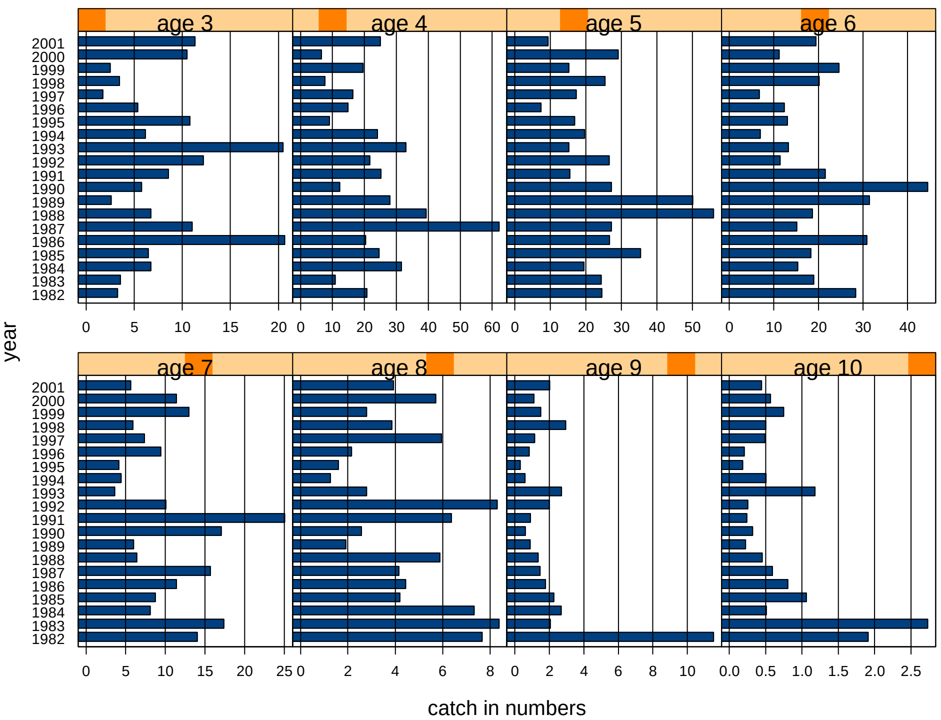


Figure 3.3.4 Cod in division Va. Catch in numbers by year and age.

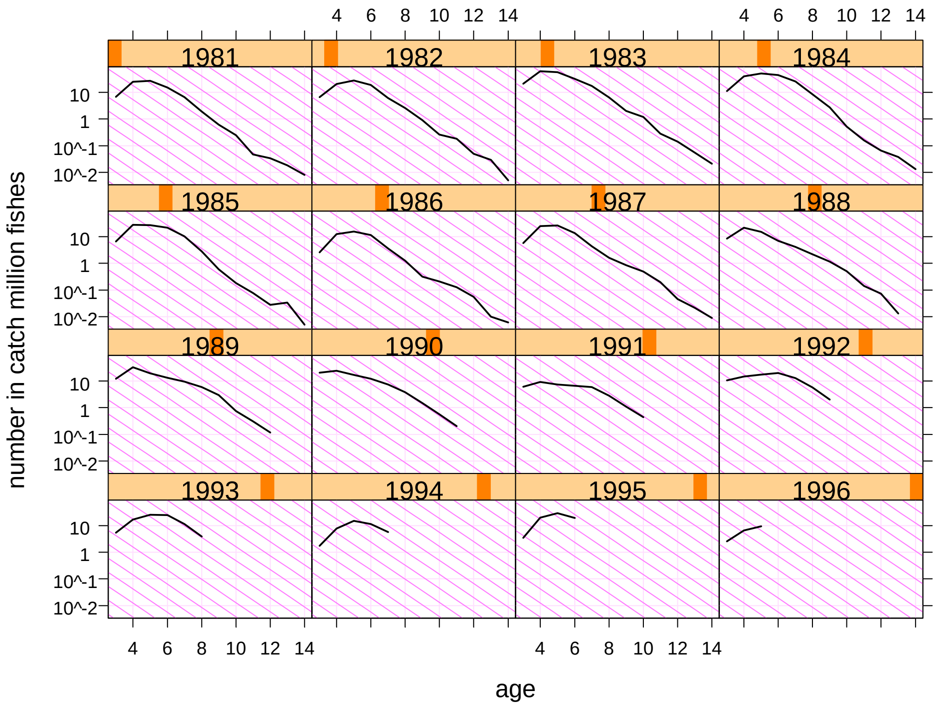


Figure 3.3.5 Icelandic cod. Catch curves. Grey lines show Z = 1.

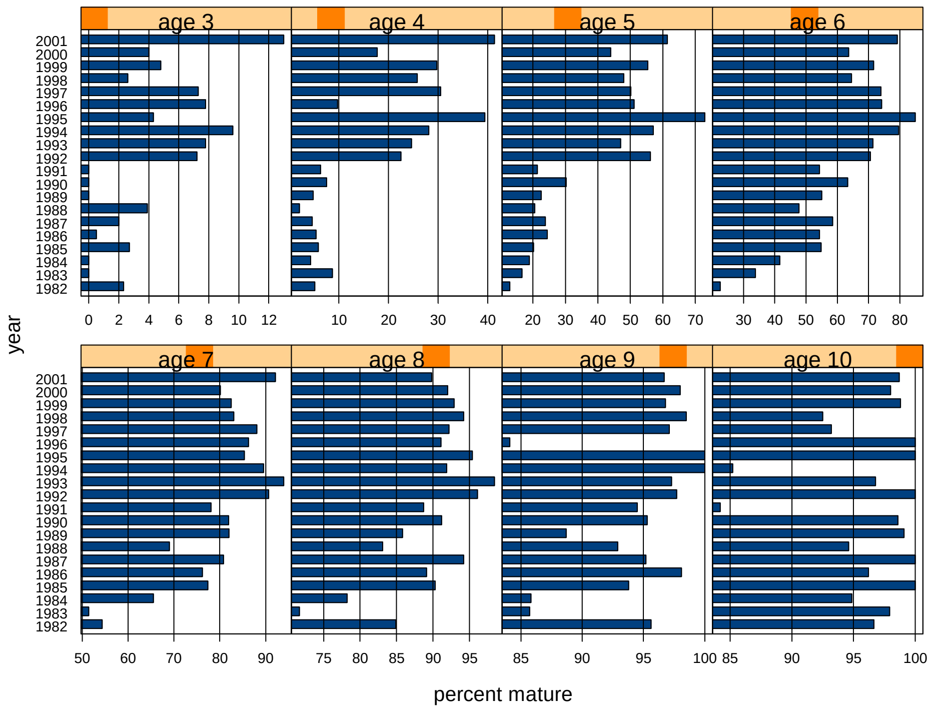


Figure 3.3.6 Cod in division Va. Maturity at age in the catches.

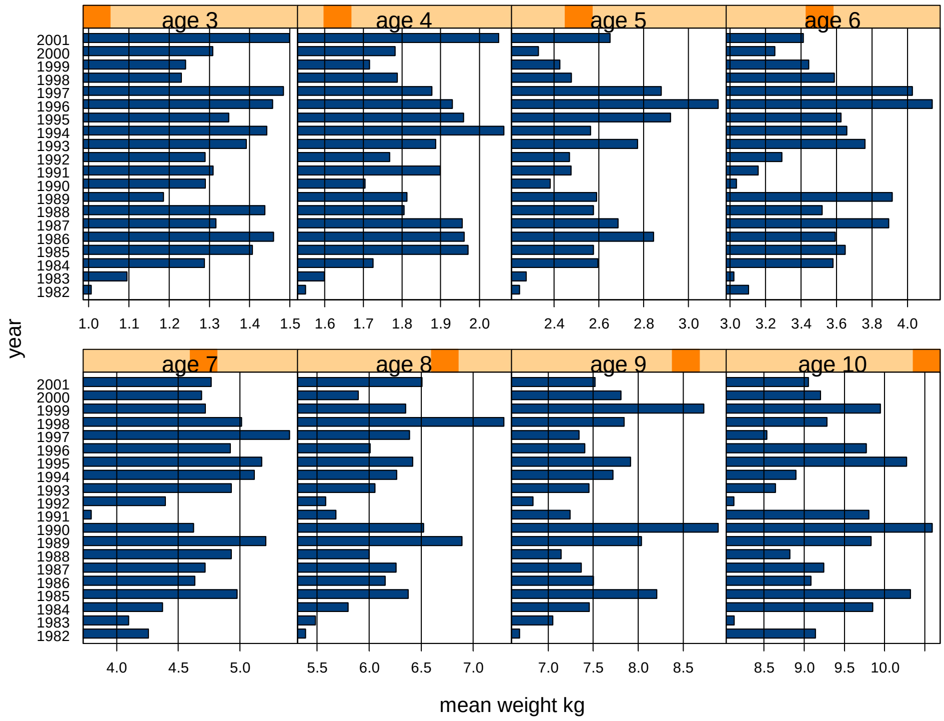


Figure 3.3.7 Cod in division Va. Mean weight at age in the catches.

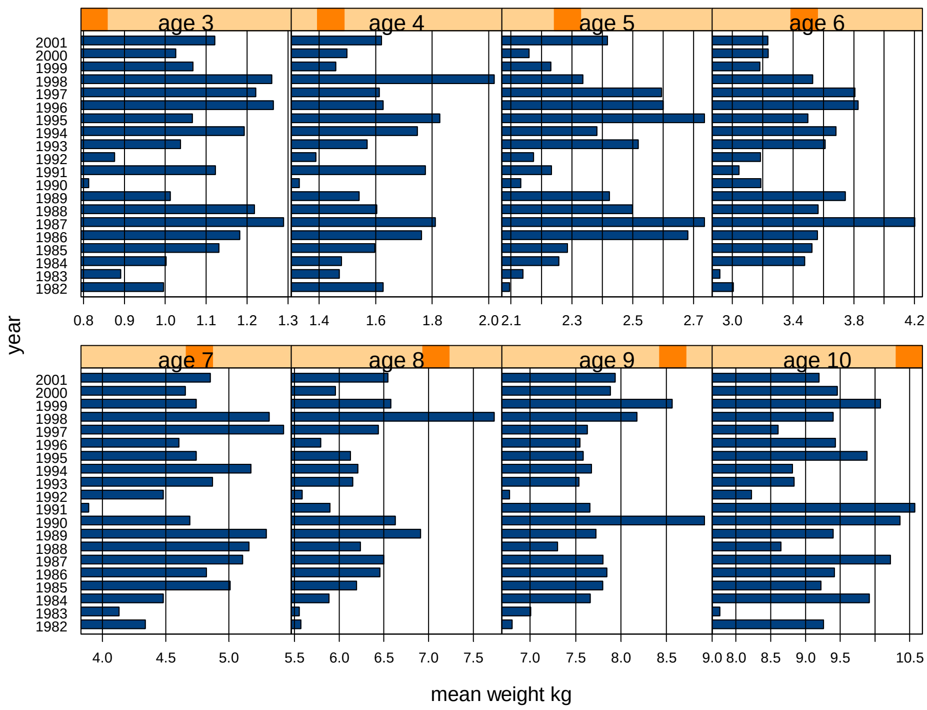


Figure 3.3.8 Cod in division Va. Mean weight at age in the SSB.

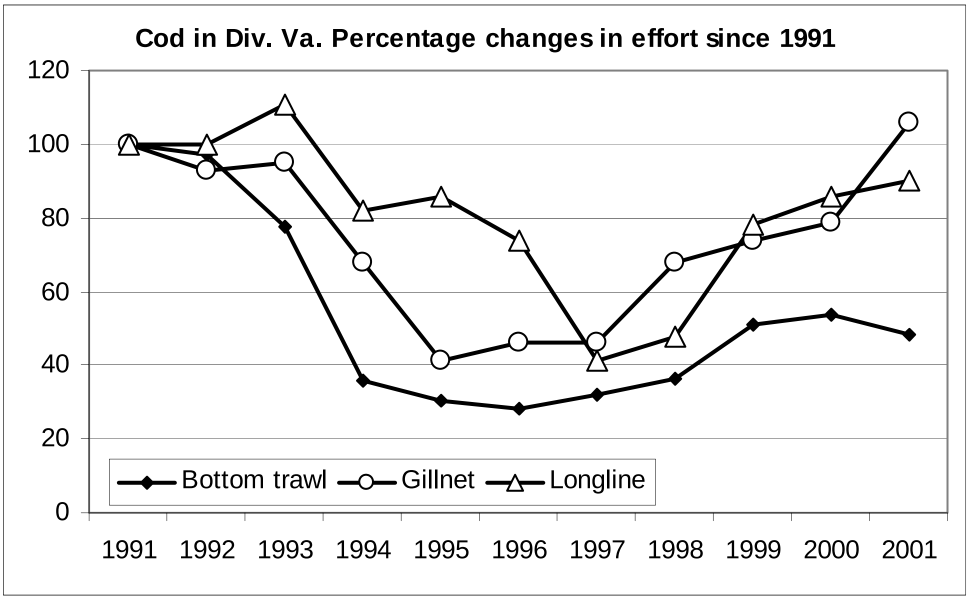


Figure 3.3.9.A Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

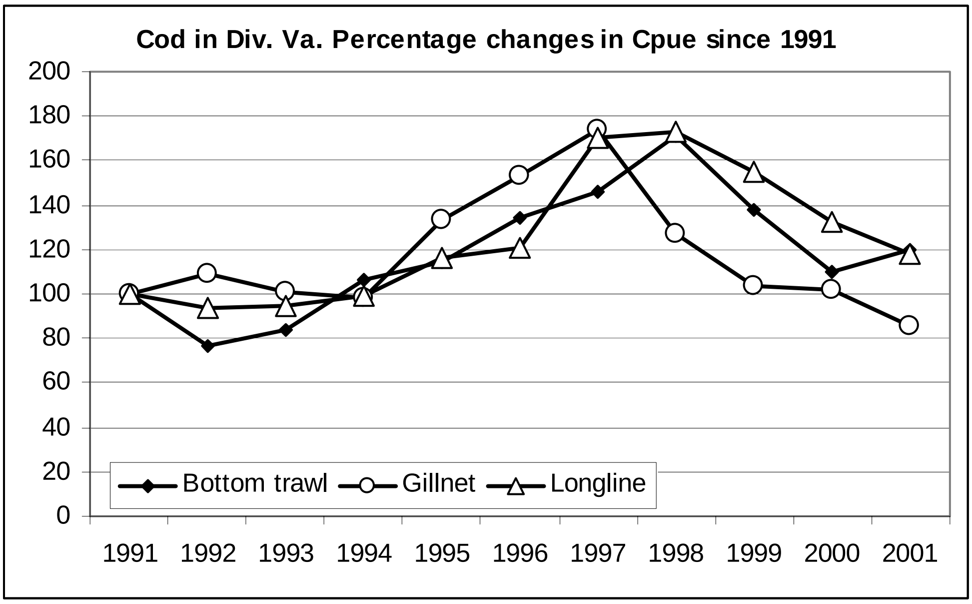


Figure 3.3.9.B Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

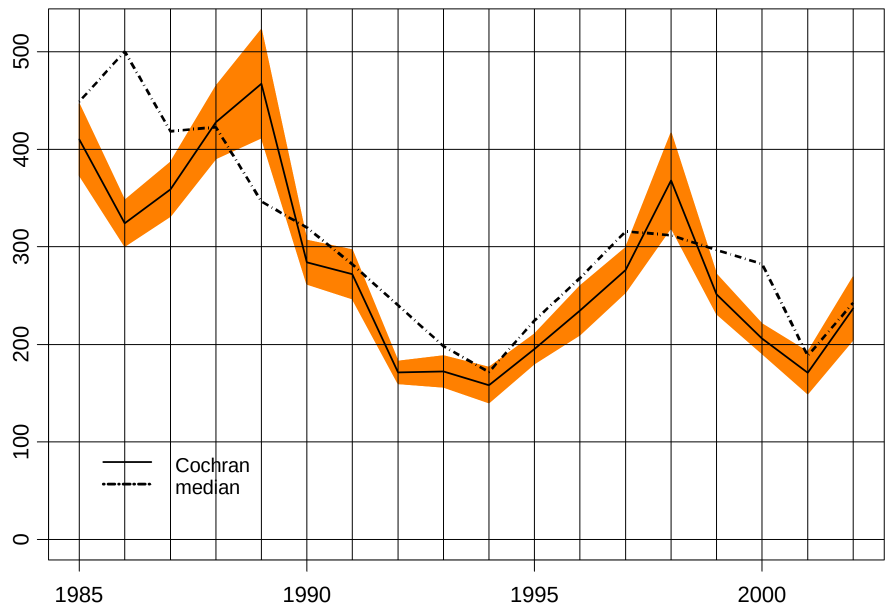


Figure 3.3.10 Cod in division Va. Total biomass index from the groundfish survey. Index base on the median of all stations where cod was caught is shown for comparison. The scale is 100 thousand tonnes.

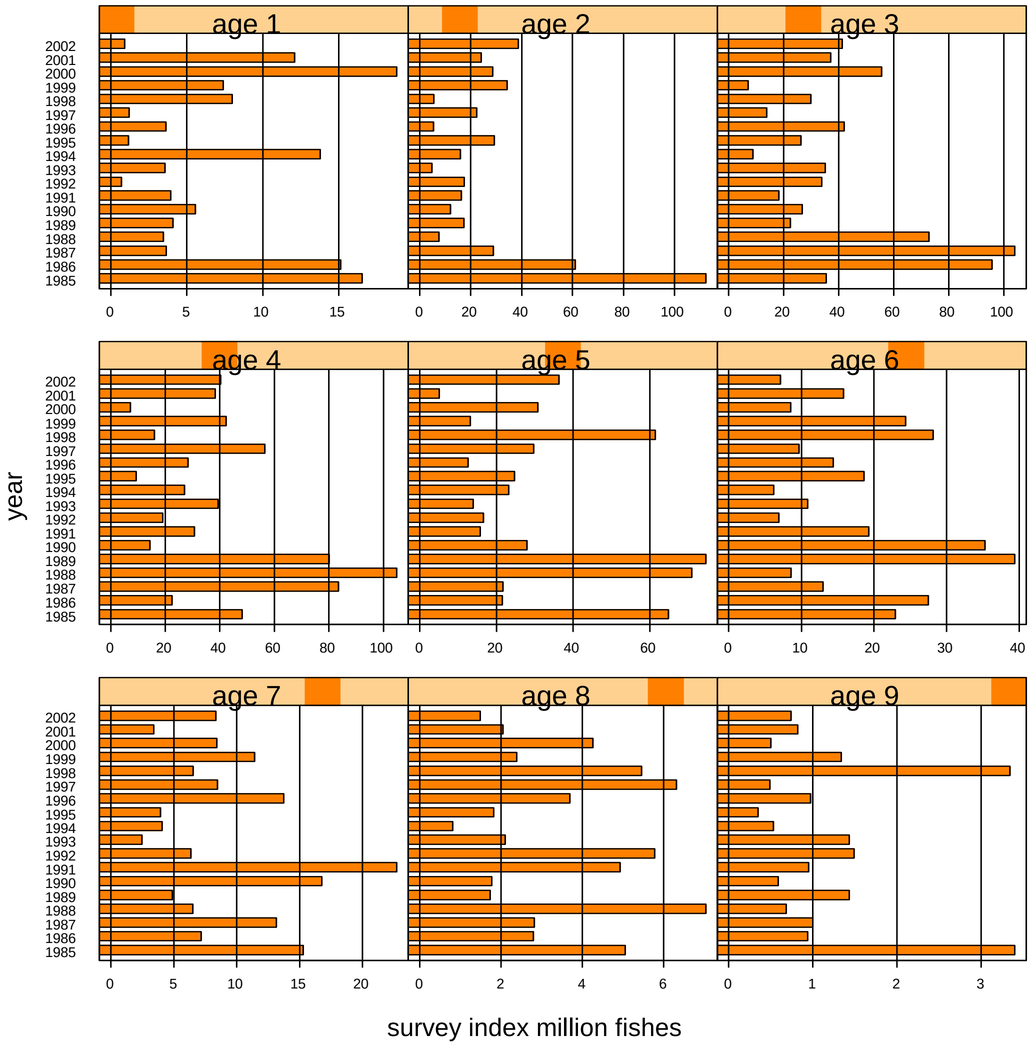


Fig 3.3.11 Cod in division Va. Survey indices from the March survey. Numbers by year and age.

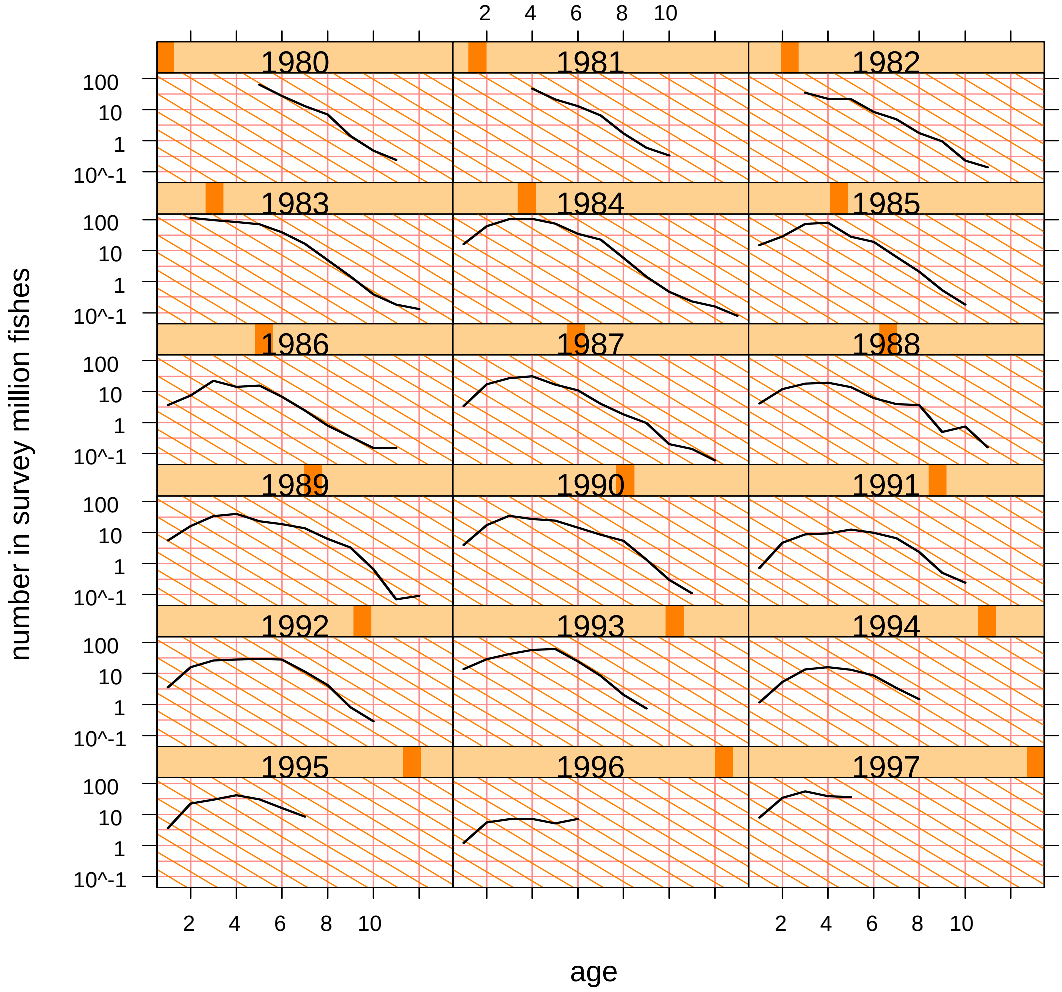


Figure 3.3.12 Cod in division Va. Catchcurves from the survey. The grey lines show Z=1

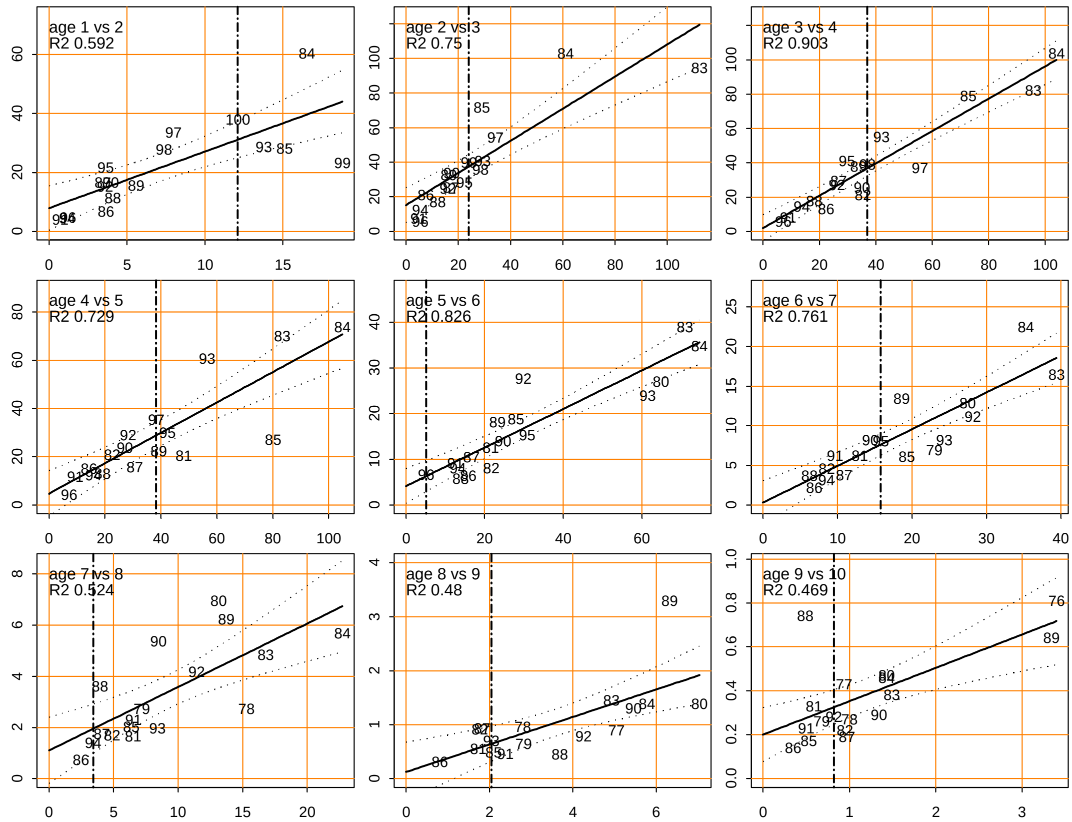


Figure 3.3.13 Cod in division Va. Indices from the groundfish suevey vs. index of the same year class in survey a year later.

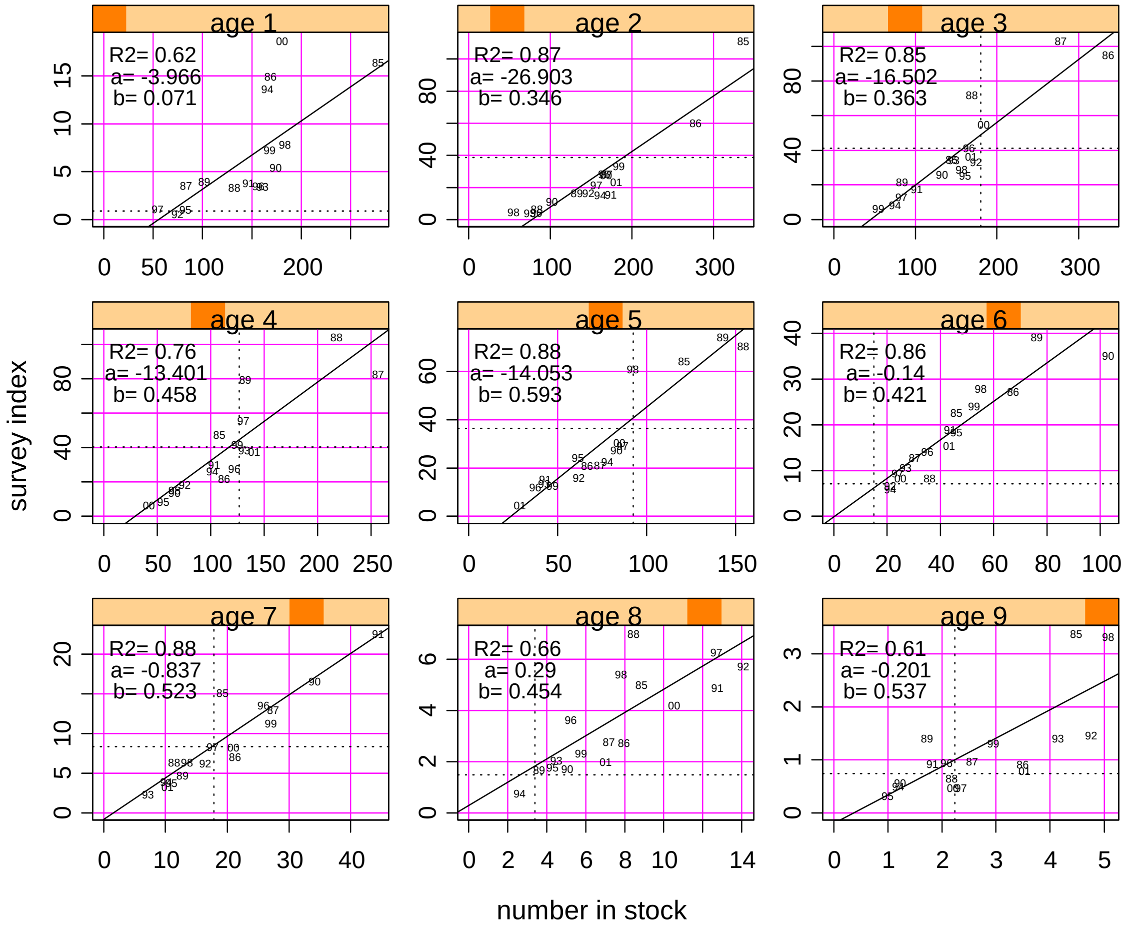


Figure 3.3.14 Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale

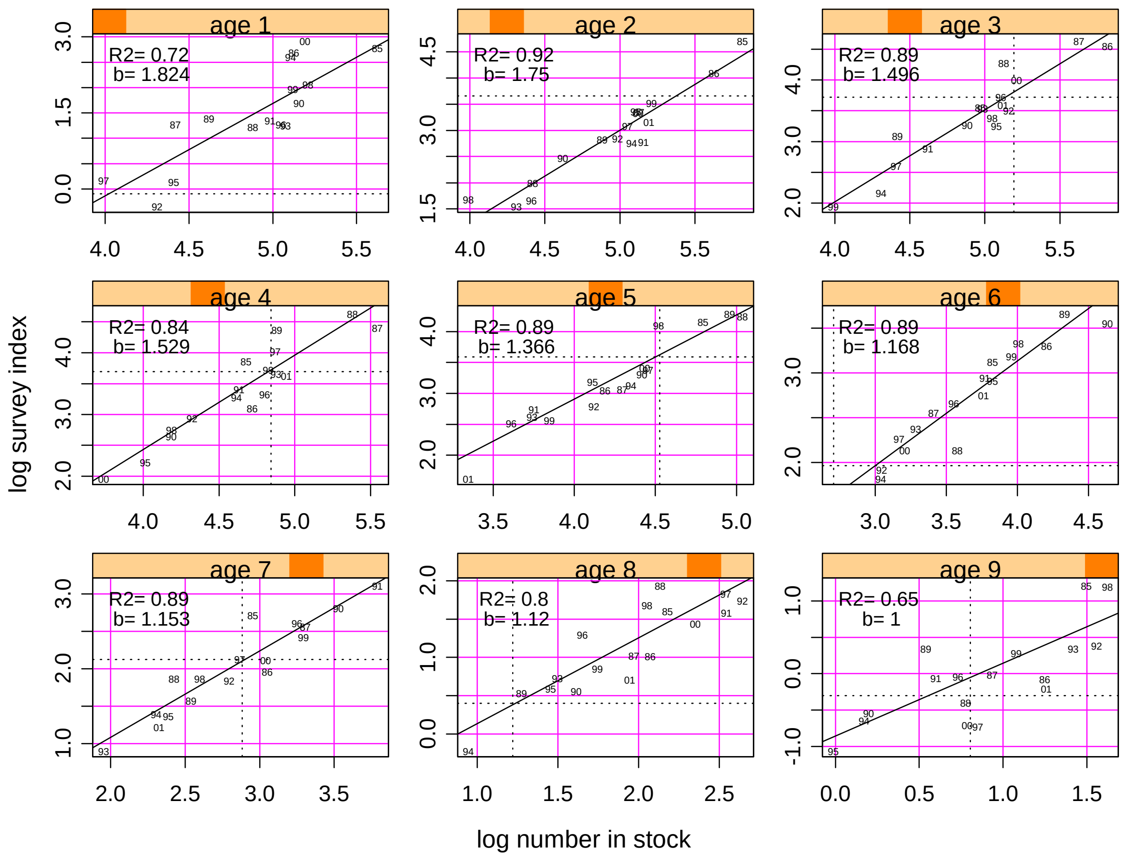


Figure 3.3.15 Cod in division Va. Survey indices vs. number in stock. Line fitted on logscale (power curve)

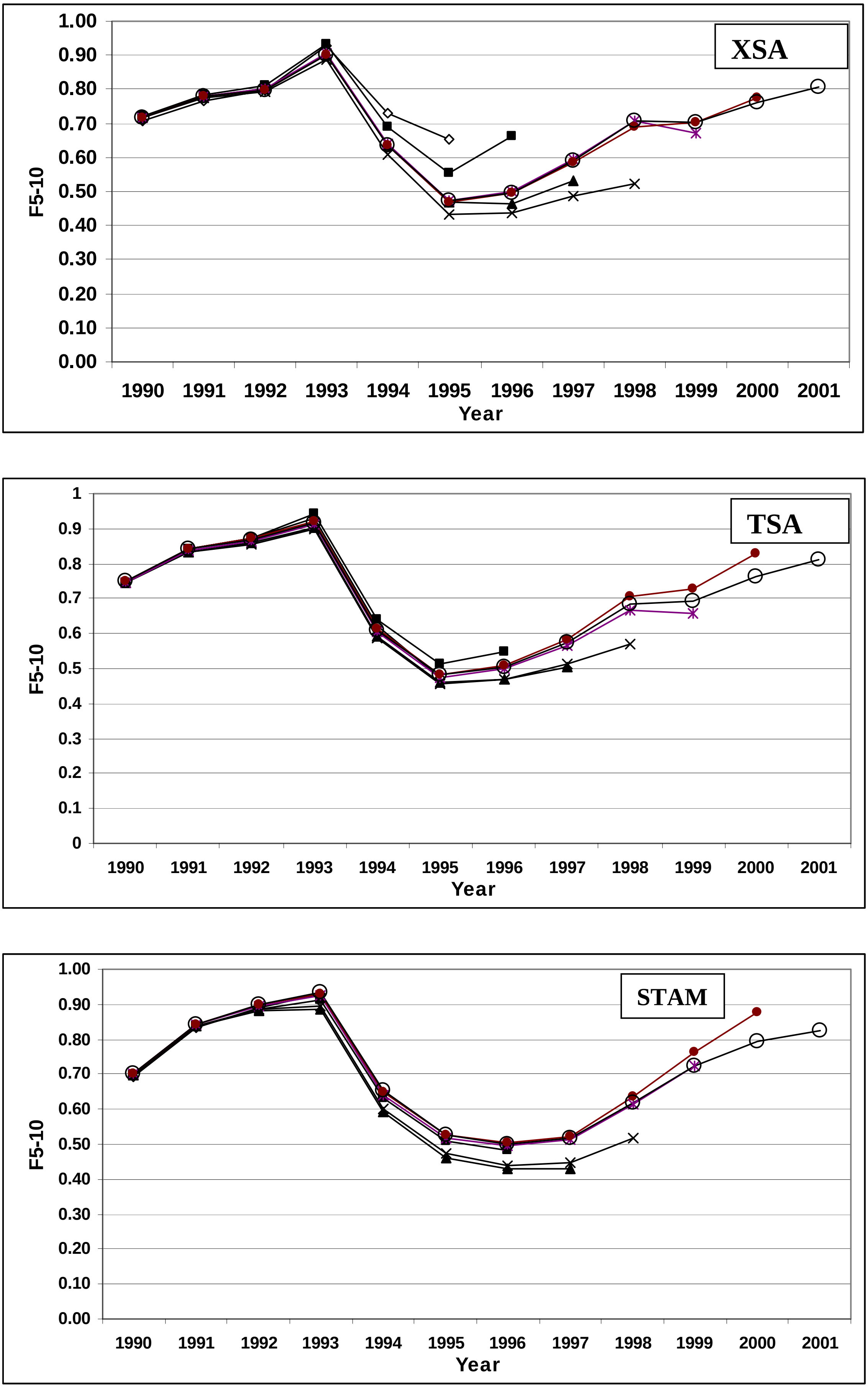


Figure 3.3.16 Retrospective pattern from assessment runs. The figures show mean fishing mortality of ages 5 to 10.

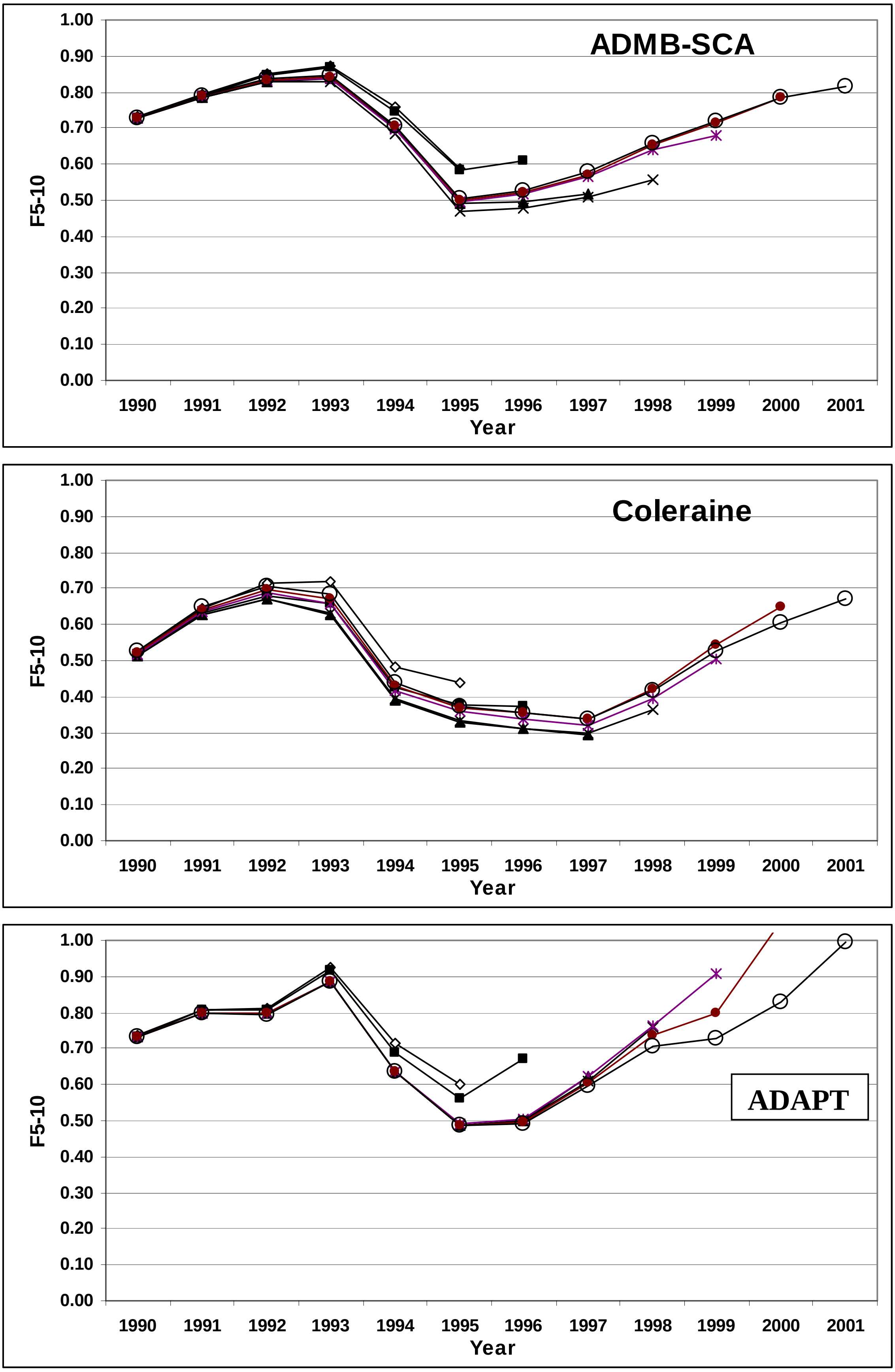


Figure 3.3.16. (Continued)

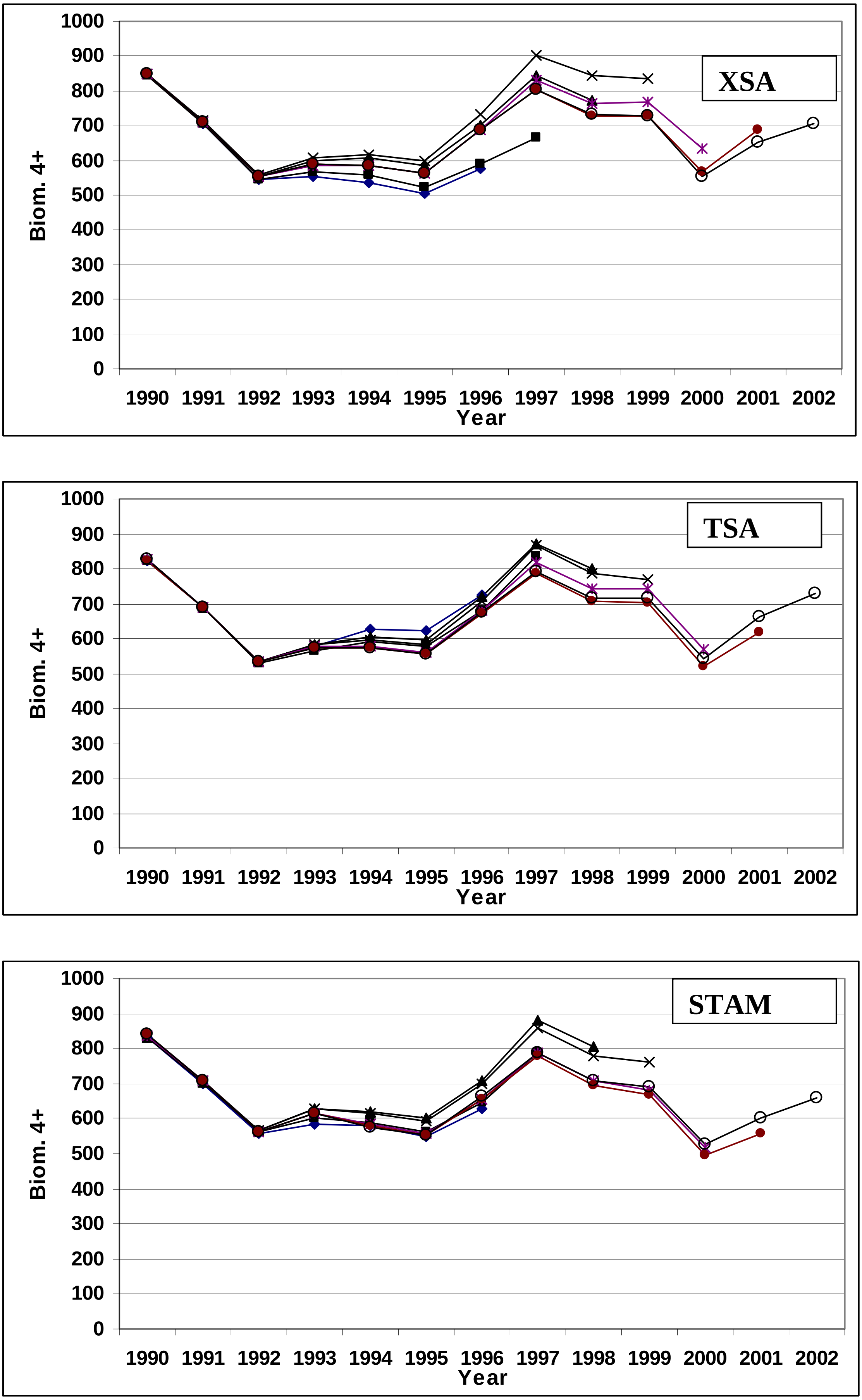


Figure 3.3.17 Retrospective patterns from assessment runs. The figures show number of age and older multiplied by the weight in the catches.

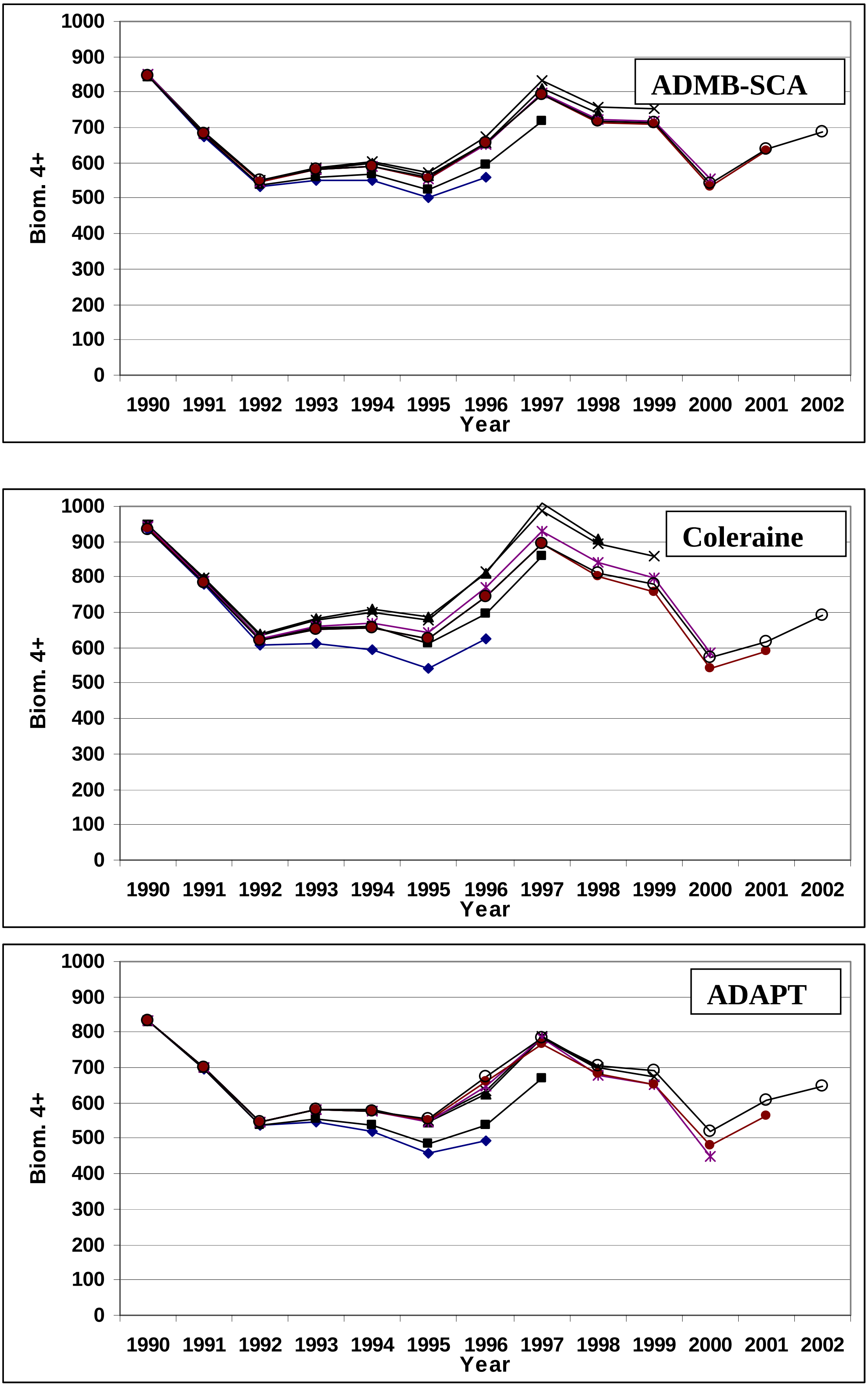


Figure 3.3.17. (Continued)

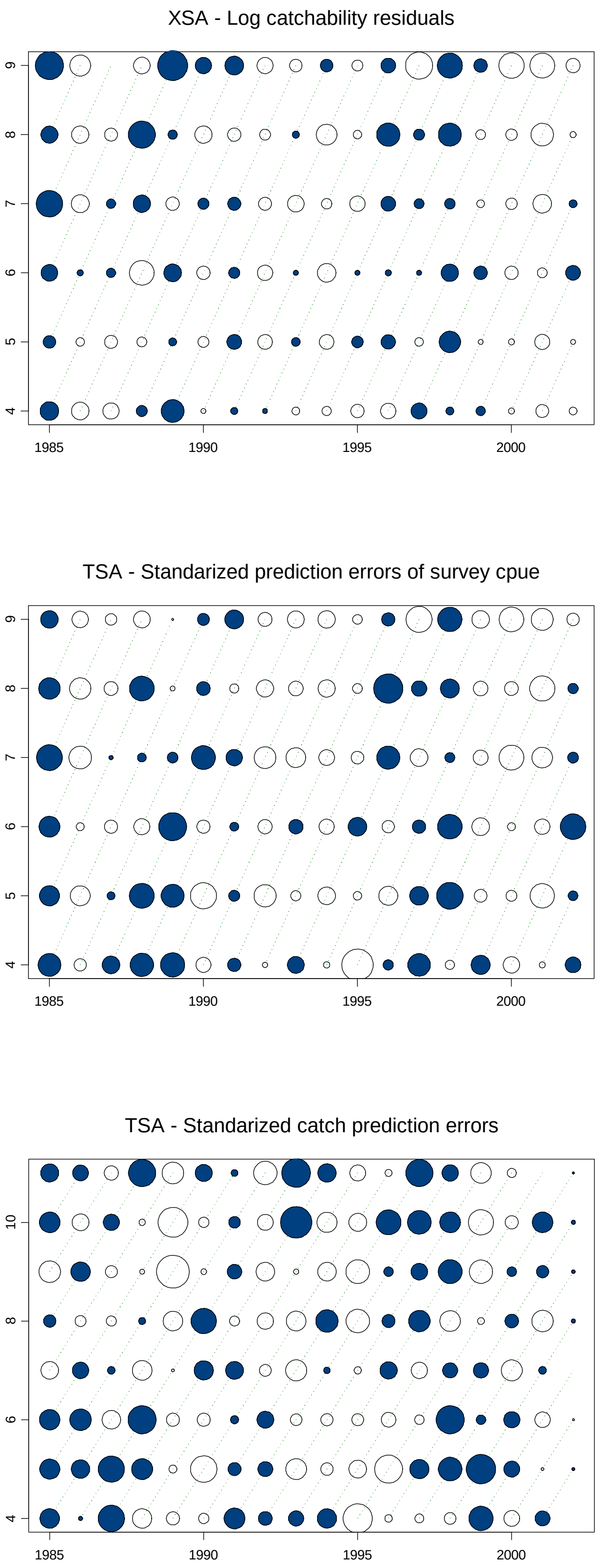
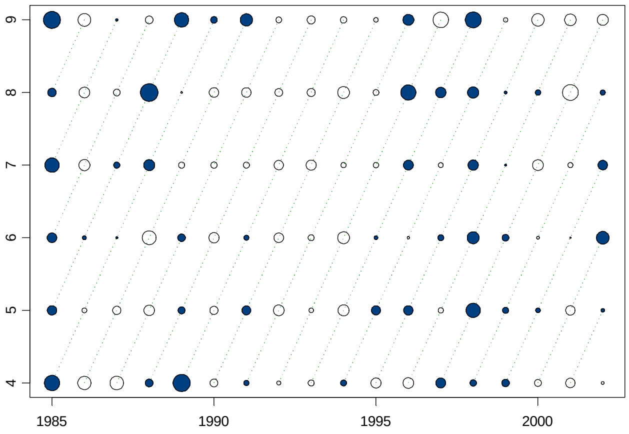
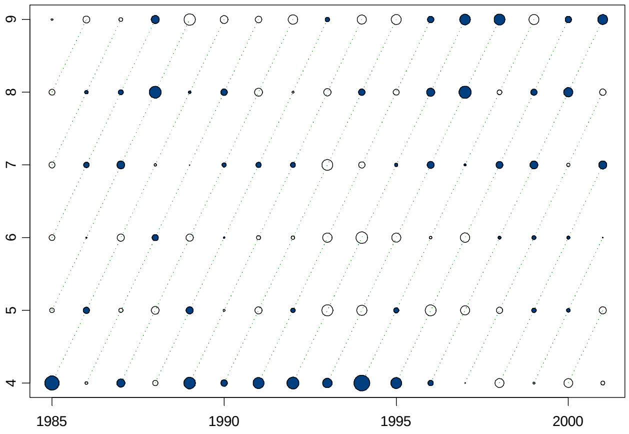


Figure 3.3.18 Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

STAM ln(Uay-observed/Uay-predicted)



STAM ln(CNay-observed/CNay-predicted)



ADMB-SCA ln(Uay-observed+0.3/Uay-predicted+0.3)

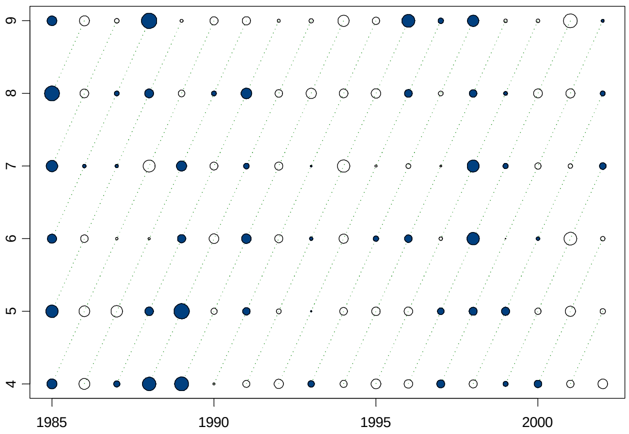
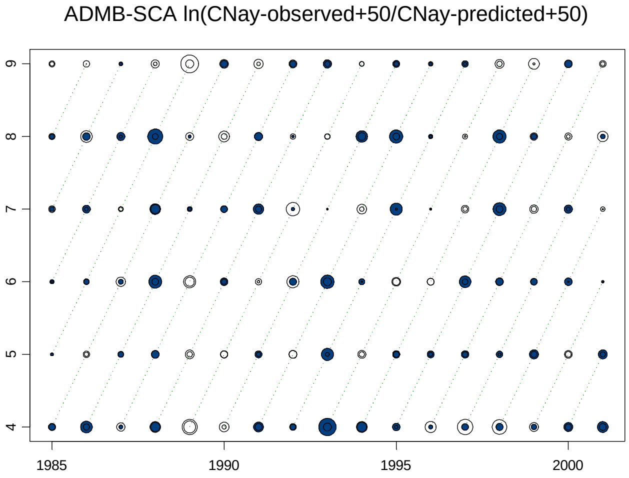


Figure 3.3.18. (Continued)



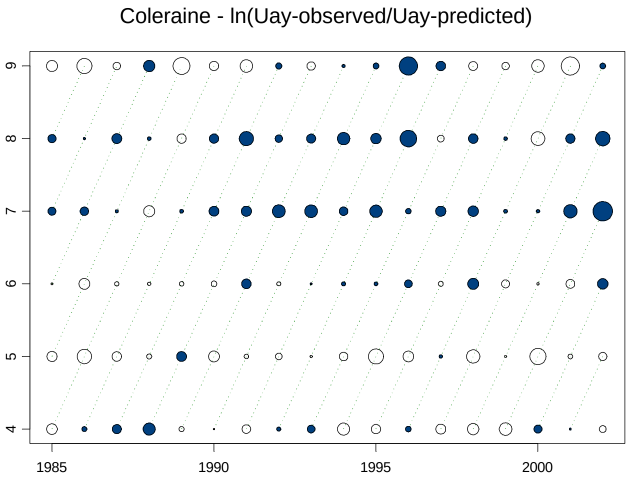


Figure 3.3.18. (Continued)

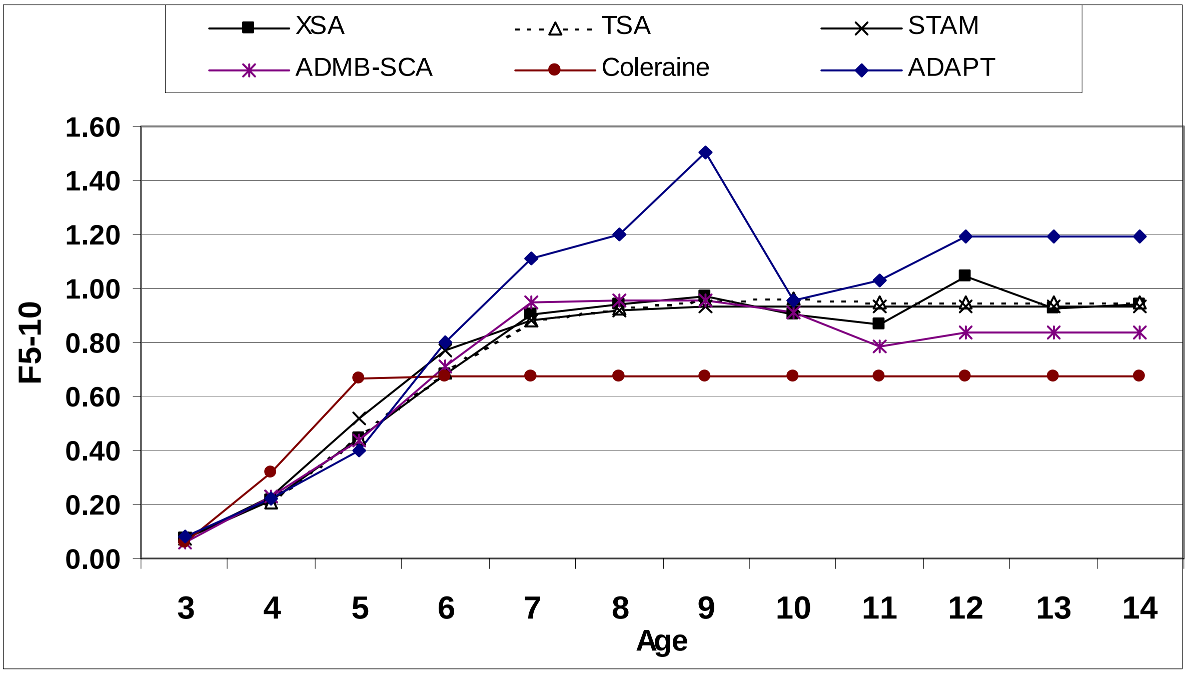


Figure 3.3.19 Comparison of estimated fishing mortalities in 2001 from different assessment runs.

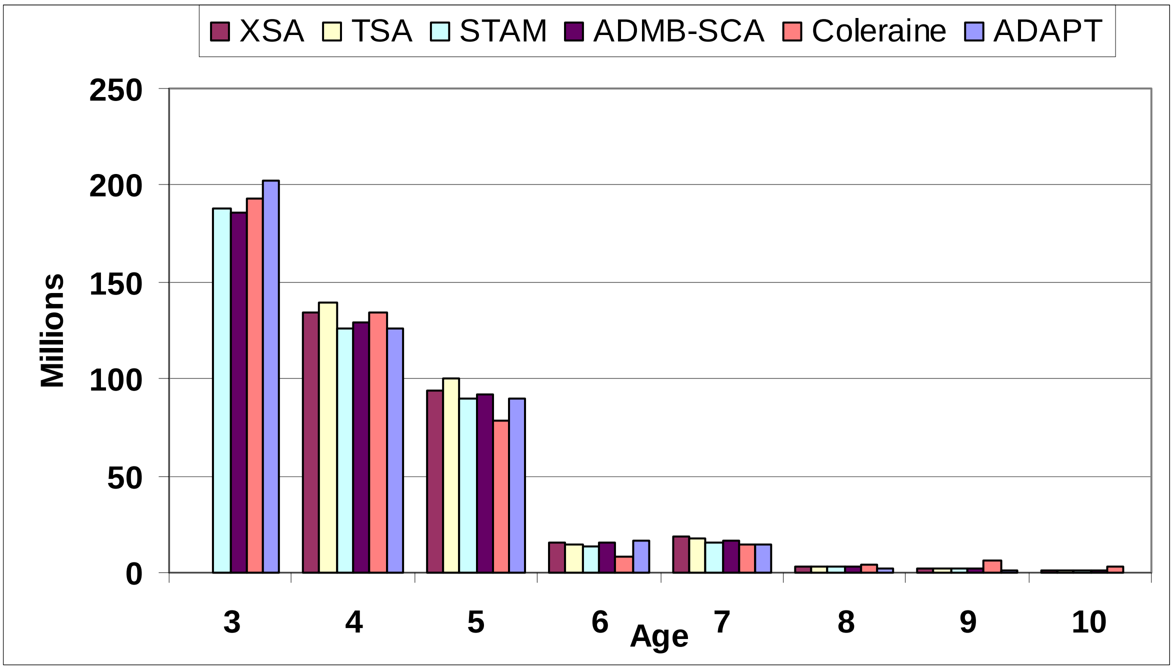


Figure 3.3.20 Comparison of estimated stock in numbers in 2002 from different assessment runs.

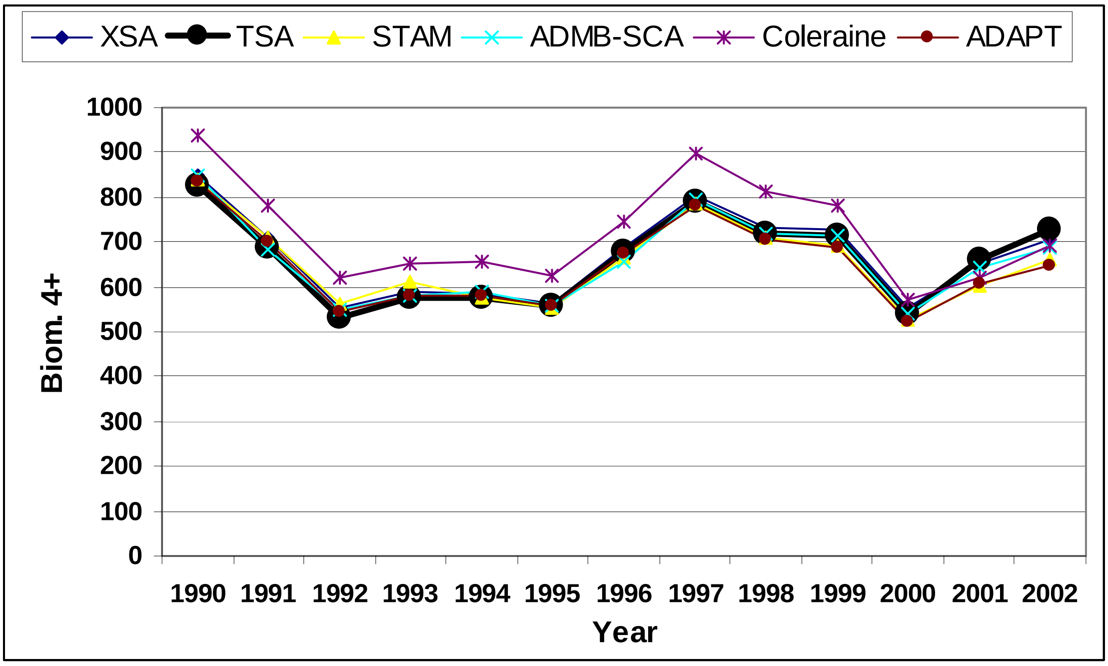


Figure 3.3.21 Estimated 4+ biomass from the various assessment models.

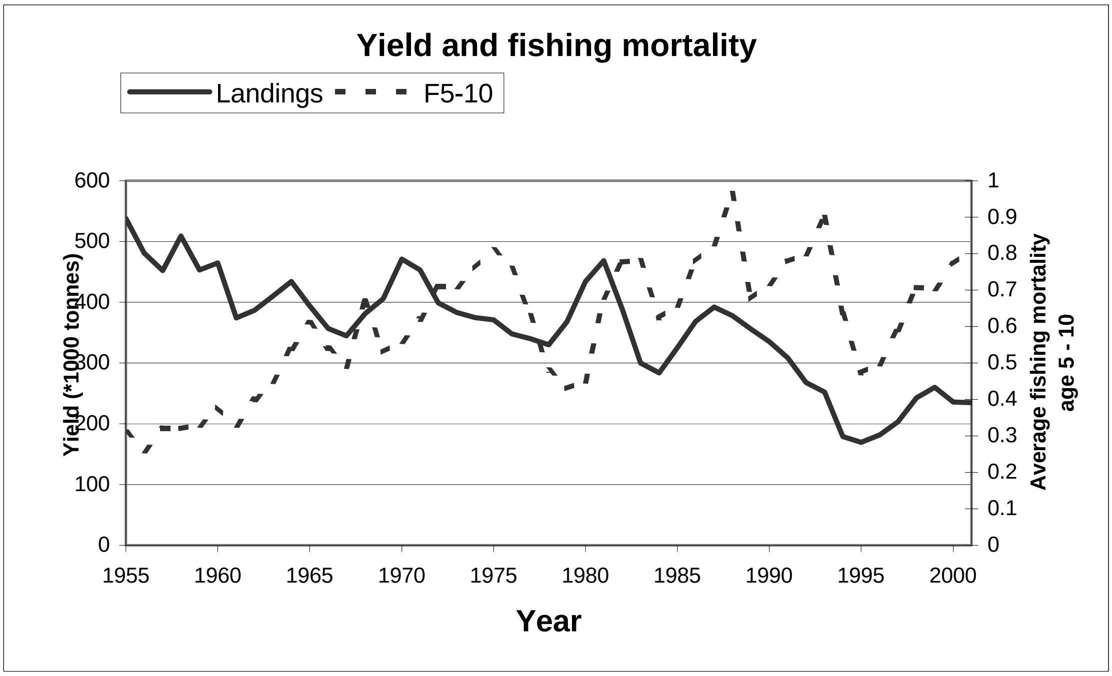


Figure 3.3.22A Yield and fishing mortality

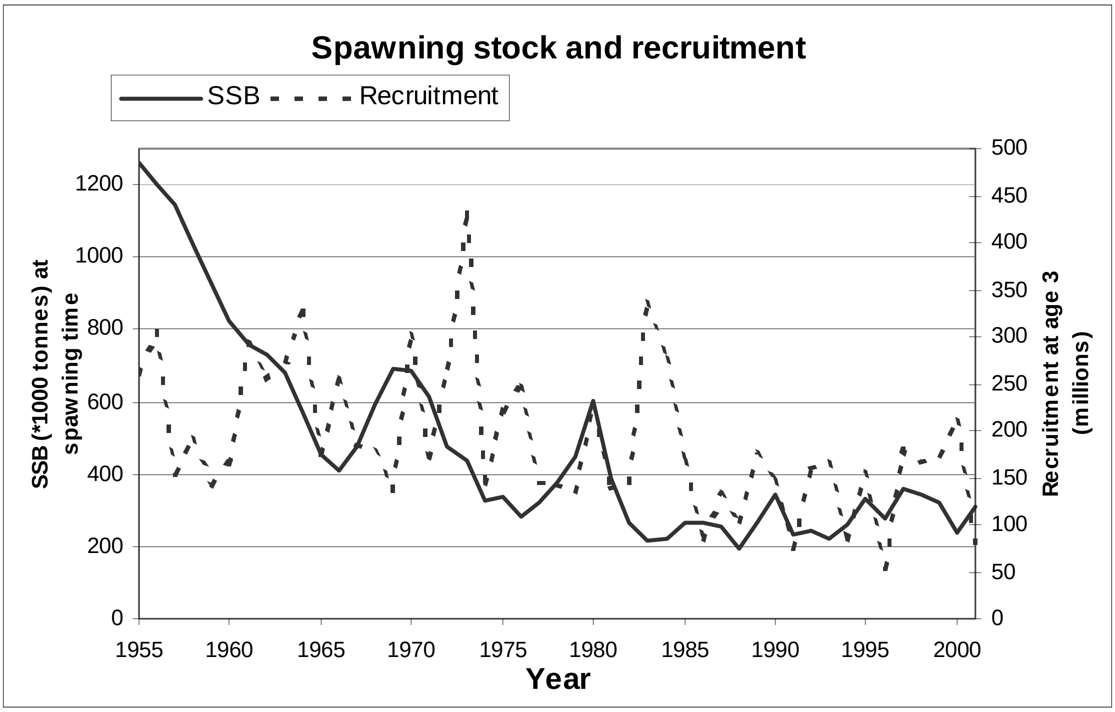


Figure 3.3.22B Spawning stock and recruitment.

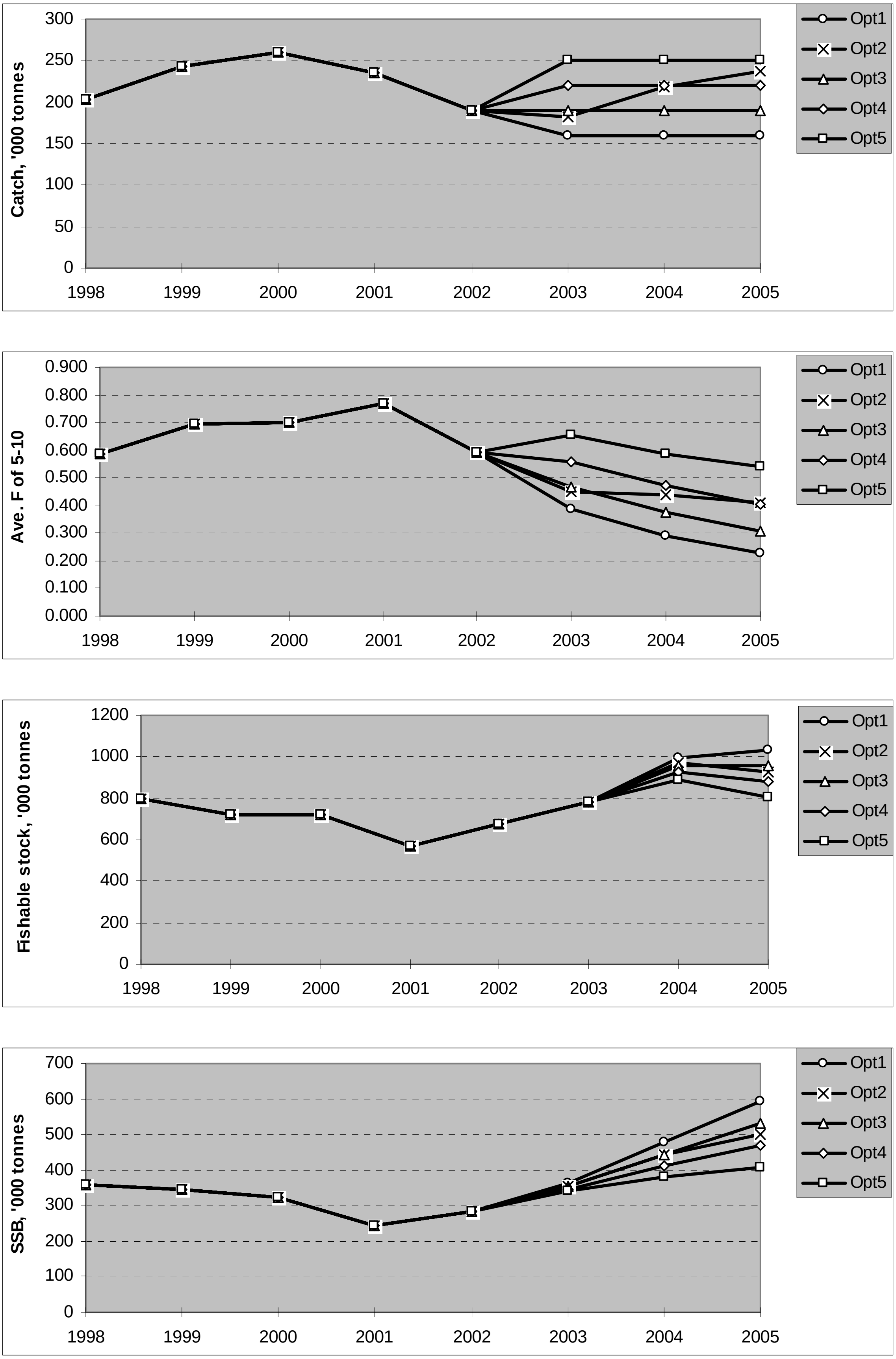


Figure 3.3.23 Results of different management options.

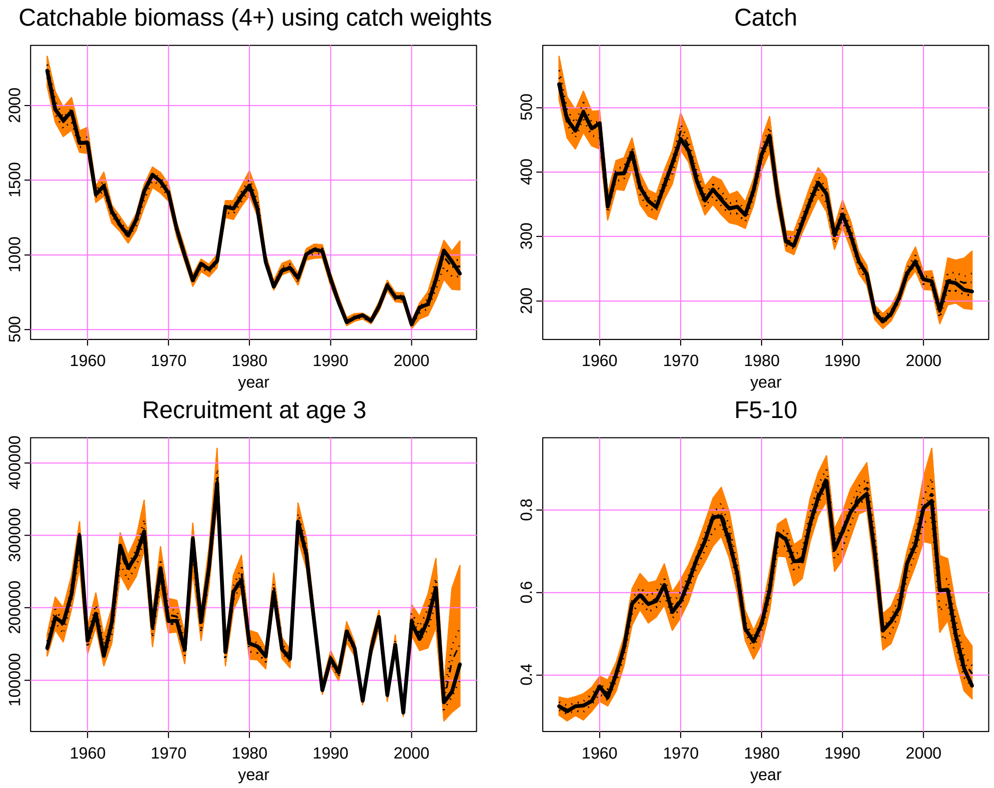


Figure 3.2.24A Cod in division Va. Stock estimate and short term prognosis using the ammended catchrule.

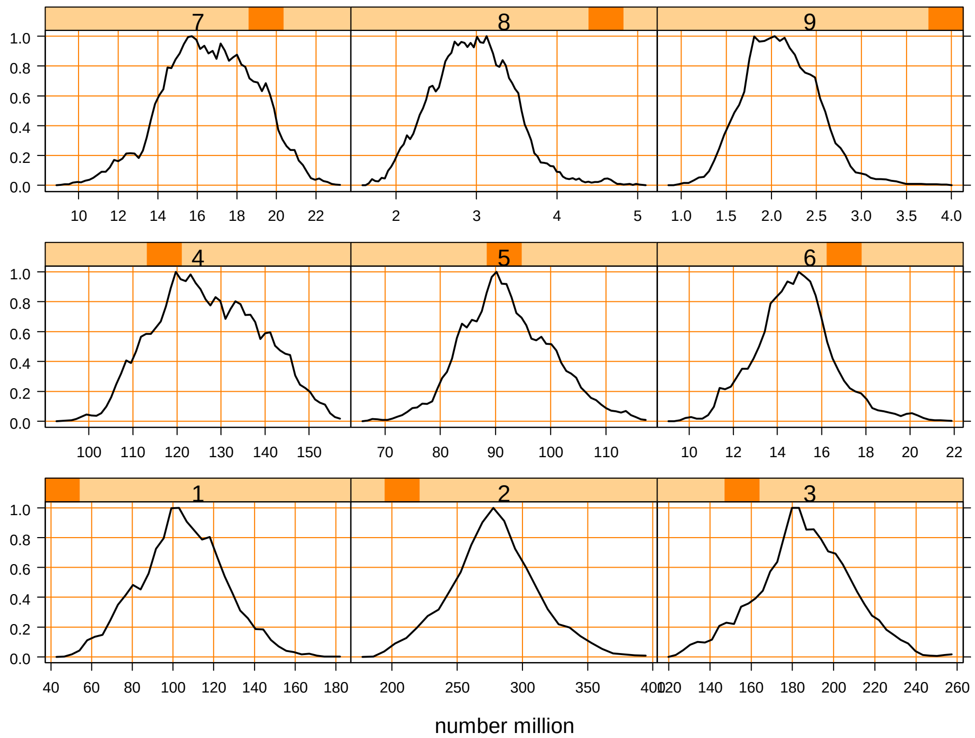


Figure 3.3.24B Cod in division Va. Posterior distribution of number in stock at the start of 2002.

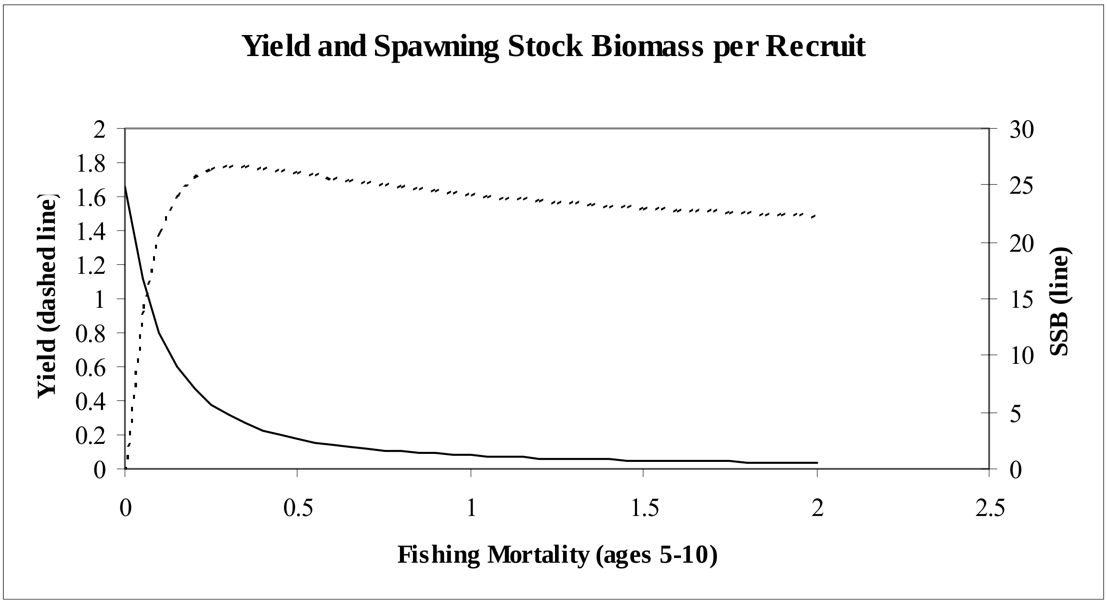


Figure 3.3.25 Yield per recruit

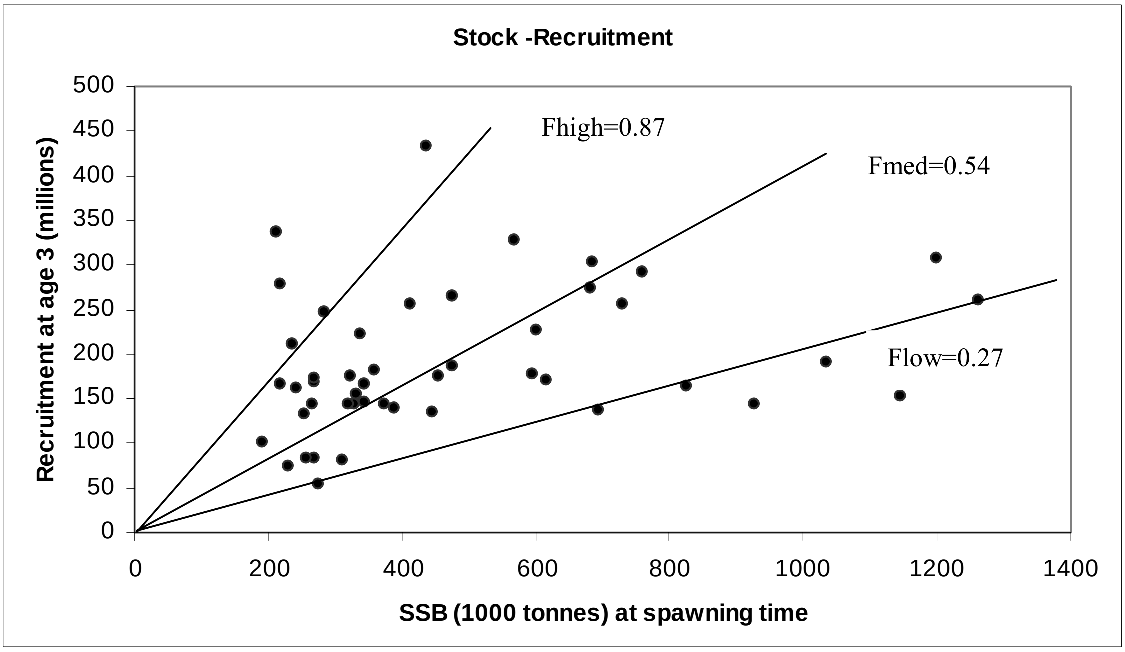


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

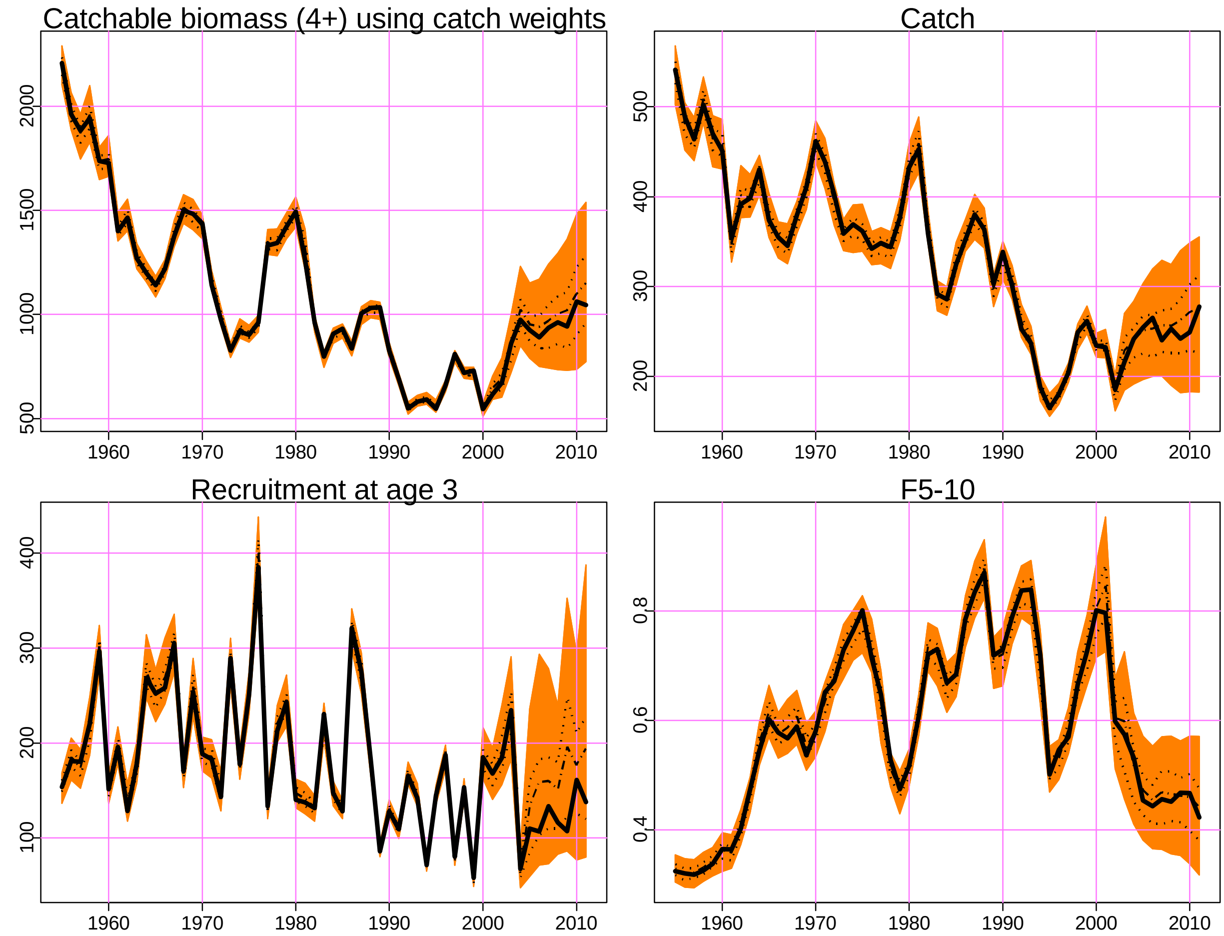


Figure 3.3.27 **AD-CAM** medium term projections

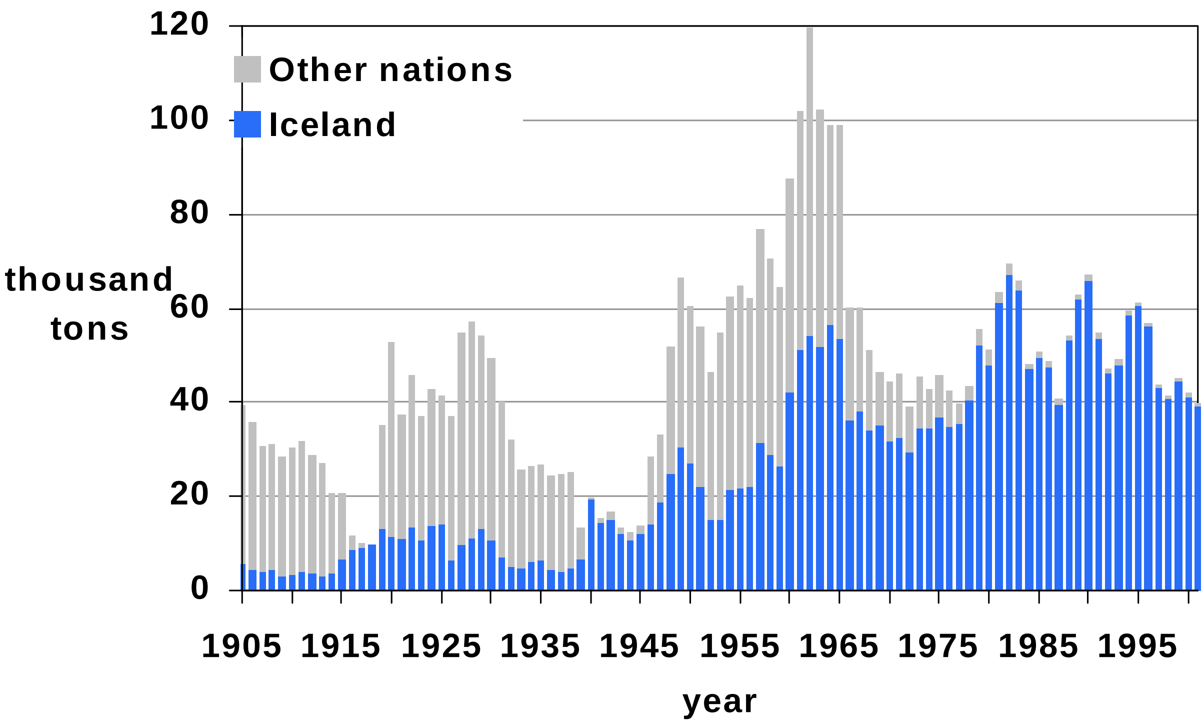


Figure 3.4.2.1 Haddock Division VA. Nominal landings (tonnes) 1905 – 2000.

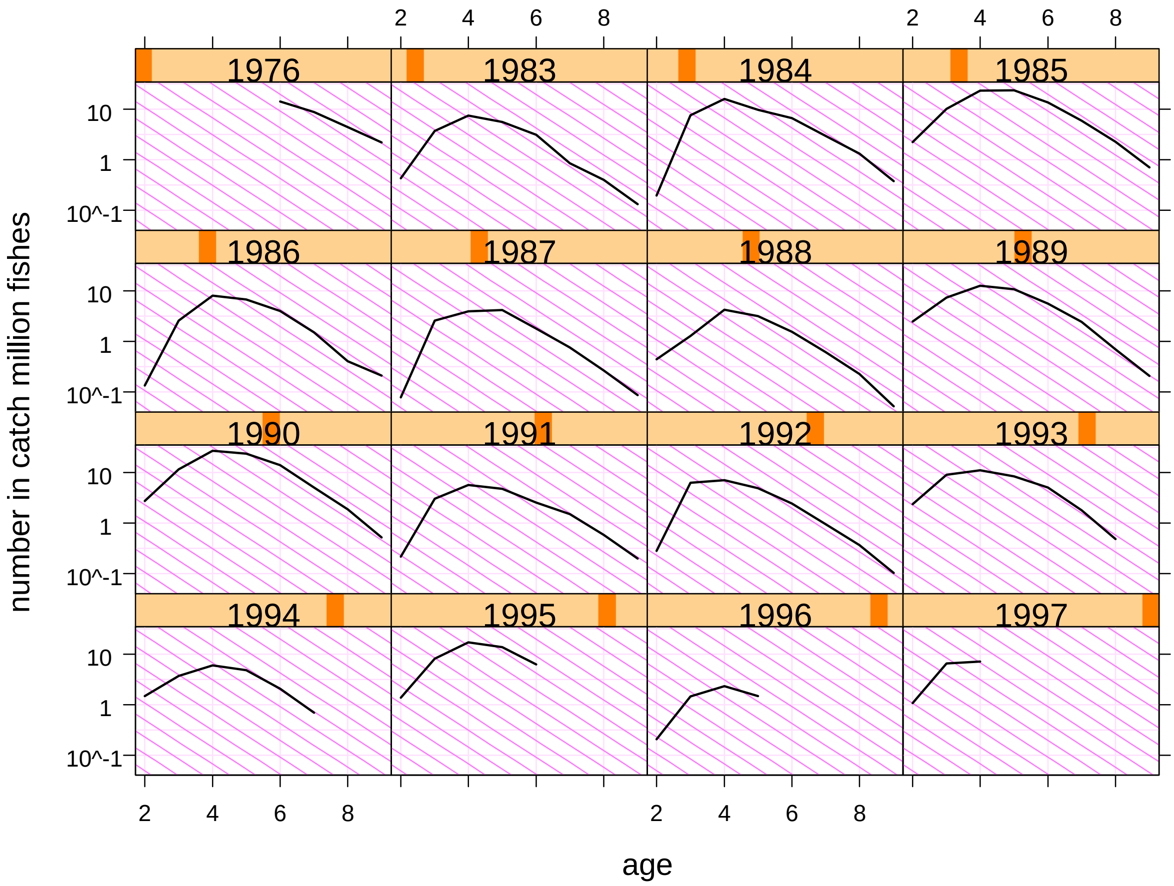


Figure 3.4.3.1 Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

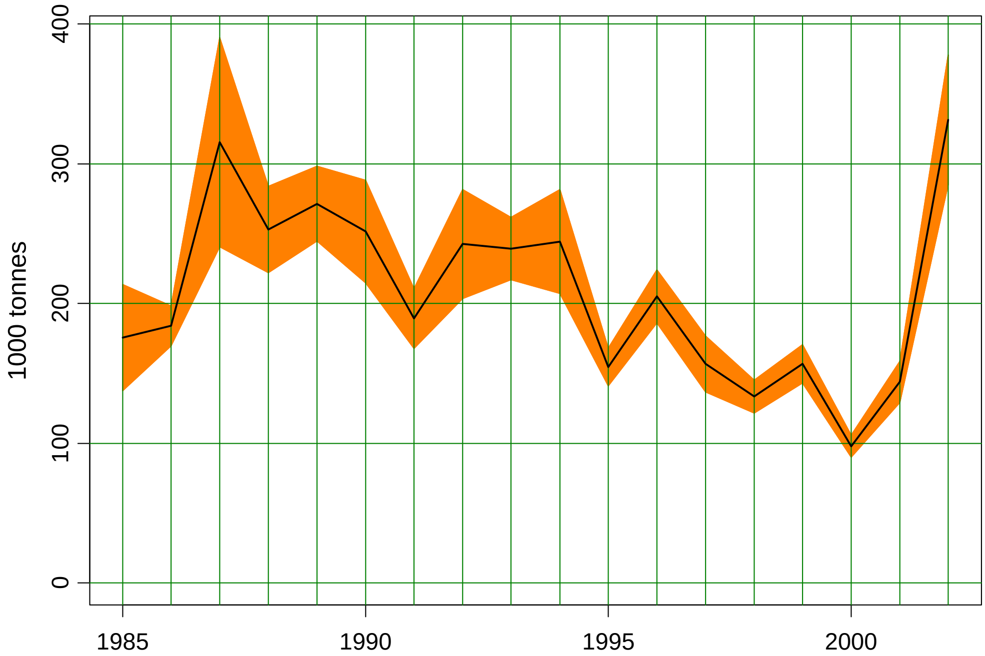


Figure 3.4.5.1. Haddock in Division Va. Biomass indices from the groundfish survey. Shaded areas show 2 times the standard error in the survey biomass.

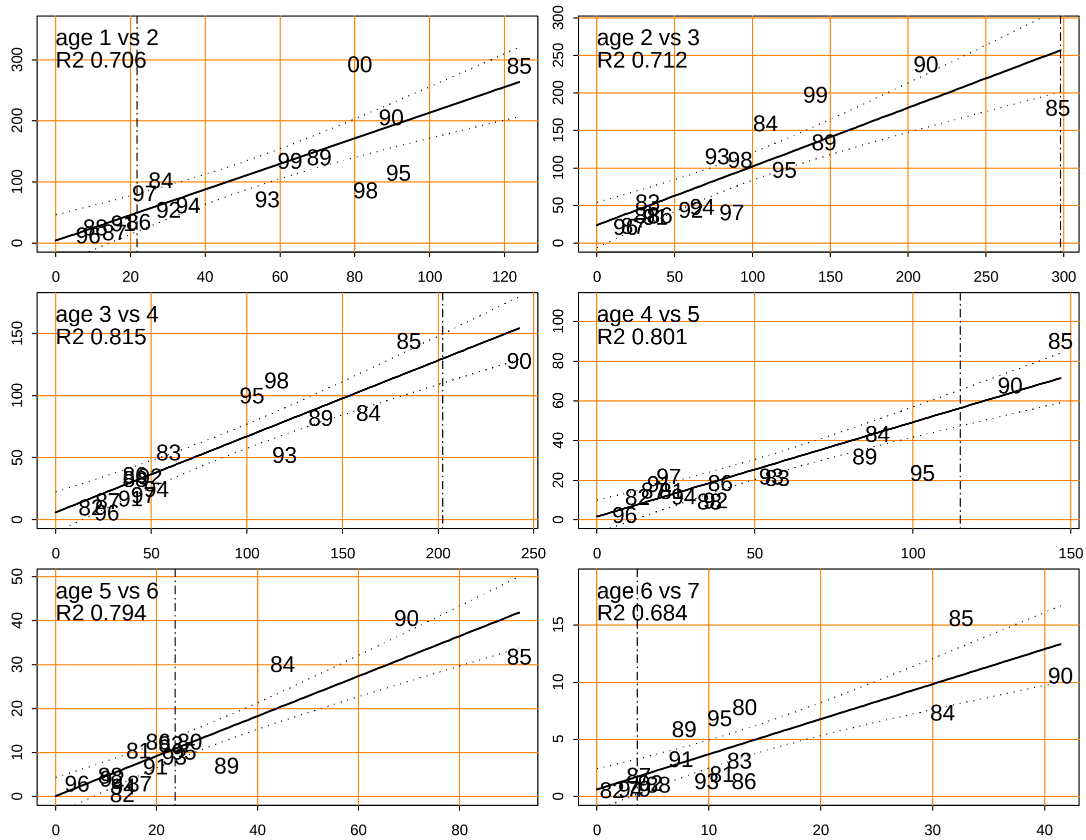
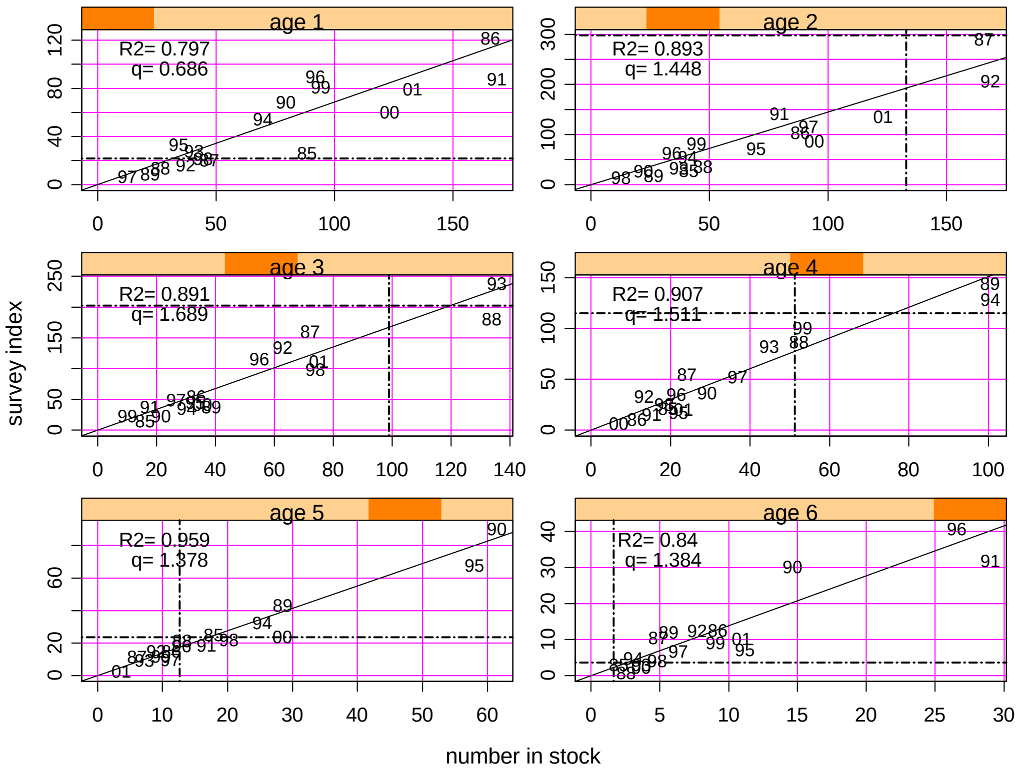


Figure 3.4.5.2 Haddock in division Va. Survey indices plotted against survey indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.



values.

Figure 3.4.5.3 Haddock in division Va. Survey indices plotted against estimated stock size from VPA. The fitted line uses the data until 1999. Dashed lines show most recent estimates.

Figure 3.4.5.4 Haddock in Division Va. Catch per unit effort in the most important gear types. The figure is based on records where more than 50% of the catch is haddock.

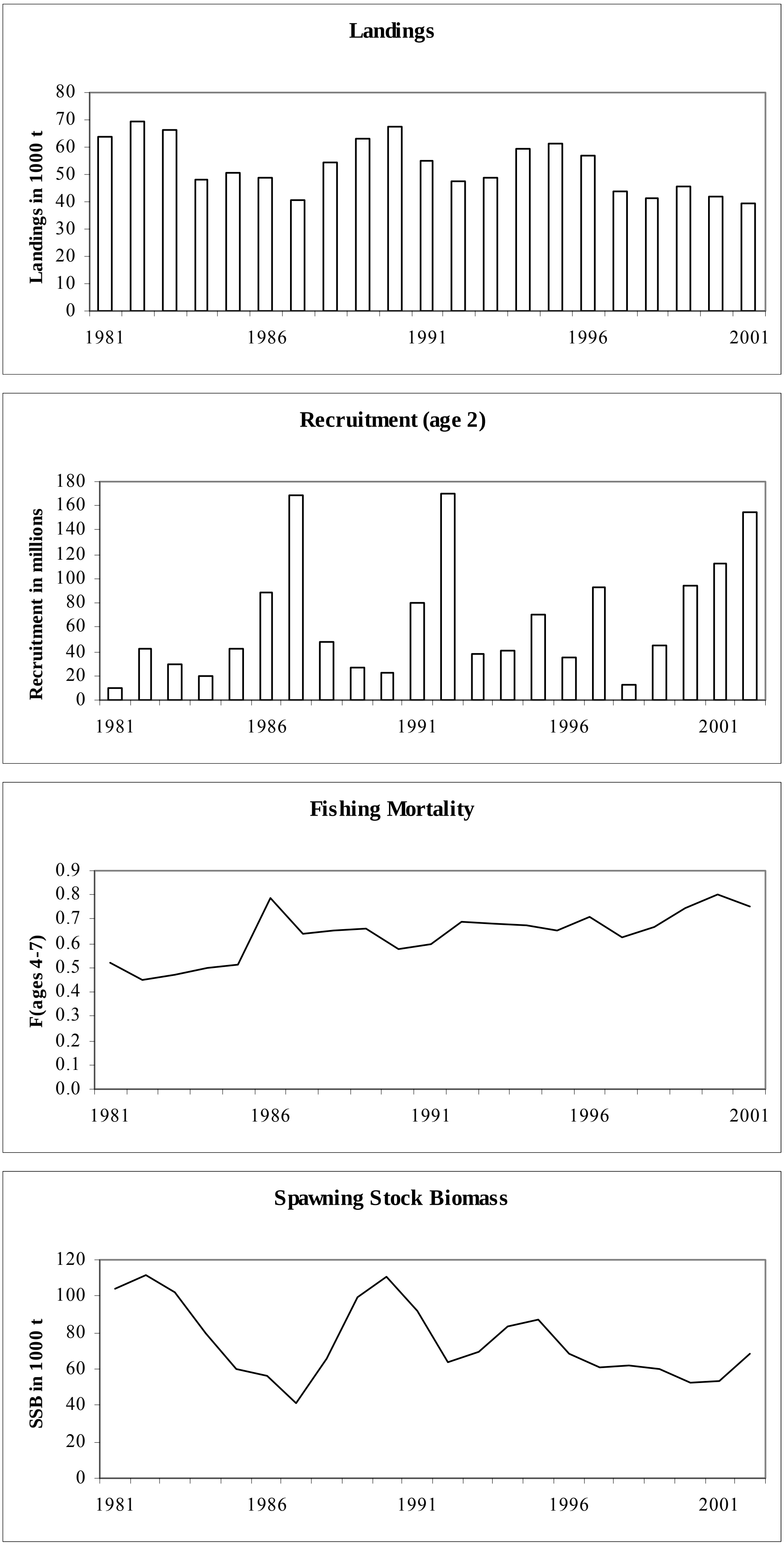


Figure 3.4.6.1 Haddock in division Va. Summary plots

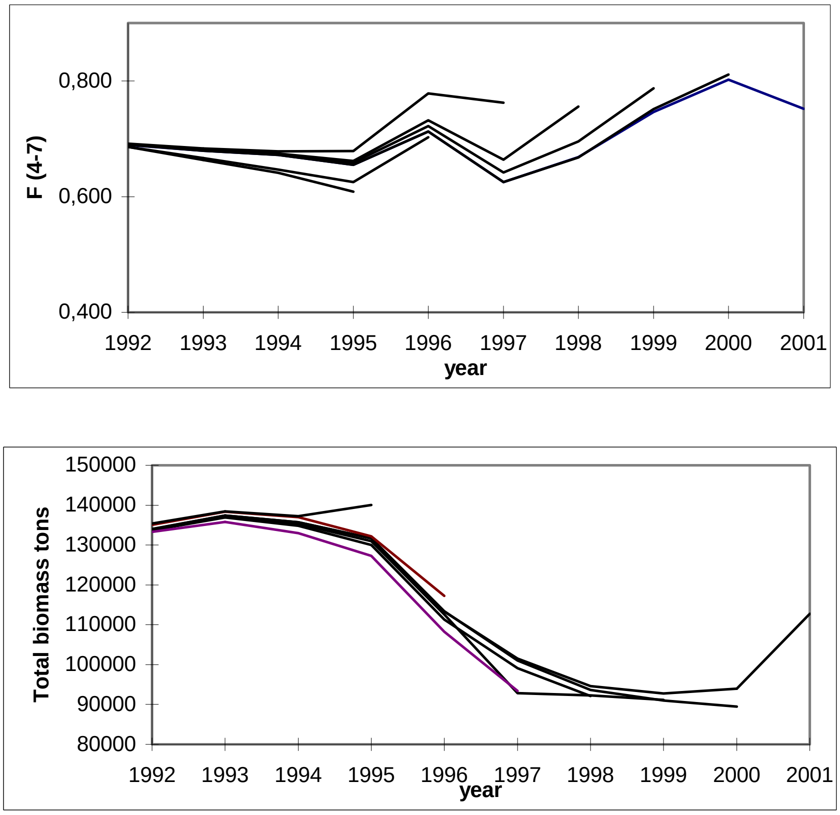


Figure 3.4.6.2 Haddock in division Va. Retrospective pattern from the base run using survey indices from age 2 to 9

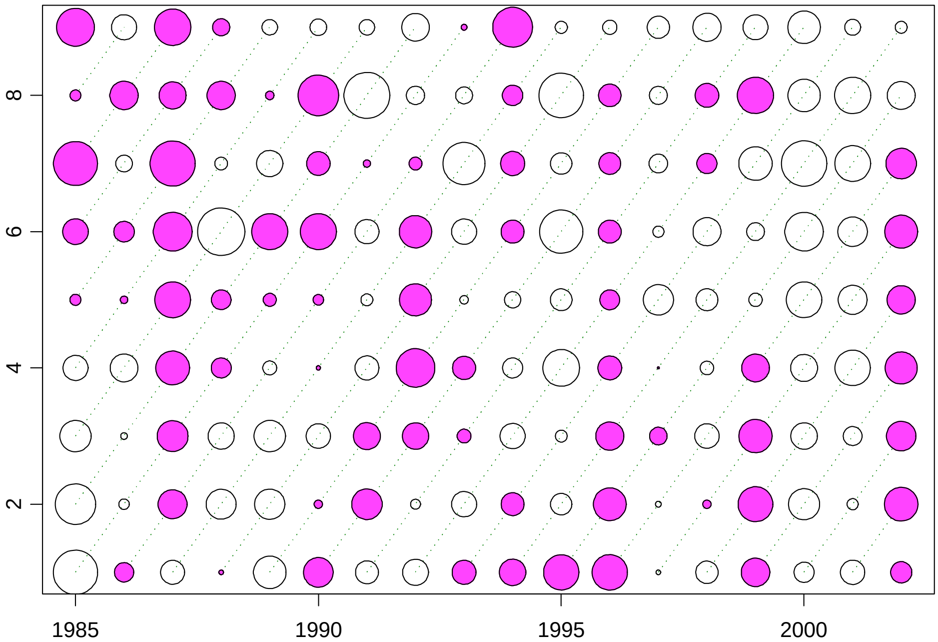


Figure 3.4.6.3 Haddock in division Va. Residuals from ADCAM fit to survey data. . $\dfrac{\log(I_{ay}+0.3)}{\log(\hat{I}_{ay}+0.3)}$. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.68 and residuals are proportional to the area of the circles

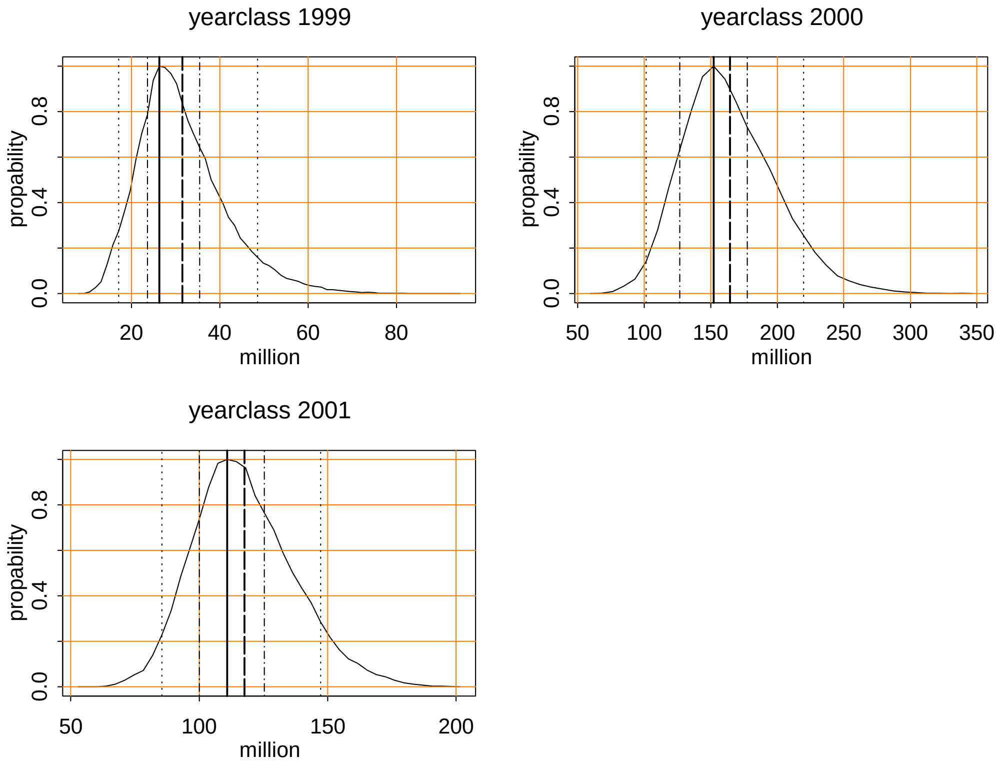


Figure 3.4.7.1 Haddock in division Va. Posterior profiles of recruitment estimates for year classes 1999 – 2001 as 2 year olds from the ADCAM model. The vertical lines in the figure show 5, 25, 50, 75 and 95 percentiles as well as the mean.

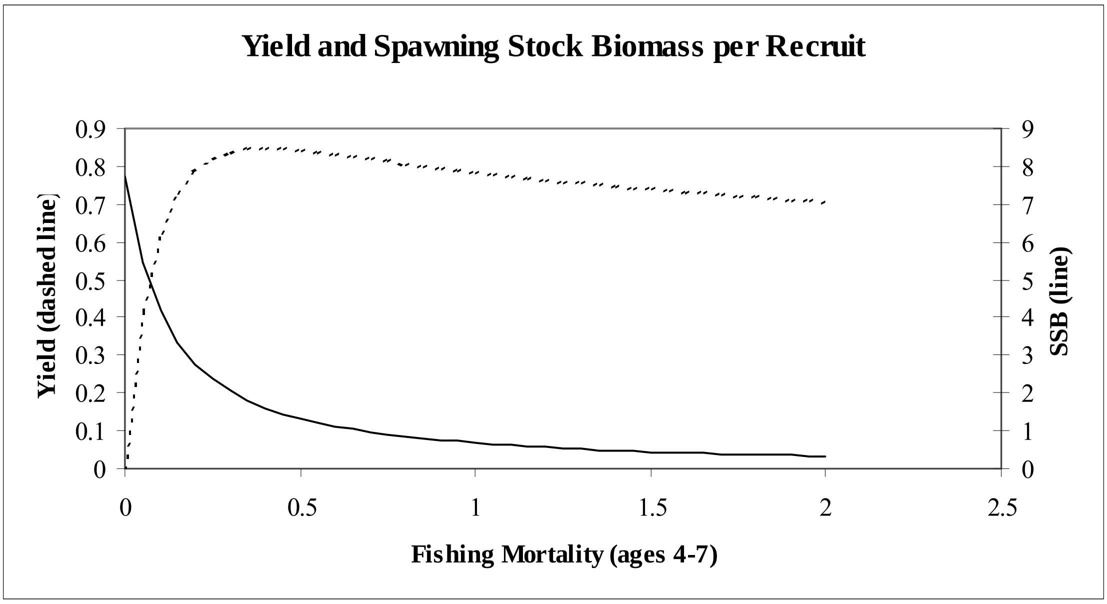


Figure 3.4.8.1 Haddock in division Va. Yield per recruit.

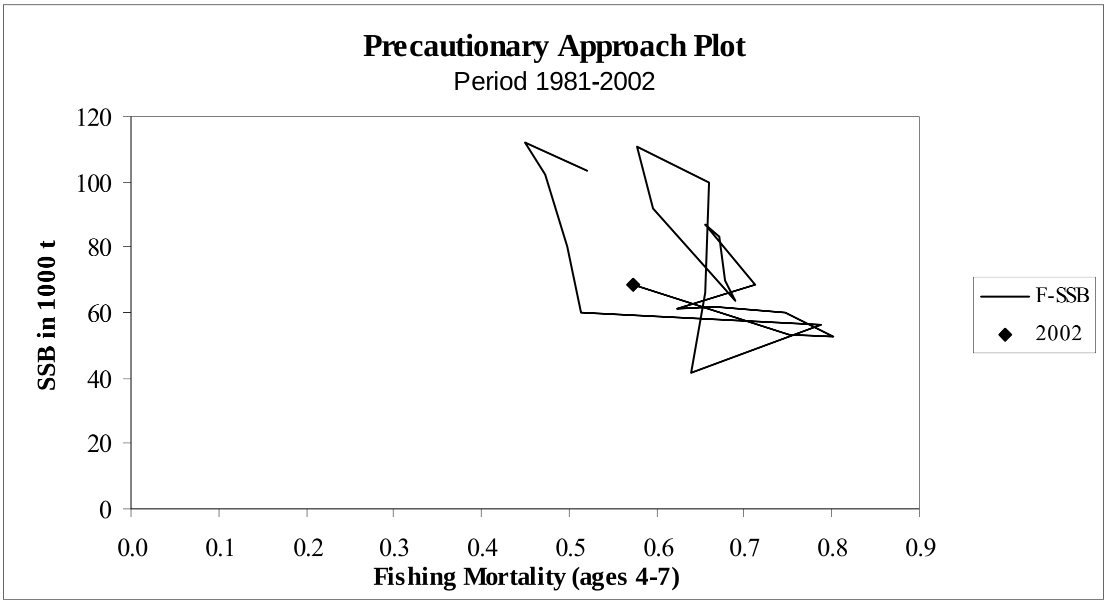


Figure 3.4.8.2 Haddock in division Va. Spawning stock vs. fishing mortality.

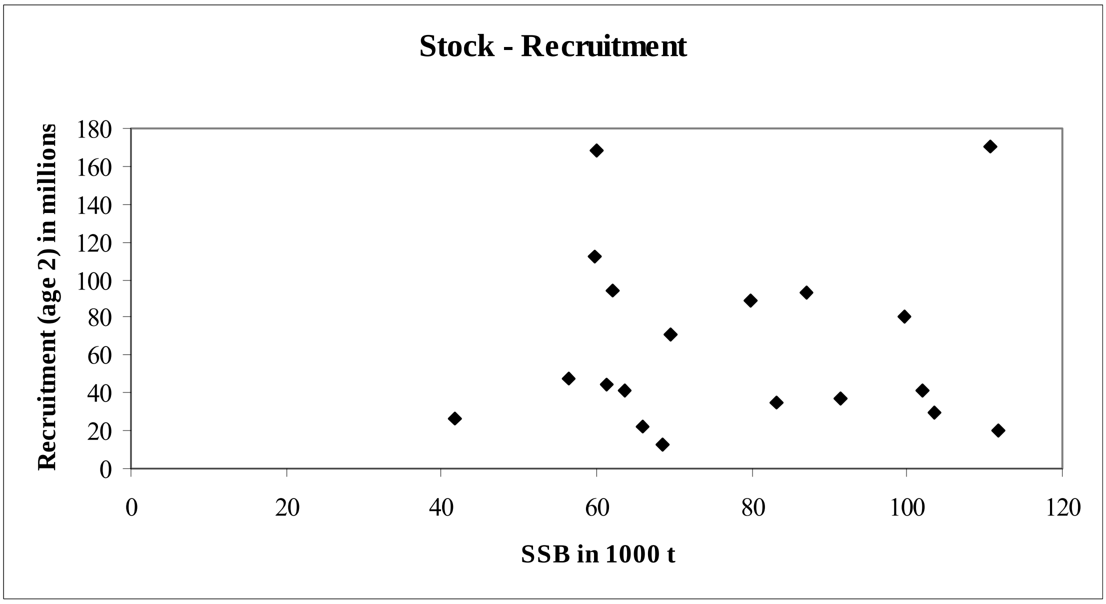


Figure 3.4.8.3 Haddock in division Va. Recruitment vs. spawning stock.

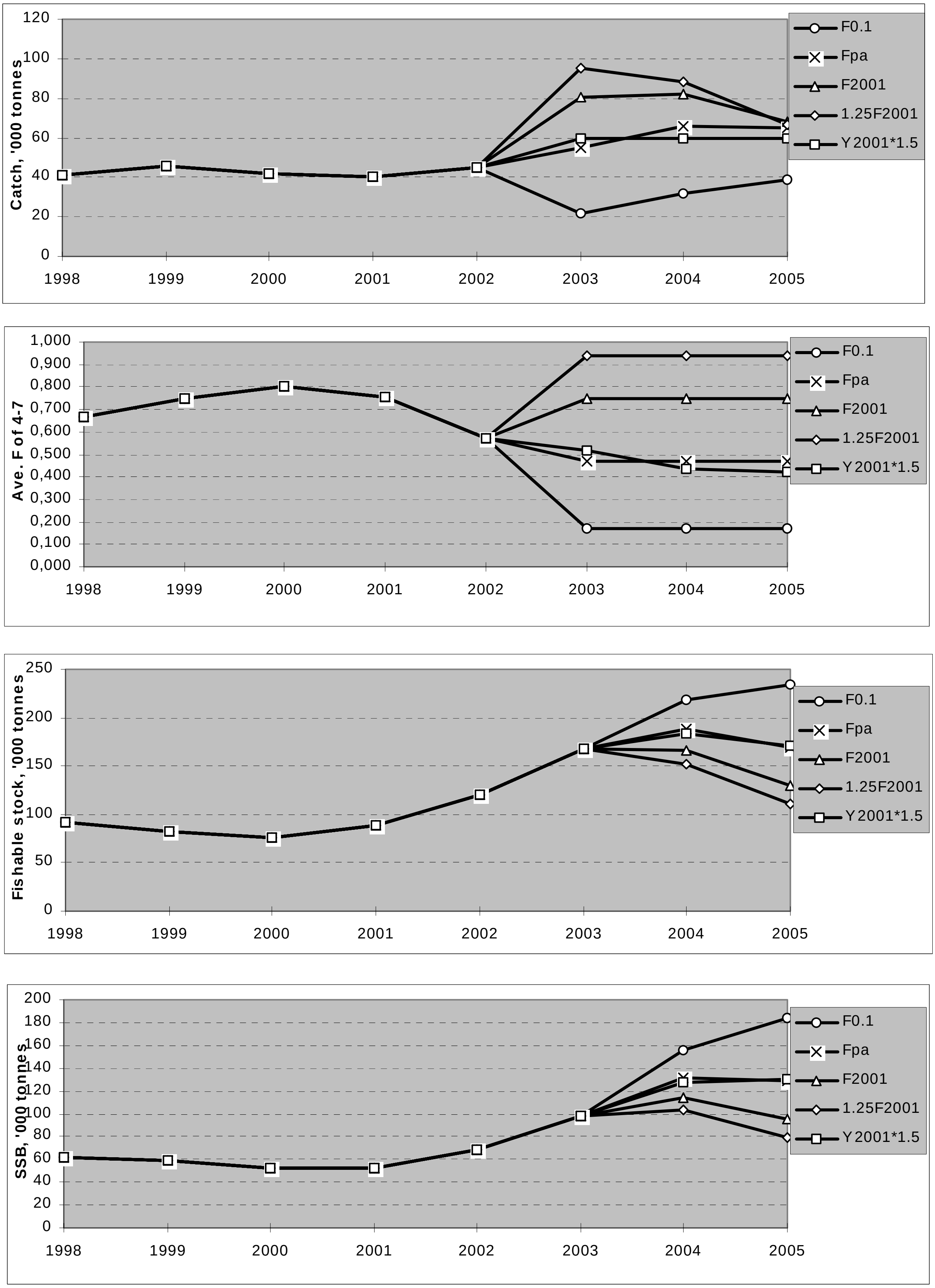


Figure 3.4.8.4 Haddock in division Va. Short term prediction. Summary of results for 5 different options.

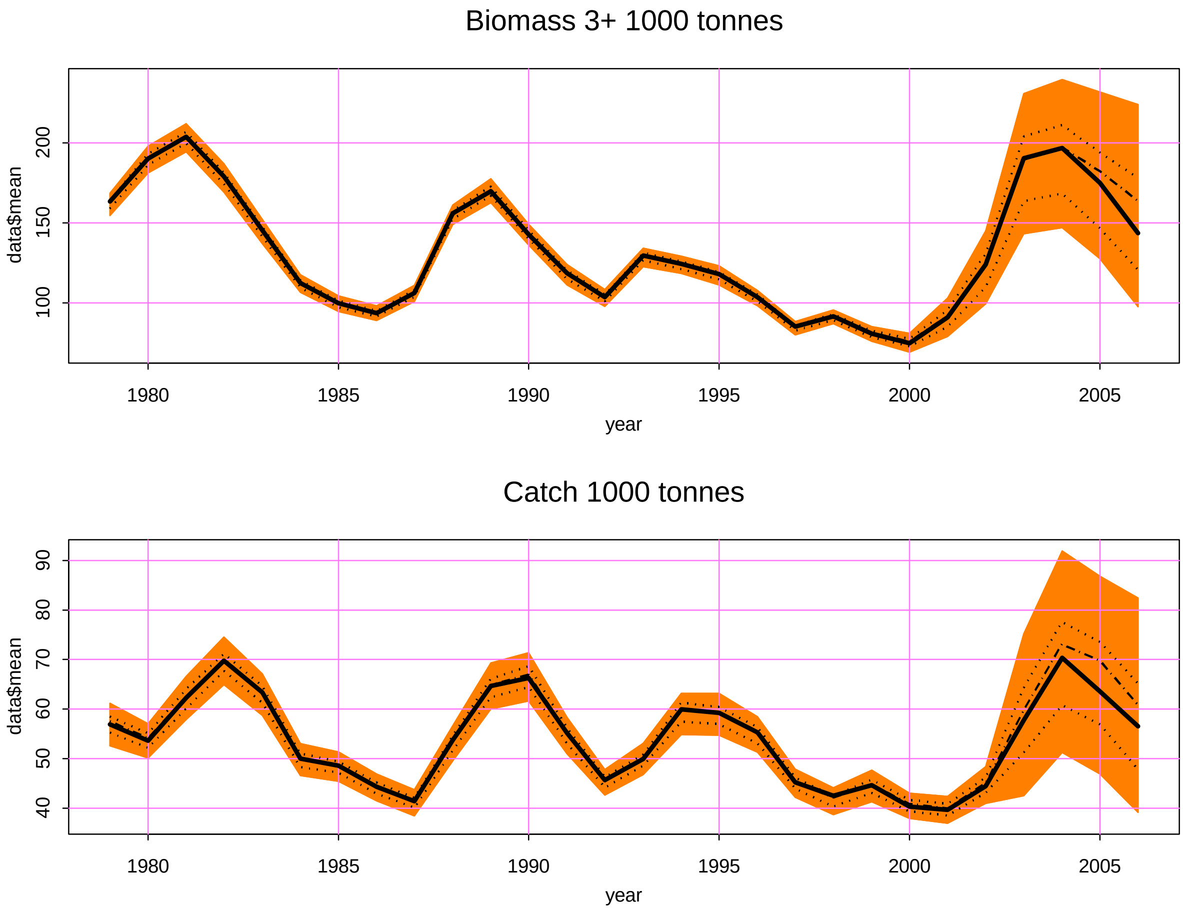


Figure 3.4.8.5 Haddock in division Va. Results from simulations fishing at F=0.47 after 2002. Assessment error lognormal with CV = 0.1. Shown in the figure are 5 and 95 percentiles (shaded areas), 25 and 75 percentiles (dashed lines) mean and median.

4 THE COD STOCK COMPLEX IN GREENLAND (NAFO SUBAREA 1 AND ICES SUBAREA XIV) AND ICELANDIC WATERS (DIVISION Va)

4.1 Inter-relationship Between the Cod Stocks in the Greenland-Iceland Area

Tagging experiments carried out at Greenland and Iceland show that mature cod at West Greenland migrate to East Greenland. Tagging experiments at East Greenland also show that mature cod from that area migrate to Iceland (Tåning, 1937; Hansen, 1949; and Anon. 1971). On the other hand, immature cod seem not to emigrate from East Greenland to Iceland, but in some years immature cod migrate from East Greenland to the West Greenland stock (Anon. 1971). Tagging experiments at Iceland show that migration of cod from Iceland to Greenland waters occurs very seldom and can be ignored in stock assessments (Jonsson 1965, 1986). Migrations from Greenland waters to Iceland can, therefore, be regarded as a one-way migration.

In egg and larval surveys cod eggs have been found in an almost continuous belt from Iceland to East Greenland, along the East Greenland coast, round Cape Farewell and over the banks at West Greenland (Tåning 1937, Anon. 1963). From 0-group surveys carried out in the East Greenland-Iceland area since 1970, it becomes quite evident that the drift of 0-group cod from the Iceland spawning grounds to the different nursery areas at Iceland varies from year to year. The same applies to the drift of 0-group cod with the currents from Iceland to East Greenland (Table 4.1.1). In some years it seems that no larval drift has taken place to the Greenland area, while in other years some, and in some years like 1973 and 1984, considerable numbers drifted to East Greenland waters (Vílhjalmsson and Fridgeirsson 1976, Vílhjalmsson and Magnússon 1984, Sveinbjörnsson and Jónsson 1999). Since 1995, 0-group surveys were continued with the area coverage reduced to the Icelandic EEZ. However, the estimates of the year classes 1997 to 2001 are exceptionally high. In 2001, more than 60% of the 0-group cod were distributed in northern areas off Iceland (Table 4.1.1) and an exceptional high proportion of O-group cod were distributed off East Iceland. However, none of these year classes seem to have drifted in significant numbers to the Greenland shelf.

The 1973 and 1984 year classes have been very important to the fisheries off both West and East Greenland. Tagging results have shown that when these two year classes became mature, they had migrated in large numbers from West to East Greenland and, to some extent, to the spawning area off the southwest coast of Iceland. This migration of mature cod from Greenland to Iceland influences the assessment of these stocks (Schopka, 1993) and it cannot therefore be ignored in the assessments.

Table 4.1.1 Abundance indices of O-group cod from international and Icelandic O-group surveys (Sveinbjörnsson and Hjörleifsson, 2001) in the East Greenland/Iceland area, 1971-2001 (except 1972 and 1995-96).

Year class	Dohrn Bank East Greenland	SE Iceland	SW Iceland	W Iceland	N Iceland	E Iceland	Total
1971	+	-	-	60	214	-	283
1973	135	10	107	96	757	86	1191
1974	2	-	-	22	30	+	54
1975	+	-	2	50	73	5	130
1976	5	9	30	102	2015	584	2743
1977	7	2	+	26	305	94	435
1978	2	-	+	169	335	47	552
1979	2	+	1	22	345	+	370
1980	1	2	+	38	507	10	557
1981	19	-	-	41	19	-	78
1982	+	-	+	7	4	-	11
1983	+	-	+	85	66	2	153
1984	372	5	+	200	826	369	1772
1985	32	+	+	581	197	2	812
1986	+	1	2	15	32	+	50
1987	7	-	1	2	61	10	81
1988	0	-	1	7	12	+	20
1989	1	-	3	7	30	+	41
1990	3	-	+	2	30	2	37
1991	+	-	-	+	5	+	6
1992	0	-	+	15	21	5	42
1993	1	-	+	36	116	2	155
1994	0	-	0	1	71	2	74
1997	4[1]	+	+	97	1007	46	1152
1998[2]		+	2	814	1799	137	2752
1999[2]		25	9	221	8255	898	9408
2000[2]		118	15	171	2520	264	3088
2001[2]		55	0	38	1549	722	2364

[1]) Figure reflects Dohrn Bank area only due to reduced survey area.
[2]) No estimate available for the Dohrn Bank-East Greenland area due to reduced survey area.

5 COD STOCKS IN THE GREENLAND AREA (NAFO AREA 1 AND ICES SUBDIVISION XIVB)

5.1 Cod off Greenland (offshore component)

Prior to 1996, the cod stocks off Greenland have been divided into West and East Greenland or treated as one stock unit for assessment purposes to avoid migration effects. Fjord populations (inshore) have always been included. In 1996, the offshore component off West and East Greenland, the so called Bank Cod, was assessed separately as one stock unit and distinguished from the inshore populations for the first time. The completion of a re-evaluation of available German sampling data for the offshore catches back to 1955 enabled such an analysis given in the 1996 North-Western Working Group report (ICES 1996/Assess:15). Due to the severely depleted status of the offshore stock component, the directed cod fishery was given up in 1992, the final year in the VPA. Since then, no adequate data were available to update the assessment. Therefore, the present report includes the summary table and figures of the 1996 assessment only appended by long term management considerations and updated survey results and catch information.

5.1.1 Trends in landings and fisheries

Officially reported catches are given in Tables 5.1.1 and 5.1.2 for West and East Greenland including inshore catches, respectively. Landings as used by the working group are listed in Table 5.1.3 by inshore and offshore areas and gear for both West and East Greenland combined, their trends being illustrated in Figure 5.1.1. Until 1975, offshore landings have dominated the total figures by more than 90%. Thereafter, the proportions taken offshore declined to 40–50% and inshore landings have dominated the most recent yields since 1993. Otter trawl board catches (OTB) were most important throughout the time series for offshore fisheries. Miscellaneous gears, mainly long lines and gill nets, contributed 30–40% until 1977 but have disappeared since then.

Annual landings taken offshore averaged about 300 000 t during the period 1955–60. Until 1968, figures increased to a higher level between 330 000 t and of 440 000 t in 1962. Landings decreased sharply by 90% to 46 000 t in 1973. Subsequently, the landings dropped below 40 000 t in 1977 and were very variable. The level of 40 000 t was only exceeded during the periods 1980–83 and 1988–1990. Since 1970, there have been large changes in effort, which increased during exploitation of the strong year classes born in 1973 and 1984. The offshore fishery was closed in 1986 and for the first 10 months in 1987. During 1990–92, the landings decreased from 100 000 t by 90% to 11 000 t. Since then, almost no directed cod fishery has taken place offshore and the reported landings varied from 116 t to 736 t. A total offshore catch amounting to 221 t was reported for 2000.

It is important to note that catch figures, especially since 1992, are believed to be incomplete due to unreported by-catches in the shrimp fishery which has recently expanded to all traditional areas of the groundfish fisheries. Discards of finfish by-catches were difficult to record due to the processing of the shrimp catch on board. A first assessment of the catch taken by the shrimp fishery amounted to 32 t or 110 000 individuals of cod in 1994. This estimate was added to the catch figures used by the Working Group for the 1992–95 period.

5.1.2 Surveys

5.1.2.1 Results of the German groundfish survey off West and East Greenland

Annual abundance and biomass indices have been derived using stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in the report of the 1993 North-Western Working Group (ICES 1993/Assess:18) and Working Doc. 10. Figure 5.1.2 indicate names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile line offshore except for some inshore regions in Strata 6.1 and 6.2 off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, and 1994 the survey coverage was incomplete off East Greenland partly due to technical problems.

5.1.2.1.1 Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–2001. Trends of the abundance and biomass estimates for West and East Greenland were shown in Figures 5.1.3 and 5.1.4, respectively, including the adult stock parts. These Figures illustrate the pronounced increase in stock abundance and biomass indices from 23 million individuals and 45 000 t in 1984 to 828 million individuals and 690 000 t in 1987. This trend was the result of the recruitment of the predominating year classes 1984 and 1985, which were mainly distributed in the northern and the shallow strata 1.1, 2.1 and 3.1 off West Greenland during 1987–89. Such high indices were never observed in strata off East Greenland, although their abundance and biomass estimates increased during the period 1989–91 suggesting an eastward migration. During the period 1987–89, which were years with high abundance, the precision of survey indices was extremely low due to enormous variation in catch per tow data. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000 t in 1993. The 2001 survey results confirmed the severely depleted status of the stock, although they represent the highest stock size since 10 years. The total abundance and biomass indices amounted to 16 million individuals and 18 000 t, respectively.

5.1.2.1.2 Age composition

Age disaggregated abundance indices for West, East Greenland and the total are listed in Tables 5.1.5–7, respectively, and are based on 1 242 individual age determinations. In 2001, the recruiting year classes 1998, 1999 and 2000 are considered weak as compared to the strong 1984 and 1985 year classes. The year class 1999 at age 2 however is estimated as the third strongest year class since 1982 and thus to provide some recovery potential in the next few years. The O-group indices are considered unrepresentative of year class strength at age 3 due to gear specifications while the age group 1 seems to be quantitatively estimated and to represent a reasonable recruitment index. (Figure 5.1.5).

5.1.2.1.3 Mean weight at age

Mean weight of the age groups 1–10 years for West, East Greenland and weighted by abundance to the total were listed in Tables 5.1.8–10, respectively. Weight (g) at age calculations are based on the regression $f(x) = 0.00895x^{3.00589}$, x = length (cm), which has been determined on the basis of 3 482 individual measurements. The trends of these values are illustrated in Figure 5.1.6 for the period 1982–2001. They reveal pronounced area and temperature effects. Age groups 2–10 years off East Greenland were found to be bigger than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1–5 displayed a decrease during 1986–87 and remained at low levels until 1991. Since then, the weight at age at ages 3 to 8 years increased significantly and remained at that high level until 2000, when very low values were recorded. However, the 2001 values indicate increased growth rates for most ages.

5.1.2.2 Results of the Greenland groundfish survey off West Greenland

Since 1988, the Greenland Institute of Natural Resources has annually conducted a bottom trawl survey off West Greenland (Working Doc. 2). The main purpose of the survey is to evaluate the biomass and abundance of Northern shrimp (*Pandalus borealis*), but data on most fish spices have been recorded. The survey covers the offshore areas at West Greenland between 59°00'N and 72°30'N from the 3-mile limit to the 600 m depth contour line and the inshore area Disko Bay (Figure 5.1.7). The survey area is divided into NAFO Divisions, which were further subdivided into three depth strata (0-200, 201-400 and 401-600 m) on basis of depth contour lines. The area surveyed has, however, changed throughout the years. From 1988 to 1990 the survey area included Division 1AN to 1D. In 1991 the Division 1AN was not covered. In 1992 the survey area was extended to include Division 1AN to 1F and Disko Bay (Division. 1AX), and this area is now surveyed annually. The survey was originally designed as a shrimp survey and sampling of fish data was not complete in the period 1988-1991. Since 1992 the sampling of fish has improved and the survey is now considered as a combined groundfish/shrimp survey. The survey period was July to September.

The survey is designed as a stratified-random trawl survey. A minimum of two hauls per stratum is always planned. Due to lack of information of the bottom topography Division 1AN and Disko Bay are considered as two single strata. The number of valid hauls by year and stratum is listed in Table 2. The trawl is a Skjervoy 3000/20 with bobbin gear and double bag. The mesh size in the codend is 20 mm. The standard trawling time offshore is 15-60 minutes at a mean towing speed of 2.5 knots. Stratified abundance and biomass estimates were calculated from catch-per-tow data using the stratum areas as weighting factor (Cochran, 1953). The coefficient of catchability was set at 1.0, implying that estimates are merely indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

5.1.2.2.1 Stock abundance indices

Tables 5.1.11 and 5.1.12 list abundance and biomass indices of cod by year and stratum. The biomass indices for cod ranged between 4 000-7 000 t in 1988-1990. In 1991, the biomass decreased by more than 95 % to only 250 t and 528 000 individuals and remained at this low until recent years. There are indications of a slight improvement in the abundance of small cod. Abundance indices in 2001 were estimated to 1.6 million individuals, which is the highest estimate in the abundance time series. In 1999 to 2001 a significant amount of cod was captured in area 1AS, 1AX and 1BN for the first time.

5.1.2.2.2 Age composition

Age disaggregated abundance indices are listed in Table 5.1.13. In 2001, the recruiting year classes 1997, 1998 and 1999 dominated the stock by 94% with equal shares. Their abundance at ages 2 to 4 represent highest or second highest values of the time series, respectively.

5.1.3 Biological sampling of commercial catches

No commercial sampling data were available to assess recent catch in numbers, weight and maturity at age.

5.1.4 Results from the 1996 assessment

The historical stock status was assessed based on the terminal Fs derived from an XSA tuning run applying 1992 as the final year.

Trends in yield and fishing mortality are shown in Figure 5.1.8. An increasing trend in Fbar from 0.1 to 0.4 was determined during the period 1955–68. During the same period, the yield increased from a level of 280 000 t to 380 000 t but decreased drastically to 100 000 t in the early 70s. Thereafter, the fishing mortality was highly variable and seemed to be dependent on the changes in effort directed to the exploitation of individual strong year classes. Periods when Fbar for ages 5–8 years exceeded 0.5 were 1974–1977, 1980–1984 and 1988–1992.

Trends in spawning stock biomass and recruitment were shown in Figure 5.1.9. During 1955 to 1973, the spawning biomass decreased almost continuously from 1.8 million t to 110 000 t, a decrease of 94%. Thereafter, the spawning stock biomass averaged 50 000 t. During the period 1955–73 before the spawning stock decreased below 100 000 t, the recruitment at age 3 varied enormously between 4 million and 700 million and averaged 220 million. Since 1974, the spawning stock varied around the mean of 50 000 t and produced an average recruitment of 41 million representing a mean reduction by 95% and 80%, respectively. The long term mean recruitment was not exceeded for 8 of 19 years from 1955 to 1973, while it has been below that value for 17 of 19 years since then. During the last 30 years, only 2 year classes have reached the long term mean recruitment level at age 3, namely those produced in 1973 and 1984.

5.1.5 State of the stock

The two surveys, the German survey off West and East Greenland and the Greenland shrimp survey off West Greenland, do confirm that the offshore component of the cod off Greenland is at a very low level.

Both surveys indicate increased recruitment of the year classes 1997, 1998, 1999 and 2000, the year class 1999 being the third strongest at age 2 since 1982 in the German survey. However, the recruiting year classes cannot be described as strong being estimated to be less than 10 % of the most recent previous strong year class of 1984. Although rebuilding to previous high stock sizes cannot be expected to occur based on these year classes, they suggest that the process of rebuilding may have begun.

The age composition of the stock indicates high mortality rates of juvenile cod for the past decade, especially off West Greenland.

5.1.6 Estimation of management reference points

Input parameters for the estimation of long term yield and spawning stock biomass per recruit are listed in Table 5.1.14 for age groups 3–12. Maturity and weight at age vectors were calculated as long-term means covering the period 1955–92. The natural mortality M was increased to 0.3 for age groups 5 and older to account for an emigration to Iceland. The exploitation pattern was derived as Fbar from the three most recent years from the final VPA. Determined F-factors for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ were scaled according to the mean reference F over the age groups 5–8. The resulting estimates of yield and spawning stock biomass per recruit are illustrated in Figure 5.1.10. The values of $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are indicated by arrows and amounted to 0.3 and 0.72, respectively. The lack of a well definite peak in the yield per recruit curve is due to increased natural mortality.

Recruitment at age 3 is plotted against the spawning stock biomass in Figure 5.1.11. $\mathbf{F}_{med}$ amounted to 0.09. The corresponding spawning stock biomass per recruit was as high as 4.5 kg. $\mathbf{F}_{high}$ amounted to 0.59 with the accompanied spawning stock biomass per recruit of 1.0 kg.

However, neither the determined Beverton & Holt nor the Ricker model fitted the observed recruitment-spawning stock biomass points well. The Beverton & Holt curve quickly reached the long term mean recruitment level affected by the strong 1973 and 1984 year classes related to low biomass values and extremely poor year classes 1969–72 produced by spawning stock sizes exceeding 250 000 t. The Ricker curve did not reach a maximum over the available range of observed spawning stock sizes. The time series, however, includes a remarkable variation in several parameters; larval drift from Icleland, changes in hydrographical regimes and a substantial reduction (extinction) of the West Greenland spawning stock. These conditions impede the use of total time series for estimation of biomass reference points.

5.1.7 Management considerations

Cod is described a common species in the Greenland fauna, although reaching here its ecological boundary. Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. The size of the SSB was identified to have a major impact on recruitment at age 3 in the period 1955-89 ($r2=0.41$; Rätz et al., 1999), supported by the evidence of spawning in Greenland waters (Wieland and Hovgård, 2002). However, even with sizeable SSBs present and spawning occurring, water temperature may be so cold that eggs and larvae will not survive. An example of hampered recruitment was identified for the period 1969–72 when a continued cold event off West Greenland and an almost complete recruitment failure was observed (Figure 5.1.11). If cold water conditions persist for a sufficiently long time period, they may result in very low biomass of offshore cod. Although it is well documented that cod is always present at Greenland, it is similarly well documented that there have been periods of very low abundance (e.g. in the XIXth century), presumably due to persistent periods of cold temperature (Jensen and Hansen, 1931; Vilhjálmsson, H. 1997). Stock parameters, slow growth and poor conditions (Lloret and Rätz 2000), late maturation, and highly variable recruitment strongly affected by environmental conditions, suggest that to be sustainable, exploitation rates would need to be low, particularly in periods of cold water. In productive periods, higher exploitation rates could be sustainable, but it would be advisable to maintain a spawning stock biomass sufficiently large to buffer for brief periods of cold water.

The former VPA assessment of the offshore cod stocks off Greenland revealed that over-fishing was an important cause for the collapse of this unit in the beginning of the 70s. Since that time, the spawning stock has remained below 100 000 t and has not been able to produce adequate recruitment. Relatively strong year class were produced in 1973 and 1984 despite the low SSBs, but these are believed to have emigrated from Iceland as larvae. An increase in effort directed towards the strong 1973 and 1984 year classes at a young age resulted in a rapid decrease in abundance. The migration back to Iceland as mature fish further diminished the contribution of those year classes to local egg production. Recruitment pulses from Iceland could contribute to a substantial recovery of the offshore component in the short term. However, strong recruitment pulses are rare events (2 known occurrences in the last 30 years). In addition, strong year classes originating from Iceland may have a tendency to go back to Iceland when they mature. Therefore, increases in biomass from immigrating eggs and larvae may not be sustained. The links between the cod stocks off Iceland, Greenland and along the Canadian Atlantic shelves through egg and larval drifts are currently investigated by an ICES/GLOBEC project.

No fishing should take place until a substantial increase in stock size is evident. Technical measures to avoid the by-catch of juvenile cod should be maintained (mandatory use of a 22 mm sorting grid since October 1, 2000).

5.1.8 Comments on the assessment

The present assessment is based on survey indices only, due to the termination of the cod directed offshore fishery in 1992.

The VPA assessment conducted in 1996 was affected by several uncertainties in data as well as ecological factors. The effect of emigration was only directly covered for the 1973 and 1984 year classes and had been taken into account by an increase of the natural mortality to 0.3 for age groups 5 and older. The sampling of commercial catches was historically rather inconsistent and did not cover the 30% taken by miscellaneous gears, mainly longlines and gill nets up to 1977. Since 1991, catch at age and weight at age data had to be calculated using survey data. Maturity data were poorly reported implying uncertainties in spawning stock estimates.

No XSA tuning could be applied since 1997 when low levels in landings, effort and stock abundance were observed. The age disaggregated survey indices had to be adjusted to account for incomplete coverage of the survey area in 1992 and 1994.

5.2 Inshore cod stock off Greenland

In the last decade, the inshore cod fishery at West Greenland has contained cod from two different spawning areas. Icelandic cod spawned off South-western Iceland, which in some years are carried by the Irminger Current to settle off South Greenland, and local fjord populations. Spawning cod are found in several fjords of the West Greenland, especially in NAFO Divisions 1B, 1C and 1D. Although tagging experiments suggest a high degree of residency for fjord populations, the recruitment seems to be correlated between the different fjords (Engelstoft 1997).

5.2.1 Trends in Landings and Effort

Historically, the inshore landings have been minor compared to total landings accounting for only 5–10% of the total international catch in NAFO SA 1. Annual landings of 15 000–20 000 t have been taken inshore during the period 1955–1973. Since then the landings have been varying consistently with the recruitment of strong year classes to the offshore fishery. High landings of about 50 000 t in 1980 and 1989 have been followed by periods of very low landings. In recent years the landings has decreased dramatically from about 2000 tons annually in 1993–1995 to only 307 tons in 2000. No catch figure is available for 2001.

NAFO Div	1993	1994	1995	1996	1997	1998	1999	2000*	2001*
1A	333	209	53	41	18	9	360		
1B	323	332	521	211	454	133	131		
1C	173	589	710	471	198	79	44		
1D	968	914	332	164	99	58	75		
1E	18	11	4	11	4	9	8		
1F	109	62	81	46	117	31	4		
Total	1926	2115	1710	948	904	319	622	307	

* no landing statistics available

The inshore fishery takes place from small vessels (< 40 GRT). Pound nets, gillnets and handlines are used to take about 95% of the inshore catch. A commercial pound net CPUE series is available since 1992 (Table 5.2). The mean catch pr pound net setting has decreased from 804 t in 1994 to 284 in 1999. No commercial catch or effort data from 2000 was available for 2001.

5.2.2 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes has been conducted since 1985 with the objective to assess the abundance and distribution of pre-recruit cod in inshore areas of Greenland. The survey has usually been carried out in three inshore areas off West Greenland: Qaqortoq (NAFO Division 1F), Nuuk (Division 1D) and Sisimiut (Division 1B). The Greenland inshore cod stock is not distributed in the Qaqortoq area, but occasional in$\mathbf{F}_{low}$ of pre-recruited cod from East to West Greenland shows up here. Technical problems caused that only Division 1D was covered in 1999, and again in 2000 only Division 1D and Division 1F was covered. A more detailed description of the survey is provided in the 2001 report. No survey took place in 2001.

The recruitment index of 2-year old cod is shown in Figure 5.2 and reveals a strong 1985 and 1987-year class, a moderate 1990- and 1993-year class and four successive weak year classes up to 2000. The survey results confirm the severely depleted status of the stock, although the very low 1997- and 1998- class year might not be representative due to insufficient survey coverage.

5.2.3 Assessment of the stocks

No commercial input data have been available for the group since 2000 to assess the latest stock status of the inshore cod. Previously a Schaefer general production model was fitted to the Greenland inshore cod landing data using the commercial pound net CPUE results for 1993 to 1997 as an index of stock biomass. Lack of contrast in data impeded the model to run satisfactory.

The decreasing CPUE series and the present recruitment failure of the stock indicate that the severely depleted stock situation has continued until 2000.

5.2.4 Biological reference points

No specific values can be put forward as reference points due to the depleted state of the stocks.

5.2.5 Management Considerations

The inshore fishery exploiting possible self-sustained local fjord populations off West Greenland has historically been small, and the fishery has never been constricted by catch regulations. The data presented indicate that the stock has undergone a series of recruitment failures in recent years. The latest year classes are all estimated to be very poor in the juvenile survey. No fishing should take place until a substantial increase in recruitment and biomass is evident.

Table 5.1.1 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1988-2001 as officially reported to NAFO.

Country	1988	1989	1990	1991	1992	1993	1994
Faroe Islands	-	-	51	1	-	-	-
Germany	6.574	12.892	7.515	96	-	-	-
Greenland	52.135	92.152	58.816	20.238	5.723	1.924	2.115
Japan	10	-	-	-	-	-	-
Norway	7	2	948	-	-	-	-
UK	927	3780	1.631	-	-	-	-
Total	59.653	108.826	68.961	20.335	5.723	1.924	2.115
WG estimate	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-	-

Country	1995	1996	1997	1998	1999	2000 [1]	2001 [1]
Faroe Islands	-	-	-				
Germany	-	-	-				
Greenland	1.710	948	904	319	622		
Japan	-	-	-				
Norway	-	-	-				
UK	-	-	-				
Total	1.710	948	904	319	622	307	
WG estimate	-	-	-	-	-	-	-

[1]) Provisional data reported by Greenland authorities
[2]) Includes 3,000 t reported to be caught in ICES Sub-area XIV
[3]) Includes 2,741 t reported to be caught in ICES Sub-area XIV
[4]) Includes 29,513 t caught inshore

Table 5.1.2 Nominal catch (tonnes) of cod in ICES Sub-area XIV, 1988-2001 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994
Faroe Islands	12	40	-	-	-	-	1
Germany	12.049	10.613	26.419	8.434	5.893	164	24
Greenland	345	3.715	4.442	6.677	1.283	241	73
Iceland	9	-	-	-	22	-	-
Norway	-	-	17	828	1.032	122	14
Portugal							
Russia		-	-	-	126		-
UK (Engl. and Wales)	-	1.158	2.365	5.333	2.532	-	-
UK (Scotland)	-	135	93	528	463	163	-
United Kingdom	-	-	-	-	-	46	296
Total	12.415	15.661	33.336	21.800	11.351	-	408
WG estimate	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-	736	-
						-	

Country	1995	1996	1997	1998	1999	2000	2001 [5]
Faroe Islands	-	-	-	-	6		
Germany	22	5	39	128	13	3	92
Greenland	29	5	32	37 [5]	+ [5]		
Iceland	1	-	-		-	-	
Norway	+	1	-	+	2	- [5]	
Portugal				31	-	-	
Russia	-	-	-				
UK (E/W/NI)	232	181	284	149	95	149	
UK (Scotland)	-	-	-				
United Kingdom							129
Total	284	192	355	345	116		
WG estimate	-	-	-	-	-	-	

[1]) Excluding 3,000 t assumed to be from NAFO Division 1F and including 42 t taken by Japan

[2]) Excluding 2,741 t assumed to be from NAFO Division 1F and including 1,500 t reported from other areas assumed to be from Sub-area XIV and including 94 t by Japan and 155 t by Greenland (Horsted, 1994)

[3]) Includes 129 t by Japan and 48 t additional catches by Greenland (Horsted, 1994)

[4]) Includes 18 t by Japan

[5]) Provisional data

Table 5.1.3 Cod off Greenland (offshore component). Catches (t) as used by the Working Group, inshore and offshore by gear based on Horsted (1994).

Year	inshore	Offshore Miscellaneous	offshore OBT	offshore total	total
1955	19787	117238	136028	253266	273053
1956	21063	121876	193593	315469	336532
1957	24790	104632	151666	256298	281088
1958	26684	121636	182516	304152	330836
1959	28184	97457	128777	226234	254418
1960	28708	115273	122859	238132	266840
1961	35164	140110	192007	332117	367281
1962	36283	168092	273598	441690	477973
1963	24173	138451	289143	427594	451767
1964	23106	118495	243714	362209	385315
1965	25209	133855	225150	359005	384214
1966	29956	149234	200086	349320	379276
1967	28277	132415	293519	425934	454211
1968	21215	64286	323800	388086	409301
1969	22119	36276	174031	210307	232426
1970	16114	16101	102196	118297	134411
1971	14039	25450	113207	138657	152696
1972	14753	29765	94730	124495	139248
1973	9813	16740	46141	62881	72694
1974	8706	18086	27695	45781	54487
1975	6779	13363	33692	47055	53834
1976	5446	8710	32157	40867	46313
1977	14964	10081	21726	31807	46771
1978	20295	4	26059	26063	46358
1979	36785	36	20056	20092	56877
1980	40122	0	57584	57584	97706
1981	40021	0	40266	40266	80287
1982	26934	2020	49827	51847	78781
1983	26689	3339	40991	44330	71019
1984	19967	5	22358	22363	42330
1985	8488	1	8499	8500	16988
1986	5320	2	6036	6038	11358
1987	8445	1	10836	10837	19282
1988	22814	7	49089	49096	71910
1989	38788	2	85946	85948	124736
1990	29513	948	99535	100483	129996
1991	18950	0	22966	22966	41916
1992	5723	0	11351	11351	17074
1993	1924	0	736	736	2660
1994	2115	0	408	408	2523
1995	1739	0	254	254	1993
1996	953	0	187	187	1140
1997	936	0	338	338	1274
1998	333	0	332	332	665
1999	622	0	116	116	738
2000	307	0	156	156	463
2001		0	221	221	221

Table 5.1.4 Cod off Greenland (offshore component), German survey. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2001. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	Abundance					Biomass				
	WEST	EAST	TOTAL	CI	Spawn. St.	WEST	EAST	TOTAL	CI	Spawn. St.
1982	92276	8090	100366	28	33793	128491	23617	152107	25	79511
1983	50204	7991	58195	25	23889	82374	34157	116531	25	57223
1984	16684	(6603)	(23286)	32	17653	25566	(19744)	(45309)	34	36162
1985	59343	12404	71747	33	17349	35672	33565	69236	39	45630
1986	145682	15234	160915	32	14350	86719	41185	127902	26	48976
1987	786392	41635	828026	59	25467	638588	51592	690181	63	65584
1988	626493	23588	650080	48	128578	607988	52946	660935	46	155556
1989	358725	91732	450459	59	332589	333850	239546	573395	46	514773
1990	34525	25254	59777	43	46355	34431	65964	100395	34	77064
1991	4805	10407	15213	29	6404	5150	32751	37901	36	17756
1992	2043	(658)	(2700)	50	560	607	(1216)	(1823)	69	1091
1993	1437	3301	4738	36	2327	359	5600	5959	41	4024
1994	574	(801)	(1375)	36	457	140	(2792)	(2930)	68	1732
1995	278	7187	7463	93	2340	57	15525	15581	155	10445
1996	811	1447	2257	38	592	373	3599	3973	56	2017
1997	315	4153	4469	75	3411	284	13722	14007	90	10416
1998	1723	1671	3394	54	1133	130	4348	4479	91	3820
1999	912	2769	3681	34	809	240	3917	4157	62	3004
2000	1926	4816	6742	36	3556	570	4778	5349	40	4176
2001	8160	7604	15764	39	8252	2666	15271	17937	42	13381

Table 5.1.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2001. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5).

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33470	11368	32504	9528	2622	578	939	91	90	92250
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	159	5	38	2070	1531	9848	842	1873	87	186	27	0	16666
1985	831	38016	1481	948	6403	2833	7682	467	646	27	35	0	59369
1986	0	14148	112532	4089	903	6823	2095	4271	133	616	34	39	145683
1987	0	317	45473	692567	24230	5929	11813	1637	4006	0	366	30	786368
1988	0	257	3332	102767	510980	5425	613	1122	654	1274	32	35	626491
1989	12	204	2461	3565	93687	254002	3934	0	535	114	228	0	358742
1990	159	47	1007	3005	1244	21724	7221	47	0	0	0	19	34473
1991	0	293	224	476	1397	164	1894	317	6	0	0	0	4771
1992	0	263	1427	220	36	77	0	28	0	0	0	0	2051
1993	0	10	832	544	20	28	6	0	0	0	0	0	1440
1994	0	283	45	199	38	5	0	5	0	0	0	0	575
1995	0	0	241	16	22	0	0	0	0	0	0	0	279
1996	0	147	11	638	10	0	10	0	0	0	0	0	816
1997	0	12	27	15	263	0	0	0	0	0	0	0	317
1998	48	1642	0	0	5	25	0	0	0	0	0	0	1720
1999	29	401	392	87	7	0	6	0	0	0	0	0	922
2000	0	165	1015	615	116	0	0	0	0	0	0	0	1911
2001	0	620	6202	1100	159	51	0	0	0	0	0	0	8132

Table 5.1.6 Cod off East Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2001. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	239	841	1764	1999	1227	379	130	1392	73	72	8116
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
(1984)	0	18	74	1342	657	1397	855	1617	407	103	36	95	6601
1985	230	1932	556	118	2494	2034	1852	785	2000	295	56	36	12388
1986	0	1397	3351	1693	551	2417	1120	2191	566	1627	116	139	15168
1987	0	13	13785	17788	3890	1027	1770	457	1571	187	1093	36	41617
1988	11	25	163	6982	11094	2016	480	1435	152	674	98	469	23599
1989	0	7	179	489	17396	63216	3021	294	4870	406	1795	42	91715
1990	0	38	80	551	462	5128	18012	265	72	251	0	349	25208
1991	0	106	377	394	685	147	3512	5035	81	37	11	9	10394
(1992)	15	44	77	74	69	54	47	143	52	0	0	6	581
1993	0	17	44	1857	370	279	278	88	272	95	0	0	3300
(1994)	0	87	0	29	261	143	87	145	0	29	0	0	781
1995	0	7	2523	1125	370	1730	450	141	460	36	217	125	7184
1996	0	0	0	502	258	295	255	60	77	0	0	0	1447
1997	0	0	37	28	1508	1611	566	236	140	0	0	19	4145
1998	63	240	192	21	45	462	435	156	43	0	0	0	1657
1999	191	632	665	417	138	302	179	200	0	35	24	0	2783
2000	0	808	1074	1341	787	157	291	75	141	115	31	0	4820
2001	0	309	944	1468	2244	1349	705	211	191	73	36	9	7539

Table 5.1.7 Cod off Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2001. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	1123	34311	13132	34503	10755	3001	708	2331	164	162	100366
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	1140	58198
(1984)	159	23	112	3412	2188	11245	1697	3490	494	289	63	95	23267
1985	1061	39948	2037	1066	8897	4867	9534	1252	2646	322	91	36	71757
1986	0	15545	115883	5782	1454	9240	3215	6462	699	2243	150	178	160851
1987	0	330	59258	710355	28120	6956	13583	2094	5577	187	1459	66	827985
1988	11	282	3495	109749	522074	7441	1093	2557	806	1948	130	504	650090
1989	12	211	2640	4054	111083	317218	6955	294	5405	520	2023	42	450457
1990	159	85	1087	3556	1706	26852	25233	312	72	251	0	368	59681
1991	0	399	601	870	2082	311	5406	5352	87	37	11	9	15165
(1992)	15	307	1504	294	105	131	47	171	52	0	0	6	2632
1993	0	27	876	2401	390	307	284	88	272	95	0	0	4740
(1994)	0	370	45	228	299	148	87	150	0	29	0	0	1356
1995	0	7	2764	1141	392	1730	450	141	460	36	217	125	7463
1996	0	147	11	1140	268	295	265	60	77	0	0	0	2263
1997	0	12	64	43	1771	1611	566	236	140	0	0	19	4462
1998	111	1882	192	21	50	487	435	156	43	0	0	0	3377
1999	220	1033	1057	504	145	302	185	200	0	35	24	0	3705
2000	0	973	2089	1956	903	157	291	75	141	115	31	0	6731
2001	0	929	7146	2568	2403	1400	705	211	191	73	36	9	15671

Table 5.1.8 Cod off West Greenland (offshore component), German survey. Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2001.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	190	568	920	1770	2164	2962	4078	5065	6995
1983										
1984	68	136	379	807	1356	1990	2885	3600	4476	6177
1985	96	168	568	981	1475	2010	3121	3341	4408	4014
1986	72	325	498	1118	1697	2217	2784	3889	4159	4493
1987	37	223	697	926	1194	2154	2239	3028		3541
1988	38	211	456	1019	1145	1941	2949	2735	3630	4192
1989	36	159	423	796	1403	1443		2885	3229	4562
1990	38	114	334	599	909	1395	1111			
1991	50	139	356	649	926	1356	1743	920		
1992	75	230	379	668	938		2061			
1993	41	132	405	494	920	920				
1994	45	126	456	608	1111		2461			
1995		186	328	482						
1996	42	104	510	753		3645				
1997	68	334	375	994						
1998	50			1567	1516					
1999	77	340	612	1111		2822				
2000	39	234	405	796						
2001	63	283	522	1064	951					

Table 5.1.9 Cod off East Greenland (offshore component), German survey. Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2001. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982		423	769	1419	2326	3498	4597	5523	6633	6500
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	109	437	1038	1761	3161	3369	4459	4755	5824	7957
1986	88	375	915	1715	2674	4225	4159	4954	6030	6722
1987	33	283	640	885	1653	3600	4545	5120	6072	7684
1988		275	733	1770	3067	4291	4702	6500	6949	7418
1989	68	252	538	1118	2507	3690	3951	5027	5662	6457
1990	52	419	510	1145	1618	2625	3858	5702	6880	
1991	86	194	402	1173	1864	2315	3355	4374	5139	10198
(1992)	18	402	758	1575	3175	3028	3271	3469		
1993	81	353	728	1333	2315	2834	3600	4827	6135	
(1994)	41		1111	2271	3054	4791	4827		5742	
1995	68	249	430	1508	2949	4176	5233	5926	9645	7442
1996			717	1921	2461	3586	5120	5824		
1997		104	1525	1931	3454	4062	4562	4685		
1998	101	155	1045	1779	3028	3541	3858	6745		
1999	84	269	594	1173	2949	3735	4917		8522	9004
2000	94	184	459	874	1601	2102	3243	5196	6284	8160
2001	134	392	957	1835	2337	2809	3935	5139	6391	7228

Table 5.1.10 Cod off Greenland (offshore component), German survey. Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2001. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	230	572	975	1798	2293	3148	4324	5967	6767
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	97	225	612	1173	2081	2239	3920	4374	5702	6219
1986	73	325	603	1326	1921	2822	3216	4738	5484	6177
1987	36	237	697	920	1259	2315	2649	3541	6072	6435
1988	61	214	471	1032	1550	2822	3858	3285	4614	6522
1989	37	164	437	845	1584	2250	3951	4791	5046	6219
1990	44	128	359	722	1025	2217	3299	5702	6880	
1991	58	172	375	801	1318	1941	3243	4014	5139	10198
(1992)	63	237	459	1208	1644	3028	3041	3469		
1993	64	141	644	1281	2154	2784	3600	4827	6135	
(1994)	44	126	518	1980	2962	4791	4738		5742	
1995	68	244	426	1427	2949	4176	5233	5926	9645	7442
1996	42	104	594	1864	2461	3586	5120	5824		
1997	68	180	1000	1761	3454	4062	4562	4685		
1998	56	155	1045	1761	2923	3541	3858	6745		
1999	82	294	594	1173	2949	3705	4917		8522	9004
2000	82	207	441	862	1601	2102	3243	5196	6284	8160
2001	83	297	753	1779	2271	2809	3935	5139	6391	7228

Table 5.1.11 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by stratum, 1991-2001. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1991	*	0	11	7	32	429	78	*	*	(528)	73
1992	0	0	4	16	33	242	242	0	9	547	45
1993	0	0	0	0	0	54	36	205	12	308	67
1994	9	0	0	0	54	98	0	7	0	167	43
1995	0	0	0	33	17	504	42	20	46	662	58
1996	0	0	0	0	0	47	78	66	108	298	40
1997	0	0	0	2	8	35	0	0	0	45	64
1998	0	0	0	5	0	0	25	28	4	62	44
1999	0	10	18	141	52	17	18	8	0	261	41
2000	0	188	273	311	201	86	47	9	205	1321	19
2001	0	0	15	239	86	140	498	210	373	1561	23

Table 5.1.12 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by stratum, 1988-2001. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	Westgr.	CI
1988	0	0	*	35	0	1230	2613	*	*	(3879)	81
1989	44	0	*	73	0	41	1002	*	*	(1217)	51
1990	4	13	*	7	7	118	6825	*	*	(7004)	45
1991	*	0	7	1	2	188	53	*	*	(250)	58
1992	0	0	3	22	31	74	85	0	2	217	44
1993	0	0	0	0	0	24	8	87	4	122	69
1994	0	3	0	0	12	41	0	1	0	58	43
1995	0	0	0	3	2	158	22	2	5	190	67
1996	0	0	0	0	0	16	26	21	49	112	41
1997	0	0	0	2	2	60	0	0	0	64	65
1998	0	0	0	<1	0	0	55	57	4	117	43
1999	0	1	4	38	5	<1	13	1	0	64	31
2000	0	63	65	80	60	27	6	2	56	360	20
2001	0	0	9	126	38	72	186	67	110	609	26

Table 5.1.13 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2001.

YEAR	1	2	3	4	5	6	7	8+	TOTAL
1992	0	221	126	123	63	10	3	1	547
1993	0	39	170	73	16	7	1	2	308
1994	0	10	126	22	8	1	0	0	167
1995	19	345	101	157	40	0	0	0	662
1996	0	14	203	78	3	0	0	0	298
1997	0	0	10	3	24	8	1	0	46
1998	0	17	25	20	0	0	0	0	62
1999	7	144	66	23	6	1	1	1	249
2000	90	711	363	92	13	52	0	0	1321
2001	97	540	546	376	0	0	0	0	1559

Table 5.1.14 Cod off Greenland (offshore component). Input parameters in for calculations of yield and spawning stock biomass per recruit.

Age	WEIGHT (kg)	MATURITY	Exploit. pattern	M
3	0.815	0.001	0.154	0.2
4	1.255	0.004	0.425	0.2
5	1.863	0.15	0.643	0.3
6	2.549	0.449	0.931	0.3
7	3.295	0.795	1.07	0.3
8	4.157	0.946	1.145	0.3
9	4.967	0.99	1.267	0.3
10	5.836	1	1.027	0.3
11	6.447	1	1.027	0.3
12	7.09	1	1.027	0.3

Table 5.2 Greenland cod (inshore component). Landings, observed and predicted CPUE based on data from inshore pound net fishery.

Year	Predicted biomass	Predicted CPUE	Observed CPUE	Ln(CPUE/B)	Observed Catch
1993	11226	664	730	2.73	1924
1994	9331	591	768	2.50	2215
1995	7151	490	600	2.49	1710
1996	5478	438	536	2.32	948
1997	4563	460	423	2.38	904
1998	3690	489	248	2.70	326
1999	3390	579	284	2.48	622
2000*	2793				na
2001*					na

*Predicted

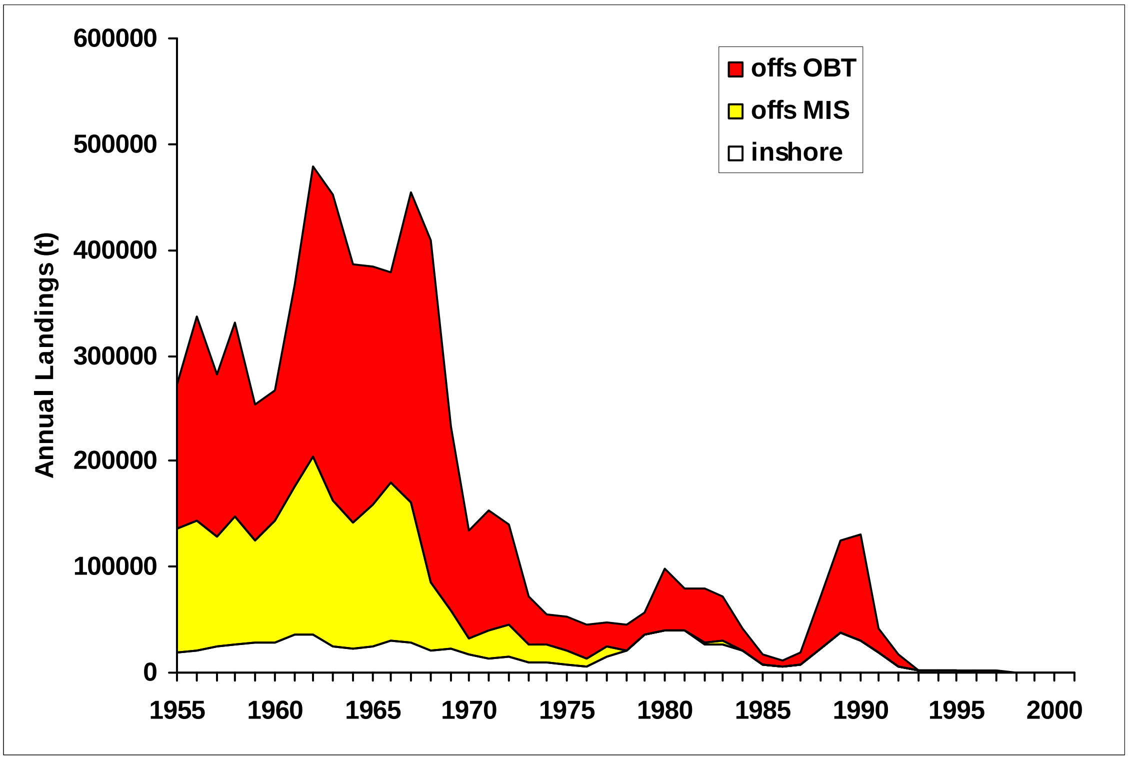


Figure 5.1.1 Cod off Greenland. Catches 1955-2000 as used by the Working Group, inshore and offshore by gear (Horsted,1994).

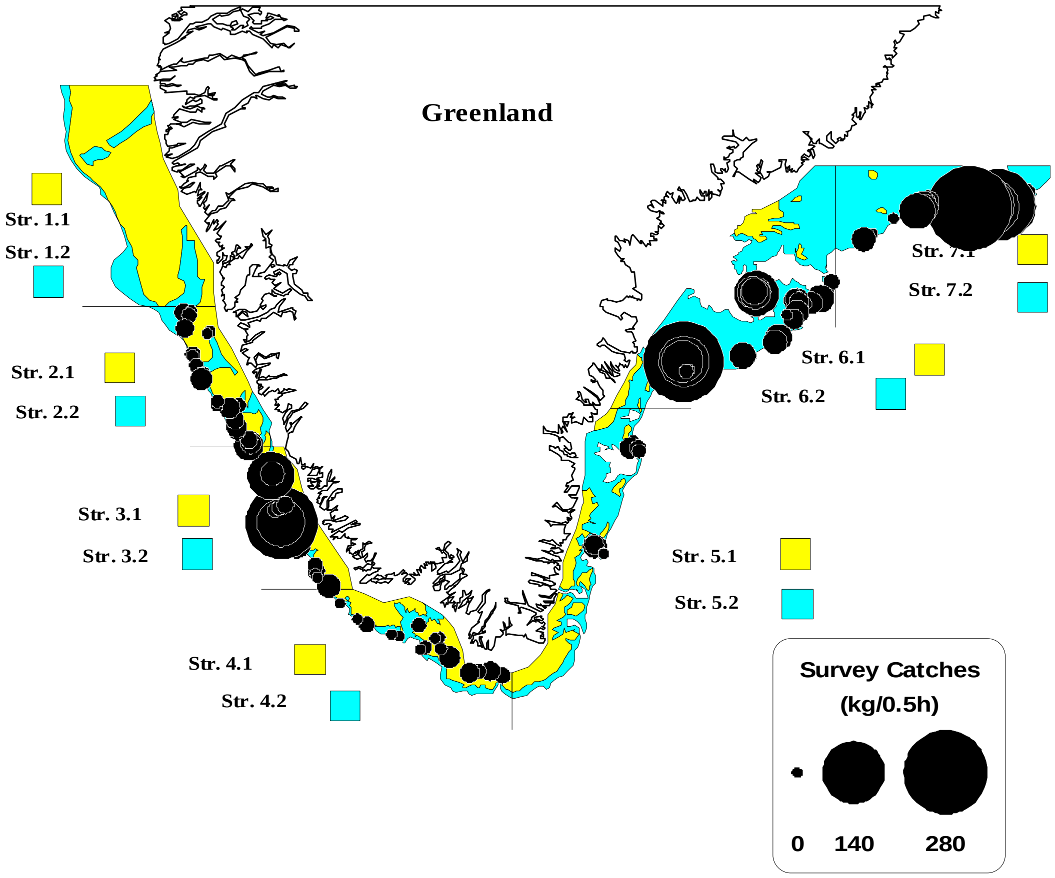


Figure 5.1.2 Cod off Greenland (offshore component), German survey. Survey area, stratification and position of hauls carried out in 2001.

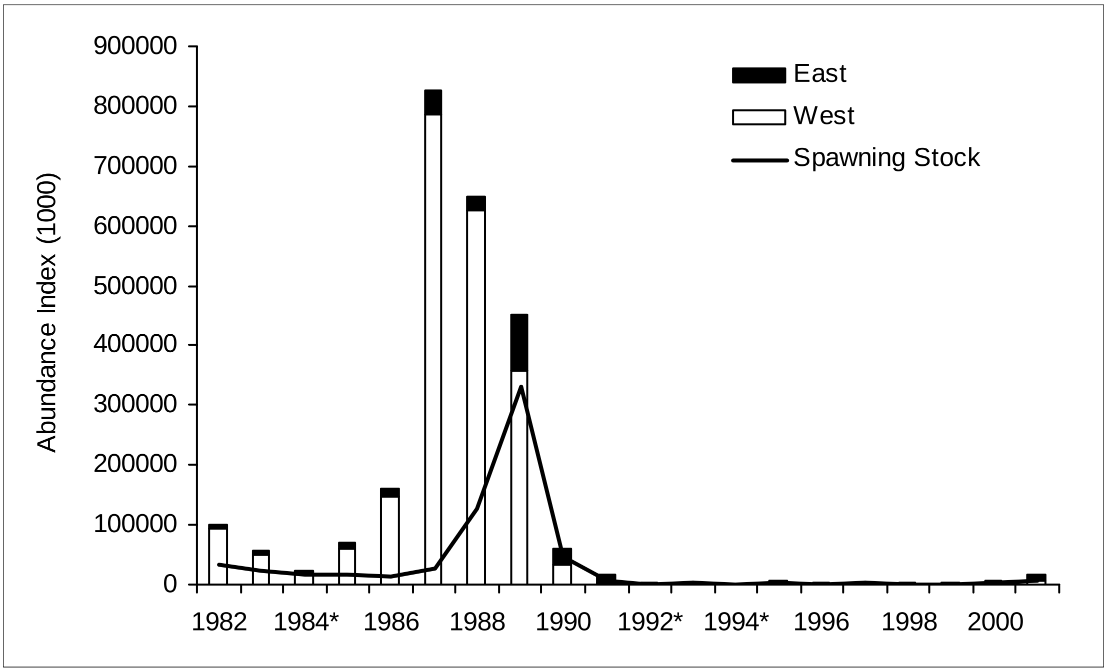


Figure 5.1.3 Cod off Greenland (offshore component), German survey. Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-2001. *) incomplete survey coverage.

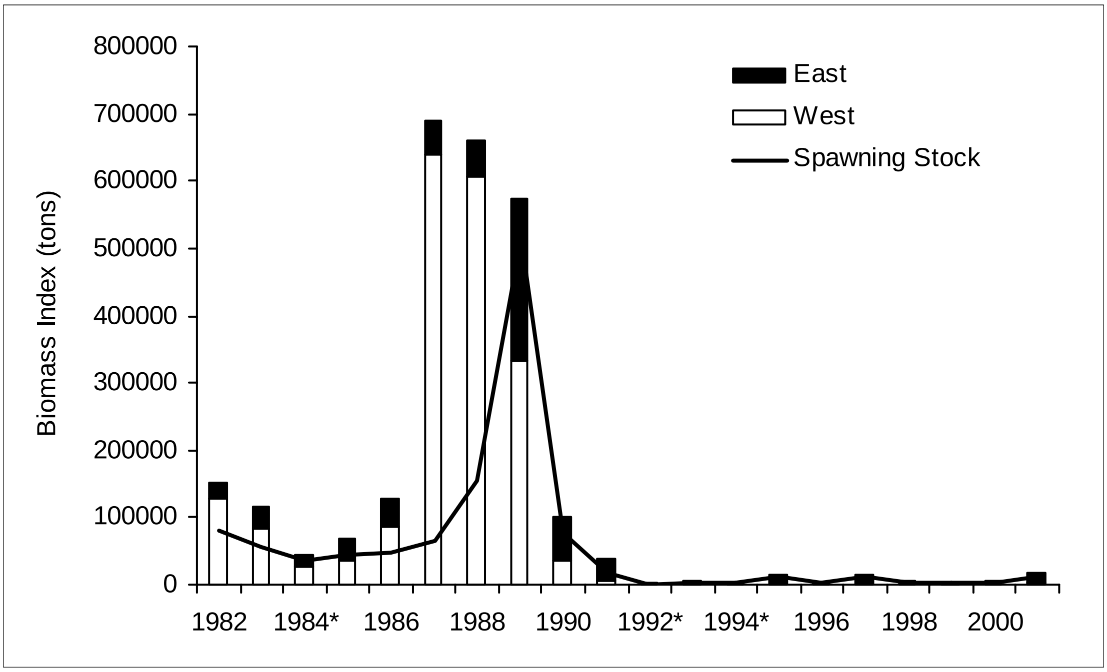


Figure 5.1.4 Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-2001. *) incomplete survey coverage.

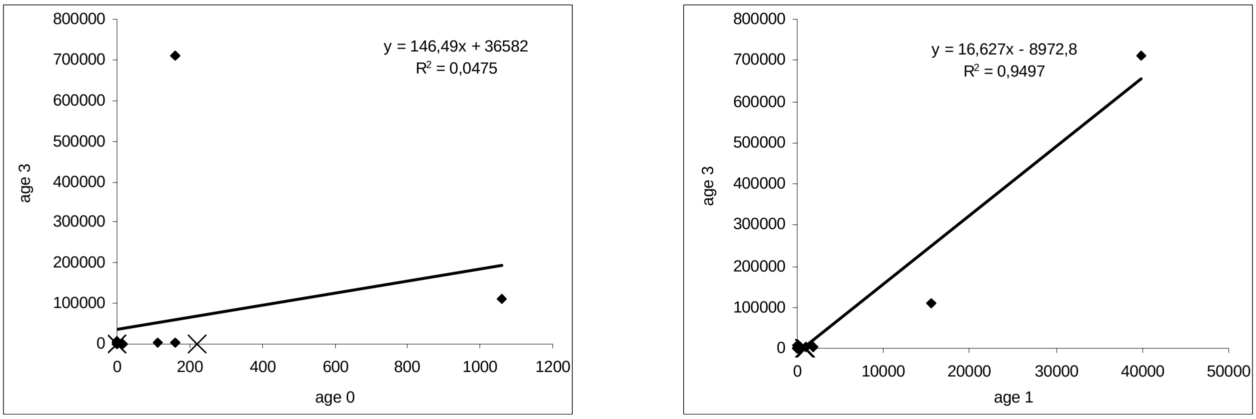


Figure 5.1.5 Cod off Greenland (offshore component), German survey. Use of 0 and 1 age group indices to predict year class strength at age 3. The x indicate the 1999, 2000 and 2001 year classes at age 0 and the 1999 and 2000 at age 1, respectively.

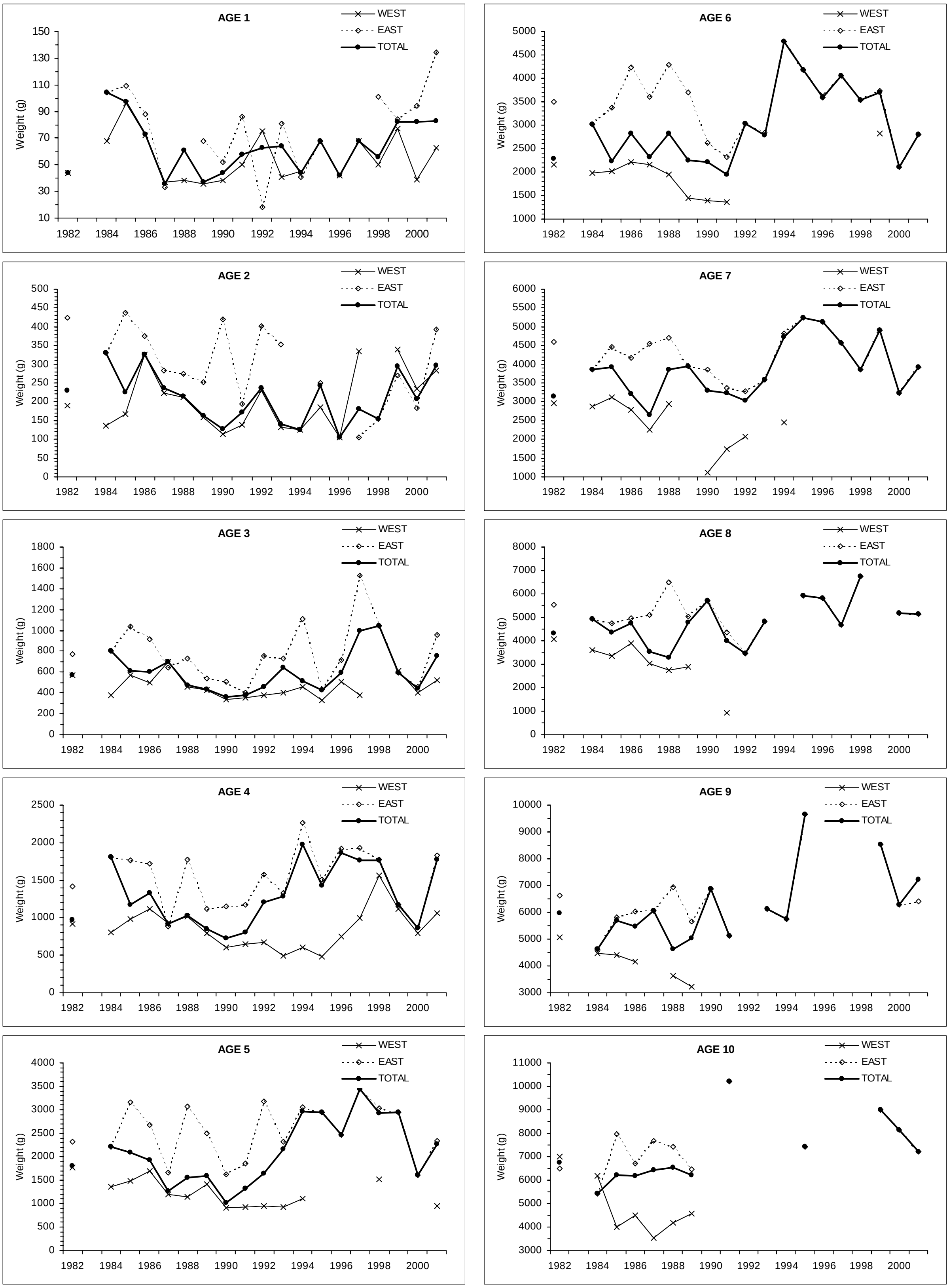


Figure 5.1.6 Cod off Greenland (offshore component), German survey. Weighted mean weight at age 1-10 years for West, East Greenland and total, 1982-2001.

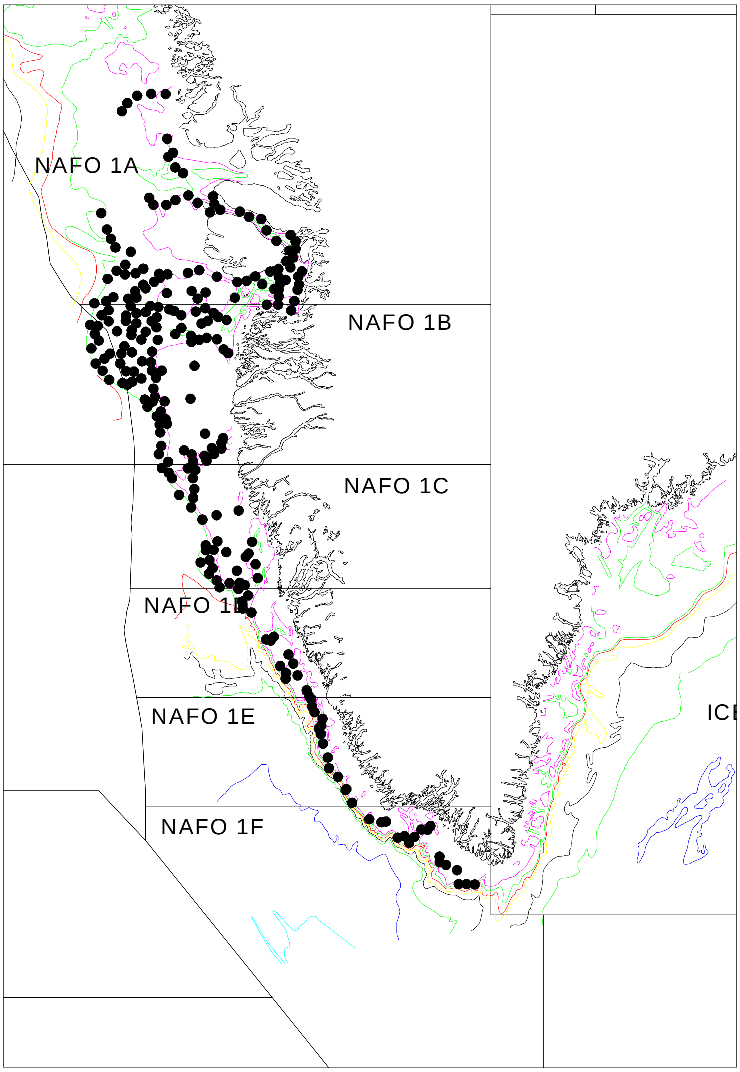


Figure 5.1.7 Cod off Greenland (offshore component), Greenland survey. Survey area, stratification and position of hauls carried out in 2001.

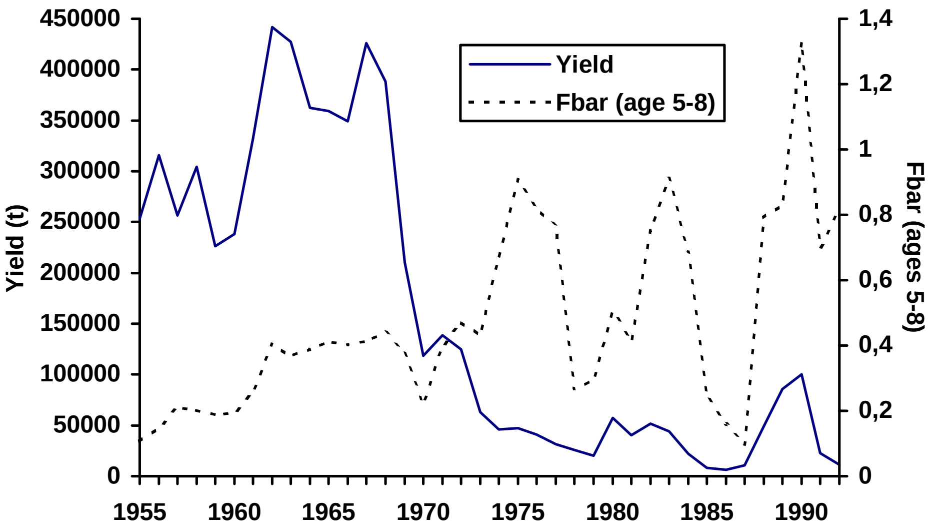


Figure 5.1.8 Greenland cod (offshore component). Trends in yield and fishing mortality.

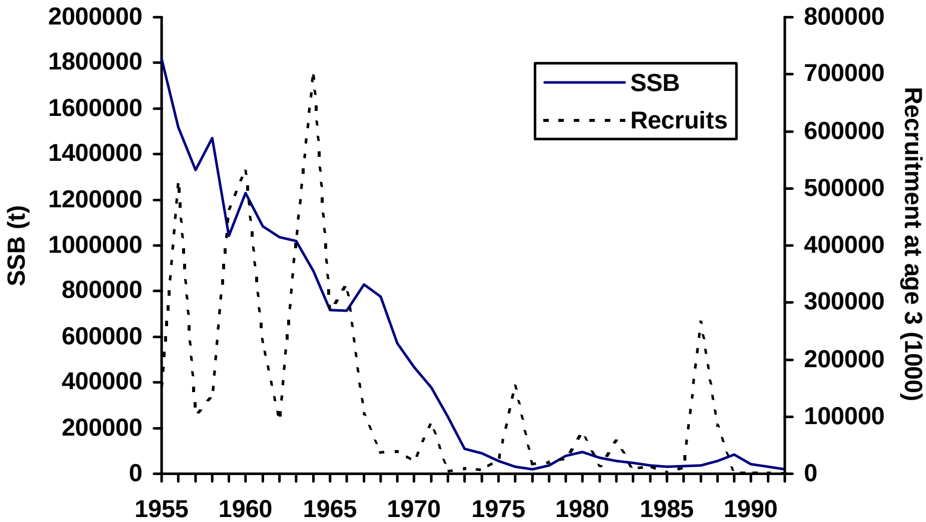


Figure 5.1.9 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

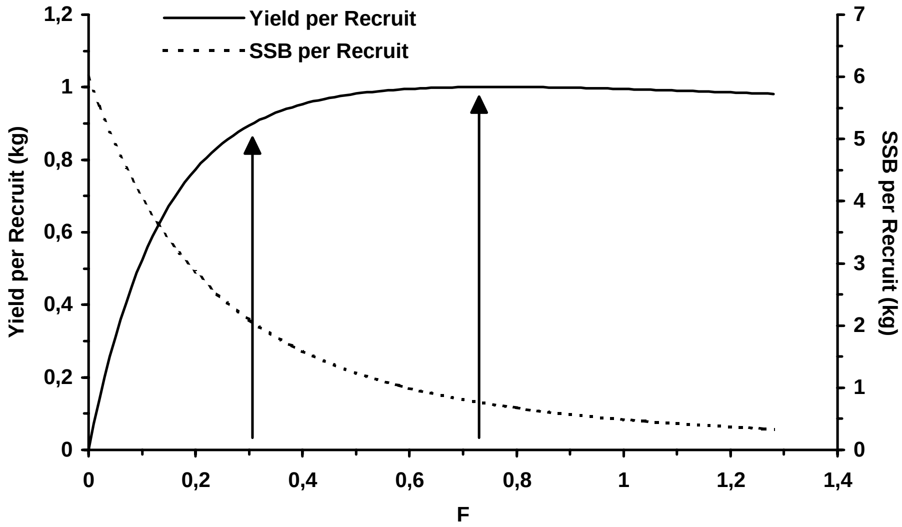


Figure 5.1.10 Greenland cod (offshore component). Long term yield and spawning stock biomass. $\mathbf{F}_{0.1}$ reference age 5-8=0.297; $\mathbf{F}_{max}$ reference age 5-8=0.722.

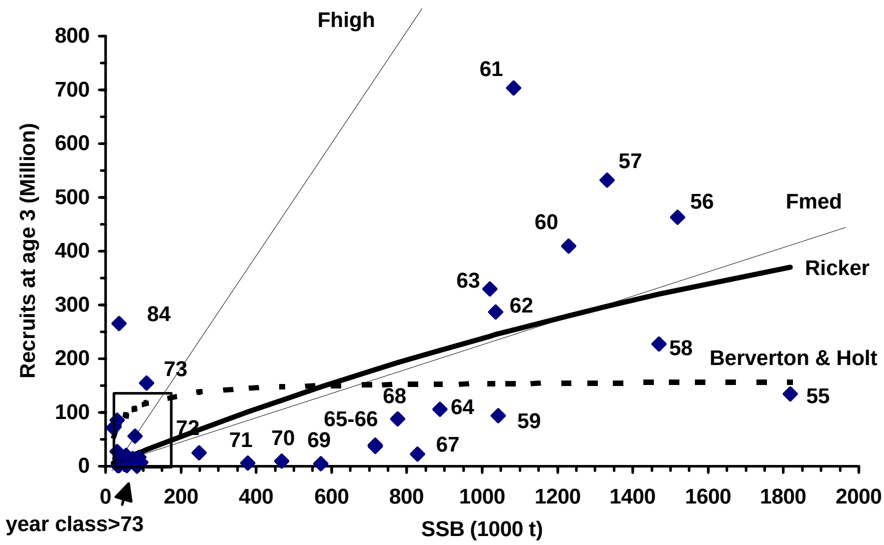


Figure 5.1.11 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. $\mathbf{F}_{med}$=0.09 corresponding to a SSB/R=4.44 kg; $\mathbf{F}_{high}$=0.59 corresponding to a SSB/R=0.98 kg.

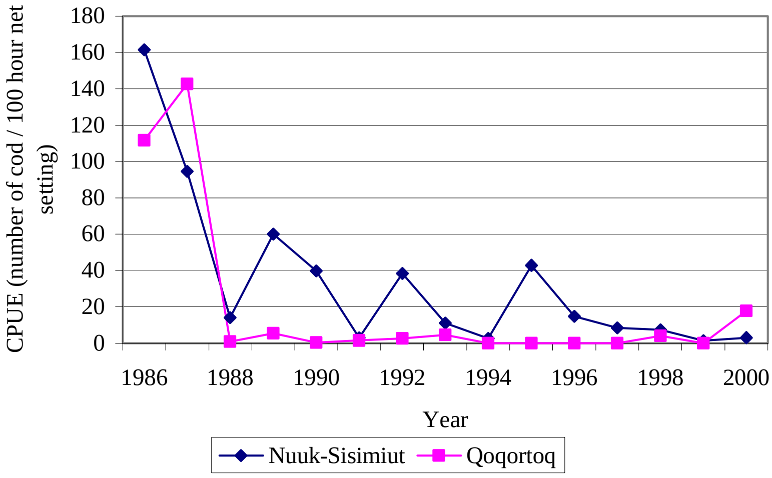


Figure 5.2 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland Young cod survey 1987-2000.

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries, Fleet and Stock perception

Total annual landings in Divisions Va, Vb and Sub-area XIV are presented for the years 1981–2001 in Tables 6.1.1–6.1.5 and from 1961 in Figure 6.1.1. Landings during the decade prior to the extension of the EEZ to 200 nm by coastal nations in 1976 were in the order of 20-35 kt. From 1976, landings increased from a low of 5kt to above 30 kt after 1982. In the years 1987–1989, landings increased to about 61 kt, followed by a decrease to about 35-40 kt during 1992-96. After 1996, landings declined to 20 kt in 1998 and 1999. Since 2000 an increase in landings has been observed, to nearly 26 kt in 2000 and about 28 kt in 2001. Landings not officially reported to ICES have been included in the assessment.

Catches in Icelandic waters have, due to quota regulations, decreased from 37 kt in 1990 to 11 kt in 1998 and 1999, but again rising to 14 kt in 2000 and about 16 kt in 2001. Faroese catches in Vb increased from of 1 kt in 1981–1991 to 6.5 kt in 1996, but have been of the order of 4-5 kt in the last 5 years. Catches in division XIVb have increased from below 1 kt in 1987–1991 to 8.5 kt in 1997 followed by a decrease to 5 kt in 1999. Since then catches have increased to about 7 kt.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed fishery, only minor catches in Va by Iceland, and in XIVb by Germany and the UK are by-catches in redfish fisheries. A detailed description of the fishery performance and areas is given in NWWG report 1998. No major changes were observed in 2001. Table 6.1.6 describes the working group best landing estimates for the year 2001 with respect to area and gear.

Stock perception

The current definition of the Greenland halibut in East Greenland, Iceland and Faroe waters as one stock, specified by ICES in 1976 was "based on a strong probability that the spawning grounds [for Greenland halibut in these waters] are the same". A summary of the current state of knowledge on Greenland halibut in the above mentioned waters shows that key information on the life cycle is lacking (Woll 2000). Information on the spawning location and spawning time of the stock is very limited. It is hypothesised, based on information on one scientific bottom trawl cruise in 1977, that the major spawning grounds are located on the continental slopes west of Iceland at depths around and below 1000 m (Magnusson 1977; Sigurdsson 1977; Sigurdsson and Magnusson 1980). In recent years (1995 and 2000), some spawning has been observed in East Greenland waters (62°N and 64°N) in August (Gundersen *et al.* 1997; Fossen and Gundersen 2000).

Standard 0-group fish surveys have been carried out annually in early fall (mainly in August) in Icelandic and in East Greenland waters since 1970. Larvae are mainly observed along the shelf region off East Greenland and are in some years abundant all over the shelf area south to 60° N, which is the southernmost limit of the survey area. Highest abundance is observed on the continental shelf north of 64° N and just east off the continental shelf south of 64° N. 0-group larvae are only occasionally observed on the Icelandic shelf in very limited numbers. Nursery grounds for young Greenland halibut (ages 1-3, fish less than 45 cm long) are well known in West Greenland waters, where they are most abundant from Store Hellefiske Bank to Disko and in Disko Bay between 66^{o}-69^{o} latitude on depths of about 200 m (Riget and Boje 1988). When it comes to knowledge on young fish in East Greenland and Icelandic waters, information is very sparse. A gillnet survey targeting for young Greenland halibut, modelling of advection of eggs and larvae with currents from assumed spawning areas in Icelandic and East Greenland waters (Woll 2000), and results of historic Greenland ichtyoplankton surveys (Boje 1997) indicated that larvae were transported to Southwest Greenland waters before settling, mixing with specimens from the Greenland-Canadian stock complex. Analyses of shrimp surveys in Icelandic and Greenland waters (Boje and Hjørleifsson 2000) concluded that nursery grounds were neither to be found in Icelandic nor in East Greenland waters.

The highest aggregation of commercial sized Greenland halibut is found just south of the Greenland-Iceland ridge. In this area the major portion of the annual catch in the past 10 to 15 years has been taken, mainly at depths between 500 and 1000 meters. Other locations of Greenland halibut in exploitable densities (for trawl fisheries) are found along the north and east coast of Iceland, mainly at depth between 500 to 700 meters, in waters of Faroe Islands as well as along the continental slope off East Greenland. The size of the Greenland halibut in the trawl fisheries depend largely on location and depth, and to some extent on the season. In Icelandic waters, smaller fish are found along the east and north coast, with somewhat larger fish in the deeper waters south of the Faroe-Iceland ridge. Largest fish are, however, always found on the main fishing grounds between Iceland and Greenland.

6.2 Trends in Effort and CPUE

Indices of CPUE for the Icelandic trawl fleet for the period 1985–2001 (Table 6.2.1) were estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the Icelandic trawling fleet in Division Va were used to estimate the total effort for each year (y) for all the fleets fishing for Greenland halibut in areas V and XIV according to:

$$E_{y,V\,\&\,XIV} = Y_{y,V\,\&\,XIV} \big/ CPUE_{y,Va_{trawl}}$$

where E is total effort, Y is the total reported landings in region V and XIV.

The CPUE series as derived in 2001 differs from the present and also from former series, due to a change in the species selection from the logbook database.

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1995, but stabilised in 1995–1997. In 1998, an increase of 50% in CPUE was observed for all fishing grounds coinciding with a drastic (60%) reduction in effort (Table 6.2.1, Figure 6.2.1). Since 1999 further increases in CPUE have been observed (8-20%). The total effort increased up to 1989, decreased somewhat in the next two years, but increased steeply from 1991 to a maximum in 1993. Effort during 1998-2001 has been less than half of that in 1995-97. The CPUE was relatively stable in 1985–1989, but declined thereafter by 70% to a historic low in 1996 and 1997. With the increase during the last 3 years the CPUE is now around 60% of the maximum value (Table 6.2.1).

For division XIVb, CPUE from logbooks in the years 1991–2001 were standardised using a multiplicative model taking into account locality, fleet, season and year (Table 6.2.1). CPUE increased from 1991 to 1993, thereafter it remains relatively stable. Effort increased continuously until 1996, but declined by 30% until 1999. Since 1999 the effort increased and is record high in 2001 However, the fishery in XIVb is just starting out and catches have increased from below 500 tons annually before 1991 to about 7000 t in the last three years. The fishery was therefore assumed to be in the process of learning in the beginning of the CPUE series.

Information from logbooks from the Faroe otterboard trawl fleet (> 1 000 hp) was available for the years 1995-2000 (Table 6.2.1). The logbooks were standardised using a multiplicative model taking into account locality, fleet, season and year. The fishery in the area has increased from about 1000 t in 1992 to 5000 t in 2000. It is a fairly new fishery and the location of the fishery has changed from the eastern side of the islands in 1995-1998, to the western side in 2000. Therefore, the fishery is assumed to be in the process of learning. The CPUE is stable throughout the period.

6.3 Catch at Age

Age-length keys for 2001 were from: the Icelandic trawl fleet operating in Icelandic waters (252 otoliths). This key was used to obtain catch in number for the length samples for each of the following commercial fleets and areas:

Gear	Area	Landings	No. samples	No. fish	A/L-Key
Bottom trawl	Iceland-west	14423	52	6394	Icelandic bottom trawl
Bottom trawl	Iceland-north & east	1223	11	1479	Icelandic bottom trawl
Bottom trawl	Iceland-southeast	1106	10	2339	Icelandic bottom trawl
Gill Net (&line)	Faroe Islands	2812	12	4535	Icelandic bottom trawl
Bottom trawl	Faroe Islands	1241	5	606	Icelandic bottom trawl
Long line	East Greenland	983	18	2478	Icelandic bottom trawl
Bottom trawl	East Greenland	6233	14	1532	Icelandic bottom trawl
Total		28021	122	19363	

The following length-weight relationships were applied to convert sampled lengths to weights:

Gear	Area	Length - weight key	Comments
Bottom trawl	Iceland	$W = 0.01758 * L^{2.84387}$	Same key as 1999
Bottom trawl	East Greenland	$W = 0.00161 * L^{3.4457}$	Commercial trawl N=2468, same as 2001
Bottom trawl	Faroe Islands	$W = 0.00202 * L^{3.398}$	Trawl survey, N=1916
Gill Net (&line)	Faroe Islands	$W = 0.00202 * L^{3.398}$	Trawl survey, N=1916
Long line	Iceland	$W = 0.01758 * L^{2.84387}$	Same key as 1999
Long line	East Greenland	$W = 0.00208 * L^{3.373}$	Longline survey, N=664, same as 2001

The total catch in numbers (Table 6.3.1) was obtained from the sum of the above weighted with the catch within each group. Apart from 1994 and 1996 – 2000, only Icelandic data has been available.

6.4 Weight at Age

The mean weight at age in 2001 (Table 6.4.1) was derived from the weighted average of the above groups. Weights at age in the catch are also used as weights at age in the stock.

6.5 Maturity at Age

Maturity data were not updated for 2001 as visual determination of maturity has been questionable as stated in 2001 report.

6.6 Survey information

An October groundfish survey in Icelandic waters, covering the distributional area of Greenland halibut within the Icelandic EEZ, was started in 1996. The survey is a fixed station stratified random survey consisting of 300 stations on the continental shelf and slope down to a depth of 1300 m. An increase in the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) is observed from 1996 to 2001 (Figure 6.6.1). Abundance indices of smaller fish (<50 cm) indicate signs of improved recruitment in 1998 and 1999 that may account for the increase in the estimated fishable biomass over the period. Aged indices from the Icelandic survey are not yet available and were therefore not possible to use the survey as input into age-based model.

Since 1998, a Greenland survey for Greenland halibut has been carried out in East Greenland waters from 60°N to 67°N at the main commercial fishing grounds at depths of 400-1500 m in late June/early July. In 2000 a total of 75 stations were hauled. No survey took place in 2001. Total estimated biomass was estimated to 23 kt compared to 15 kt in 1999 and 21 kt in 1998. The increase is, however, dependant on the inclusion of new strata since 1998. Since the age composition in the catches does not indicate changes in recruitment to the area, the increase in biomass must be considered to be within the error margin of the estimates.

6.7 Stock Assessment

6.7.1 Age based assessement

Age-disaggregated CPUE values for age groups 7–12 from the Icelandic trawling fleet operating in Division Va, have previously been used in the XSA tuning assessments. Since 2000 the XSA assessment have been considered unreliable due to poor diagnostics and was thus rejected as a base for advice. This year the working group ran an XSA assessment with the same settings as in 2000 report as an exploratory exercise. Since the diagnostics of the model was of similarly poor quality (see log(q) residuals in Figure 6.7.1.1 and retrospective pattern of F in Figure. 6.7.1.2), the working group decided that an XSA model was not a reliable estimator of recent stock history.

6.7.2 Stock production model

The group decided to proceed with the stock-production model approach ASPIC, fitted to indices and catches. The model requires series of catch data and indices of stock biomass, either corresponding effort, CPUE, or survey catch rates. Corresponding catch and effort data is available for Division Va (formerly used as a tuning fleet in the XSA) and in addition several CPUE series (Figure 6.2.1) were available:

Fleet and index	Period	Division
Icelandic trawler CPUE from GLIM	1973-2001	Va
Icelandic fall groundfish survey	1996-2001	Va
Greenland deepwater bottom-trawl survey	1997-2000	XIVb
Faroese trawler CPUE from GLIM	1995-2000	Vb
Icelandic shrimp fishery	1986-1994	Va
Icelandic shrimp survey	1987-2000	Va

The Icelandic shrimp fishery no longer exploits Greenland halibut, because of implementation of sorting grids in recent years. It does thus not provide indices of recent stock trends and was thus not included in the model. Since the shrimp survey covers a relatively limited area, the index was also excluded as an input candidate into the model. A run using the remaining four indices showed conflicting signals for the Faroese trawlers and the East Greenland survey compared with each other and with the Icelandic trawler and survey series, i.e. negative correlations of the CPUE indices. As ASPIC will not run on negatively correlated data series, these two indices were also omitted. For the two remaining indices — Icelandic trawler standardized CPUE and Icelandic groundfish survey — ASPIC was run with a reduced commercial time-series from 1985-2001 and the fall groundfish survey from 1996-2001. The decision of using only a reduced time series is because the CPUE index from 1973 to 1985 may not be reliable because it is based on limited logbook material and may cover a learning period at the the beginning of the fishery.

ASPIC requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/$\mathbf{B}_{MSY}$ ratio and *q*, catchability coefficients. Initially ASPIC was run with different starting guesses of these parameters to explore stability of parameter estimation. For an appropriate range of input values, ASPIC results were very stable. The parameter estimates from ASPIC were comparable to last year (Table 6.7.2.1.). MSY is estimated to 37 kt and $\mathbf{B}_{MSY}$ to 98 kt. Biomass in 2002 is estimated to be about 30% below $\mathbf{B}_{MSY}$ and fishing mortality in 2001 slightly above $\mathbf{F}_{MSY}$. Observed and estimated CPUE's are given in Figure. 6.7.2.1.

The state of the stock relative to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$ is given in the Figure 6.7.2.2. Biomass is increasing from a record low in 1997-98 and in 2002 is about 25% below $\mathbf{B}_{MSY}$. F has in the last decade been very high (60% above $\mathbf{F}_{MSY}$), but since 1998 is estimated to be near or above $\mathbf{F}_{MSY}$.

Retrospective analyses were carried out for both B/$\mathbf{B}_{MSY}$ and F/$\mathbf{F}_{MSY}$ in order to exploit the consistency of ASPIC with the currently used cpue series (Figure. 6.7.2.3). Within the last three years ASPIC behaved very consistent, due to contrasting cpue data, but omitting more years from the cpue series would prevent ASPIC to give consistent output.

6.7.3 Stock projection

From calculated stock-dynamic parameters and input fishing regimes, ASPIC can project forward trajectories of population biomass and fishing mortality including uncertainty estimates based on bootstrapping. In all forward projections it was assumed that the catch in 2002 would be maintained at 30 kt. This is based on the following: TAC in Icelandic waters is maintained at 20 kt and expected to be caught. Given that the landings in Vb and XIV will be the same as in 2001 and that the Icelandic fleet will catch all its quota, it is anticipated that total landings in the year 2002 also will be in the order of 30 kt. Three different trajectories were produced using the following options:

1) F(2002-10)=2/3$\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$,
2) F(2002-10)=$\mathbf{F}_{sq}$
3) Catch(2001-2010)=30,000 t.

Plots of B-ratios (B/$\mathbf{B}_{MSY}$) are given in Figure. 6.7.3 and biomass trajectory for option 1 only is given in Table 6.7.3. By fishing at $\mathbf{F}_{pa}$ (2/3$\mathbf{F}_{MSY}$) it is expected that the biomass will increase to $\mathbf{B}_{MSY}$ by 2005. Fishing at $\mathbf{F}_{sq}$ (~$\mathbf{F}_{MSY}$) is, however, expected to reach $\mathbf{B}_{MSY}$ by 2007, although the confidence interval is wide. Fishing at 30 kt annually is expected to allow recovery to $\mathbf{B}_{MSY}$ by 2007, but with a significant risk (80% confidence intervals) that the stock will remain low. Landings in 2003 associated with the trajectories are 23 000 t at $\mathbf{F}_{pa}$ and 34 000 t at $\mathbf{F}_{sq}$.

6.7.4 Biological reference points

Defined reference points for Greenland halibut have previously been defined on the basis of an age-based analytical assessment. The working group considers it appropriate to define $\mathbf{F}_{pa}$ as 2/3 of $\mathbf{F}_{MSY}$ estimated from the stock-production model. Using 2/3 as $\mathbf{F}_{pa}$, $\mathbf{F}_{lim}$ could be calculated using $\mathbf{F}_{lim}=\mathbf{F}_{pa}*e^{1.645\sigma}$, when σ could be 0.30.

6.8 Management Considerations

No formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland and the Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC's advised by ICES. A likely scenario is therefore a continuation of *status quo* catch at 30kt in the short term. This will most probably result in a steady recovery of the biomass in the near future, but with a risk that the stock will remain low.

6.9 Comments on the Assessment

Analytical assessment (XSA) was attempted with same settings as in 2000 and 2001, but was rejected due to poor diagnostics and a substantial new perception of the stock size. Both former XSA and this years stock production model suggest that the Greenland halibut stock biomass has been falling since the late 1980'ies. Also according to both assessment methods, the fishing mortality has been substantially above $\mathbf{F}_{pa}$ for a decade. The decline in biomass seems to have been halted since 1998, but biomass is still well below $\mathbf{B}_{MSY}$. A combination of unreliable maturity data and age readings from recent years still impede any age-disaggregated assessment and therefore also any estimate of SSB and its use in relation to $\mathbf{B}_{pa}$ and SSB as a reference point for management advice for the stock.

The stock production model used to assess the status of the stock relies on the same trawlers CPUE series as previously used in the XSA. Output estimates of biomass and fishing mortality of the production model cannot be taken face value, but should rather be good estimates of state of the stock in relation to MSY parameters.

Table 6.1.1. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-areas V, XII and XIV 1981-2001, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	767	1,532	1,146	2,502	1,052	853	1,096	1,378	2,319
France	8	27	236	489	845	52	19	25	-
Germany	3,007	2,581	1,142	936	863	858	565	637	493
Greenland	+	1	5	15	81	177	154	37	11
Iceland	15,457	28,300	28,360	30,080	29,231	31,044	44,780	49,040	58,330
Norway	-	-	2	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	19,239	32,441	30,891	34,024	32,075	32,984	46,622	51,118	61,156
Working Group estimate	-	-	-	-	-	-	-	-	61,396

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998 [1]
Denmark	-	-	-	-	-	-	1	-	
Faroe Islands	1,803	1,566	2,128	4,405	6,241	3,763	6,148	4,971	3,817
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3,368	3,342	3,056
Greenland	40	66	437	288	867	533	1,162	1,129	747
Iceland	36,557	34,883	31,955	33,987	27,778	27,383	22,055	18,569	10,728
Norway	50	34	221	846	1,173 [1]	1,810	2,164	1,986	1,367
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	109	811	513	1,436	386	218	190
UK (Scotland)	-	-	19	26	84	232	25	26	43
United Kingdom									
Total	38,813	36,890	35,259	40,780	37,305	36,006	35,762	30,289	20,360
Working Group estimate	39,326	37,950	35,423	40,817	36,958	36,300	35,825	30,267	-

Country	1999 [1]	2000 [1]	2001 [1]
Denmark		-	-
Faroe Islands	3,884	4,812	-
France	-	-	-
Germany	3,082	3,271	2,810
Greenland	200	-	-
Iceland	11,180	14,537	16,590
Norway	1,187	1,272	1,510
Russia	138	183	186
UK (Engl. and Wales)	261	370	-
UK (Scotland)	69	121	-
United Kingdom	-	-	324
Total	20,001	24,566	21,420
Working Group estimate	20,371	26,839	28,021

1) Provisional data

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-2001, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	325	669	33	46			15	379	719
Germany									
Greenland									
Iceland	15 455	28 300	28 359	30 078	29 195	31 027	44 644	49 000	58 330
Norway			+	+	2				
Total	15 780	28 969	28 392	30 124	29 197	31 027	44 659	49 379	59 049
Working Group estimate									59 272 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Faroe Islands	739	273	23	166	910	13	14	26	6
Germany					1	2	4		9
Greenland					1				[1]
Iceland	36 557	34 883	31 955	33 968	27 696	27 376	22 055	16 766	10 580
Norway									
Total	37 296	35 156	31 978	34 134	28 608	27 391	22 073	16 792	10 595
Working Group estimate	37 308 [2]	35 413 [2]							

Country	1999	2000 [1]	2001 [1]
Faroe Islands	9		
Germany	13	22	50
Greenland	[1]		
Iceland	11 087	14 507	16 590
Norway			6
UK (E/W/I)	26	73	
UK Scottland	3	5	
UK			59
Total	11 138	14 607	16 705
Working Group estimate		14 519 [3]	16 752

1) Provisional data

2) WG estimate inclueds additional catches as described in Working group report for each year and in the report from 2001.

3) Includes additional 125 t by Iceland

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-2001, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	442	863	1 112	2 456	1 052	775	907	901	1 513
France	8	27	236	489	845	52	19	25	...
Germany	114	142	86	118	227	113	109	42	73
Greenland	-	-	-	-	-	-	-	-	-
Norway	2	+	2	2	2	+	2	1	3
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	566	1 032	1 436	3 065	2 126	940	1 043	969	1 589
Working Group estimate	-	-	-	-	-	-	-	-	1 606 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1 064	1 293	2 105	4 058	5 163	3 603	6 004	4750	3660
France [6]	...	...	3 [1]	2	1	28	29	11	8 [1]
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281	42	114
UK (Engl. and Wales)	-	-	1	15	-	31	122		
UK (Scotland)	-	-	1	-	-	27	12	26	43
United Kingdom	-	-	-	-	-				
Total	1 149	1 333	2 206	4 434	5 225	3 832	6 469	4 870	3825
Working Group estimate	1 282 [2]	1 662 [2]	2 269 [2]	-	-	-	-	-	-

Country	1999	2000 [1]	2001 [1]
Denmark			
Faroe Islands	3873	4812	
France			
Germany	22	6	7
Greenland			
Norway	87	110 [1]	53
UK (Engl. and Wales)	9	35	
UK (Scotland)	66	116	
United Kingdom			195
Total	4057	5079	255
Working Group estimate	4265 [2]		3 951

1) Provisional data

2) WG estimate inclueds additional catches as described in Working group report for each year and in the report from 2001.

Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-2001, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2 893	2 439	1 054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2 893	2 440	1 060	835	753	1 017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3 343	3 301	3 399
Greenland	40	66	437	288	866	533	1 162	1 129	747 [1,10]
Iceland	-	-	-	19	82	7	-	1 803	148
Norway	8	18	196	511	1 120	1 668	1 881	1 944	1 253
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	190
UK (Scotland)	-	-	18	26	84	205	13		
United Kingdom	-	-	-	-	-	-	-		
Total	368	401	1 075	2 212	3 472	4 783	7 218	8 580	5940
Working Group estimate	736 [2]	875 [2]	1 176 [2]	2 249 [2]	3 125 [2]	5 077 [2]	7 283 [2]	8 558 [2]	

Country	1999	2000	2 001 [1]
Denmark			
Faroe Islands	2		
Germany	3047	3243	2 753
Greenland	200 [1,4]		
Iceland	93	30	
Norway	1100	1162 [1]	1 451
Russia	138	183	186
UK (Engl. and Wales)	226	262	
UK (Scotland)			
United Kingdom			70
Total	4806	4880	4 460
Working Group estimate	5376 [3]	6958 [5]	7 216 [6]

1) Provisional data

2) WG estimate inclueds additional catches as described in Working group report for each year and in the report from 2001.

3) Includes 125 t by Faroe Islands, 206 t by Greenland.

4) Excluding 4732t reproted as area unknown.

5) Includes: 1523 t by Norway 102 t by Faroe Islands, 3343 by Germany, 1910 t by Greenland, 180 t by Russia, as reported to Greenland authorities.

6) Includes 2849 t by Greenland, 1424t by Norway, 2750t by Germany

Table 6.1.5. GREENLAND HALIBUT. Nominal catches (tonnes) by countries in Sub-area XII, as officially reported to the ICES.

Country	1996	1997	1998	1999	2000	2001
Faroe Islands		47				
Norway	2					
Total	2	47	-	-	-	-
WG estimate						102 [1]

[1] 102 t by Faroe Islands as reported to Faroe Island authorities

Table 6.1.6. 2001 Catch statistics for GREENLAND HALIBUT in V and XIV.
Working Group best estimates.

Va	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands					0
Germany, Fed. Rep.		49		50	99
Greenland					0
Iceland	393	16 193	2		16 588
Norway				6	6
UK (E/W/NI)					0
UK (Scotland)					0
UK				59	59
Total	393	16 242	2	115	16 752

Vb	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands	1	1 046	2 811	6	3 864
France				37	37
Germany Fed. Rep.		7			7
Norway				8	8
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom				35	35
Total	1	1 053	2 811	86	3 951

XII	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands	0			102	102
Total	0	0	0	102	102

XIV	Long line	Trawl	Gill Net	Unknown	SUM
Denmark					0
Faroe Islands					0
EU (GER)		2 750			2 750
Greenland		2 849			2 849
Iceland (outside 200 EEZ)					0
Norway (inside 200 EEZ)	983	441			1 424
Norway (outside 200 EEZ)					0
Russia				186	186
Ireland				7	7
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom					0
Total	983	6 040	0	193	7 216

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM
	1 377	23 335	2 813	496	**28 021**

Table 6.2.1. CPUE indices of Icelandic, Grenland and Faroe trawl fleets as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	effort	% change in effort between years
Iceland Va	1985	1.00		32198	32198	
	1986	0.96	-4	33099	34514	7.2
	1987	0.90	-6	46767	51733	49.9
	1988	1.06	17	51307	48540	-6.2
	1989	1.04	-1	61323	58851	21.2
	1990	0.74	-29	38935	52757	-10.4
	1991	0.78	6	36882	47103	-10.7
	1992	0.63	-19	35382	56073	19.0
	1993	0.54	-15	40844	76344	36.2
	1994	0.41	-23	37302	90320	18.3
	1995	0.31	-25	35904	115819	28.2
	1996	0.27	-12	35857	131827	13.8
	1997	0.28	1	29751	108185	-17.9
	1998	0.42	53	20077	47576	-56.0
	1999	0.49	15	20333	41924	-11.9
	2000	0.52	8	26839	51317	22.4
	2001	0.63	20	28021	44478	-13.3
Greenland, XIVb	1991	1.00		875	875	
	1992	1.05	5	1176	1116	22
	1993	1.81	71	2249	1245	10
	1994	2.01	11	3125	1554	20
	1995	1.95	-3	5077	2597	40
	1996	2.08	6	7283	3510	26
	1997	2.28	10	8558	3760	7
	1998	2.24	-2	5940	2657	-41
	1999	2.12	-5	5376	2539	-5
	2000	2.16	2	6958	3219	21
	2001	1.88	-13	7216	3843	16
Faroe Islands, Vb	1995	1.00		3832	3832	0
	1996	1.01	1	6469	6405	40
	1997	0.92	-9	4870	5293	-21
	1998	1.00	9	3226	3226	-64
	1999	0.90	-10	4265	4739	32
	2000	0.92	2	5079	5521	14

Table 6.3.1 Catch in numbers

Run title : GREENLAND HALIBUT ICES V+XIV

At 1/05/2002 15:15

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE							
5,	120,	43,	0,	23,	29,	47,	26,
6,	800,	296,	34,	91,	197,	502,	158,
7,	1775,	584,	671,	347,	1605,	1536,	580,
8,	1782,	621,	1727,	1037,	2253,	2630,	1160,
9,	1259,	431,	2289,	1214,	3090,	3126,	1430,
10,	926,	240,	834,	848,	1693,	2324,	1764,
11,	464,	121,	420,	567,	880,	1739,	1299,
12,	459,	86,	423,	312,	394,	849,	664,
13,	279,	37,	174,	232,	246,	578,	435,
14,	193,	32,	120,	218,	189,	306,	252,
15,	137,	14,	28,	114,	147,	143,	176,
+gp,	39,	6,	86,	112,	101,	82,	114,
0 TOTALNUM,	8233,	2511,	6806,	5115,	10824,	13862,	8058,
TONSLAND,	23494,	6045,	16578,	14349,	23616,	31252,	19239,
SOPCOF %,	128,	101,	102,	105,	102,	100,	102,

Catch numbers at age Numbers*10**-3

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
5,	8,	10,	83,	125,	245,	182,	129,	499,	188,	289,
6,	300,	240,	277,	441,	612,	3123,	742,	1657,	463,	1225,
7,	1140,	1611,	891,	1018,	1033,	4863,	2068,	4485,	1513,	1797,
8,	2451,	2651,	2139,	2295,	1942,	2586,	2985,	5961,	3515,	2866,
9,	2646,	3060,	3568,	3454,	2983,	2156,	3166,	5763,	4186,	2935,
10,	2456,	2443,	2800,	2749,	3097,	3476,	2966,	3246,	3143,	2074,
11,	1803,	1693,	1825,	1452,	1683,	1847,	1848,	1601,	1224,	1130,
12,	963,	978,	1134,	627,	820,	1829,	1761,	1458,	959,	1072,
13,	609,	424,	588,	423,	550,	886,	1851,	1237,	568,	924,
14,	331,	174,	363,	137,	202,	243,	701,	506,	358,	554,
15,	195,	37,	92,	36,	59,	31,	216,	362,	137,	342,
+gp,	82,	17,	13,	46,	30,	1,	246,	145,	61,	82,
0 TOTALNUM,	12984,	13338,	13773,	12803,	13256,	21223,	18679,	26920,	16315,	15290,
TONSLAND,	32441,	30891,	34024,	32075,	32984,	46622,	51118,	61396,	39326,	37950,
SOPCOF %,	101,	102,	100,	103,	101,	98,	101,	100,	100,	101,

Catch numbers at age Numbers*10**-3

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
5,	17,	44,	78,	503,	178,	86,	90,	82,	53,	46,
6,	421,	397,	672,	1587,	1488,	549,	550,	366,	310,	174,
7,	2023,	1896,	2197,	3031,	2908,	2723,	1882,	1363,	1543,	1006,
8,	3262,	5024,	3815,	3287,	3181,	2579,	2051,	1606,	2256,	2947,
9,	2646,	4324,	3648,	2608,	2119,	2331,	1657,	1828,	1485,	2364,
10,	3019,	2859,	2330,	1963,	1755,	1247,	1067,	1287,	1256,	1559,
11,	1962,	1539,	1715,	1548,	1610,	975,	737,	1018,	1235,	1536,
12,	1278,	1412,	990,	1132,	1216,	937,	710,	762,	1006,	1052,
13,	509,	576,	422,	657,	665,	652,	359,	492,	777,	800,
14,	144,	136,	371,	444,	548,	374,	195,	231,	778,	375,
15,	36,	135,	168,	240,	238,	282,	150,	137,	539,	418,
+gp,	56,	7,	177,	211,	323,	262,	106,	119,	174,	122,
0 TOTALNUM,	15373,	18349,	16583,	17211,	16229,	12997,	9554,	9291,	11412,	12399,
TONSLAND,	35423,	40817,	36958,	36300,	35825,	30267,	20360,	20371,	26839,	28021,
SOPCOF %,	100,	100,	100,	100,	103,	110,	107,	111,	108,	103,

Table 6.4.1 Catch and stock weight at age

Table 2 Catch weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,
AGE							
5,	.9680,	1.1570,	1.1570,	.9680,	.9110,	1.1250,	1.0710,
6,	1.1990,	1.5850,	1.0460,	1.1990,	.9420,	1.2830,	1.2570,
7,	1.4230,	1.7680,	1.4290,	1.4230,	1.2780,	1.4870,	1.4400,
8,	1.8540,	2.1800,	1.7940,	1.8540,	1.6760,	1.7560,	1.6600,
9,	2.2560,	2.5700,	2.2280,	2.2560,	2.0720,	2.1530,	1.9670,
10,	2.6070,	3.0180,	2.6870,	2.6070,	2.3330,	2.2790,	2.2580,
11,	3.0810,	3.7300,	3.0170,	3.0810,	2.7230,	2.4980,	2.5150,
12,	3.5910,	4.0520,	3.9140,	3.5910,	3.2970,	3.0590,	2.9500,
13,	4.6040,	4.8150,	4.0400,	4.6040,	3.9850,	3.7830,	3.4500,
14,	4.6950,	5.3480,	4.7140,	4.6950,	4.6680,	4.5070,	4.0330,
15,	5.1510,	5.7520,	5.4010,	5.1510,	4.7920,	5.1390,	4.6520,
+gp,	5.8930,	6.2270,	5.0540,	5.8930,	5.2290,	5.6330,	4.7140,
0 SOPCOFAC,	1.2794,	1.0068,	1.0227,	1.0471,	1.0187,	.9975,	1.0189,

Table 2 Catch weights at age (kg)

YEAR,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,
AGE										
5,	1.0100,	.9840,	.9420,	.9950,	1.0300,	1.0300,	1.1290,	.8420,	1.0290,	1.0010,
6,	1.3680,	1.3380,	1.2750,	1.2300,	1.2380,	1.2180,	1.3040,	1.0470,	1.2100,	1.2470,
7,	1.6180,	1.5770,	1.5920,	1.6300,	1.4990,	1.5330,	1.5410,	1.4250,	1.5720,	1.4720,
8,	1.9050,	1.8480,	1.8170,	1.9510,	1.9370,	1.8240,	1.7700,	1.7270,	1.7900,	1.8100,
9,	2.1870,	2.1590,	2.2400,	2.3670,	2.3630,	2.1870,	2.2360,	2.1250,	2.1260,	2.0880,
10,	2.5160,	2.4340,	2.4610,	2.6370,	2.6310,	2.6660,	2.6830,	2.6370,	2.5360,	2.4400,
11,	2.7610,	2.6030,	2.8350,	2.8290,	2.8480,	2.9960,	3.0820,	3.2200,	3.2140,	2.9350,
12,	3.1290,	3.0340,	3.2620,	3.3530,	3.3350,	3.5950,	3.6240,	3.7330,	3.6930,	3.7370,
13,	3.7850,	3.7840,	3.9620,	4.0060,	4.0390,	4.4310,	4.3120,	4.1350,	4.4480,	4.4010,
14,	4.4750,	4.4460,	4.9360,	4.7920,	4.9250,	5.1400,	5.0980,	5.3800,	5.1970,	5.0220,
15,	4.9850,	4.7510,	5.2300,	5.2310,	5.4660,	5.7640,	5.2130,	6.5690,	5.8910,	5.9910,
+gp,	5.6100,	6.2090,	6.9680,	6.3230,	5.7640,	5.7640,	5.7640,	6.4970,	6.0490,	6.4120,
0 SOPCOFAC,	1.0104,	1.0176,	.9953,	1.0258,	1.0069,	.9792,	1.0063,	.9999,	.9998,	1.0097,

1

Table 2 Catch weights at age (kg)

YEAR,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE										
5,	1.0160,	.9910,	1.1630,	.9500,	1.1010,	.9190,	.8070,	.8610,	.7700,	.7320,
6,	1.2560,	1.2490,	1.2540,	1.2130,	1.1240,	1.1070,	1.0860,	.9530,	.9680,	.8650,
7,	1.4010,	1.4010,	1.4880,	1.4130,	1.3460,	1.3340,	1.3630,	1.2880,	1.2720,	1.2190,
8,	1.7180,	1.6850,	1.7360,	1.7030,	1.6490,	1.6400,	1.6580,	1.5650,	1.6070,	1.5770,
9,	2.0490,	1.9820,	2.1500,	2.0280,	1.9250,	1.8810,	1.8860,	1.7390,	1.7690,	1.8510,
10,	2.4360,	2.4250,	2.3520,	2.2790,	2.3420,	2.2400,	2.1670,	2.0120,	2.1220,	2.2020,
11,	2.8680,	2.9520,	2.7360,	2.6430,	2.5950,	2.5380,	2.4150,	2.3510,	2.3140,	2.3990,
12,	3.4780,	3.4290,	3.0820,	2.9920,	3.0130,	2.8460,	2.8440,	2.6340,	2.7220,	2.7000,
13,	4.5100,	4.4790,	3.6070,	3.5680,	3.5150,	3.3850,	3.1730,	3.0310,	3.0100,	3.3110,
14,	4.6810,	6.0430,	4.2420,	4.0680,	4.1230,	4.3590,	4.2370,	3.5320,	3.4230,	4.0720,
15,	6.0100,	5.8320,	5.2930,	5.3020,	4.9960,	4.8510,	4.6560,	3.8740,	4.0660,	4.5500,
+gp,	5.1280,	5.5120,	6.0870,	5.6860,	5.6930,	5.0910,	5.0800,	4.9370,	4.5730,	5.8670,
0 SOPCOFAC,	1.0033,	1.0010,	1.0001,	1.0042,	1.0329,	1.1044,	1.0674,	1.1142,	1.0819,	1.0307,

1

Table 6.7.2.1 Output from ASPIC using Icelandic trawler cpue and groundfish survey

```
G.halibut cpue 1985 to 2001
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.91)                                         FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center                                 ASPIC User's Manual
        101     Pivers Island Road; Beaufort, North Carolina  28516  USA                                is available gratis
                                                                                                      from the author.
Ref:    Prager, M. H.  1994.  A suite of extensions to a nonequilibrium
        surplus-production model.  Fishery Bulletin 92: 374-389.


CONTROL PARAMETERS USED (FROM INPUT FILE)
------------------------------------------------------------------------------------------------------------------------
Number of years analyzed:                       17           Number of bootstrap trials:                            0
Number of data series:                           2           Lower bound on MSY:                            5.000E+03
Objective function computed:             in effort           Upper bound on MSY:                            1.000E+09
Relative conv. criterion (simplex):      1.000E-08           Lower bound on r:                              7.000E-02
Relative conv. criterion (restart):      3.000E-08           Upper bound on r:                              2.500E+00
Relative conv. criterion (effort):       1.000E-04           Random number seed:                              2010417
Maximum F allowed in fitting:                8.000           Monte Carlo search mode, trials:           1       10000


PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                                         code  0
------------------------------------------------------------------------------------------------------------------------
Normal convergence.

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
                                       |
 1  input CPUE indices                 |   1.000
                                       |      17
                                       |
 2  ICESURVEY indices                  |   0.746   1.000
                                       |       6       6
                                       -------------------------------------------------
                                               1       2


GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS
------------------------------------------------------------------------------------------------------------------------
                                                   Weighted            Weighted      Current    Suggested    R-squared
Loss component number and title                         SSE    N            MSE       weight       weight      in CPUE

Loss(-1)  SSE in yield                            0.000E+00
Loss( 0)  Penalty for B1R > 2                     0.000E+00    1            N/A    1.000E-01          N/A
Loss( 1)  input CPUE indices                      7.491E-01   17      4.994E-02    1.000E+00    8.683E-01        0.776
Loss( 2)  ICESURVEY indices                       1.263E-01    6      3.158E-02    1.000E+00    1.373E+00        0.278
TOTAL OBJECTIVE FUNCTION:                    8.75436634E-01

Number of restarts required for convergence:             15
Est. B/BMSY coverage index (0 worst, 2 best):        0.9155             < These two measures are defined in Prager
Est. B/BMSY nearness index (0 worst, 1 best):        1.0000             <     et al. (1996), Trans. A.F.S. 125:729


MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------------
Parameter                                          Estimate     Starting guess     Estimated   User guess

B1R       Starting B/BMSY, year 1985              1.364E+00         1.000E+00          1            1
MSY       Maximum sustainable yield               3.700E+04         6.000E+05          1            1
r         Intrinsic rate of increase              7.550E-01         8.000E-01          1            1
........  Catchability coefficients by fishery:
q( 1)     input CPUE indices                      7.903E-03         1.000E-02          1            1
q( 2)     ICESURVEY indices                       7.839E-03         1.000E-02          1            1


MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------------
Parameter                                          Estimate            Formula        Related quantity

MSY       Maximum sustainable yield               3.700E+04              Kr/4
K         Maximum stock biomass                   1.960E+05
BMSY     Stock biomass at MSY                     9.801E+04               K/2
FMSY     Fishing mortality at MSY                 3.775E-01               r/2

F(0.1)    Management benchmark                    3.398E-01          0.9*FMSY
Y(0.1)    Equilibrium yield at F(0.1)             3.663E+04          0.99*MSY

B./BMSY  Ratio of B(2002) to BMSY               7.334E-01
F./FMSY  Ratio of F(2001) to FMSY               1.074E+00
F01-mult  Ratio of F(0.1) to F(2001)              8.383E-01
Ye./MSY   Proportion of MSY avail in 2002         9.289E-01         2*Br-Br^2     Ye(2002) = 3.437E+04

........  Fishing effort at MSY in units of each fishery:
FMSY( 1)  input CPUE indices                     4.777E+01         r/2q( 1)       f(0.1) = 4.299E+01
```

Table 6.7.2.1 (Cont'd)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to F_{MSY}	Ratio of biomass to B_{MSY}
1	1985	0.240	1.336E+05	1.337E+05	3.208E+04	3.208E+04	3.210E+04	6.357E-01	1.364E+00
2	1986	0.248	1.337E+05	1.332E+05	3.298E+04	3.298E+04	3.221E+04	6.557E-01	1.364E+00
3	1987	0.370	1.329E+05	1.259E+05	4.662E+04	4.662E+04	3.394E+04	9.806E-01	1.356E+00
4	1988	0.456	1.202E+05	1.120E+05	5.112E+04	5.112E+04	3.617E+04	1.209E+00	1.227E+00
5	1989	0.670	1.053E+05	9.161E+04	6.140E+04	6.140E+04	3.665E+04	1.775E+00	1.074E+00
6	1990	0.501	8.051E+04	7.851E+04	3.933E+04	3.933E+04	3.553E+04	1.327E+00	8.215E-01
7	1991	0.505	7.672E+04	7.515E+04	3.795E+04	3.795E+04	3.498E+04	1.338E+00	7.828E-01
8	1992	0.484	7.375E+04	7.331E+04	3.549E+04	3.549E+04	3.465E+04	1.282E+00	7.525E-01
9	1993	0.599	7.291E+04	6.891E+04	4.125E+04	4.125E+04	3.372E+04	1.585E+00	7.440E-01
10	1994	0.593	6.539E+04	6.276E+04	3.719E+04	3.719E+04	3.220E+04	1.570E+00	6.672E-01
11	1995	0.632	6.040E+04	5.743E+04	3.629E+04	3.629E+04	3.064E+04	1.674E+00	6.163E-01
12	1996	0.706	5.476E+04	5.081E+04	3.586E+04	3.586E+04	2.840E+04	1.869E+00	5.587E-01
13	1997	0.653	4.730E+04	4.555E+04	2.975E+04	2.975E+04	2.640E+04	1.730E+00	4.826E-01
14	1998	0.430	4.395E+04	4.733E+04	2.036E+04	2.036E+04	2.709E+04	1.139E+00	4.484E-01
15	1999	0.367	5.068E+04	5.554E+04	2.037E+04	2.037E+04	3.002E+04	9.714E-01	5.171E-01
16	2000	0.420	6.033E+04	6.330E+04	2.657E+04	2.657E+04	3.235E+04	1.112E+00	6.156E-01
17	2001	0.405	6.611E+04	6.908E+04	2.800E+04	2.800E+04	3.376E+04	1.074E+00	6.746E-01
18	2002		7.188E+04						7.334E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) input CPUE indices

----

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in log yield
1	1985	1.000E+03	1.056E+03	0.2400	3.208E+04	3.208E+04	0.05468	
2	1986	9.590E+02	1.053E+03	0.2475	3.298E+04	3.298E+04	0.09351	
3	1987	9.040E+02	9.952E+02	0.3702	4.662E+04	4.662E+04	0.09615	
4	1988	1.057E+03	8.854E+02	0.4563	5.112E+04	5.112E+04	-0.17715	
5	1989	1.042E+03	7.240E+02	0.6702	6.140E+04	6.140E+04	-0.36412	
6	1990	7.380E+02	6.204E+02	0.5009	3.933E+04	3.933E+04	-0.17357	
7	1991	7.830E+02	5.939E+02	0.5050	3.795E+04	3.795E+04	-0.27640	
8	1992	6.310E+02	5.794E+02	0.4841	3.549E+04	3.549E+04	-0.08538	
9	1993	5.350E+02	5.446E+02	0.5985	4.125E+04	4.125E+04	0.01778	
10	1994	4.130E+02	4.960E+02	0.5926	3.719E+04	3.719E+04	0.18303	
11	1995	3.100E+02	4.538E+02	0.6319	3.629E+04	3.629E+04	0.38112	
12	1996	2.720E+02	4.016E+02	0.7056	3.586E+04	3.586E+04	0.38958	
13	1997	2.750E+02	3.600E+02	0.6531	2.975E+04	2.975E+04	0.26929	
14	1998	4.220E+02	3.741E+02	0.4301	2.036E+04	2.036E+04	-0.12057	
15	1999	4.850E+02	4.389E+02	0.3667	2.037E+04	2.037E+04	-0.09987	
16	2000	5.230E+02	5.002E+02	0.4198	2.657E+04	2.657E+04	-0.04456	
17	2001	6.300E+02	5.459E+02	0.4053	2.800E+04	2.800E+04	-0.14323	

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                  -1       -0.75     -0.5      -0.25       0       0.25      0.5       0.75       1
                   |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual   ------------------------------------------------------------------------------------
1985     0.0547                                            |==
1986     0.0935                                            |====
1987     0.0961                                            |====
1988    -0.1771                                     =======|
1989    -0.3641                             ===============|
1990    -0.1736                                     =======|
1991    -0.2764                                 ===========|
1992    -0.0854                                         ===|
1993     0.0178                                            |=
1994     0.1830                                            |=======
1995     0.3811                                            |===============
1996     0.3896                                            |================
1997     0.2693                                            |===========
1998    -0.1206                                       =====|
1999    -0.0999                                        ====|
2000    -0.0446                                          ==|
2001    -0.1432                                      ======|
                  ------------------------------------------------------------------------------------
```

Table 6.7.2.1 (Cont'd)

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) ICESURVEY indices

---

Data type I2: End-of-year biomass index Series weight: 1.000

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1985	0.000E+00	0.000E+00	0.0	*	1.048E+03	0.00000	0.0
2	1986	0.000E+00	0.000E+00	0.0	*	1.042E+03	0.00000	0.0
3	1987	0.000E+00	0.000E+00	0.0	*	9.423E+02	0.00000	0.0
4	1988	0.000E+00	0.000E+00	0.0	*	8.251E+02	0.00000	0.0
5	1989	0.000E+00	0.000E+00	0.0	*	6.311E+02	0.00000	0.0
6	1990	0.000E+00	0.000E+00	0.0	*	6.014E+02	0.00000	0.0
7	1991	0.000E+00	0.000E+00	0.0	*	5.781E+02	0.00000	0.0
8	1992	0.000E+00	0.000E+00	0.0	*	5.716E+02	0.00000	0.0
9	1993	0.000E+00	0.000E+00	0.0	*	5.125E+02	0.00000	0.0
10	1994	0.000E+00	0.000E+00	0.0	*	4.735E+02	0.00000	0.0
11	1995	0.000E+00	0.000E+00	0.0	*	4.292E+02	0.00000	0.0
12	1996	1.000E+00	1.000E+00	0.0	3.460E+02	3.708E+02	-0.06916	-2.478E+01
13	1997	1.000E+00	1.000E+00	0.0	4.140E+02	3.445E+02	0.18383	6.952E+01
14	1998	1.000E+00	1.000E+00	0.0	4.200E+02	3.973E+02	0.05566	2.274E+01
15	1999	1.000E+00	1.000E+00	0.0	5.280E+02	4.729E+02	0.11011	5.505E+01
16	2000	1.000E+00	1.000E+00	0.0	3.960E+02	5.182E+02	-0.26902	-1.222E+02
17	2001	1.000E+00	1.000E+00	0.0	5.570E+02	5.634E+02	-0.01147	-6.427E+00

* Asterisk indicates missing value(s).

```
UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 2
                   -1       -0.75     -0.5      -0.25       0       0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -----------------------------------------------------------------------------------
1985    0.0000                                              |
1986    0.0000                                              |
1987    0.0000                                              |
1988    0.0000                                              |
1989    0.0000                                              |
1990    0.0000                                              |
1991    0.0000                                              |
1992    0.0000                                              |
1993    0.0000                                              |
1994    0.0000                                              |
1995    0.0000                                              |
1996   -0.0692                                           ===|
1997    0.1838                                              |=======
1998    0.0557                                              |==
1999    0.1101                                              |====
2000   -0.2690                                   ===========|
2001   -0.0115                                              |
```

Table 6.7.3 Trajectories from an ASPIC production model assuming 2002 catch = 30kt and F(2003-2011)=$\mathbf{F}_{pa}$(~2/3$\mathbf{F}_{MSY}$).

Results from ASPICP.EXE, version 3.10 — 02 May 2002 at 20:56.50
G.halibut cpue 1985 to 2001 — Page 1
Project 2/3$\mathbf{F}_{pa}$

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	aspic.bio
Name of output file (this file)	ghlboot_catch23$\mathbf{F}_{pa}$.out
Production-model type	Logistic
Number of years of projections	10
Type of confidence intervals	Bias-corrected percentile
Confidence interval smoothing	ON

Year	Input data	User data type
2002	3.000E+04	TAC
2003	6.660E-01	F/F(2001)
2004	6.660E-01	F/F(2001)
2005	6.660E-01	F/F(2001)
2006	6.660E-01	F/F(2001)
2007	6.660E-01	F/F(2001)
2008	6.660E-01	F/F(2001)
2009	6.660E-01	F/F(2001)
2010	6.660E-01	F/F(2001)
2011	6.660E-01	F/F(2001)

TRAJECTORY OF RELATIVE BIOMASS B/$\mathbf{B}_{MSY}$ (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1985	1.363E+00	1.340E-01	9.83%	7.695E-01	2.121E+00	9.792E-01	1.700E+00	7.211E-01	0.529
1986	1.364E+00	5.382E-02	3.95%	8.566E-01	1.822E+00	1.051E+00	1.581E+00	5.302E-01	0.389
1987	1.356E+00	2.273E-02	1.68%	9.137E-01	1.631E+00	1.096E+00	1.480E+00	3.841E-01	0.283
1988	1.227E+00	1.091E-02	0.89%	8.789E-01	1.413E+00	1.033E+00	1.310E+00	2.770E-01	0.226
1989	1.074E+00	7.779E-03	0.72%	8.281E-01	1.222E+00	9.413E-01	1.140E+00	1.984E-01	0.185
1990	8.215E-01	5.201E-03	0.63%	6.785E-01	1.022E+00	7.431E-01	9.201E-01	1.771E-01	0.216
1991	7.827E-01	4.703E-03	0.60%	6.521E-01	9.642E-01	7.120E-01	8.736E-01	1.616E-01	0.206
1992	7.525E-01	5.110E-03	0.68%	6.291E-01	9.141E-01	6.873E-01	8.305E-01	1.432E-01	0.190
1993	7.439E-01	7.326E-03	0.98%	6.231E-01	8.761E-01	6.888E-01	8.012E-01	1.124E-01	0.151
1994	6.671E-01	9.614E-03	1.44%	5.642E-01	7.953E-01	6.161E-01	7.241E-01	1.080E-01	0.162
1995	6.163E-01	1.270E-02	2.06%	5.203E-01	7.415E-01	5.694E-01	6.701E-01	1.007E-01	0.163
1996	5.587E-01	1.622E-02	2.90%	4.760E-01	6.970E-01	5.155E-01	6.193E-01	1.037E-01	0.186
1997	4.826E-01	1.854E-02	3.84%	4.012E-01	6.587E-01	4.339E-01	5.683E-01	1.343E-01	0.278
1998	4.484E-01	1.833E-02	4.09%	3.405E-01	6.649E-01	3.932E-01	5.602E-01	1.670E-01	0.372
1999	5.171E-01	1.744E-02	3.37%	3.898E-01	7.459E-01	4.491E-01	6.257E-01	1.766E-01	0.342
2000	6.156E-01	1.790E-02	2.91%	4.694E-01	8.226E-01	5.295E-01	7.148E-01	1.853E-01	0.301
2001	6.746E-01	1.956E-02	2.90%	4.980E-01	8.678E-01	5.764E-01	7.709E-01	1.945E-01	0.288
2002	7.332E-01	2.227E-02	3.04%	5.208E-01	9.267E-01	6.151E-01	8.249E-01	2.097E-01	0.286
2003	7.826E-01	2.468E-02	3.15%	5.284E-01	9.803E-01	6.335E-01	8.731E-01	2.396E-01	0.306
2004	9.208E-01	2.107E-02	2.29%	6.270E-01	1.131E+00	7.465E-01	1.020E+00	2.733E-01	0.297
2005	1.033E+00	1.251E-02	1.21%	7.208E-01	1.240E+00	8.574E-01	1.138E+00	2.810E-01	0.272
2006	1.117E+00	3.214E-03	0.29%	7.992E-01	1.312E+00	9.456E-01	1.217E+00	2.718E-01	0.243
2007	1.176E+00	-3.948E-03	-0.34%	8.693E-01	1.354E+00	1.015E+00	1.268E+00	2.536E-01	0.216
2008	1.215E+00	-8.207E-03	-0.68%	9.230E-01	1.378E+00	1.066E+00	1.302E+00	2.361E-01	0.194
2009	1.241E+00	-1.002E-02	-0.81%	9.734E-01	1.396E+00	1.110E+00	1.322E+00	2.123E-01	0.171
2010	1.257E+00	-1.020E-02	-0.81%	1.001E+00	1.404E+00	1.131E+00	1.334E+00	2.025E-01	0.161
2011	1.268E+00	-9.448E-03	-0.75%	1.028E+00	1.412E+00	1.151E+00	1.344E+00	1.931E-01	0.152
2012	1.274E+00	-8.275E-03	-0.65%	1.033E+00	1.411E+00	1.157E+00	1.345E+00	1.875E-01	0.147

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.10 — 02 May 2002 at 20:56.50
G.halibut cpue 1985 to 2001 — Page 2
Project 2/3$\mathbf{F}_{pa}$

TRAJECTORY OF RELATIVE FISHING MORTALITY RATE F/$\mathbf{F}_{MSY}$ (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1985	6.358E-01	5.484E-03	0.86%	4.826E-01	9.335E-01	5.588E-01	8.046E-01	2.458E-01	0.387
1986	6.557E-01	3.919E-03	0.60%	5.597E-01	8.864E-01	6.061E-01	7.865E-01	1.804E-01	0.275
1987	9.807E-01	2.675E-03	0.27%	8.894E-01	1.235E+00	9.380E-01	1.132E+00	1.936E-01	0.197
1988	1.209E+00	-2.636E-04	-0.02%	1.126E+00	1.457E+00	1.171E+00	1.350E+00	1.786E-01	0.148
1989	1.775E+00	6.456E-04	0.04%	1.680E+00	2.036E+00	1.732E+00	1.920E+00	1.886E-01	0.106
1990	1.327E+00	2.547E-03	0.19%	1.233E+00	1.464E+00	1.281E+00	1.396E+00	1.151E-01	0.087
1991	1.338E+00	9.619E-05	0.01%	1.256E+00	1.468E+00	1.299E+00	1.402E+00	1.032E-01	0.077
1992	1.282E+00	-5.180E-03	-0.40%	1.230E+00	1.433E+00	1.260E+00	1.364E+00	1.042E-01	0.081
1993	1.585E+00	-1.320E-02	-0.83%	1.528E+00	1.763E+00	1.560E+00	1.689E+00	1.296E-01	0.082
1994	1.570E+00	-1.997E-02	-1.27%	1.513E+00	1.726E+00	1.545E+00	1.663E+00	1.177E-01	0.075
1995	1.674E+00	-2.982E-02	-1.78%	1.600E+00	1.823E+00	1.642E+00	1.757E+00	1.143E-01	0.068
1996	1.869E+00	-3.675E-02	-1.97%	1.611E+00	1.985E+00	1.760E+00	1.934E+00	1.733E-01	0.093
1997	1.730E+00	-1.868E-02	-1.08%	1.371E+00	1.960E+00	1.555E+00	1.851E+00	2.968E-01	0.172
1998	1.139E+00	-2.045E-04	-0.02%	8.893E-01	1.353E+00	1.016E+00	1.250E+00	2.335E-01	0.205
1999	9.713E-01	-6.001E-04	-0.06%	7.841E-01	1.156E+00	8.783E-01	1.072E+00	1.937E-01	0.199
2000	1.112E+00	-2.001E-03	-0.18%	9.109E-01	1.360E+00	1.011E+00	1.247E+00	2.355E-01	0.212
2001	1.075E+00	-1.057E-04	-0.01%	8.728E-01	1.380E+00	9.742E-01	1.232E+00	2.579E-01	0.240
2002	1.069E+00	6.455E-03	0.60%	8.614E-01	1.494E+00	9.610E-01	1.283E+00	3.223E-01	0.302
2003	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2004	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2005	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2006	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2007	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2008	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2009	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2010	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240
2011	7.156E-01	-7.043E-05	-0.01%	5.813E-01	9.194E-01	6.488E-01	8.206E-01	1.718E-01	0.240

Table 6.7.3 (Cont'd)

TABLE OF PROJECTED YIELDS

2002	3.000E+04	0.000E+00	0.00%	3.000E+04	3.000E+04	3.000E+04	3.000E+04	0.000E+00	0.000
2003	2.260E+04	2.973E+01	0.13%	2.018E+04	2.591E+04	2.130E+04	2.434E+04	3.042E+03	0.135
2004	2.593E+04	-6.848E+01	-0.26%	2.245E+04	3.054E+04	2.395E+04	2.843E+04	4.478E+03	0.173
2005	2.853E+04	-2.249E+02	-0.79%	2.424E+04	3.395E+04	2.627E+04	3.139E+04	5.129E+03	0.180
2006	3.041E+04	-3.612E+02	-1.19%	2.572E+04	3.639E+04	2.822E+04	3.377E+04	5.545E+03	0.182
2007	3.170E+04	-4.394E+02	-1.39%	2.707E+04	3.831E+04	2.976E+04	3.556E+04	5.803E+03	0.183
2008	3.255E+04	-4.598E+02	-1.41%	2.766E+04	3.912E+04	3.034E+04	3.639E+04	6.047E+03	0.186
2009	3.309E+04	-4.391E+02	-1.33%	2.819E+04	3.973E+04	3.069E+04	3.689E+04	6.202E+03	0.187
2010	3.344E+04	-3.955E+02	-1.18%	2.853E+04	4.022E+04	3.113E+04	3.731E+04	6.178E+03	0.185
2011	3.365E+04	-3.430E+02	-1.02%	2.871E+04	4.064E+04	3.128E+04	3.748E+04	6.197E+03	0.184

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.10 — 02 May 2002 at 20:56.50
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TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1985	1.336E+05	1.986E+04	14.87%	7.665E+04	2.341E+05	9.585E+04	1.764E+05	8.051E+04	0.603
1986	1.336E+05	1.129E+04	8.44%	8.682E+04	2.099E+05	1.051E+05	1.663E+05	6.125E+04	0.458
1987	1.329E+05	7.710E+03	5.80%	9.635E+04	2.022E+05	1.123E+05	1.651E+05	5.282E+04	0.398
1988	1.202E+05	6.230E+03	5.18%	9.060E+04	1.827E+05	1.028E+05	1.481E+05	4.531E+04	0.377
1989	1.052E+05	5.608E+03	5.33%	8.088E+04	1.640E+05	9.088E+04	1.316E+05	4.072E+04	0.387
1990	8.050E+04	5.240E+03	6.51%	5.788E+04	1.337E+05	6.727E+04	1.038E+05	3.650E+04	0.453
1991	7.670E+04	4.922E+03	6.42%	5.544E+04	1.254E+05	6.413E+04	9.867E+04	3.455E+04	0.450
1992	7.374E+04	4.707E+03	6.38%	5.360E+04	1.190E+05	6.184E+04	9.399E+04	3.215E+04	0.436
1993	7.290E+04	4.627E+03	6.35%	5.411E+04	1.147E+05	6.181E+04	9.155E+04	2.974E+04	0.408
1994	6.537E+04	4.664E+03	7.13%	4.822E+04	1.042E+05	5.513E+04	8.264E+04	2.751E+04	0.421
1995	6.039E+04	4.801E+03	7.95%	4.445E+04	9.598E+04	5.091E+04	7.667E+04	2.576E+04	0.427
1996	5.475E+04	5.047E+03	9.22%	3.989E+04	8.906E+04	4.591E+04	7.018E+04	2.428E+04	0.443
1997	4.729E+04	5.335E+03	11.28%	3.237E+04	8.148E+04	3.818E+04	6.261E+04	2.443E+04	0.517
1998	4.394E+04	5.513E+03	12.55%	2.739E+04	7.872E+04	3.388E+04	5.988E+04	2.599E+04	0.592
1999	5.067E+04	5.518E+03	10.89%	3.176E+04	8.614E+04	3.922E+04	6.664E+04	2.743E+04	0.541
2000	6.033E+04	5.421E+03	8.99%	3.958E+04	9.629E+04	4.842E+04	7.681E+04	2.839E+04	0.471
2001	6.611E+04	5.292E+03	8.00%	4.404E+04	1.008E+05	5.324E+04	8.104E+04	2.780E+04	0.421
2002	7.185E+04	5.118E+03	7.12%	4.888E+04	1.039E+05	5.853E+04	8.471E+04	2.618E+04	0.364
2003	7.669E+04	4.824E+03	6.29%	5.198E+04	1.052E+05	6.251E+04	8.875E+04	2.624E+04	0.342
2004	9.024E+04	4.203E+03	4.66%	6.420E+04	1.173E+05	7.580E+04	1.019E+05	2.607E+04	0.289
2005	1.012E+05	3.397E+03	3.35%	7.559E+04	1.303E+05	8.678E+04	1.141E+05	2.732E+04	0.270
2006	1.095E+05	2.725E+03	2.49%	8.454E+04	1.418E+05	9.620E+04	1.245E+05	2.835E+04	0.259
2007	1.152E+05	2.356E+03	2.04%	9.027E+04	1.506E+05	1.025E+05	1.333E+05	3.075E+04	0.267
2008	1.191E+05	2.284E+03	1.92%	9.315E+04	1.557E+05	1.060E+05	1.375E+05	3.153E+04	0.265
2009	1.216E+05	2.422E+03	1.99%	9.435E+04	1.579E+05	1.075E+05	1.396E+05	3.210E+04	0.264
2010	1.232E+05	2.675E+03	2.17%	9.482E+04	1.604E+05	1.079E+05	1.414E+05	3.351E+04	0.272
2011	1.242E+05	2.972E+03	2.39%	9.510E+04	1.617E+05	1.080E+05	1.421E+05	3.417E+04	0.275
2012	1.248E+05	3.267E+03	2.62%	9.528E+04	1.628E+05	1.080E+05	1.428E+05	3.478E+04	0.279

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

Results from ASPICP.EXE, version 3.10 — 02 May 2002 at 20:56.50
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TRAJECTORY OF ABSOLUTE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Point estimate	Estimated bias	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1985	2.400E-01	1.159E-02	4.83%	1.446E-01	3.854E-01	1.861E-01	3.155E-01	1.294E-01	0.539
1986	2.476E-01	9.080E-03	3.67%	1.619E-01	3.603E-01	1.996E-01	3.044E-01	1.048E-01	0.423
1987	3.703E-01	1.112E-02	3.00%	2.426E-01	4.997E-01	2.986E-01	4.328E-01	1.342E-01	0.363
1988	4.563E-01	1.275E-02	2.79%	2.988E-01	6.050E-01	3.685E-01	5.332E-01	1.647E-01	0.361
1989	6.703E-01	2.468E-02	3.68%	4.160E-01	9.055E-01	5.292E-01	7.905E-01	2.613E-01	0.390
1990	5.010E-01	2.229E-02	4.45%	3.050E-01	6.960E-01	3.893E-01	6.009E-01	2.115E-01	0.422
1991	5.051E-01	2.075E-02	4.11%	3.109E-01	6.972E-01	3.946E-01	6.032E-01	2.086E-01	0.413
1992	4.841E-01	1.611E-02	3.33%	3.049E-01	6.558E-01	3.828E-01	5.744E-01	1.916E-01	0.396
1993	5.986E-01	1.674E-02	2.80%	3.785E-01	8.085E-01	4.739E-01	7.077E-01	2.337E-01	0.390
1994	5.927E-01	1.488E-02	2.51%	3.723E-01	8.028E-01	4.665E-01	7.029E-01	2.365E-01	0.399
1995	6.320E-01	1.391E-02	2.20%	3.916E-01	8.607E-01	4.945E-01	7.511E-01	2.566E-01	0.406
1996	7.058E-01	1.946E-02	2.76%	4.223E-01	1.010E+00	5.448E-01	8.601E-01	3.153E-01	0.447
1997	6.532E-01	3.261E-02	4.99%	3.728E-01	1.008E+00	4.926E-01	8.318E-01	3.392E-01	0.519
1998	4.302E-01	2.799E-02	6.51%	2.465E-01	6.839E-01	3.218E-01	5.543E-01	2.326E-01	0.541
1999	3.667E-01	1.954E-02	5.33%	2.242E-01	5.695E-01	2.863E-01	4.643E-01	1.780E-01	0.485
2000	4.198E-01	1.644E-02	3.92%	2.666E-01	6.328E-01	3.341E-01	5.167E-01	1.826E-01	0.435
2001	4.057E-01	1.183E-02	2.92%	2.730E-01	6.005E-01	3.400E-01	5.029E-01	1.629E-01	0.402
2002	4.034E-01	9.406E-03	2.33%	2.891E-01	5.909E-01	3.471E-01	5.000E-01	1.529E-01	0.379
2003	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2004	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2005	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2006	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2007	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2008	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2009	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2010	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402
2011	2.702E-01	7.877E-03	2.92%	1.818E-01	3.999E-01	2.264E-01	3.349E-01	1.085E-01	0.402

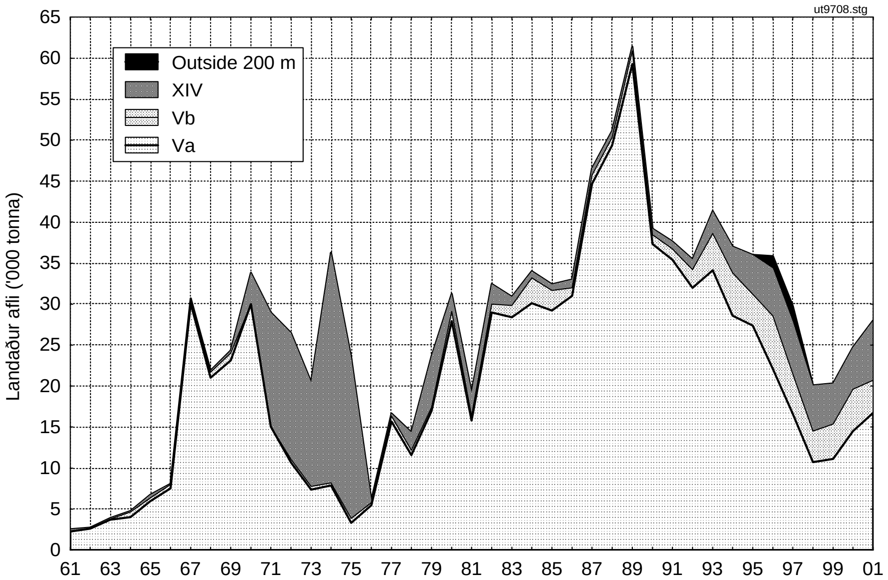


Figure 6.1.1 Landings of Greenland halibut in Divisions Va, Vb and Sub-area XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

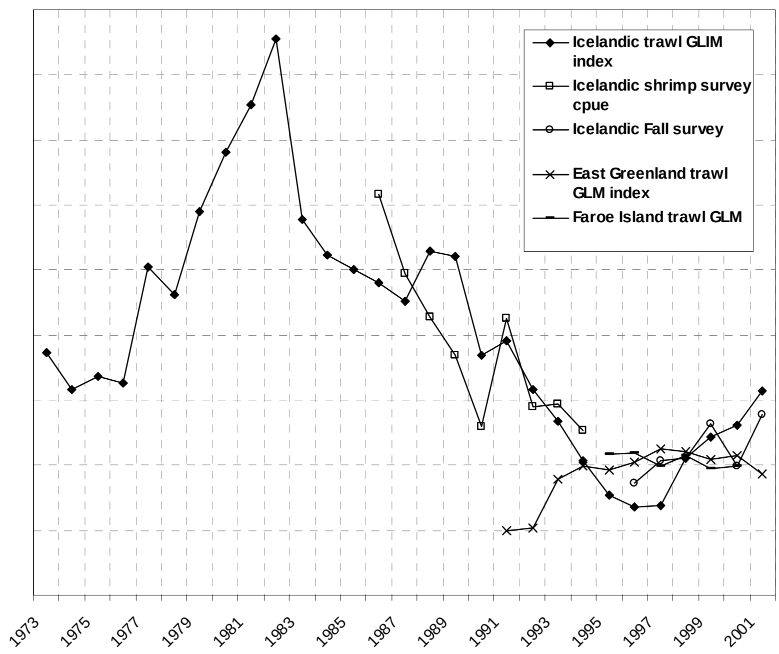


Figure 6.2.1 Various commercial and survey indices of Greenland halibut.

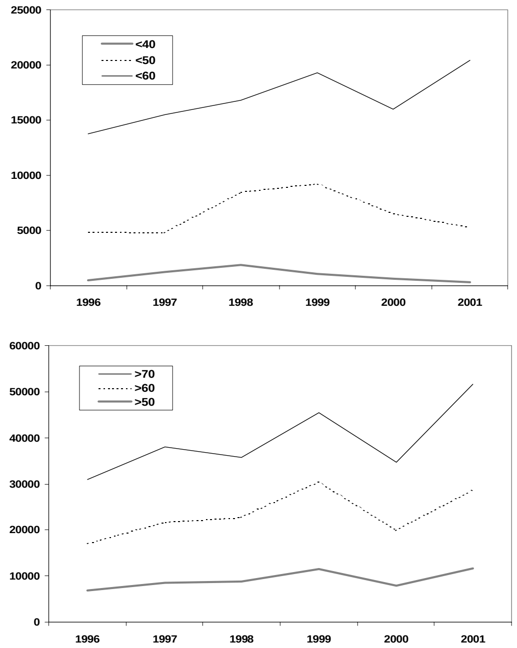


Figure 6.6.1 Greenland halibut in Icelandic fall groundfish survey a) abundance indices by lengths smaller than indicated and b) biomass indices of lengths larger than indicated.

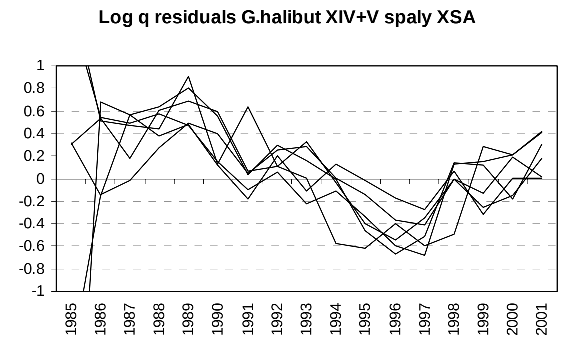


Figure 6.7.1.1 Log q residuals from an XSA using the same settings as in 2000 and 2001.

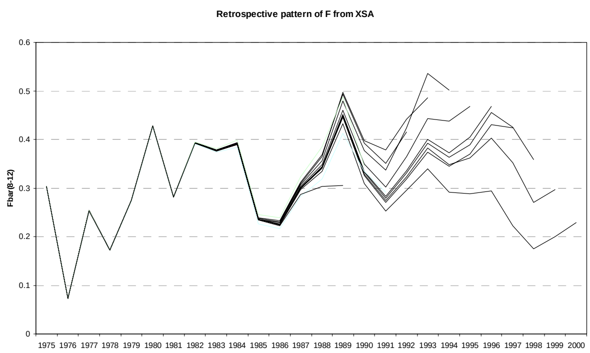


Figure 6.7.1.2 Retrospective pattern of Fbar(8-12) from XSA with same settings as in 2000 and 2001.

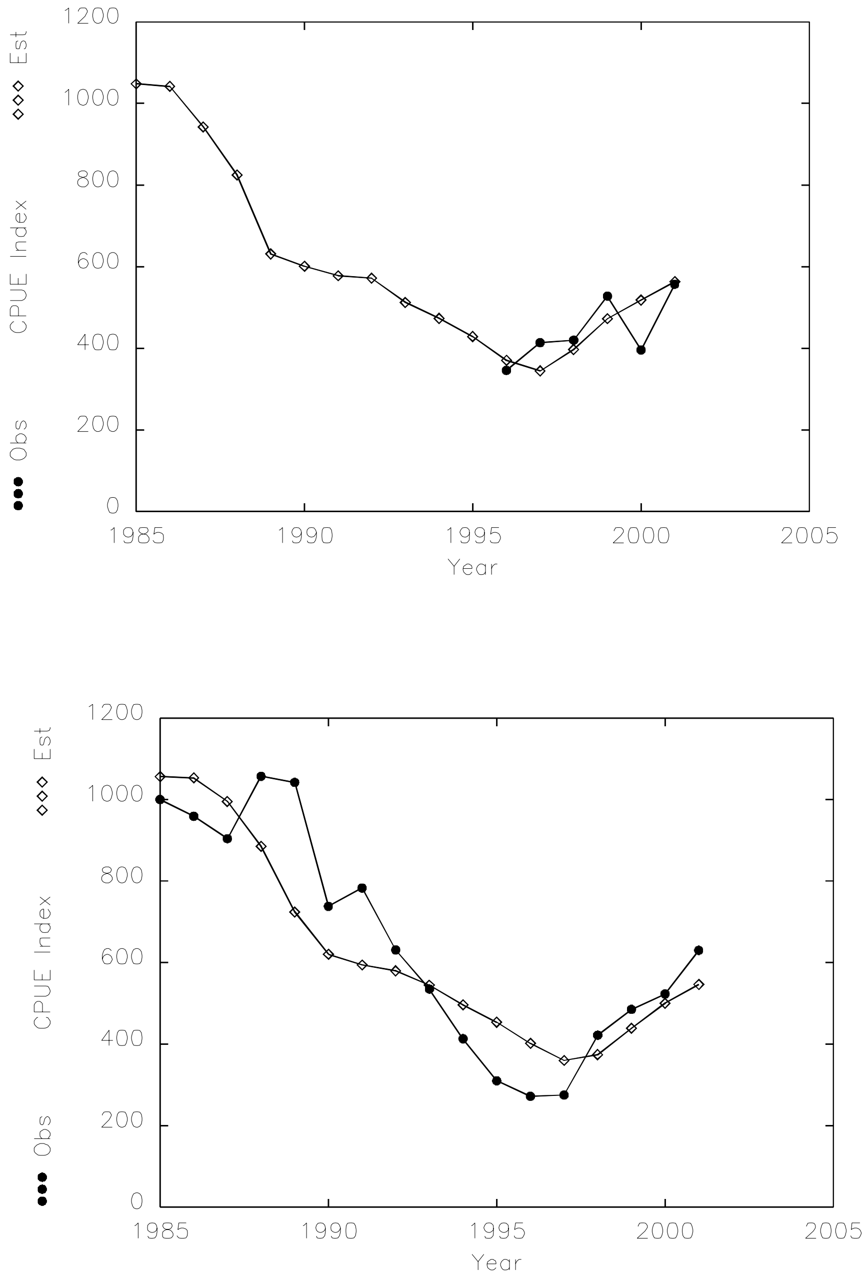


Figure 6.7.2.1 Observed and predicted CPUE's. Upper: Icelandic groundfish survey
Lower: Icelandic trawler CPUE

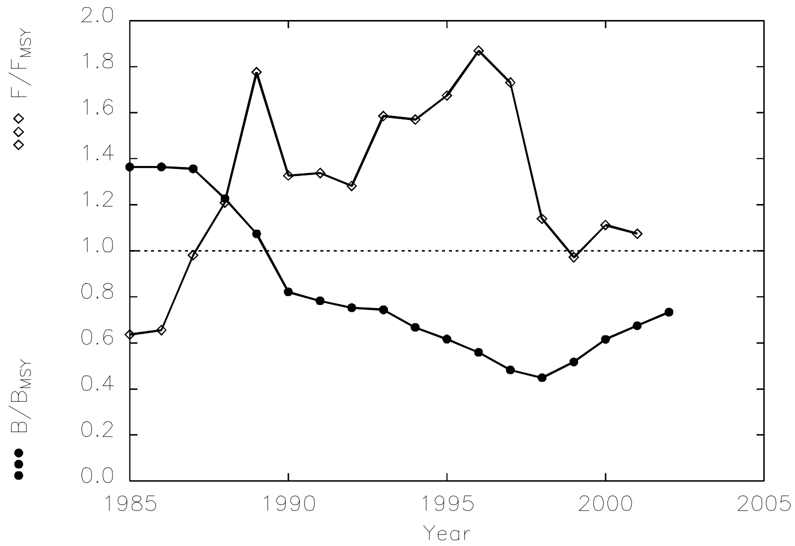
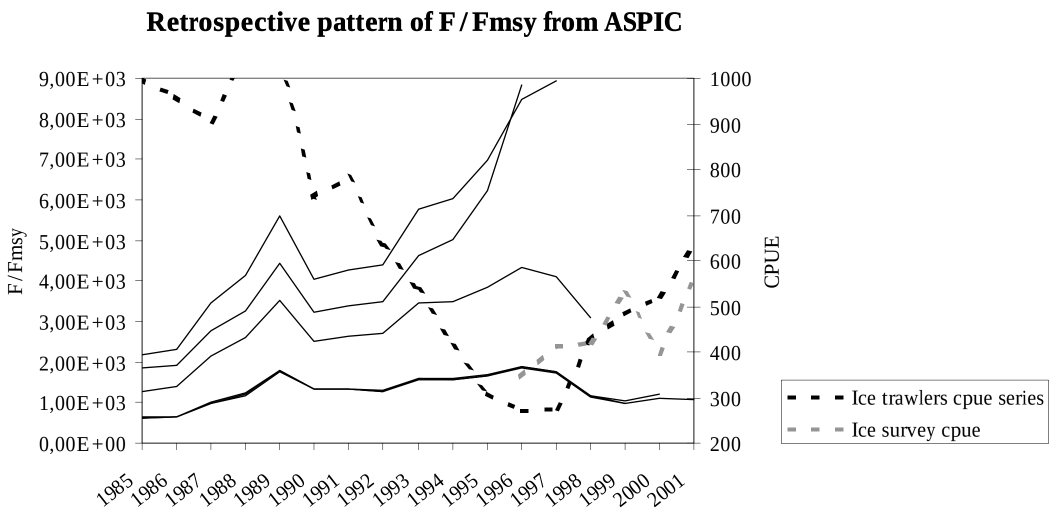


Figure 6.7.2.2 Output from ASPIC (Table 6.7.2.1.) with B/$\mathbf{B}_{MSY}$ and F/$\mathbf{F}_{MSY}$.



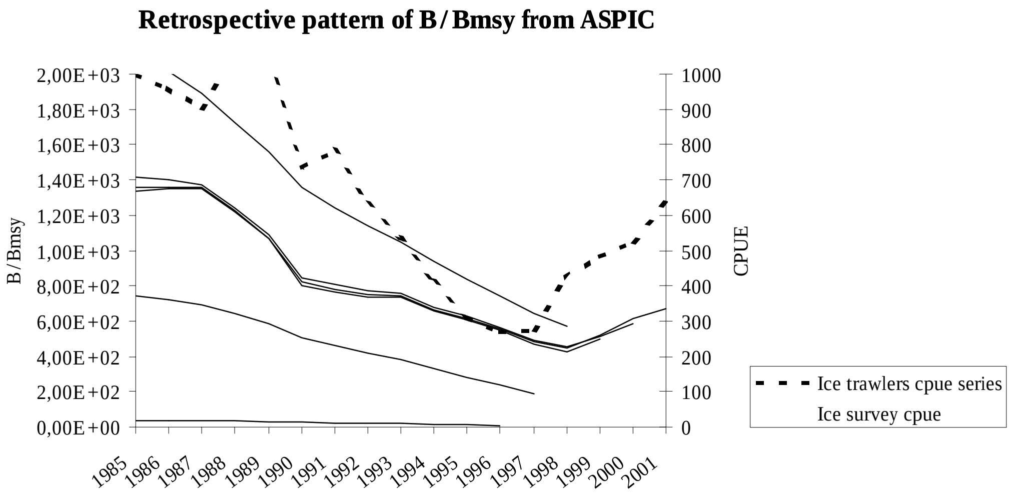
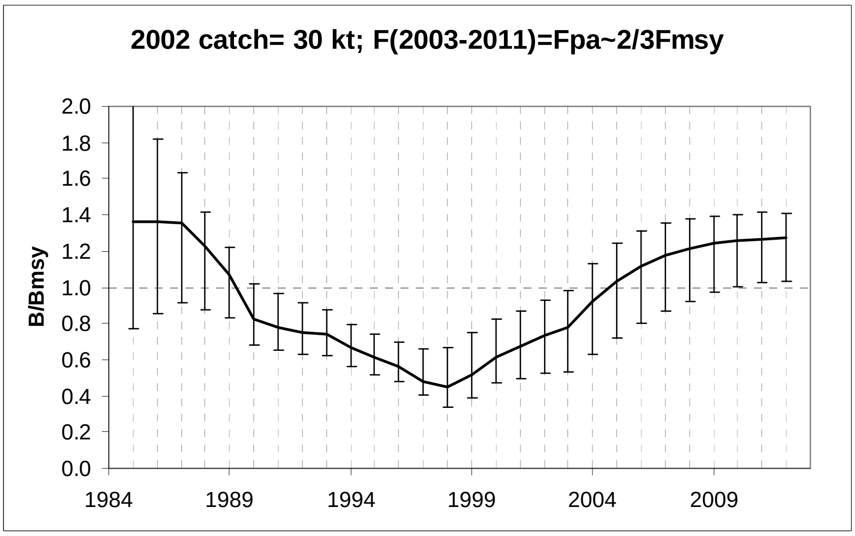
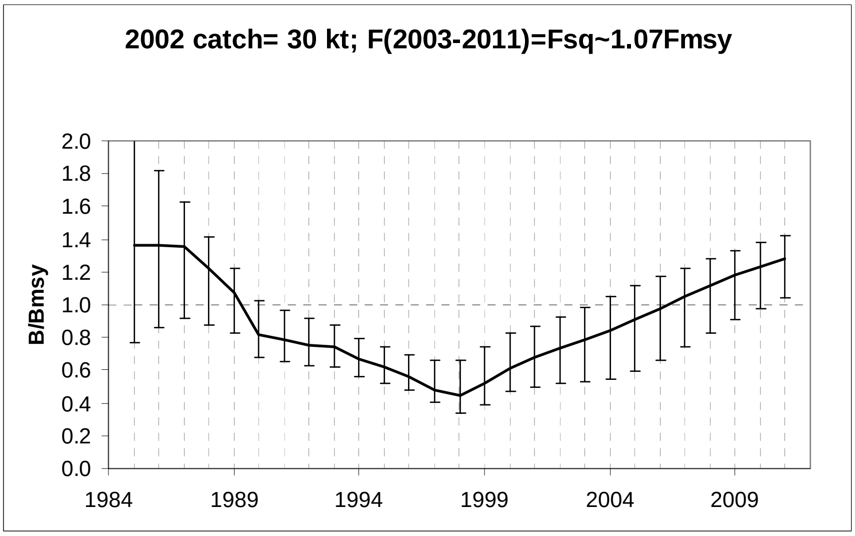


Figure 6.7.2.3 Retrospective analyses ASPIC model.





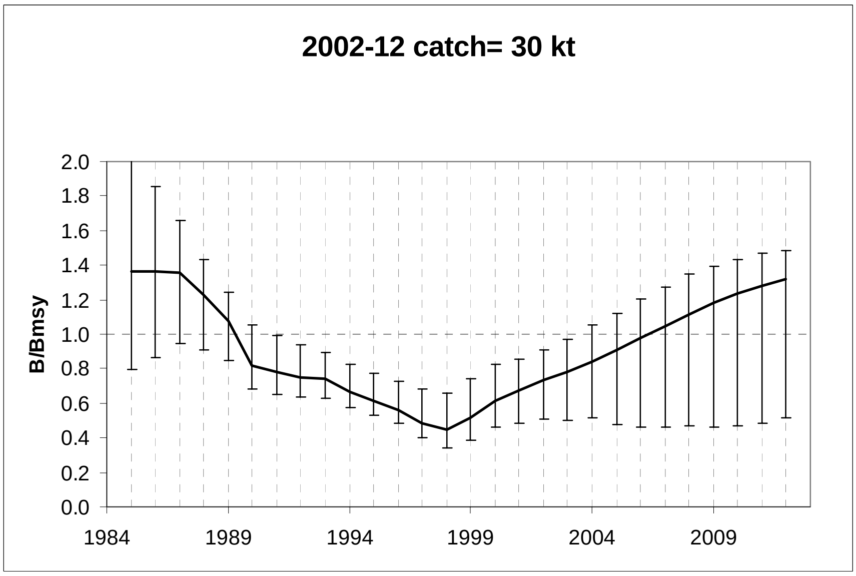


Figure 6.7.3 Biomass projections under 3 different options.

7 REDFISH IN SUBAREAS V, VI, XII AND XIV

The genus *Sebastes* is very common and widely distributed in the North Atlantic, where it is found off the coast of Britain, along Norway, in the Barents Sea and Spitzbergen, off the Faroe Islands, Iceland, East Greenland, West Greenland, and along the east coast of North America from Baffin Island to Cape Cod. All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter - late spring/early summer but copulation occurs in autumn-early winter.

7.1 Description of problems regarding stock identity of the species and stocks in the area

In ICES Subareas V, VI, XII and XIV there are at least 3 species of redfish, *S. marinus*, *S. mentella* and *S. viviparus*. The last has only been of minor commercial value. Iceland has started to fish *S. viviparus* in 2 small areas south of Iceland at depths of 150 - 250 m. The landings of *S. viviparus* decreased continuously from 1,160 t in 1994 to only 21 t in 2001.

During recent years, the existence of more than one stock of *S. mentella* in the area was discussed. Historically *S. mentella* was fished on the shelves and banks of the Faroe Islands, Iceland and East Greenland and was considered as one stock. With the start of a new pelagic fishery in the open Irminger Sea in 1982, a new stock was defined for management purposes for *S. mentella* inhabiting the Irminger Sea. In 1992, the Study Group on Redfish Stocks distinguished between these types as deep-sea *S. mentella* (shelf redfish) and oceanic *S. mentella* (Irminger Sea redfish). In the early 90's, the pelagic fishery in the open Irminger Sea moved to deeper layers beyond 500 m. Some researchers considered that some of the fish caught pelagically deeper than 500 m were different to those living shallower than 500 m and resembled more the deep-sea *S. mentella* living on the shelves. *S. mentella* living deeper than 500 m has been called "pelagic deep-sea *S. mentella*". Recently, it has become apparent that distribution of pelagic *S. mentella* in the upper 500 m has extended significantly south-westerly, compared with the early 1990's into the NAFO Convention Area. It is not known if these types are more than one stock and different hypotheses have been put forward:

A **single stock hypothesis:** All *S. mentella* from the Faroe Islands to the Grand Banks constitute one stock, segregated according to age/size.

A **two stock hypothesis:** *S. mentella* living on the shelves (deep-sea *S. mentella*) and that living in deeper pelagic waters of Irminger Sea (pelagic deep-sea *S. mentella*) constitute one stock unit which is separated from the oceanic *S. mentella* living in upper layers of the Irminger Sea.

A **three stock hypothesis:** The described components constitutes a distinct stock.

The uncertainty about stock identity is high but extensive research is presently ongoing (EU-QLK5-CT1999-01222). The project is an internationally coordinated research directed to answer important questions related to the biology and exploitation of the highly migratory and straddling redfish resources. The research focuses on three main areas: 1. "Population structure", 2. "Reproductive strategies" and 3. "Abundance and demography". In part 1, extensive work seeking for species and stock identification markers has been conducted and by now at least over 25 markers for stock identification have been found and for stock structure and stock origin analysis of *S. mentella* and *S. marinus* at least 10-13 suitable markers have been identified. Now, as markers have been found, continued screening will reveal whether the observed variations in such markers do represent stock structures.

In 1999, The Faroese Fisheries Laboratory initiated a research to study the stock structure *of S. mentella* in the North-East Atlantic. Sampling of *S. mentella* was carried out from different locations and depths in the Irminger Sea, off Iceland, Faroes and in the Barents Sea. Several different stock identification methods (incl. morphometrics, fatty acid analysis, electrophoresis and DNA analysis) were applied on the same fishes by researchers from several countries. Some of the analyses are finished and the results (i.e. from the fatty acid analysis and electrophoresis) have been submitted for publication. Some results have been presented supporting multi-stock theory (Joensen 2001) and will be available within the next months as a part of a Dr. Scient thesis.

7.2 Nominal catches and splitting of the landings into stocks

The official statistics sent to ICES do not report catch by species/stocks (Tables 7.2.1 - 7.2.5).

Various information (i.e. proportion in samples taken from different fishing areas, information on products etc.) from different laboratories is used to split catches into species/stock. The technique and data for such splitting was described in the 1998 NWWG report.

7.3 Abundance and distribution of 0-group and juvenile redfish

Available data on distribution patterns of 0-group and juvenile *S. marinus* indicate that there are nursery grounds in Icelandic and Greenland waters only. No nursery grounds are known around the Faroe Islands. In the 1983 Redfish Study Group report (ICES C.M. 1983/G:3) and in Magnússon and Jóhannesson (1997), the distribution of 0-group *S. marinus* off East Greenland was evaluated, showing that there are considerable amounts of *S. marinus* at East Greenland mixed with *S. mentella* (Magnússon et al., 1988 and 1990) in variable proportions in different sub-areas and periods (ICES CM 1998/G:3). In Icelandic waters, nursery areas for *S. marinus* are found mostly west and north of Iceland at depths between 50 and approximately 350 m, but also in the South and East (ICES C.M.1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As length (age) increases, migration of young *S. marinus* along the north coast to the west coast takes place towards the most important fishing areas around Iceland.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970 – 1995. Thereafter, the survey was discontinued. Above or average year class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

Abundance, biomass indices and length compositions have been derived using German annual groundfish surveys covering shelf areas and the continental slope off West and East Greenland down to 400 m depth (WD 11). Due to difficult identification, juvenile redfish (< 17 cm) were only classified to genus as *Sebastes spp.* Trends in survey abundance for juvenile redfish (< 17 cm) are shown in Figure 7.3.1 for West and East Greenland. Since 1993, *Sebastes spp.* were very abundant and distributed mainly off East Greenland. The 1999-2001 survey results indicate low abundance and biomass, similar to those observed in the late 1980's.

7.4 Discards and by-catch of small redfish

7.4.1 Discards of redfish in East and West Greenland

An offshore shrimp fishery with small meshed trawls (44 mm) began in the early 1970s off the west coast of Greenland and expanded to the east coast in the beginning of the 1980s, mainly on the shallower part of the Dohrn Bank and on the continental shelf from 65° N to 60° N. Observer samples derived from the Greenland Fishery Licence Control showed that redfish is a bycatch in the shrimp fishery off Greenland. There was no information available to quantify the by-catches and their length composition in recent years. Since the 1st of October 2000, sorting grids have been mandatory but their actual effect on the bycatch in the commercial fishery has not yet been documented.

7.5 Special Requests

In the ToR for the Working Group, there are several questions regarding stock structure, distribution and fishery information of *S. mentella* in the area. The following paragraphs deal with ToR c, e, and f and special request b) and c) from NEAFC. Under different redfish chapters, the Working Group also deals with these questions, in some cases in more detail.

ToR c) Detailed descriptions of the fishery of different nations are given in chapters 8.2, 9.2 and 10.2, based on various working documents. WD07 gives the geographical fishery overview of five nations which together are fishing over 70% of the total catches in recent years. Figure 7.5.1 shows the geographical distribution of the catches by months in 2001 and Figure 7.5.2 gives the distribution by year from 1995-2001. Based on data from these nations (Germany (1995-2001), Iceland (1989-2001), Norway (1990-2001), Russia (1999-2000) and Greenland (1999-2001)) it was concluded that the fishing pattern has been similar in the last four years. WD 4 gives the locations of a part of the Spanish fishery in the Irminger Sea, and it shows that they had same pattern in 2001 as the above-mentioned fleets (Figure 7.5.3). The same applies for the Russian fleet in 2001 (Figure 7.5.4).

Fishing started in April, and up to the end of June, it was prosecuted in area east of 32°W and north of 61°N. In July and August, the fleet moved about 400-500 nautical miles to areas south of 60°N and west of about 36°W where the fishery continued until October. In the third quarter of the year, the fishing has, in general, moved towards the southern part of the area within Sub-area XII as well as in the NAFO Convention Area, both outside and inside the Greenlandic EEZ. There has traditionally been very little fishing activity from November until late March, and in 2000/2001 no activity was reported during that time.

Although no depth information from all fishing nations was available, the general pattern is that the fishing in the first and second quarter of the year in the north-eastern part is mostly conducted deeper than 500 m. Haul depth data from Spain, Faroe Islands, Greenland and Iceland confirms this (WD's 4,8,15). In the third quarter, fishing occurs mostly at depths shallower than 500 m. Further, although no depth data on haul-by-haul information of the German catches were available, WD12 describes that the fishery in the first two quarters was characterised by fishing deeper than 500 m and at shallower depths during the third and fourth quarters in 1995-2001.

However, it is important to note that the described fishing pattern of the different fleets has changed significantly prior to 1996 mainly in terms of area and depth expansion. The reasons for such changes do not necessarily reflect stock changes only but might also be due to commercial considerations.

Although the fish in all seasons are sexually mature, the mean length in the second half of the year, in Sub-area XII and in NAFO Convention Area is about 8 cm shorter than in the first half of the year in Subarea XIV (Figure 7.5.5).

As has been reported in earlier reports of the working group, Iceland has classified its pelagic catches between oceanic and pelagic deep-sea redfish according to a contentious method. The results of this classification have shown that the proportion of fish classified as oceanic type redfish did decrease from about 70% in 1995 down to only about 5% in 2000. In 2001, the percentage did increase again up to about 1/3 of the catch, this being largely a result of increased effort in the south-western fishing area at depths shallower than 400m. Based on the samples, the results indicate that at depths shallower than 500-600 m, the proportion “oceanic” is between 85-100%, and the proportion deeper than 600 m is usually between 0-20%. The increase in 2001 is due to the effort regulations in the fishery. Each vessel was forced to fish at least 1/3 of it’s catches south of around 62°N in order to spread the effort.

The above observations indicate that in last three years a) the fishery in the north-eastern area in the first half of the year is occurring at depths deeper than 500 m and catching larger fish, and b) the fishery in the south-western area in the second half of the year is mainly occurring at depths shallower than 500 m catching smaller fish.

The working group recommends that NEAFC requests all nations participating in the pelagic redfish fishery to provide ICES with information on the trawling depth (headline depth for each haul as a log-book data), so ICES can give a more detailed description of the fishery by season and areas as a basis for advice on this resource.

ToR e and NEAFC special request b) and c). New information presented at the meeting (WD19 and WD17) supports the one stock theory. WD19 deals with analysis of genetic material and WD17 deals with analysis of biological characteristics and peculiarities of infestation with parasites. Genetic structure of the species was also the issue of a newly published article (Roques et. al, 2002), concluding that there is a lack of genetic differences and lack of genetic isolation by geographic distance among samples from the Panoceanic zone, from the Faroe Islands to the Grand Banks. In an ICES paper (Joensen 2001), results based on chemometry of the fatty acid profile in selected tissues supports a multi-stock theory. Based on the available information and information described in previous working group reports and published articles, the NWWG concluded that there are still uncertainties in the stock structure of *S .mentella* in ICES Sub-areas V, XII and XIV and the NAFO Convention Area (see Figure 7.1). In accordance with the precautionary approach the units should at present, be managed such that each component is not overexploited. This implies that fishing effort and catches should be spread out.

ToR f) Limited information is available for describing the distribution of the stock(s) in the area throughout the year and the new information from the international trawl-acoustic survey in 2001 does not add much to the current knowledge. Information from various acoustic estimates in recent years only describes the distribution at one time of the year (June/July). Information from the fishery of various nations cannot be used alone as a description of the distribution. These sources are thus not considered adequate to describe the seasonal distribution of the various components. In chapter 10, a description of the distribution from the 2001 international acoustic survey and description of the fishery are given. Compared with acoustic results in June/July 1999, the pelagic redfish shallower than 500 meters is now found more westerly and southerly, into the NAFO Convention Area (see Figure 10.3.2). In 1999 and 2001, about one third of the stock was distributed in the NAFO Convention Area. Substantial fishery in NAFO Convention Area was also observed in 2001. In the data available to the working group, all information supports that the fishery in the NAFO Convention Area is from the same stock as fished in western part of ICES Sub-area XII (WD4,WD6, WD8, WD 13, WD16).

Table 7.2.1 REDFISH. Nominal catches (tonnes) by countries, in Division Va 1994-2001, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001[*]
Belgium	50	-	-	-	-	-	-	
Faroe Islands	202	521	309	242	280	255	210	
Germany	46	229	233	-	284	428	513	844
Iceland	95,091	89,474	67,757	73,976	108,380	81,430	84,870	64,889
Norway	-	-	134	-[*]	-[*]	18[*]	36*	26
UK (E/W/NI)	-	-	-	-	-	542	…	
UK (Scotland)	-	-	-	-	-	149	…	
United Kingdom							-	1,144
Total	95,389	90,224	68,433	74,218	108,944	82,822		

[*]Preliminary.

Table 7.2.2 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1994-2001, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001[*]
Faroe Islands	8,872	7,978	7,286	7,199	6,484	6,191	5,748	
France	90	111	62	98	110[*]		282[3]	
Germany	155	91	189	36	-	207	79	88
Norway	34	36	33	25	39	37	43	25
Russia	3	-	-	-	-	-	12	54
UK (E/W/NI)	1	2	40	+	4	15	111	….
UK (Scotland)	18	24	43	36	27	46	142	…
United Kingdom							253	208
Total	9,173	8,242	7,653	7,394	6,664			

[*]Preliminary.

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries, in Division VI 1986-2001, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001[*]
Faroe Islands	-	2	-	12	-	44	0	
France[1]	555	529	489	395	297[*]			
Germany	87	5	9	1	1	+	+	
Ireland	-	4	-	10	10	34	54	1
Norway	2	1	7	6	3[*]	8[*]	11	5
Portugal	-	-	-	-	1	-	-	
Russia	-	-	-	-	-	243	461	33
Spain						38	4	
UK (E/W/NI)	9	105	54	19	12	4	20	…
UK (Scotland)	118	500	603	518	364	762	405	…
United Kingdom								530
Total	771	1,146	1,162	960	732			

[*]Preliminary. [1]Golden redfish.

Table 7.2.4 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1986-2001, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001*
Estonia	17,875	16,854	7,092	3,720	3,968	2,108	4,000	
Faroe Islands	2,896	3,897[3]	5,424[3]	3,420[3]	5,681[3]	4,656[3]	2,833[3]	
France	-	-	-	-	3*			
Germany	6,354	9,673	4,391	8,866	9,746	8,204	1,128	3,877
Greenland	-	1,856	3,537	…	1,180*	1,188*		
Iceland	17,892	19,577	3,613	3,856	1,311	5,072	3,121	
Latvia	13,205	5,003	1,084	-	-	-	-	
Netherlands	-	13	-	-	-	-	-	
Norway	4,514	3,893	1,013	31	602	2,040*	2,158*	879
Poland	-	-	-	662	-	-	-	
Russia	10,489	34,730	606	-	89	7,682	9,243	4,509
Spain	-	20	410	1,155	2,231	1,723	576	
UK (E/W/NI)	-	-	33	-	+	187	…	…
UK (Scotland)	-	-	13	-	-	1	+	…
United Kingdom							-	
Total	73,225	95,086	24,919	22,112	20,923	28,749		

*Preliminary. [1]Includes 720 t Beaked redfishes, [2]Beaked redfishes. [3] Revised according to NEAFC statistics.

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1986-2001, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000	2001*
Estonia	-	-	-	-	-	-	3,811	598
Faroe Islands	164	8	298	123	47	2	4	
Germany	22,406	9,702	16,996	11,610	9,709	8,935	7,840	6,760
Greenland	422	2,936	2,699	193	296*	3,152*		
Iceland	29,114	8,947	49,381	33,820	6,441	23,770[3]	17,999	27,744
Norway	2,546	2,890	6,453	3,187	525	3,253	3,803*	4,258
Poland	-	-	-	114	-	-	-	
Portugal	1,887	5,125	2,379	3,674	4,133	4,302	4,154	2,514[4]
Russia	13,917	9,439	45,142	36,930	25,748	16,652	14,851	23,851
Spain	-	4,534	3,897	7,552[1]	4,660	4,175	2,657	
UK (E/W/NI)	138	48	247	28	43	68	…	
UK (Scotland)	4	10	6	-	-	-	…	
United Kingdom							45	
Total	70,598	43,639	127,498	94,477	51,602	64,309		

*Preliminary. [1]Includes 3,718 t Beaked redfishes. [2]Beaked redfishes. [3]Note Excluding 58 t reported as area unknown. [4]Reported as V/XII/XIV.

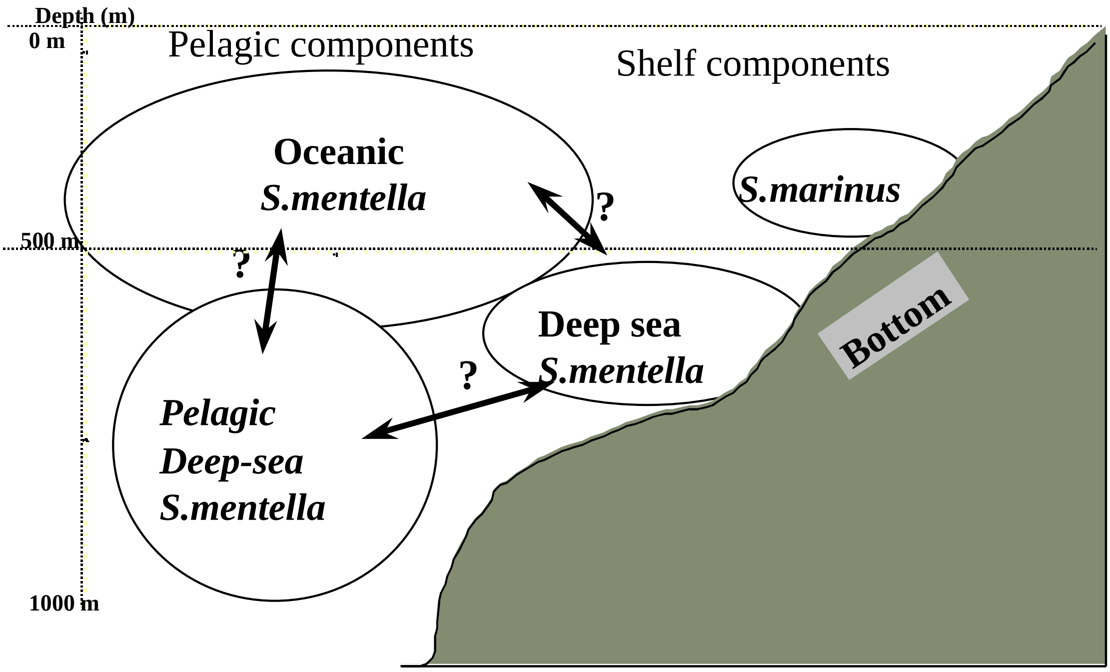


Figure 7.1 Schematically possible relationship between different stocks of redfish in the Irminger Sea and adjacent waters.

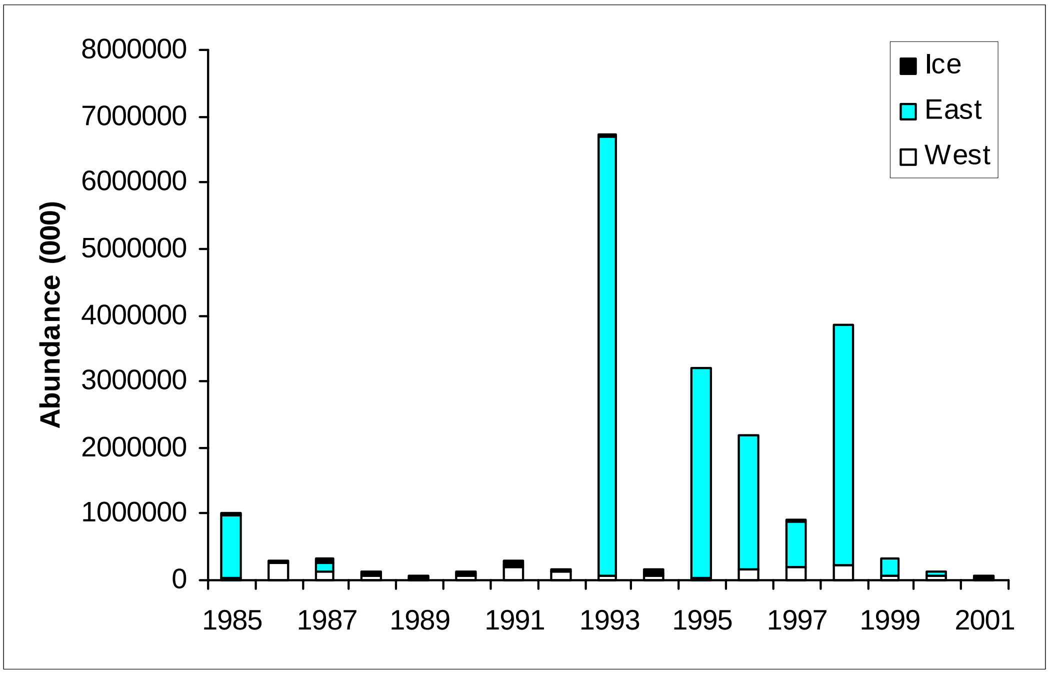


Figure 7.3.1 *Sebastes spp.* (<17 cm). Survey abundance indices for East and West Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985-2001.

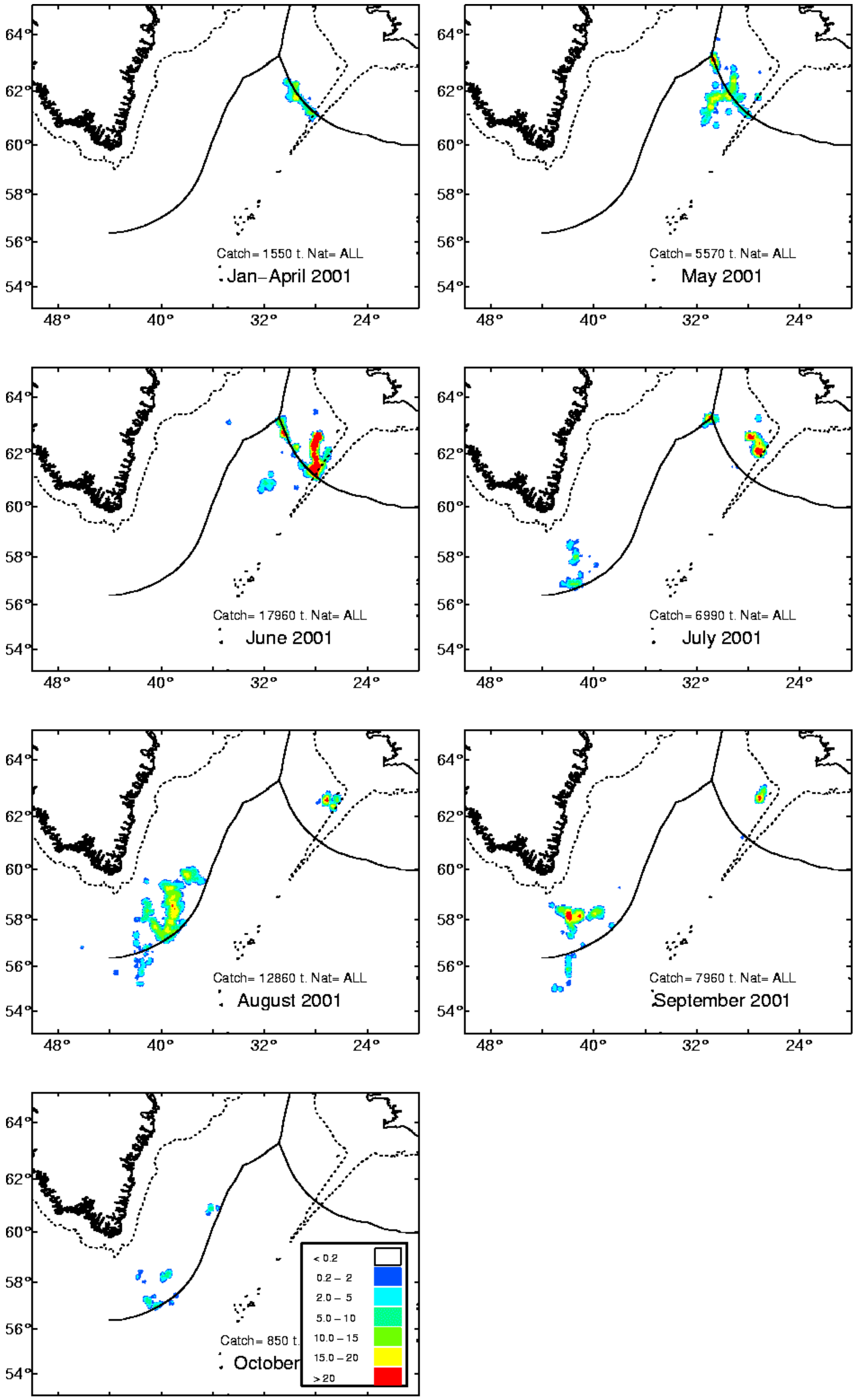


Figure 7.5.1 Fishing areas of the pelagic redfish by periods in 2001, including data from Germany, Iceland, Greenland and Norway. The scale given on the pictures indicates the catches in tonnes per square nautical mile. Total catch registered for each period is also shown on the figures.

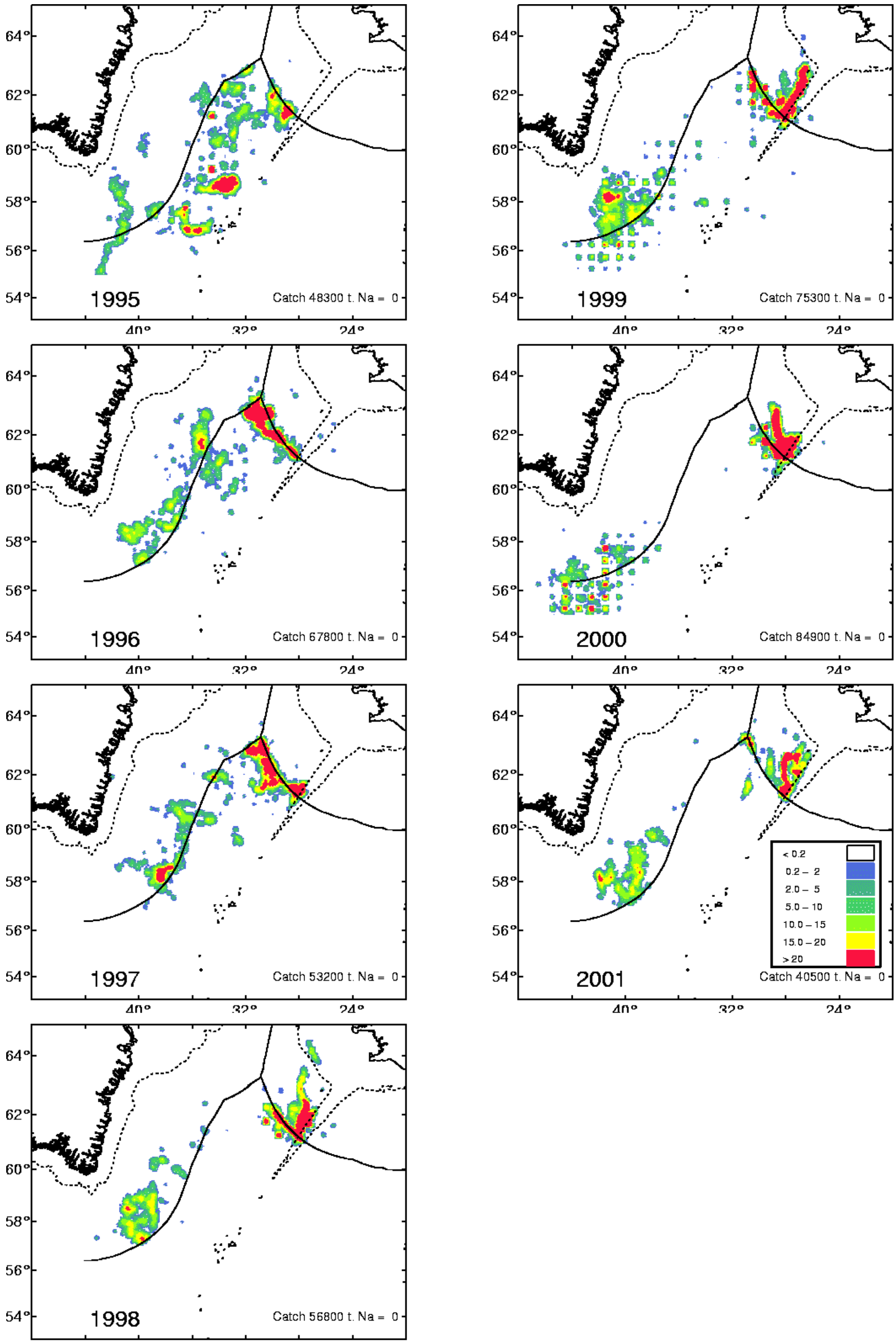


Figure 7.5.2 Fishing areas of the pelagic redfish by year from 1995-2001. Data from Germany (1995-2001), Norway (1995-2001) Greenland (1999-2001), Russia (1999-2000) and Iceland (1995-2001). The scale given on the pictures indicates the catches in tonnes per square nautical mile.

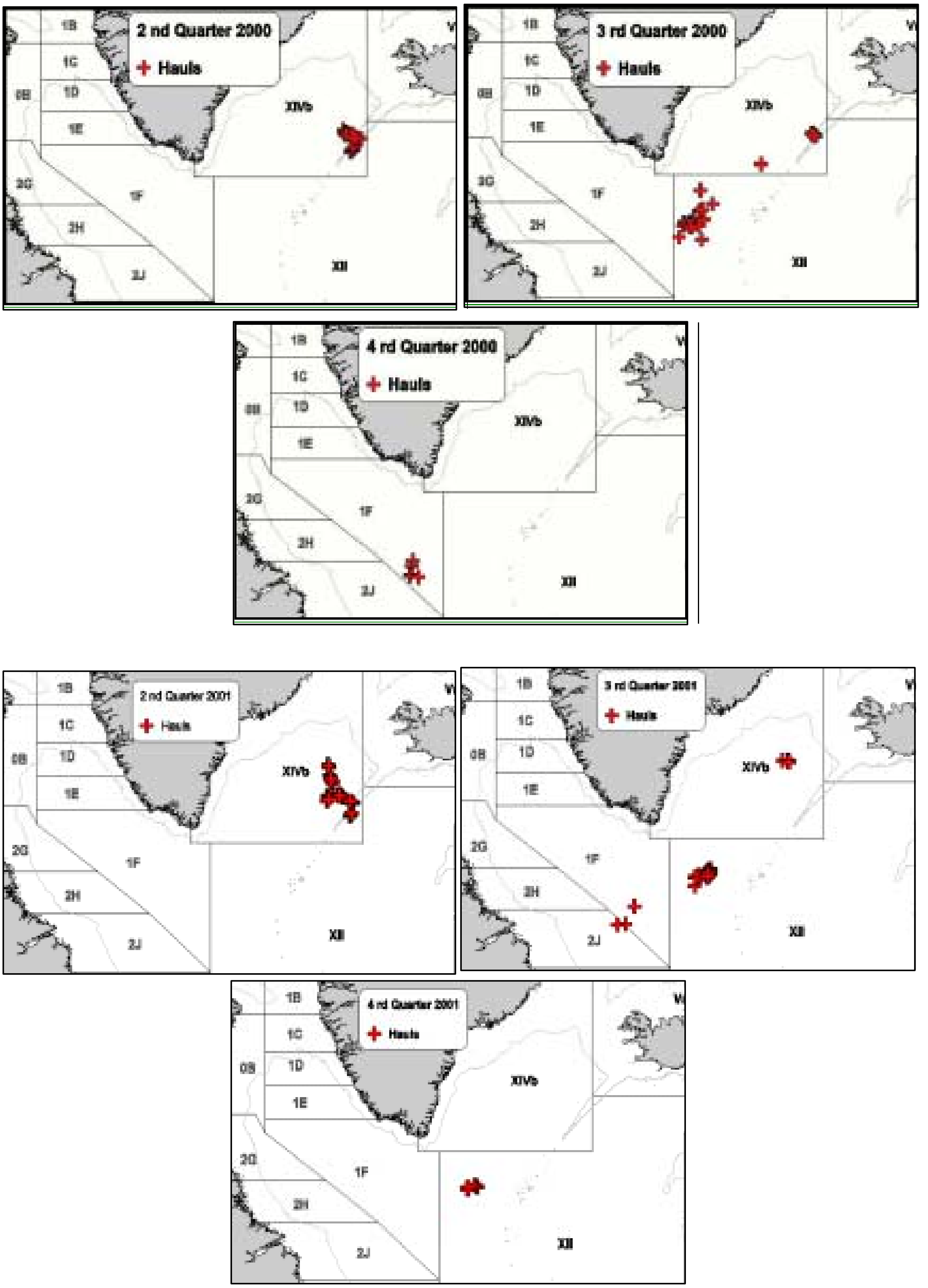


Figure. 7.5.3 Fishing effort distribution of the Spanish oceanic redfish fishery in 2000-2001 by Divisions by quarter.

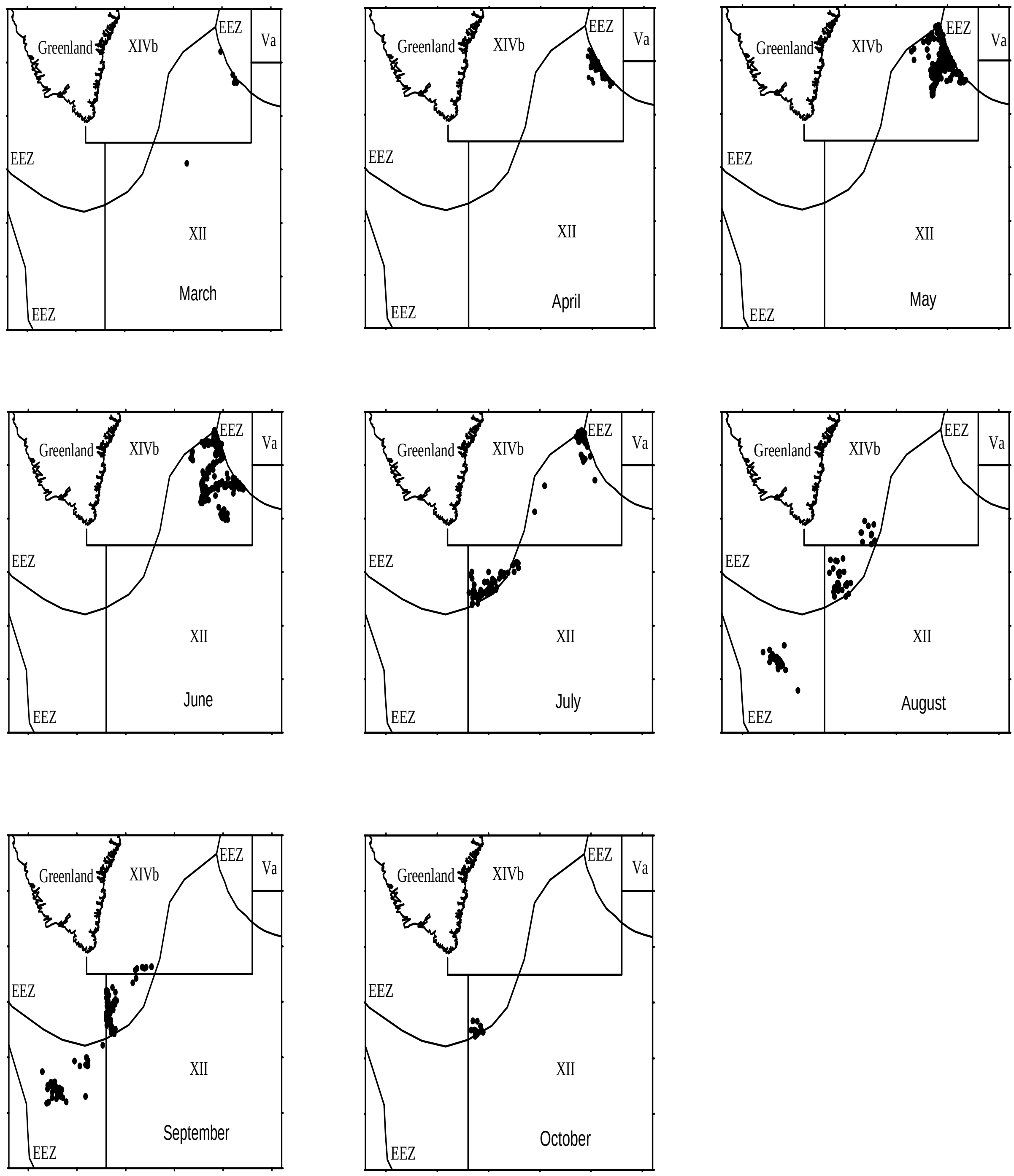


Figure 7.5.4 Russian fleet monthly position in the Irminger Sea in 2001.

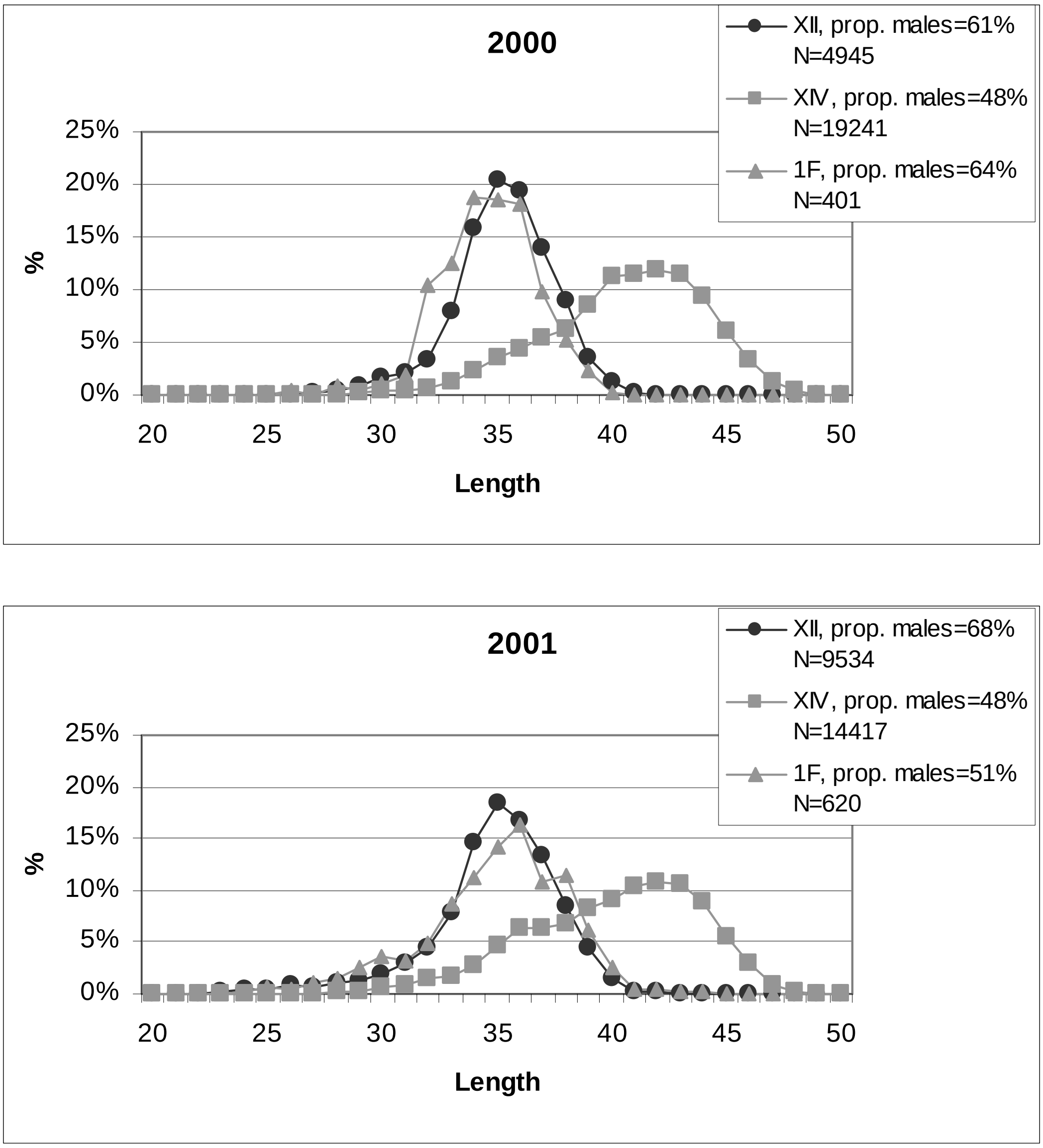


Figure. 7.5.5 Length distribution of the Spanish oceanic redfish fishery in ICES Divisions XII, XIV and in NAFO Division 1F in the year 2000 and 2001. The proportion of males is also given.

8 SEBASTES MARINUS

8.1 Landings and Trends in the Fisheries

Since the early 1980'ies total catches have decreased more than 70%. from about 130 000 t in 1982 to 37 000 t in 2001 (Table 8.1.1In recent years catches have been stable around 40 000 t, a slight increase in 1999-2000 are due to increased catches in Sub-areas Va and VI (Table 8.1.1).

The catches of *S. marinus* in Va in recent years are the lowest since 1978. Catches declined from about 63 000 t in 1990 t, to a low (34 000 t) in 1996. Since then catches varied between 35 000 and 41 000 t, with the lowest catch in 2001. The low catch in 1994 was partly due to area closures imposed on the fishery by Iceland in order to reduce the catches of *S. marinus,* and to reduce the effort on the nursery grounds. However, landings in 1995 increased to approximately 42 000 t. The length distributions in the Icelandic landings in 1989-2001 along with measurements from the commercial trawler fleet are shown in Figure 8.1.1. Number of measured fish by statistical square are given in Figure 8.1.2, and the fishing grounds are shown in Figure 8.1.3. About 90-95% of the total *S. marinus* catches in area Va have in recent years been taken by bottom trawlers (both fresh fish and freezer trawlers; length 48-65 m) targeting on redfish. The remainder is taken partly as bycatch in gillnet and longline fishery. In 2001, as in previous years, most of the catches were taken along the shelf of W, SW and to SE of Iceland, mostly between 12ºW and 27ºW (Figure 8.1.3).

In Division Vb, catches have dropped continuously since 1985 from 9 000 t to 1 500 t in 2001. (Table 8.1.1). Most of the *S. marinus* catches in Vb have been taken by pair trawlers and single trawlers (< 1000 HP). The CPUE decreased from 1996-1999 by 40% and has been low in 2000 and 2001 with 13 and 8% of the 1999 value, respectively (Figure 8.1.4). No length distribution from the catches was available for 2001.

The catches in Sub-area VI increased since 1978, reaching almost 600 t in 1987, followed by a decline to 1992 and since increased to about 800 t (Table 8.1.1) in 2000 and 500 t in 2001. No length distribution from the catches was available for 2001.

In Sub-area XIV catches have been more variable than in the other Sub-areas and Divisions. Since the highest catch on record (31 000 t), in 1982 a rapid decrease was observed to about 2 000 t in 1985. During the next 10 years catches varied between 600 and 4 200 t. In 1995-1997 almost no directed fishery for *S. marinus* or *S. mentella* occurred. A minor directed fishery occurred in 1998 and catches increased to 175 t. In 2000 and in 2001 the catch is estimated to be less than 100 t. from direct redfish fishery of large bottom trawlers targeting at *S. mentella*. Some bycatch is reported from the shrimp fishery in the area.

The following text-table shows the fishery related sampling by gear type and Divisions.

Area	Nation	Gear	Landings	Samples	Fish measured
Va	Iceland	Bottom trawl	34,693	262	52,444
Va	Germany/UK	Bottom trawl	232		
Va	Faroe	Line/hooks	62		
Vb	Faroe	Bottom trawl	1,513		
XIV	Germany	Bottom trawl	88		
VI	UK	Bottom trawl			
XIV	Norway	Longline			

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey (IGS), data (<400 m depth). The index is a biomass index of the fishable stock, computed by using a sharp fishable stock ogive (from 34-36 cm, L_{50} = 35 cm) The survey (see Pálsson *et.al*, 1989) is stratified (Figure 8.2.3). In Table 8.2.1 the contribution of each stratum to the index is given. The index indicates a decrease in the fishable biomass from 1999, and is now comparable with 1996-1998. The lowest index was in 1995, only about 30% of the maximum in 1987. The increase in the survey index in 1999 was not supported by the results in March 2000 and 2001, but in 2002, the index increased significantly. The results since 1995 might indicate that the catchable biomass estimate have been increasing slowly from the record low index of 1995.

Length distributions from IGS show that the peak (Figure 8.2.4) which has been followed during the last years (first in 1987) now has reached the fishable stock. The increase in the survey index since 1995 therefore reflects the recruitment of a strong year class (1985 year class and the 1990 year class). This indication of strong year classes is also confirmed by age readings.

The 1985 year class has dominated the catches since 1995 (Figure 8.2.5), and in 2001 that year class contributed to almost 30% of the total catch in Va. The survey results have also shown that 1990/1991 year classes are also strong, and contributing with nearly 30% of the total weight in the catch in 2001, indicating that it might be at similar size as the 1985 year class was at similar age. The 1990 year class (age 11) contributes about 15% of the total catches in 2000, according to the age readings. The average Z, estimated from this 7 year series of catch at age data is 0.24 for age groups 15+ and about 0.21 for age 20+. In WD 11 in the NWWG report 2001, age reading results are compared between readers and otolith preparation methods in terms of bias and precision. There were significant differences between readers and between methods, mainly for the older fish (> 20 years). Precision estimates, involving the high longevity of redfish, were relatively good compared to previous age reading comparisons on redfish species.

CPUE indices for the Icelandic trawl fleet for the period 1985-2001 are estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effect. All hauls at depths above 500 m with redfish exceeding 10% of the total catch, were included in the CPUE estimation (Figure 8.2.6). Also, a simple CPUE was calculated (sum of catch / sum of hours trawled for each year, each haul where redfish exceeded 10% of the total catch in each haul). The results from the trawler fleet reflect the situation shown in the groundfish survey. Although the CPUE was low in recent years it increased in 1997 and was relatively stable in 1998-2000. A considerably increase was observed in 2001 and the GLIM index is now above 80% of the1986 value, which is the first year in the series. The raw index is now higher than it was in 1986.

In summary, the Icelandic groundfish survey, as well as the CPUE series, seem to indicate a considerable decline in the fishable biomass of *S. marinus* during the period from 1986 to 1994. The stock seems to have started to recover but it is still low according to the survey index. A large proportion of the catches in recent years is caught from two year classes.

The Icelandic groundfish survey indices (U) may be assumed to be related to overall biomass (B) by a simple linear relationship (U=kB). If catches are assumed to be proportional to stock size and effort (Y=cEB), then it follows that catch over survey index is proportional to effort (Y/U=aE, see Table 8.2.3) and this allows a one-year prediction of catch, assuming a status-quo effort level.

Although calculated confidence limits in the groundfish survey are quite low, year to year variation in catchability/availability will affect the results drastically while using only the last observation value as a basis for extrapolation of catches in the coming year, based on a constant effort. By using a running average over few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions. The following text table gives the running mean of the IGS index given in Table 8.2.3.

The following text table gives the running mean of the IGS index given in Table 8.2.3.

	Year															
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3 year running average	1097	1053	986	810	704	567	493	464	406	438	471	539	598	577	536	503

In Division Vb, CPUE of *S. marinus* were available from the Faroes groundfish survey 1983- 2000. After an increase in the period from 1995-1998 there is a decrease in 1999 -2000. The results also indicate a high variability in the series, and the values are based on only 43 hauls each year (20-61 hauls). The value in 1999 - 2000 is only about 70% of the average value for the whole period since 1983 (Figure 8.2.7).

The new Faroes summer survey (see chapter 2) that has been conducted since 1996 shows a constant decreasing trend throughout the series. The index in 2000 and 2001 is only about 1/3 of the CPUE in 1995 and about the same level as in 1999 and 1998 (Figure 8.2.8).

For the period 1982-2001, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm are illustrated in Figures 8.2.8 and 8.2.9. From 1986-1995, an almost continuous reduction in survey biomass has occurred. However, in 1998 and 2000 a weak signal of possible recovery was observed, although the values are very low compared with the period before 1990. It can be taken from Figures 8.2.8 and 8.2.9 that redfish around Greenland were mainly distributed off the East coast, as the abundance and biomass indices off West Greenland decreased to almost zero. The length frequencies from the German groundfish survey are illustrated for West and East Greenland in Figures 8.2.11-8.2.12, along with the length distributions in the IGS. The adults seem to remain almost depleted in East Greenland waters.

During the Greenland halibut survey (400-1500m) in XIVb in June/July 2000, *S. marinus* was only observed between 400 and 600 m. *S. marinus* was caught in 12 of the 55 hauls taken. The length distribution ranged from 19 to 54 cm with a peak in the length of 29 cm. The survey was not conducted in 2001.

8.2.2 Alternative assessment methods

At the 1999 working group meeting, an alternative model (BORMICON(BOReal MIgration and CONsumption model)) was applied to the stock. The model is described in WD 18 in ICES CM 1999/ACFM:17 and has been presented in different forum during the last years.

The BORMICON model was run using the same settings as last year. Simulation period is from 1970 to 2002. Two time steps are used each year. Results from the runs are shown in Figures 8.2.12 - 8.2.14 and comparison with last years results in Figure 8.2.15. As may be seen the stock estimate this year is relatively similar, although little lower, the difference probably driven by the survey and possibly length distributions from the catch. (In last years assessment the length distributions for 2000 were not included). Survey indices for this species increased since 1993 to a maximum of 377 in 1999. Since then indices have been in the range 221-260. Indices have been attended with relatively high CV's (Table 8.2.5). In spite of increase in the index from 2001 to 2002 the index is still below the values in 2000 and especially 1999 and could be pulling the results down. The CV of the survey index in 2002 is on the other hand lower than has been for a number of years.

Natural mortality is set to 0.15 for the youngest decreasing gradually to 0.05 for age 5 and older. Alternatives with other values on natural mortalities (M=0.1 for age 5+) were tested. They gave worse fit, and are therefore not incorporated here. The ages used are 1 to 30 years. The oldest age is treated as a plus group. Recruitment was at age 1. Prior to 1989 length at recruitment was 7.1 cm, but 8.1 cm in later years. This was supposed to reflect length of the 1985 and 1990 year classes in the groundfish survey.

As in last years model runs, the 1991 year class is nearly as big as the 1990 year class which has previously been considered as much bigger than the 1991 year class.. To throw light on this problem, length at recruitment was estimated separately for the 1990 and 1991 year classes, and the selection of the commercial fleet was allowed to change annually since 1998. The results are shown in Figures 8.2.14, 8.2.15 - 8.2.17. The figures show that the difference between the 1990 and 1991 year class has now increased and the stock size is closer to what was estimated last year. The estimated value of L50 is shown in Table 8.2.4. The change in recent years could be due to several factors; that the fishermen are keeping/targeting smaller fish, the model is wrong, or that the data comes increasingly from sampling programs aimed towards area closures. However, the samples included are a mixture of harbour samples and samples taken by inspector aboard the vessels. The first mentioned possibility could explain some of the difference as some of the trawlers have, during the last years, been equipped with a "small-redfish fillet-machine".

Using a fixed selection pattern and estimating length at recruitment for the 1990 and 1991 year class increases the difference between the 1990 and 1991 year class (though not as much as when the selection is variable) but the catchable biomass does not change from the base case.

The groundfish survey in March 2002 does not indicate any improvement in redfish recruitment which has been bad since 1990-1991. The estimated average year class size in 1992-2001 is 80 million (at age 0). Maximum yield per recruit is 250g so this recruitment can only sustain an annual catch of 20 000 tonnes. According to the predictions here, the stock is going to be stable for the next years with an annual catch of 30-35 000 tonnes. This value might though have to be reduced every year when no sign of good recruitment is seen.

Finally, the runs shown here have used M = 0.05. M = 0.1 gives similar or better fit. Figure 8.2.18 shows the results using M=0.1.

In 2001 the model was also run with the total S.*marinus* catch in ICES Divisions XIV, Va and Vb. This addition increased the estimated stock size as the catch increased. The proportion of the catch taken in Division Va has though been relatively stable since 1985, with about 85-90% taken in Va. As the tuning data are identical, similar trends in the stock size are to be expected in recent years, with about 10% higher biomass in 2000 than when using only the data from Va.

The main indicator for recruitment is the groundfish survey, which does not indicate any strong year class after the 1990/1991 year class. Simulations were used to determine the value of $\mathbf{F}_{max}$. A year class was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The total yield from the year class was then calculated. $\mathbf{F}_{max}$ was calculated 0.165 using 40 years simulations, and $_{F0.}$1was estimated to be 0.09. Here, F is not fishing mortality, but close to it when small time steps are used, or mortalities are small. It is also the mortality of a fish where the selection is 1.

Different catch options were tested in the future simulations for fixed catch. As may be seen on Figure 8.2.12, 8.2.13 and 8.14-8.17, the catchable biomass will increase until 2005, using fixed catch after the year 2002 for all catch options below 40 000 t. The total biomass will at the end of the period be lower than it is now for catches exceeding about 35 000 t annually.

From the above mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new large year class will recruit within the next 10 years.

8.2.3 State of the stock and catch projections

All available survey information and CPUE data from Division Va show that the *S. marinus* stock decreased considerably from 1985 to the lowest recorded biomass in 1995. An improvement in fishable biomass has, however, been seen in the recent years due to improved recruitment. Standardised CPUE in Va did increase by 20% from 2000 to 2001. During the last few years, the 1985 year class has contributed significantly to the fishable stock, and the 1990 year class did also contribute significantly to the fishable biomass in the last years. It is expected that those year classes will dominate the catches in the next few years. In Division Vb, survey indices as well as CPUE from the fleet do all indicate a very bad situation in the area. The adult stock of *S. marinus* in Sub-area XIV has nearly been exhausted in the most recent years. There are no indications of any recruitment of significance in area XIV.

By assuming same effort in 2003 as in 2001 (see chapter 8.2.1) the predicted catch in Va will be around 33 000 tonnes, using the following formula, $Catch_{2002}$ = Average Survey $index_{2000-2002}$ * $Effort_{2001}$.

Based on the BORMICON model, the fishable biomass will increase in the next few years. Thereafter a decrease is expected for all catch options above about 35 000 t. This is due to the poor recruitment after the 1990/91 year class. Based on the results from the BORMICON model, a TAC of about 35 000 t in the next 5 years would provide a fishable stock size above U_{Pa} at the end of the period. A large proportion of the catch is from the two year classes from 1985 and 1990. Based on the BORMICON model, the estimated average year class since 1992 is about 80 millions (at age 0) and maximum yield per recruit is about 250 gr. Therefore, after these two strong year classes have passed the fishery, one can not expect higher yield than about 20 000 t from the year classes that come into the fishable stock in the next years.

In Division Vb the CPUE from the Faroes winter survey shows an increase in 1996-1998, but decrease in 1999 – 2000. The new summer survey shows a decrease during the entire period since 1996. In Sub-area XIV the fishable stock of *S. marinus* is almost depleted.

In order to protect the two strong year classes, any fishing effort on this stock should be kept low to prevent a decrease in the near future. It should also be kept in mind that, based on the groundfish survey, there is no indication of new, strong, year classes after the 1990 year class. Therefore, as stated in 8.2.2, the year classes 1985 and 1990 needs to be preserved, since it is unlikely that other year classes will contribute substantially to the catches in the next years. Therefore, the Working Group recommends **that, in order to keep the stock within safe biological limits, the catch should remain below current level of about 35,000 tonnes.**

8.3 Biological reference points

S. marinus is mainly caught in Division Va and the relative state of the stock can be assessed through survey and a CPUE index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max}/5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been below, but close to U_{pa} during the last years. Based on the BORMICON model the corresponding values for reference points (for the period 1985-1999) are then U_{max}= 250 (in 1985); U_{lim}= 50 and U_{pa}= 150, and the stock seems to have been below U_{pa} in the period from 1993- 1997. The survey index series is only available back to 1985.

8.4 "Giant" *S. marinus*.

No additional information was obtained in 2001 compared to the NWWG report from 2001.

Table 8.1.1 *S. marinus*. Landings (in tonnes) by area used by the Working Group.

	Area					
Year	Va	Vb	VI	XII	XIV	Total
1978	31,300	2,039	313	0	15,477	49,129
1979	56,616	4,805	6	0	15,787	77,214
1980	62,052	4,920	2	0	22,203	89,177
1981	75,828	2,538	3	0	23,608	101,977
1982	97,899	1,810	28	0	30,692	130,429
1983	87,412	3,394	60	0	15,636	106,502
1984	84,766	6,228	86	0	5,040	96,120
1985	67,312	9,194	245	0	2,117	78,868
1986	67,772	6,300	288	0	2,988	77,348
1987	69,212	6,143	576	0	1,196	77,127
1988	80,472	5,020	533	0	3,964	89,989
1989	51,852	4,140	373	0	685	57,050
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,460	40	0	746	55,710
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,274	129	0	1,443	42,515
1995	41,516	2,581	606	0	62	44,765
1996	33,558	2,316	664	0	59	36,597
1997	36,342	2,839	542	0	37	39,761
1998	36,771	2,565	379	0	109	39,825
1999	39,824	1,436	773	0	7	42,040
2000	41,110	1,498	776	0	89	43,473
2001	34,940	1,513	530	0	88	37,071

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey by depth.

Depth interv / year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
< 100m	7	2	2	1	1	2	2	1	1	1	0	1	1	2	1	2	2	2
100-200m	91	86	124	95	101	68	76	62	48	58	36	44	60	57	56	47	33	64
200-400m	140	180	150	110	118	81	53	59	50	51	45	76	71	71	107	69	67	74
400-500m	24	12	10	4	11	22	8	9	17	1	11	21	34	3	44	8	6	11
Total 0 - 400m	237	268	276	206	220	151	130	122	98	110	81	121	133	130	164	117	101	140
Total	262	281	287	228	234	187	141	133	117	112	93	143	166	133	208	125	107	151

Table 8.2.2 *S. marinus*. Catch in Va in weight (tonnes) by age.

Year/ Age	1995	1996	1997	1998	1999	2000	2001
7	59	0	33	24	0	0	230
8	366	354	229	285	367	118	252
9	1572	808	483	598	1492	595	604
10	9312	3622	1039	1213	1244	3977	2322
11	2698	8943	2704	1134	1820	1894	10057
12	1314	2072	11563	3257	2651	2524	2101
13	3548	1300	2820	12548	2330	1610	2174
14	5684	1459	1366	2086	15703	2292	1298
15	6000	4398	3123	2039	1171	14272	776
16	1743	5641	3621	2411	1235	1778	10173
17	859	921	3024	3410	1884	1234	439
18	371	388	896	2048	2769	1843	623
19	1148	268	644	1015	2317	2379	785
20	1158	337	960	726	1219	2201	1160
21	511	1210	448	521	487	571	667
22	684	1033	544	390	231	619	287
23	1447	803	691	425	347	226	273
24	673	0	595	662	226	124	73
25	773	0	753	516	948	585	75
26	370	0	271	400	281	503	64
27	354	0	140	425	587	248	156
28	736	0	208	359	175	493	112
29	0	0	155	54	107	471	102
30	134	0	31	226	234	451	183

Table 8.2.3 *S. marinus* Results from the Icelandic groundfish survey in Va, total catch in Va and effort towards *S. marinus*.

Year	Survey index	Catch (Va)	Effort
1985	1000	67,312	67
1986	1131	67,772	60
1987	1165	69,212	60
1988	869	80,472	93
1989	928	51,852	56
1990	637	63,156	99
1991	549	49,677	91
1992	515	51,464	100
1993	414	45,890	111
1994	464	38,669	84
1995	342	41,516	122
1996	511	33,558	66
1997	561	36,342	65
1998	549	36,771	67
1999	692	39,824	58
2000	494	41,110	83
2001	426	34,940	82
2002	590		

Table 8.2.4 Results of the BORMICON model. BASE CASE, estimated value of L_{50}.

Year	<1998	1998	1999	2000	2001
L_{50}	34.43	34.94	34.63	34.09	33.56

Table 8.2.5 Index of total biomass of *S.marinus* from the groundfish survey in March and CV in the estimate

Year	index	CV
1985	333.00	0.094
1986	373.55	0.134
1987	350.08	0.114
1988	283.57	0.103
1989	337.59	0.151
1990	310.72	0.313
1991	203.42	0.104
1992	173.50	0.093
1993	203.53	0.143
1994	189.67	0.125
1995	163.40	0.138
1996	227.79	0.211
1997	278.97	0.310
1998	227.64	0.158
1999	377.87	0.206
2000	260.77	0.202
2001	221.08	0.153
2002	255.36	0.122

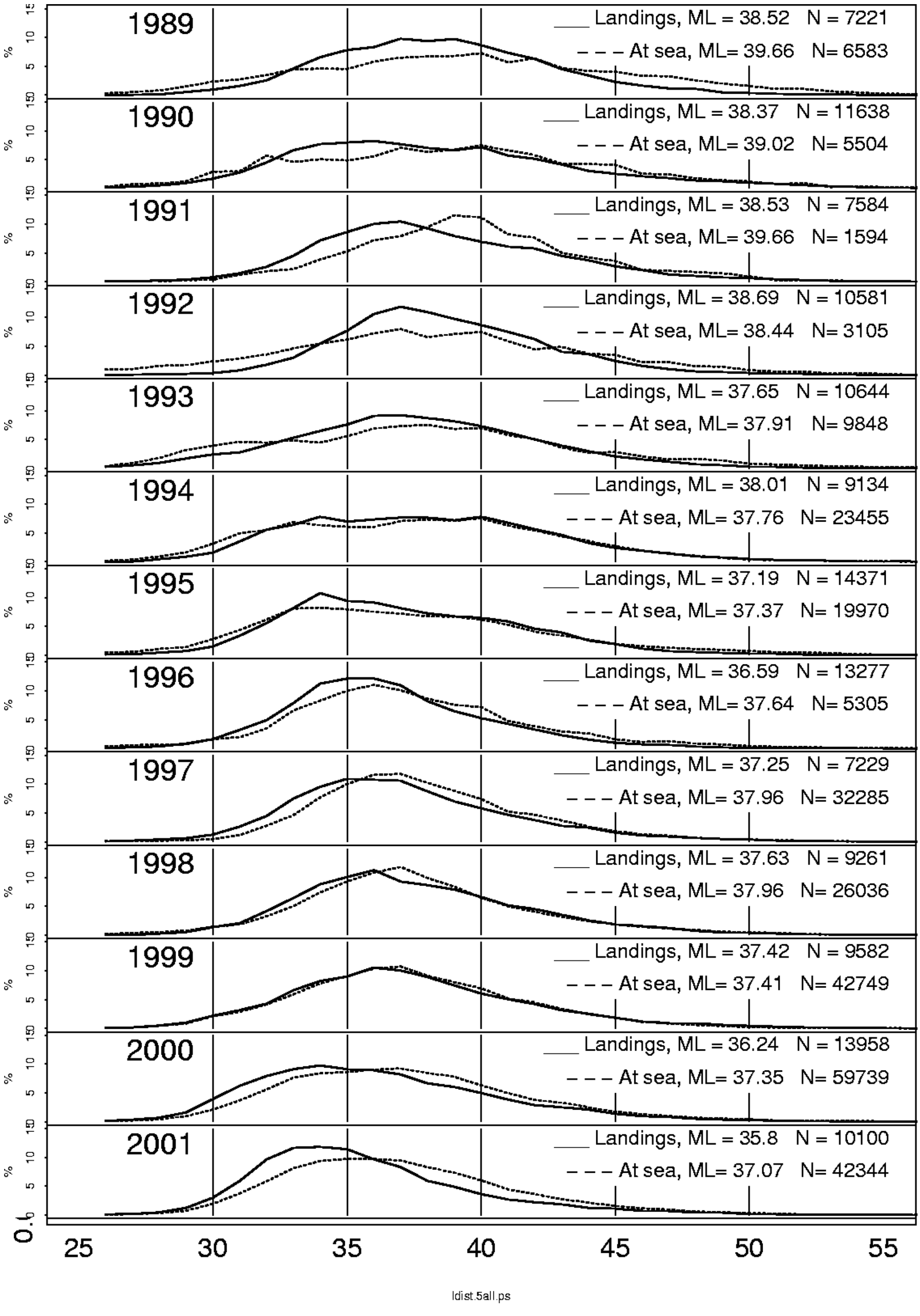


Figure 8.1.1 *S. marinus*. Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-2001.

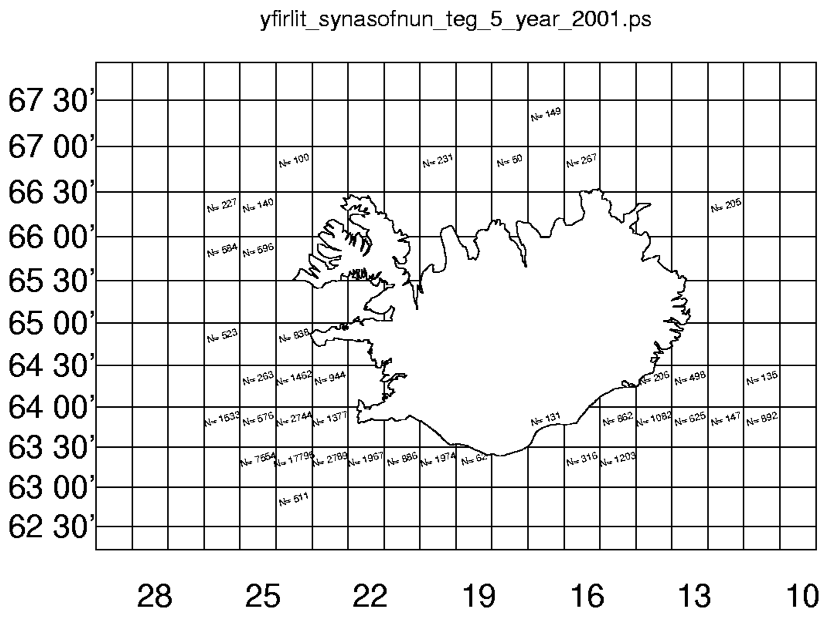


Figure 8.1.2 Number of measured *S. marinus* in 2001 by statistical square.

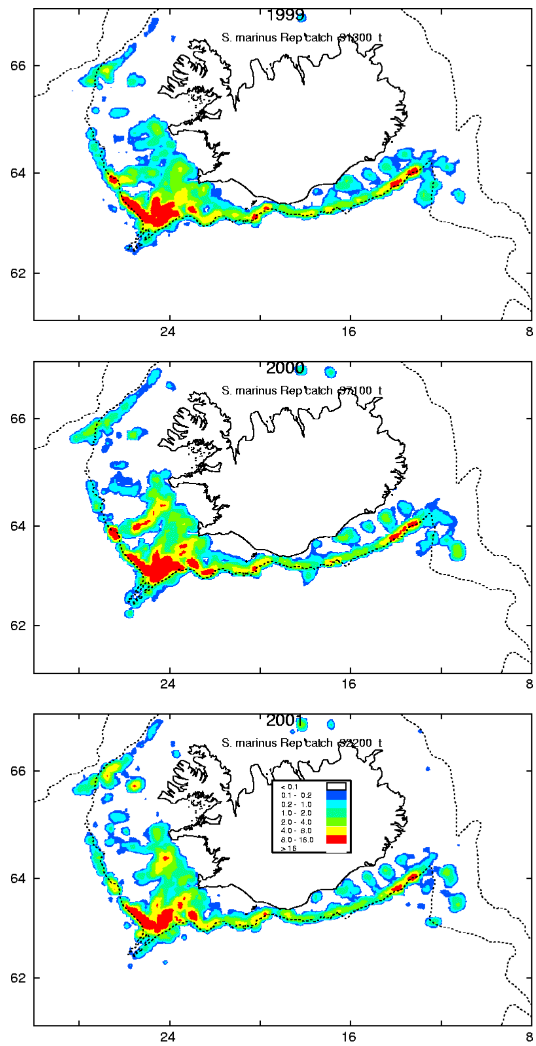


Figure 8.1.3 Distribution of S.marinus catches in division Va from 1999-2001.

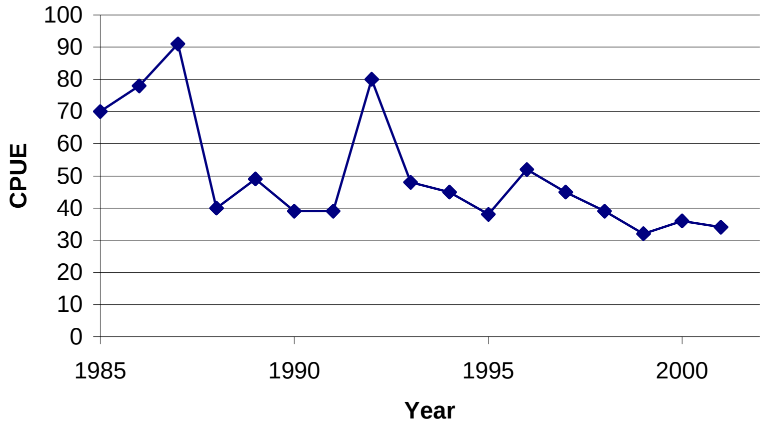


Figure 8.1.4 CPUE from the Faroese pair-trawlers in ICES division 1985-2001.

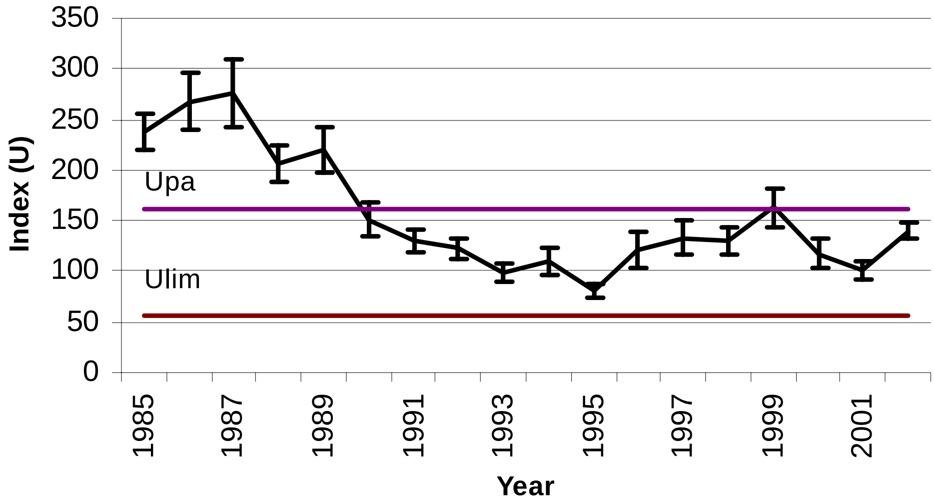


Figure 8.2.1 Index on fishable stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

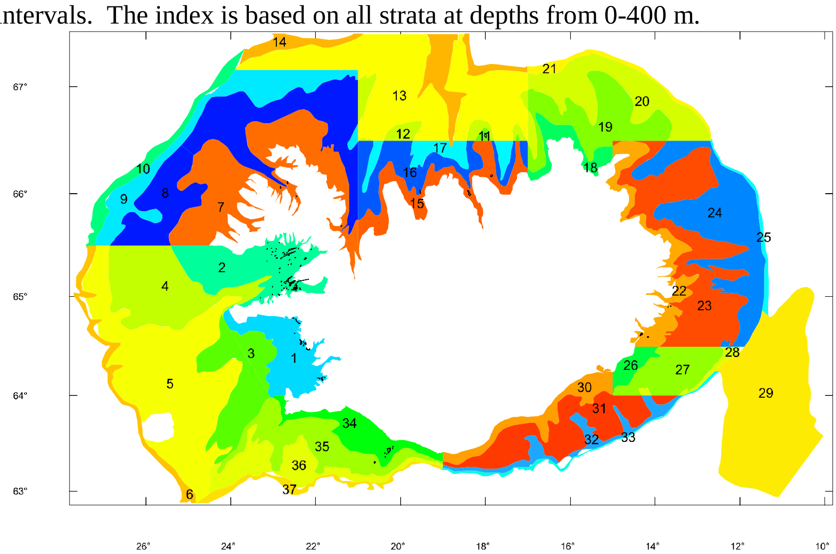


Figure 8.2.3 Stratification in the Icelandic groundfish survey by depth down to 500 m. The numbers show stratified index (Palsson *et al.* 1989). See also table 8.2.1.

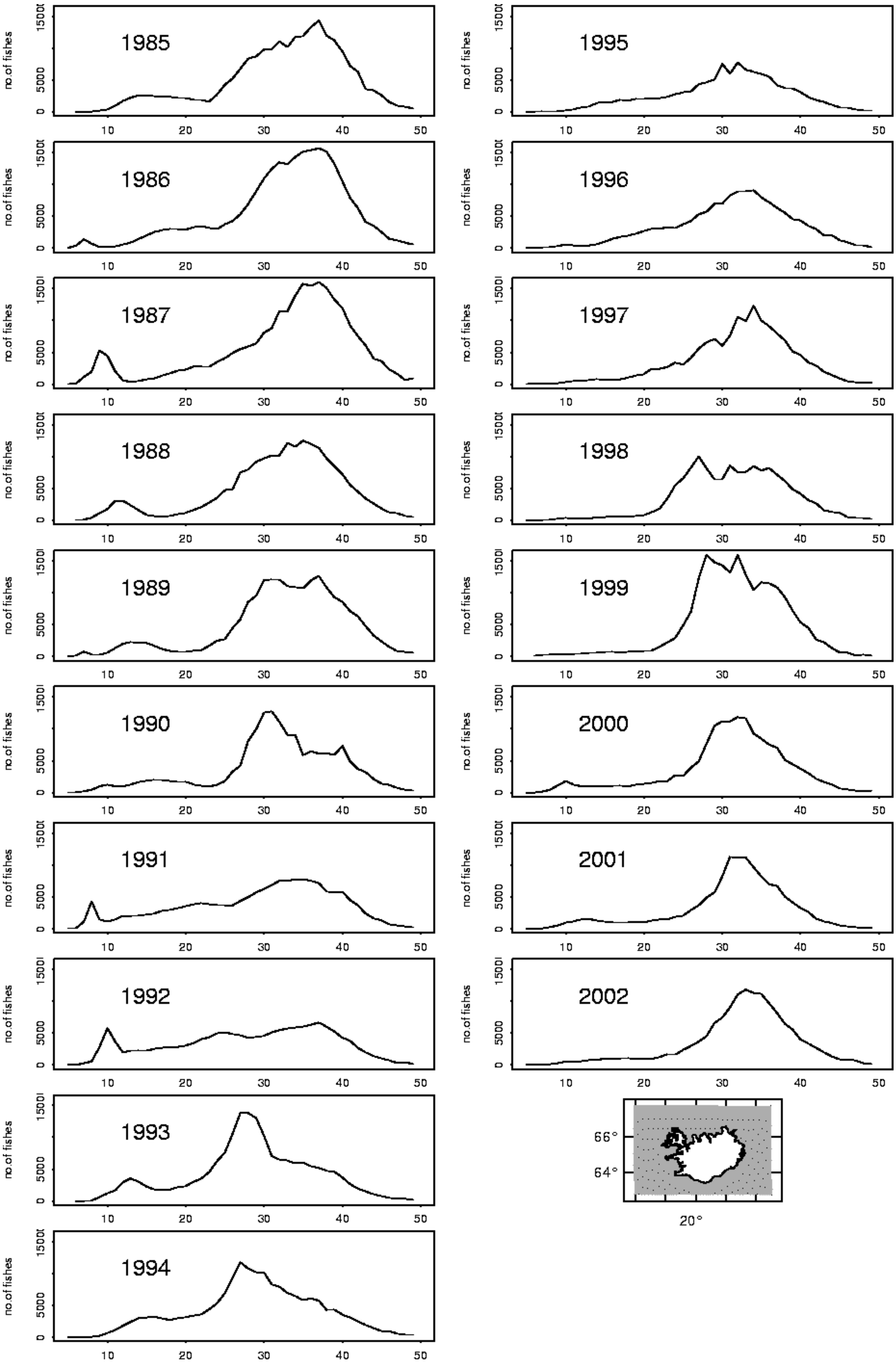


Figure 8.2.4 Length distribution of *S. marinus* in the Icelandic groundfish survey.

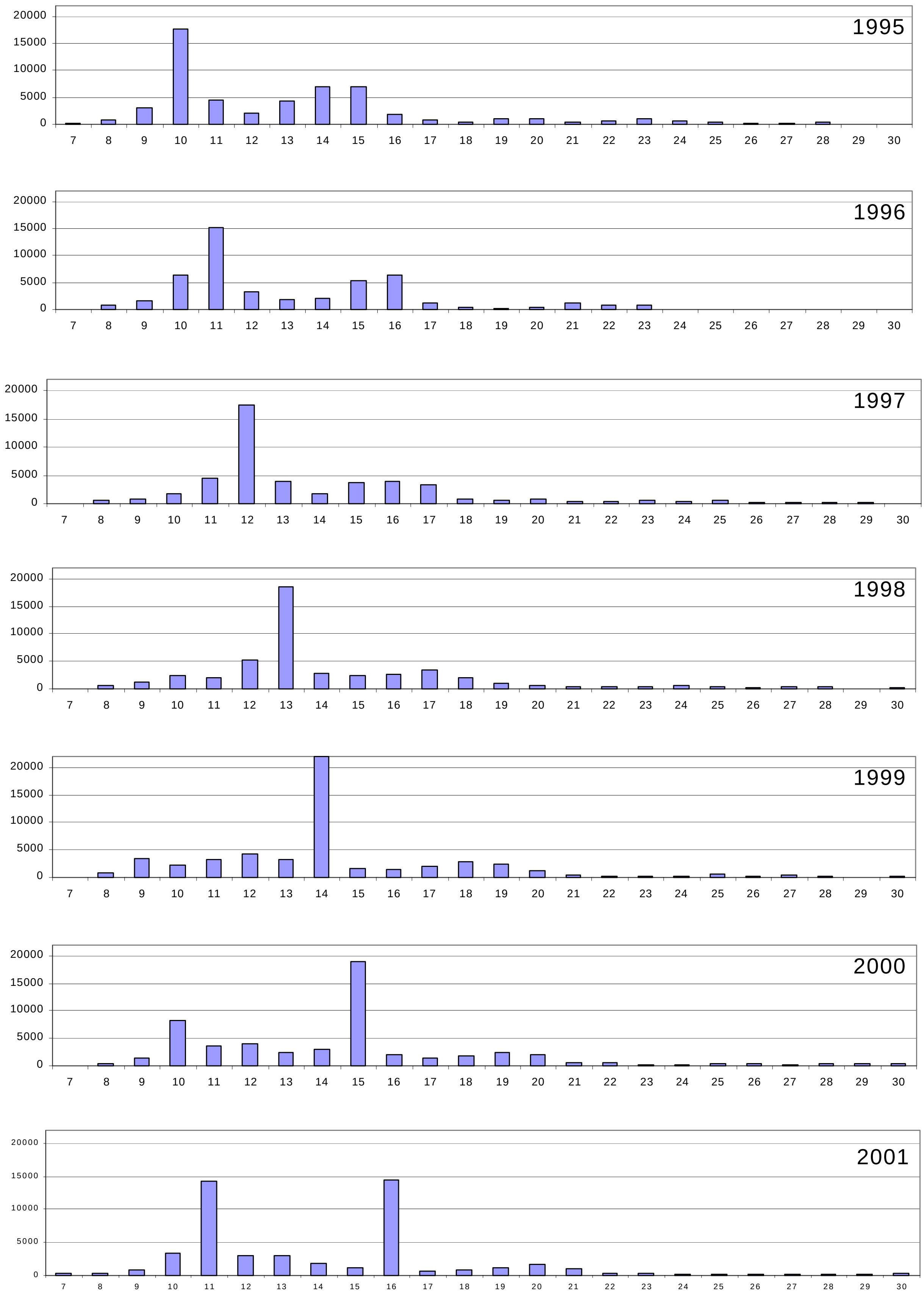


Figure 8.2.5 *S. marinus.* Catch in number by age in ICES Sub-division Va 1995-2001.

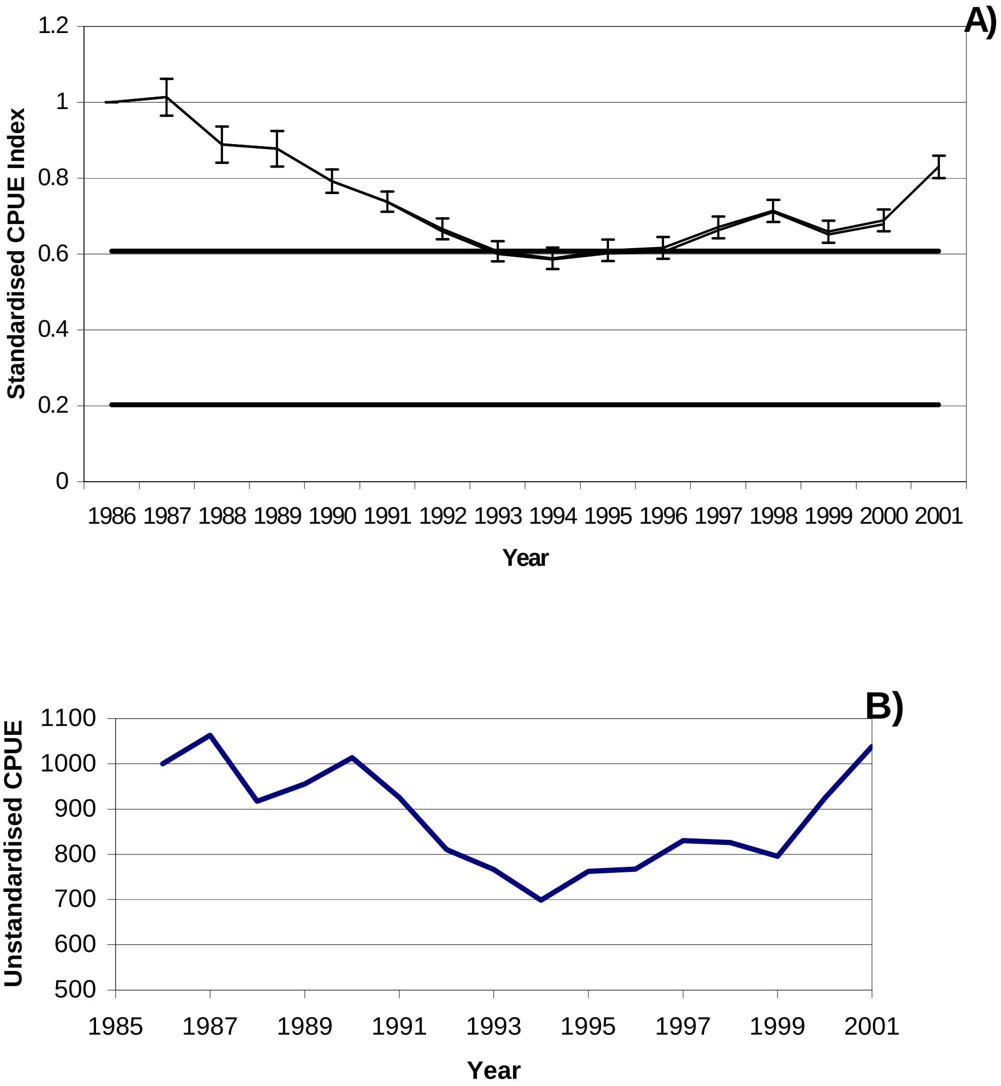


Figure 8.2.6 CPUE in *S. marinus* from Icelandic trawlers, both based on results from GLIM model 1985-2000 (A) with 95% CV) and based on simple mean of hauls where *S. marinus* catch compose 50% or more of the total catch in each haul (B).

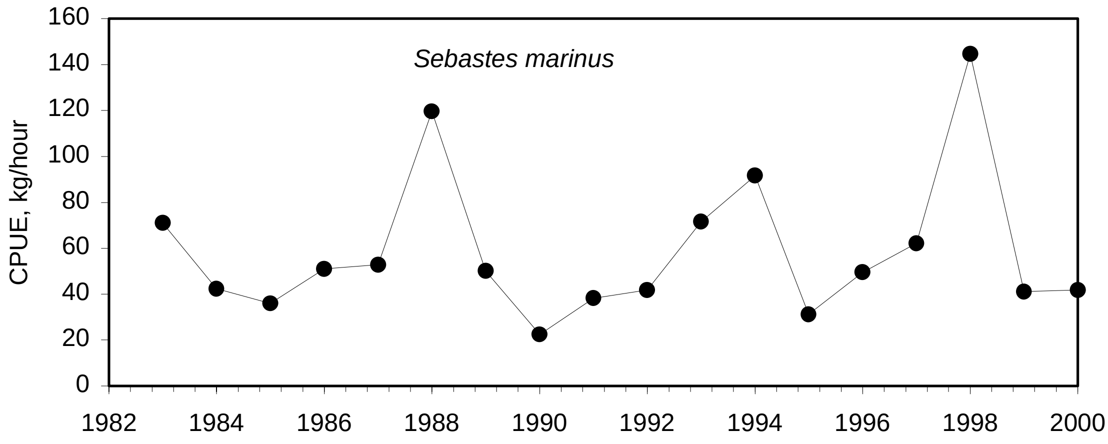


Figure 8.2.7 CPUE of S.marinus in the Faroes groundfish survey 1983-2000.

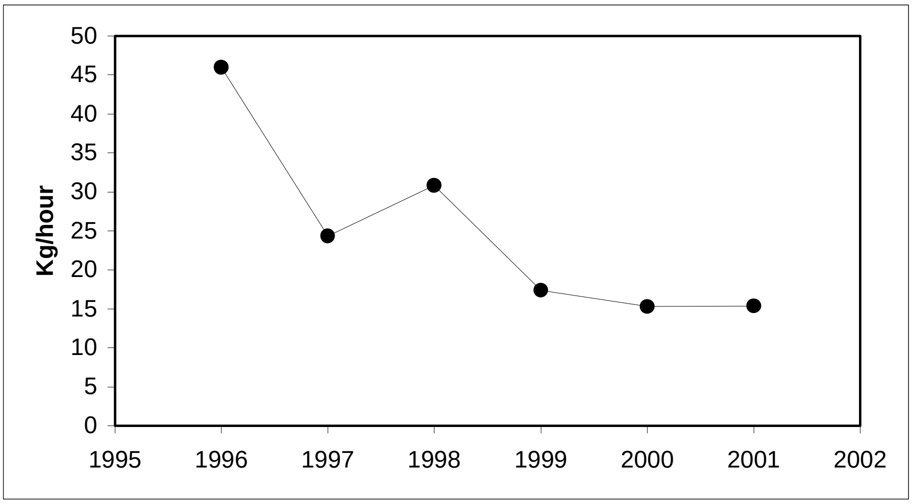


Figure 8.2.8 CPUE of *S. marinus* in the Faroes summer survey in Division Vb1 from 1996-2001.

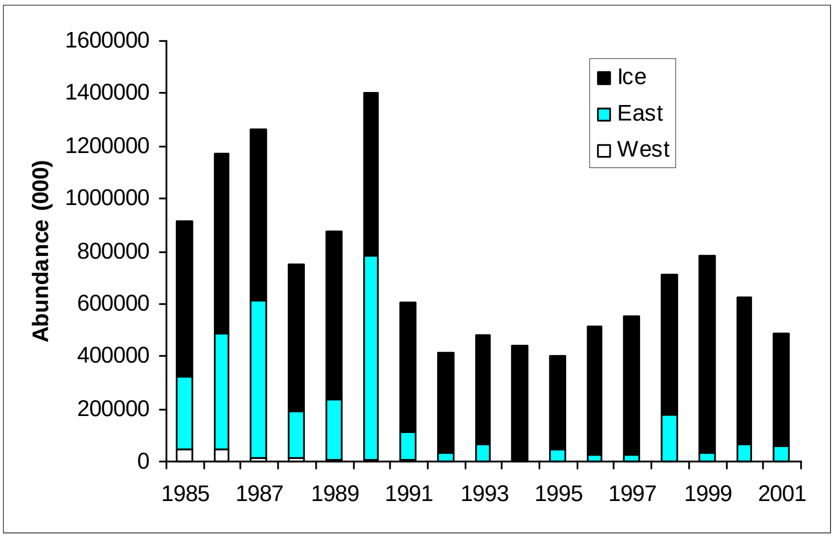


Figure 8.2.8 *S. marinus* (≥17 cm). Survey abundance indices for East, West Greenland and Iceland 1985-2001.

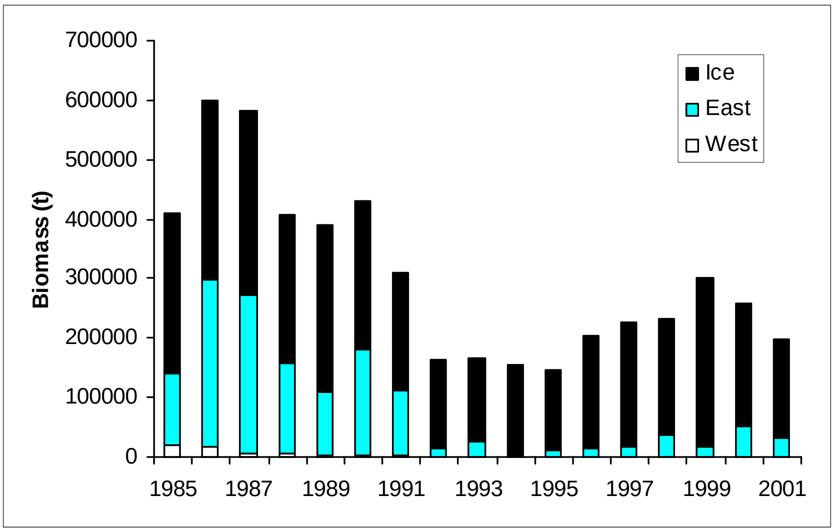


Figure 8.2.9 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland and Iceland, 1985-2001.

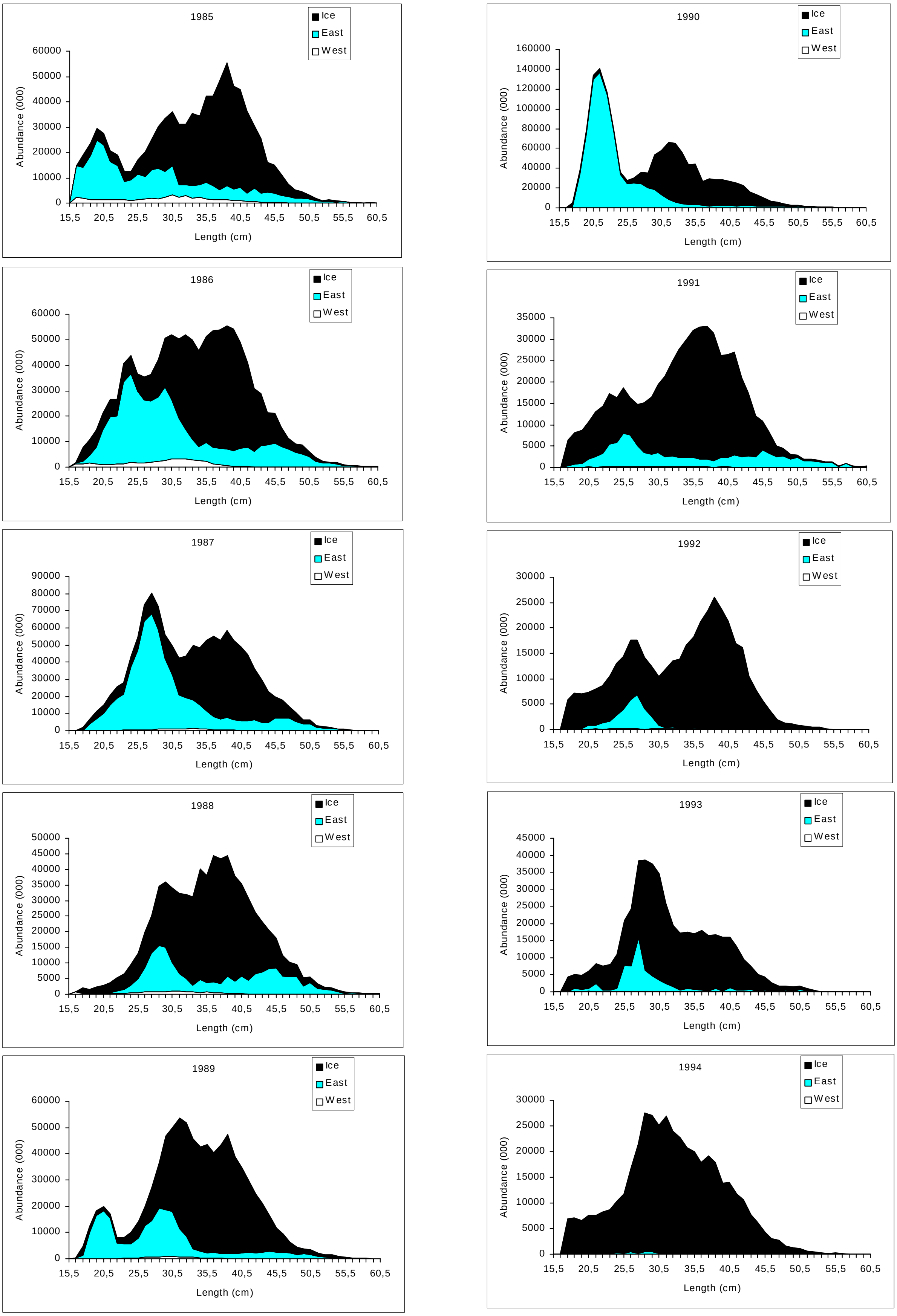


Figure 8.2.10 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1985-1994.

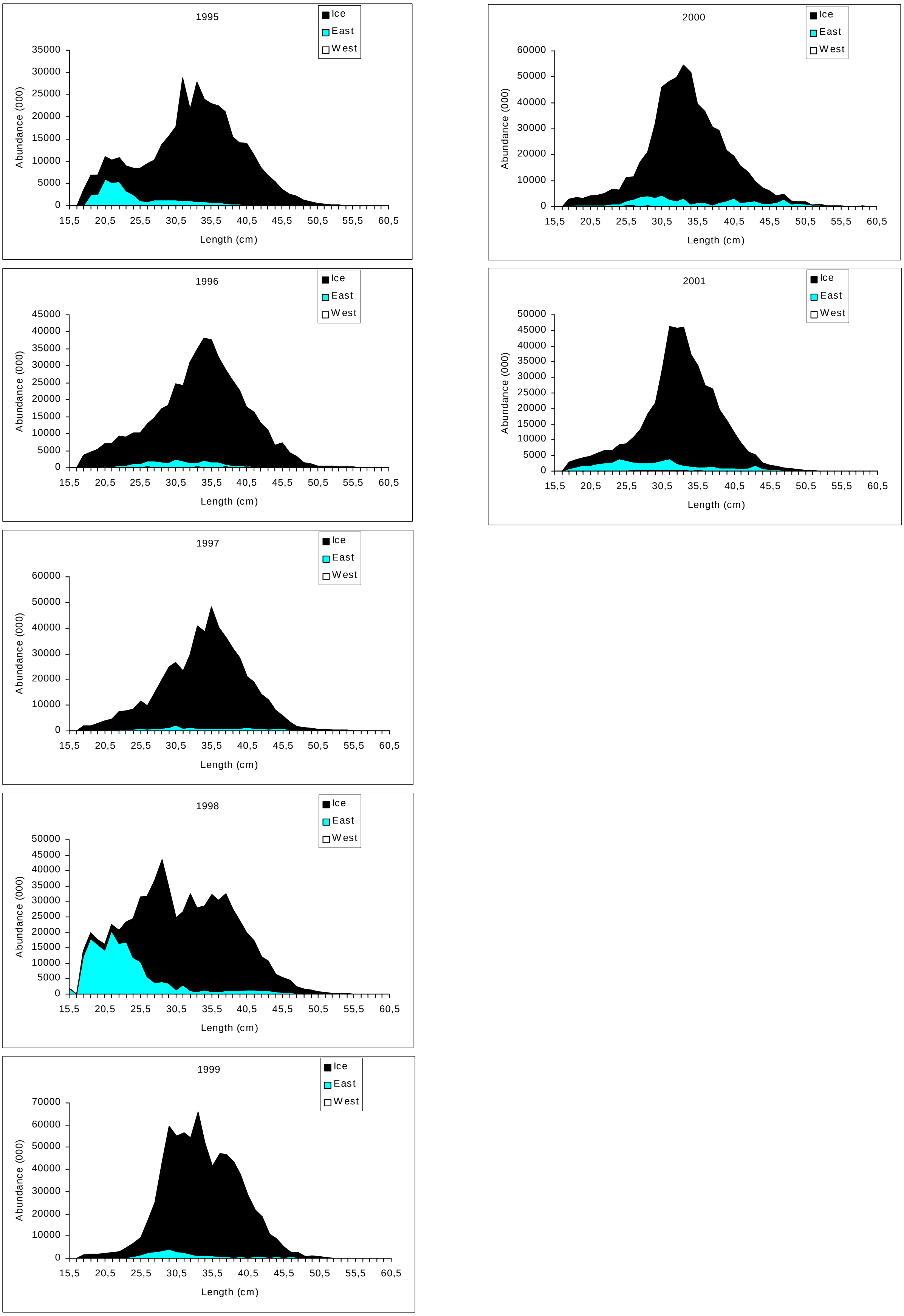


Figure 8.2.11 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1995-2001.

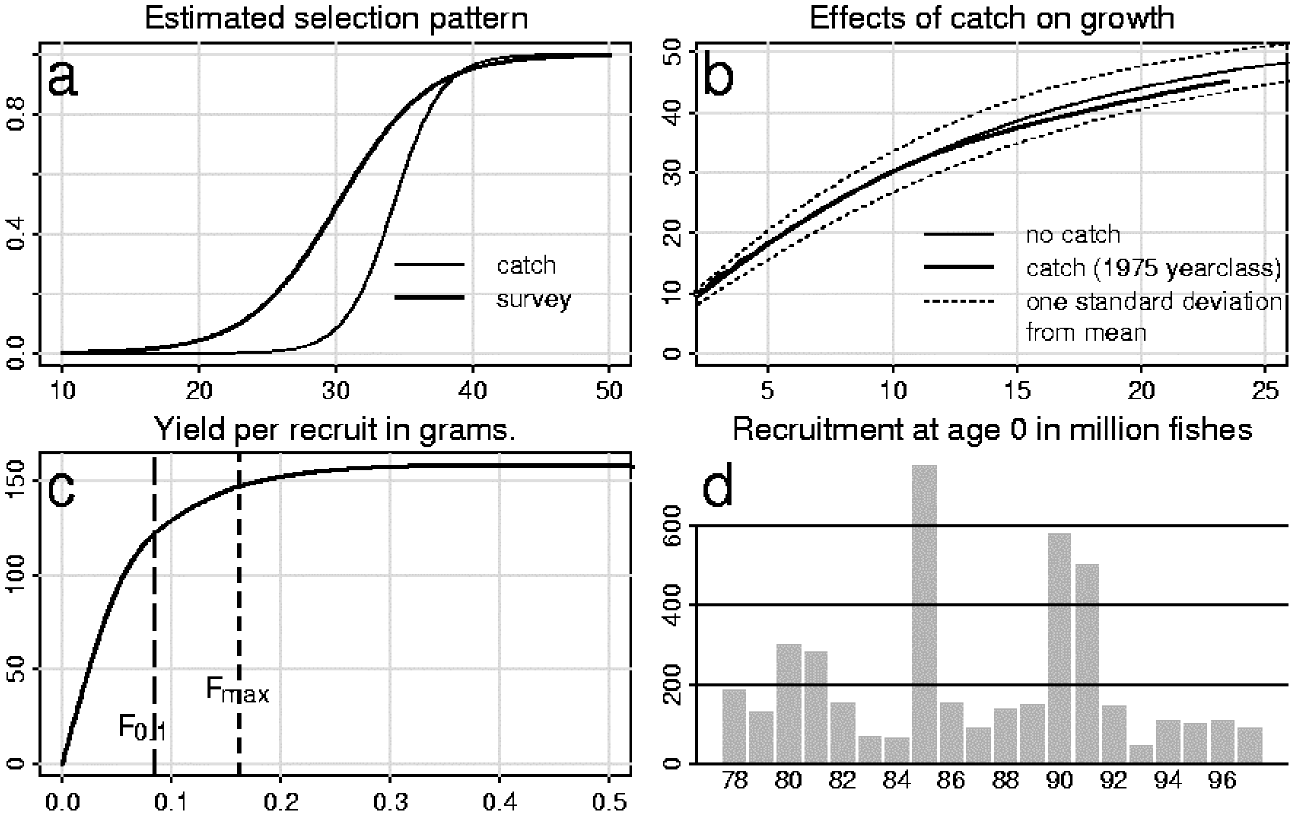


Figure 8.2.12 Results out of the BORMICON model-BASE CASE, using catch data from ICES Division Va only. a) estimated selection pattern of the commercial fleet and the survey, b) Mean length (the figure also demonstrates the effect of catch on length at age), c) Yield per recruit and c) estimated recruitment at age 0.

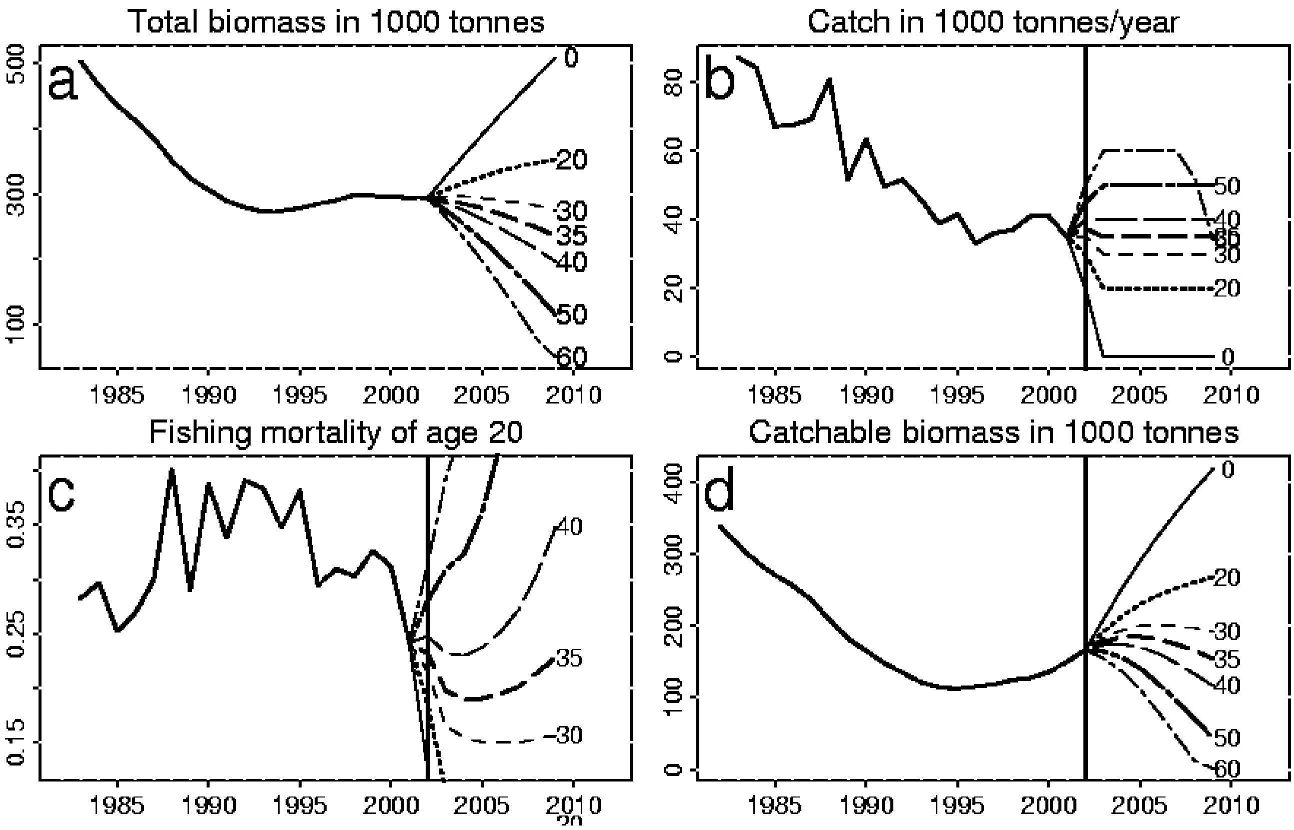


Figure 8.2.13 Results from BASE CASE run, using only catch in ICES Division Va. The figures show development of biomass and F, using different catch options (0-60 000 t) after 2002.

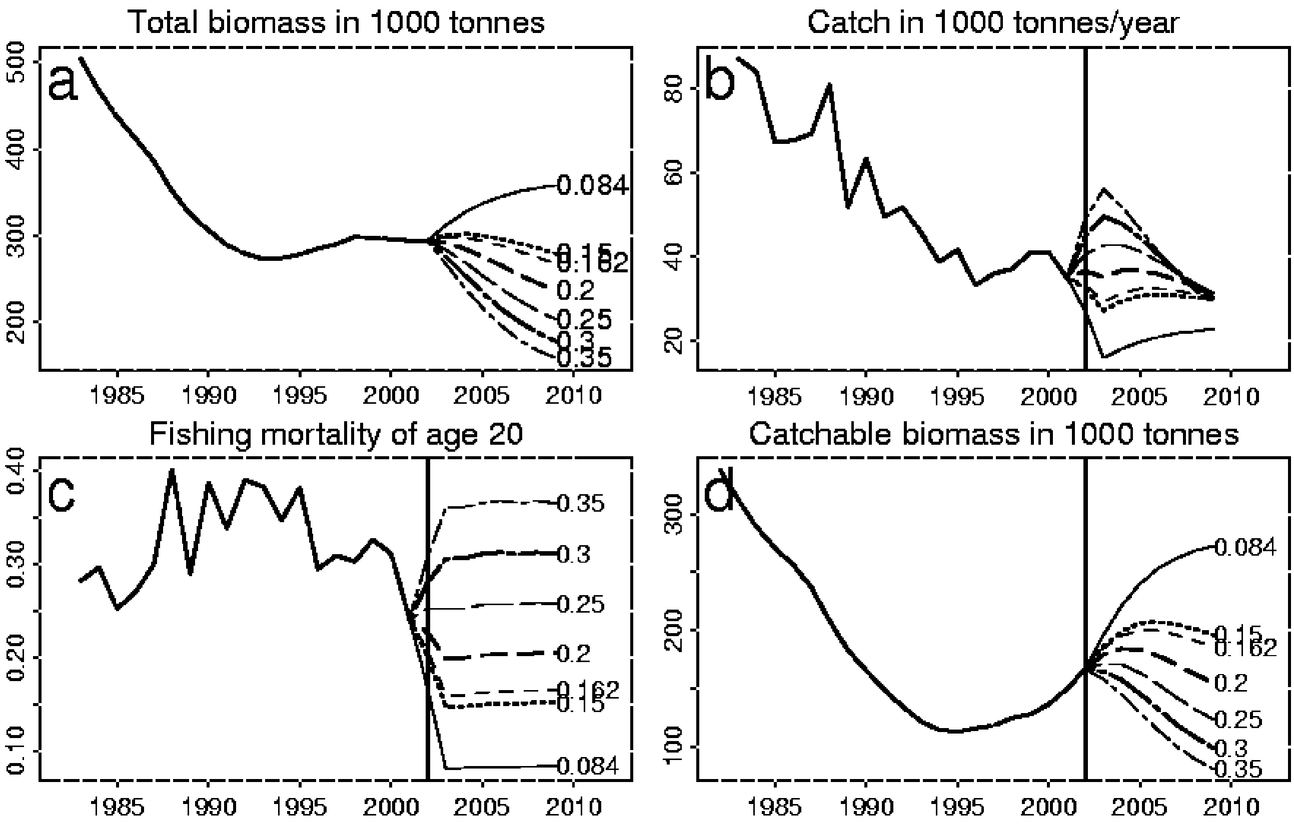


Figure 8.2.14 Results from BASE CASE run, using only catch in ICES Division Va. The figures show development of biomass and F, using different effort after 2002.

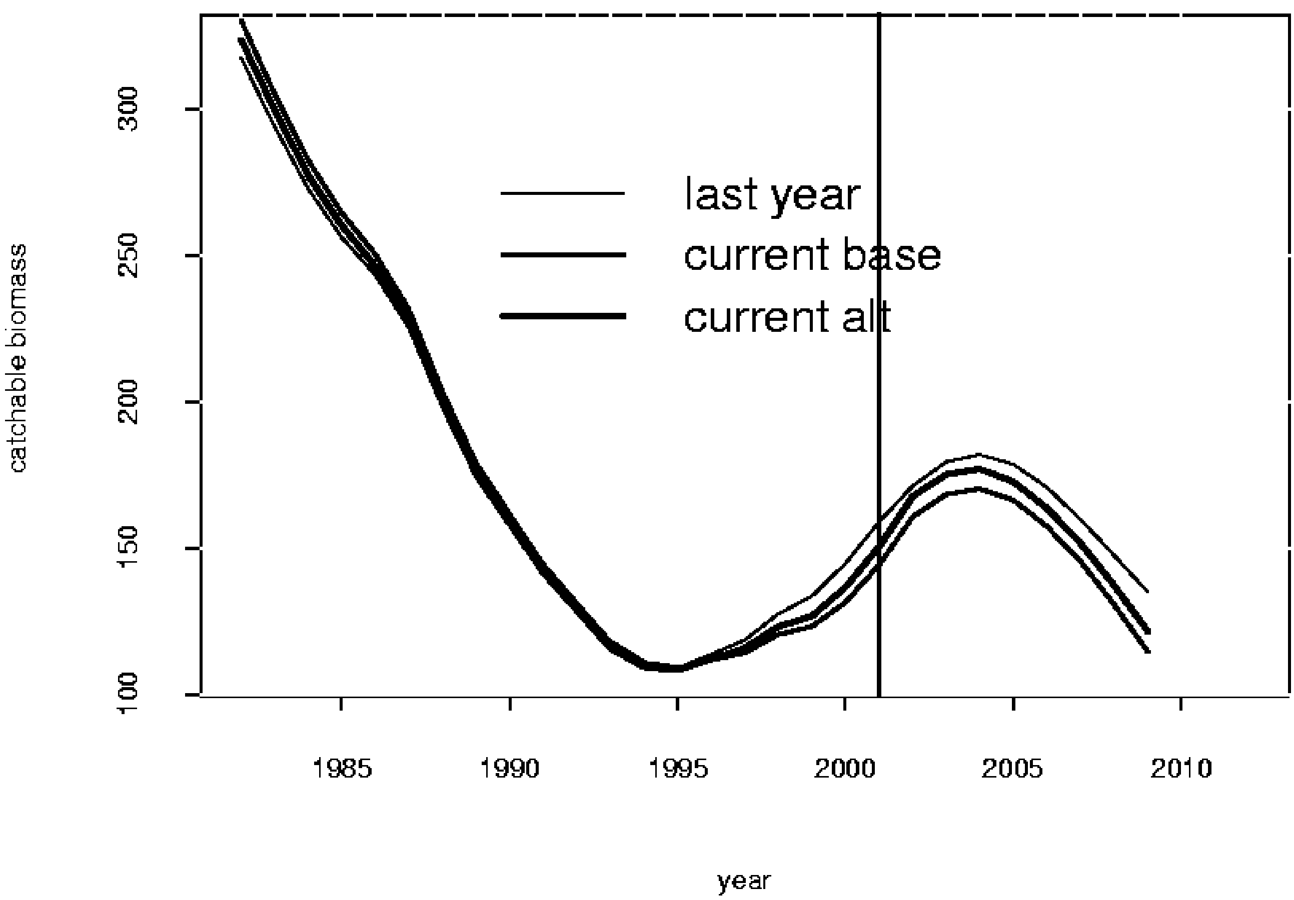


Figure 8.2.15 Comparison of catchable biomass using the data obtained now and last year, for same settings. Results are obtained using only the catch history from in ICES Division Va.

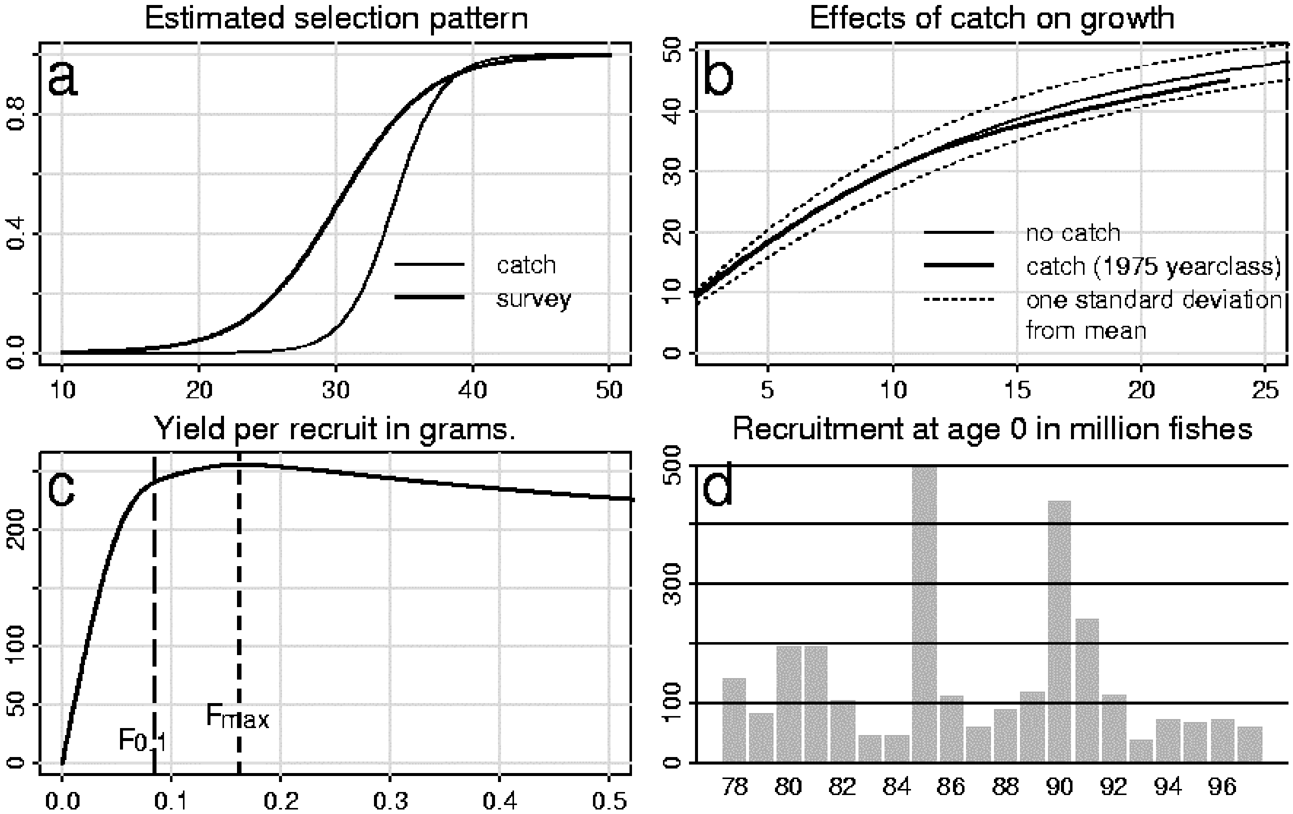


Figure 8.2.16 Results out of the BORMICON, allowing variable selection after 1997. The run is using catch data from ICES Division Va only. a) .estimated selection pattern of the commercial fleet and the survey, b) Mean length (the figure also demonstrates the effect of catch on length at age), c) Yield per recruit and c) estimated recruitment at age 0.

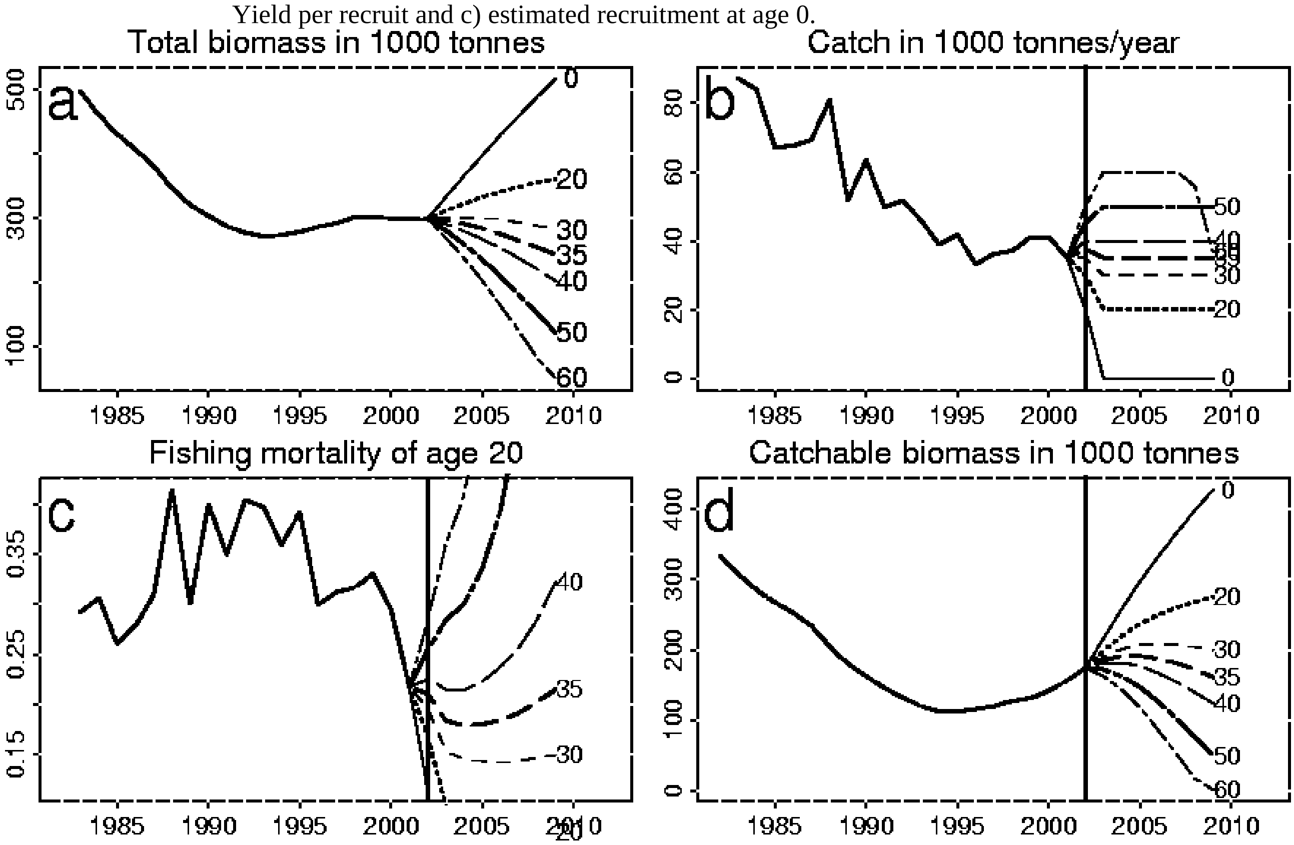


Figure 8.2.17 Results from model run where variable selection is allowed after 1997 The model is only using catch in ICES Division Va. The figures show development of biomass and F, using different catch options after 2002.

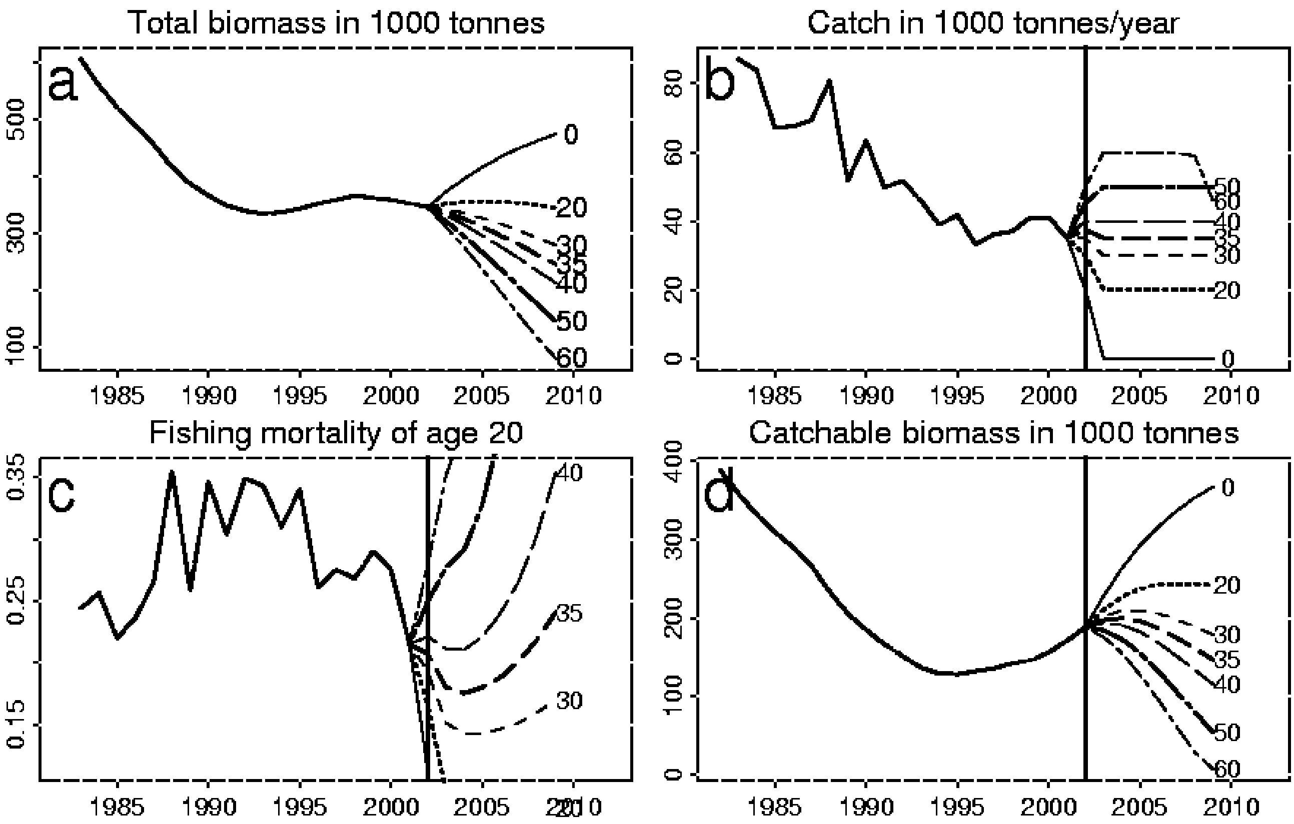


Figure 8.2.18 Results from model using M=0.1. The model is only using catch in ICES Division Va. The figures show development of biomass and F, using different catch options after 2002.

9 DEEP-SEA *S. MENTELLA* ON THE CONTINENTAL SHELF

Traditionally, the *S. mentella* on the shelves and banks around the Faroe Islands, Iceland and at East Greenland have been treated as one stock unit, with a common area of larval extrusion to the SW of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters at East Greenland, and feeding and copulation areas on the shelves and banks around Faroe Islands, Iceland and at East Greenland. In Faroese waters spawning has been observed in some years to the south and west of the islands, implying that there could be a local component in the area; no nursery areas have, however, been found so far (Reinert, 1990). A relationship to other ICES areas (II and IV) has also been suggested (Reinert *et al.,* 1992; Reinert and Lastein, 1992). The question of a possible relationship between the deep-sea *S. mentella* on the shelf in Subareas V and XIV and the pelagic deep-sea *S. mentella* in the Irminger Sea has been raised several times. The ICES Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM) states that the presence of significant genetic differences between these two deep-sea components probably indicates distinct genetic stocks (ICES 1999). The NWWG therefore continues treating the deep-sea *S. mentella* on the shelf as a separate self-contained stock unit. For management purposes the Icelandic authorities separate the deep-sea *S. mentella* on the shelf (some of which are caught in pelagic trawls) from the pelagic *S. mentella* in the Irminger Sea (both oceanic and pelagic deep-sea type) by straight lines through three positions (Figure 9.1.1).

9.1 Landings and Trends in the Fisheries

The total annual landings of deep-sea *S. mentella* from Divisions Va and Vb and Subareas VI and XIV varied considerably in the 1980s mainly in the range 30 000 to 60 000 t. In 1990, the landings were 44 000 t, and reached 67 000 t in 1991, decreased slightly in 1992 (63 000 t) but increased to about 83 000 t in 1994. Since then the landings decreased to approximately 38,000 t in 2000 and in 2001 the catches decreased to only 23 000 tonnes, which are the lowest catches since 1980 (Table 9.1.1).

From Division Va, total landings in 2001 were 17 000 t. about 45% reduction from the catches of 2000. This is the lowest recorded catch since 1988. In general, the landings have been decreasing from the record high in 1994 of 57 000 t. In the 1980s landings varied from 10 000-40 000 t. From 1990 to 1994 the landings doubled from 28 000 t to 57 000 t. This increase in the catch coincides with the introduction of large pelagic trawls used by a part of the Icelandic fleet during the autumn and early winter months. This pelagic fishery has now decreased to 465 t, which is less than 5% of the 1994 landings. The catches in the autumn decreased considerable in 2001, compared with the latest years (Figure 9.1.2). The reason for this drop in the catches seems be connected with decreased effort at that time of year, but some fishermen report that the reason for the decreased effort is a lack of redfish in the traditional fishing areas west and southwest of Iceland. About 95% of the total deep-sea *S. mentella* landings in area Va in 2001 have been taken by bottom trawlers (both fresh fish and freezer trawlers). Length distributions measured by the Icelandic observers in 1989-2001 are shown in Figure 9.1.3 for the bottom trawl fishery and in Figure 9.1.4 for the pelagic fishery since 1994. An increase in the number of small fish have been shown in recent years, and from the length distributions peak of about 32 cm in 1994 can been followed by 1 cm growth annually in 1996-2001. Length distributions from the pelagic fishery show decrease in the mean length in 2000-2001, with a peak of about 39-40 cm. If the proportion of redfish below 33 cm in the catches exceeds 20% in numbers in Division Va the, fishing area is closed.

In Division Vb annual landings of deep-sea *S. mentella* varied from 5 000–8 000 t until 1984. Then landings increased rapidly to about 15 000 t in 1986. The landings declined again to 9 000 t in 1990. They increased to about 13 000 t 1991. Since then they remained very low until 2000 as it increased to 8 000 t, mainly due to Russian catches of more than 2 500 t, which were reported to Faroese authorities (Table 9.1.1). The catches in 2001 decreased again to about 5 000 t. The CPUE from the Faroese trawlers (>1000HP) are shown in Figure 9.1.5. No biological sampling was available to the working group on the catches.

In Subarea VI the annual landings were highest in 1980 (1 100 t), but have varied from 130 - 880 t during recent years, except for 1996 when the landings were about 1 050 t, the highest recorded in the series since 1980 (Table 9.1.1). The limited information on the redfish catch in 2001 indicates that only about 40 t were caught in 2001. No biological sampling was conducted on redfish catches.

In Subarea XIV, annual landings have varied considerably. In the beginning of the 1980s, the landings were between 10 000-15 000 t, but then decreased to 6 000 t in 1987-1992 and increased to 19 000 t in 1994. At that time the fleet was mainly fishing very small redfish. Since then there was a decrease to only 200 t in 1997, which was a bycatch in the shrimp fishery. In 1998, Germany started again a directed fishery on the juveniles with a total catch of about 1 400 t. This fishery has continued and the total landing in 2000 was about 1000 t, and the effort was similar as in 1998-1999 (Table 9.1.2). In 2001 the total effort decreased and the catches were 800 tonnes. No biological sampling was conducted on redfish catches.

The 2001 biological sampling from catch and landings of deep-sea *S. mentella* from the continental shelf in each Division and by gear type is shown in the text table below.

Area	Gear	Landings	Nos. samples	Nos. fish measured
Va	Pelagic trawl	465	8	988
Va	Bottom trawl	1,7103	91	18,796
Vb	Bottom trawl	4,439		
XIVb	Bottom trawl	866		

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

CPUE of the Icelandic trawler fleet for deep-sea *S. mentella* in Division Va is based on bottom trawl tows taken below 500 m depth and where the total catches of redfish compose a certain percentage of the total catch in each tow (10, 50 and 90%). Data prior to 1986 are poor. In the period from 1986 -1989 CPUE was rather stable. From 1989 to 1994 CPUE declined to only 488 kg/h (for 10%; see text table below and Figure 9.2.1), and it has remained rather low since then although it increased again in 1999-2000. The 2001 value showed a slight decrease again, compared with 2000 and there seems to be steeper reduction in the fourth quarter.

Indices of CPUE for the Icelandic trawl fleet for the period 1986-2001 are also estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effects. All hauls with redfish at depths deeper than 500 m, exceeding 50% of the total catch were included in the CPUE estimation (Figure 9.2.1.a). There is some discrepancy between the results of the model now and in 2000. The reason for the difference is due to changes in the database where the hauls for the calculations are selected. Ling, blue ling, tusk and greater silver smelt were added to the database in 2001 and consequently the total catch as reported in the database for each haul changed. The trawler fleets started to fish greater silver smelt in 1997 in significant amount but the catches were not included in the logbook database and hence affected the selection of hauls for the CPUE calculations. The effort that is used is therefore higher than real effort and hence, the CPUE is underestimated in some years. The difference in highest in 1998, but in that year the same trawler fleet fished almost 14,000 t. of Greater silver smelt. The results of the “corrected” GLIM model show a similar trend as unstandardised CPUE, i.e. a relatively stable situation between 1986-1991, a sharp decline from there until 1995 and thereafter a stable, very low level until 1998. The GLIM model shows thereafter an increase both in 1999 and 2000, but a minor decrease in 2001. The index is now about 70% of the 1986 value.

Year	CPUE 50% Glim	CPUE 10% raw	Total landings	Effort (Glim/raw)
1986	1000	943	18,898	20 / 18
1987	1090	977	19,293	19 / 17
1988	989	877	14,290	16 / 14
1989	946	974	40,269	41 / 42
1990	904	806	28,429	35 / 31
1991	907	771	47,651	61 / 52
1992	705	611	43,414	71 / 61
1993	636	549	51,221	93 / 80
1994	569	488	56,720	116 / 99
1995	583	515	48,708	94 / 83
1996	588	489	34,741	70 / 59
1997	617	565	37,876	67 / 61
1998	621	545	33,125	60 / 53
1999	661	620	28,590	46 / 43
2000	696	636	30,696	48 / 44
2001	678	571	17,313	30 / 25

The effort in Division Va in the time when the stock was considered in stable condition i.e., from 1986 -1990 was 20 000-40 000 hours. During the period since 1986, the effort increased drastically until 1994. Since then, the effort has decreased by less than 10% each year until 2000 (the advice of ICES has been a 25% reduction annually from 1995-2000). The effort in 2001 has, decreased by about 40% compared with the effort in 2000. The effort in 2001 is thus reduced by 75% from the record high effort in 1994.

Icelandic groundfish survey in Division Va only covers depths down to approximately 500 m and there seem not to be any nursery grounds of major importance in Division Va, these results add little to the current stock evaluation (WD08). A recently started deep-water survey (covering depth approx. 500-1200 m) around Iceland in autumn may, however, add valuable information about the fishable stock of deep-sea *S. mentella* in near future.

In Division Vb a CPUE-series (1985–1997) of deep-sea *S. mentella* was presented in the 1997 Working Group report. The series shows a decrease since 1993, which seems to have stabilised below 50% of the maximum in the time series. The continuation of the series (Figure 9.1.5) shows a slow increase in the CPUE 1996-1999, but a slow decrease in 2000 and 2001. It should however be noted that the series are not completely comparable as they are calculated differently.

The new summer survey in Division Vb (see chapter 2.4.5), show nearly continuous decrease in the catch rate, from less than 10 kg/hour to about 3 kg/h, except in 1999 when the catches were over 10 kg/h.

In Division XIV all redfish catches in the period 1982-1997 was as bycatch. Since 1998, there was a directed fishery for redfish along the continental slope of East Greenland where *S. mentella* was the targeted species. The effort was similar in both years, and the CPUE in 1998 was about 638 kg/h, decreased to 352 kg/h in 1999 and has increased again in 2000 to 433 kg/h and further to 746 kg/h in 2001.

Survey abundance and biomass estimates for deep sea *S. mentella* (≥17 cm) are presented in Figures 9.2.3-9.2.4, broken down by stratum, West and East Greenland, Iceland and aggregated to total. The trends in stock size in numbers are illustrated in Figures 9.2.5-9.2.6. The abundance figures are clearly dominated by the occurrences off East Greenland, while there were only negligible parts distributed off West Greenland and Iceland at depths of 0-400 m. It can be derived from those figures that the surveys do cover only the immature part of the stock (recruits) since the figures also are dominated by a single strong year class recorded in 1989 for the first time at a mean length of 20 cm (Figure 9.2.5). This cohort grew about 2 cm a year and recruited to the survey gear until 1997 (Figure 9.2.6), when it reached its maximum abundance and biomass at a length of about 27 cm (total abundance 7 billion and biomass 1.5 million tons). During the following years, this year class seems to have left the surveyed area. Most recently, there are indications of further recruiting year classes which seem, however, to be significantly less abundant.

9.2.2 Production model

The group tried again the ASPIC (Prager 1992) stock production model for the stock. The model requires catch data and corresponding effort or CPUE data that are reasonable indices of the stock biomass. Corresponding catch and effort data is available for Division Va using the GLIM CPUE index from the Icelandic trawl fishery from 1986 onwards and the total catches in Divisions V, VI and XIVb during the same period. The model requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/$\mathbf{B}_{MSY}$ ratio and *q*, catchability coefficients. Initially ASPIC was run with different starting guesses of these parameters to explore stability of parameter estimation. For an appropriate range of input values, ASPIC responds very stable for the changes that were tried.

The program was run with the time-series from 1985-2001 including Icelandic corrected CPUE's. MSY is now estimated around 50 000 t for all the options tried and $\mathbf{B}_{MSY}$ around 200 000 (Table 9.2.1) Biomass in 2001 is estimated to be over 30% above $\mathbf{B}_{MSY}$ and the fishing mortality in 2001 is estimated to be about 50% below $\mathbf{F}_{MSY}$ Observed and estimated CPUE's are given in Figure 9.2.7 and state of the stock relative to Retrospective runs (Figure 9.2.8.) show rather stable situation, but indicates that B/ $\mathbf{B}_{MSY}$ has been underestimated and F/ $\mathbf{F}_{MSY}$ overestimated systematically in recent years. The changes compared with the results in last year's report are due to the changes (correction) in the input series (see 9.2.1). The biomass is slowly increasing from the record low in 1995. Although the retro runs show relatively consistency between years, the parameters that are used as a basis for calculating MSY, $\mathbf{F}_{MSY}$,$\mathbf{B}_{MSY}$ (K and r) are changing over time. Further, the r (intrinsic rate of increase) is very high for such a long-lived species and it also change considerable depending of the length of the input series, as shown in the texttable below.

Range	MSY	K	r	K/r
1996- 2001	50120	426000	0.470	906383
1996- 2000	51480	381600	0.539	707978
1996- 1999	51830	372900	0.556	670683
1996- 1998	52790	349500	0.604	578642
1996- 1997	55410	296900	0.747	397723

The model allows trajectories of population biomass and fishing mortality based on bootstrap estimates. Trajectories were performed for $\mathbf{F}_{pa}$, (2/3$\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$, Plot of B-ratio (B/$\mathbf{B}_{MSY}$) along with biomass trajectory is given in Figures 9.3.1.

Fishing at $\mathbf{F}_{pa}$ will keep the stock well above $\mathbf{B}_{MSY}$ within the next years. The ASPIC model results shows that catching at $\mathbf{F}_{pa}$ would result in a total catch of 47 000 t in 2003. Those catches apply for the whole distribution area.

9.2.3 State of the stock

All CPUE indices as well as the production model show a drastic reduction from highs in the late 1980s, but indices indicate that the stock seems to have started a slow recovery in the middle of 1990s from being close to 50% of the maximum in 1994-1996. Fishermen have reported of less *S. mentella* in the fishing areas Southwest and West of Iceland during recent years and this is confirmed by the low CPUE and catches in the fourth quarter of 2001 in Va and could indicate worse situation. The increase in the fishable biomass in Division Va since 1996 seems to be related to recruiting fish, most likely from East-Greenland. It is, however, uncertain to what extent the juvenile *S. mentella* observed at East-Greenland will recruit to this stock.

In Division Vb development in CPUE resembles that in Division Va, i.e., the CPUE seems to have stabilised at below 50% of the maximum in the time series (1985–1997), and the new CPUE series indicate a deteriorating situation since then.

Based on survey results the SSB of deep-sea *S. mentella* on the continental shelf in area XIV remains severely depleted. The strong recruiting cohort(s) observed in 1993-97 emigrated in 1998-2000 and have seemingly recruited to both the pelagic redfish stock and the stock at the shelf.

9.3 Catch projections

It is possible to compute effort as well as a TAC corresponding to different effort for deep-sea *S. mentella* by using a similar approach as described for *S. marinus*, although for the deep-sea *S. mentella*, the survey index is replaced by CPUE index. The management advice for current year is to not increase the effort from the 2000 level. That would corresponds to a catch of 31 000 t in Va in 2003 and lower than 35 000 for the whole stock.

9.4 Biological reference points

The relative state of the stock can be assessed through survey and CPUE index series (U) from the commercial fishery, which imply a maximum, U_{max}, as well as the present state. Given these data, it has been proposed by ACFM that reference points be defined in terms of the current state with respect to $U_{lim} = U_{max}/5$ and $U_{pa} = U_{max}/2$. Based on these definitions, the stock could be considered above U_{pa}.

9.5 Management considerations

The two types of pelagic redfish in the Irminger Sea (i.e., the oceanic and the pelagic deep-sea *S. mentell*a) in the present context are treated separately from the deep-sea *S. mentella* on the continental shelf. It can, however, not be excluded that there may be a relationship between the demersal deep-sea *S. mentella* on the continental shelves of the Faeroe Islands, Iceland, Greenland and the pelagic deep-sea *S. mentella* in the Irminger Sea and this should be considered in the management of this stock (see also chapter 7.5).

In Division Va, the catches in 2001 were considerable lower than the set quota for the quota year. That could be due to different reasons such as increased effort towards other species such as cod, but it should not be excluded that the explanations could be related to a deteriorating stock situation. Also, a joint quota has been given for *S .marinus* and *S. mentella* and in recent years the proportion of *S. mentella* /*S. marinus* catches have been close to the advice. Although the catches of those two stocks in Va have decreased by 27%, the decrease in the *S. marinus* only decreased by 15% as the *S. mentella* decreased by 43%. In order to let the ratio not deviate from advice ratio, the working group recommends that the TAC of demersal redfish stocks should be given separately.

The management strategy to reduce the effort in Division Va has resulted in an increase in the catchable biomass since 1995, according the data from the fishery. The WG recommends that effort should be kept low and **no higher than it was in 2000**. That could correspond to a catch of no more than about 30 800 tonnes in 2003in divison Va.

All signs from the fishery indicate decreasing abundance in Subarea Vb. Therefore the Working Group recommends that the **effort in Division Vb should be decreased from current level**.

In Division XIV the Working Group recommends maximum protection of the juveniles and **no directed** fishery in order to maximise the probability of stock recovery to safe biological limits.

Table 9.1.1 Deep-sea *S. mentella* on the continental shelf. Landings (in tonnes) by area used by the Working Group.

	Area					
Year	Va	Vb	VI	XII	XIV	Total
1978	3,902	7,767	18	0	5,403	17,090
1979	7,694	7,869	819	0	5,131	21,513
1980	10,197	5,119	1,109	0	10,406	26,831
1981	19,689	4,607	1,008	0	19,391	44,695
1982	18,492	7,631	626	0	12,140	38,889
1983	37,115	5,990	396	0	15,207	58,708
1984	24,493	7,704	609	0	9,126	41,932
1985	24,768	10,560	247	0	9,376	44,951
1986	18,898	15,176	242	0	12,138	46,454
1987	19,293	11,395	478	0	6,407	37,573
1988	14,290	10,488	590	0	6,065	31,433
1989	40,269	10,928	424	0	2,284	53,905
1990	28,429	9,330	348	0	6,097	44,204
1991	47,651	12,897	273	0	7,057	67,879
1992	43,414	12,533	134	0	7,022	63,103
1993	51,221	7,801	346	0	14,828	74,196
1994	56,720	6,899	642	0	19,305	83,566
1995	48,708	5,670	536	0	819	55,733
1996	34,741	5,337	1,048	0	730	41,856
1997	37,876	4,558	419	0	199	43,051
1998	33,125	4,089	298	3	1,376	38,890
1999	28,590	5,294	243	0	865	34,992
2000	30,696	4,841	885	0	986	37,408
2001	17,313	4,339	39	0	866	22,567

Table 9.1.2 *Sebastes marinus* and deep sea *S. mentella* catches and effort (hours fished) in ICES Divisions Va, Vb, VI and XIVb by year and quarter of the German fleet, 1998-2001.

Year		Total		Va		Vb		VI		XIVb	
	Quarter	Catch (t)	Effort (h)	Catch (t)	Effort (h)	Catch (t)	Effort (h)	Catch (t)	Effort (h)	Catch (t)	Effort (h)
1998	1	0	0	0	0	0	0	0	0	0	0
1998	2	290	629	0	0	0	0	0	15	290	614
1998	3	401	1202	226	945	0	0	0	0	175	260
1998	4	1001	1628	58	287	0	0	0	6	943	1335
1998		1693	3459	284	1232	0	0	1	21	1408	2206
1999	1	11	240	0	0	0	0	0	4	11	236
1999	2	139	513	0	0	7	113	0	0	132	400
1999	3	508	2460	284	1162	188	775	0	0	36	523
1999	4	783	1961	145	757	12	82	0	0	625	1123
1999		1441	5174	429	1919	207	970	0	4	804	2282
2000	1	542	872	0	0	0	0	0	0	542	872
2000	2	277	916	0	0	2	105	0	0	275	811
2000	3	521	2277	321	1448	73	401	0	24	127	404
2000	4	196	1249	192	1123	4	33	0	0	0	93
2000		1536	5314	513	2571	79	539	0	24	944	2180
2001	1	0	0	0	0	0	0	0	0	0	0
2001	2	30	497	0	0	29	448	1	49	0	0
2001	3	720	3093	661	2724	58	330	0	0	1	39
2001	4	967	2024	180	934	1	74	0	0	786	1016
2001		1717	5614	841	3658	88	852	1	49	787	1055

Table 9.2.1 Results of the ASPIC fit procedure for shelf *S. mentella*

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ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.91) — FIT Mode

Author: Michael H. Prager; NOAA/NMFS/S.E. Fisheries Science Center
101 Pivers Island Road; Beaufort, North Carolina 28516 USA

ASPIC User's Manual is available gratis from the author.

Ref: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389.

CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	16	Number of bootstrap trials:	0
Number of data series:	1	Lower bound on MSY:	5.000E+03
Objective function computed:	in effort	Upper bound on MSY:	1.000E+09
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	1.000E-01
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	9.000E-01
Relative conv. criterion (effort):	1.000E-04	Random number seed:	2010417
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 10000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) — code 0

Normal convergence.

GOODNESS-OF-FIT AND WEIGHTING FOR NON-BOOTSTRAPPED ANALYSIS

Loss component number and title	Weighted SSE	N	Weighted MSE	Current weight	Suggested weight	R-squared in CPUE
Loss(-1) SSE in yield	0.000E+00					
Loss(0) Penalty for B1R > 2	2.777E-05	1	N/A	1.000E-01	N/A	
Loss(1) ICE CPUE indices tot	5.350E-02	16	3.821E-03	1.000E+00	1.000E+00	0.925
TOTAL OBJECTIVE FUNCTION:	5.35258670E-02					

NOTE: B1/**B**$_{MSY}$ constraint term contributing to loss. Sensitivity analysis advised.
Number of restarts required for convergence: 29
Est. B/**B**$_{MSY}$ coverage index (0 worst, 2 best): 0.9950 < These two measures are defined in Prager
Est. B/**B**$_{MSY}$ nearness index (0 worst, 1 best): 0.9950 < et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting B/**B**$_{MSY}$, year 1986	2.034E+00	1.000E+00	1	1
MSY	Maximum sustainable yield	5.012E+04	2.000E+06	1	1
r	Intrinsic rate of increase	4.707E-01	2.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	ICE CPUE indices tot	2.623E-06	3.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	5.012E+04	Kr/4	
K	Maximum stock biomass	4.260E+05		
B$_{MSY}$	Stock biomass at MSY	2.130E+05	K/2	
F$_{MSY}$	Fishing mortality at MSY	2.354E-01	r/2	
F(0.1)	Management benchmark	2.118E-01	0.9***F**$_{MSY}$	
Y(0.1)	Equilibrium yield at F(0.1)	4.962E+04	0.99*MSY	
B./**B**$_{MSY}$	Ratio of B(2002) to **B**$_{MSY}$	1.348E+00		
F./**F**$_{MSY}$	Ratio of F(2001) to **F**$_{MSY}$	3.467E-01		
F01-mult	Ratio of F(0.1) to F(2001)	2.596E+00		
Ye./MSY	Proportion of MSY avail in 2002	8.787E-01	2*Br-Br^2	Ye(2002) = 4.404E+04
....	Fishing effort at MSY in units of each fishery:			
F$_{MSY}$(1)	ICE CPUE indices tot	8.973E+04	r/2q(1)	f(0.1) = 8.076E+04

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to **F**$_{MSY}$	Ratio of biomass to **B**$_{MSY}$
1	1986	0.113	4.331E+05	4.113E+05	4.645E+04	4.645E+04	6.510E+03	4.799E-01	2.034E+00
2	1987	0.098	3.932E+05	3.827E+05	3.757E+04	3.757E+04	1.824E+04	4.171E-01	1.846E+00
3	1988	0.085	3.738E+05	3.694E+05	3.143E+04	3.143E+04	2.309E+04	3.616E-01	1.755E+00
4	1989	0.153	3.655E+05	3.519E+05	5.391E+04	5.391E+04	2.873E+04	6.508E-01	1.716E+00
5	1990	0.132	3.403E+05	3.347E+05	4.420E+04	4.420E+04	3.373E+04	5.611E-01	1.598E+00
6	1991	0.216	3.298E+05	3.142E+05	6.788E+04	6.788E+04	3.872E+04	9.179E-01	1.549E+00
7	1992	0.217	3.007E+05	2.903E+05	6.310E+04	6.310E+04	4.349E+04	9.237E-01	1.412E+00
8	1993	0.278	2.811E+05	2.665E+05	7.420E+04	7.420E+04	4.689E+04	1.183E+00	1.320E+00
9	1994	0.355	2.538E+05	2.356E+05	8.357E+04	8.357E+04	4.945E+04	1.507E+00	1.192E+00
10	1995	0.257	2.197E+05	2.167E+05	5.574E+04	5.574E+04	5.011E+04	1.093E+00	1.031E+00
11	1996	0.192	2.140E+05	2.183E+05	4.186E+04	4.186E+04	5.009E+04	8.147E-01	1.005E+00
12	1997	0.191	2.223E+05	2.258E+05	4.305E+04	4.305E+04	4.994E+04	8.100E-01	1.044E+00
13	1998	0.166	2.292E+05	2.347E+05	3.889E+04	3.889E+04	4.959E+04	7.041E-01	1.076E+00
14	1999	0.142	2.399E+05	2.470E+05	3.499E+04	3.499E+04	4.883E+04	6.019E-01	1.126E+00
15	2000	0.145	2.537E+05	2.591E+05	3.747E+04	3.747E+04	4.777E+04	6.145E-01	1.191E+00
16	2001	0.082	2.640E+05	2.760E+05	2.252E+04	2.252E+04	4.569E+04	3.467E-01	1.240E+00
17	2002		2.872E+05						1.348E+00

Table 9.2.1, cont .

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RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) ICE CPUE indices tot

Data type CC: CPUE-catch series Series weight: 1.000

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in log yield
1	1986	1.000E+00	1.079E+00	0.1129	4.645E+04	4.645E+04	0.07587	
2	1987	1.090E+00	1.004E+00	0.0982	3.757E+04	3.757E+04	-0.08244	
3	1988	9.894E-01	9.688E-01	0.0851	3.143E+04	3.143E+04	-0.02101	
4	1989	9.456E-01	9.231E-01	0.1532	5.391E+04	5.391E+04	-0.02409	
5	1990	9.036E-01	8.780E-01	0.1321	4.420E+04	4.420E+04	-0.02875	
6	1991	9.066E-01	8.241E-01	0.2160	6.788E+04	6.788E+04	-0.09538	
7	1992	7.047E-01	7.613E-01	0.2174	6.310E+04	6.310E+04	0.07725	
8	1993	6.361E-01	6.991E-01	0.2784	7.420E+04	7.420E+04	0.09432	
9	1994	5.687E-01	6.179E-01	0.3547	8.357E+04	8.357E+04	0.08299	
10	1995	5.827E-01	5.684E-01	0.2572	5.574E+04	5.574E+04	-0.02485	
11	1996	5.875E-01	5.725E-01	0.1917	4.186E+04	4.186E+04	-0.02584	
12	1997	6.167E-01	5.923E-01	0.1906	4.305E+04	4.305E+04	-0.04026	
13	1998	6.214E-01	6.156E-01	0.1657	3.889E+04	3.889E+04	-0.00938	
14	1999	6.607E-01	6.479E-01	0.1417	3.499E+04	3.499E+04	-0.01950	
15	2000	6.963E-01	6.795E-01	0.1446	3.747E+04	3.747E+04	-0.02443	
16	2001	6.781E-01	7.239E-01	0.0816	2.252E+04	2.252E+04	0.06541	

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                    -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                     |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year  Residual    ---------------------------------------------------------------------------------------
1986    0.0759                                              |===
1987   -0.0824                                           ===|
1988   -0.0210                                             =|
1989   -0.0241                                             =|
1990   -0.0287                                             =|
1991   -0.0954                                          ====|
1992    0.0773                                              |===
1993    0.0943                                              |====
1994    0.0830                                              |===
1995   -0.0248                                             =|
1996   -0.0258                                             =|
1997   -0.0403                                            ==|
1998   -0.0094                                              |
1999   -0.0195                                             =|
2000   -0.0244                                             =|
2001    0.0654                                              |===
                  ---------------------------------------------------------------------------------------
```

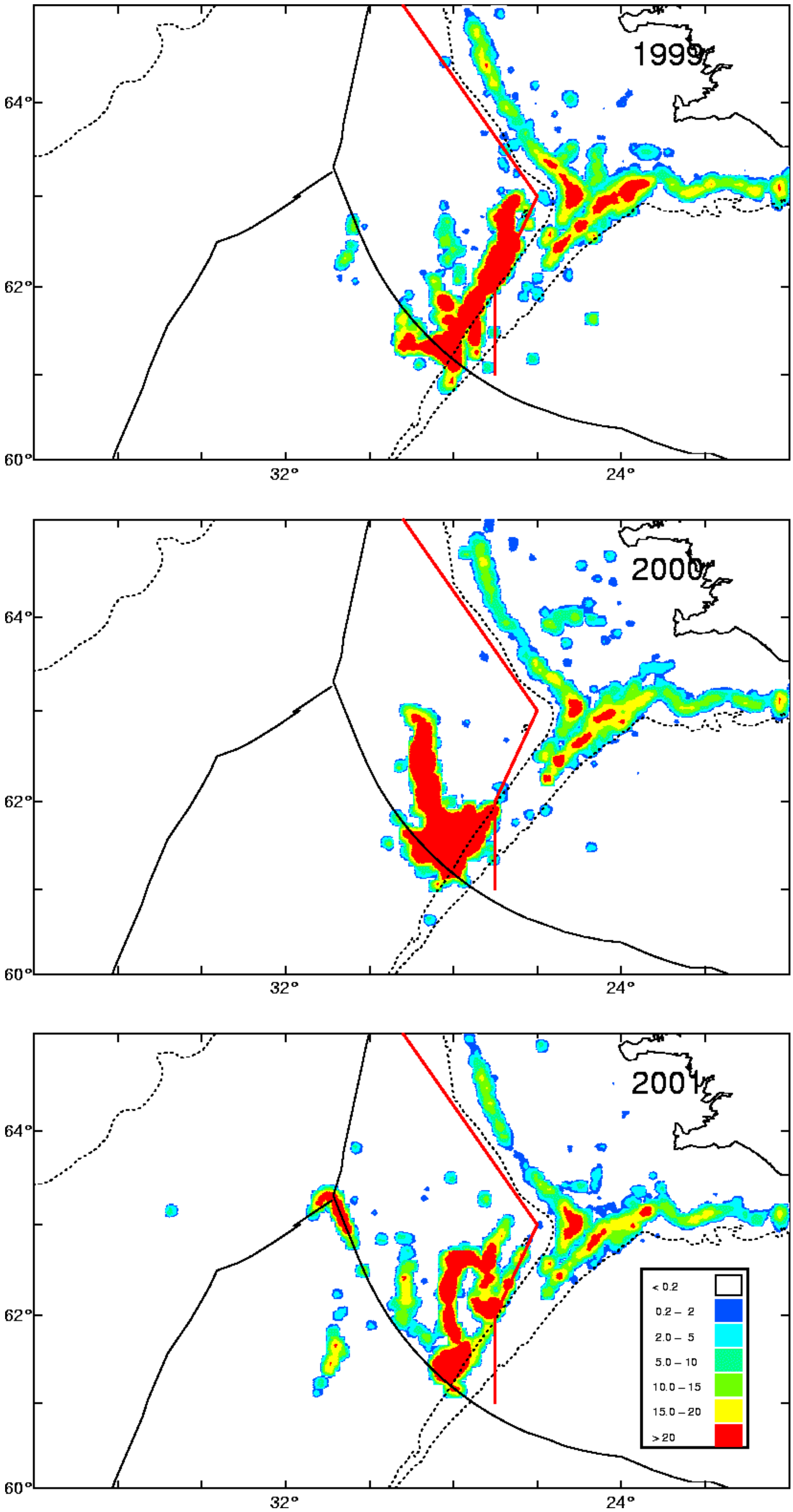


Figure 9.1.1 Map showing the line used by Icelandic authorities to separate the landing statistics between deep-sea. The figures also show the fishing grounds of demersal fishing for redfish and the oceanic redfish fishery in 1999 –2001 as record in the log-books. The catches west of the "redfish line" is from the pelagic fishery as the catch north and east of the line of "shelf type".

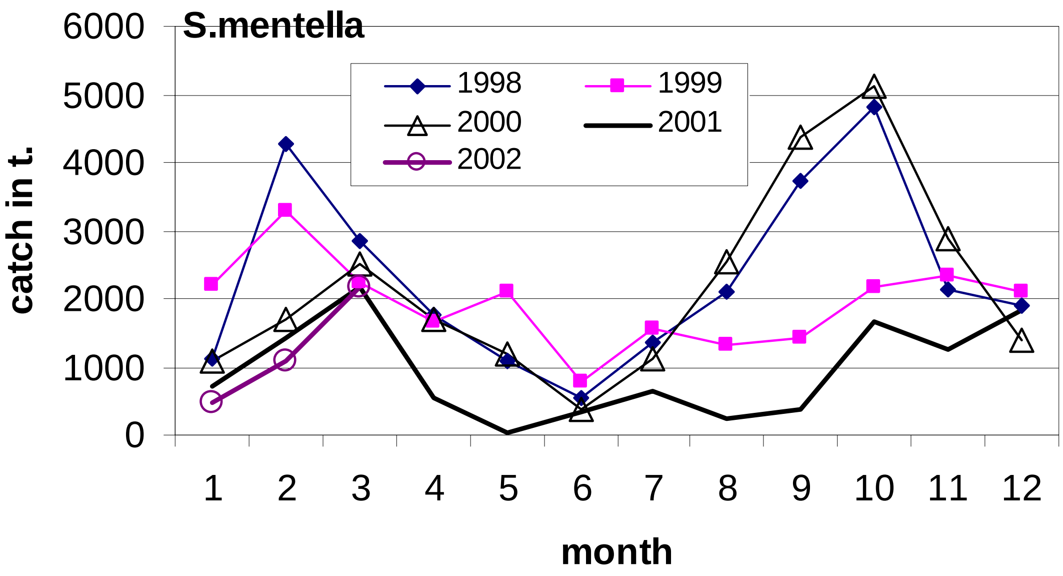


Figure 9.1.2 *S. mentella* catches by month since 1998.

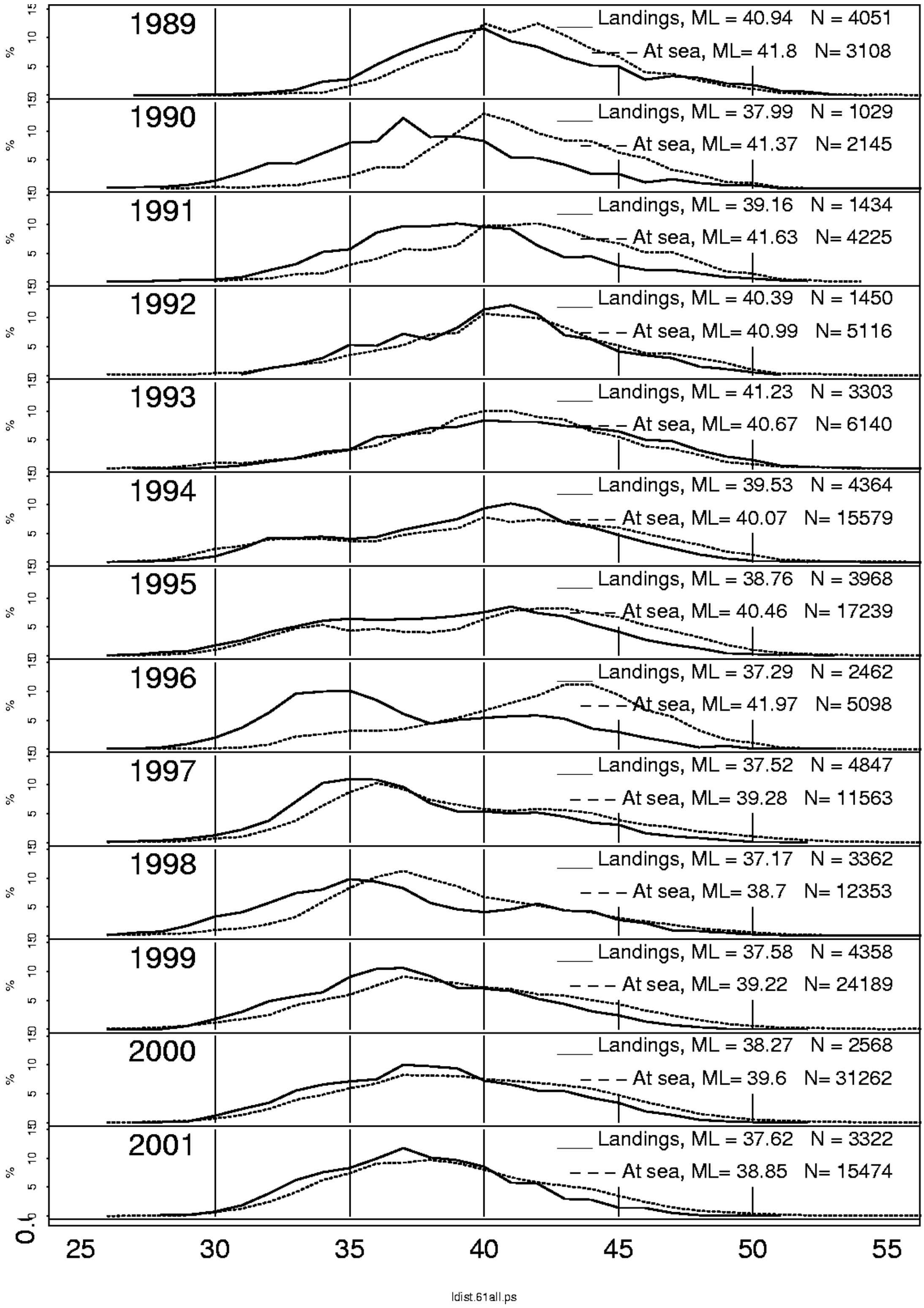


Figure 9.1.3 Length distributions of deep-sea *S. mentella* catch and landings from the Icelandic bottom trawl fishery in 1989-2001.

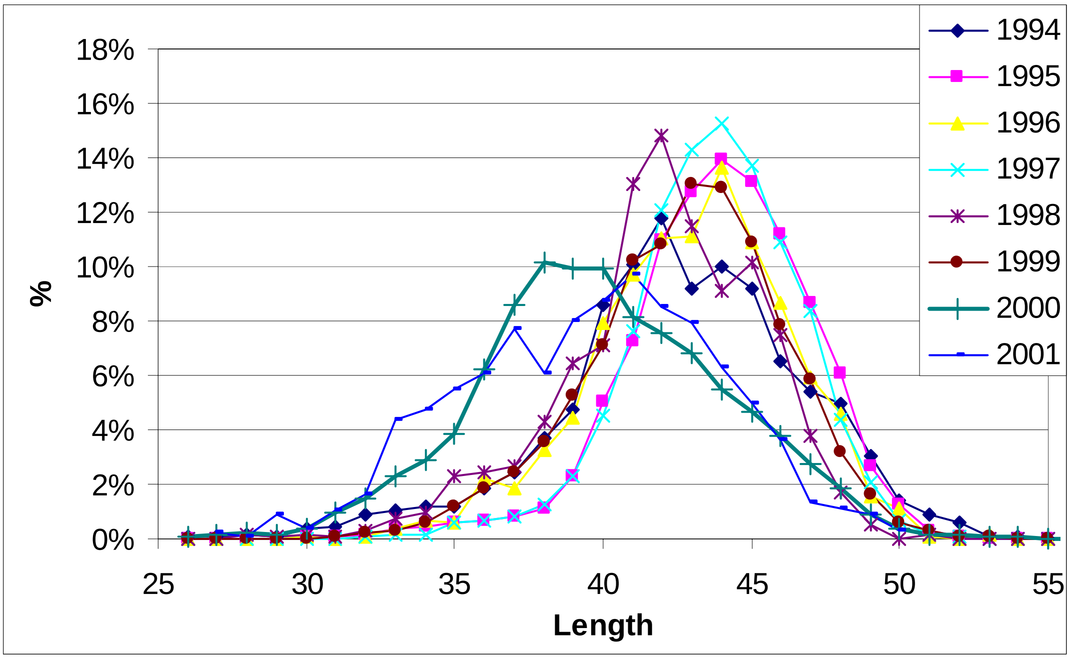


Figure 9.1.4 Length distributions of deep-sea *S. mentella* catch and landings from the Icelandic pelagic trawl fishery in 1994-2001.

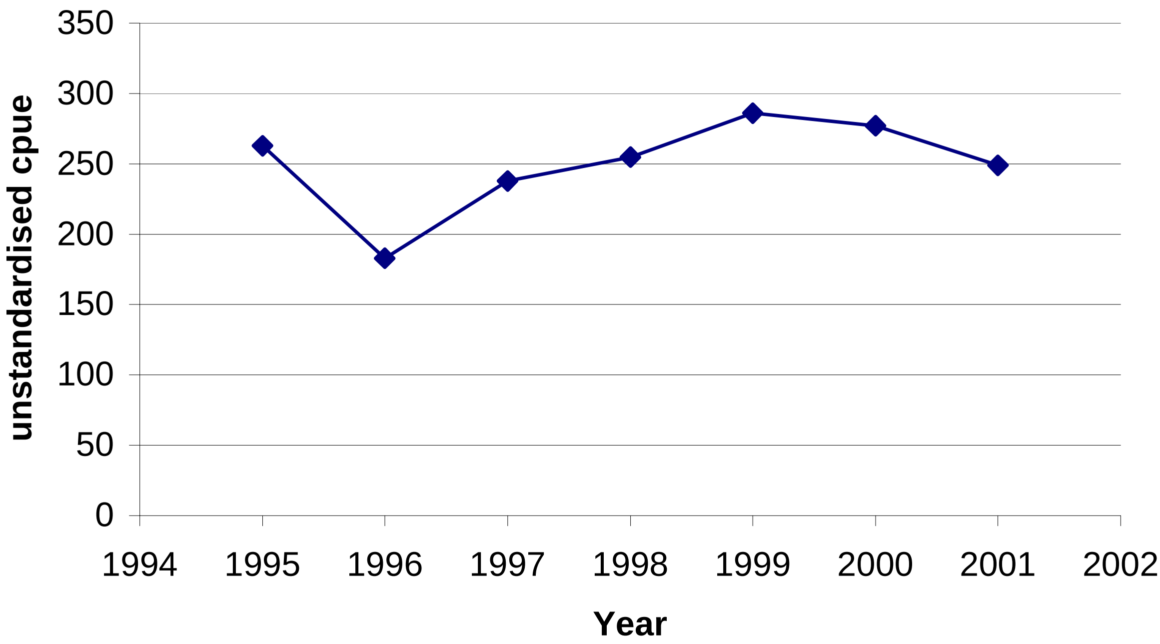


Figure 9.1.5 CPUE from the Faroese bottom trawl fleet.

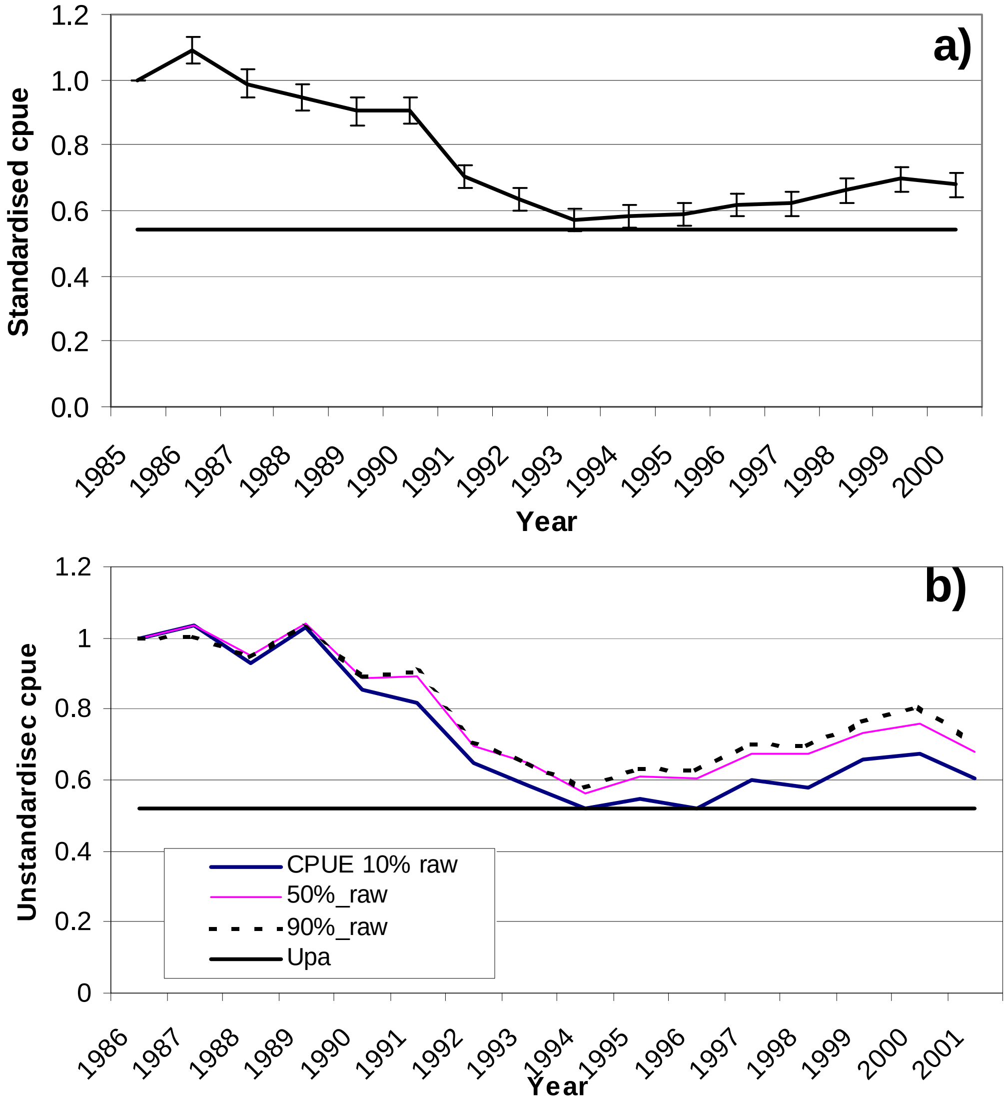


Figure 9.2.1 CPUE, relative to 1986, from the Icelandic bottom trawl fishery for deep-sea *S. mentella* on the continental shelf, based on a GLIM model (a) and based on simple mean (b). The GLIM model shows the modelled development using GLIM including hauls where redfish deeper than 500 m compose 50% or more of the total catch in each haul. Simple mean means CPUE calculated on hauls where redfish deeper than 500 m compose 10% (50, 70 and 90% lines are also shown) or more of the total catch in each haul.

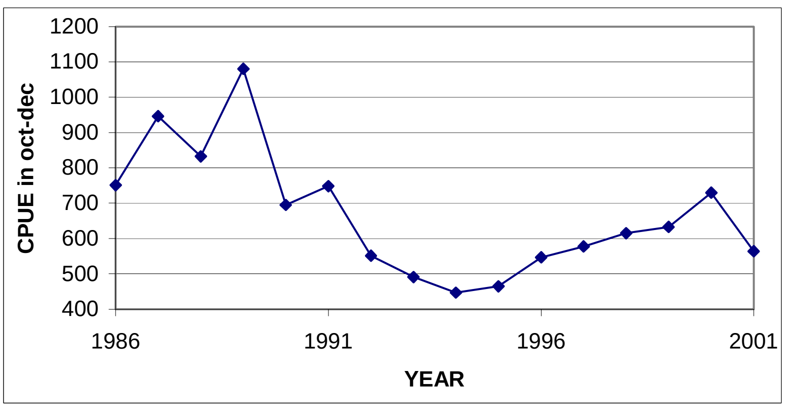


Figure 9.2.2 CPUE of the Icelandic trawler fleet for deep-sea *S. mentella* based on hauls below 500 m and only including catches of redfish more than 10% of the total catch.

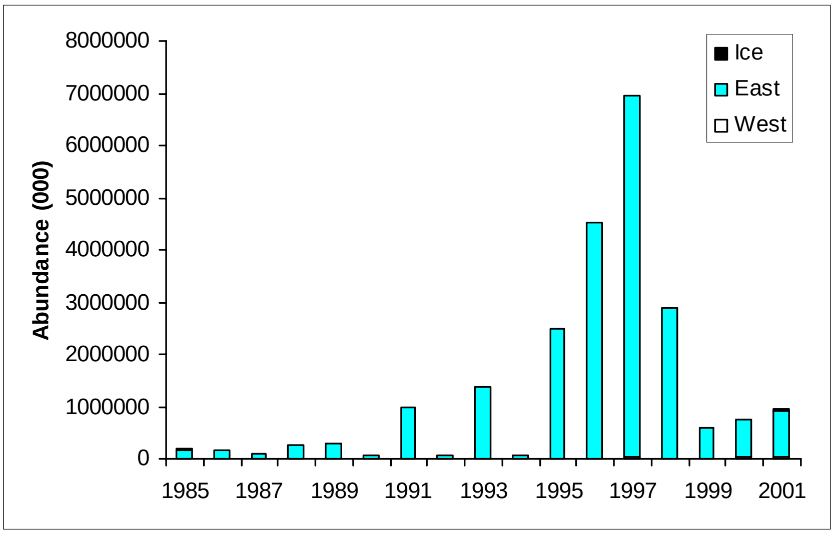


Figure 9.2.3 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985–2001.

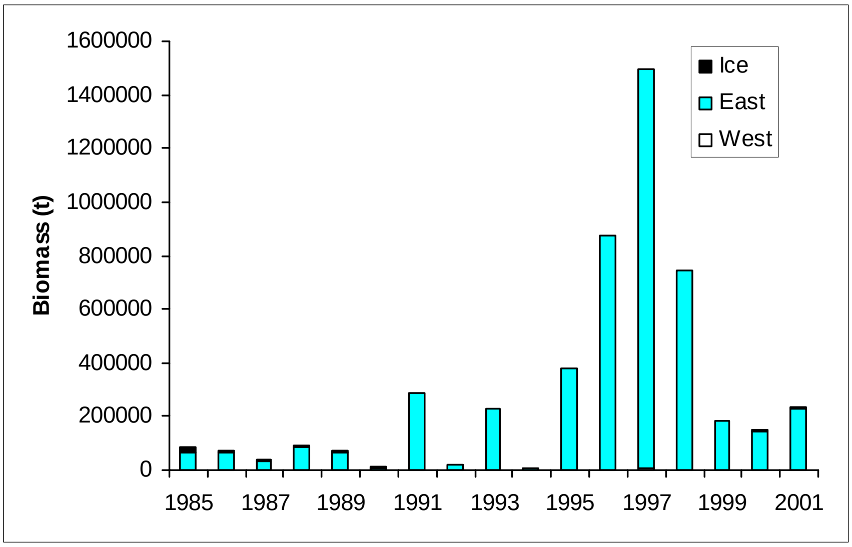


Figure 9.2.4 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland and Iceland, as derived from the German and Icelandic groundfish surveys, 1985-2001.

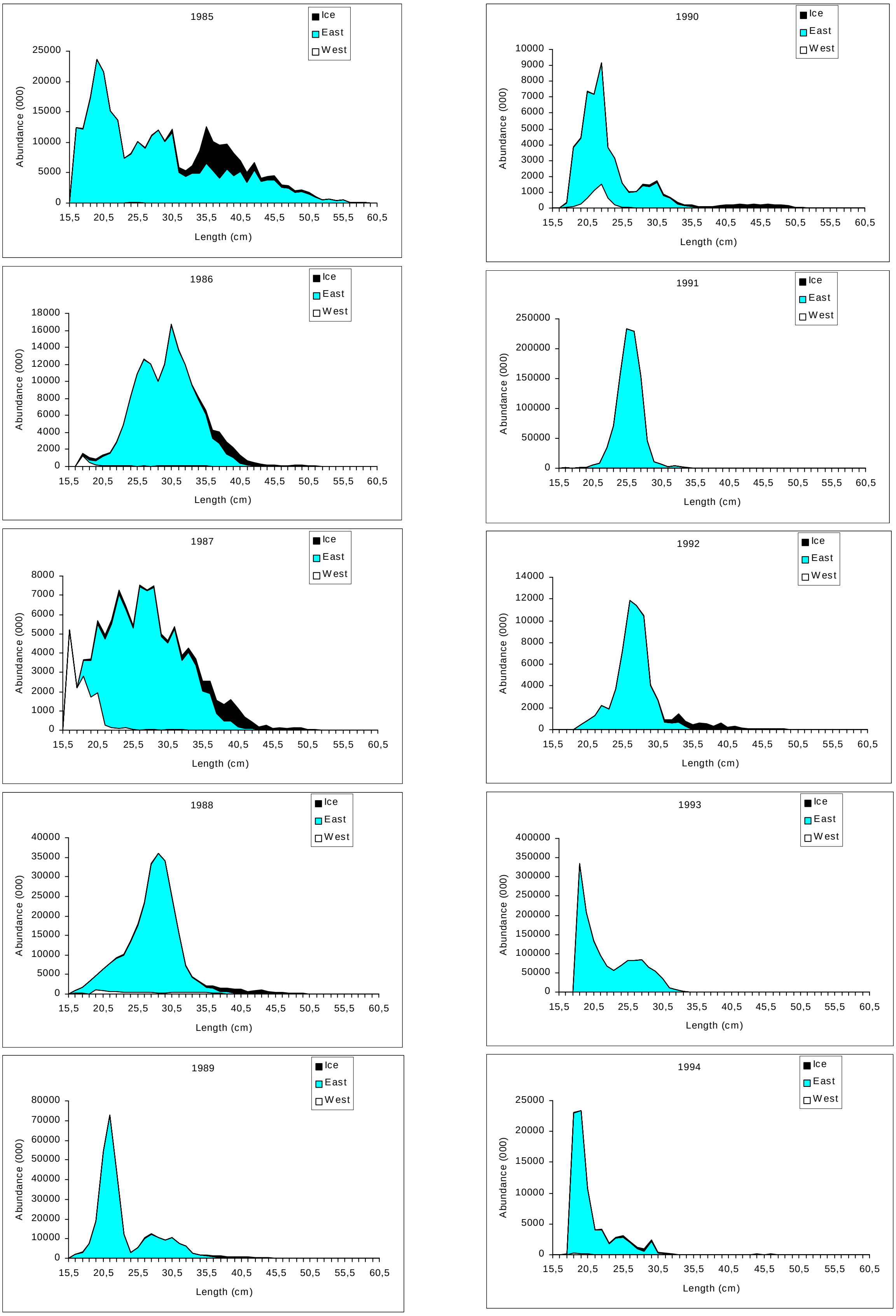


Figure 9.2.5 Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985-1994.

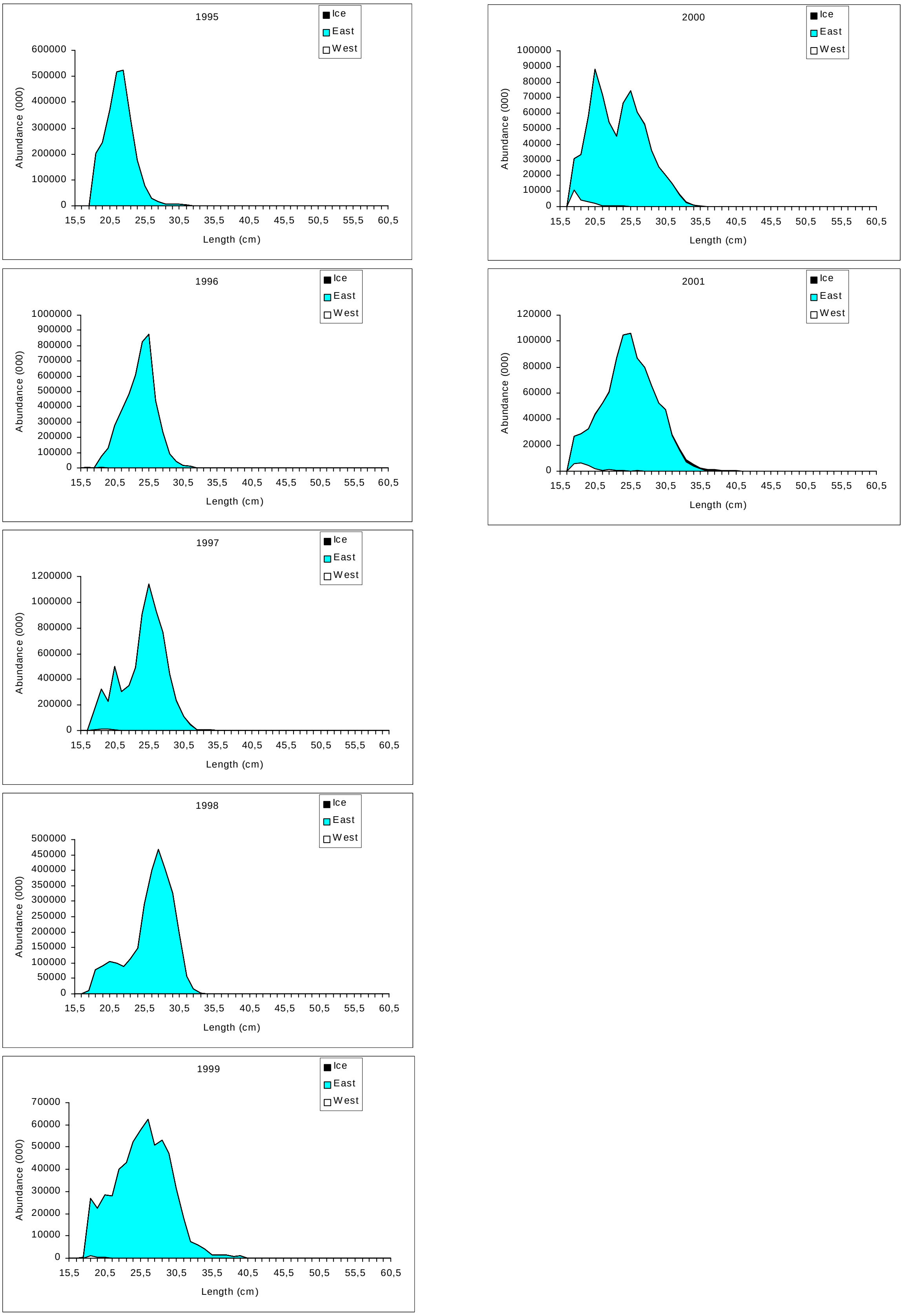
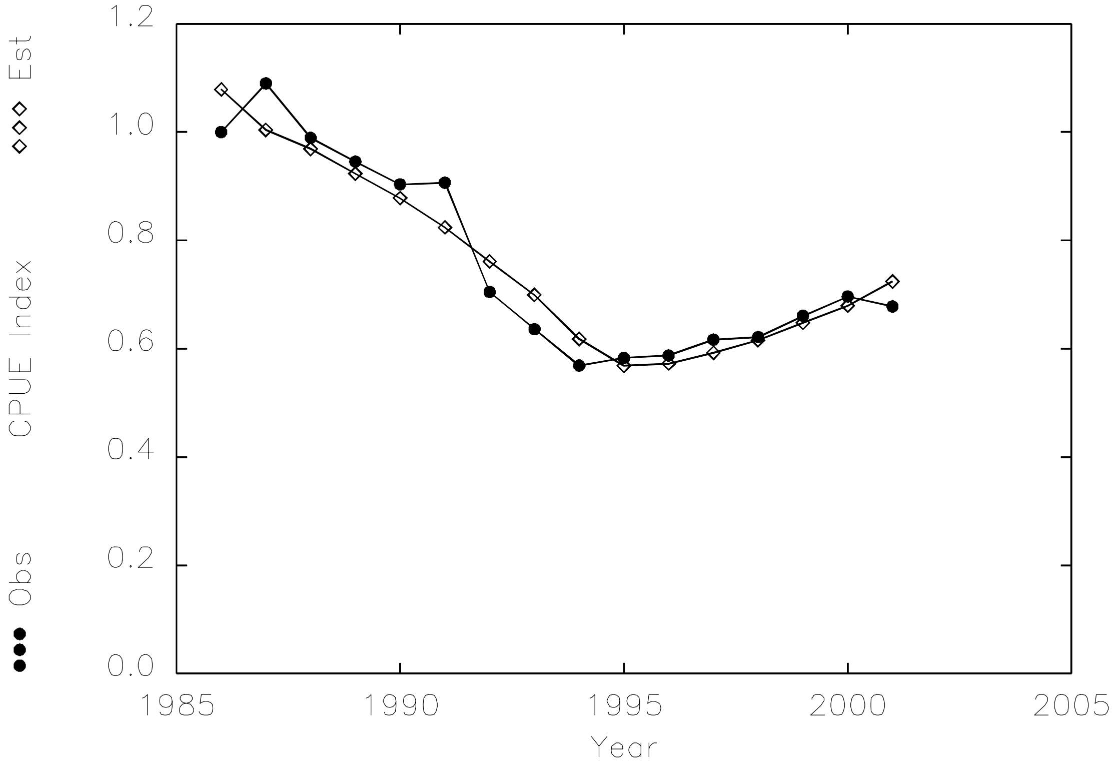


Figure 9.2.6 Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1995-2001.



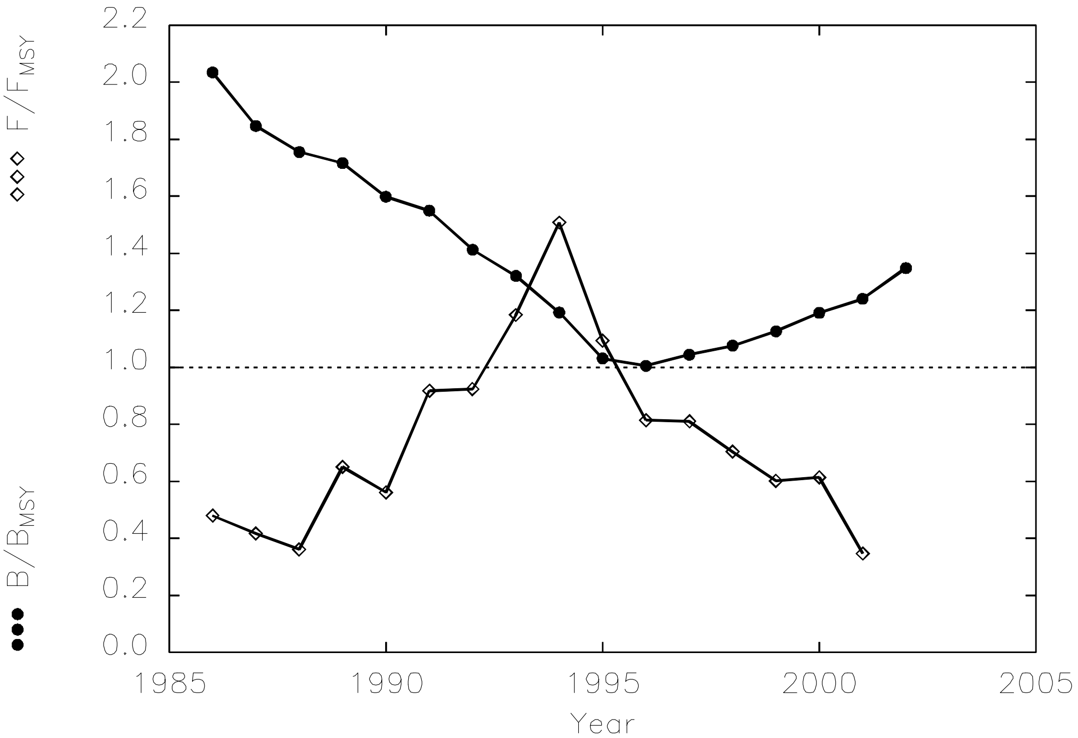
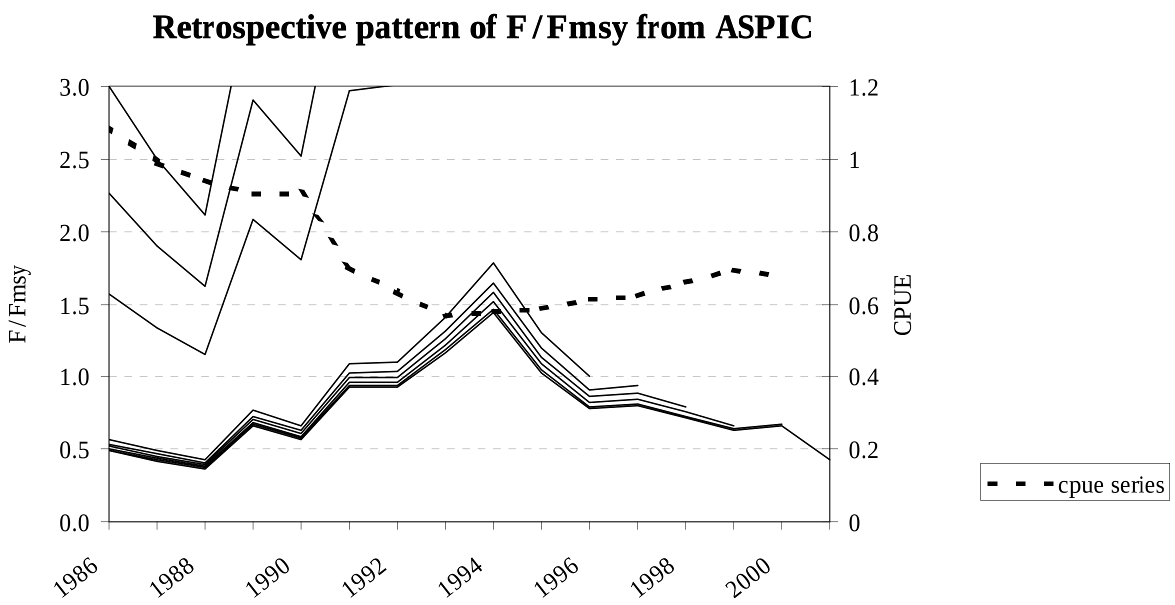


Figure 9.2.7 Observed and estimated CPUE and time plot of estimated F and B ratio for *S. mentella*, using the ASPIC production model.



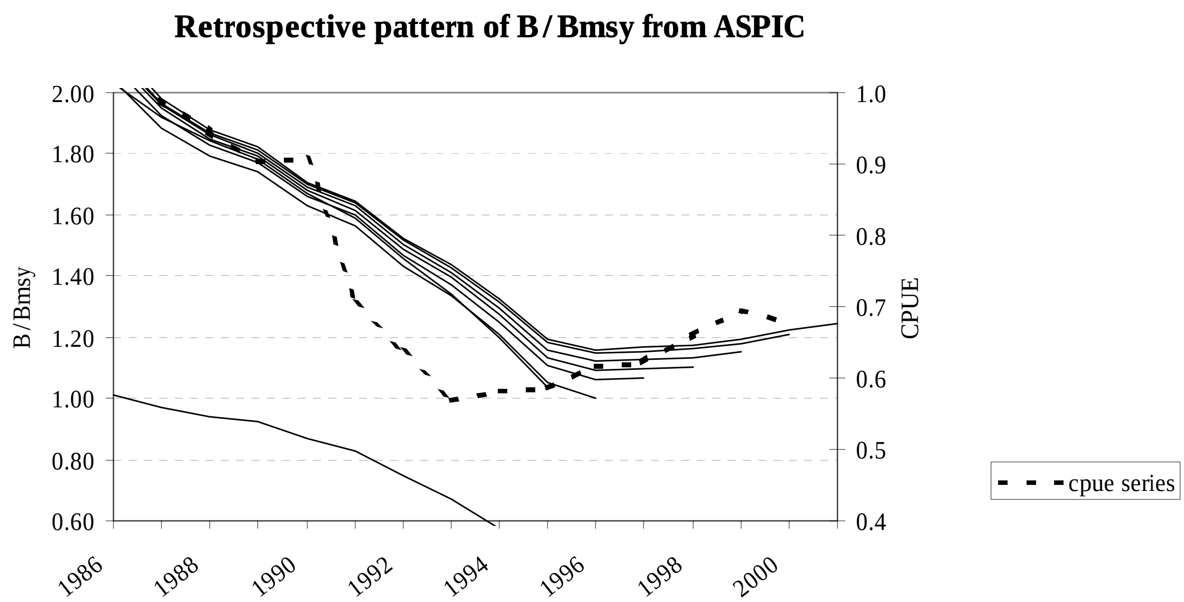


Figure 9.2.8 Retrospective analysis of the ASPIC model. The used CPUE index is also shown.

10 PELAGIC SEBASTES MENTELLA

This section includes information on the pelagic fishery for *S. mentella* both shallower and deeper than 500 m in the Irminger Sea (Subarea XII, parts of Division Va, Subarea XIV and eastern parts of NAFO Divisions 1F, 2H and 2J).

Under chapter 7.5, comments are made on special requests in the ToR. Aside from what is said there, the WG refers to last years' reports on the matter of stock/delineation in the area.

10.1 Fishery

10.1.1 Historical development of the fishery

Russian trawlers started fishing pelagic *S. mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from Russia in 1984. Total catches increased from 60 600 t in 1982 to 105 000 t. in 1986. Since 1987, the total landings decreased to a minimum in 1991 of 28 000 t. The main reason for this decrease was a reduction in fishing effort, especially by the Russian fleet. Since 1989, the number of countries, participating in the pelagic *S. mentella* fishery gradually increased. As a consequence, total catches have also increased after the 1991 minimum and reached a historical high of 180 000 t in 1996 (Tables 10.1.1–10.1.2). In 2000 and 2001, the WG estimate of the catch has been 126 000 and 118 000 t, respectively.

In the period 1982–1992, the fishery was carried out mainly from April to August. In 1993–1994, the fishing season was prolonged considerably, and in 1995 the fishery was conducted from March to December. In 1997 and 1998, the main fishing season occurred during the second quarter, but fishery was also longer. The pattern in the fishery has been reasonably consistent in the last 3-4 years: In the first months of the fishing season (which usually starts in early April), the fishery is conducted in area west of 32°W and north of 61°N; in May and June the fishery is more or less at same areas, but in July (August), the fleet moves to areas south of 60°N and west of about 32°W where the fishery continues until October (see figures 7.5.1-7.5.6). There is very little fishing activity in the period from November until late March or early April when the next fishing season starts. The fleets participating in this fishery have continued to develop their fishing technology, and most trawlers now use large pelagic trawls ("Gloria"-type) with vertical openings of 80–150 m. The vessels have operated in 1998-2001 at a depth range of 200 to 950 m, but mainly deeper than 600 m in the first and second quarter but at depths shallower than 500 m in third and fourth quarter.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2001:

Faroes	3 factory trawlers
Germany	7 factory trawlers
Greenland	1 factory trawler
Iceland	25 factory trawlers and 1 freshfish trawlers
Norway	4 factory trawlers
Russia	28 factory trawlers
Spain	6 factory trawlers

A summary of the catches by depth by nation as estimated by the Working Group is given in Table 10.1.2.

10.1.2 Description on the fishery of various fleets

10.1.2.1 Faroes

The Faroese fishery for pelagic redfish in the Irminger Sea and adjacent waters started in 1986. In the first years, only 1-2 trawlers participated in the fishery. Fishing depths were mainly shallower than 500 m although some trials were made down to about 700 m. From 1992 onwards, several trawlers have made trips to this area fishing almost exclusively deeper than 500-600 m.

In 1999, the Faroese fishery in the international parts of the Irminger Sea started in late April and continued until late August with 5 trawlers participating in the fishery and all hauls being deeper than 600 m. From September, two of the trawlers fished within the Greenlandic EEZ; all hauls were shallower than 600 m.

In 2000 as well as in 2001, the Faroese fishery started in international waters in the NE part of the Irminger Sea in the middle of April (ICES Division XIV). Up to late July, the fishing area was mainly between 61°N-62N and 27°N-

30°00’W, then they moved to the SW, to south of 60°N and west of 37°W (ICES Division XII), fishing mostly within the Greenlandic EEZ. Two trawlers participated in 2000, and 3 in 2001. The fishing depth from the beginning of the fishery to July was nearly exclusively deeper than 600 m, but from July onwards, the fish was taken at shallower depths than 600 m.

10.1.2.2 Germany

The reported German fishing effort in 2001 was only slightly higher than the low effort in 2000, the lowest observed in the last seven years, and amounted to 13 000 trawling hours only, a 26 % decrease as compared with 1999. As observed in previous years, the majority of the 2001 effort was applied during the second and third quarters by 7 vessels. During the second quarter in 2001, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Subarea XIV between the Greenland and Icelandic EEZs. In 2001, there was reduced fishing effort exerted in the NAFO Div. 1F mainly within the Greenland EEZ during the third quarter as compared with 2000. The decrease of annual catches continued since 1996 with a catch of 10 700 tons in 2001. In 2001, 8 % or 800 tons of the total catch were taken in the NAFO Div. 1 F. During 1995-1999, the overall unstandardised CPUE decreased from 2 055 kg/h by 53 % to 970 kg/h. In 2000 and 2001, the CPUE remained low. Catch rates recorded in NAFO Div. 1F are slightly higher than observed in the adjacent ICES Subarea XII, especially inside the Greenland EEZ. Given the technical, temporal, geographical and depth changes of the fishing activities the relevance of the estimated reduction in CPUE as indicator of stock abundance remained difficult to assess. However, the continued reduction in CPUE during 1996-1999 should be interpreted as reaction of the stock to removed biomass.

10.1.2.3 Greenland

The Greenlandic fleet was fishing in the same area as the Icelandic fleet (see below), and therefore, the Greenlandic log-book data were included in the figure of the Icelandic fishery.

10.1.2.4 Iceland

Catches in 1995-2000 were generally taken in the area between the Greenlandic EEZ and the Reykjanes Ridge. Since 1996, the catches have mostly been taken close to or inside the 200-mile boundary Southwest of Iceland. In recent years, the fishery has started in April close to the Icelandic 200-mile boundary and then moved northward in May-July. In the springtime and until June, the largest proportions of the catches were taken deeper than 500 m. In 1998, the fishery expanded further north in July-September. In 1999, a similar pattern was observed, except that the fishery did not continue close to the shelf of Iceland. The few vessels that had quota left after that, moved about 480 nautical miles to southwest, to the area S-SE of Cape Farewell (Subarea XII), where they fished shallower than 500 m depth in July-September. In 2000, the fishery started in April at the same locations as in the past and moved slowly northward until the fishery ended in July due to quota limitation. The Icelandic trawlers fished mainly at a depth of 600-800 m during the period 1995-2000 (Figure 10.1.1). In 2000, less than 8% of the catches in the log-books were reported shallower than 500 m depth and no catches were reported at depths shallower than 400 m.

In 2001, the fishery started in May, and total of only 3000 tonnes were reported in that month, all taken in the area close to the Icelandic 200 miles boundary. In June and until middle of July, the fishery was exclusively within the Icelandic EEZ moving slowly in northward direction. In May – July over 90% of the catches were taken at depths deeper than 600 m. According to the fishermen, the fishery in that period was mainly from the same “school”. The legislation for the fishery changed in 2001, compared with the previous years. Every vessel was forced to fish 1/3 of its catches south of about 60 in order to spread the effort. Therefore, the fishery continued in August in the area southeast of Cape Farwell, mostly between 38 and 42°W. In September and October, the fishery continued in the same area. About 1/3 of the Icelandic catches were taken in the “south-western” fishing area and nearly all that catches were taken shallower than 400 m depth. The length distribution from the catch is shown in Figure 10.1.2.

10.1.2.5 Norway

Information on the fishery in 1998 and 1999 indicated a depth shift in the fishery, from fishing 95% of its catch shallower than 500 m in 1998 to fishing exclusively deeper than 500 m in 1999. The catches in 1999 were taken in areas XII and XIV from April to August, at a ratio of about 2:3. In 2000, Norway fished 6 075 t whereof 3 823 t were taken in ICES Subarea XIV and 2 252 t in Subarea XII. The fishing season was from April – September. In 2001, the fishery started in April, close to the Icelandic 200 miles boundary (Subarea XIV). The fishery continued there until beginning of June, when the fleet moved to Subarea XII between 55 and 58°N and between 40 and 42°W. There is no information on the trawling depth or about length distributions in the catches.

10.1.2.6 Russia

The regular Russian commercial fishery for pelagic redfish in the Irminger Sea started in 1982. Total catch of redfish taken by the USSR/Russia makes up about 0,76 mill. t or 43% of the total world catch for a whole period of the fishery in the Irminger Sea. In 1982-1988, the annual Russian catch of redfish constituted 60-85 thou. t. The fishery duration was 4-4,5 months. In 1989-1994, the catch decreased to 9-25 thou. t. Fishing efficiency of STM-type vessels was 10-15 t per a vessel/fishing day. A shift of the fishery to the depths deeper than 500 m, and due to an increase in trawl size, an increase in fishing efficiency was observed in 1994. A reduction in redfish catches from the depths deeper than 500 m has been observed since 1997. The extension of fishing period to 8 months and extension of areas due to the increased fishery within the 200-mile zone of Greenland and adjacent areas of the Labrador Sea occurred simultaneously.

In 2001, the Russian fishery for pelagic redfish in the Irminger Sea and adjacent waters of the NAFO Regulatory Area lasted from March to October. It was conducted by 28 trawlers of different types. 72 % of the total catch and 70 % of the fishing effort were recorded in June-July. As in 2000, fishing effort and the catch of redfish increased. Scouting for commercial concentrations began in late March. In April, the fishery started in the traditional area near the Icelandic EEZ. During the second quarter of the year, redfish was fished at 550-850 m depth in the open part of Subarea XIV. During the third quarter redfish fishery shifted south-westwards to Subareas XIV and XII and was conducted at 200-900 m depth in the international waters and in the Greenlandic EEZ. Total catch in ICES Subareas XII and XIV made up preliminary 28360 t (WD 16). In early August, 4 Russian trawlers started a fishery in the NAFO Regulatory Area at 150-350 m depth. In September, fishing conditions were much worse and vessels left the area. The total catch in all NAFO Divisions made up preliminary 1652 t.

10.1.2.7 Spain

Four Spanish freezer trawlers fished pelagic redfish in 1995-1997, increasing to 6 vessels since 1998. The fleet has used a Gloria-type pelagic trawl, with a maximum vertical opening of 80-120 m.

The Spanish pelagic fishery in ICES Subareas XII and XIV and in NAFO Div. 1F shows a persistent seasonal pattern in terms of its geographical and depth distribution. The main fishing occurs in the second and third quarter each year. In the second quarter, the fishery takes place in Subarea XIV between the Greenland and Iceland EEZs deeper than 500 m, capturing fish of bigger size. The proportion of females in the catches is greater than for the males. The yields obtained in this quarter are larger and the mean trawling time of the hauls is shorter than in the third quarter. In the third quarter, the fleet moves towards the Southwest to ICES Subarea XII and NAFO Div. 1F, and the depth of hauls is shallower than 500 meters. The length distributions in the catches are lower than in the second quarter and are unimodal and relatively stable in time. The proportion of males in the catches is higher than for the females. The yields are smaller and the mean trawling time of the hauls is greater than those of the second quarter.

10.1.2.8 Other nations

No information on the fishing areas, seasons and depths of the fleets of other nations was available for the Working Group.

10.1.3 Discards

Icelandic landings of oceanic redfish were raised by 16% prior to 1996 to into account discards of redfish infested with *Sphyrion lumpi*. This value of was based on measurements from 1991–1993 when the fishery was mostly on depths shallower than 500 m. In May-July 1997, discard measurements on 10 vessels showed a discard rate of 10%. This was added to the landings in 1996 and 1997. A new measurement from 1998 shows that the discard rate has decreased to 2%. Information from observers in 2000 and 2001 indicated that discards were negligible, and therefore no catches were added to the Icelandic landings.

Norwegian fishermen currently report approximately 3% discards of redfish infested with parasites. This percentage has in recent years become less due to a change in the production from Japanese cut to mainly fillets at present.

The Spanish discards are based on measurements made by the scientific observers. However, it can be safely assumed that these reflect approximately the behaviour of the rest of the non-surveyed Spanish trawlers. Discard of *Sebastes mentella* of the Spanish fleet were often composed of fish infested with *Sphyrion lumpi*. The discard quantities vary annually. In 1995, about 4% of the total catches were discarded, while in 1996, it was 6.5 %. From 1997-2000, the discards of the Spanish fleet have been insignificant. In 2001, 4.4 % of the total catches were discarded. This variability can also be observed for depth strata, the discarded percentage being much larger in the stratum >500 meters. Since 1997, this variability can be due to that the percentage of discards does not depend directly on parasite fish by *Sphyrion* *lumpi*, but it is related with the haul catch. When the haul catch is very high, the fish is discarded under worse conditions by the lack of time to elaborate the whole catch. When the catches are between the standard values there is enough time to elaborate the whole fish, even the infested ones, and there are no discards.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Trends in landings and fisheries

A Working Group estimate of catches in 2001 is estimated to be about 118 000 t, which was similar to the total catches observed since 1997. In 1995 and 1996, the catches amounted 176 000 and 180 000, respectively, representing the highest catches on record (Table 10.1.1-10.1.2). The actual catches in 2001 might increase due to the lack of reporting from some countries participating in the fishery.

At the beginning of the fishery in 1982, catches of pelagic redfish were reported from both Subareas XII and XIV. But most of the catches were taken in Subarea XII (40 000-60 000 t) until 1985, and then the greater part of the catches was reported from Subarea XIV. The landings from Subarea XII were again in the majority in 1994 and in 1995 with 94 000 t and 129 000 t landed respectively. In 1996–1999, the main part of the total catch was taken from Div. Va and Subarea XIV (Table 10.1.1). In 2000, considerable amounts of the catches were taken in NAFO Div. 1F, as observed in this magnitude for the first time. In 2001, about 200 t of pelagic *S. mentella* were caught by Lithuania in NAFO Div. 2H, and about 1300 t by Russia in NAFO Div. 2H and 2J.

Pelagic *S. mentella* fishery in ICES Div. Va started in 1992. The catch varied from 2 000-14 000 from 1992-1995. Since 1995, the catches in Div. Va have increased to about 45 000 t in 2000 (Table 10.1.1). In 2001, they have decreased to about 28 000 t.

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian and Spanish commercial catches were reported for 2001 and are given in Figure 10.1.2. A bimodal distribution over the past 4 years could be observed as a reflection of the samples being taken from different areas. Figure 10.1.3 illustrates the depth effect on the length distributions in the German and Spanish catches, taken shallower and deeper than 500 m.

The 2001 biological sampling from catches and landings of pelagic *S. mentella* in each Subarea/Division and by gear type is shown in the text table below.

Country	Area	Gear	Landings (t)	No. of samples	No. of fish measured
Germany	XII, XIV and NAFO 1F	Pelagic	10669	81	70079
Iceland	XIV and Va	Pelagic	42472	36	2634
Russia	XII, XIV, NAFO 1F, 2H, 2J	Pelagic	30012	?	52802
Spain	XII, XIV and NAFO 1F	Pelagic	10083	156	28428

10.1.5 Age readings

Several nations have increased their effort to age pelagic redfish, using different ageing methods and thus making a comparison of age readings difficult.

The catches in 1999 and 2000, and also the acoustic survey in 1999, suggested that a new cohort is entering into the fishable stock of pelagic redfish. Age readings within an otolith exchange between Germany, Iceland and Norway, based on material collected in July 1999 (WD9), showed that this cohort is mainly consisting of 10 year old fish and that ageing error for fish older than 20 years is relatively high. Applying a tolerance level of ± 5 years disagreement between age readers, however, around 90% total agreement can be reached. This indicates that age-structured models could be possible on a 3- or 5-annual basis.

10.2 Assessment

10.2.1 Acoustic assessment

10.2.1.1 Acoustic assessment shallower than 500m

The 2001 trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Germany, Iceland, Russia and Norway in June/July (ICES CM 2002/D:08 Ref.ACFM). Approximately 420 000 square nautical miles were covered, which is the most extended coverage for acoustic assessment pelagic redfish in the Irminger Sea. The stock size measured with the acoustics was assessed to be about 715 000 t at depths down to the deep-scattering layer or about 350 m, with redfish having a mean length of 34.6 cm. Table 10.2.1 informs about the estimated trend in stock size and the increased survey areas covered. The acoustic survey results (shallower than 500 m) indicate a stable stock situation size compared with the 1999 results.

A decreasing trend in the proportion of females was observed during the last decade, but whether it is related to overexploitation of the females is not known. Recruits with a peak length about 26-27 cm were recorded, particularly in the western most area of the investigation, the western part of NAFO Div. 1F but also in the eastern parts of 2H and 2J. The lengths of these pre-recruits were similar to the length of the abundant juveniles growing up at the shelf of East Greenland.

In 2001, as well as in 1999, the stock shallower than 500 m was observed more south-westerly and deeper than it has been during former acoustic surveys in the last decade. During the same period, a gradual increase in temperature in the observation area has been observed. This may have influenced the distribution pattern of the redfish in June-July as the highest concentrations were found in the colder, *i.e.* south-western part of the survey area. In June/July 2001, about half of the total acoustically estimated stock biomass was found in the NAFO Convention Area shallower than 500 m omitting the Canadian EEZ (Table 10.2.2).

Since 1994, the results of the acoustic estimate show a drastic decreasing trend. The estimate was only 0.7 million tonnes in 2001, compared with 2.2 and 1.6 and 0.6 million tonnes in 1994, 1996 and 1999, respectively. This represents a reduction of about 1.5 million tonnes in the period. During the same period, the total catch has been about 800 000 tonnes. Therefore, the catch alone cannot explain the changes in the stock estimate. During the same period, the fishery has also developed towards greater depth and towards bigger fish, and in recent years, the majority of the catch has been caught at depths deeper than 500 m. Thus, acoustic estimates cannot be considered accurate measures of relative changes in stock size of the upper layer fish, as availability may have changed during the surveyed period. Information suggests that fish inhabiting the upper layer may have migrated out of the surveyed area, both horizontally and vertically (deeper).

Since the early 1990s, national and international trawl-acoustic surveys have been carried out in the Irminger Sea and adjacent waters. Since 1995, the surveys have been carried out in June/July when the hydro-acoustic conditions (minimum impediment by the deep scattering layer) are favourable. It must be noted that none of the consistent international June/July surveys of the past decade has succeeded in identifying the horizontal and vertical distribution boundaries of pelagic *S. mentella*. Because of the limited depth range coverage (down to less than 500 meters) the surveys have mainly covered the oceanic *S. mentella*, and should therefore only be used as an estimate on redfish above the deep scattering layer.

10.2.1.2 Trawl estimate

In addition to the acoustic measurements, an attempt was made to estimate the redfish within and below the deep scattering layer. This was done by correlating catches and acoustic values at depths between 100 and 450 m. The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance (ICES CM 2002/D:08). For that purpose, standardised trawl hauls were carried out at different depth intervals (three depths intervals in hauls deeper than 500 m and 2 depth intervals in shallower hauls), evenly distributed over the survey area. Data for the correlation calculations between trawl catches and the acoustic results were obtained during trawling only. In addition, scrutinised acoustic values were only taken from exactly the same position and depth range as covered by the trawl. Low correlation between catch and the acoustic values used for the abundance estimation make the method questionable and also the assumption that the catchability of the trawl is the same, regardless of the trawling depth. Estimate based on above described calculations both above and below 500 m depth, must be considered as a very rough measure with high uncertainty as the applicability of the method can only be verified after replicate measurements.

By applying the trawl approach, biomass in the depth layers from 0-500 depth, including layer where the redfish that was mixed with the deep scattering layer, was estimated to about 1.1 mill. t. Such estimates are not directly comparable with the acoustic estimates shallower than 500 m depth and should be interpreted with care due to their innovate nature.

About 1.1 mill. t was estimated by the trawl-acoustic method deeper than 500 m. At these depths, the densest concentrations were found in the NE part of the area (Fig. 10.2.1). The average length of the fishes caught deeper than 500 m was 39.5 cm. Hydrographic observations indicated that the highest concentrations of redfish deeper than 500 m were associated with eddies and fronts.

In June/July 2001, one third of the biomass obtained with the trawl method of about 2 mill. t was found in the NAFO Convention Area omitting the Canadian EEZ (Table 10.2.2).

In June/July 2003, an international hydroacoustic survey on pelagic redfish will be carried out with participation of Iceland, Russia and Germany.

10.2.2 CPUE

In Table 10.2.3, the CPUE series for Bulgarian, German, Icelandic, Norwegian, Russian, and Spanish fleets are given. Figures 10.2.3.a and 10.2.3.b show the overall CPUE from different fleets in recent years, in depths shallower and deeper than 500m, respectively. In Figure 10.2.3.a, the estimated biomass derived from the international and Russian hydroacoustic surveys is given. The trend in CPUE in depths shallower than 500m indicates a steep downward trend since 1995, and the 2001 acoustic estimate confirms these changes compared with the beginning of the last decade. In recent years, there is no clear signal in CPUE, but it should be noted that CPUE has decreased from 2000 to 2001 for most indices, both shallower and deeper than 500 m (Figures 10.2.3.a-10.2.3.b). Information from Russia does, however, not confirm the above status, as the average catch per day in 2001 was about 17.8 tonnes, increasing from 15.3 tonnes in 2000 (about 16% increase).

In Figure 10.2.3.c, the standardised CPUE, derived from a GLM CPUE model (WD 7) incorporating data from Germany (1995-2001), Iceland (1995-2001), Greenland (1999-2001) and Norway (1995-2001) is given. The model takes into account year, month, vessel and area (ICES statistical square). The model shows that the index did decrease until 1997 and increased thereafter until 2001 when it decreased by about 15% from 2000 value. Overall, the GLM model indicates a stable CPUE since 1995 both shallower and deeper than 500 m.

10.2.3 Ichthyoplankton assessment

The traditional ichthyoplankton survey, conducted by Russia in 1982-1995 has not been carried out since 1996. The historical series of ichthyoplankton surveys was presented in the 2000 Working Group report.

10.2.4 State of the stock

Table 10.2.1 shows available survey estimates of stock size by acoustic and trawls. The biomass can be estimated acoustically for depths less than 500m. Acoustic biomass estimates have been relatively stable during 1991 to 1995, but they have declined substantially since from 2.48 million tonnes in 1995 to 0.72 million tonnes in 2001. The acoustic estimates from the last three surveys are considered minimum biomass estimates because trawl sets during those surveys have shown that there was considerable redfish biomass deeper than the depths where biomass can be estimated acoustically. However the proportion of fish above and below 500m is not known to be stable over years and it cannot be concluded that acoustic biomass estimates prior to 1996 are minimum biomass estimates, because of high variances in the acoustic surveys for those years. These possible changes in the depth distribution above and below 500m combined with the differences in geographic coverage in different years mean that the acoustic biomass series cannot be interpreted as a consistent series showing relative changes in stock size. It is not known if the trawl survey acoustic biomass estimates are minimum or if they can overestimate stock size.

Adding the trawl biomass estimate below 500m to the acoustic estimates (1.8 million tonnes) or adding the two trawl biomass estimates together (2.1 million tonnes) indicates that the biomass in 2001 is probably in the order of 2 million tonnes, distributed also in large portions of the NAFO Convention Area down to depth of 1000m.

Given the technical, seasonal, geographical and depth changes of the fishing activities, the relevance of the national CPUE series as indicator of stock abundance remains difficult to assess. However, from the standardised CPUE series, it can be concluded that the pelagic redfish CPUE remained stable since 1995 for all fishing areas as well as separated above and below 500 m depth. The models do not indicate significant stock reductions since 1995.

Taking into account the uncertainty in stock indicators, it is not known if the exploitation rate generated by recent catches is above or below the 5% exploitation rate.

10.3 Estimation of reference points

The former proposed MBAL biomass reference of 1.5 Mill. t is considered inappropriate as it was derived from a production model disregarding the increased knowledge about the stock distribution and expanded fishing grounds. None of the available data series are considered appropriate to develop reference points (ASPIC models were run with various conditions without success).

10.4 Management considerations

The working group did again experience difficulties in gaining catch estimates from the various international fleets like in the past.

An update on the pelagic fishery, in particular with respect to seasonal and area distribution, was requested in the ToR. Catch rates shallower than 500 m remained steady but low, and deeper than 500 m remained steady. The main new feature of the fishery was an increasingly clear distinction between two widely separated grounds fished at different seasons and different depths. In 2000 and 2001, the more south-westerly fishing ground extended into the NAFO Convention Area. The parameters analysed so far do suggest, however, that the newly discovered aggregations in the NAFO Convention Area do not form a separate stock component. The 1999 and 2001 surveys indicated that about one third of the stock is distributed in the NAFO Convention Area. The genetic structure of the pelagic and demersal stocks of deep-sea redfish (*S. mentella*) in the North Atlantic remains poorly known, but further research is currently being carried out.

Given this pattern of seasonally localised fishing, a seasonal or geographic dimension for management of the fishery on the different grounds could be considered from a management perspective. This would also account for depth separation and reduce the risk of overexploitation or depletion of possibly separate stocks or components, which will exist as long as they are managed under a common TAC.

The recent exploitation level seems not to cause stock size reduction.

10.5 Precautionary approach

Based on the status of the knowledge of the stock(s) in the area, the Working Group could not come up with any information on reference points.

Considering the uncertainty related to definition of stock units, action must be taken in accordance with the precautionary approach and attempts be made to assess each stock component separately until better knowledge on the relationship between each stock or stock components are known. Such assessment must be based on what information is currently available. Furthermore, there exists considerable concern about the precision of the used stocks indicators.

Table 10.1.1 Pelagic *S. mentella*. Landings (in tonnes) by area as used by the Working Group. Due to the lack of area reportings for some countries, the exact share in Sub-areas XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	NAFO 1F	NAFO 2H	NAFO 2J	Total
1982	0	0	0	39,783	20,798				60,581
1983	0	0	0	60,079	155				60,234
1984	0	0	0	60,643	4,189				64,832
1985	0	0	0	17,300	54,371				71,671
1986	0	0	0	24,131	80,976				105,107
1987	0	0	0	2,948	88,221				91,169
1988	0	0	0	9,772	81,647				91,419
1989	0	0	0	17,233	21,551				38,784
1990	0	0	0	7,039	24,477	385			31,901
1991	0	0	0	10,061	17,089	458			27,608
1992	1,968	0	0	23,249	40,745				65,962
1993	2,603	0	0	72,529	40,703				115,835
1994	15,472	0	0	94,189	39,028				148,689
1995	1,543	0	0	132,039	42,260				175,842
1996	4,744	0	0	42,603	132,975				180,322
1997	15,301	0	0	19,822	87,812				122,935
1998	40,612	0	0	22,446	53,910				116,968
1999	36,524	0	0	24,085	48,521	534			109,665
2000	44,677	0	0	19,862	50,722	10,815			126,076
2001[1]	28,139	0	0	28,957	53,753	5,299	208	1,284	117,649

1) Provisional data

Table 10.1.2 Pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Sub-areas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany [3]	Greenland	Iceland	Japan	Latvia	Lithuania	Netherland	Norway	Poland	Portugal	Russia [2]	Spain	UK	Ukraine	Total
1982														581		60,000				60,581
1983						155										60,079				60,234
1984	2,961					989								239		60,643				64,832
1985	5,825					5,438								135		60,273				71,671
1986	11,385			5		8,574								149		84,994				105,107
1987	12,270			382		7,023								25		71,469				91,169
1988	8,455			1,090		16,848										65,026				91,419
1989	4,546			226		6,797	567	3,816						112		22,720				38,784
1990	2,690					7,957		4,537					7,085			9,632				31,901
1991			2,195	115		571		8,783					6,197			9,747				27,608
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654			15,733				65,962
1993	3,216		6,365	7,121		17,813	710	22,908		6,803	7,899		14,990			25,229			2,782	115,835
1994	3,600		17,875	2,896	606	17,152		53,332		13,205	7,404		7,357		1,887	17,814			5,561	148,689
1995	3,800	602	16,854	5,239	226	18,985	1,856	34,631	1,237	5,003	22,893	13	7,457		5,125	44,182	4,555		3,185	175,842
1996	3,500	650	7,092	6,271		21,245	3,537	62,903	415	1,084	10,649		6,842		2,379	45,748	7,229	260	518	180,322
1997		111	3,720	3,945		20,476		41,276	31				3,179	886	3,674	36,930	8,707			122,935
1998			3,968	7,474		18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577			116,968
1999			2,108	4,656		16,489	4,269	43,923					5,435	6	4,302	17,957	10,332	188		109,665
2000			11,811	2,837		12,499	4,204	45,232			450		5,194		3,731	29,224	10,894			126,076
2001[1]			887	8,077		10,669	3,309	42,472			4,300		5,326		2,514	30,012	10,083			117,649

1) Provisional data.
2) Former USSR until 1991.
3) Former GDR and GFR.

Table 10.1.3 Pelagic *S. mentella* landings (in tonnes) in 2001 by countries and depth (A), and in 1997-2001 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	Total	not splitted	shallower than 600 m	deeper than 600 m
Estonia	887	100 %		
Faroes	8,077	100 %		
Germany	10,669		52 %	48 %
Greenland	3,309	100 %		
Iceland	42,472		37 %	63 %
Lithuania	4,300	100 %		
Norway	5,326	100 %		
Portugal	2,514	100 %		
Russia	30,012	100 %		
Spain	10,083		11 %	89 %
Total	117,649			

Derived from effort data

B.	Total	not splitted	shallower than 600 m	deeper than 600 m
1996	180,322	43 %	14 %	43 %
1997	122,935	37 %	20 %	43 %
1998	116,968	14 %	20 %	66 %
1999	109,665	22 %	14 %	64 %
2000	126,076	46 %	15 %	39 %
2001	117,649	46 %	19 %	35 %

Table 10.1.4 Results of dividing the Icelandic pelagic redfish catch (t) according to the Icelandic samples from the fishery.

Year	Oceanic	Deep sea	Not classified	Catch Oceanic	Catch Deep sea	Total Catch
1995	72%	27%	0%	25186	9445	34631
1996	45%	52%	3%	29182	33721	62903
1997	36%	64%	0%	14859	26417	41276
1998	10%	85%	4%	5504	46780	52284
1999	15%	85%	0%	6765	37159	43924
2000	5%	95%	0%	2262	42970	45232
2001	34%	66%	0%	14440	28032	42472

Table 10.2.1 Pelagic redfish *S. mentella*. Time series of survey results, areas covered, hydro-acoustic abundance and biomass estimates shallower and deeper than 500 m (based on standardized trawl catches converted into hydro-acoustic estimates derived from linear regression models).

Year	Area covered (1000 NM^2)	Acoustic estimates < 500 m (10^6 ind.)	Acoustic estimates < 500 m (1000 t)	Trawl estimates < 500 m (10^6 ind.)	Trawl estimates < 500 m (1000 t)	Trawl estimates > 500 m (10^6 ind.)	Trawl estimates > 500 m (1000 t)
1991	105	3498	2235				
1992	190	3404	2165				
1993	121	4186	2556				
1994	190	3496	2190				
1995	168	4091	2481				
1996	253	2594	1576				
1997	158	2380	1225				
1999	296	1165	614			638	497
2001	420	1370	716	1955	1075	1446	1057

Table 10.2.2 Pelagic redfish *S. mentella*. 1999 and 2001 survey biomass estimates and area splitting between NAFO and NEAFC Convention areas by depth (shallower and deeper than 500 m).

	NAFO (000 t)	NAFO %	NEAFC (000 t)	NEAFC %	Sum (000 t)
1999 shallower than 500 m *	540	46.3	626	53.7	1166
1999 deeper than 500 m	74	11.6	564	88.4	638
1999 Sum	614	34.0	1190	66.0	1804
2001 shallower than 500 m	686	63.8	390	36.2	1076
2001 deeper than 500 m	165	15.6	892	84.4	1057
2001 Sum	851	39.9	1282	60.1	2133

* acoustically measured

Table 10.2.3 Pelagic *S. mentella*. Catch per unit effort (t/h) by country in Sub-areas XII and XIV.

Year	Bulgaria	Germany[2]	Iceland	Norway	USSR-Russia (BMRT)	Spain
1982	-	-	-	-	1.99	-
1983	-	-	-	-	1.60	-
1984	1.25	-	-	-	1.48	-
1985	1.85	-	-	-	1.68	-
1986	2.04	-	-	-	1.35	-
1987	1.22	0.79	-	-	1.10	-
1988	0.82	1.28	-	-	1.00	-
1989	-	0.70	1.11	-	1.00	-
1990	-	0.89	1.02	1.09	0.99	-
1991	-	-	1.52	1.42	0.80	-
1992	-	-	1.66	1.79	0.63	-
1993	-	-	3.27	2.02	0.63	-
1994	-	-	2.64	2.83	1.70	-
1995	-	2.06	2.00	2.05	1.00	0.71
1996	-	1.45	1.74	1.20	1.30	0.97
1997	-	1.31	1.11	0.66	-[3]	0.83
1998	-	1.30	1.56	0.75	-	0.81
1999	-	0.97	1.55	0.97	-	1.10
2000	-	1.05	1.98	1.12	-	1.17
2001[1]	-	0.91	1.40	0.88	-	0.96

1 Preliminary
2 1987-1990 reported as GDR (FVSIV)
3 Since 1997, Russian effort data are only available as fishing days

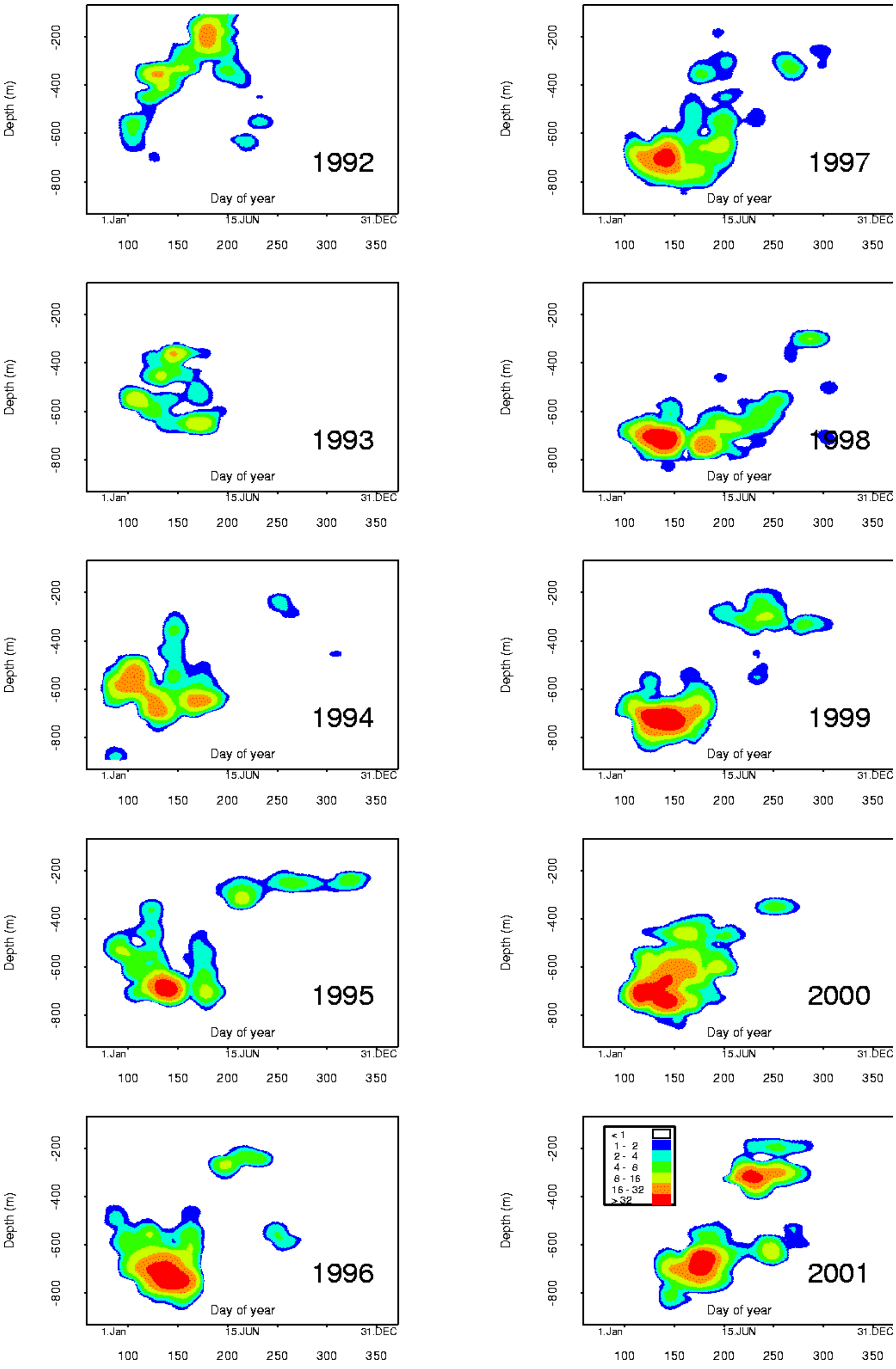


Figure 10.1.1 Depth distribution of Icelandic trawl hauls for pelagic redfish as reported in the log-books since Iceland began its oceanic redfish fishery in 1989. x-axis = day of year; y-axis = depth.

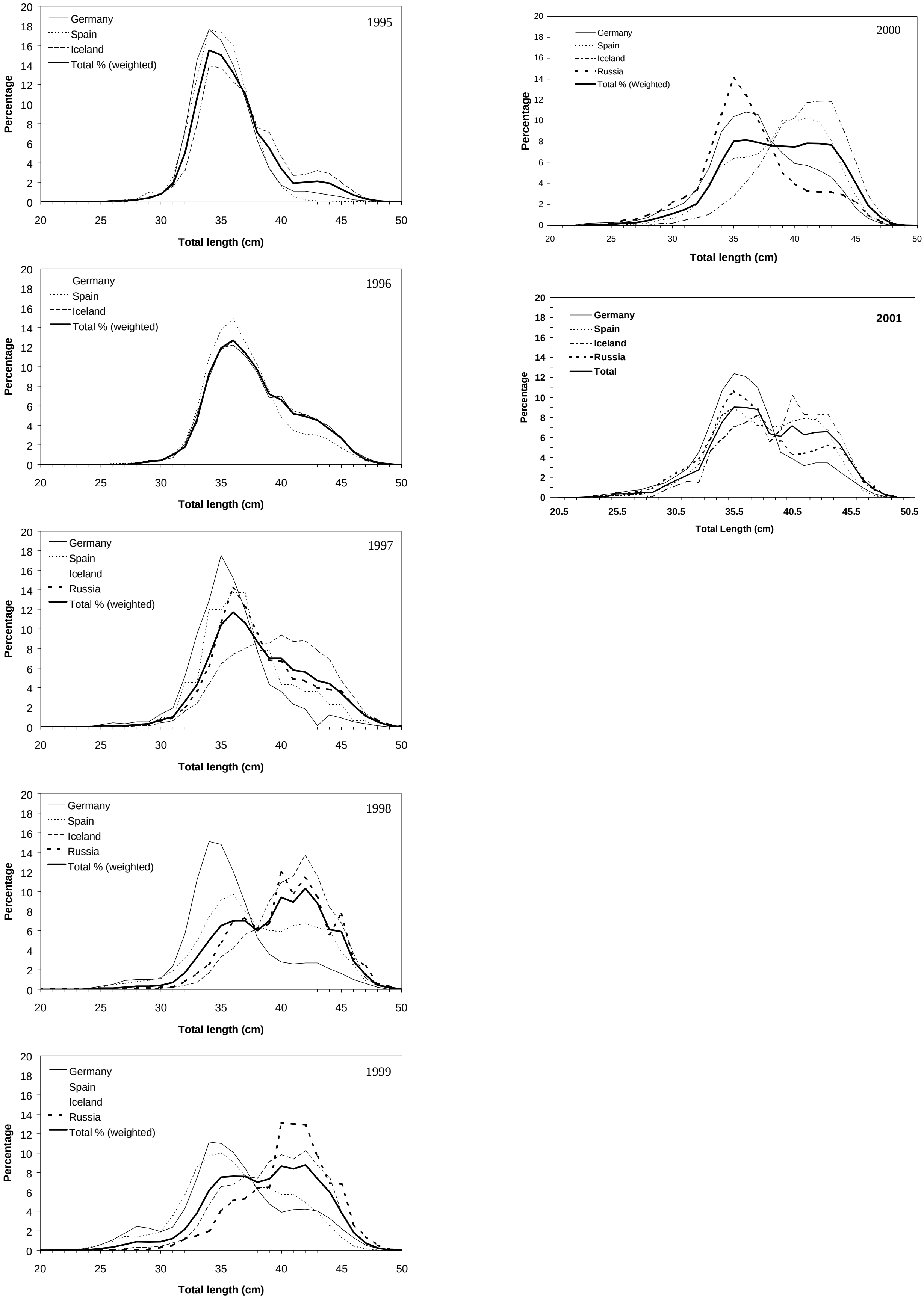


Figure 10.1.2 Length distributions from landings of pelagic *S. mentella* in 1995-2001.

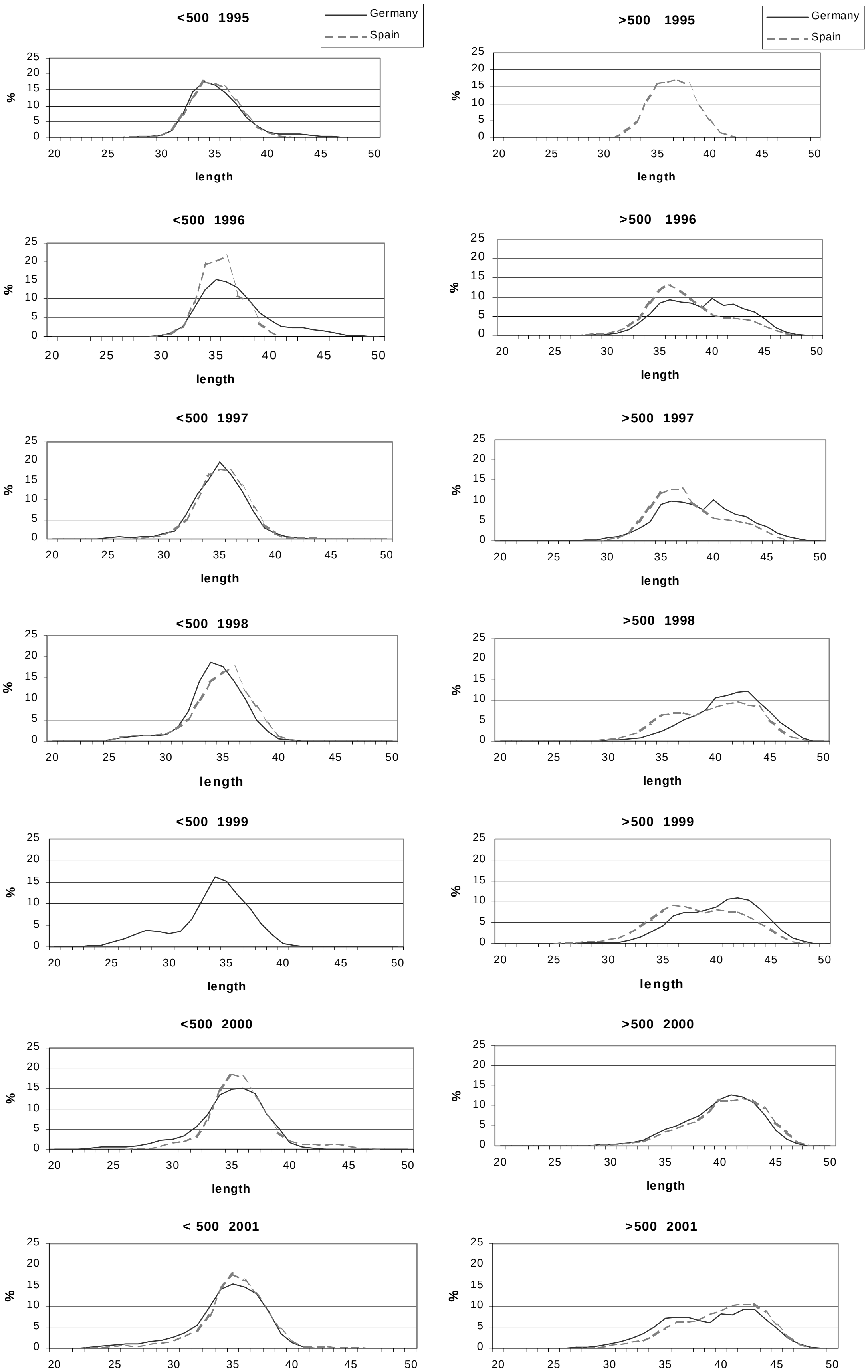


Figure 10.1.3 Length distributions from German and Spanish landings of pelagic *S. mentella* in 1995-2001, divided by depths shallower and deeper than 500 m.

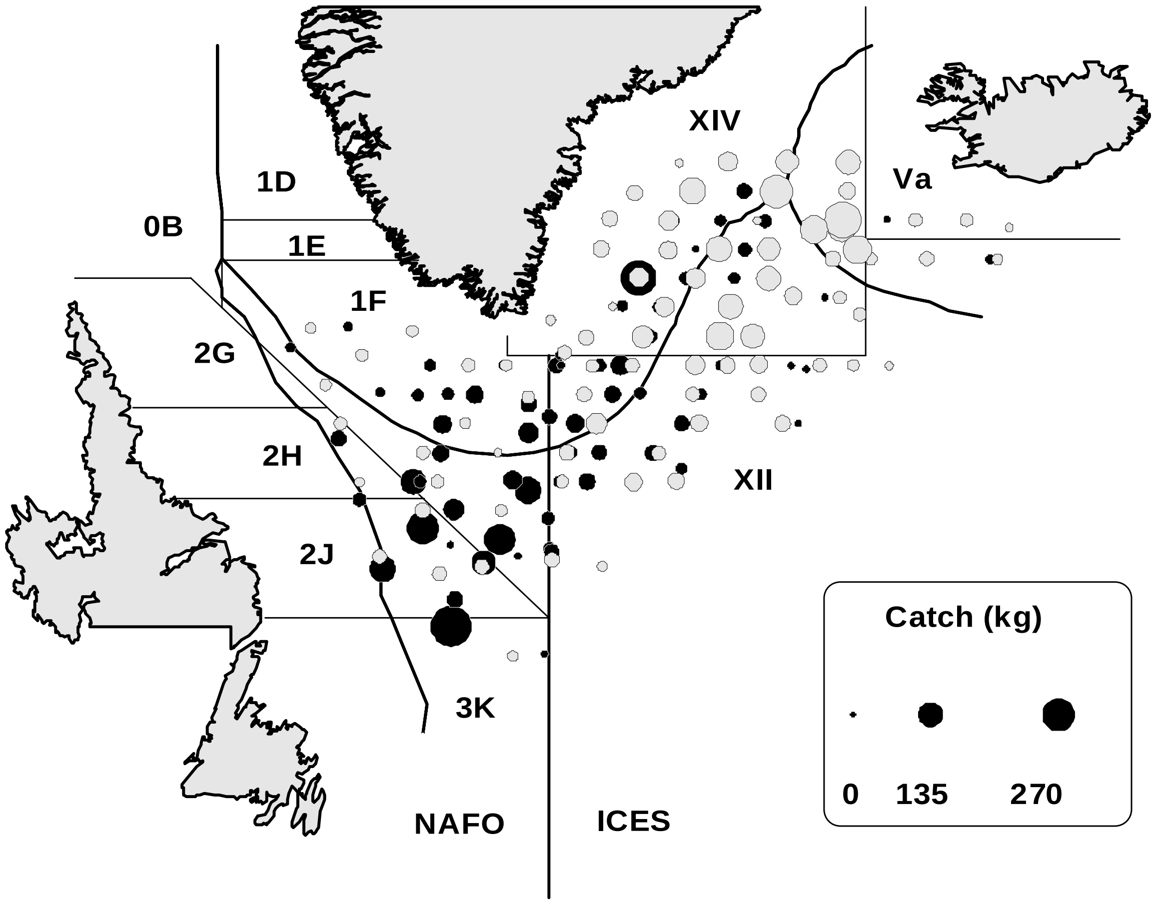


Figure 10.2.1 Pelagic redfish *S. mentella*. Survey catches in June/July 2001 shallower than 500 m depth (black) and deeper than 500 m depth (grey).

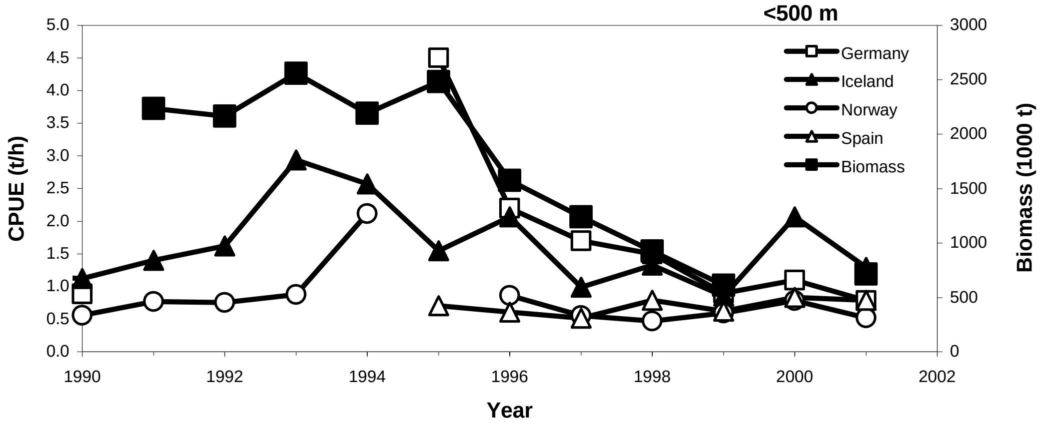


Figure 10.2.3.a Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, shallower than 500m, and estimated acoustic biomass from surveys.

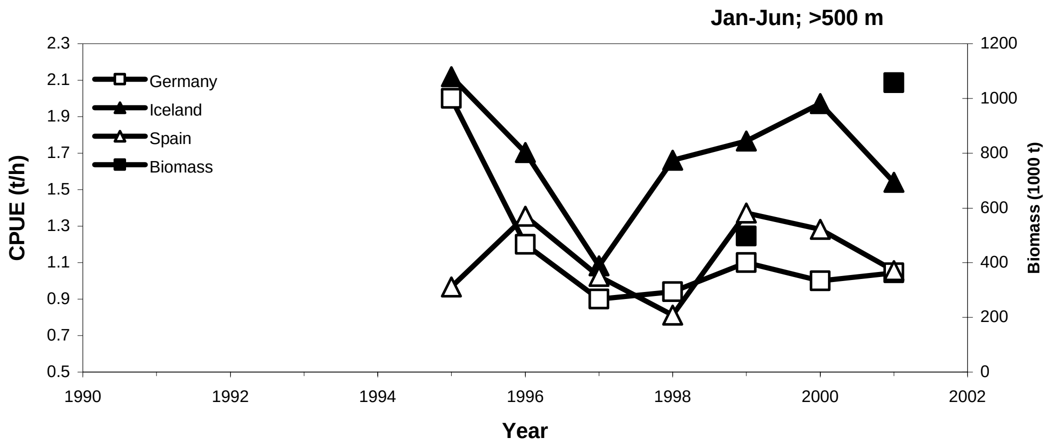


Figure 10.2.3.b Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, deeper than 500m, and estimated trawl biomass from surveys.

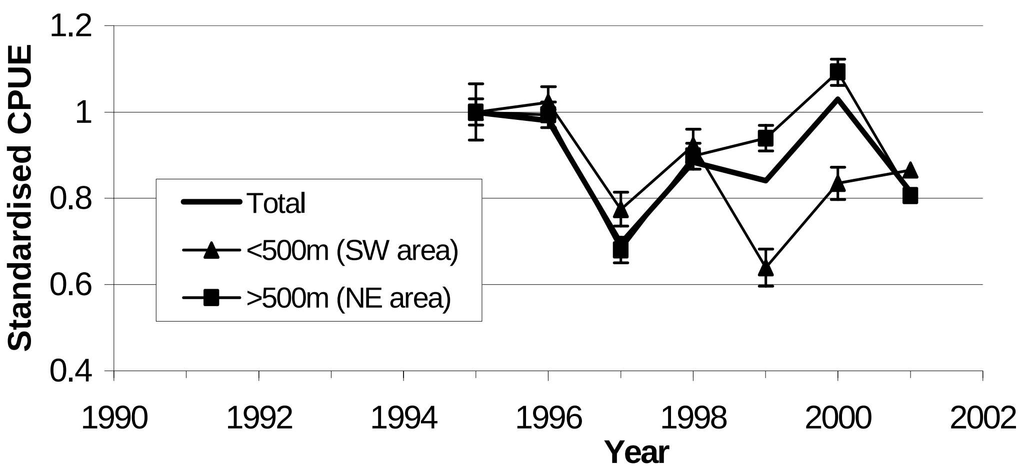


Figure 10.2.3.c Standardised CPUE, as calculated by using data from Germany (1995-2001), Iceland (1995-2001), Greenland (1999-2001) and Norway (1995-2001) in the GLM model (see chapter 10.2.2.), divided by depths shallower (south-western area) and deeper than 500 m (north-eastern area) and both depth layers (areas) combined (Total).

11 LIST OF WORKING DOCUMENTS

1. J. Boje. The fishery for Greenland halibut in ICES Div. XIVb in 2001

2. J.J. Engelstoft. Cod stock investigations off West Greenland

3. A. Hoines. Information about the Norwegian fishery for pelagic *Sebastes mentella* in the Irminger Sea, *S. marinus* and Greenland halibut in ICES XII and XIV in 2000 (revised) and 2001 (provisional).

4. F. Gonzales, G. Ramilo and I. Loureiro. Description of the Spanish pelagic fishery of oceanic redfish (*Sebastes mentalla* Travin) in the North Atlantic (1995-2001).

5. T. Sigurdsson and H. Bjornsson. *Sebastes marinus* – an update

6. T. Sigurdsson. Information on the Icelandic fishery of oceanic redfish (S. mentella Travin); information based on log-book data and sampling from the commercial fishery

7. T. Sigurdsson, H.J. Ratz, K. Nedreaas, S.P. Melnikov and B. Bardarsson. Fishery on pelagic redfish (S. mentella, Travin): Information based on log-book data from Germany, Greenland, Iceland, Norway and Russia.

8. Thorsteinn Sigurdsson. Information on Deep Sea redfish in Division Va

9. C. Stransky, S. Gudmundsdóttir, T. Sigurdsson, S. Lemvig and K. Nedreaas. Age reading of *Sebastes mentella* otoliths: bias and precision between readers.

10. H.J. Rätz. Groundfish survey results for cod off Greenland (offshore component): 1982-2001.

11. H.J. Rätz and T. Sigurdsson. Abundance and length composition for *Sebastes marinus* L., deep-sea *S. mentella* and juvenile redfish (*Sebastes spp*.) off Greenland and Iceland based on groundfish surveys 1985-2001.

12. H.J. Rätz. On the German fishery and biological characteristics of oceanic redfish (*Sebastes mentella* Travin).

13. H.J. Rätz. Data on German catches and effort for Greenland halibut (*Reinhardtius hippoglossoides*), redfish (*Sebastes marinus* and deep sea *S. mentella*), and Atlantic cod (*Gadus morhua*) in ICES Div. Va, Vb, VIa and XIV, 1995-2001

14. P. Steingrund. Faroe Plateau cod: Tables and figures

15. J. Reinert. Some information on the Faroese redfish fishery

16. V.N. Shibanov, S.P. Melnikov, V.G. Anikeev and A.M. Safronov. Preliminary information about Russian fishery for the oceanic S. mentella in ICES subareas XII, XIV, in NAFO divisions 1F, 2J, 2H in 2001 and biological sampling from commercial catches

17 S.P. Melnikov and Yu I. Bakay. Spatial structure of pelagic concentrations of *Sebastes mentella* of the Irminger Sea and adjacent waters.

18. S.P. Melnikov, V.S. Mamylov and G.B. Rudneva. On stock status and assessment of a possible commercial withdrawal of pelagic *Sebastes mentella* in the Irminger Sea.

19. G.G. Novikov, A.N. Stroganov, K.I. Afanasjev, V.N. Shibanov, and S,P. Melnikov. Analysis of population and genetic characteristic of redfish in the Irminger Sea.

20 A.C. Gundersen and I. Fossen. Length distributions from Norwegian fishery for Greenland halibut in ICES XIVb, 2001.

21 B.Æ. Steinarsson and H. Björnsson. Icelandic haddock

22 E. Hjörleifsson. STatistical Age Model (STAM) of Icelandic cod using Excel.

23 J. Reinert. Preliminary assessment of Faroe haddock

24 L.H. Ofstad and L. Ridao. Assessment of Faroe saithe 2001

25 H. Björnsson and B.Æ. Steinarsson. Icelandic cod in division Va

26 J. Boje, E. Hjorleifsson, A.C. Gundersen and A.S. Höines. Greenland halibut in V and XIV

27 E. Hjörleifsson. "An Icelandic view" on the Greenland halibut

28 S. Jónsson. Icelandic saithe

29 A. Magnusson. 2002 Coleraine assessment of the Icelandic cod stock

30 G. Gudmundsson. Time series analysis of Icelandic cod, haddock and saithe

31 G. Gudmundsson and S. Jónsson. Catchability of Icelandic trawl fishing of cod, haddock and saithe 1985-2001

32 G. Gudmundsson. Time series models in fish stock analysis

33 H. Björnsson. Description of an assessment and prognosis tool (ADCAM).

34 L. R. Crus. Faroe Bank Cod: Tables and figures.

12 REFERENCES

Anon. 1994. Hagkvæm nýting fiskistofna (On Rational Utilization of fish stocks). In Icelandic. Reykjavik, 27pp.

Baldursson, F.M., Daníelsson, Á. and Stefánsson, G. 1996. On the rational utilization of the Icelandic cod stock. *ICES Journal of Marine Science* **53:** 643-658.

Daníelsson, Á., Stefánsson, G., Baldursson, F.M. and Thórarinsson, K. 1997. Utilization of the Icelandic Cod Stock in a Multispecies Context. *Marine Resource Economics* **12:** 329-244.

Stefánsson, G., Hauksson, E., Bogason, V., Sigurjónsson, J. and Víkingsson, G. 1997. Multispecies interactions in the C Atlantic. Working paper to NAMMCO SC SC/5/ME13 1380 (unpubl.).

Stefánsson, G., Sigurjónsson, J. and Víkingsson, G.A. 1997. On Dynamic Interactions Between Some Fish Resources and Cetaceans off Iceland Based on a Simulation Model. *Northw. Atl., Fish. Sci.* **22:** 357-370.

Boje, J. & E. Hjørleifsson. 2000. Nursery grounds for the West Nordic Greenland halibut? Where are they? ICES CM 2000/N:03, 12p.

Boje, J. 1997. Larval Greenland halibut growth and distribution in West Greenland water and the possible influences by hydrographic conditions. ICES CM

Fossen, I. & A.C. Gundersen. 2000. Ressursundersøkelse ved Kap Bille Banke og Heimlandsryggen, Øst-Grønland august 2000. Rapport fra Møreforsking Ålesund, Å0018, 44p.

Gavaris 1980

Gavaris 1988

Gundersen, A.C., A.K. Woll, T. Johansen & J. Boje. 1997. Fiske med garn og teiner etter blåkveite (*Reinhardtius hippoglossoides*), Pp. 19-96. *In* A.K. Woll & A.C. Gundersen (eds.), Forsøk med garn og teiner ved Øst-Grønland. Nordisk Ministerråd. TemaNord Fiskeri, 1997:526, 153p.

Horsted, Sv. A. 1994. A Review with some Proposals for Amendments of the Catch Statistics for the Cod Fisheries in Greenland Waters since 1911. NAFO SCR Doc. 94/38, Ser. No. N2407

ICES 1984 Report of the Working Group on Cod Stocks off East Greenland. ICES CM 1994/Assess:5

ICES 1993 Report of the North Western Working Group. ICES CM 1993/Assess:18.

ICES 1996 Report of the North Western Working Group. ICES CM 1996/Assess:15.

ICES 1998 Report of the North Western Working Group. ICES CM 1998/ACFM:19.

ICES 2001. Report of the North Western Working Group. ICES CM 2001/ACFM:20.

Jensen, A.S. and P. M. Hansen 1931. "Investigations of the Greenland cod." Rapp.P.-v.Reun.Cons.int.Explor.Mer LXXII (1931): 3-41.

Joensen, H., Grahl-Nielsen, O. (2001). Discrimination among species and stocks of redfish and herring by chemometry of the fatty acid profile in selected tissues. ICES CM 2001/J:22

Lloret, J. and H.-J. Rätz 2000. Condition of cod (Gadus morhua) off Greenland during 1982-1998. Fisheries Research, 48 (1) (2000) pp. 79-86

Magnusson, J. V. 1977. Notes on eggs and larvae of Greenland halibut at Iceland. ICES CM 1977/F:47.

Pope, J.G. 2000. Report on aspects of effort management used for demersal fish stocks of the Faroes.

Rätz, H.-J., M. Stein and J. Lloret 1999. Variation in Growth and Recruitment of Atlantic Cod (*Gadus morhua*) off Greenland During the Second Half of the Twentieth Century. J. Northw. Atl. Fish. Sci., 25: 161–170.

Riget,F. & J.Boje. 1988. Fishery and some biological aspects of Greenland halibut (Reinhardtius hippoglossoides) in West Greenland waters. NAFO Sci. Coun. Studies, 13:41-52.

Rivard and Gavaris 2000

Roques, S. Sévigny, J.-M. and Bernatchez, L. 2002. Genetic structure of deep-water redfish, *Sebastes mentella*, populations across the North Atlantic. Marine Biology (2002) 140: 297-307.

Sigurdsson, A. & J. V. Magnusson (1980). "On the nursery grounds of the Greenland halibut spawning in Icelandic waters." ICES C.M.(1980/G:45): 8 pp.

Sigurdsson, A. (1977). "On the spawning grounds of Greenland halibut in Icelandic waters." ICES E.M. 1977/F:28.

Sinclair, A. and S. Gavaris. 1996. Some examples of probabilistic catch projections using ADAPT output. DFO Atlantic Fisheries Res. Doc. 96/51: 12p.

Stefánsson 1987, 1988

Steingrund, P., and Gaard, E. in prep. Relationship between phytoplankton production and cod production on the Faroe shelf.

Sveinbjörnsson, S. and H. Hjörleifsson, 2001. Report on the O-group fish survey in Icelandic waters, August-September 2001. ICES CM 2001/ACFM:20, 14 pp.

Vilhjálmsson, H. 1997. Climatic variations and some examples of their effects on the marine ecology of Icelandic and Greenland waters, in particular during the present century. Rit Fiskideildar, 15(1): 1-29.

Wieland, K. and H. Hovgård, 2002. Distribution and of Atlantic cod (*Gadus morhua*) eggs and larvae in Greenland offshore waters. ICES/GLOGEC workshop on transport of cod larvae, 14-17 April 2002, Hillerød, Denmark, working document 8, 21 pp.

Woll, A.K. 2000. (Editor) Greenland halibut in East Greenland waters. Recruitment studies and mapping of nursery grounds. Nordic project 1998-1999. Tema Nord, Fiskeri: 2000:585.