REPORT OF THE

North-Western Working Group

ICES Headquarters
29 April–8 May 2003

PARTS 1 AND 2

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

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

TECHNICAL MINUTES

North-Western Working Group (NWWG)

ACFM Meeting May 2003

Sub-group Chair: Dankert Skagen
Working Group Chair : Einar Hjörleifsson
Rapporteur/reviewer : Holger Hovgård
Reviewer : André Forest
Jesper Boje, Jakup Reinert, Ken Patterson

The WG chair introduced the report with a discussion on the various models used in the NWWG meeting in 2003. The WG found it considerable easier to inspect peculiarities of the data using some of the alternate approaches than by using the standard XSA software. The NWWG found that the standard software were not taken the development in assessment models and computer technology into account and included a number of stabilising techniques which final weight are based on ad hoc decisions that are not always transparent. The chair noted that some of new approaches (e.g. the AD-CAM) integrated 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 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. The Sub-group noted that the is a need for a description of the assumptions used in the various alternate model and there is a need for describing how to interpret input and output to facilitate the assessment reviews.

General comments

The sub-group appreciated the fact that the WG use a broad range of assessment models. However, use of more flexible models 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 sub-group noted that the Yield-per-recruit analyses uses the long-term averages of weight, maturities and exploitation patterns. For weights and maturity this may be justified but it appears questionable for the exploitation rate.

In several cases important graphs are presented as very small. Considering the old age of the reviewers this may impede a thorough evaluation.

The NWWG often uses various models to predict mean weights in the projections. In several cases the models used are poorly described leaving little possibility for the reviewer to evaluate if the estimates are better than simple averages.

Icelandic Stocks

The sub-group appreciated that a section on discard are provided for the Icelandic stocks. The estimated discard levels reported appears low considering the incentives for high grading in the ITQ regulation applied. Discards are not included in the assessment due to lack of historical information.

Icelandic cod

The gillnet mesh size used should be given in cm, full mesh.

The working group appreciated the extensive use of simple descriptive statistics methods to scrutinize data and the various quality control plots comparing survey abundances and VPA estimates.

The work up of the survey indices is not clearly described. The wording "conventional Cochran type method" is ambiguous (should be read as a stratified random design).

The tuning fleets file used in the models should be explicitly tabled. For the XSA run it should be explained that the survey year is shifted except for the youngest age group.

Different measurements WEST are used for the SSB (first 5 month commercial catch data) and for the exploitable biomass (B+). The reason – that the B+ measure relates to the established HCL – should have been given in the report. It should be considered to use the observed spring weights and maturities from the surveys instead of the commercial values.

The significant work associated with comparing a range of different models is appreciated and it is comforting that the main model provides similar results. The AD-CAM model chosen as a) statistically based and b) combining assessment and forecast.

There are blocks in the F's for the oldest ages for the AD-CAM model (T. 3.3.12). The reason for that should be explored.

Icelandic Haddock

The reasoning in the text is sometimes difficult to follow and the text would benefit from a stringent editing. Table headings are in several cases poor. More digits are needed in the CAA table.

The report contains a full documentation of one XSA run but no tabled output from the chosen AD-CAM. This severely impedes the possibility for reviewing the quality of the assessment. The AD-CAM model allow a presentation of the CAA residuals that should be provided.

All examined model fails to provide good fits of the spring 2003 survey. The high survey biomass is expected caused by changes in haddock availability.

Given that two large surveys are available attempts should be given to use all the survey information available.

The sub group inspected the estimated stock numbers and mortalities from the final ADCAM run (tabled below). Apparently a very strong constraint has been applied on the year to year variation at the oldest ages. A justification for this should be given. Moreover, this constraint does not carry over to the prediction phase.

Table 1 Icelandic haddock. Estimates of population size at the beginning of the year. Estimates based on the ADCAM model (the adopted run used for the catch forecast)

year/age	1	2	3	4	5	6	7	8	9
1979	46294	78691	119060	26335	19886	21236	3181	756	112
1980	11953	37902	64162	95220	18337	10910	8758	1149	244
1981	51577	9786	30750	51320	67929	10743	4808	3321	370
1982	37140	42228	7979	24610	36722	39768	4578	1810	1064
1983	23032	30408	34489	6339	17196	21261	18089	1754	575
1984	52210	18857	24839	27430	4138	9662	9051	7282	555
1985	105382	42746	15379	19479	17541	2193	3905	3709	2302
1986	206095	86280	34753	11397	11553	8648	838	1562	1157
1987	52232	168736	70327	25185	6211	5072	2963	321	483
1988	30275	42764	136790	51505	13883	2625	1854	1121	99
1989	28740	24787	34822	101966	29220	6074	944	686	344
1990	99943	23531	20161	26000	61021	14398	2143	341	209
1991	204106	81827	18937	14643	15166	29072	5529	766	104
1992	43360	167108	65228	14049	8428	6896	11199	1960	232
1993	47053	35500	134449	47151	7837	3584	2516	3834	592
1994	85293	38524	28788	98775	26689	3372	1315	831	1154
1995	43617	69832	31187	20742	57257	11575	1238	427	249
1996	117513	35710	55489	21127	11923	25983	4176	401	126
1997	17785	96211	28273	37555	11220	5635	9431	1334	118
1998	58095	14562	77323	19687	20251	4900	2223	3106	393
1999	144659	47564	11707	55291	10489	8734	1796	747	913
2000	173030	118437	38049	8202	30106	4215	3019	589	220
2001	190594	141665	94847	25745	4511	12755	1438	959	173
2002	49014	156045	114060	67673	14699	2251	4989	452	284
2003	138684	40129	126781	83629	40738	7355	868	1551	134
2004	63212	113545	32453	93711	52441	21912	3422	369	621
2005	63212	51754	91842	24024	58995	28382	10280	1468	149
2006	63212	51754	41862	67988	15124	31929	13315	4409	594
2007	63212	51754	41862	30989	42801	8185	14979	5711	1785

Table 2 Icelandic haddock. Estimates of fishing mortality. Estimates based on the ADCAM model (the adopted run used for the catch forecast)

year/age	1	2	3	4	5	6	7	8	9	F4-7
1979		0.00	0.02	0.16	0.40	0.69	0.82	0.93	0.93	0.516
1980		0.01	0.02	0.14	0.33	0.62	0.77	0.93	0.93	0.465
1981		0.00	0.02	0.13	0.34	0.65	0.78	0.94	0.94	0.475
1982		0.00	0.03	0.16	0.35	0.59	0.76	0.95	0.95	0.463
1983		0.00	0.03	0.23	0.38	0.65	0.71	0.95	0.95	0.492
1984		0.00	0.04	0.25	0.44	0.71	0.69	0.95	0.95	0.520
1985		0.01	0.10	0.32	0.51	0.76	0.72	0.97	0.97	0.577
1986		0.00	0.12	0.41	0.62	0.87	0.76	0.97	0.97	0.666
1987		0.01	0.11	0.40	0.66	0.81	0.77	0.98	0.98	0.659
1988		0.01	0.09	0.37	0.63	0.82	0.80	0.98	0.98	0.653
1989		0.01	0.09	0.31	0.51	0.84	0.82	0.99	0.99	0.620
1990		0.02	0.12	0.34	0.54	0.76	0.83	0.99	0.99	0.617
1991		0.03	0.10	0.35	0.59	0.75	0.84	0.99	0.99	0.633
1992		0.02	0.12	0.38	0.66	0.81	0.87	1.00	1.00	0.680
1993		0.01	0.11	0.37	0.64	0.80	0.91	1.00	1.00	0.681
1994		0.01	0.13	0.35	0.64	0.80	0.92	1.01	1.01	0.677
1995		0.03	0.19	0.35	0.59	0.82	0.93	1.02	1.02	0.673
1996		0.03	0.19	0.43	0.55	0.81	0.94	1.02	1.02	0.684
1997		0.02	0.16	0.42	0.63	0.73	0.91	1.02	1.02	0.672
1998		0.02	0.14	0.43	0.64	0.80	0.89	1.02	1.02	0.691
1999		0.02	0.16	0.41	0.71	0.86	0.92	1.02	1.02	0.724
2000		0.02	0.19	0.40	0.66	0.88	0.95	1.02	1.02	0.720
2001		0.02	0.14	0.36	0.50	0.74	0.96	1.01	1.01	0.638
2002		0.01	0.11	0.31	0.49	0.75	0.97	1.01	1.01	0.630
2003		0.01	0.10	0.27	0.42	0.57	0.66	0.72	0.72	0.477
2004		0.01	0.10	0.26	0.41	0.56	0.65	0.70	0.70	0.470
2005		0.01	0.10	0.26	0.41	0.56	0.65	0.70	0.70	0.470
2006		0.01	0.10	0.26	0.41	0.56	0.65	0.70	0.70	0.470
2007		0.01	0.10	0.26	0.41	0.56	0.65	0.70	0.70	0.470

Farose Plateau Cod

Considering the little difference in the various individual tuning fleets the WG may consider conducting runs including all potential tuning fleets.

The high value of F this year is surprising as anecdotal information may indicate no drastic increase in fishing effort. Questionable how much confidence can be placed on the high F given that the retrospective indicates that F is consistently overestimated. The high variability in F may to some extent be expected considering the low value of shrinkage used. The review group conducted two exploratory runs a) a run with fixed q's on the older ages and b) a run applying a more heavy shrinkage of 0.5. There were no differences between the NWWG run and the fixed q run whereas the 0.5 shrinkage run gave lower Fbar's for the last years. The WG is encouraged to further evaluate the effect of the XSA settings at its next meeting.

There are signs of changes in the residuals for age 5-6 over the survey time-series that should be investigated. Given that the only tuning fleets are one surveys potential changes in availabilities should be investigated. However, the reason for these trends may also be found in the catch data series that appears very noisy especially for the older ages.

The subgroup would welcome if more descriptive diagnostic were presented, e.g. plots of survey year class size versus VPA estimates.

Faroese Bank cod

There is apparently no incentives for misreporting catches to the bank in recent years. This may place some confidence to the amount caught and reported from the Bank.

The use of the ratio of the catch to the survey CPUE hinges on differences between the two indices in the earlier period as the two indices is highly correlated for the reason years. It should be asserted that both the surveys and the catch figures indices are reliable for the up to 1990.

Faroese Haddock

The shifting of the spring survey should have been explicitly stated in the text.

The spring survey has been made available since last year and included as requested from ACFM.

The WG should ascertain that the expansion of the age group down to the age 0 do not affect the survivor estimates of the older age groups. It could be considered to remove the youngest age group in each survey as the XSA residuals are considerable.

Faroese Saithe

Again this year the final run is not provided. There is in fact little reason to run a hand tuned VPA. Revision could be restricted to the forecast.

There are trends in the residuals with large negative residuals in the earlier years. Considering that this a commercial fleet that are subjected to technological changes the WG group should consider to shorten the time-series used.

The setting of the 1998 YC is sat conservatively at 80 mill. Actual knowledge of the YC and basically based on the CAA. The survey estimates (summer) do however confirm that the YC is large.

Greenland Cod

The sub-group appreciated the effort to assess the inshore stock components. Given that the fishery presently is limited there may be little scope for conducting assessments based on CAA (mortality assumed to be driven by natural mortality). Information on sampling levels should be provided.

Survey data may be appropriate for evaluating the age structure of the inshore stocks. However, the present gillnet survey are only efficient for catching younger cod. Addition of larger mesh sizes in the net series may be considered.

However, it may also be considered to increase the depth strata covered as the present survey is restricted to shallow water.

The Sub-Group appreciates the work conducted on defining reference points for the offshore stock. The suggested measures –rescaled B4+ biomass from a log-log regression appears somewhat in transparent.

Greenland Halibut

The working may consider to investigate possible technological creeping in the fisheries as that may be of considerable importance when using commercial catch rates in the production model.

Catch expectations for 2003 are assumed as 33 000 tons (revised from 30Kt in WG report).

Redfish

For information on how the splitting of the commercial catches on species/stocks readers are referred to the 1998 WG report. A short outline on the procedures will facilitate the review. Similarly, comments on possible problems and potential biases caused by the splitting procedures will be appreciated.

Marinus

The sub-group appreciates the work carried out to use BORNICOM as a tool for assessing S. marinus. If this model is to be accepted for assessing the stock a proper review it requires more comprehensive presentations of settings, input and results.

It clearly appears that recruitment varies considerable and that the stock depends on a few outstanding year classes, i.e. 1985 and 1990. As abundant year classes are only discernable from ca. age 10 (Table 8.1.5) this imply that there are only 2 known poor YC's since the latest good one. The available data do therefore not suggest immediate recruitment crises.

Deep sea mentella on the continental slope

The review group had few comments on this stock that was assessed using similar procedures as last year.

Pelagic mentella

The stock status is obviously very difficult to evaluate due to its wide geographical distribution and the considerable number of fleets that exploit it. The review group also notes considerable uncertainties in the historical catch statistics.

The assessment is based on an international survey combining acoustics and trawling. No survey data were available for 2002. A comprehensive international survey is to be conducted in summer 2003 and there may therefore be reasons to revisit the assessment when this data become available.

TABLE OF CONTENTS

Section **Page**

PART 1

Section	Page

PART 2

Section	Page

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 (part-time)
Kristján Kristinsson	Iceland
Jean-Jacques Maguire	Faroe Islands
Sergei Melnikov	Russia
Lise Helen Ofstad	Faroe Islands
Marie Storr-Paulsen	Greenland
Jákup Reinert	Faroe Islands
Þorsteinn Sigurdsson	Iceland
Björn Ævarr Steinarsson	Iceland
Petur Steingrund	Faroe Islands

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 2003 to:

a) assess the status of and provide catch options for 2004 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 2004;

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) comment on the PA reference points proposed by the Study Group on Precautionary Reference Points for Advice on Fishery Management;

j) structure the assessment report following the guidelines as adopted by ACFM in October 2002 with special attention to the quality issues.

NWWG will report by 9 May 2003 for the attention of ACFM.

Request from NEAFC to ICES for scientific advice for 2004

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

1. Regarding redfish stocks:

a) 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;
b) Provide information on the horizontal and vertical distribution of pelagic redfish and fisheries in the Irminger Sea and adjacent waters as well as seasonal and interannual changes in distribution;
c) Comment on whether the horizontal, vertical and seasonal distribution of pelagic redfish in the Irminger Sea indicates the presence of different stock components within the area.

1.3 Report structure

The format of the report is similar to the years 1999-2001, 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. This year the text on the *Sebastes mentella* was reduced and hopefully clarified, this is in response to readers' request to make it more digestible. Other systematic attempts to reduce the amount of documentation have not been made in the last four years' reports.

Based on the limited experimentation by the Working Group it was concluded that the adopted ACFM guidelines are an improvement of the current practice (ToRj). During the meeting it became apparent that the change in the structure of the report could not be completed within the time frame of the meeting and thus intersessional work will be done to complete the task.

1.4 Stocks assessed by NWWG

1.4.1 Introduction

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 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 standard ICES analytical assessment, and the offshore cod in Greenland, where a ceased fishery prevents a VPA (At this meeting exploration of incomplete catch data from the inshore cod in Greenland were done for the first time by applying a statistical approach). In the second class are most of the redfish management units as well as Greenland halibut. One redfish stock, *S. marinus*, sits in the middle of these two extremes, being assessed by a length-based model (Bormicon).

1.4.2 Age-based analytical assessements

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 commercial or survey indices. In the final run only the Faroe saithe was based on a commercial tuning series since no reliable survey index is available for that stock.

1.4.2.1 Faroe stocks

The assessment on the Faroese stocks has been based on the Lowestoft software. In last year's assessment the Faroe summer survey tuning fleet was available for the first time. In last year's assessment the point estimators carried forward into the predictions for cod and haddock were based on using only those indices and exclude all commercial indices. The longer Faroe spring survey series, which has been extensively reworked in the past years was made available to the WG for the first time this year. After some preliminary analysis it was concluded that it was justified to include the spring survey in the tuning of Faroe haddock. Due to large residuals in cod indices from the spring survey, especially in older age groups, it was decided not to use that survey in the tuning of that stock. At this Working Group meeting various alternatives to the XSA were explored in particular to i) study some of the peculiarities of the XSA outcome that may be related to the assumptions in the model, and ii) get a sense of the noise in the input data. Time as well as unfamiliarity of some of the members to the methods used did not permit us to include the various analyses in the Working Group report. However, the advantages of e.g. statistical catch-at-age compared with the XSA model were obvious, particularly in relation to establishing a more reasonable fishing pattern in recent years.

1.4.2.2 Icelandic stocks

The Icelandic saithe was not assessed at this Working Group meeting. In recent years both the cod and haddock have been assessed by using various software packages. The reason for the use of different software is a result of the preference and expertise of the individual user that does the assessment. All the models are based on catch-at-age analysis (i.e. using the stock and the catch equation) using survey information as additional information. Various different assumptions are then explored by the different individuals running the different software – the final choice of settings by each person is based on personal judgement (sometimes referred to as expert opinion). The point estimators from the different models are thus not driven by the name of the model but by the assumptions behind each model!

The results from the studies indicate that the input data for the cod is not very sensitive to the model assumptions made. However, the haddock assessment this year is more uncertain than previously experienced. This is because the 2003 spring survey indices by most year classes are relatively high in relation to information in previous surveys. By keeping to the rigid assumption of constant natural (unaccounted) mortality and fixed catchability in the survey it was difficult to account fully for the residuals in any of the haddock runs, irrespective of software name or model specifications.

The selection of the program to use as the basis of the "final run" for the Icelandic cod and haddock was based on statistical integrity of the methods used as well as on the basis of convenience. The current norm within ICES is to take the assessment through four software packages generating i) historical assessment, ii) recruitment estimates, iii) short-term predictions, and iv) medium-term prediction. Using statistical catch-at-age one can obtain these estimates within the same "package". As the estimates of different age groups are correlated one can also ignore problems related to selecting estimates of some age groups from one model and other age groups from another model.

1.5 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. 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 catch rule for Icelandic cod has been 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. The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested new $\mathbf{B}_{\text{lim}}$ points for some of the stocks assessed by this Working Group. Considering that ACFM is unlikely to redefine and use new reference points as a basis for advice in the year 2004, the Working Group decided to postpone further work on the issue related to ToRi.

1.6 The road ahead

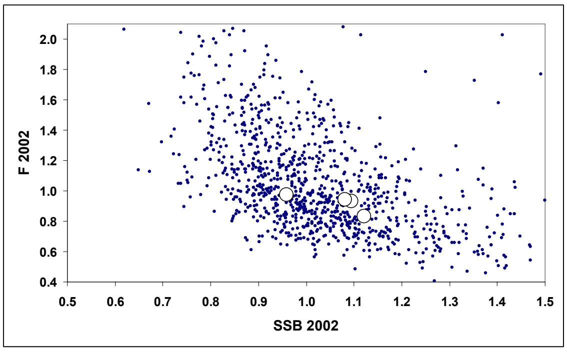
The newly available software at the ICES Secretariat to produce standard graphs for the Working Group and ACFM reports suffers from an antiquated philosophy and needs to be automated so as to minimise user intervention. The user should have to invoke only one program in one location, and she should be directed by the program through the absolute minimum number of steps that cannot be fully automated once file names have been standardised. One important thing to keep in mind in the design phase is that many of the Working Group members may only use this package once a year.

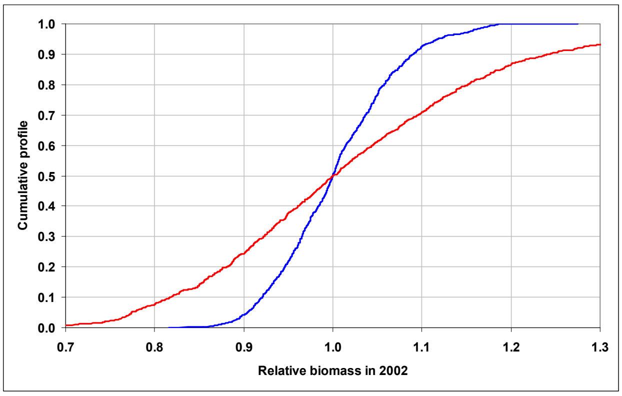
As indicated above, the WG considered assessments using several different approaches for several of the stocks. The WG found it considerably easier to inspect peculiarities of the data using the alternate approaches than using the standard software. The Lowestoft software suite is based on the philosophy of trying to produce the best possible assessment under average conditions, and to minimise the probability of widely erroneous assessments. Yet, there remains a considerable margin for variability in the results by modifying the various settings and input data. The WG sees three main problems with the adopted approach:

1. It is an antiquated piece of software that is awkward to use and with limitations that do not take advantage of the latest developments in computer technology as well as in fisheries modelling;
2. The historical stock assessment software as well as the recruitment generator apply a number of stabilising techniques (time-tapering, shrinking of F and/or P) whose final weight is often based on very ad hoc and non-transparent decisions.
3. Moving results of estimators of one set of age groups to another program to estimate other age groups ignores the fact that estimates of different age groups are often correlated.

The WG recognises the importance of utilising routines/programs that have been tested for errors/bugs. It also recognises that the standard software package has been and still is, when properly used, a very valuable tool to come up with reasonably sound estimates of stock abundance (most alternative approaches provided results similar to, or consistent with the standard package). However, the WG considers that a more flexible approach to assessment software, in the spirit of the C++ or R software, would be superior to the current insistence on "black box" assessment software. In the proposed spirits, basic individual independent functions/libraries for calculating VPA, Y/R, stock projections would be used by well-trained users.

A simple, although somewhat naive, illustration of the use of the modern methods and computer power to improve **the stock assessment process** is as follows. The plot below shows a point cloud of 1000 bootstrapped estimates of scaled terminal F and SSB from an unspecified NWWG stock based on a statistical catch-at-age model. Superimposed are the point estimator values (open, larger circles) from different XSA runs that were considered by the WG when selecting "the final run".





Based on the results from the bootstrap estimates it could be argued that the different XSA runs are within the noise in the input data and thus more or less equally likely. If only the XSA point estimators are available, the noise in the data are hidden, and working groups may spend considerable, but meaningless time in trying to justify one run and its settings over the others.

Another example is the continuous use of point estimator in the advice without carrying any information about uncertainty in different stocks. On the left is a comparison of the cumulative bootstrap values of the scaled terminal biomass estimates from two stocks that were assessed by the Working Group. Although the cumulative values should not indicate true significance it is indicative that the noise in the data of one stock is around double that of the other.

It is neither being claimed here that the above examples are something novice nor that they will provide us with a better point estimators. They are intended to show how information that is available in the input data can, by applying simple statistical principles, be of help in improving the assessment and advisory process – something that is hidden and not dealt with in the current ICES approach.

It is the opinion of the WG that the limitations of the standard software packages used by ICES supersedes the issue of software approval. The fast development in the field, particularly in dealing with the uncertainty in the assessments requires that heavy emphasis should be put on certifying the assessor, not just the software. Courses should be designed such that they teach the principles, with emphasis on "how to do it" and not "what to do". Training WG participants in the usage of a particular piece of antiquated software is at best a waste of time for those participating in the training. At worst, it contributes to wasting the time of assessment WG members by being an impediment to more transparent and more modern approaches.

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

2.1 General Trends in Demersal Fisheries in the Faroe Area

The fishery in Faroese waters is a multi-fleet and multi-species fishery. Figure 2.1.1 gives a summary of the 2003 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 (between 0.20 and 0.30) 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 until 1998, with some variability since. 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 0.32 in 1997 to about 0.45 in 2002, during a period in which effort was meant to be constant.

The SSB for cod shows four cycles (Figure 2.1.3) and possibly the beginning of a fifth one, the SSB for saithe two and a half, and the SSB for haddock, three with possibly the beginning of a fourth one. The haddock SSB appears to lag that of cod by 2 years (r = 0.82). 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 declines almost steadily until 1992, except for a brief increasing period from 1983 to 1985. SSB has shown a relatively steady increasing trend since then. In 2002, all species are increasing.

Haddock shows the largest recruitment variability (Figure 2.1.5). There is a more than 60-fold difference between the smallest year class (1.8 million) and the largest one (110 millions). Cod shows the next largest variability with a 13-fold difference between the smallest year class (3.7 millions) and the largest one (48 millions). Saithe shows a 10-fold difference between the smallest year class (8.4 millions) and the largest one (80 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 others 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 have 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 measures 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.

2.1.1 The management system implemented in 1996

The catch quota management system introduced in the Faroese fisheries in 1994 was met with considerable criticism and it resulted in at least some fleets misreporting substantial portions of their catches. As a result of the dissatisfaction with the catch quota management system, the Faroese Parliament has adopted a law stipulating that the quota system would end as of May 31, 1996. In addition, the Faroese government has developed, in close cooperation with the fishing industry, a new system based on within-fleet category individual transferable effort quotas in days. The new system entered into force on 1 June 1996.

The within-fleet category individual transferable effort quotas apply to 1) the longliners less than 110 GRT, the jiggers and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 110 GRT. The single trawlers larger than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 n. miles limit and the areas closed to them as well to the pairtrawlers have increased in area and time. Their harvest of cod and haddock is limited by maximum bycatch allocation of 4% and 1.75%. In addition, this fleet (13 trawlers) in the present fishing year have been permitted to perform directed cod and haddock fisheries and consequently allocated individual catch quotas of cod and haddock of 100 t each. These quotas have not been accounted for in the allocation of days to other fleets. The single trawlers < 400 HP are given special licenses to fish inside 12 n. miles with a bycatch allocation of 30% cod and 10% haddock. Holders of individual transferable effort quotas who fish outside an area where cod and haddock are normally found can fish 3 days for each day allocated within the area of normal cod and haddock distribution. One fishing day by longliners less than 110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Therefore longliners less than 110 GRT (and single trawlers < 400 HP) could double their allocation by converting to jigging. Figure 2.1.6 gives an overview of the different area regulations.

The effort quotas are transferable within gear categories. The allocations of number of fishing days by fleet categories was made such that together with other regulations of the fishery they should result in average fishing mortalities on each of the 3 stocks of 0.45 corresponding to average annual catches of 33% of the exploitable stocks in numbers. Built into the system is also an assumption that the day system is self-regulatory, because the fishery will move between stocks according to the relative availability of each of them and no stock will be overexploited. Pope (2000) examined changes in stock sizes and price and could not find relationships that would support the hypothesis that the economics of the fishery would prevent overfishing of the stocks by shifting the fishing effort to the most abundant species.

The number of days fished by gear category since 1985, and the number of days by category as stated in the law, are presented in Tables 2.1.1 and 2.1.2.

In addition to the number of days allocated in the law, it is also stated in the law what percentage of total catches of cod, haddock, saithe and redfish, each fleet category on average are allowed to fish. These percentages are as follows:

Fleet category	Cod	Haddock	Saithe	Redfish
Longliners < 110GRT, jiggers, single trawl. < 400HP	51 %	58 %	17.5 %	1 %
Longliners > 110GRT	23 %	28 %		
Pairtrawlers	21 %	10.25 %	69 %	8.5 %
Single trawlers > 400 HP	4 %	1.75 %	13 %	90.5 %
Others	1 %	2 %	0.5 %	0.5 %

Technical measures such as area closures during the spawning periods, to protect juveniles and young fish and mesh size regulations are also in effect (Figure 2.1.6).

Table 2.1.1 Number of fishing days used by various fleet groups in Vb1 1985-95 and 1998-02. For other fleets there are no effort limitations. Catches of cod, haddock saithe and redfish are regulated by the by-catch percentages given in section 2.1.1. In addition there are special fisheries regulated by licenses and gear restrictions.

(This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears)

Year	Longliner 0-110 GRT, jiggers, trawlers < 400 HP	Longliners > 110 GRT	Pairtrawlers > 400 HP
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
Average(85-95)	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
Average(98-01)	25945	2511	6806

Table 2.1.2 Number of allocated days for each fleet group since the new management scheme was adopted and number of licenses per fleet.

	Fleets	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	No. of licenses
Group 1	Single trawlers > 400 HP	Regulated by area and by-catch limitations							13
Group 2	Pair trawlers > 400 HP	8225	7199	6839	6839	6839	6839	6771	31
Group 3	Longliners > 110 GRT	3040	2660	2527	2527	2527	2527	2502	19
Group 4	Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	9320	9328	8861	8861	8861	8861	8772	106
Group 5	Longliners and jiggers < 15 GRT	22000	23625	22444	22444	22444	22444	22220	696

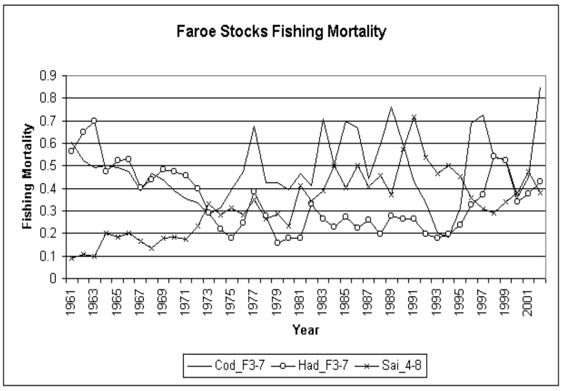


Figure 2.1.1: Faroe demersal stocks fishing mortality.

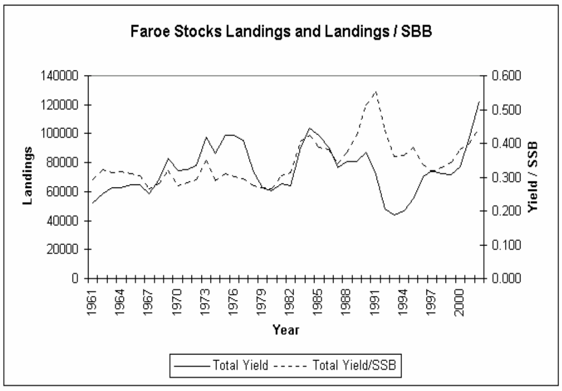


Figure 2.1.2: Faroe demersal stocks total landings and overall yield/SSB ratios.

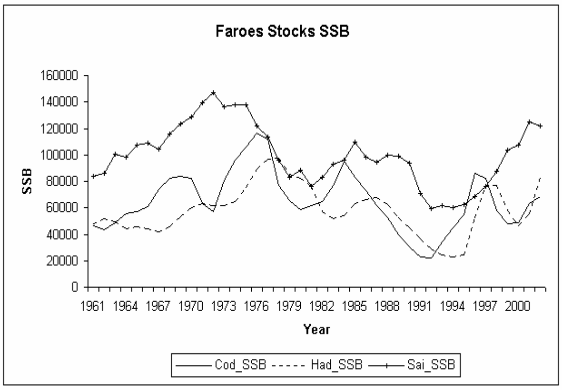


Figure 2.1.3: Faroe demersal stocks individual SSB trends.

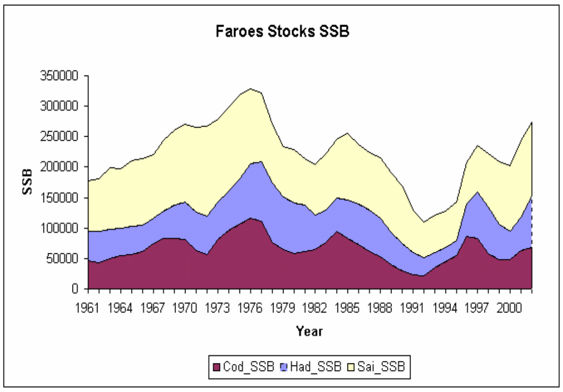


Figure 2.1.4: Faroe demersal stocks spawning stock biomasses.

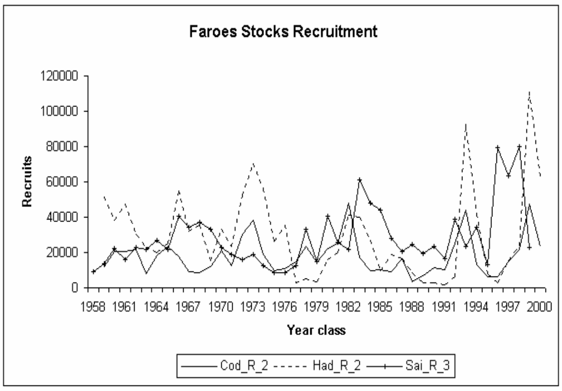
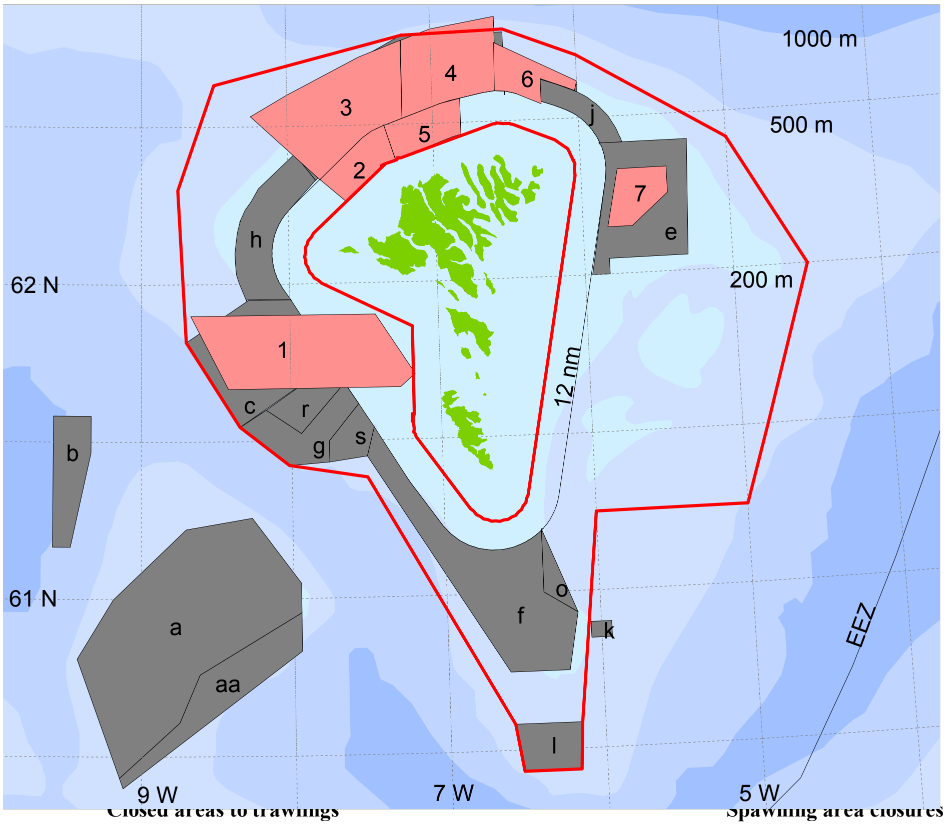


Figure 2.1.5: Faroe demersal recruitment time series.



Closed areas to trawlings

Spawning area closures

Areas inside the 12 nm zone closed year round

Area	Period
a	1 jan- 31 des
aa	1 jun – 31 aug
b	20 jan- 1 mar
c	1 jan- 31 des
d	1 jan- 31 des
e	1 apr- 31 jan
f	1 jan- 31 des
g	1 jan- 31 des
h	1 jan- 31 des
i	1 jan- 31 des
j	1 jan- 31 des
k	1 jan- 31 des
l	1 jan- 31 des
m	1 feb- 1 jun
n	31 jan- 1 apr
o	1 jan- 31 des
p	1 jan- 31 des
r	1 jan- 31 des
s	1 jan- 31 des

Area	Period
1	15 feb-31 mar
2	15 feb- 15 apr
3	1 feb- 1 apr
4	15 jan- 15 mai
5	15 feb- 15 apr
6	15 feb- 15 apr
7	15 jan- 1 apr

Figure 2.1.6 Fishing area regulations in Division Vb. Allocation of fishing days applies to the area inside the outer thick line on the Faroe Plateau. Holders of effort quotas who fish outside this line can triple their numbers of days. Longliners larger than 110 GRT are not allowed to fish inside the inner thick line on the Faroe Plateau. If longliners change from longline to jigging, they can double their number of days. The Faroe Bank shallower than 200 m depths (a, aa) is regulated separate from the Faroe Plateau. It is closed to trawling and the longline fishery is regulated by individual day quotas.

2.2 Faroe Plateau Cod

2.2.1 Stock definition

Faroe Plateau cod is distributed on the entire plateau down to approximately the 500-m depth contour. Tagging experiments show that immigration to other areas is very rare (about 0.1% of recaptured cod; Strubberg, 1916, 1933; Tåning, 1940, 1943; unpublished data). Cod spawn in February-March at two main spawing grounds north and west of the islands at depths of around 90-120 m. The larvae hatch in April and are carried by the Faroe Shelf residual current (Hansen, 1992) that flows clockwise around the Faroe plateau within the 100- to 130-m isobath (Gaard *et al*. 1998; Larsen *et al.*, 2002). The fry settle in July-August and occupy the near-shore areas, which normally are covered by dense algae vegetation. In autumn the following year (i.e. as 1-group), the juvenile cod begin to migrate to deeper waters (usually within the 200-m contour), thus entering the feeding areas of adult cod. They seem to be fully recruited to the fishing grounds as 3-year-olds. Faroe plateau cod mature as 3-4 years old. The spawning migration seems to start in December-January and ends in May. Cod move gradually to deeper waters when they are growing older. The diet in shallow water (< 200 m) is dominated by sandeels and benthic crustaceans, whereas the diet in deeper water mainly consists of Norway pout, blue whiting and a few species of benthic crustaceans.

2.2.2 Trends in landings

The annual landings of Faroe cod (ICES Division Vb) normally varied between 20 and 40 thousand tonnes during the last century. English and Scottish vessels took the majority of the catches up to the 1950s. Thereafter their part of the catches declined gradually, and when the Faroe Islands established the 200 nm EEZ in 1977, the vast majority of the catch was taken by Faroese vessels. From 1965 there have been separate catch figures for Faroe Plateau (ICES Division Vb1) and Faroe Bank (ICES Division Vb2).

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 (3 000 t 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.

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.

Since the introduction of the EEZ, the Faroe Plateau cod has almost entirely been exploited by the Faroese fishing fleets. In recent years, the longliners and the pair trawlers have usually taken most of the catches. Since autumn 1999 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).

The nominal landings of cod (1986-2002) from the Faroe Plateau by nations as officially reported to ICES, are given in Table 2.2.1.1. Table 2.2.1.2 shows the figures used in the assessment. In 2002, the catches exceeded 40 thousand tonnes, which is the normal maximum. Table 2.2.1.3 shows the landings for the most important fleet categories.

2.2.3 Catch-at-age

The sampling strategy is to have length, length-age, and length-weight samples from all major gears during three periods: January-April, May-August and September-December. In the period 1985-1995, the year was split into four periods: January-March, April-June, July-September, and October-December. When sampling was insufficient, length-age and length-weight samples were borrowed from similar fleets in the same time period. Length measurements were, if possible, not borrowed.

Landings-at-age were updated to account for a change in the nominal landings for 2001. Landings-at-age for 2002 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 2002 are shown in Table 2.2.2.2. Catch curves are shown in Fig. 2.2.2.1. 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, causing atypical catch curves for longliners.

Samples from commercial fleets in 2002.

Fleet	Size	Samples	Length	Otoliths	Weights
Open boats		33	6,485	660	420
Longliners	<100 GRT	75	15,118	1,440	600
Longliners	>100 GRT	67	12,764	1,740	960
Jiggers		5	907	180	180
Sing. trawlers	<400 HP	13	2,619	296	236
Sing. trawlers	400-1000 HP	27	5,371	598	179
Sing. trawlers	>1000 HP	22	3,943	420	240
Pair trawlers	<1000 HP	10	1,830	300	240
Pair trawlers	>1000 HP	62	12,711	1,200	1,200
Total		281	55,263	6,174	3,835

2.2.4 Mean weight-at-age

Mean weight-at-age data for 1961-2002 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 2002 showed a discrepancy of less than 1 %.

Figure 2.2.3.1 shows the mean weight-at-age for 1961 to 2002. The weights increased from 1998 to high levels in 2000, but have decreased since.

2.2.5 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 - 2002) and shown in Figure 2.2.4.1 (1983 - 2003). The average maturity-at-age for 1983 to 1996 were used in years prior to 1983. The values for 1994-1997 are revised (Working Document 14) in connection with the correction of the spring groundfish survey, but values prior to 1994 are not changed. The working document deals with the correction of maturities for 1994-1997. On about half of the stations, many fish were incorrectly classified as “maturing”, which is highly unlikely for a spring spawner. They were reclassified as “immature” or “spent” according to criteria derived from the years 1999-2002, which data were assumed to be correct. The maturities were calculated in the same way as previously: pooling all fish with information on age and maturity and obtaining the proportion mature directly. 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.

2.2.6 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 estimate is the stratified mean catch per hour in numbers-at-age calculated using smoothed age/length keys. The same strata were used as in the summer survey and calculated in the same way (see below). All cod less than 25 cm were set to 1 year old. The calculation of the age-disaggregated CPUEs from the spring survey should be regarded as preliminary, because the time was limited.

The overall mean catch of cod per unit effort (scaled down to kg/15 min. trawling) 1983-2003 is given in Figure 2.2.5.1 and catch curves in Figure 2.2.5.2. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased from 2002 to 2003. 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 1996-2003.

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. The overall mean catch of cod per unit effort (kg/trawl hour) 1996-2002 is shown in Figure 2.2.5.1, and catch curves in Figure 2.2.5.3. 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 youngest age groups, all cod less than 15 cm were considered being 0 years and between 15-34 cm 1 year. Since the age-length 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.

The age-disaggregated CPUEs for the summer series are slightly modified compared to last year. Last year a few hauls were ignored in the calculations due to technical problems.

2.2.7 Stock assessment

2.2.7.1 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 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 2.2.6.1.2 (Cuba trawlers) and Figure 2.2.6.1.3 (longliners). The NWWG 2002 decided to use only the summer groundfish survey as tuning series in the 2002 assessment (see last year's report, ICES, 2002), and this procedure was repeated in this years assessment.

Information about the longliners and Cuba trawlers is found in last year's report (ICES, 2002). The criteria for selecting settings or hauls for CPUE-calculations is changed this year: Instead of using the whole year (January-December), the period February-May was excluded in order to avoid the spawning migration and spawning of cod. During the spawning migration and spawning, mature cod are less accessible (longliners) or not accessible at all (Cuba trawlers). In addition CPUEs may not be an appropriate estimate of stock biomass when the fish are moving and/or are densely aggregated.

Before choosing the final XSA run, four XSA runs were considered: 1) same settings as last year, i.e. the summer survey alone, 2) Cuba trawlers only, 3) longliners only, 4) spring survey only. The diagnostics for the commercial tuning series and the spring survey were poorer than the summer survey. The logQ residual of the summer survey is shown in Fig. 2.2.6.1.4. The longliner tuning series seemed to have an important deficiency, since the catchability was dependent on the growth rate of cod (Figure 2.2.6.1.5 in last year's report (ICES, 2002)). This suggests that cod preference for longline bait depends on natural food availability. Age 2 was removed from the Cuba series, because they were only expected to catch 2-year-old cod when the specific year class was large, i.e. they were overestimating large year classes and underestimating poor year classes. The CPUE index of mature or partially mature fish (age 3+) from the spring survey was considered to be poorly defined, because a few very large catches on the spawning grounds had a large influence on the index. Thus, the spring survey was not used in this year's assessment. The results from three XSA runs (summer survey, longliners and Cuba trawlers) are presented in Figure 2.2.6.1.6. The overall picture was the same for all three XSA runs.

For the longliners, only 30 iterations were used. If more iterations were performed, a divergence in fishing mortality was observed in the past (which was unexpected) (see comments on the assessment).

The results from the retrospective analysis of the XSA (Figure 2.2.6.1.5) show that there is a tendency to overestimate fishing mortality and underestimate recruitment, stock biomass and spawning stock biomass.

The estimated fishing mortalities are shown in Tables 2.2.6.1.3 and 2.2.6.1.5 and Figure 2.2.6.1.7. The average F for age groups 3 to 7 in 2002 is estimated at 0.85, considerably higher than $\mathbf{F}_{max}$ = 0.48, but this is due to anomalously large fishing mortalities on ages 7 (1.8) and 8 (1.6). It therefore gives an erroneous impression of the fishing pressure, but is nevertheless presented for consistency with previous assessments. The ratio yield and exploitable biomass, defined as ages 3 and older biomass (Y/B3+), is considered a more reliable indication of the fishing pressure on the stock (Fig. 2.2.6.1.8). The ratio was high during the 1980s and dropped considerably during the poor state of the cod stock in the beginning of the 1990s. It has remained high and stable (between 0.34 and 0.37) after the effort management system was introduced in 1996.

2.2.7.2 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 2.2.6.1.7. The stock-recruitment relationship is presented in Figure 2.2.6.2.1.

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 22 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before, declining to a level of about 48 000 t in 1999. The 1998 year class is 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). The 2000 year class is estimated to be above average strength.

2.2.8 Predictions of catch and biomass

2.2.8.1 Short-term prediction

In order to estimate the strength of the year classes 2000-2002, the RCT3 program was used. Table 2.2.6.1.6 shows the input values. The indices used were: 0-group survey, 1-group from summer survey (SS1y), 2-group from spring survey (SP2y), 2-group from summer survey (SS2y) and a new index of primary production (P.Prod). Steingrund and Gaard (in submission) have found a positive relationship between an index of primary production and the recruitment of 2-year-old cod the following year. The long time span (1964-2002) was used in order to reduce the influence of the poor recruitment in the period 1987-1991 on the VPA mean. The problem with a few large catches dominating the CPUE index from the spring survey is not supposed to be any problem for immature fish (age 2).

The input data for the short-term prediction are given in Table 2.2.7.1.1. The estimate of year classes 2001-2003 was taken from the RCT3 run. The 2003 year class was estimated as the geometric mean for the period 1961-2002. Estimates of stock size (ages 3+) were taken directly from the VPA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2000-2002 (not rescaled to 2002 values), omitting high fishing mortalities on ages 7-8 in 2002. The weights-at-age in the catches in 2003 were estimated from the weights in the spring survey. Regression analyses were made between weights in the catches and in the spring survey, and the weights in the catches in 2003 were predicted from those relationships. The weights in the catches in 2004 were set to the values in 2002, since an increase was expected. It was not clear whether the weights in 2005 would increase or decrease, so the values for 2002 were used for 2005. The proportion mature in 2003 was set to the 2003 values from the spring groundfish survey, and for 2004-2005 to the average values for 2001-2003.

Table 2.2.7.1.2 shows that the landings in 2003 are expected to be 32 000 tonnes if the fishing mortality is on the average level of 2000-2002 (excluding high F-values for ages 7-8 in 2002). The spawning stock biomass is expected to be 66 000 tonnes in 2003, 82 000 tonnes in 2004 and eventually 70 000 tonnes in 2005. The VPA suggest that the 1999 year class is as high as the highest observed (1982 year class at 47 millions).

2.2.8.2 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$^{.645□}$..assuming a □ 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 suggests that $\mathbf{F}_{pa}$ = 0.35 may be overly conservative. The updated assessment indicates an $\mathbf{F}_{med}$ = 0.48, $\mathbf{F}_{0.1}$ = 0.27 and $\mathbf{F}_{max}$ = 0.48. $\mathbf{F}_{pa}$ could therefore be set in the order of $\mathbf{F}_{med}$ = 0.48. Following the logic used to set $\mathbf{B}_{pa}$, $\mathbf{F}_{lim}$ was set at $\mathbf{F}_{lim}$=Fpae1$^{.645□}$..that is, $\mathbf{F}_{lim}$=0.68. The Working Group suggests that the $\mathbf{F}_{lim}$ be adjusted, using □ of about 0.40, according to the review of $\mathbf{F}_{pa}$, that is $\mathbf{F}_{lim}$ = 0.90. The highest fishing mortality in the history of the fishery is in the terminal year (0.85), but this is due to anomalously high values at age 7 and 8 in 2002. The next largest fishing mortality is 0.76. The Working Group agrees with the SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) that there is no basis to change the existing $\mathbf{B}_{lim}$ for Faroe cod.

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

2.2.8.3 Medium-term prediction

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

2.2.8.4 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 (not rescaled to 2002 values) and weight-at-age were set to the average values for 1961-2002. The proportion mature was set to the average for 1983-2003.

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 (F3-7) in 2002 of 0.85 is substantially above $\mathbf{F}_{max}$ and $\mathbf{F}_{med}$ = 0.48 (Figure 2.2.7.2.1). (The program that calculates the long-term prediction has, incorrectly, interchanged the values of $\mathbf{F}_{low}$ and $\mathbf{F}_{high}$).

2.2.9 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 0.32 in 1995 to 0.69 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 purposes 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%. This is much more than the 1% reduction in fishing days for the fishing year 2002-2003.

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.

From an ecological point of view, it should be an advantage to reduce the fishing mortality. The abundance of large cod would increase and the predation on blue whiting should be higher. Since the majority of the blue whiting stock is growing up outside the Faroe Plateau, and mainly is present in the Faroese area in connection with the spawning migration, an increased predation on blue whiting should represent an influx of energy to the Faroe Plateau ecosystem and eventually a higher catch of cod.

2.2.10 Comment on the assessment

New or changed things compared to last year's report: The assessment was done in exactly the same way as last year. The estimation of recent year classes by the RCT3 program now was based on two indices more: The 2 year olds from the spring survey and an index of primary production.

In the preliminary XSA runs, there seemed to be a problem with the XSA run when using the longliners as the only tuning series. When having more than 30 iterations, unexpected deviations in fishing mortalities for some years back in time were obtained (Fig. 2.2.9.1). When stopping at 30 iterations, more likely values were obtained (Fig. 2.2.6.1.6). These problems were not observed when using ADAPT, because the assumptions about the fishing mortalities on the oldest ages is different.

In last year's report, the main problem in the short-term prediction was the uncertainty about the large 1999 year class as well as the year classes 2000-2001, because few indices of year-class strength were available. This years assessment shows that the 1999 year class is as strong as expected, and more indices are available to assess the strength of recent year classes (2000-2002 year classes). In this sense, the short-term prediction this year should be more accurate compared to last year. On the other hand it was difficult to decide on the selection pattern because it varied so much between years. It was decided to use the default year range (last 3 years) and excluding high fishing mortalities on ages 7 and 8 in 2002. Since no trend in the fishing mortalities was detected, no rescaling to the final year was done. The short-term prediction predicted the catch in 2003 to be about 32 000 tonnes. This is less than expected, since the landings the first three months in 2003 are similar to the same period in 2002 (and the catch in 2002 was 40 000 tonnes). A statistical catch-at-age model (see Icelandic cod) predicted a catch in the range of 37-40 000 tonnes.

The most important change compared to last year's assessment is the perception of fishing mortality and stock size. The F3-7 in 2001 has changed from 0.71 to 0.45 which shows that the advice should not only be based on F3-7. The stock biomass and spawning stock biomass are estimated to be around 10 000 t higher in recent years (1999-2001). The changes in the spawning stock biomass in 1994-1995 (reduction of about 10 000 t) comes from the revised maturities. The perception of recruitment is very similar to the 2002 assessment.

2.2.10.1 References

Gaard, E., Hansen, B., and Heinesen, S. P. 1998. Phytoplankton variability on the Faroe shelf. ICES J. Mar. Sci., 55: 688-696.

Hansen, B. 1992. Residual and tidal currents on the Faroe Plateau. ICES CM 1992/C:12, 18 pp.

ICES. 1997. Report of the Study Group on the Precautionary Approach to Fisheries Management. ICES C.M. 1997/Assess:7

ICES. 2001. Report of the North Western Working Group. ICES CM 2001/ACFM:20.

ICES. 2002. Report of the North-Western Working Group. ICES CM 2002/ACFM:20. 405 pp.

Larsen, K. M. L., Hansen, B., Svendsen, H., and Simonsen, K. 2002. The front on the Faroe shelf. ICES CM 2002/P:10, 15 pp.

NEFSC. 2002. Final Report of the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish. Northeast Fisheries Science Center Reference Document 02-04. Posted on the web March 27, 2002.

Pope, J.G. 2000. Report on aspects of effort management used for demersal fish stocks of the Faroes.

Sinclair, A. and S. Gavaris. 1996. Some examples of probabilistic catch projections using ADAPT output. DFO Atlantic Fisheries Res. Doc. 96/51: 12p.

Sissenwine, M. P. and Shepherd, J. G. 1987. An alternative perspective on recruitment overfishing and biological reference points. Can. J. Fish. Aquat. Sci. 44:913–918.

Steingrund, P., and Gaard, E. in prep. Relationship between phytoplankton production and cod production on the Faroe shelf. Submitted to ICES Journal of Marine Science.

Strubberg, A. C. 1916. Marking experiments with cod at the Faroes. Meddelelser fra Kommissionen for Danmarks Fiskeri– og Havundersøgelser. Serie Fiskeri, 5 (2).

Strubberg, A. C. 1933. Marking experiments with cod at the Faroes. II. Second Report. Experiments in 1923-27. Meddelelser fra Kommissionen for Danmarks Fiskeri– og Havundersøgelser. Serie Fiskeri, 9 (7).

Tåning, Å. V., 1940. Migration of cod marked on the spawning places off the Faroes. Meddelelser fra Kommissionen for Danmarks Fiskeri– og Havundersøgelser. Serie Fiskeri, 10 (7).

Tåning, Å. V., 1943. Fiskeri og Havundersøgelser ved Færøerne. Skrifter udgivet af Kommissionen for Danmarks Fiskeri- og Havundersøgelser, 12.

Table 2.2.1.1 Faroe Plateau (Subdivision Vb1) COD. Nominal catches (tonnes) by countries, 1986-2002, 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	2002 *
Denmark	-			
Faroe Islands	19,156			
France [1)]	- *	1	7 *	20
Germany	39	2	9	6 [2]
Norway	450	374 *	544 *	732
Greenland				
UK (Engl. and Wales)	51 [2]	18 [2]	50 [2]	
UK (Scotland)	-			
United Kingdom				[1]
Total	19,696	395	610	758

* Preliminary

1) Included in Vb2.

2) Reported as Vb.

Table 2.2.1.2 Nominal catch (tonnes) of COD in Subdivision Vb1 (Faroe Plateau) 1986-2002, 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	2002 *
Officially reported	19,696	395	610	758
Faroese catches in Vb1		21,793 *	28,511	39,102 *
Greenland				26
Catches reported as Vb2:				
UK (E/W/NI)	-	-	-	
UK (Scotland)	210	245	288	
United Kingdom				273
Used in the assessment	19,906	22,433	29,409	40,159

*) Preliminary

Table 2.2.1.3 Faroe Plateau (Subdivision 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
2002	3.8	32.9	5.8	0.3	9.9	6.7	6.6	2.5	7.2	24.4	0.0	0.0	39,102

Table 2.2.2.1 Faroe Plateau COD. Catch in numbers-at-age per fleet in 2002. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats longline	Open boats jiggers	Longliners < 100 GRT	Jiggers	Single trwl 0-399HP	Single trwl 400-1000H	Single trwl > 1000 HP	Pair trwl 700-999 HI	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others	Catch-at-age
2	74	67	1114	207	26	52	17	7	29	444	0	134	2171
3	159	127	2743	725	353	452	340	140	402	1700	1	463	7605
4	61	64	1038	351	232	281	210	98	302	665	3	216	3521
5	43	31	546	177	133	140	95	32	80	359	2	107	1745
6	6	12	160	47	28	30	20	6	16	134	2	30	491
7	10	11	223	39	20	24	30	5	12	148	2	32	556
8	7	5	204	32	20	18	6	2	8	100	3	26	431
9	2	3	89	25	12	15	8	3	12	113	2	19	303
10+	0	0	5	0	0	1	0	0	0	0	0	1	7
Sum	362	320	6122	1603	824	1013	726	293	861	3663	15	1028	16830
G.weight	637	638	11175	3357	1970	2262	2246	838	2454	8297	92	2213	36179

Others include industrial bottom trawlers, longlining for halibut, small gillnetters, pair trawlers 400-699 HP, foreign fleets, and scaling to correct catch.

Table 2.2.2.2 Faroe Plateau COD. Catch in numbers-at-age 1961-2002.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND_su
At 2/05/2003 17:09

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

YEAR	1961	1962
AGE		
2	3093	4424
3	2686	2500
4	1331	1255
5	1066	855
6	232	481
7	372	93
8	78	94
9	29	22
0 TOTALNUM	8887	9724
TONSLAND	21598	20967
SOPCOF %	91	94

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

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
2	4110	2033	852	1337	1609	1529	878	402	328	875
3	3958	3021	3230	970	2690	3322	3106	1163	757	1176
4	1280	2300	2564	2080	860	2663	3300	2172	821	810
5	662	630	1416	1339	1706	945	1538	1685	1287	596
6	284	350	363	606	847	1226	477	752	1451	1021
7	204	158	155	197	309	452	713	244	510	596
8	48	79	48	104	64	105	203	300	114	154
9	30	41	63	33	27	11	92	44	179	25
0 TOTALNUM	10576	8612	8691	6666	8112	10253	10307	6762	5447	5253
TONSLAND	22215	21078	24212	20418	23562	29930	32371	24183	23010	18727
SOPCOF %	96	98	113	109	102	106	109	99	123	125

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

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
2	723	2161	2584	1497	425	555	575	1129	646	1139
3	3124	1266	5689	4158	3282	1219	1732	2263	4137	1965
4	1590	1811	2157	3799	6844	2643	1673	1461	1981	3073
5	707	934	2211	1380	3718	3216	1601	895	947	1286
6	384	563	813	1427	788	1041	1906	807	582	471
7	312	452	295	617	1160	268	493	832	487	314
8	227	149	190	273	239	201	134	339	527	169
9	120	141	118	120	134	66	87	42	123	254
0 TOTALNUM	7187	7477	14057	13271	16590	9209	8201	7768	9430	8671
TONSLAND	22228	24581	36775	39799	34927	26585	23112	20513	22963	21489
SOPCOF %	105	104	100	103	70	102	101	107	107	104

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

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	2149	4396	998	210	257	509	2237	243	192	205
3	5771	5234	9484	3586	1362	2122	2151	2849	451	455
4	2760	3487	3795	8462	2611	1945	2187	1481	2152	466
5	2746	1461	1669	2373	3083	1484	1121	852	622	911
6	1204	912	770	907	812	2178	1026	404	303	293
7	510	314	872	236	224	492	997	294	142	132
8	157	82	309	147	68	168	220	291	93	53
9	104	34	65	47	69	33	61	50	53	30
0 TOTALNUM	15401	15920	17962	15968	8486	8931	10000	6464	4008	2545
TONSLAND	38133	36979	39484	34595	21391	23182	22068	13487	8750	6396
SOPCOF %	99	99	97	97	98	102	98	101	109	108

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

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
2	120	573	2615	351	200	455	1288	2230	4082	2171
3	802	788	2716	5164	1278	745	1080	2812	3923	7605
4	603	1062	2008	4608	6710	1558	869	834	2192	3521
5	222	532	1012	1542	3731	5140	1204	455	383	1745
6	329	125	465	1526	657	1529	2420	719	382	491
7	96	176	118	596	639	159	477	863	750	556
8	33	39	175	147	170	118	65	111	455	431
9	22	23	44	347	51	28	19	8	38	303
0 TOTALNUM	2227	3318	9153	14281	13436	9732	7422	8032	12205	16823
TONSLAND	6107	9046	23045	40422	34304	24005	19906	22433	29409	40159
SOPCOF %	107	103	103	100	104	104	102	104	101	100

Table 2.2.3.1. Faroe Plateau COD. Catch weight-at-age 1961-2002.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND_su
At 2/05/2003 17:09

Table 2 Catch weights-at-age (kg)

	YEAR,	1961,	1962,
	AGE		
	2,	1.0800,	1.0000,
	3,	2.2200,	2.2700,
	4,	3.4500,	3.3500,
	5,	4.6900,	4.5800,
	6,	5.5200,	4.9300,
	7,	7.0900,	9.0800,
	8,	9.9100,	6.5900,
	9,	8.0300,	6.6600,
0	SOPCOFAC,	.9068,	.9444,

Table 2 Catch weights-at-age (kg)

	YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
	AGE										
	2,	1.0400,	.9700,	.9200,	.9800,	.9600,	.8800,	1.0900,	.9600,	.8100,	.6600,
	3,	1.9400,	1.8300,	1.4500,	1.7700,	1.9300,	1.7200,	1.8000,	2.2300,	1.8000,	1.6100,
	4,	3.5100,	3.1500,	2.5700,	2.7500,	3.1300,	3.0700,	2.8500,	2.6900,	2.9800,	2.5800,
	5,	4.6000,	4.3300,	3.7800,	3.5100,	4.0400,	4.1200,	3.6700,	3.9400,	3.5800,	3.2600,
	6,	5.5000,	6.0800,	5.6900,	4.8000,	4.7800,	4.6500,	4.8900,	5.1400,	3.9400,	4.2900,
	7,	6.7800,	7.0000,	7.3100,	6.3200,	6.2500,	5.5000,	5.0500,	6.4600,	4.8700,	4.9500,
	8,	8.7100,	6.2500,	7.9300,	7.5100,	7.0000,	7.6700,	7.4100,	10.3100,	6.4800,	6.4800,
	9,	11.7200,	6.1900,	8.0900,	10.3400,	11.0100,	10.9500,	8.6600,	7.3900,	6.3700,	6.9000,
0	SOPCOFAC,	.9573,	.9824,	1.1262,	1.0905,	1.0224,	1.0598,	1.0851,	.9943,	1.2264,	1.2481,

Table 2 Catch weights-at-age (kg)

	YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
	AGE										
	2,	1.1100,	1.0800,	.7900,	.9400,	.8700,	1.1120,	.8970,	.9270,	1.0800,	1.2300,
	3,	2.0000,	2.2200,	1.7900,	1.7200,	1.7900,	1.3850,	1.6820,	1.4320,	1.4700,	1.4130,
	4,	3.4100,	3.4400,	2.9800,	2.8400,	2.5300,	2.1400,	2.2110,	2.2200,	2.1800,	2.1380,
	5,	3.8900,	4.8000,	4.2600,	3.7000,	3.6800,	3.1250,	3.0520,	3.1050,	3.2100,	3.1070,
	6,	5.1000,	5.1800,	5.4600,	5.2600,	4.6500,	4.3630,	3.6420,	3.5390,	3.7000,	4.0120,
	7,	5.1000,	5.8800,	6.2500,	6.4300,	5.3400,	5.9270,	4.7190,	4.3920,	4.2400,	5.4420,
	8,	6.1200,	6.1400,	7.5100,	6.3900,	6.2300,	6.3480,	7.2720,	6.1000,	4.4300,	5.5630,
	9,	8.6600,	8.6300,	7.3900,	8.5500,	8.3800,	8.7150,	8.3680,	7.6030,	6.6900,	5.2160,
0	SOPCOFAC,	1.0485,	1.0432,	1.0033,	1.0285,	.7026,	1.0228,	1.0055,	1.0680,	1.0674,	1.0428,

Table 2 Catch weights-at-age (kg)

	YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
	AGE										
	2,	1.3380,	1.1950,	.9050,	1.0990,	1.0930,	1.0610,	1.0100,	.9450,	.7790,	.9890,
	3,	1.9500,	1.8880,	1.6580,	1.4590,	1.5170,	1.7490,	1.5970,	1.3000,	1.2710,	1.3640,
	4,	2.4030,	2.9800,	2.6260,	2.0460,	2.1600,	2.3000,	2.2000,	1.9590,	1.5700,	1.7790,
	5,	3.1070,	3.6790,	3.4000,	2.9360,	2.7660,	2.9140,	2.9340,	2.5310,	2.5240,	2.3120,
	6,	4.1100,	4.4700,	3.7520,	3.7860,	3.9080,	3.1090,	3.4680,	3.2730,	3.1850,	3.4770,
	7,	5.0200,	5.4880,	4.2200,	4.6990,	5.4610,	3.9760,	3.7500,	4.6520,	4.0860,	4.5450,
	8,	5.6010,	6.4660,	4.7390,	5.8930,	6.3410,	4.8960,	4.6820,	4.7580,	5.6560,	6.2750,
	9,	8.0130,	6.6280,	6.5110,	9.7000,	8.5090,	7.0870,	6.1400,	6.7040,	5.9730,	7.6190,
0	SOPCOFAC,	.9901,	.9872,	.9695,	.9715,	.9755,	1.0153,	.9810,	1.0064,	1.0857,	1.0770,

Table 2 Catch weights-at-age (kg)

	YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
	AGE										
	2,	1.1550,	1.1940,	1.2180,	1.0160,	.9010,	1.0040,	1.0500,	1.4160,	1.1640,	1.0170,
	3,	1.7040,	1.8430,	1.9860,	1.7370,	1.3410,	1.4170,	1.5860,	2.1700,	2.0760,	1.7680,
	4,	2.4210,	2.6130,	2.6220,	2.7450,	1.9580,	1.8020,	2.3500,	3.1870,	3.0530,	2.8050,
	5,	3.1320,	3.6540,	3.9250,	3.8000,	3.0120,	2.2800,	2.7740,	3.7950,	3.9760,	3.5290,
	6,	3.7230,	4.5840,	5.1800,	4.4550,	4.1580,	3.4780,	3.2140,	4.0480,	4.3940,	4.0950,
	7,	4.9710,	4.9760,	6.0790,	4.9780,	4.4910,	5.4330,	5.4960,	4.5770,	4.8710,	4.4750,
	8,	6.1590,	7.1460,	6.2410,	5.2700,	5.3120,	5.8510,	8.2760,	8.1820,	5.5630,	4.6500,
	9,	7.6140,	8.5640,	7.7820,	5.5930,	6.1720,	7.9700,	9.1290,	11.8950,	7.2770,	6.2440,
0	SOPCOFAC,	1.0652,	1.0303,	1.0299,	1.0026,	1.0367,	1.0376,	1.0178,	1.0430,	1.0054,	1.0019,

Table 2.2.4.1 Faroe Plateau (Subdivision Vb1) COD. Proportion mature-at-age 1983-2002. From 1961-1982 the average from 1983-1996 is used.

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

At 2/05/2003 17:09

Table 5 Proportion mature-at-age

YEAR,	1961,	1962,
AGE		
2,	.1700,	.1700,
3,	.6400,	.6400,
4,	.8700,	.8700,
5,	.9500,	.9500,
6,	1.0000,	1.0000,
7,	1.0000,	1.0000,
8,	1.0000,	1.0000,
9,	1.0000,	1.0000,

Table 5 Proportion mature-at-age

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
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,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
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,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
2,	.0300,	.0700,	.0000,	.0000,	.0000,	.0600,	.0500,	.0000,	.0000,	.0600,
3,	.7100,	.9600,	.5000,	.3800,	.6700,	.7200,	.5400,	.6800,	.7200,	.5000,
4,	.9300,	.9800,	.9600,	.9300,	.9100,	.9000,	.9800,	.9000,	.8600,	.8200,
5,	.9400,	.9700,	.9600,	1.0000,	1.0000,	.9700,	1.0000,	.9900,	1.0000,	.9800,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	.9400,	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,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
2,	.0300,	.0500,	.0900,	.0400,	.0000,	.0000,	.0200,	.0200,	.0700,	.0400,
3,	.7300,	.3300,	.3500,	.4300,	.6400,	.6200,	.4300,	.3900,	.4700,	.3700,
4,	.7800,	.8800,	.3300,	.7400,	.9100,	.9000,	.8800,	.6900,	.8600,	.7600,
5,	.9100,	.9600,	.6600,	.8500,	.9700,	.9900,	.9800,	.9200,	.9400,	.9700,
6,	.9900,	1.0000,	.9700,	.9400,	1.0000,	.9900,	1.0000,	.9900,	1.0000,	.9300,
7,	1.0000,	.9600,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,
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)        SU.TXT
101
SUMMER SURVEY
1996 2002
1 1 0.6 0.7
2 8
 200  829.7   6317.1   3840.5   1416.5   703    244.4   51.4
 200  566.2   1839.8   6263.6   1597.7   179    140.3   30.2
 200  518.4    548.4   1104.9   3517.5   973.8   53.6   37.2
 200  372.3   1267.1    778.8    754    1298.3  256.5   38.7
 200 1344.3   1132.3    697.2    315.5   434.6  614.9   35.5
 200 3375.1   2471.4   1524.7    429.5   246.6  297.3  248.6
 200 2289.2   5198.4   1794.4    806.5   145.3   85.8   70.5
```

Table 2.2.6.1.2 Faroe Plateau (Subdivision Vb1) COD. Final XSA run.

Lowestoft VPA Version 3.1

2/05/2003 17:08

Extended Survivors Analysis

```
COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_IND_su

CPUE data from file SU.TXT

Catch data for  42 years. 1961 to 2002. Ages  2 to   9.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                  ,    year, year,  age ,  age
SUMMER SURVEY      ,   1996, 2002,   2,     8,   .600,   .700


Time-series weights :

     Tapered time weighting not applied


Catchability analysis :

     Catchability dependent on stock size for ages <    3

        Regression type = C
        Minimum of   5 points used for regression
        Survivor estimates shrunk to the population mean for ages <  3


     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 had not converged after   30 iterations


Total absolute residual between iterations
29 and  30 =     .00046

Final year F values
Age         ,      2,      3,      4,      5,      6,      7,      8,      9
Iteration 29,  .1081,  .2714,  .5399,  .9083,  .7050, 1.8313, 1.6077,  .8995
Iteration 30,  .1081,  .2714,  .5399,  .9083,  .7050, 1.8314, 1.6078,  .8997


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



Fishing mortalities
   Age,  1996,  1997,  1998,  1999,  2000,  2001,  2002

     2,  .030,  .035,  .081,  .102,  .121,  .099,  .108
     3,  .187,  .146,  .174,  .279,  .336,  .323,  .271
     4,  .447,  .395,  .266,  .317,  .361,  .479,  .540
     5,  .783,  .816,  .603,  .339,  .272,  .280,  .908
     6,  .888,  .962,  .999,  .646,  .349,  .387,  .705
     7, 1.134, 1.314,  .650, 1.061,  .504,  .760, 1.831
     8,  .868, 1.326,  .951,  .610,  .770,  .548, 1.608
     9,  .833,  .882,  .813,  .374,  .135,  .664,  .900
```

Table 2.2.6.1.2 (Cont'd)

1
XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1996	1.31E+04	3.35E+04	1.41E+04	3.14E+03	2.87E+03	9.71E+02	2.80E+02	6.79E+02
1997	6.50E+03	1.04E+04	2.27E+04	7.39E+03	1.18E+03	9.66E+02	2.56E+02	9.62E+01
1998	6.49E+03	5.14E+03	7.37E+03	1.25E+04	2.67E+03	3.68E+02	2.13E+02	5.56E+01
1999	1.47E+04	4.91E+03	3.54E+03	4.62E+03	5.62E+03	8.06E+02	1.57E+02	6.72E+01
2000	2.17E+04	1.09E+04	3.04E+03	2.11E+03	2.70E+03	2.41E+03	2.28E+02	6.99E+01
2001	4.77E+04	1.57E+04	6.37E+03	1.73E+03	1.32E+03	1.56E+03	1.19E+03	8.65E+01
2002	2.34E+04	3.54E+04	9.33E+03	3.23E+03	1.07E+03	7.32E+02	5.96E+02	5.64E+02

Estimated population abundance at 1st Jan 2003

	0.00E+00	1.72E+04	2.21E+04	4.45E+03	1.07E+03	4.34E+02	9.60E+01	9.77E+01

Taper weighted geometric mean of the VPA populations:

	1.55E+04	1.14E+04	6.87E+03	3.69E+03	1.83E+03	8.57E+02	3.57E+02	1.50E+02

Standard error of the weighted Log(VPA populations) :

	.5711	.5635	.5364	.5367	.5602	.5758	.6331	.7651

1

Log-catchability residuals.

Fleet : SUMMER SURVEY

Age	1996	1997	1998	1999	2000	2001	2002
2	-.06	.25	.19	-.95	-.01	.13	.45
3	.16	.06	-.42	.53	-.34	.06	-.04
4	.24	.21	-.48	-.06	.01	.13	-.05
5	.78	.07	.19	-.52	-.65	-.14	.27
6	.32	-.11	.79	.11	-.45	-.27	-.39
7	.51	.07	-.35	.69	.11	-.01	.20
8	.02	-.12	.03	.15	-.21	-.06	.06

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

Age	3	4	5	6	7	8
Mean Log q	-6.8697	-6.4154	-6.2392	-6.3190	-6.3190	-6.3190
S.E(Log q)	.3191	.2423	.4913	.4427	.3920	.1219

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
2	1.02	-.084	7.81	.72	7	.49	-7.85

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	.99	.063	6.90	.86	7	.35	-6.87
4	.89	.930	6.71	.93	7	.22	-6.42
5	.86	.530	6.53	.74	7	.45	-6.24
6	.75	1.151	6.66	.81	7	.32	-6.32
7	.89	.498	6.23	.80	7	.33	-6.14
8	1.02	-.257	6.35	.97	7	.13	-6.34

1

Table 2.2.6.1.2 (Cont'd)

```
Terminal year survivor and F summaries :

Age  2   Catchability dependent on age and year class strength

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,     26960.,   .569,       .000,    .00,   1,  .450,     .070

  P shrinkage mean  ,     11393.,    .56,,,,                        .510,     .159

  F shrinkage mean  ,     21446.,   2.00,,,,                        .040,     .088

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    17216.,       .39,      .44,    3,   1.110,   .108


Age  3   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
SUMMER SURVEY       ,     22020.,   .298,       .070,    .23,   2,  .971,     .272

  F shrinkage mean  ,     23922.,   2.00,,,,                        .029,     .253

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    22073.,       .29,      .05,    3,    .169,   .271


1
Age  4   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
SUMMER SURVEY       ,      4403.,   .211,       .035,    .17,   3,  .979,     .544

  F shrinkage mean  ,      7211.,   2.00,,,,                        .021,     .366

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4450.,       .21,      .05,    4,    .240,   .540


Age  5   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       ,      1028.,   .204,       .201,    .99,   4,  .962,     .930

  F shrinkage mean  ,      2662.,   2.00,,,,                        .038,     .466

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1067.,       .21,      .19,    5,    .923,   .908
```

Table 2.2.6.1.2 (Cont'd)

```
Age  6   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       ,       433.,   .191,       .157,    .82,   5,  .972,     .706

   F shrinkage mean  ,       461.,   2.00,,,,                        .028,     .675

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       434.,       .19,      .14,    6,    .713,   .705


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

 Year class = 1995

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,        86.,   .183,       .130,    .71,   6,  .922,    1.927

   F shrinkage mean  ,       365.,   2.00,,,,                        .078,     .867

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        96.,       .23,      .20,    7,    .875,  1.831


1
 Age  8   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       ,        91.,   .185,       .088,    .48,   7,  .941,    1.663

   F shrinkage mean  ,       291.,   2.00,,,,                        .059,     .850

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        98.,       .21,      .13,    8,    .631,  1.608


 Age  9   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       ,       192.,   .200,       .046,    .23,   6,  .946,     .888

   F shrinkage mean  ,       130.,   2.00,,,,                        .054,    1.132

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       188.,       .22,      .05,    7,    .251,   .900
```

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

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND_su
At 2/05/2003 17:09
Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1961	1962
AGE		
2	.3346	.2701
3	.5141	.4982
4	.4986	.4838
5	.5737	.7076
6	.4863	.5569
7	.9566	.3662
8	.8116	.6826
9	.6715	.5641
0 FBAR 3- 7	.6059	.5226

Table 8 Fishing mortality (F) at age

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
2	.2534	.1086	.1209	.0829	.0789	.1010	.1099	.0530	.0309	.0464
3	.4138	.2997	.2518	.1969	.2389	.2318	.3063	.2081	.1337	.1476
4	.5172	.4523	.4498	.2552	.2687	.3949	.3806	.3654	.2225	.2070
5	.5124	.5229	.5622	.4499	.3442	.5339	.4180	.3409	.3845	.2497
6	.5405	.5659	.6604	.5016	.5779	.4472	.5709	.3709	.5572	.6058
7	.4879	.6677	.5305	.9680	.5203	.7132	.5118	.6559	.4651	.4686
8	.3269	.3531	.4345	.8520	1.0438	.3331	.8457	.4208	.7528	.2464
9	.4806	.5164	.5318	.6106	.5556	.4882	.5499	.4339	.4800	.3578
0 FBAR 3- 7	.4944	.5017	.4909	.4743	.3900	.4642	.4375	.3882	.3526	.3358

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

At 2/05/2003 17:09

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
2	.0657	.0816	.0774	.0933	.0481	.0588	.0433	.0544	.0523	.0585
3	.2322	.1568	.3193	.1723	.3036	.1896	.2622	.2391	.2877	.2226
4	.3048	.2046	.4359	.3665	.4748	.4291	.4308	.3695	.3408	.3601
5	.2813	.2953	.4134	.5568	.7532	.4289	.5049	.4337	.4368	.3886
6	.2526	.3797	.4544	.5167	.7333	.4850	.4906	.5181	.5643	.4046
7	.3722	.5330	.3504	.7619	1.1138	.5968	.4480	.4119	.6939	.6925
8	.3259	.3052	.4485	.6429	.7776	.5674	.6902	.6437	.5014	.5525
9	.3091	.3457	.4235	.5738	.7783	.5054	.5170	.4790	.5115	.4833
0 FBAR 3- 7	.2886	.3139	.3947	.4748	.6757	.4259	.4273	.3945	.4647	.4137

Table 8 Fishing mortality (F) at age

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
2	.0990	.1071	.0655	.0244	.0279	.0644	.1630	.0757	.0323	.0199
3	.4669	.3707	.3537	.3523	.2173	.3365	.4206	.3222	.1963	.0999
4	.5582	.5783	.5065	.6206	.4710	.5506	.7004	.5793	.4320	.3198
5	.6408	.6604	.6121	.7004	.4825	.5406	.7275	.6592	.5152	.3276
6	.7833	.4529	.9220	.8218	.5517	.7658	.9302	.6366	.5198	.4906
7	1.0774	.4758	1.1059	.8367	.4853	.7871	1.0312	.7706	.4815	.4506
8	.9412	.4787	1.3183	.5384	.6172	.8492	1.0606	1.0308	.5954	.3312
9	.8084	.5335	.9026	.7103	.5257	.7053	.8996	.7425	.5128	.3865
0 FBAR 3- 7	.7053	.5076	.7000	.6664	.4416	.5961	.7620	.5936	.4289	.3377

Table 8 Fishing mortality (F) at age

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-**
AGE											
2	.0131	.0253	.0683	.0300	.0346	.0806	.1017	.1207	.0993	.1081	.1094
3	.1012	.1113	.1605	.1869	.1458	.1744	.2788	.3361	.3225	.2714	.3100
4	.1863	.1890	.4566	.4474	.3948	.2662	.3167	.3614	.4786	.5399	.4600
5	.2476	.2493	.2772	.7826	.8164	.6031	.3394	.2722	.2800	.9083	.4868
6	.1875	.2147	.3600	.8878	.9618	.9993	.6464	.3492	.3869	.7050	.4804
7	.2923	.1448	.3231	1.1341	1.3139	.6497	1.0613	.5038	.7605	1.8314	1.0319
8	.1909	.1844	.2097	.8682	1.3263	.9510	.6104	.7705	.5478	1.6078	.9754
9	.2220	.1973	.3273	.8326	.8816	.8135	.3745	.1352	.6644	.8997	.5664
0 FBAR 3- 7	.2030	.1818	.3155	.6878	.7265	.5385	.5285	.3646	.4457	.8512	

1

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

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND_su
At 2/05/2003 17:09
Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,
AGE		
2,	12019,	20654,
3,	7385,	7042,
4,	3747,	3616,
5,	2699,	1863,
6,	666,	1245,
7,	668,	335,
8,	155,	210,
9,	66,	56,
0 TOTAL,	27403,	35021,

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

YEAR,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,
AGE										
2,	20290,	21834,	8269,	18566,	23451,	17582,	9325,	8608,	11928,	21320,
3,	12907,	12893,	16037,	5999,	13990,	17744,	13012,	6840,	6684,	9469,
4,	3503,	6986,	7823,	10207,	4034,	9020,	11522,	7843,	4548,	4788,
5,	1825,	1710,	3639,	4085,	6475,	2525,	4976,	6447,	4456,	2981,
6,	752,	895,	830,	1698,	2133,	3757,	1212,	2682,	3754,	2483,
7,	584,	358,	416,	351,	842,	980,	1967,	561,	1516,	1760,
8,	190,	294,	151,	200,	109,	410,	393,	965,	238,	779,
9,	87,	112,	169,	80,	70,	31,	240,	138,	519,	92,
0 TOTAL,	40138,	45083,	37333,	41186,	51104,	52050,	42647,	34085,	33643,	43673,

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

At 2/05/2003 17:09

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE										
2,	12573,	30480,	38320,	18575,	9995,	10749,	14999,	23587,	14004,	22140,
3,	16664,	9640,	23000,	29036,	13853,	7799,	8298,	11760,	18290,	10881,
4,	6689,	10817,	6747,	13683,	20010,	8373,	5282,	5227,	7580,	11231,
5,	3187,	4037,	7217,	3572,	7765,	10190,	4463,	2811,	2957,	4414,
6,	1901,	1969,	2460,	3908,	1676,	2994,	5433,	2206,	1492,	1564,
7,	1109,	1209,	1103,	1279,	1909,	659,	1509,	2724,	1076,	695,
8,	902,	626,	581,	636,	489,	513,	297,	789,	1477,	440,
9,	499,	533,	378,	304,	274,	184,	238,	122,	340,	732,
0 TOTAL,	43524,	59312,	79806,	70993,	55971,	41459,	40519,	49225,	47215,	52097,

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
2,	25186,	47832,	17404,	9645,	10308,	9019,	16433,	3684,	6675,	11477,
3,	17096,	18676,	35184,	13346,	7706,	8207,	6924,	11430,	2796,	5292,
4,	7130,	8775,	10555,	20225,	7682,	5077,	4799,	3722,	6780,	1881,
5,	6415,	3340,	4029,	5208,	8902,	3927,	2397,	1951,	1707,	3604,
6,	2450,	2767,	1413,	1789,	2116,	4499,	1873,	948,	826,	835,
7,	855,	917,	1440,	460,	644,	998,	1712,	605,	411,	402,
8,	285,	238,	466,	390,	163,	324,	372,	500,	229,	208,
9,	207,	91,	121,	102,	187,	72,	114,	105,	146,	103,
0 TOTAL,	59623,	82637,	70613,	51165,	37709,	32124,	34623,	22945,	19571,	23802,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	GMST 61-**	AMST 61-**
AGE													
2,	10228,	25362,	43777,	13106,	6504,	6494,	14721,	21674,	47706,	23427,	0,	14879,	17220,
3,	9211,	8265,	20246,	33476,	10412,	5144,	4905,	10887,	15728,	35365,	17216,	10986,	12711,
4,	3921,	6815,	6054,	14119,	22735,	7368,	3538,	3039,	6369,	9327,	22073,	6834,	7937,
5,	1119,	2664,	4619,	3140,	7390,	12542,	4623,	2110,	1733,	3231,	4450,	3778,	4350,
6,	2126,	715,	1700,	2866,	1175,	2674,	5618,	2696,	1316,	1073,	1067,	1866,	2170,
7,	419,	1443,	472,	971,	966,	368,	806,	2410,	1556,	732,	434,	847,	998,
8,	210,	256,	1022,	280,	256,	213,	157,	228,	1192,	596,	96,	342,	416,
9,	122,	142,	174,	679,	96,	56,	67,	70,	87,	564,	98,	147,	198,
0 TOTAL,	27355,	45663,	78066,	68635,	49534,	34860,	34436,	43114,	75688,	74315,	45433,		

Table 2.2.6.1.5. Faroe Plateau (Subdivision Vb1) COD. Summary table.

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

At 2/05/2003 17:09

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,	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,	14004,	86921,	62067,	22963,	.3700,	.4647,
1982,	22140,	96656,	64711,	21489,	.3321,	.4137,
1983,	25186,	121715,	76964,	38133,	.4955,	.7053,
1984,	47832,	150401,	94941,	36979,	.3895,	.5076,
1985,	17404,	129879,	83303,	39484,	.4740,	.7000,
1986,	9645,	98966,	73173,	34595,	.4728,	.6664,
1987,	10308,	78583,	61964,	21391,	.3452,	.4416,
1988,	9019,	67099,	52574,	23182,	.4409,	.5961,
1989,	16433,	60600,	39536,	22068,	.5582,	.7620,
1990,	3684,	39571,	30376,	13487,	.4440,	.5936,
1991,	6675,	30186,	22500,	8750,	.3889,	.4289,
1992,	11477,	37071,	22023,	6396,	.2904,	.3377,
1993,	10228,	52724,	34545,	6107,	.1768,	.2030,
1994,	25362,	86563,	44775,	9046,	.2020,	.1818,
1995,	43777,	146947,	55225,	23045,	.4173,	.3155,
1996,	13106,	145023,	86464,	40422,	.4675,	.6878,
1997,	6504,	97773,	82212,	34304,	.4173,	.7265,
1998,	6494,	68670,	57673,	24005,	.4162,	.5385,
1999,	14721,	68776,	47940,	19906,	.4152,	.5285,
2000,	21674,	96651,	48411,	22433,	.4634,	.3646,
2001,	47706,	135144,	63060,	29409,	.4664,	.4457,
2002,	23427,	137877,	68587,	40159,	.5855,	.8512,
Arith. Mean ,	18094,	95493,	65198,	24965,	.3860,	.4837,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 2.2.6.1.6 Faroe Plateau (Subdivision Vb1) COD. Input to the RCT3 program.

```
FAROE PLATEAU COD: SURVEYS, 0-GROUP, AND P.PROD
5 39 2
'Yrclass'   'VPA'     'Ogrpsurv'     'SS1y'   'SS2y'    'SP2y'  'P.PROD'
1964       18566       -11          -11         -11      -11      -11
1965       23451       -11          -11         -11      -11      -11
1966       17582       -11          -11         -11      -11      -11
1967        9325       -11          -11         -11      -11      -11
1968        8608       -11          -11         -11      -11      -11
1969       11928       -11          -11         -11      -11      -11
1970       21320       -11          -11         -11      -11      -11
1971       12573       -11          -11         -11      -11      -11
1972       30480       -11          -11         -11      -11      -11
1973       38320       -11          -11         -11      -11      -11
1974       18575       -11          -11         -11      -11      -11
1975        9995       -11          -11         -11      -11      -11
1976       10749       -11          -11         -11      -11      -11
1977       14999       -11          -11         -11      -11      -11
1978       23587       -11          -11         -11      -11      -11
1979       14004       -11          -11         -11      -11      -11
1980       22140       -11          -11         -11      -11      -11
1981       25186       -11          -11         -11      -11      -11
1982       47832       -11          -11         -11      -11      -11
1983       17404       -11          -11         -11      -11      -11
1984        9645       -11          -11         -11      -11      -11
1985       10308       -11          -11         -11      -11      -11
1986        9019       -11          -11         -11      -11      -11
1987       16433       -11          -11         -11      -11      -11
1988        3684       -11          -11         -11      -11      -11
1989        6675        78          -11         -11      -11      289
1990       11477       523          -11         -11      -11      553
1991       10228        17          -11         -11      -11      708
1992       25362       120          -11         -11      524     1008
1993       43777      1193          -11         -11      797     1182
1994       13106       664          -11         830      268     1229
1995        6504        59           38         566       98      674
1996        6494       380           70         518       52      765
1997       14721      1196          -11         372      654      845
1998       21674      8676          111        1344      265     1079
1999       47706      6202          440        3375     1371     1624
2000         -11      2661          205        2289      346     1578
2001         -11      2760          697         -11      123      355
2002         -11      1502          -11         -11      -11      -11
```

Table 2.2.6.1.7

Analysis by RCT3 ver3.1 of data from file :

COD8RCT3.TXT

FAROE PLATEAU COD: SURVEYS, 0-GROUP, AND P.PROD

Data for 5 surveys over 39 years : 1964 - 2002

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.

Year class = 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			
Ogrpsu	.59	5.98	.93	.410	11	7.89	10.62	1.133	.067
SS1y	1.01	4.85	.44	.883	4	5.33	10.23	.732	.162
SS2y	1.13	1.93	.56	.702	6	7.74	10.67	.829	.126
SP2y	.77	5.31	.39	.818	8	5.85	9.81	.487	.366
P.PROD	2.18	-5.10	.66	.581	11	7.36	10.94	.842	.122
					VPA Mean =		9.54	.743	.157

Year class = 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			
Ogrpsu	.59	5.97	.93	.413	11	7.92	10.63	1.144	.090
SS1y	1.01	4.85	.44	.883	4	6.55	11.46	.964	.127
SS2y									
SP2y	.77	5.32	.40	.817	8	4.82	9.02	.518	.440
P.PROD	2.22	-5.42	.66	.585	11	5.87	7.64	.941	.133
					VPA Mean =		9.55	.751	.210

Year class = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Ogrpsu	.59	5.95	.93	.419	11	7.32	10.24	1.131	.310
SS1y									
SS2y									
SP2y									
P.PROD									
					VPA Mean =		9.58	.759	.690

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
2000	25284	10.14	.29	.21	.52		
2001	12126	9.40	.34	.54	2.45		
2002	17740	9.78	.63	.31	.24		

Table 2.2.7.1.1 Faroe Plateau (Subdivision Vb1) COD. Input to management option table.

Recruitment

	XSA	RCT3	Geomean 61-01
YC2000	23427	25284	
YC2001		12126	
YC2002		17740	
YC2003			15307

Stock size

2003	
12126	
18580	=25284*exp(-0.2-0.1081)
22073	
4450	
1067	
434	
96	
98	

Maturity

Age	Observed 2003	Av.01-03 2004	Av.01-03 2005
2	0	0.04	0.04
3	0.29	0.38	0.38
4	0.79	0.8	0.8
5	0.88	0.93	0.93
6	0.98	0.97	0.97
7	1	0.99	0.99
8	1	1	1
9	1	1	1
10	1	1	1

Exploitation pattern (not rescaled)
F for ages 7 and 8 removed in 1997 and 2002.

Av00-02 2003	Av97-02 2004	Av97-02 2005
0.1094	0.1094	0.1094
0.3100	0.3100	0.3100
0.4600	0.4600	0.4600
0.4868	0.4868	0.4868
0.4804	0.4804	0.4804
0.6322	0.6322	0.6322
0.6592	0.6592	0.6592
0.5664	0.5664	0.5664
0.5538	0.5538	0.5538

Weights

Est.from sp. survey 2003	As2002 2004	As2002 2005
1.0175	1.0170	1.0170
1.4870	1.7680	1.7680
2.1845	2.8050	2.8050
3.1063	3.5290	3.5290
3.5630	4.0950	4.0950
5.4120	4.4750	4.4750
5.9629	4.6500	4.6500
6.3712	6.2440	6.2440
7.4568	7.4568	7.4568

Table 2.2.7.1.2 Faroe Plateau (Subdivision Vb1) COD. Management option table.

MFDP version 1
Run: Run3
Index file 4/5-2002
Time and date: 17:00 08/05/03
Fbar age range: 3-7

2003				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
109356	65540	1.0000	0.4739	31807

2004					2005	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
118053	81601	0.0000	0.0000	0	143397	104958
.	81601	0.1000	0.0474	4213	138655	100673
.	81601	0.2000	0.0948	8246	134116	96579
.	81601	0.3000	0.1422	12109	129771	92666
.	81601	0.4000	0.1895	15808	125611	88927
.	81601	0.5000	0.2369	19350	121629	85353
.	81601	0.6000	0.2843	22744	117815	81936
.	81601	0.7000	0.3317	25995	114162	78670
.	81601	0.8000	0.3791	29110	110664	75547
.	81601	0.9000	0.4265	32095	107312	72562
.	81601	1.0000	0.4739	34956	104102	69707
.	81601	1.1000	0.5213	37699	101025	66977
.	81601	1.2000	0.5686	40328	98076	64366
.	81601	1.3000	0.6160	42849	95250	61869
.	81601	1.4000	0.6634	45267	92541	59480
.	81601	1.5000	0.7108	47586	89944	57195
.	81601	1.6000	0.7582	49810	87454	55009
.	81601	1.7000	0.8056	51944	85065	52918
.	81601	1.8000	0.8530	53992	82775	50916
.	81601	1.9000	0.9004	55957	80577	49001
.	81601	2.0000	0.9477	57844	78468	47168

Input units are thousands and kg - output in tonnes

Table 2.2.7.4.1 Faroe Plateau (Subdivision Vb1) COD. Input to yield-per-recruit calculations (long-term prediction).

Input to Yield per recruit

	Exploitation pattern Average 1961-2002 Not rescaled	Weightatage Average 1961-2002	PropMature Average 1983-2003
Age 2	0.0854	1.023	0.03
Age 3	0.2631	1.735	0.56
Age 4	0.4087	2.613	0.85
Age 5	0.4937	3.5	0.95
Age 6	0.567	4.357	0.99
Age 7	0.6858	5.401	0.99
Age 8	0.6568	6.484	1
Age 9	0.5534	7.895	1

Table 2.2.7.4.2 Faroe Plateau (Subdivision Vb1) COD. Output from yield-per-recruit calculations (long-term prediction).

MFYPR version 1
Run: YLD1
Time and date: 18:32 06/05/03
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	4.4029	13.9604	2.9365	11.9448	2.9365	11.9448
0.1000	0.0484	0.1331	0.5233	4.0854	12.2277	2.6287	10.2390	2.6287	10.2390
0.2000	0.0967	0.2343	0.8779	3.8210	10.8280	2.3734	8.8646	2.3734	8.8646
0.3000	0.1451	0.3122	1.1164	3.5987	9.6884	2.1599	7.7488	2.1599	7.7488
0.4000	0.1935	0.3732	1.2748	3.4103	8.7529	1.9799	6.8356	1.9799	6.8356
0.5000	0.2418	0.4216	1.3784	3.2490	7.9785	1.8267	6.0823	1.8267	6.0823
0.6000	0.2902	0.4608	1.4443	3.1099	7.3320	1.6953	5.4558	1.6953	5.4558
0.7000	0.3386	0.4929	1.4846	2.9889	6.7878	1.5817	4.9306	1.5817	4.9306
0.8000	0.3869	0.5198	1.5073	2.8828	6.3259	1.4828	4.4867	1.4828	4.4867
0.9000	0.4353	0.5425	1.5181	2.7891	5.9305	1.3959	4.1086	1.3959	4.1086
1.0000	0.4837	0.5621	1.5210	2.7056	5.5895	1.3192	3.7841	1.3192	3.7841
1.1000	0.5320	0.5791	1.5187	2.6309	5.2932	1.2509	3.5034	1.2509	3.5034
1.2000	0.5804	0.5941	1.5128	2.5636	5.0337	1.1898	3.2589	1.1898	3.2589
1.3000	0.6288	0.6075	1.5048	2.5026	4.8049	1.1348	3.0446	1.1348	3.0446
1.4000	0.6771	0.6196	1.4955	2.4470	4.6019	1.0850	2.8555	1.0850	2.8555
1.5000	0.7255	0.6305	1.4854	2.3961	4.4207	1.0398	2.6875	1.0398	2.6875
1.6000	0.7739	0.6405	1.4749	2.3493	4.2579	0.9985	2.5376	0.9985	2.5376
1.7000	0.8222	0.6496	1.4643	2.3060	4.1110	0.9606	2.4030	0.9606	2.4030
1.8000	0.8706	0.6581	1.4538	2.2659	3.9776	0.9257	2.2816	0.9257	2.2816
1.9000	0.9190	0.6660	1.4434	2.2286	3.8561	0.8934	2.1716	0.8934	2.1716
2.0000	0.9673	0.6733	1.4333	2.1938	3.7448	0.8635	2.0715	0.8635	2.0715

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.4837
FMax	0.9981	0.4827
F0.1	0.5579	0.2698
F35%SPR	0.8797	0.4255
Flow	2.3119	1.1182
Fmed	0.9914	0.4795
Fhigh	0.1221	0.059

Weights in kilograms

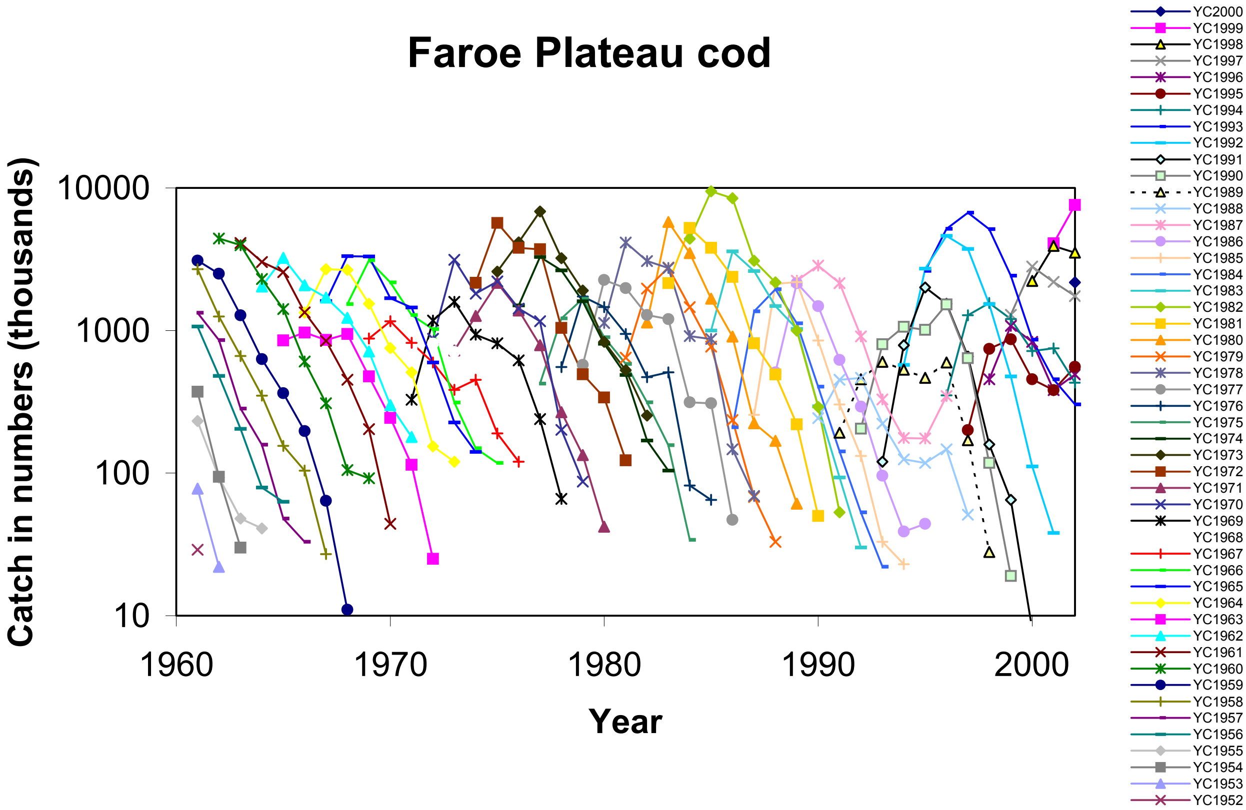


Figure 2.2.2.1 Faroe Plateau (Subdivision VB1) COD. Catch in numbers.

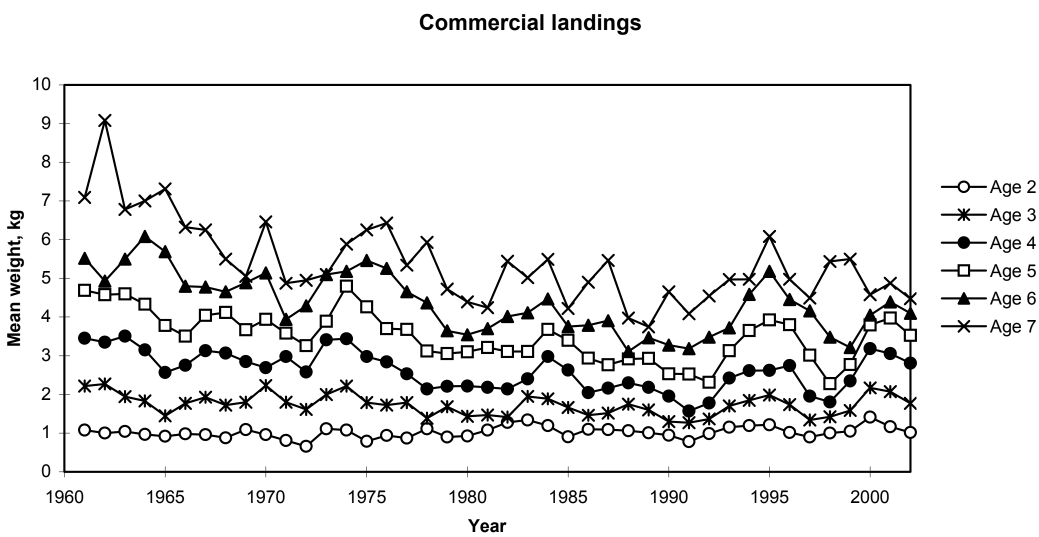


Figure 2.2.3.1 Faroe Plateau (Subdivision VB1) COD. Mean weight-at-age 1961-2002.

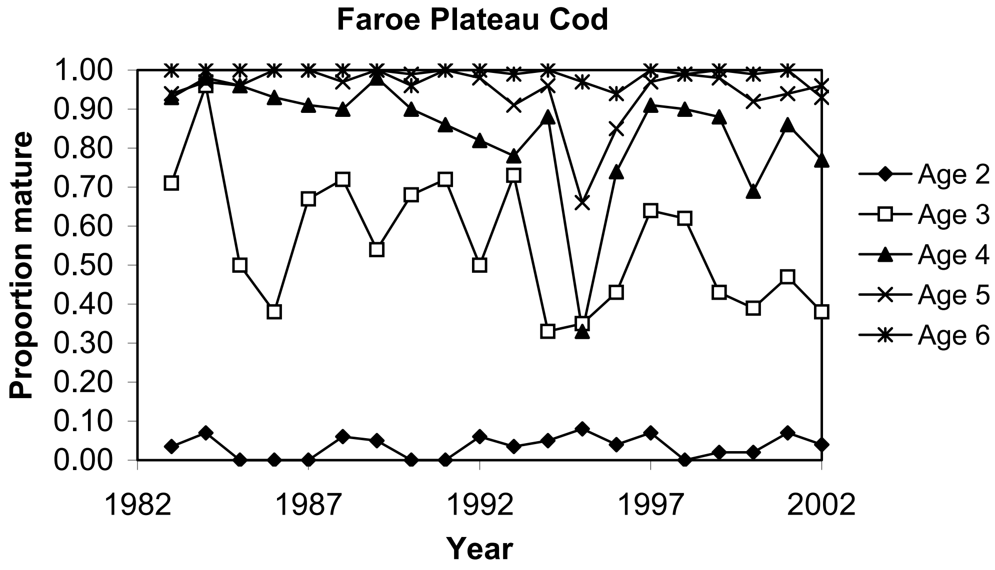


Figure 2.2.4.1 Faroe Plateau (Subdivision VB1) COD. Proportion mature-at-age as observed in the spring groundfish survey.

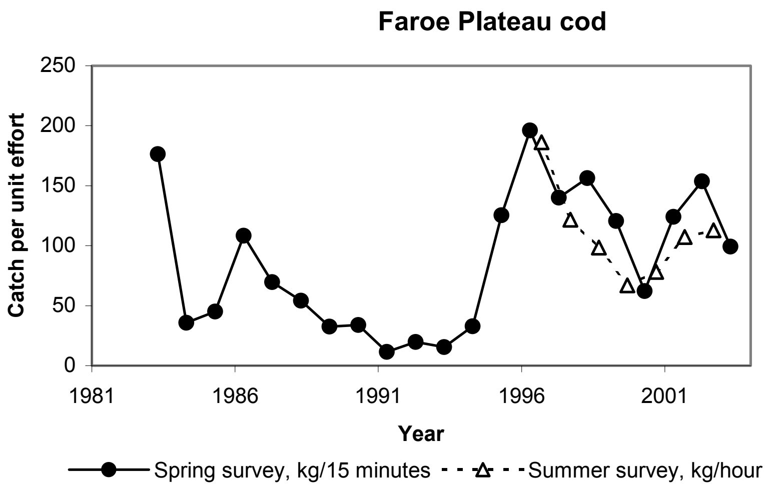


Figure 2.2.5.1 Faroe Plateau (Subdivision VB1) COD. Catch per unit effort in the spring, and summer groundfish survey.

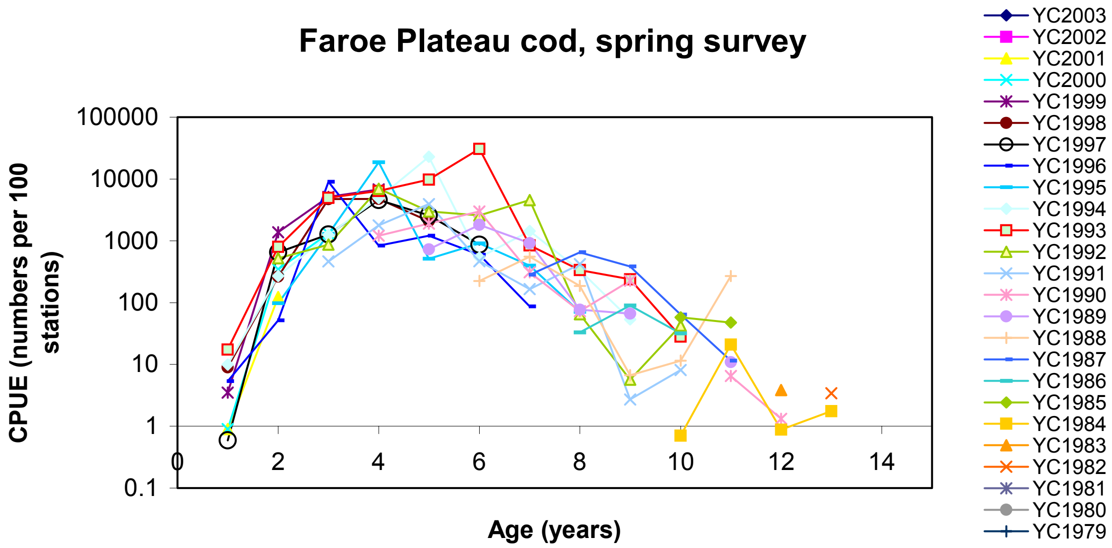


Figure 2.2.5.2 Faroe Plateau (Subdivision VB1) COD. Catch curves from the spring groundfish survey.

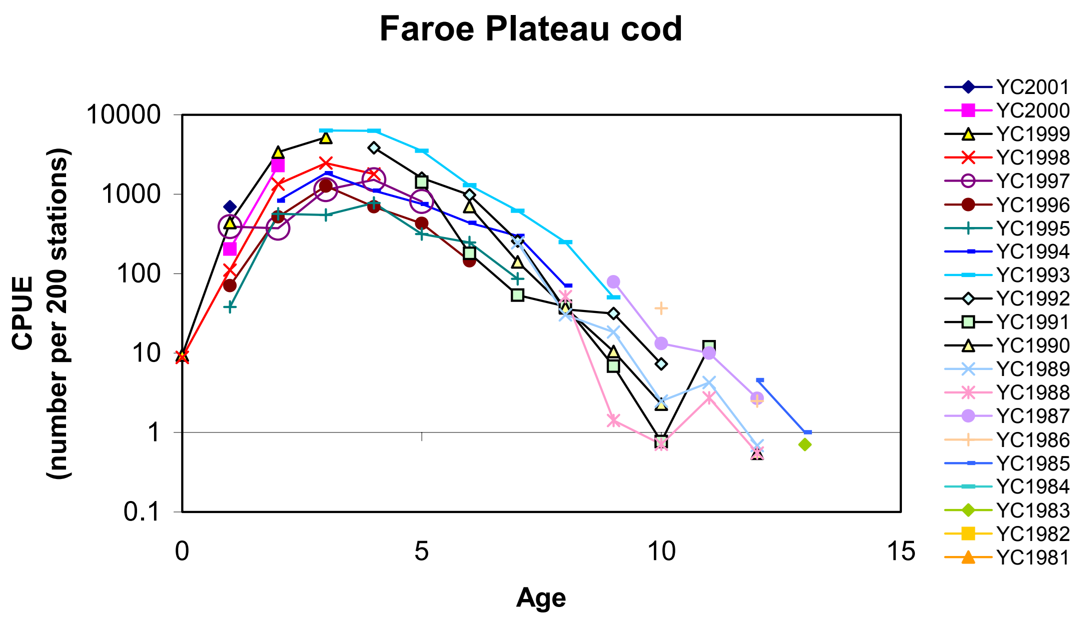


Figure 2.2.5.3 Faroe Plateau (Subdivision VB1) COD. Catch curves from the summer groundfish survey.

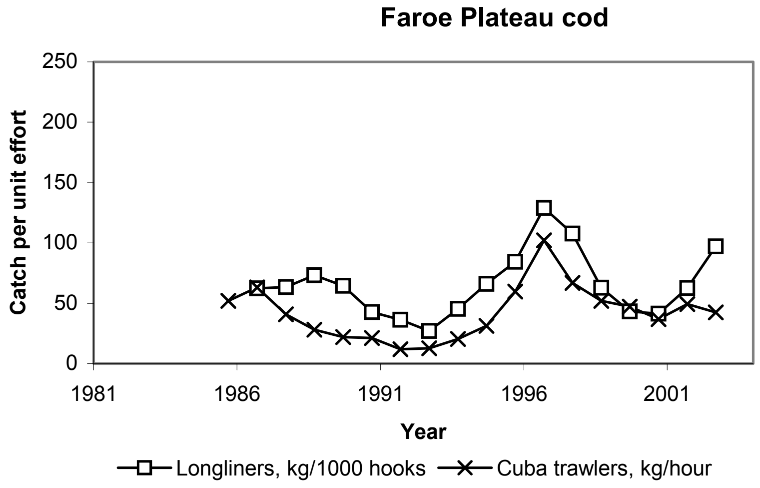


Figure 2.2.6.1.1 Faroe Plateau (Subdivision VB1) COD. Catch per unit effort for Cuba trawlers and longliners.

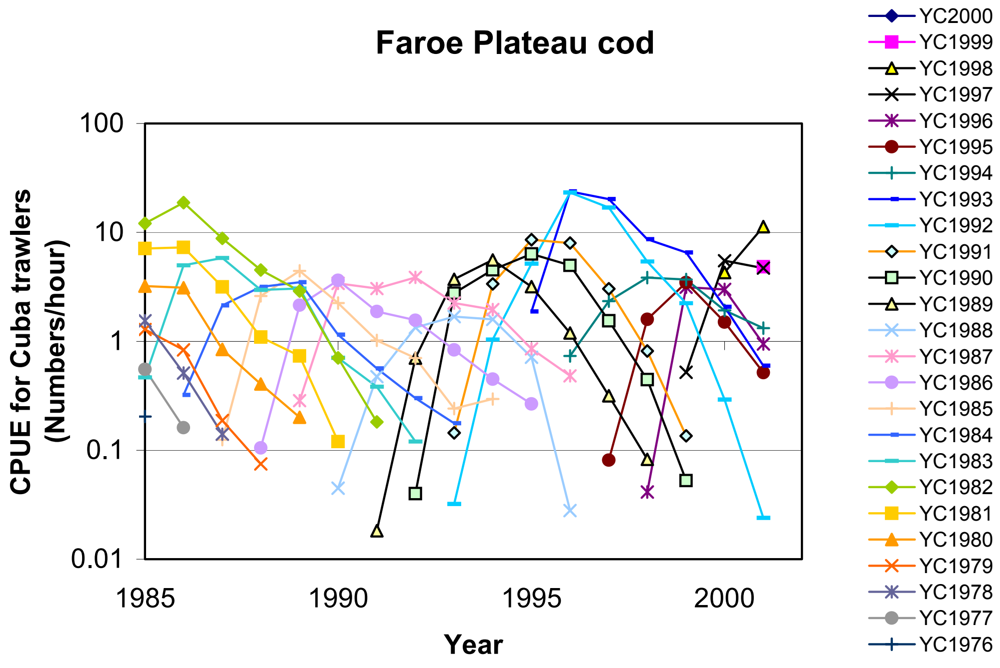


Figure 2.2.6.1.2 Faroe Plateau (Subdivision VB1) COD. Catch per unit effort for Cuba trawlers segregated to age classes.

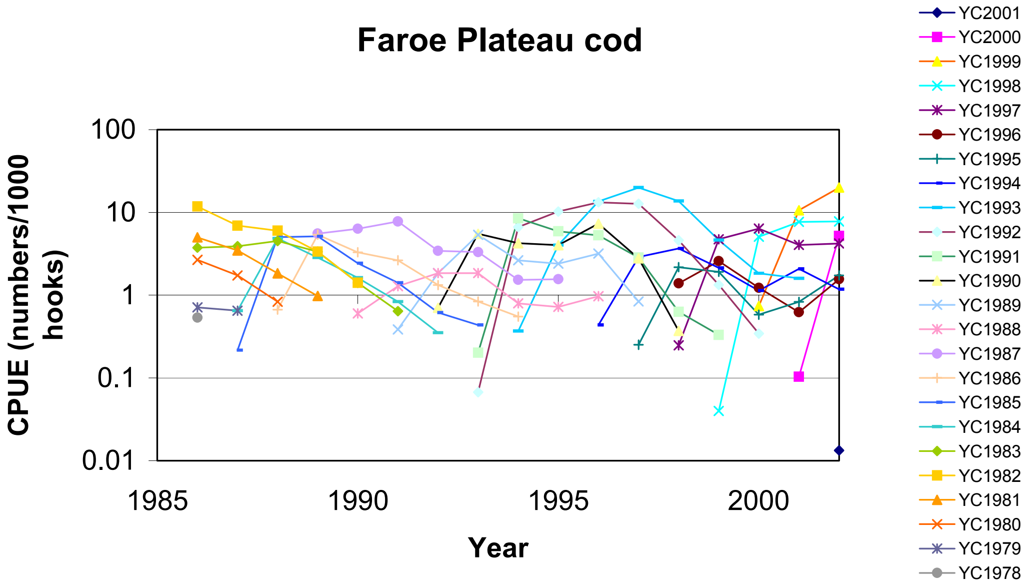
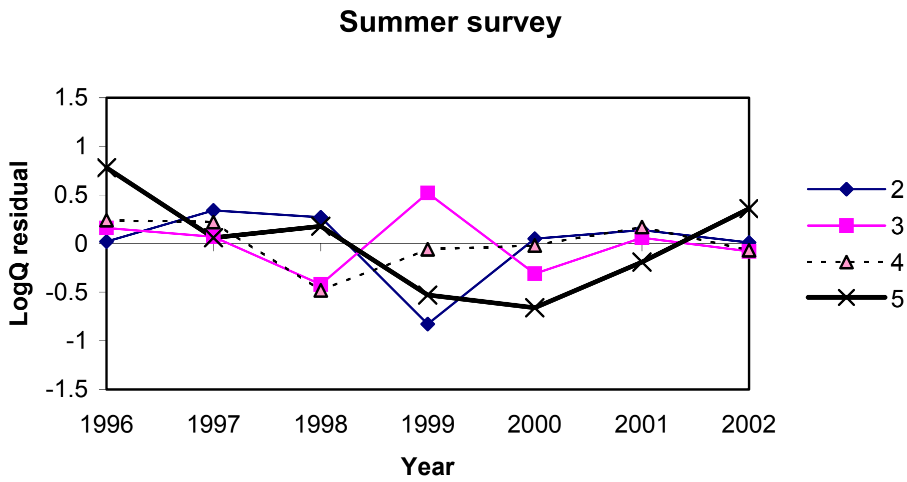


Figure 2.2.6.1.3 Faroe Plateau (Subdivision VB1) COD. Catch per unit effort for longliners segregated to age classes.



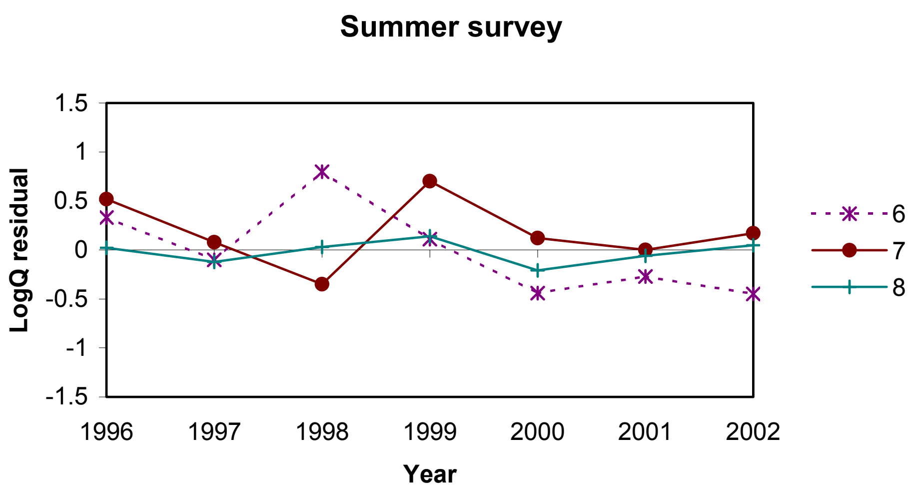
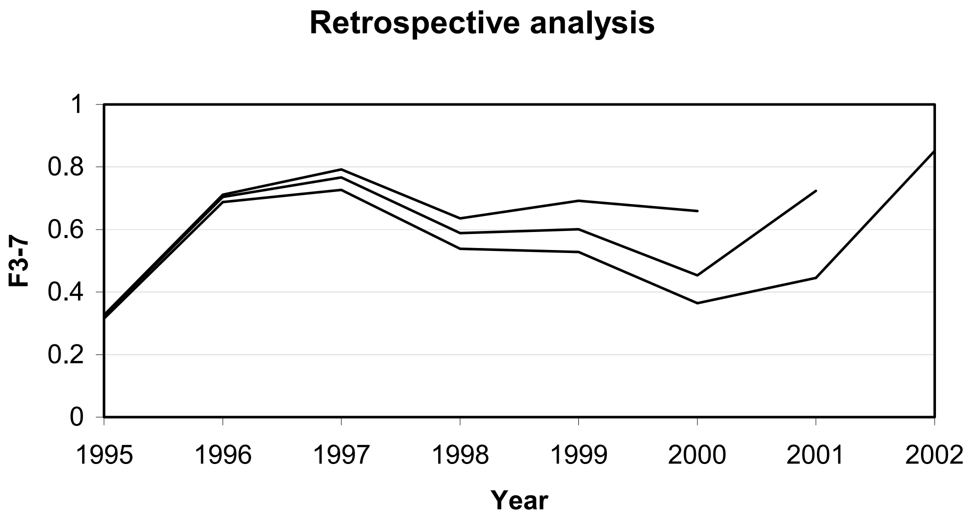


Figure 2.2.6.1.4 Faroe Plateau (Subdivision VB1) COD. Log-catchability residuals (summer survey).



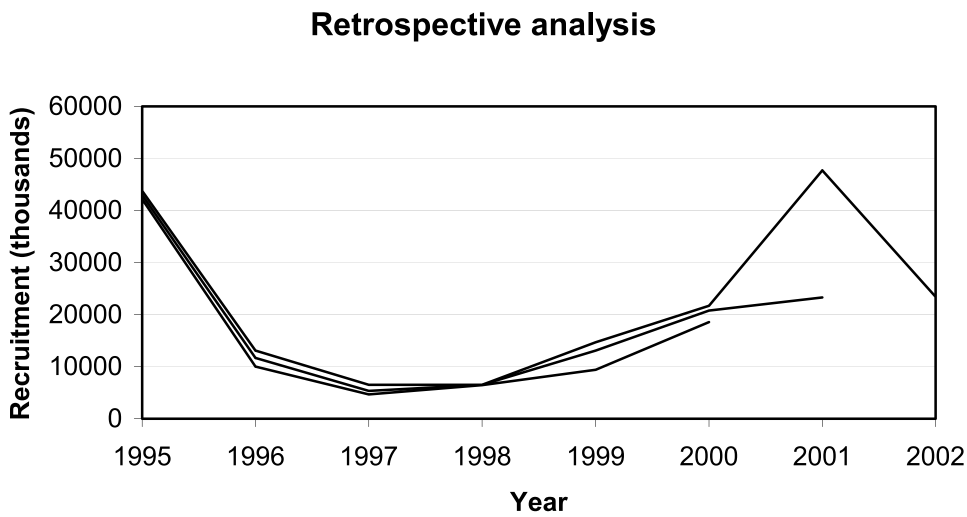
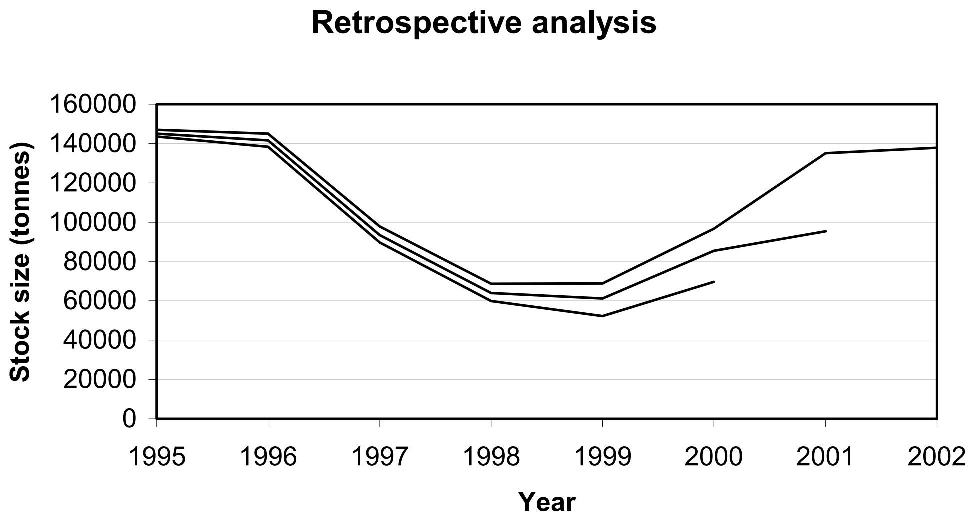


Figure 2.2.6.1.5 Faroe Plateau (Subdivision VB1) COD. Results from retrospective analysis.



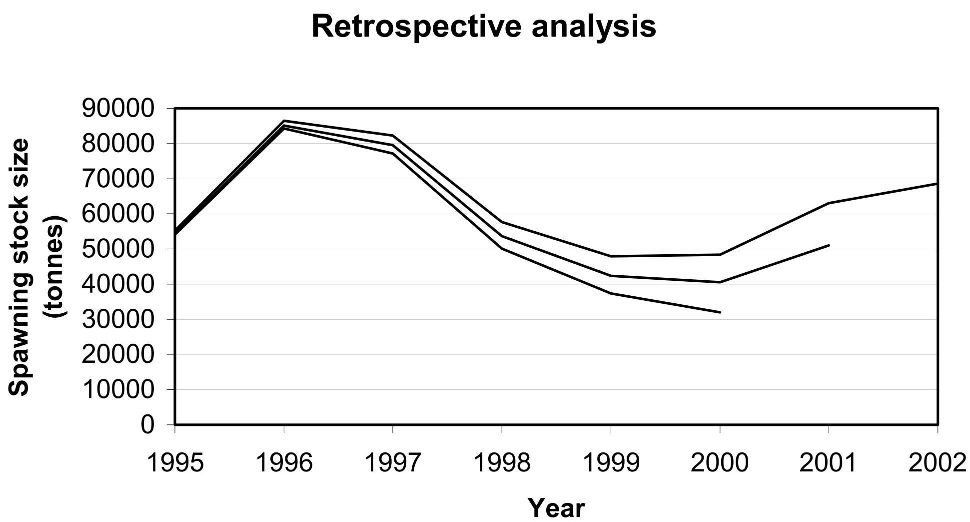


Figure 2.2.6.1.5 Faroe Plateau (Subdivision VB1) COD. Results from retrospective analysis. Continued.

Faroe Plateau cod

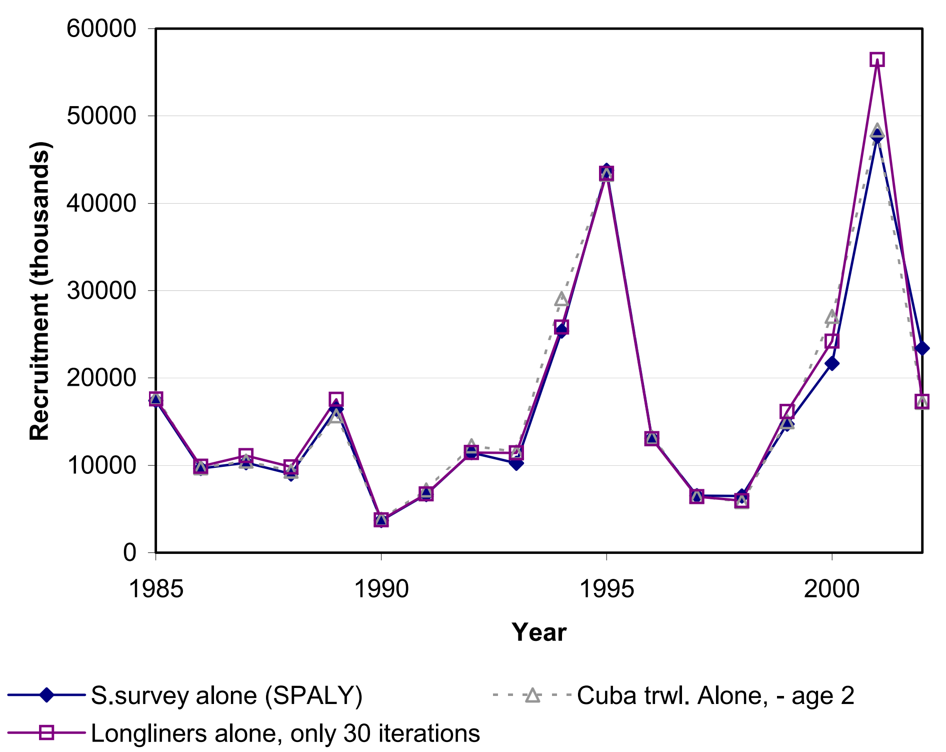


Figure 2.2.6.1.6 Faroe Plateau (Subdivision VB1) COD. Results from different XSA runs.

Faroe Plateau cod

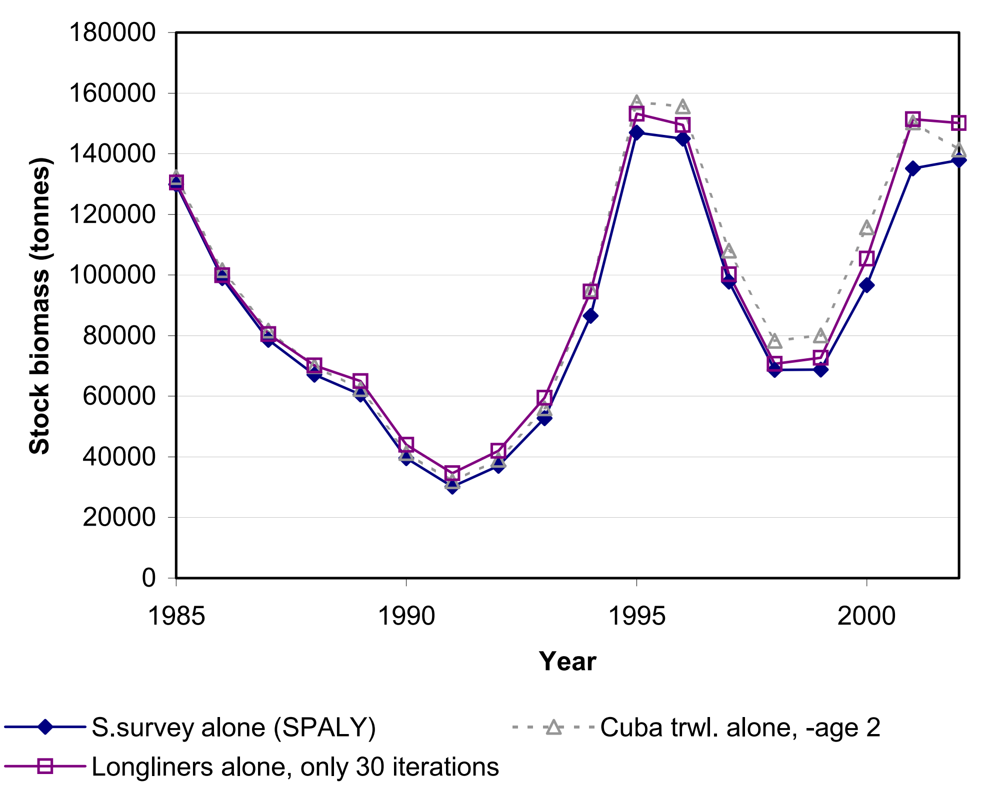


Figure 2.2.6.1.6 Faroe Plateau (Subdivision VB1) COD. Results from different XSA runs. Continued.

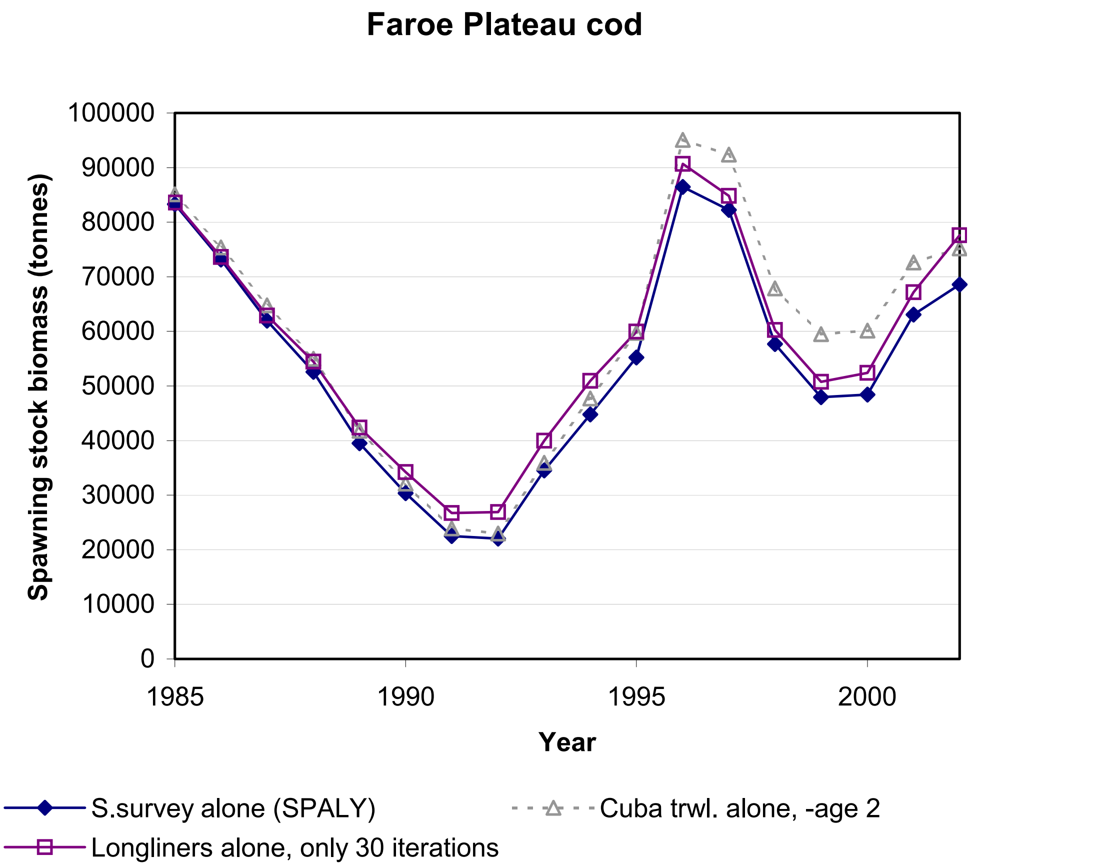


Figure 2.2.6.1.6 Faroe Plateau (Subdivision VB1) COD. Results from different XSA runs. Continued.

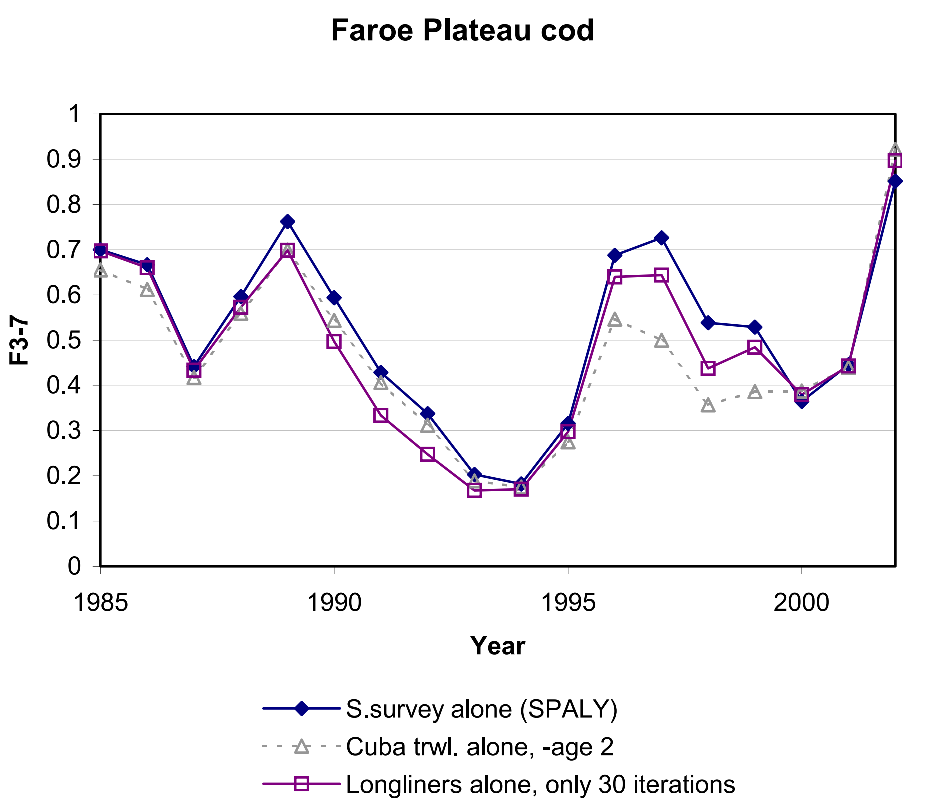
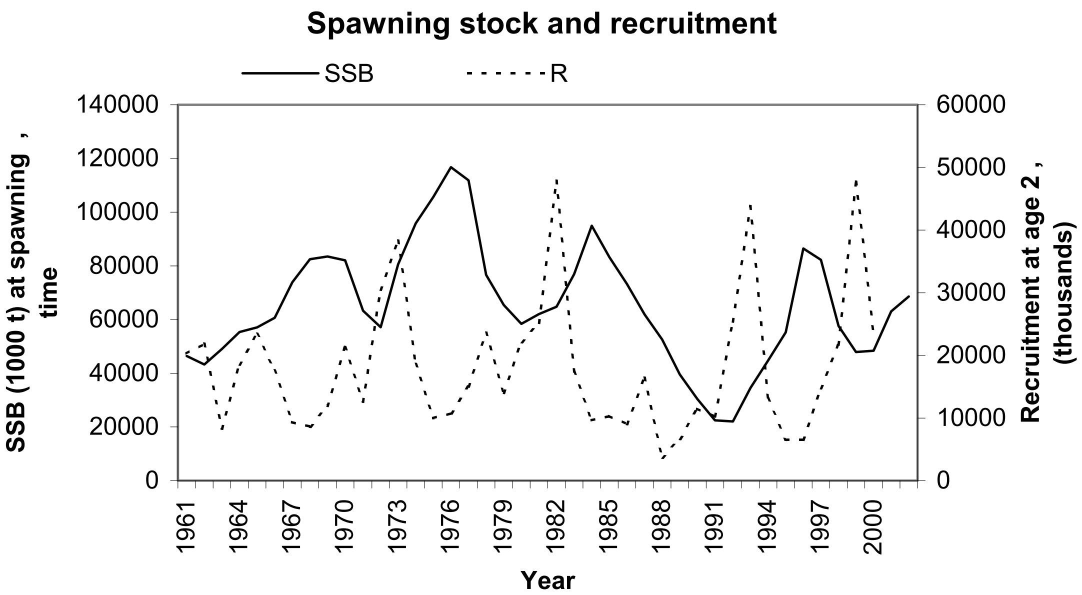


Figure 2.2.6.1.6. Faroe Plateau (Subdivision VB1) COD. Results from different XSA runs. Continued.



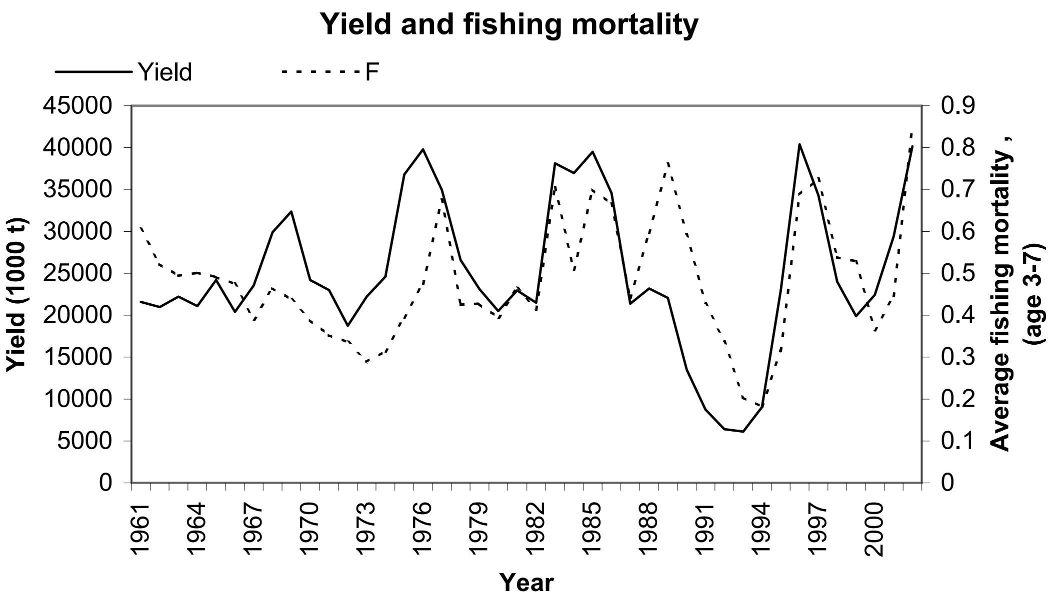


Figure 2.2.6.1.7 Faroe Plateau (Subdivision VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment versus year.

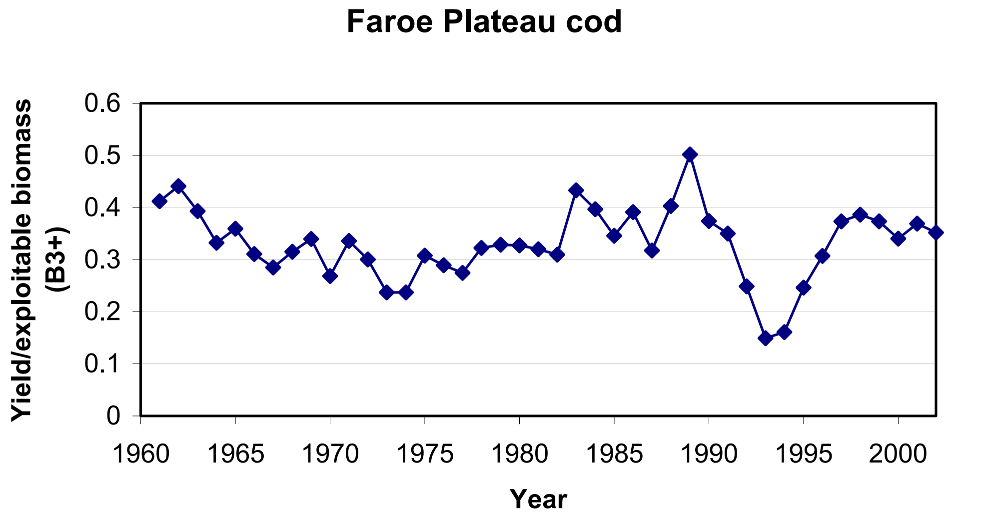


Figure 2.2.6.1.8 Faroe Plateau (Subdivision VB1) COD. Yield divided by exploitable biomass (ages 3 and older).

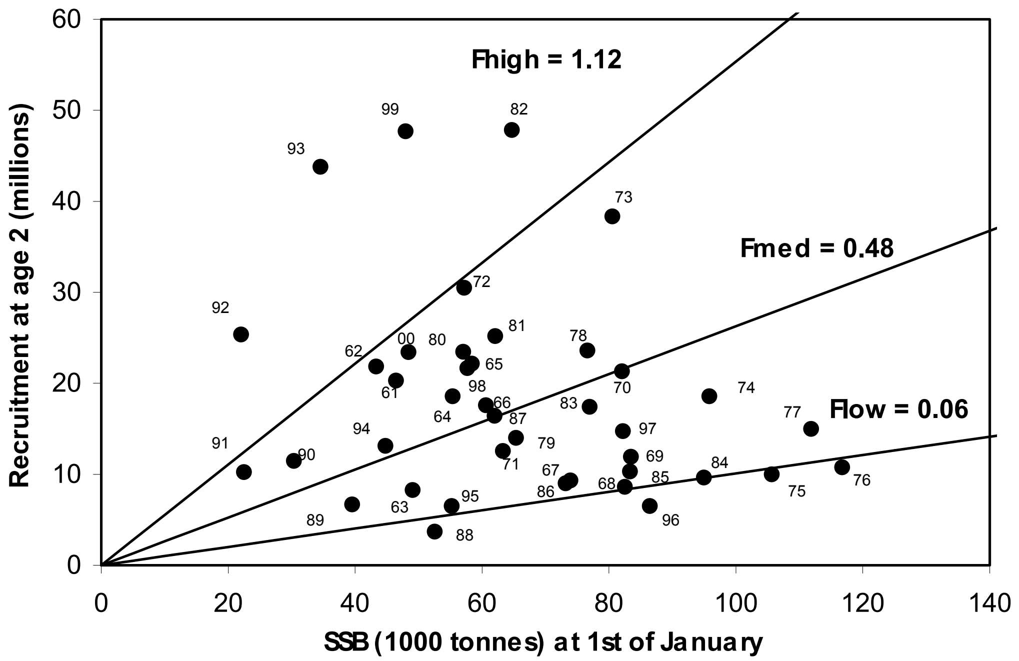


Figure 2.2.6.2.1 Faroe Plateau (Subdivision VB1) COD. Spawning stock – recruitment relationship 1961-2000. Years are shown at each data point.

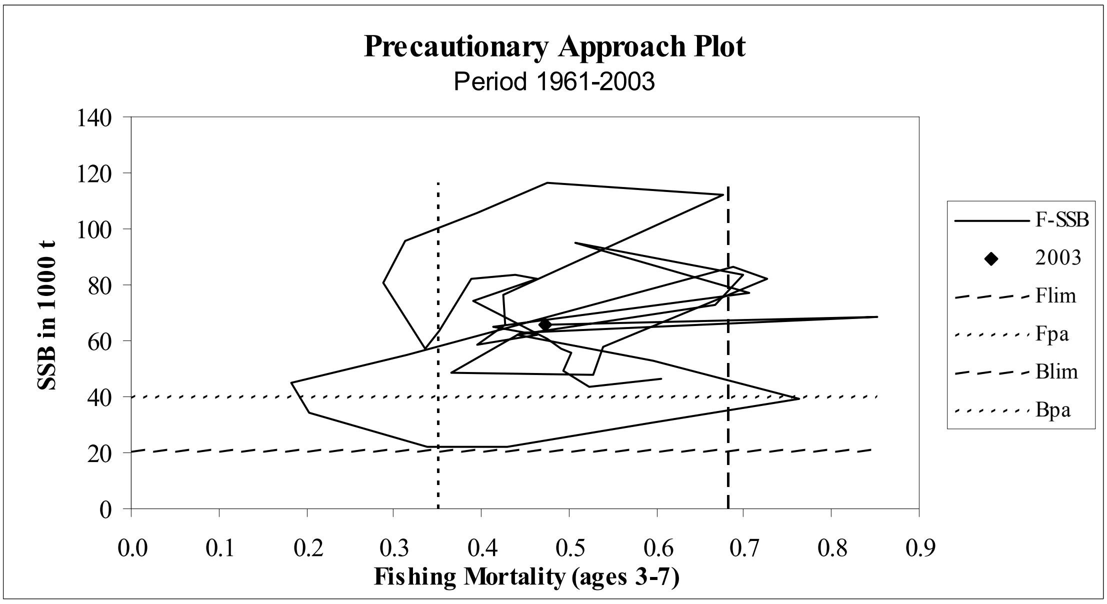
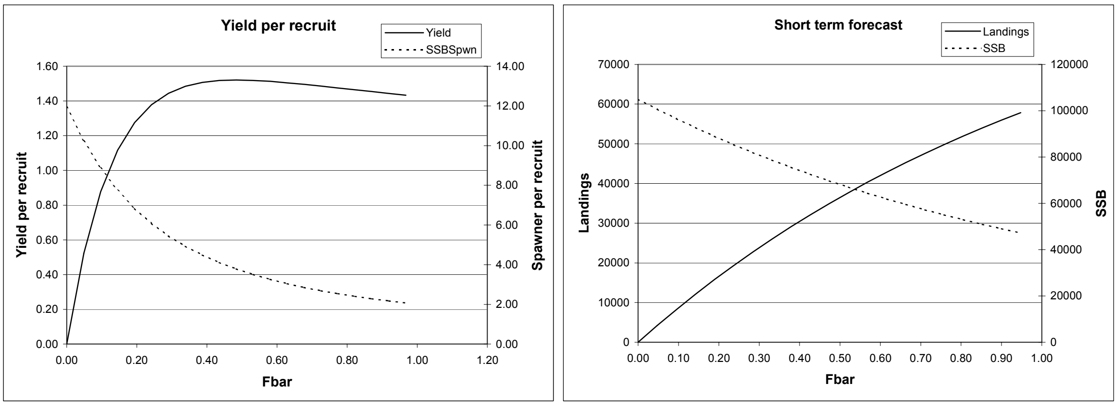


Figure 2.2.7.2.1 Faroe Plateau (Subdivision VB1) COD. Spawning stock biomass versus fishing mortality 1961-2001. Output from standard graph software.



MFYPR version 1
Run: YLD1
Time and date: 18:32 06/05/03

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.4837
FMax	0.9981	0.4827
F0.1	0.5579	0.2698
F35%SPR	0.8797	0.4255
Flow	2.3119	1.1182
Fmed	0.9914	0.4795
Fhigh	0.1221	0.0590

Weights in kilograms

MFDP version 1
Run: Run3
Index file 4/5-2002
Time and date: 17:00 08/05/03
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

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

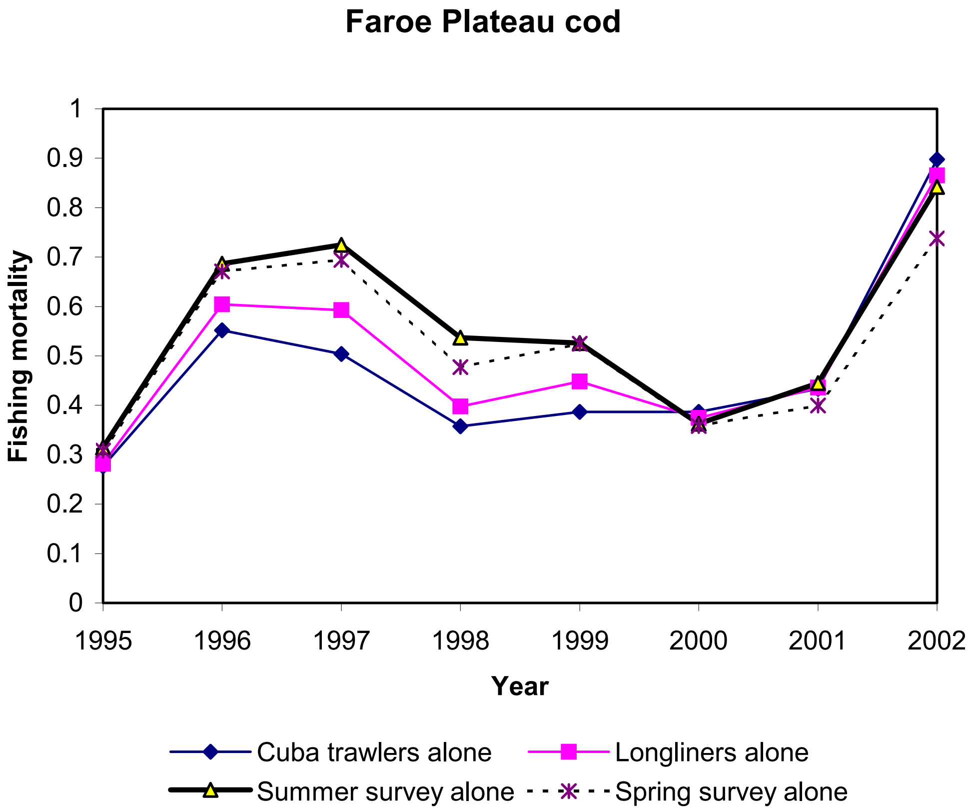


Figure 2.2.9.1 Faroe Plateau (Subdivision VB1) COD. Results from different XSA runs. Note the deviating fishing mortalities in the period 1996-1999.

2.3 Faroe Bank Cod

2.3.1 Trends in landings and effort

Total nominal landings of the Faroe Bank cod from 1986 to 2002 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 slightly exceeding 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 2002, 1 900 t 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 the 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-m contour.

2.3.2 Stock assessment

Biological samples have been taken from commercial landings since 1974 (the 2002 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 subsequent years 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 2002 is as follows :

Table 2.3.2.1. Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2002.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	<100 GRT	2	432	60	60
Longliners	>100 GRT	9	1,828	329	240
Jiggers		2	403	60	60
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	142	0	0
Pair trawlers	>1000 HP	4	809	60	60
Total		18	3,614	509	420

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 2003 value (717.5) is higher than the 2002 one (443.8). Although noisy, the survey suggests a higher, possibly increasing biomass since 1995.

The length distributions in the 1983-2003 surveys illustrated in Figure 2.3.2.2 show substantially higher numbers in 1996-2003 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, 2001 and in 2003 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 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, $B_1/\mathbf{B}_{MSY}$ 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 was used, reducing the time-series progressively. The parameter estimates from ASPIC were: MSY = 5 015 t, $\mathbf{B}_{MSY}$ = 20 960 t, $\mathbf{F}_{MSY}$ = 0.2393. The 2003 biomass is estimated to be at 1.25 $\mathbf{B}_{MSY}$. ASPIC assumes that fishing effort is the force driving stock dynamics. This is unlikely to be the case for Faroe Bank Cod where hydro-climatic conditions are likely to have greater influence. ASPIC is therefore unlikely to provide useful results for this stock. The results are presented in Table 2.3.2.5 and Figures 2.3.2.6 and 2.3.2.7 for information.

2.3.2.1 Comment on the assessment

An XSA was attempted in the 2000 assessment, but not since. The NWWG concludes that there is 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. The Working Group will attempt using a statistical age-structured model next year which would not be as sensitive to having reliable estimates of the catch-at-age data.

2.3.3 Reference points

There is 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 whether the catch originates from the Bank or from the Plateau, e.g. by storing it in different sections of the hold.

Table 2.3.1.1 Faroe Bank (Subdivision Vb2) COD. Nominal catches (tonnes) by countries 1986-2002 as officially 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]	- [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 *	2001	2002
Faroe Islands	1,001			
Norway	88	49	50 *	25
UK (E/W/NI)	- [2]	[2]	[2]	
UK (Scotland)	210	245	288	
United Kingdom		- [2]		
Total	1,299	294	338	25
Used in assessment	1,089	1,243	1,626	1,903

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

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

.

Year	Open boats	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	4.1	9.2	2.3	0.5	4.8	2.9	9.2	12.6	26.9	27.3	0.2	0.0	1434
2002	10.3	3.5	0.0	0.0	0.3	0.0	1.5	5.9	33.4	45.3	0.0	0.0	1442

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 30

Apr 2003 at 11:33.54
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:	38	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	7.693E+00	20	4.274E-01	1.000E+00	1.000E+00	0.494
TOTAL OBJECTIVE FUNCTION:	7.69269785E+00					

Number of restarts required for convergence: 7
Est. B-ratio coverage index (0 worst, 2 best): 1.0407 < 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	2.738E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	5.015E+03	3.000E+03	1	1
r	Intrinsic rate of increase	4.787E-01	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Survey CPUE	1.915E-02	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	5.015E+03	Kr/4	
K	Maximum stock biomass	4.191E+04		
$\mathbf{B}_{MSY}$	Stock biomass at MSY	2.096E+04	K/2	
$\mathbf{F}_{MSY}$	Fishing mortality at MSY	2.393E-01	r/2	
F(0.1)	Management benchmark	2.154E-01	0.9*$\mathbf{F}_{MSY}$	
Y(0.1)	Equilibrium yield at F(0.1)	4.965E+03	0.99*MSY	
B-ratio	Ratio of B(2003) to $\mathbf{B}_{MSY}$	1.250E+00		
F-ratio	Ratio of F(2002) to $\mathbf{F}_{MSY}$	3.210E-01		
F01-mult	Ratio of F(0.1) to F(2002)	2.804E+00		
Y-ratio	Proportion of MSY avail in 2003	9.374E-01	2*Br-Br^2	Ye(2003) = 4.701E+03
....	Fishing effort at MSY in units of each fishery:			
$\mathbf{F}_{MSY}$(1)	Survey CPUE	1.250E+01	r/2q(1)	f(0.1) = 1.125E+01

Faroe Bank Cod RV

Table 2.3.2.5 (Cont'd)

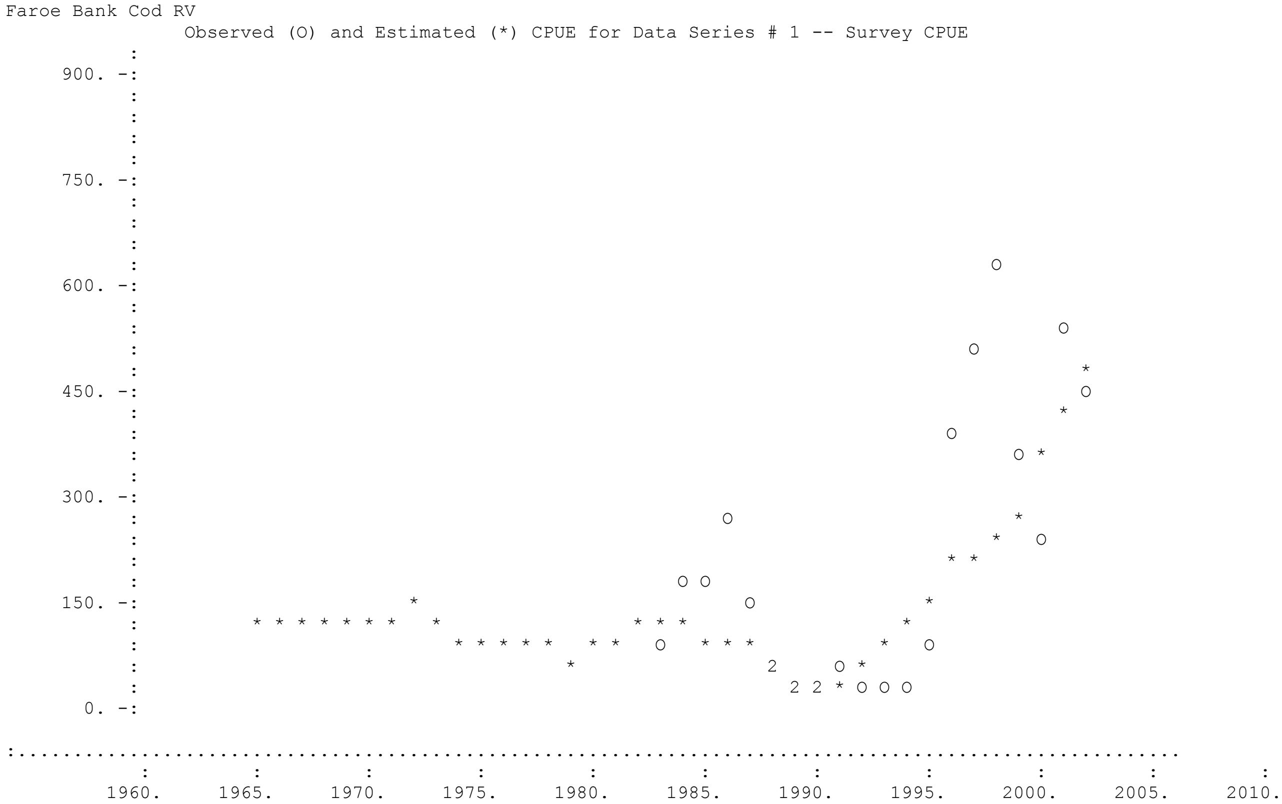
```
Faroe Bank Cod RV
RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED)                                    Survey CPUE
--------------------------------------------------------------------------------------------------
--------------------
Data type CC: CPUE-catch series                                                   Series weight:  1.000
```

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1965	*	1.102E+02	0.4067	2.341E+03	2.341E+03	0.00000	0.000E+00
2	1966	*	1.160E+02	0.3151	1.909E+03	1.909E+03	0.00000	0.000E+00
3	1967	*	1.328E+02	0.2262	1.569E+03	1.569E+03	0.00000	0.000E+00
4	1968	*	1.337E+02	0.5546	3.871E+03	3.871E+03	0.00000	0.000E+00
5	1969	*	1.255E+02	0.3750	2.457E+03	2.457E+03	0.00000	0.000E+00
6	1970	*	1.235E+02	0.4657	3.002E+03	3.002E+03	0.00000	0.000E+00
7	1971	*	1.252E+02	0.3181	2.079E+03	2.079E+03	0.00000	0.000E+00
8	1972	*	1.369E+02	0.3031	2.168E+03	2.168E+03	0.00000	0.000E+00
9	1973	*	1.166E+02	0.8318	5.067E+03	5.067E+03	0.00000	0.000E+00
10	1974	*	9.402E+01	0.4212	2.068E+03	2.068E+03	0.00000	0.000E+00
11	1975	*	9.456E+01	0.4123	2.036E+03	2.036E+03	0.00000	0.000E+00
12	1976	*	9.306E+01	0.4646	2.258E+03	2.258E+03	0.00000	0.000E+00
13	1977	*	1.031E+02	0.1781	9.590E+02	9.590E+02	0.00000	0.000E+00
14	1978	*	9.106E+01	0.9209	4.379E+03	4.379E+03	0.00000	0.000E+00
15	1979	*	7.401E+01	0.3379	1.306E+03	1.306E+03	0.00000	0.000E+00
16	1980	*	8.398E+01	0.2743	1.203E+03	1.203E+03	0.00000	0.000E+00
17	1981	*	9.945E+01	0.2366	1.229E+03	1.229E+03	0.00000	0.000E+00
18	1982	*	1.087E+02	0.4144	2.352E+03	2.352E+03	0.00000	0.000E+00
19	1983	7.899E+01	1.084E+02	0.4180	2.367E+03	2.367E+03	0.31680	0.000E+00
20	1984	1.752E+02	1.097E+02	0.3869	2.216E+03	2.216E+03	-0.46849	0.000E+00
21	1985	1.735E+02	1.043E+02	0.5439	2.961E+03	2.961E+03	-0.50913	0.000E+00
22	1986	2.661E+02	1.007E+02	0.3624	1.905E+03	1.905E+03	-0.97220	0.000E+00
23	1987	1.640E+02	8.796E+01	0.7574	3.479E+03	3.479E+03	-0.62326	0.000E+00
24	1988	7.311E+01	5.505E+01	1.0753	3.091E+03	3.091E+03	-0.28386	0.000E+00
25	1989	3.655E+01	3.336E+01	0.8105	1.412E+03	1.412E+03	-0.09142	0.000E+00
26	1990	2.324E+01	3.150E+01	0.2195	3.610E+02	3.610E+02	0.30391	0.000E+00
27	1991	5.097E+01	4.131E+01	0.1553	3.350E+02	3.350E+02	-0.21029	0.000E+00
28	1992	2.843E+01	5.858E+01	0.0503	1.540E+02	1.540E+02	0.72278	0.000E+00
29	1993	2.576E+01	8.569E+01	0.0594	2.660E+02	2.660E+02	1.20200	0.000E+00
30	1994	4.468E+01	1.189E+02	0.1168	7.250E+02	7.250E+02	0.97881	0.000E+00
31	1995	9.532E+01	1.609E+02	0.0715	6.010E+02	6.010E+02	0.52339	0.000E+00
32	1996	3.803E+02	2.027E+02	0.1989	2.106E+03	2.106E+03	-0.62908	0.000E+00
33	1997	5.164E+02	2.231E+02	0.3085	3.594E+03	3.594E+03	-0.83925	0.000E+00
34	1998	6.377E+02	2.361E+02	0.2627	3.239E+03	3.239E+03	-0.99355	0.000E+00
35	1999	3.685E+02	2.774E+02	0.0752	1.089E+03	1.089E+03	-0.28410	0.000E+00
36	2000	2.465E+02	3.458E+02	0.0688	1.243E+03	1.243E+03	0.33839	0.000E+00
37	2001	5.373E+02	4.136E+02	0.0753	1.626E+03	1.626E+03	-0.26154	0.000E+00
38	2002	4.439E+02	4.744E+02	0.0768	1.903E+03	1.903E+03	0.06641	0.000E+00

* Asterisk indicates missing value(s).

Table 2.3.2.5 (Cont'd)

```
Faroe Bank 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    ----------------------------------------------------------------------------------
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     0.3168                                             |======
1984    -0.4685                                    =========|
1985    -0.5091                                   ==========|
1986    -0.9722                          ===================|
1987    -0.6233                                 ============|
1988    -0.2839                                       ======|
1989    -0.0914                                           ==|
1990     0.3039                                             |======
1991    -0.2103                                         ====|
1992     0.7228                                             |==============
1993     1.2020                                             |========================
1994     0.9788                                             |====================
1995     0.5234                                             |==========
1996    -0.6291                                se=============|
1997    -0.8392                            =================|
1998    -0.9936                         ====================|
1999    -0.2841                                       ======|
2000     0.3384                                             |=======
2001    -0.2615                                        =====|
2002     0.0664                                             |=
                   ------------------------------------------------------------------------------
```


Faroe Bank Cod RV
Observed (O) and Estimated (*) CPUE for Data Series # 1 -- Survey CPUE
900.
750.
600.
450.
300.
150.
0.
1960.
1965.
1970.
1975.
1980.
1985.
1990.
1995.
2000.
2005.
2010.

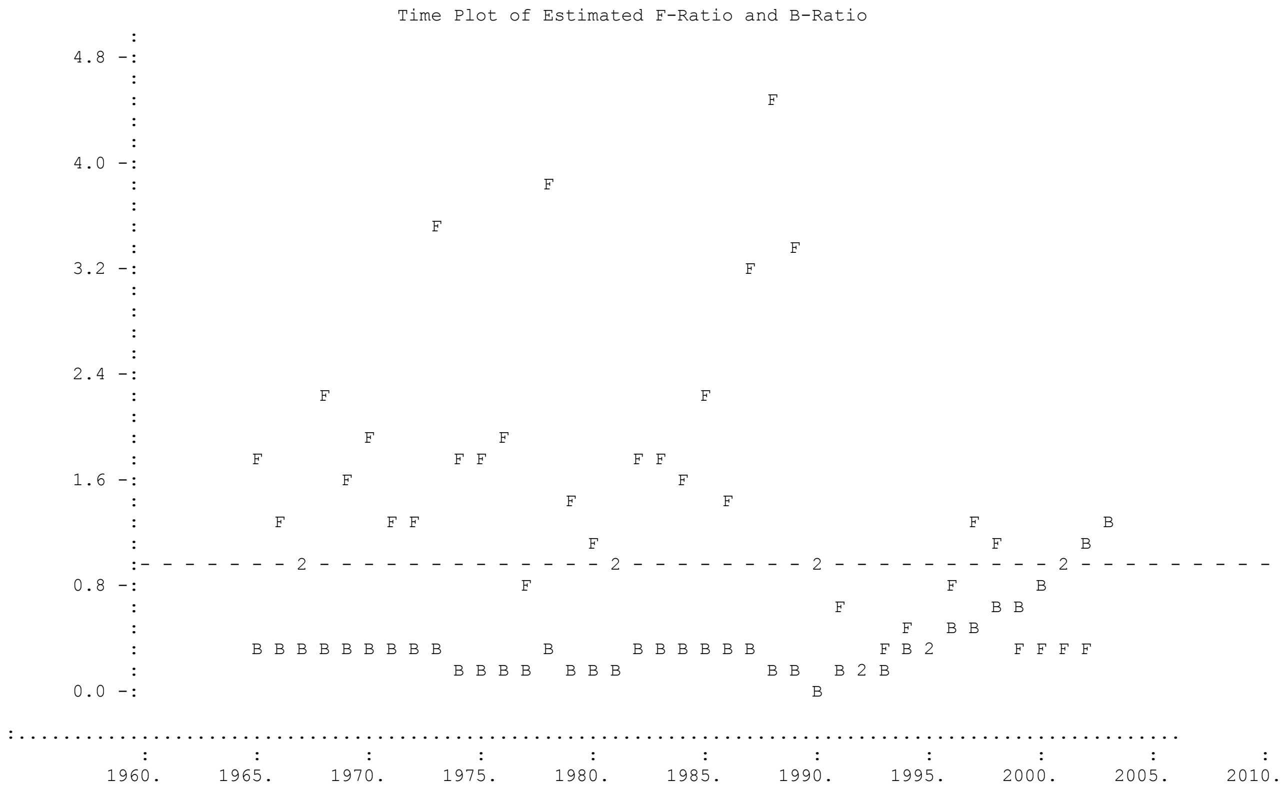

Time Plot of Estimated F-Ratio and B-Ratio
4.8
4.0
3.2
2.4
1.6
0.8
0.0
1960.
1965.
1970.
1975.
1980.
1985.
1990.
1995.
2000.
2005.
2010.

Figure ?????

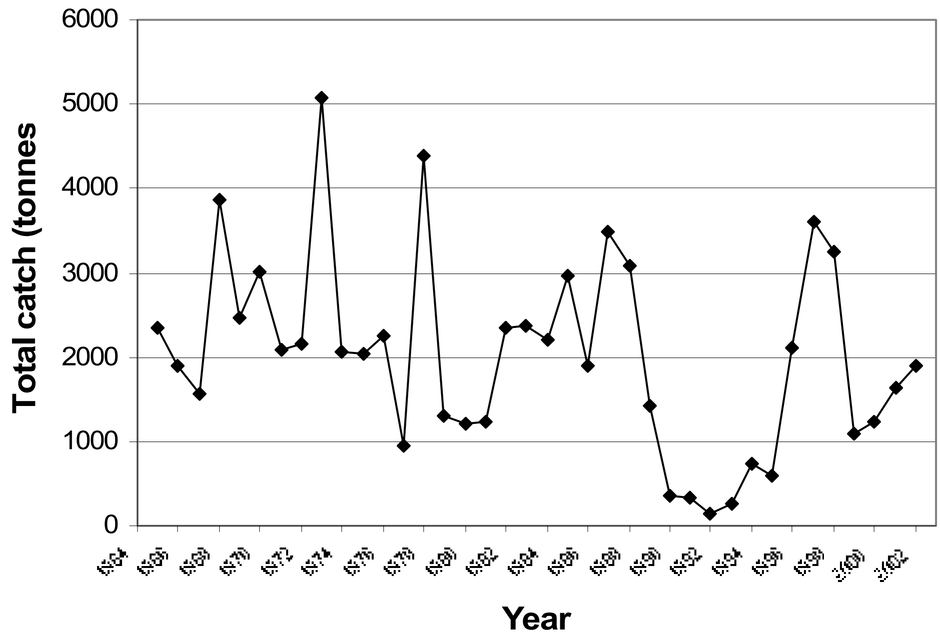


Figure 2.3.1.1 Faroe Bank (Subdivision Vb2) COD. Reported landings 1965-2002. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank.

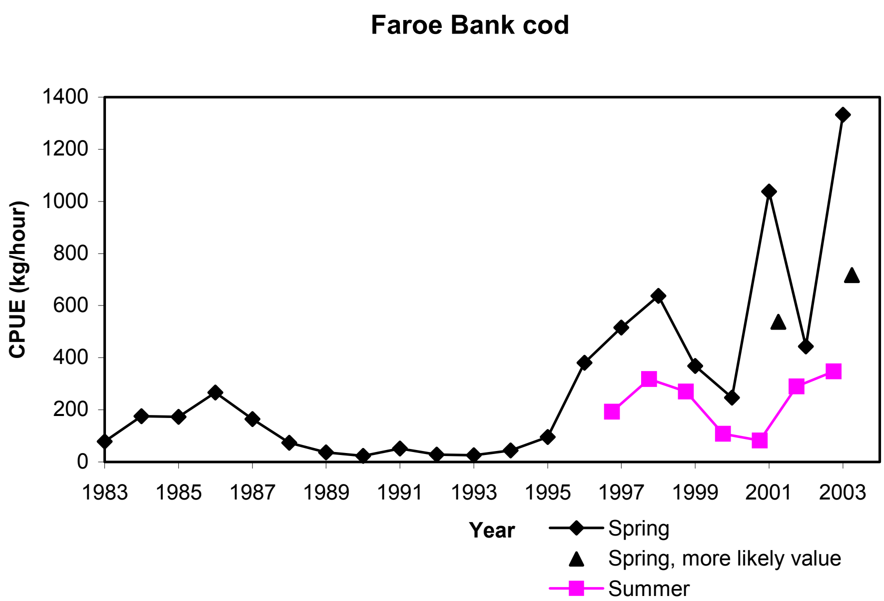
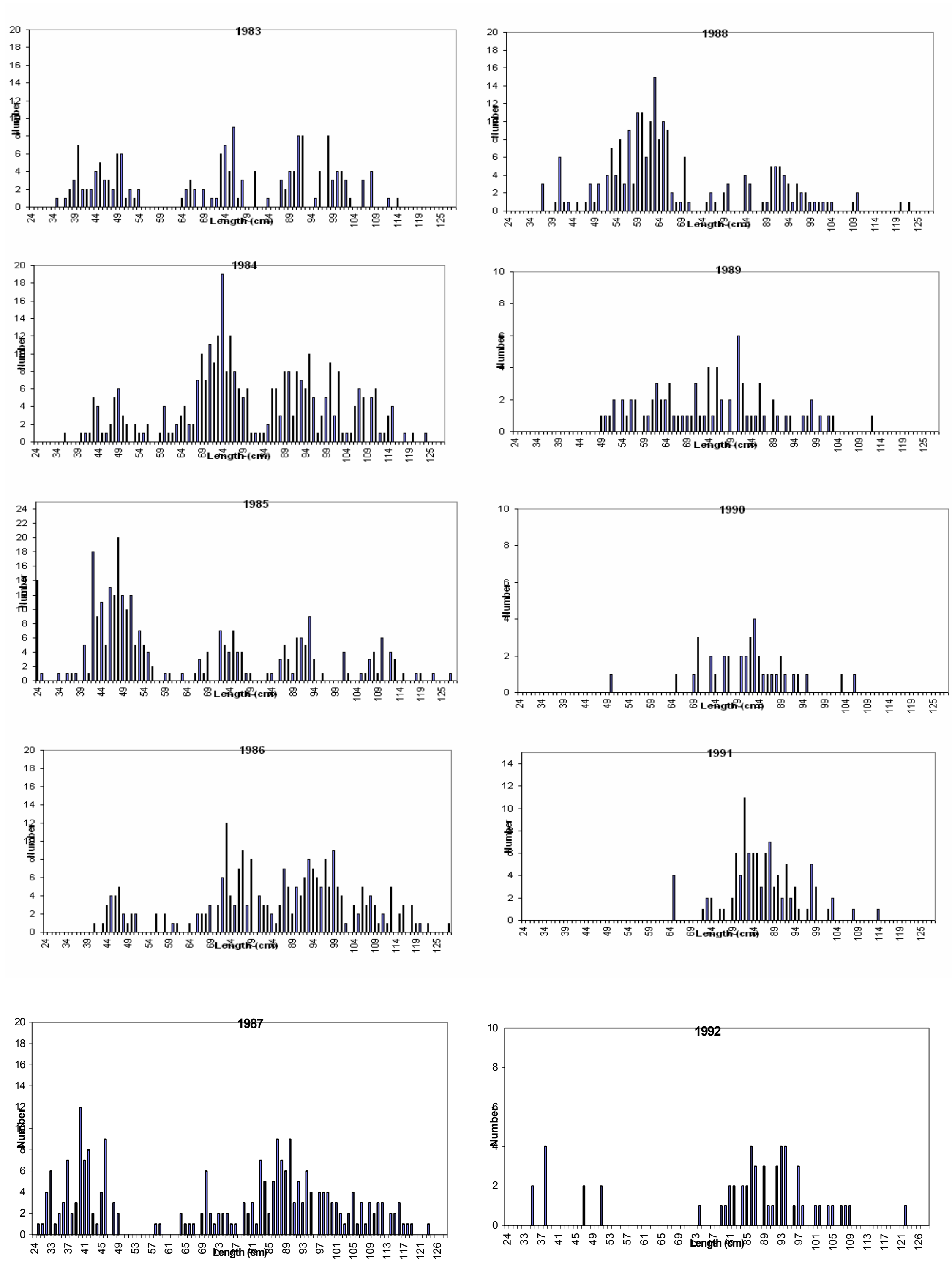


Figure 2.3.2.1 Faroe Bank (Subdivision Vb2) COD. Catch per unit of effort in the spring groundfish survey (up to 2003) and autumn groundfish survey (up to 2002). If one large haul (14 tonnes) is replaced by 4 tonnes (more typical for that particular station) the CPUE drops from about 1300 kg/hour to about 530 kg/hour.

Figure 2.3.2.2.Faroe Bank (Subdivision Vb2) COD. Length distributions in the spring survey 1983-2003.



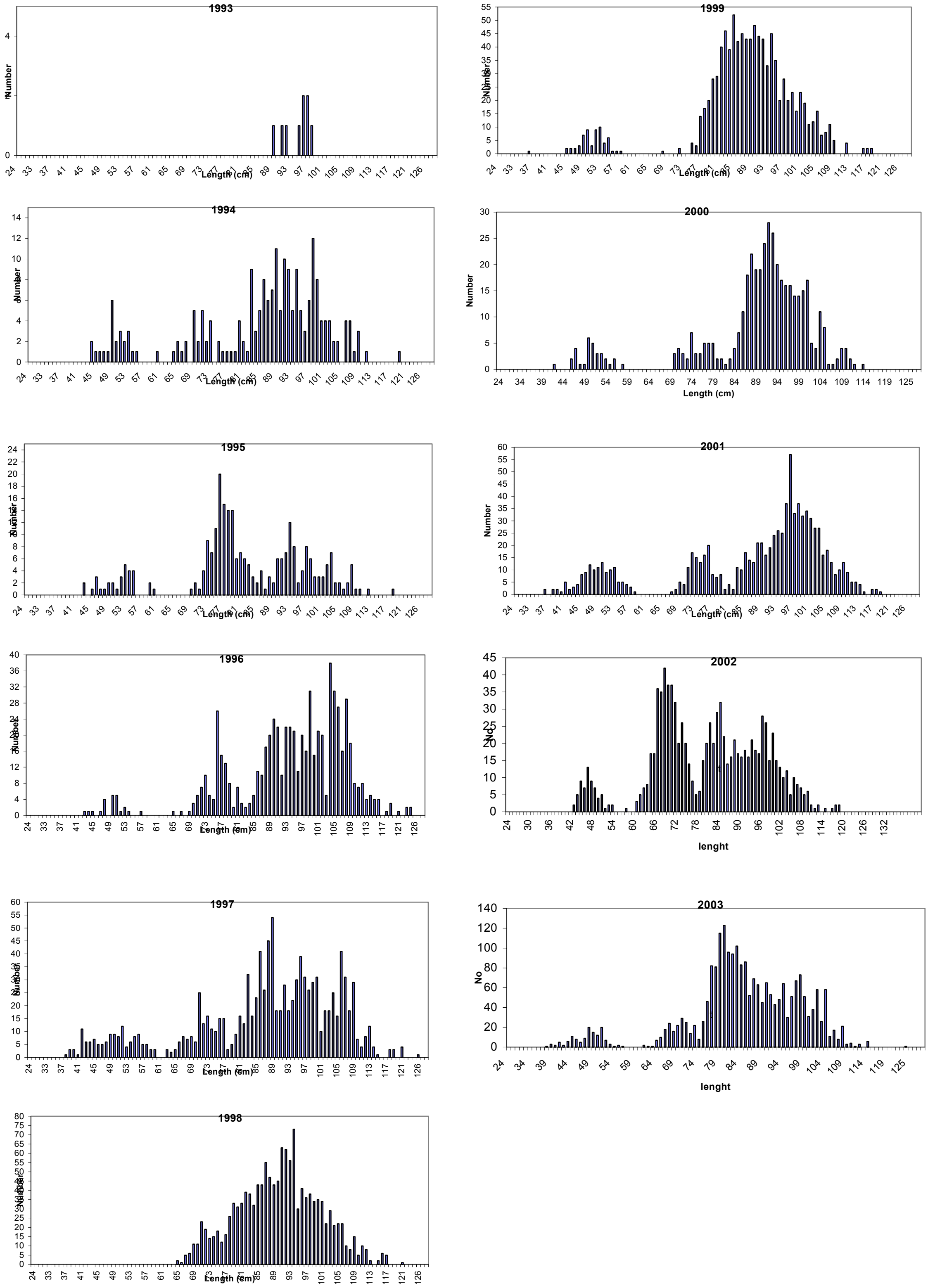


Figure2.3.2.2 (Continued)

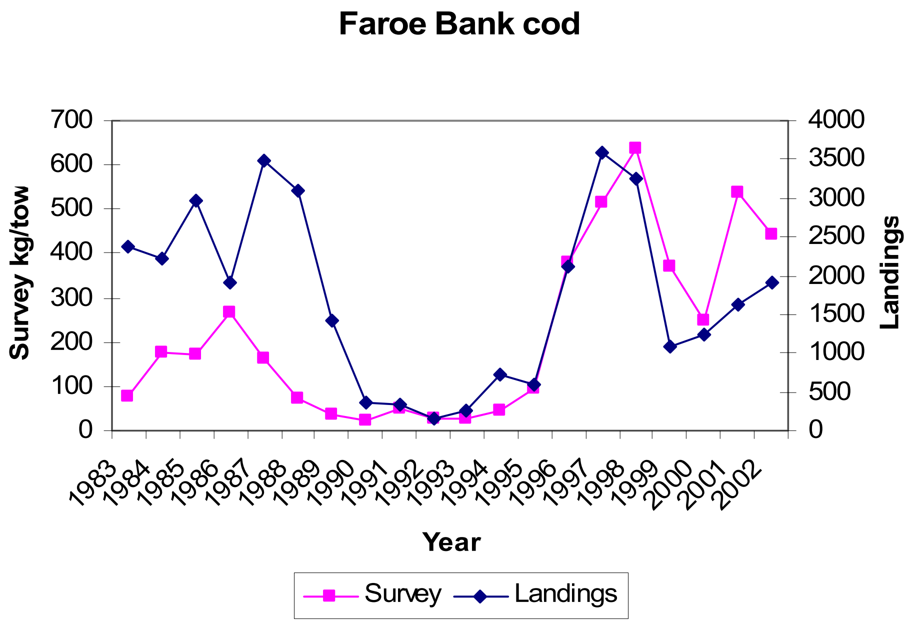


Figure 2.3.2.3 Faroe Bank (Subdivision Vb2) COD. CPUE in spring survey and landings (1983-2002)

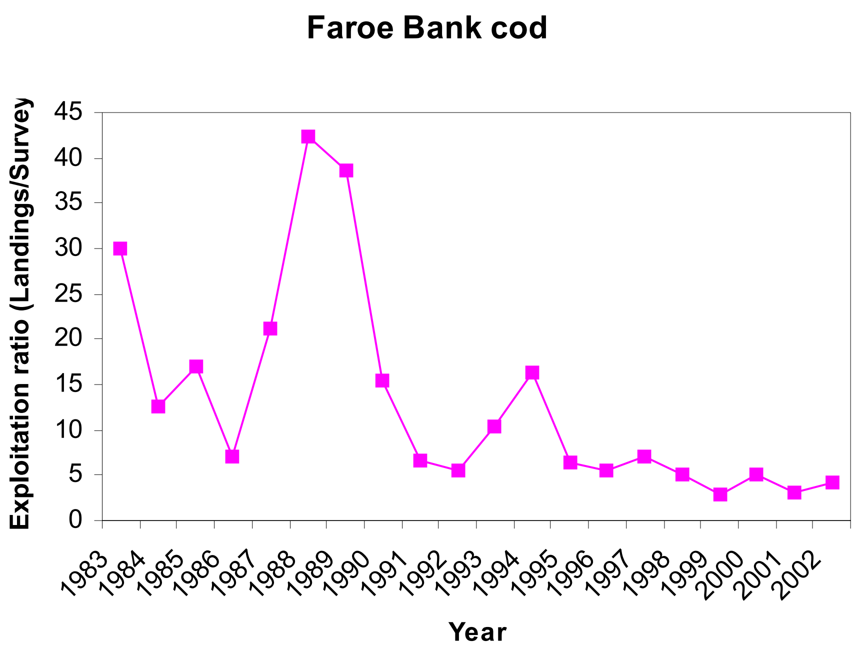
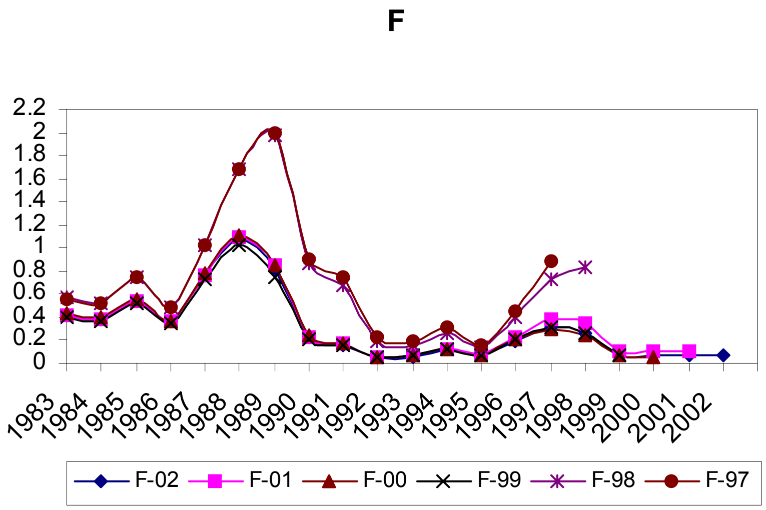


Figure 2.3.2.4 Faroe Bank (Subdivision Vb2) COD. Exploitation ratio (ratio of landings to spring survey interpreted as an index of exploitation rate.)



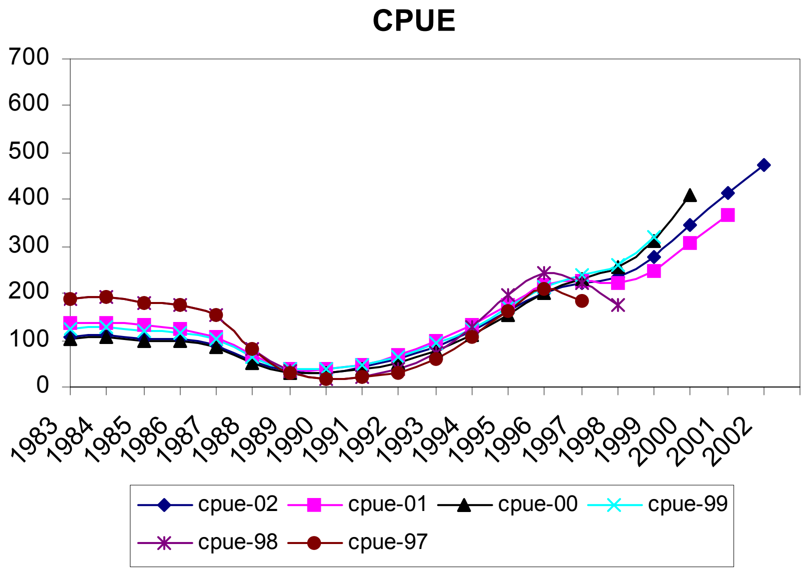
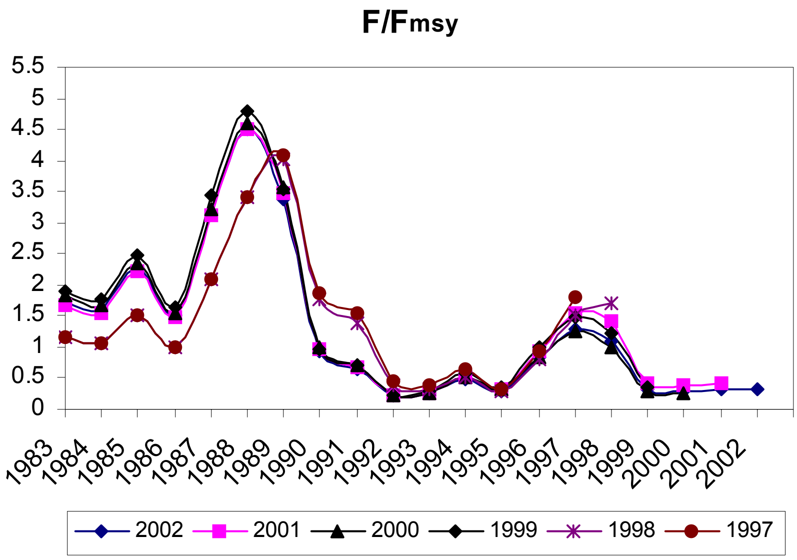


Figure 2.3.2.6 Retrospective analysis of F and CPUE estimates from ASPIC model



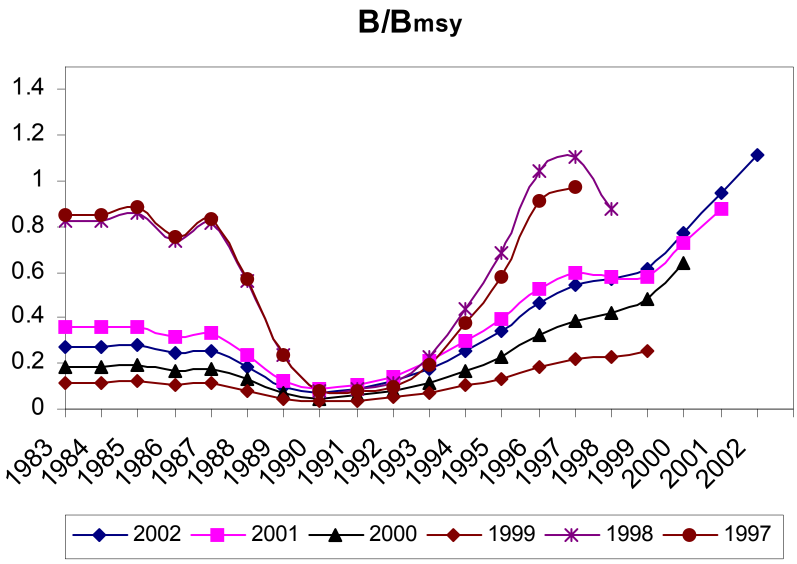


Figure 2.3.2.7 Retrospective analysis of F/$\mathbf{F}_{MSY}$ and B/$\mathbf{B}_{MSY}$ from ASPIC model

2.4 Faroe Haddock

2.4.1 Introduction

Haddock in Faroese Waters, i.e. ICES Subdivisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Subdivision Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. Spawning takes place from late March to the beginning of May with a peak in the middle of April and occurs in several areas on the Faroe Plateau and on the Faroe Bank. The haddock does not form as dense spawning aggregations like cod and saithe, nor does it perform ordinary spawning migrations. After spawning, eggs and fry are pelagic for about 4 months over the Plateau and Bank and settling starts in August. This is a prolonged process, and pelagic juveniles can be found at least until September. During their first years of life some individuals are to be found in pelagic waters and this vertical distribution seems to be connected to year-class strength. No special nursery areas can be found, because young haddock are distributed all over the Plateau and Bank. After settling the haddock is regarded very stationary as seen in tagging experiments. Different growth in different parts of the distribution area as well as a large degree of heterogeneity in genetic investigations support this.

2.4.2 Trends in landings and fisheries

Nominal landings of Faroe haddock have in recent years increased very rapidly from only 4 000 t in 1993 to more than 25 500 t in 2002. About 1-2 000 t have in recent years been taken from Subdivision Vb2, the rest from the Faroe Plateau (Tables 2.4.1 and 2.4.2). As can be seen from Figure 2.4.1, landings in 2002 were at historical high levels and from the cumulative landings by month (Figure 2.4.2) they are expected to increase even further in 2003.

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. The longliners have been taken most of the catches in recent years followed by the pair trawlers. The last 2-3 years the otterboards trawlers above 1000 HP have been given individual quotas of cod and haddock and consequently their share of the landings has increased.

The 2002 monthly Faroese landings of haddock by fleet category from Subdivisions Vb1 and Vb2, are shown in Figure 2.4.3. The landings from the Plateau were high in the first month of the year until the end of the spawning time in April/May, stayed low during the summer, and increased again in late autumn. On the Faroe Bank the monthly landings were high during the first 4 months and relatively small the rest of the year.

2.4.3 Catch-at-age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. The sampling intensity in 2002 is shown in the table below. Compared to 2001, the number of samples and of individual length measurements was lower in 2002, whereas the number of age readings and of individual weightings of the fish was somewhat higher.

Sampling of Faroese haddock landings from Vb in 2002

	Open Boats	LLiners < 100GRT	LLiners > 100GRT	OB. trawl. < 400HP	OB. trawl. 400-999HP	OB. trawl. > 1000HP	Pair trawl. < 1000HP	Pair trawl. > 1000HP	Total
No. of samples	23	74	81	8	24	5	10	52	277
No. of length measurements	4525	14910	17113	1667	5009	1210	2527	11416	58377
No. of aged fish	480	1482	2647	120	603	180	120	1140	6772
No. of weighted fish	360	420	1260	60	180	60	120	960	3420

Samples from each fleet category were disaggregated by season and then raised by the catch proportions to give the 2002 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 2.4.4 the LN (catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent, except for the behaviour of a few small year classes, both in numbers and mean weights-at-age. Also there are some problems with what ages should be included in the plus group; there are some periods where no or only a few fishes are older than 9 years, and other periods with a quite substantial plus group (10+). These problems have been adressed in former reports of this WG and will not be further dealt with here.

No estimates of discards of haddock are available. However, since almost no quotas are used in the management of this stock the incitament to discard in order to high grade the catches should be low. The practice to hang up young fish to dry for local consumption as explained for cod (Section 2.2), also applies to haddock but to a much less degree. Moreover there is a ban on discardings. The landings statistics is therefore regarded as being adequate for assessment purposes.

2.4.4 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 2.4.6). Figure 2.4.5 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. After an increase for all ages in a few years the weights have been historical high, but are now levelling off and even decreasing for some ages. The same is seen for 2003 when comparing samples from the commercial catches during the first months of the year (Figure 2.4.6). The mean weights-at-age in the catch were also assumed for the stock.

2.4.5 Maturity-at-age

Maturity-at-age data is available from the Faroese Spring Groundfish Surveys 1982–2003. The survey is 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. However, when revising the spring survey data, some inconsistencies were detected. These have been corrected in the revised spring survey series back to 1994, as explained for cod (Section 2.2) and in WD14; there could however be some problems further back in time.

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 2.4.7).

2.4.6 Assessment

2.4.6.1 Tuning and estimates of fishing mortality

Commercial cpue series. Although several commercial catch per unit effort series are updated every year, only two commercial series are used in the evaluations of stock size and fishing mortality. The two commercial series consist of a longliner series including the logbook data from 5 selected longliners larger than 100 GRT (directed effort measured as number of hooks) and a trawler series including logbook data (catch-at-age in numbers and corresponding effort in number of trawl hours) from a homogeneous group of pair trawlers larger than 1 000 HP (CUBA), which have been engaged in a mixed saithe, cod, and haddock fishery since the middle of the 1980s.

Fisheries-independent cpue series. Two annual groundfish surveys are available, 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). Biomass estimates (kg/hour) are available for both series, but due to problems with the database (see last year's report), age-disaggregated data were only available last year for the summer series. A major revision of the data is ongoing. As last year the whole summer survey series is available, and this year the spring survey was available back to 1994.

Choice of tuning series. In the tuning of this stock it has been standard to combine all available series in one tuning file. 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. Therefore the WG last year 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 were shown, and ranges of results given. The WG concluded that since the main differences between the runs are the recruitment estimates, it was appropriate just 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 (prior to this catchability was assumed to be dependent on stock size for ages younger than 3) and a shrinkage of 2.0 as has been normal for this stock in recent years (except in 2000 when shrinkage was set at 0.5). This was questioned by ACFM, arguing that this series is very short and has little information on older ages; in such a case the very light shrinkage also was dangerous. Inclusion of the two commercial series was advised.

This year the WG did some more analysis on the two commercial cpue series as well as on the two survey series. And again it was decided not to use the commercial series for tuning of the presented XSA. Arguments for this are given below.

Retrospective plots with the two commercial series were given in last year's report (and in former reports) and did in general not behave very good. Log q residuals for the pair trawlers (Cuba), as shown in Figure 2.4.8A, are noisy and with trends, even when removing some ages as has been the common practice in the past (Figure 2.4.8B). The same applies to the longliners (Figure 2.4.9A), and although most of the trends have been removed by shortening the time-series and removing of some ages (common practice for this series) the series is still very noisy (Figure 2.4.9B).

LN(numbers-at-age) for the summer survey is presented in Figure 2.4.10 and shows a consistent pattern. Also log q residuals behave satisfactorily for ages 2-8 (Figure 2.4.11) and the same applies for the relationship between the indices for one age compared with the indices for the same age one year after (Figure 2.4.12). The same analysis on the spring survey is presented in Figures 2.4.11, 2.4.13 and 2.4.15, and with the same conclusions except for the log q residuals for some ages which consequently have been left out of the further analysis. In general there is a good consistency between the indices at age as estimated in the two series (Figure 2.4.14).

Plots of age-aggregated CPUE's (kg/hour) for the two commercial series and for the two surveys are given in Figure 2.4.16. In general, all series show that the stock has increased from a low level in the mid-1990s and after a decrease for a few years have increased again. However, there are apparently som time lags involved, and in a few cases the series give contradictionary signals; see last year's report for more details.

Last year the summer survey alone was used for tuning, with tapered time weighting, catchability independent of stock size for all ages and F shrinkage of 2.0; a retrospective plot of this spaly run this year is shown in Figure 2.4.17. Using tapered time weighting was a mistake, but omitting this gave only marginal differences (not shown but available in WG folder). As explained above the WG this year decided to use the two surveys combined for tuning as they now have more years included and seem to behave reasonably for the most important age groups in the landings. First the same ages as in the spaly run with the same settings (no tapered time weighting) were used and the restrospective plots are shown in Figure 2.4.17. In order to use the results from the XSA for estimation of future recruitment, ages 0 and 1 were included. The results were very similar but for some unknown reason several statistical diagnostics could not be given in the output (were zero). Exploring this it was seen that this was connected to the shringage applied and only with shrinkages heavier than 0.6, the outputs were satisfactory. After careful inspection of all diagnostics and retrospective plots (Figure 2.4.17), the WG decided to use a shrinkage of 0.5. Reasons for using shrinkage of 2.0 in recent years were changes in the fleet behaviour in connection with the introduction of the new management system in 1996 and the sudden changes in the stock at the same time. These arguments may not be valid any more. A comparison of these 4 different runs is given in Figure 2.4.18. Figure 2.4.19 compares 11 runs with each tuning series separately and different combinations thereof.

Results. The indices at age for the present tuning series are shown in Table 2.4.8 and the XSA with diagnostics in Table 2.4.9.

The fishing mortalities from the final XSA run are given in Table 2.4.10 and in Figure 2.4.23B. According to this the fishing mortality showed 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 0.37 and 0.40, respectively. The estimated point value for Fbar(3-7) from this year's assessment is 0.45. The reference ages include a high F-value for the very small 1996 YC at age 6; excluding this age will imply a Fbar of 0.38. In comparisons all the runs with different fleets and different shrinkages gave fishing mortalities in the range of 0.35 to 0.52 (Figure 2.4.19).

2.4.6.2 Stock estimates and recruitment

Compared to former assessments, the 2000 assessment changed the perception of stock size (and fishing mortality) considerably and this year's assessment is consistent with this. 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 Tables 2.4.12 and 2.4.18 and in Figure 2.4.23C,D. According to this assessment, the spawning stock biomass decreased from 67 000 t in 1987 to 21 000 t in 1994, increased to 75 000 t in 1997, but has since decreased to about 42 000 t in 2000. In 2001 it increased again to 50 000 t and again in 2002 to above 70 000 t. For comparison, this year's different runs gave SSB's in the range of 61-87 000 t (Figures 2.4.18 and 2.4.19). The decline in the spawning stock began in the late 1970s due to very poor recruitment in the years before. 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 very 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. In the past there have been considerable doubts about the sizes of incoming year classes. Due to the lack of reliable recruitment indices it has been normal practise to replace XSA estimates with the geometric mean of a reference period's recruitments at age 2. With the presence of two survey series and inclusion of indices from them for ages outside the commercial catch-at-age the information on incoming year classes has improved; it was not felt worthwhile to repeat the use of RCT3 estimates as at least the same information is derived directly from the XSA. The 1999 YC is now confirmed being the highest on record at age 2 (89 mio.) and the YC's from 2000 and 2001 are estimated above average (about 47 mio.), Tables 2.4.12, 2.4.18 and Figure 2.4.23C. The different exploratory XSA runs gave estimates for the 1999 YC at age 2 in the order of 90-125 mio.

2.4.7 Prediction of catch and biomass

2.4.7.1 Input data

2.4.7.1.1 Short-term prediction

The input data for the short-term predictions are given in Tables 2.4.13-14. All year classes up to 2000 are from the final VPA, the 2001-2002 year classes at age 2 are estimated from the XSA at ages 0 and 1 and applying a natural mortality of 0.2 in a foreward calculation of the numbers using basic VPA equations. The YC 2003 at age 2 in 2005 is estimated as the geometric mean of the 2-year-olds in 1980-2004.

The exploitation pattern used in the prediction was derived from averaging the 2000–2002 fishing mortality matrices from the final VPA without rescaling to the recent values. The high F values for age 8 in 2000 and age 6 in 2002 have been excluded from the averaging, since they are very small and presumably only represent noise in the data and they will have a large impact on the prediction of future biomasses and catches. When excluding these to datapoints from the series, a rescaling of the average exploitation pattern to the 2002 reference F will give almost exactly the same result as the unscaled ones. The same exploitation pattern was used for all three years.

The mean weight-at-age for ages 2-10 in 2003-2005 was calculated using the cohort aproach as described by K. Brander in a WD which was circulated to the ACFM members, i.e. mean weight-at-age a+1 = mean weight-at-age a + Growth of the same YC. The weights-at-age in 2002 were used as starting points. By inspecting the weights-at-age 2 for recent years (Figure 2.4.5) and also the 2 first months of the year (Figure 2.4.6), they appear very stable and the value for year 2002 were assumed for all the years. Then the remaining weights-at-age were derived by adding the corresponding geometric mean growth for each cohort (age a to age a+1). The mean weight for the +group in 2002 was also applied in 2003-2005. The same weights-at-age were used for the catch and for the stock as was done in the assessment.

The maturity ogive for 2003 is based on samples from the Faroese Groundfish Spring Survey 2002 and the ogives in 2004-2005 are estimated as the average of the smoothed 2001-2003 values.

2.4.7.1.2 Long-term Prediction

The input data for the long-term yield and spawning stock biomass (yield-per-recruit calculations) are listed in Table 2.4.16. Mean weights-at-age (stock and catch) are averages for the 1977–2002 period. The maturity ogives are averages for the years 1982-2002. The exploitation pattern was derived from the fishing mortality matrix from the final VPA as average F-values for the long time period (1961 onwards), rescaled to the 2002 F_{bar} (age 3-7).

2.4.7.2 Biological reference points

The yield- and spawning stock biomass-per-recruit (age 2) based on the long-term data are shown in Table 2.4.17 and Figure 2.4.20. $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are indicated here as 0.52 and 0.19, respectively. From Figure 2.4.22, showing the recruit/spawning stock relationship, and from Table 2.4.17, $\mathbf{F}_{low}$, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated to be 0.05, 0.23 and 0.83, 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 2.4.21) and ACFM established $\mathbf{B}_{lim}$ = 40 000 t. In the 1998 assessment, the $\mathbf{B}_{pa}$ was calculated as the value lying 2 standard deviations above $\mathbf{B}_{lim}$, that is 65 000 t. By examining among other things the SSB-R plot, ACFM instead proposed $\mathbf{B}_{pa}$ = 55 000 t. The reference point $\mathbf{F}_{pa}$ was proposed by ACFM as the $\mathbf{F}_{med}$ value 0.25. The $\mathbf{F}_{lim}$ is defined to be two standard deviations above $\mathbf{F}_{pa}$ and was set by ACFM at 0.40. The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested that $\mathbf{B}_{lim}$ for Faroe haddock could be decreased to 20 000 t, considering that two strong year classes have been produced at SSB below $\mathbf{B}_{lim}$. The Working Group considers it premature to change $\mathbf{B}_{lim}$ at this time. Of the 5 year classes produced at SSB below $\mathbf{B}_{lim}$, three were very small, and two very strong. The strong year classes are believed to be due to favourable environmental conditions, and there is no guarantee that similarly good environmental conditions would occur again should the SSB decrease below $\mathbf{B}_{lim}$.

The $\mathbf{F}_{lim}$ and $\mathbf{F}_{pa}$ appear to be rather conservative. The fishing mortality has been above $\mathbf{F}_{lim}$ during one third of the time-series (14 of the 42 years), while it was above $\mathbf{F}_{pa}$ almost 70% of the time (29 out 42 years). Clearly, there is not a high probability that the stock will collapse at fishing mortality in the vicinity of $\mathbf{F}_{lim}$, particularly given the current high stock biomass. The average fishing mortality over the time period, F = 0.35 could therefore be considered as a candidate for $\mathbf{F}_{pa}$, with an associated $\mathbf{F}_{lim}$, using $\mathbf{F}_{pa}\, e^{1.645\sigma}$ assuming a σ of about 0.30, giving $\mathbf{F}_{lim}$ = 0.55.

The history of the haddock fishery in relation to the present four reference points can be seen in Figure 2.4.23. In the period 1961-69 the fishing mortality was above $\mathbf{F}_{lim}$ and the spawning stock biomass was below $\mathbf{B}_{pa}$. Then the fishing mortality decreased and the stock biomass increased, resulting in the stock/fishery being within or close to biological safe limits in most of the 1970s and 1980s. In 1989 the stock went below $\mathbf{B}_{pa}$ and continued to decrease below $\mathbf{B}_{lim}$ 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 1996 been above. The fishing mortality has however been above $\mathbf{F}_{pa}$ since 1996, and except for the year 2000 even above $\mathbf{F}_{lim}$.

2.4.7.3 Projections of catch and biomass

2.4.7.3.1 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 2003 as in 2002. The fleet is almost the same and the number of fishing days per fleet was only reduced by 1% for the fishing year 2002-2003 as compared to the seasons since 1998/1999. The catch in 2003 is then predicted to be about 31 000 t (the highest on record), and continuing with this fishing mortality will result in a 2004 catch in the same order of magnitude (32 000 t). The SSB will in this case stay stable in 2003 and 2004 (about 96 000 t – among the highest observed), and decrease to 85 000 t in 2005. The results of the short-term prediction are shown in Table 2.4.15 and in Figure 2.4.21.

2.4.8 Medium-term projections

Medium-term projections were made in the 2001 assessment and not repeated here.

2.4.9 Management considerations

Stock and yield are highly variable due to fluctuations in recruitment, especially when fishing mortality is high. With the present favourable environmental conditions the stock appears to be able to produce enough recruits to stay above $\mathbf{B}_{pa}$. It is doubtful, however, whether the current high fishing mortality could be maintained without seriously jeopardising stock productivity, should a relatively long period of low productivity occur. It would therefore be prudent to decrease fishing mortality in order to have a buffer SSB, should productivity decrease. Juvenile and young fish area closures for all gears capable of catching these fishes could result in substantial increases in yield.

2.4.10 Comments on the assessment

This year the assessment indices from the commercial fleets were not used for tuning of the VPA and the assessment was tuned with the same summer survey (updated) as last year combined with the revised spring survey. The decision to exclude the commercial series was based on retrospective pattern, 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 (see last year's report), revealing marked trend in catchabilty in CPUE series from commercial fleets, were taken 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 the terminal point estimates were different.

Compared to the predicted values last year regarding recruitment, exploitable biomass (age 2+), spawning stock biomass and fishing mortality for 2002, this year's estimate for 2002 of recruitment is 100% higher, exploitable biomass is 55% higher, spawning stock biomass is 17% higher, fishing mortality 18% higher and landings 21% higher. The main reason for these discrepancies is the poor estimation of recruitment to this stock in recent years. The use of the summer survey and the revised spring survey series in the tuning of the VPA and in the prediction of future recruitment is believed to make this year's assessment and predictions more reliable. The major reason for the discrepancy in fishing mortality derives from a high F value for age 6 in this year's assessment; this is the very small 1996 year class. This age is in the reference ages, and removing it will give a reference F of 0.39 – almost exactly the same as the predicted value.

Table 2.4.1 Faroe Plateau (Subdivision Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2002, as officially reported to ICES , and the total Working Group estimate in Vb.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Denmark	-	-	-	-	1	8	4	-	-	-	4,655
Faroe Islands	10,319	11,898	11,418	13,597	13,359	13,954	10,867	13,506	11,106	8,074	164
France[1]	2	2	20	23	8	22	14	-	-	-	-
Germany	1	+	+	+	1	1	-	+	+	+	
Norway	12	12	10	21	22	13	54	111	94	125	71
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-	54
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	4,944
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	5,476

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002 [2]
Faroe Islands	3,622	3,675	4,549	9,152	16,585	19,135	16,643	*13,620* [8]	*14,198* [8]	*23,299* [8]
France[1]	-					2 [2,7]	- [2]	6	7 [2]	5
Germany	-		5	-	-		33	1	2	6
Greenland							30 [6]	22 [6]	0 [6]	4 [6]
Norway	28	22	28	45	45 [2]	71 [2]	411 [2]	355 [2]	260 [2]	253
UK (Engl. and Wales)	81	31	23	5	22 [1]	30 [1]	59 [7]	19 [7]	4 [7]	
UK (Scotland)[3]	-	-	-	…	…	…				
United Kingdom										204 [7]
Total	3,731	3,728	4,605	9,202	16,652	19,238	17,176	14,023	14,471	23,771
Working Group estimate[4,5,8]	4,026	4,252	4,948	9,642	17,924	22,210	18,482	15,821	16,339	25584

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

2) Preliminary 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

9) Included in Vb2

Table 2.4.2 Faroe Bank (Subdivision Vb2) HADDOCK. Nominal catches (tonnes) by countries, 1982-2002, as officially reported to ICES, and the total Working Group estimate in Vb2.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Faroe Islands	1,533	967	925	1,474	1,050	832	1,160	659	325	217	338
France[1]	-	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4	23
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-	+
UK (Scotland)[3]	48	13	+	25	26	45	15	30	725	287	869
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508	1,230

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002 [2]
Faroe Islands	185	353	303	338	1,133	2,810	1,110	*1,565* [4]	*1,655* [4]	*1784* [4]
France[1]	-	-	-	-	-				1 [2]	1
Norway	8	1	1 [2]	40 [2]	4 [2]	60 [2]	3 [2]	48	64 [2]	28
UK (Engl. and Wales)	+	+	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]	
UK (Scotland)[3]	102	170	39	62	135 [1]	102	193	185	148	
Total	295	524	343	440	1,272	2,972	1,306	1,798	1,868	1,813
Working Group estimate 4)										

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 Faroe Plateau (Subdivision Vb1) HADDOCK.

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	2002	Haddock %
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	18
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	38
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	21
Otterboard trawlers < 400HP	1	2	2	2	1	1	2	2	8	8	7	6	3	2	2	4	2	2	11
Otter board trawlers 400-999HP	6	3	5	4	3	3	1	1	3	2	5	7	6	6	5	5	5	4	12
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	1
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	7
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	4
Nets	0	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	2	1
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	0	6
Total catch, tonnes gutted	13570	12967	13829	10697	12866	10319	7469	4103	3275	3629	4371	8535	15890	19669	16062	13881	13555	21842	

Table 2.4.4 Faroe Plateau (Subdivision Vb1) HADDOCK. Catch-at-age in number 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	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	27	713	563	16	38	28	18	34	57	1497	8	23	32	2	23	1555
3	467	5308	4021	198	446	1383	207	731	505	13290	536	312	833	121	163	14406
4	41	601	877	42	86	571	117	350	106	2785	38	45	84	50	36	2954
5	17	267	372	19	46	152	52	166	43	1132	26	43	70	13	15	1231
6	2	24	51	2	5	17	4	11	5	121	2	9	11	2	2	136
7	4	68	60	5	10	15	12	39	8	222	11	9	19	1	2	245
8	15	223	237	20	52	74	40	131	31	824	13	12	25	6	10	865
9	20	329	339	28	73	79	38	133	41	1081	11	11	22	7	14	1124
10	0	11	11	0	0	1	1	3	1	28	0	1	1	0	0	29
11	0	0	4	0	0	0	0	0	0	4	0	0	0	0	0	4
12	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	2
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	594	7546	6536	329	757	2320	490	1597	798	20986	644	465	1098	203	265	22551
Catch, t.	516	6760	7037	379	851	2471	595	1928	810	21347	629	572	1201	216	285	23049

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 Faroe Haddock. Catch number-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND
At 7/05/2003 11:06

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

YEAR / AGE	1961	1962
0	0	0
1	0	0
2	7932	9631
3	7330	13977
4	5134	5233
5	1937	2361
6	1305	1407
7	838	868
8	236	270
9	59	72
+gp	0	0
0 TOTALNUM	24771	33819
TONSLAND	20831	27151
SOPCOF %	89	90

YEAR / AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	13552	2284	1368	1081	1425	5881	2384	1728	717	750
3	8907	7457	4286	3304	2405	4097	7539	4855	4393	3744
4	7403	3899	5133	4804	2599	2812	4567	6581	4727	4179
5	2242	2360	1443	2710	1785	1524	1565	1624	3267	2706
6	1539	1120	1209	1112	1426	1526	1485	1383	1292	1171
7	860	728	673	740	631	923	1224	1099	864	696
8	257	198	1345	180	197	230	378	326	222	180
9	75	49	43	54	52	68	114	68	147	113
+gp	0	0	0	0	0	0	0	0	0	0
0 TOTALNUM	34835	18095	15500	13985	10520	17061	19256	17664	15629	13539
TONSLAND	27571	19490	18479	18766	13381	17852	23272	21361	19393	16485
SOPCOF %	90	101	94	109	102	103	108	103	99	98

YEAR / AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	3300	5633	7337	4396	255	32	1	143	74	539
3	8388	2899	7952	7858	4039	1022	1161	58	455	934
4	1236	3970	2097	6798	5168	4248	1754	3724	202	784
5	2786	451	1371	1251	4918	4054	3341	2583	2586	298
6	916	976	247	1189	2128	1841	1850	2496	1354	2182
7	1051	466	352	298	946	717	772	1568	1559	973
8	150	535	237	720	443	635	212	660	608	1166
9	68	68	419	258	731	243	155	99	177	1283
+gp	11	147	187	318	855	312	74	86	36	214
0 TOTALNUM	17906	15145	20199	23086	19483	13104	9320	11417	7051	8373
TONSLAND	17976	14773	20715	26211	25555	19200	12418	15016	12233	11937
SOPCOF %	98	97	117	107	98	99	104	100	109	92

YEAR / AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	441	1195	985	230	283	655	63	105	77	40
3	1969	1561	4553	2549	1718	444	1518	1275	1044	154
4	383	2462	2196	4452	3565	2463	658	1921	1774	776
5	422	147	1242	1522	2972	3036	2787	768	1248	1120
6	93	234	169	738	1114	2140	2554	1737	651	959
7	1444	42	91	39	529	475	1976	1909	1101	335
8	740	861	61	130	83	151	541	885	698	373
9	947	388	503	71	48	18	133	270	317	401
+gp	795	968	973	712	334	128	81	108	32	162
0 TOTALNUM	7234	7858	10773	10443	10646	9510	10311	8978	6942	4320
TONSLAND	12894	12378	15143	14477	14882	12178	14325	11726	8429	5476
SOPCOF %	106	106	106	101	102	97	100	102	106	106

YEAR / AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0
2	113	277	804	326	77	106	174	1461	4504	1555
3	298	191	452	5234	2913	1055	1142	3061	3216	14406
4	274	307	235	1019	10517	5269	942	210	2491	2954
5	554	153	226	179	710	9856	4677	682	178	1231
6	538	423	132	163	116	446	6619	2685	464	136
7	474	427	295	161	123	99	226	2846	1184	245
8	131	383	290	270	93	87	26	79	1414	865
9	201	125	262	234	220	95	20	1	17	1124
+gp	185	301	295	394	516	502	192	71	18	35
0 TOTALNUM	2768	2587	2991	7980	15285	17515	14018	11096	13486	22551
TONSLAND	4026	4252	4948	9642	17924	22210	18482	15821	16339	25584
SOPCOF %	104	100	103	100	103	101	100	104	100	100

Table 2.4.6 Faroe Haddock. Catch weights-at-age.

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

   At  7/05/2003  11:06
```

Table 2 Catch weights-at-age (kg)

YEAR / AGE	1961	1962
0	.0000	.0000
1	.0000	.0000
2	.4700	.4700
3	.7300	.7300
4	1.1300	1.1300
5	1.5500	1.5500
6	1.9700	1.9700
7	2.4100	2.4100
8	2.7600	2.7600
9	3.0700	3.0700
+gp	3.5500	3.5500
0 SOPCOFAC	.8938	.9011

YEAR / AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
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
0 SOPCOFAC	.8964	1.0131	.9401	1.0920	1.0166	1.0278	1.0835	1.0274	.9874	.9795

YEAR / AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.4700	.4700	.4700	.4700	.3110	.3570	.3570	.6430	.4520	.7000
3	.7300	.7300	.7300	.7300	.6330	.7900	.6720	.7130	.7250	.8960
4	1.1300	1.1300	1.1300	1.1300	1.0440	1.0350	.8940	.9410	.9570	1.1500
5	1.5500	1.5500	1.5500	1.5500	1.4260	1.3980	1.1560	1.1570	1.2370	1.4440
6	1.9700	1.9700	1.9700	1.9700	1.8250	1.8700	1.5900	1.4930	1.6510	1.4980
7	2.4100	2.4100	2.4100	2.4100	2.2410	2.3500	2.0700	1.7390	2.0530	1.8290
8	2.7600	2.7600	2.7600	2.7600	2.2050	2.5970	2.5250	2.0950	2.4060	1.8870
9	3.0700	3.0700	3.0700	3.0700	2.5700	3.0140	2.6960	2.4650	2.7250	1.9610
+gp	3.5500	3.5500	3.5500	3.5500	2.5910	2.9200	3.5190	3.3100	3.2500	2.8560
0 SOPCOFAC	.9776	.9718	1.1712	1.0746	.9784	.9947	1.0380	1.0017	1.0870	.9238

YEAR / AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.4700	.6810	.5280	.6080	.6050	.5010	.5800	.4380	.5470	.5250
3	.7400	1.0110	.8590	.8870	.8310	.7810	.7790	.6990	.6930	.7240
4	1.0100	1.2550	1.3910	1.1750	1.1260	.9740	.9230	.9390	.8840	.8170
5	1.3200	1.8120	1.7770	1.6310	1.4620	1.3630	1.2070	1.2040	1.0860	1.0380
6	1.6600	2.0610	2.3260	1.9840	1.9410	1.6800	1.5640	1.3840	1.2760	1.2490
7	2.0500	2.0590	2.4400	2.5190	2.1730	1.9750	1.7460	1.5640	1.4770	1.4300
8	2.2600	2.1370	2.4010	2.5830	2.3470	2.3440	2.0860	1.8180	1.5740	1.5640
9	2.5400	2.3680	2.5320	2.5700	3.1180	2.2480	2.4240	2.1680	1.9300	1.6330
+gp	3.0400	2.6860	2.6860	2.9220	2.9330	3.2950	2.5140	2.3350	2.1530	2.1260
0 SOPCOFAC	1.0554	1.0602	1.0559	1.0141	1.0197	.9695	1.0025	1.0195	1.0635	1.0554

YEAR / AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.7550	.7540	.6660	.5340	.5190	.6220	.5040	.6610	.6080	.5840
3	.9820	1.1030	1.0540	.8580	.7710	.8460	.6240	.9360	.9400	.8570
4	1.0270	1.2540	1.4890	1.4590	1.0660	1.0160	.9740	1.1660	1.3740	1.4050
5	1.1920	1.4650	1.7790	1.9930	1.7990	1.2830	1.2200	1.4830	1.7790	1.7990
6	1.3780	1.5930	1.9400	2.3300	2.2700	2.0800	1.4900	1.6160	1.9710	1.9740
7	1.6430	1.8040	2.1820	2.3510	2.3400	2.5560	2.4560	1.8930	2.1190	2.3010
8	1.7960	2.0490	2.3570	2.4690	2.4750	2.5720	2.6580	2.8210	2.3730	2.3700
9	1.9710	2.2250	2.4900	2.7770	2.5010	2.4520	2.5980	3.7490	2.7500	2.6260
+gp	2.2400	2.4230	2.6780	2.5820	2.6760	2.7530	2.9530	3.1960	3.9660	3.1300
0 SOPCOFAC	1.0361	.9969	1.0331	1.0043	1.0250	1.0106	.9975	1.0363	.9964	1.0008

Table 2.4.7 Faroe Haddock. Proportion mature-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2003 11:06

Table 5 Proportion mature-at-age

YEAR AGE	1961	1962
0	.0000	.0000
1	.0000	.0000
2	.0600	.0600
3	.4800	.4800
4	.9100	.9100
5	1.0000	1.0000
6	1.0000	1.0000
7	1.0000	1.0000
8	1.0000	1.0000
9	1.0000	1.0000
+gp	1.0000	1.0000

YEAR AGE	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
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

YEAR AGE	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0600	.0800
3	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.4800	.6200
4	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.8900
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

YEAR AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0800	.0800	.0300	.0300	.0500	.0500	.0200	.0800	.1600	.1800
3	.6200	.7600	.6200	.4300	.3200	.2400	.2200	.3700	.5800	.6500
4	.8900	.9800	.9600	.9500	.9100	.8900	.8700	.9000	.9300	.9100
5	1.0000	1.0000	1.0000	.9900	.9800	.9800	.9900	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

YEAR AGE	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.1100	.0500	.0300	.0300	.0100	.0100	.0100	.0200	.0900	.0800
3	.5000	.4200	.4700	.4700	.4700	.3600	.3500	.3600	.5400	.4900
4	.8500	.8600	.9100	.9300	.9100	.8700	.8600	.8700	.9300	.9700
5	.9700	.9600	.9600	.9800	1.0000	.9900	.9900	.9900	1.0000	1.0000
6	.9900	.9900	.9900	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 Faroe Haddock

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY1.dat
102
SUMMER SURVEY
1996 2002
1 1 0.6 0.7
1 8
 200  72162.43  30779.82  63552.89   1729.67    215.02   273.61   252.65   426.64
 200  92544.30   9956.23  29234.27  44161.34   1079.06   176.28    82.31   164.08
 200  21020.47   1624.49   3446.12  15319.19  17887.29   303.13    90.97    74.63
 200  18854.27   8834.36   5848.11   1611.97   8698.55  9904.61   193.37     7.86
 200 168129.70  17172.19   8140.46    575.70   1578.78  5019.44  5432.45    87.29
 200 136589.10  99542.02  12671.66   4803.72    208.54   720.33  2703.14  3074.09
 200 110026.40  48005.29  57580.07   6097.66   1893.65   176.59   427.23  1222.96
SPRING SURVEY
1993 2002
1 1 0.95 1.0
0 6
 100   16650.20   1968.10    284.80   335.20    217.80   312.80   350.40
 100   41978.10  19710.90   1403.70   255.00    164.20    62.90   150.60
 100   29057.60  30653.90  21556.40   851.30    121.70    78.40    63.60
 100    3191.60   7215.50  16758.60 25078.00    718.70   132.60    44.20
 100    3628.60    355.40   4193.90 10696.30  12426.70   359.80     9.40
 100    5180.30   6727.10    121.20  1535.20   4317.00  3256.30    55.80
 100   26833.10   8255.60   4781.30   248.20    530.10  1825.50  1811.80
 100   30855.60  36159.40   3604.10  1167.00     32.80   136.50   438.70
 100   22182.00   9302.10  30604.80  5001.40   1167.00    54.60   111.30
 100   20184.30  24915.90   7204.80 14485.90   1570.30   371.10     8.30
•
```

Table 2.4.9 Faroe Haddock

```
Lowestoft VPA Version 3.1

    7/05/2003  10:35

 Extended Survivors Analysis

 FAROE HADDOCK (ICES DIVISION Vb)                HAD_IND

 CPUE data from file D:\Vpa\vpa2003\yc-est\comb-survey1.dat

 Catch data for  42 years. 1961 to 2002. Ages  0 to  10.

      Fleet             First  Last  First  Last  Alpha   Beta
                         year  year   age    age
 SUMMER SURVEY           1996  2002    1      8    .600    .700
 SPRING SURVEY           1993  2002    0      6    .950   1.000


 Time-series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    2

         Regression type = C
         Minimum of   5 points used for regression
         Survivor estimates shrunk to the population mean for ages <  2


      Catchability independent of age for ages >=    6


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning converged after   30 iterations

1


 Regression weights
         1.000  1.000  1.000  1.000  1.000  1.000  1.000  1.000  1.000  1.000
```

Table 2.4.9 (cont.)

Fishing mortalities

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.071	.050	.010	.009	.011	.040	.013	.073	.052	.037
3	.167	.165	.107	.084	.105	.212	.766	.322	.227	.236
4	.188	.260	.314	.371	.241	.280	.299	.299	.473	.336
5	.197	.152	.310	.420	.482	.373	.432	.368	.448	.455
6	.194	.227	.190	.386	.533	.644	.463	.477	.461	.748
7	.198	.233	.244	.374	.570	1.322	.820	.370	.399	.474
8	.159	.244	.246	.370	.386	1.088	2.145	.782	.317	.576
9	.188	.224	.262	.321	.591	.885	.805	.437	.374	.451

XSA population numbers (Thousands)

	AGE									
YEAR	0	1	2	3	4	5	6	7	8	9
1993	1.33E+05	7.74E+03	1.82E+03	2.14E+03	1.77E+03	3.43E+03	3.37E+03	2.91E+03	9.85E+02	1.30E+03
1994	5.94E+04	1.09E+05	6.34E+03	1.39E+03	1.48E+03	1.20E+03	2.30E+03	2.27E+03	1.96E+03	6.88E+02
1995	1.12E+04	4.86E+04	8.90E+04	4.94E+03	9.64E+02	9.37E+02	8.42E+02	1.50E+03	1.47E+03	1.26E+03
1996	4.47E+03	9.19E+03	3.98E+04	7.22E+04	3.63E+03	5.77E+02	5.62E+02	5.70E+02	9.64E+02	9.43E+02
1997	2.27E+04	3.66E+03	7.53E+03	3.23E+04	5.44E+04	2.05E+03	3.10E+02	3.13E+02	3.21E+02	5.45E+02
1998	3.43E+04	1.86E+04	3.00E+03	6.09E+03	2.38E+04	3.50E+04	1.04E+03	1.49E+02	1.45E+02	1.79E+02
1999	1.45E+05	2.81E+04	1.52E+04	2.36E+03	4.03E+03	1.47E+04	1.97E+04	4.46E+02	3.25E+01	4.00E+01
2000	7.09E+04	1.19E+05	2.30E+04	1.23E+04	8.98E+02	2.45E+03	7.82E+03	1.02E+04	1.61E+02	3.12E+00
2001	7.07E+04	5.81E+04	9.75E+04	1.75E+04	7.30E+03	5.45E+02	1.39E+03	3.98E+03	5.74E+03	6.02E+01
2002	3.70E+04	5.78E+04	4.75E+04	7.57E+04	1.14E+04	3.72E+03	2.85E+02	7.17E+02	2.18E+03	3.42E+03

Estimated population abundance at 1st Jan 2003

0.00E+00	3.03E+04	4.74E+04	3.75E+04	4.90E+04	6.69E+03	1.93E+03	1.10E+02	3.65E+02	1.01E+03

Taper weighted geometric mean of the VPA populations:

2.83E+04	2.34E+04	1.92E+04	1.46E+04	9.27E+03	5.52E+03	3.30E+03	1.95E+03	9.77E+02	4.36E+02

Standard error of the weighted Log(VPA populations) :

1.0389	1.0439	1.0457	1.0141	1.0012	1.0006	1.0124	.9820	1.1478	1.4763

Log-catchability residuals.

Fleet : SUMMER SURVEY

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	No data for this fleet at this age									
1	99.99	99.99	99.99	1.29	3.31	-4.88	-5.78	2.47	2.27	1.32
2	99.99	99.99	99.99	-.07	.46	-.41	-.36	-.07	.23	.21
3	99.99	99.99	99.99	-.13	-.08	-.48	1.35	-.26	-.23	-.17
4	99.99	99.99	99.99	-.17	.28	.07	-.39	.08	.22	-.08
5	99.99	99.99	99.99	-.29	.09	.00	.18	.22	-.25	.04
6	99.99	99.99	99.99	-.13	.12	-.47	-.05	.21	-.02	.35
7	99.99	99.99	99.99	-.23	-.63	.70	.04	-.05	.21	.13
8	99.99	99.99	99.99	-.24	-.08	.38	.31	.24	-.08	.13

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

Age	2	3	4	5	6	7	8
Mean Log q	-5.3460	-5.1158	-5.4978	-5.5925	-5.5075	-5.5075	-5.5075
S.E(Log q)	.3215	.6105	.2336	.1989	.2645	.4095	.2530

Table 2.4.9 (cont.)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	4.43	-2.477	-16.25	.09	7	4.07	-4.19

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	.90	.975	5.79	.95	7	.29	-5.35
3	1.36	-1.490	3.43	.77	7	.76	-5.12
4	.93	1.036	5.73	.98	7	.22	-5.50
5	.93	1.653	5.77	.99	7	.16	-5.59
6	1.02	-.215	5.48	.97	7	.29	-5.51
7	1.03	-.210	5.45	.93	7	.46	-5.48
8	1.09	-1.935	5.35	.99	7	.21	-5.41

Fleet : SPRING SURVEY

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	-.97	1.66	2.60	-.84	-2.21	-1.92	-.12	.88	.23	.69
1	-.05	-.55	.67	.99	-.90	.22	.00	-.07	-.62	.30
2	-.27	.06	.11	.66	.94	-1.66	.37	-.27	.41	-.34
3	-.29	-.13	-.25	.43	.40	.23	-.10	-.64	.37	-.02
4	-.18	-.21	-.03	.48	.49	.30	.00	-1.28	.36	.08
5	-.26	-.85	-.23	.88	.67	-.07	.28	-.58	.08	.08
6	.29	-.14	-.03	.20	-.61	.07	.43	-.05	.29	-.44
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	3	4	5	6
Mean Log q	-5.9242	-5.8135	-6.1443	-6.3546	-6.7754
S.E(Log q)	.7175	.3520	.5188	.5292	.3321

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.97	-1.962	.34	.34	10	1.62	-5.39
1	.93	.387	5.94	.80	10	.62	-5.63

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	.83	1.256	6.58	.87	10	.57	-5.92
3	.89	1.603	6.18	.97	10	.29	-5.81
4	.80	2.621	6.61	.95	10	.32	-6.14
5	1.03	-.181	6.32	.86	10	.57	-6.35
6	.86	2.439	6.85	.98	10	.23	-6.78

Table 2.4.9 (cont.)

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	1.	.000	.000	.00	0	.000	.000
SPRING SURVEY	60348.	1.712	.000	.00	1	.271	.000
P shrinkage mean	23412.	1.04				.729	.000
F shrinkage mean	0.	.50				.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
30264.	.89	.81	2	.907	.000

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	176632.	4.444	.000	.00	1	.014	.000
SPRING SURVEY	63594.	.623	.026	.04	2	.727	.000
P shrinkage mean	19204.	1.05				.258	.000
F shrinkage mean	0.	.50				.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
47359.	.53	.36	4	.685	.000

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

Year class = 2000

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	46891.	.343	.155	.45	2	.497	.030
SPRING SURVEY	25204.	.473	.270	.57	3	.261	.054
F shrinkage mean	36427.	.50				.242	.038

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
37517.	.24	.15	6	.628	.037

Age 3 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	56932.	.304	.160	.53	3	.388	.206
SPRING SURVEY	50510.	.294	.091	.31	4	.423	.230
F shrinkage mean	33544.	.50				.189	.328

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48981.	.20	.10	8	.527	.236

Table 2.4.9 (cont.)

Age 4 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	6054.	.216	.132	.61	4	.516	.366
SPRING SURVEY	7620.	.259	.176	.68	5	.335	.301
F shrinkage mean	7079.	.50				.150	.320

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6694.	.16	.09	10	.590	.336

Age 5 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	1958.	.183	.121	.66	5	.575	.450
SPRING SURVEY	1787.	.248	.211	.85	6	.267	.485
F shrinkage mean	2113.	.50				.158	.423

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1934.	.15	.09	12	.635	.455

Age 6 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
SUMMER SURVEY	122.	.167	.150	.90	6	.531	.698
SPRING SURVEY	69.	.230	.171	.74	7	.295	1.021
F shrinkage mean	181.	.50				.174	.520

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
110.	.14	.13	14	.946	.748

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	381.	.157	.103	.65	7	.577	.459
SPRING SURVEY	456.	.208	.179	.86	7	.265	.396
F shrinkage mean	217.	.50				.158	.703

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
365.	.13	.10	15	.792	.474

Table 2.4.9 (cont.)

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	1157.	.156	.030	.19	7	.650	.517
SPRING SURVEY	1222.	.208	.114	.55	7	.175	.495
F shrinkage mean	490.	.50				.175	.954

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1005.	.14	.10	15	.747	.576

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	1743.	.161	.047	.29	6	.612	.460
SPRING SURVEY	2376.	.204	.124	.61	7	.185	.356
F shrinkage mean	1484.	.50				.203	.522

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1787.	.15	.06	14	.418	.451

Table 2.4.10 Faroe Haddock. Fishing mortality (F) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2003 11:06

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1961	1962
AGE		
0	.0000	.0000
1	.0000	.0000
2	.1875	.3232
3	.4162	.5866
4	.4209	.5980
5	.4387	.3480
6	.5879	.6706
7	.9483	1.0499
8	.8742	.9736
9	.6600	.7351
+gp	.6600	.7351
0 FBAR 3- 7	.5624	.6506

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.3801	.0876	.0691	.0609	.0641	.1261	.0860	.0552	.0526	.0253
3	.5639	.3723	.2354	.2370	.1873	.2647	.2364	.2529	.1937	.4228
4	.7261	.5193	.4767	.4515	.2971	.3483	.5320	.3345	.4187	.2855
5	.5591	.5369	.3678	.5006	.2997	.2847	.3330	.3639	.2755	.4520
6	.4026	.6107	.5882	.5421	.5406	.4540	.4975	.5559	.5560	.1495
7	1.2493	.3375	.9618	.9128	.6906	.8367	.8276	.8739	.8378	.6720
8	1.1139	1.2027	2.3618	.7509	.6634	.5851	1.0631	.5429	.4224	.4059
9	.8185	.6472	.9619	.6373	.5022	.5057	.6566	.5386	.5060	.3957
+gp	.8185	.6472	.9619	.6373	.5022	.5057	.6566	.5386	.5060	.3957
0 FBAR 3- 7	.7002	.4753	.5260	.5288	.4030	.4377	.4853	.4762	.4564	.3964

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.1672	.1266	.1230	.0908	.0108	.0010	.0004	.0325	.0237	.0383
3	.4308	.2172	.2650	.1878	.1128	.0547	.0457	.0285	.1373	.4617
4	.2385	.3730	.2412	.3810	.1815	.1665	.1254	.2025	.1314	.3708
5	.3134	.1279	.2116	.2216	.5273	.2115	.1912	.2749	.2112	.2917
6	.2695	.1714	.0957	.2871	.7246	.3820	.1408	.2135	.2264	.2775
7	.1946	.2134	.0859	.1601	.3904	.5760	.2721	.1702	.2004	.2523
8	.2907	.1433	.1599	.2539	.3788	.4968	.3303	.3954	.0920	.2266
9	.2627	.2068	.1595	.2621	.4437	.3689	.2130	.2526	.1730	.2854
+gp	.2627	.2068	.1595	.2621	.4437	.3689	.2130	.2526	.1730	.2854
0 FBAR 3- 7	.2894	.2206	.1799	.2475	.3873	.2781	.1551	.1779	.1813	.3308

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0252	.0329	.0280	.0097	.0338	.0394	.0048	.0129	.0295	.0168
3	.1917	.1167	.1693	.0940	.0927	.0681	.1208	.1273	.1717	.0760
4	.3480	.3895	.2392	.2489	.1845	.1864	.1364	.2212	.2624	.1864
5	.3498	.2171	.3474	.2597	.2619	.2366	.3330	.2336	.2187	.2631
6	.1382	.3335	.4162	.3588	.3081	.3056	.3206	.3579	.3180	.2607
7	.2991	.0853	.2083	.1572	.4745	.2081	.5160	.4232	.4051	.2683
8	.3101	.2929	.1720	.5177	.5844	.2379	.3884	.4612	.2683	.2315
9	.2907	.2651	.2781	.3103	.3650	.2361	.3410	.3415	.2962	.2432
+gp	.2907	.2651	.2781	.3103	.3650	.2361	.3410	.3415	.2962	.2432
0 FBAR 3- 7	.2654	.2284	.2761	.2237	.2643	.2010	.2854	.2726	.2752	.2109

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0710	.0495	.0100	.0091	.0114	.0399	.0127	.0727	.0524	.0368
3	.1670	.1648	.1067	.0835	.1050	.2124	.7658	.3217	.2266	.2360
4	.1881	.2597	.3138	.3710	.2406	.2805	.2986	.2990	.4734	.3360
5	.1968	.1522	.3101	.4199	.4818	.3730	.4324	.3677	.4476	.4548
6	.1943	.2268	.1902	.3861	.5328	.6441	.4633	.4769	.4609	.7485
7	.1982	.2331	.2444	.3741	.5696	1.3224	.8203	.3704	.3992	.4741
8	.1590	.2438	.2456	.3703	.3858	1.0881	2.1448	.7825	.3175	.5758
9	.1881	.2242	.2622	.3206	.5906	.8852	.8047	.4373	.3739	.4506
+gp	.1881	.2242	.2622	.3206	.5906	.8852	.8047	.4373	.3739	.4506
0 FBAR 3- 7	.1889	.2073	.2330	.3269	.3860	.5665	.5561	.3671	.4015	.4499

Table 2.4.11 Faroe Haddock. Stock number-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2003 11:06

Terminal Fs derived using XSA (With F shrinkage)

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

	YEAR	1961	1962
	AGE		
	0	70656	44919
	1	47070	57849
	2	51279	38537
	3	23796	34806
	4	16517	12850
	5	6028	8877
	6	3245	3182
	7	1512	1476
	8	448	480
	9	135	153
	+gp	0	0
0	TOTAL	220684	203129

	YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	AGE										
	0	33781	30143	37827	81816	47691	53082	23049	49492	35342	78073
	1	36777	27658	24679	30970	66985	39046	43460	18871	40521	28935
	2	47362	30110	22644	20206	25356	54843	31968	35582	15450	33176
	3	22837	26515	22586	17302	15565	19470	39580	24016	27569	12001
	4	15850	10638	14961	14613	11176	10567	12234	25584	15270	18596
	5	5786	6278	5182	7605	7618	6798	6107	5884	14992	8225
	6	5132	2708	3005	2937	3774	4622	4187	3584	3348	9318
	7	1332	2809	1204	1366	1398	1800	2403	2084	1683	1572
	8	423	313	1641	377	449	574	638	860	712	596
	9	148	114	77	127	146	189	262	180	409	382
	+gp	0	0	0	0	0	0	0	0	0	0
0	TOTAL	169429	137286	133805	177317	180157	190991	163889	166138	155295	190874

	YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	AGE										
	0	104507	83496	39073	52361	4154	7376	5208	23623	29262	60838
	1	63921	85563	68361	31990	42870	3401	6039	4264	19341	23957
	2	23690	52334	70053	55969	26191	35099	2784	4944	3491	15835
	3	26483	16410	37750	50716	41846	21213	28708	2279	3918	2791
	4	6438	14093	10812	23712	34412	30606	16443	22453	1813	2796
	5	11444	4152	7946	6955	13263	23498	21214	11875	15014	1302
	6	4285	6849	2992	5265	4562	6409	15570	14346	7385	9952
	7	6569	2680	4724	2226	3235	1810	3581	11074	9487	4822
	8	657	4428	1772	3549	1553	1793	833	2233	7648	6356
	9	325	402	3141	1237	2254	870	893	490	1231	5711
	+gp	52	865	1396	1515	2613	1109	424	423	249	947
0	TOTAL	248372	271272	248020	235495	176953	133182	101697	98005	98840	135308

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	0	58811	39456	14055	27946	21578	13499	4367	3968	2717	9452
	1	49810	48151	32304	11507	22880	17667	11052	3575	3248	2225
	2	19615	40781	39422	26448	9421	18733	14464	9048	2927	2660
	3	12477	15660	32307	31385	21446	7458	14744	11785	7313	2327
	4	1440	8434	11409	22331	23389	16004	5704	10698	8495	5043
	5	1580	833	4677	7354	14255	15924	10874	4075	7021	5350
	6	796	912	549	2706	4644	8982	10290	6381	2641	4619
	7	6174	568	535	296	1547	2794	5417	6114	3653	1573
	8	3067	3748	427	356	207	788	1858	2647	3278	1995
	9	4149	1842	2290	294	173	95	509	1031	1367	2053
	+gp	3461	4567	4401	2930	1198	669	308	410	137	824
0	TOTAL	161380	164950	142376	133553	120739	102611	79587	59733	42798	38120

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	AGE											
	0	132839	59389	11228	4473	22697	34346	145443	70924	70651	36965	0
	1	7739	108760	48624	9193	3662	18583	28120	119079	58068	57844	30264
	2	1821	6336	89045	39810	7526	2998	15214	23023	97493	47542	47359
	3	2141	1389	4937	72176	32298	6092	2359	12299	17527	75745	37517
	4	1766	1483	964	3633	54357	23808	4033	898	7300	11440	48981
	5	3427	1198	937	577	2052	34988	14725	2450	545	3723	6694
	6	3367	2304	842	562	310	1038	19727	7824	1389	285	1934
	7	2914	2270	1504	570	313	149	446	10162	3976	717	110
	8	985	1957	1472	964	321	145	33	161	5745	2184	365
	9	1295	688	1256	943	545	179	40	3	60	3424	1005
	+gp	1187	1648	1405	1576	1264	929	378	220	63	106	1842
0	TOTAL	159481	187421	162213	134477	125347	123255	230518	247041	262818	239975	176072

Table 2.4.12 Faroe Haddock.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 7/05/2003 11:06

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1961	70656	81164	47797	20831	.4358	.5624
1962	44919	83420	51875	27151	.5234	.6506
1963	33781	80753	49547	27571	.5565	.7002
1964	30143	68577	44128	19490	.4417	.4753
1965	37827	65655	45555	18479	.4056	.5260
1966	81816	60934	43953	18766	.4270	.5288
1967	47691	60206	41959	13381	.3189	.4030
1968	53082	78075	45379	17852	.3934	.4377
1969	23049	83814	53422	23272	.4356	.4853
1970	49492	87297	59858	21361	.3569	.4762
1971	35342	81751	62908	19393	.3083	.4564
1972	78073	83079	61975	16485	.2660	.3964
1973	104507	82753	61578	17976	.2919	.2894
1974	83496	95415	64631	14773	.2286	.2206
1975	39073	121785	75405	20715	.2747	.1799
1976	52361	135610	89220	26211	.2938	.2475
1977	4154	121037	96373	25555	.2652	.3873
1978	7376	120570	97226	19200	.1975	.2781
1979	5208	97683	85394	12418	.1454	.1551
1980	23623	87636	81902	15016	.1833	.1779
1981	29262	78962	75846	12233	.1613	.1813
1982	60838	68306	56804	11937	.2101	.3308
1983	58811	63961	51811	12894	.2489	.2654
1984	39456	83382	53820	12378	.2300	.2284
1985	14055	93973	62602	15143	.2419	.2761
1986	27946	98502	65604	14477	.2207	.2237
1987	21578	87615	67294	14882	.2211	.2643
1988	13499	77373	61882	12178	.1968	.2010
1989	4367	69699	51703	14325	.2771	.2854
1990	3968	53552	43711	11726	.2683	.2726
1991	2717	38662	34663	8429	.2432	.2752
1992	9452	28997	26892	5476	.2036	.2109
1993	132839	25784	23067	4026	.1745	.1889
1994	59389	27222	21427	4252	.1984	.2073
1995	11228	82884	22389	4948	.2210	.2330
1996	4473	101356	47520	9642	.2029	.3269
1997	22697	97423	75143	17924	.2385	.3860
1998	34346	82007	73269	22210	.3031	.5665
1999	145443	62829	53552	18482	.3451	.5561
2000	70924	64457	42004	15821	.3767	.3671
2001	70651	111963	49741	16339	.3285	.4015
2002	36965	132160	73029	25584	.3503	.4499
Arith. Mean	42395	81150	56997	16219	.2907	.3508
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

See Table 2.4.18 for the summary table with recruitment at age 2!!

Table 2.4.13 Management option tables INPUT DATA FAROE HADDOCK

Stock size

The yearclasses up to 2000 included are derived from the final 2003 VPA.
The yearclasses 2001-2002 at age 2 are estimated using XSA tuned with surveys including indices for age 0-2
and apply a natural mortality of 0.2 in forward calculations of the numbers using standard VPA equations
The yearclass 2003 at age 2 in 2005 is estimated as the geomean of the yearclasses since 1980

	Age0	Age1	Age2
YC2001			47359
YC2002		30264	24778
YC2003			14267
0.818731			

Age	2003	2004	2005
2	47400	24800	14300
3	37517		
4	48981		
5	6694		
6	1934		
7	110		
8	365		
9	1005		
10+	1842		

Predicted values rounded

Year	age 2	Geomean(1980-2003)
1980	4944	
1981	3491	
1982	15835	
1983	19615	
1984	40781	
1985	39422	
1986	26448	
1987	9421	
1988	18733	14267
1989	14464	
1990	9048	
1991	2927	
1992	2660	
1993	1821	
1994	6336	
1995	89045	
1996	39810	
1997	7526	
1998	2998	
1999	15214	
2000	23023	
2001	97493	
2002	47542	
2003	47400	
2004	24800	
2005	14300	

Proportion mature at age

Age	2003	2004	2005	2001	2002	2003	Avg(01-03)
2	0.11	0.10	0.10	0.09	0.08	0.11	0.10
3	0.48	0.50	0.50	0.54	0.49	0.48	0.50
4	0.97	0.96	0.96	0.93	0.97	0.97	0.96
5	0.99	0.99	0.99	1.00	1.00	0.99	0.99
6	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
8	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
10+	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The maturity at age 2004-2005 is estimated as the
average of the maturity at age 2001-2003 (running 3-yrs average)

Catch/stock weights at age

Age	2003	2004	2005
2	0.584	0.584	0.584
3	0.805	0.805	0.805
4	1.118	1.050	1.050
5	1.826	1.452	1.364
6	2.165	2.198	1.748
7	2.149	2.358	2.393
8	2.450	2.288	2.510
9	2.438	2.520	2.354
10+	3.130	3.130	3.130

Prediction using mean catch weight at age a+1 = mean catch weight at age a in year t * Grow

	2002	2003	2004	2005	
2	0.584	0.584	0.584	0.584	Age 2 = age 2 in 2002
3	0.857	0.805	0.805	0.805	
4	1.405	1.118	1.050	1.050	
5	1.799	1.826	1.452	1.364	
6	1.974	2.165	2.198	1.748	
7	2.301	2.149	2.358	2.393	
8	2.370	2.450	2.288	2.510	
9	2.626	2.438	2.520	2.354	
10+	3.130	3.130	3.130	3.130	Age 10+ = age 10+ in 2002

Growth estimated her as the geomean since 1975

Exploitation pattern

Age	2003	2004	2005	2000	2001	2002
2	0.0540	0.0540	0.0540	0.0727	0.0524	0.0368
3	0.2614	0.2614	0.2614	0.3217	0.2266	0.236
4	0.3695	0.3695	0.3695	0.299	0.4734	0.336
5	0.4234	0.4234	0.4234	0.3677	0.4476	0.4548
6	0.4689	0.4689	0.4689	0.4769	0.4609	0.7485
7	0.4146	0.4146	0.4146	0.3704	0.3992	0.4741
8	0.4467	0.4467	0.4467	0.7825	0.3175	0.5758
9	0.4206	0.4206	0.4206	0.4373	0.3739	0.4506
10+	0.4206	0.4206	0.4206	0.4373	0.3739	0.4506
Avg3-7	0.3875	0.3875	0.3875	0.3671	0.4015	0.4499

Average F for 2000-02	
2	0.0540
3	0.2614
4	0.3695
5	0.4234
6	0.4689
7	0.4146
8	0.4467
9	0.4206
10+	0.4206
Fbar(3-7)	0.3875

The exploitation pattern is estimated from the average fishing mortality matrix 2000-2002 from the final VPA in 2002.
The high F values for age 8 in 2000 and for age 6 in 2002 have been excluded from the averaging

Table 2.4.14 Faroe Haddock. Management option table- input data

MFDP version 1
Run: farhad-mopt1
Time and date: 14:56 5/7/03
Fbar age range: 3-7

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	47400	0.2	0.11	0	0	0.584	0.0540	0.584
3	37517	0.2	0.48	0	0	0.805	0.2614	0.805
4	48981	0.2	0.97	0	0	1.118	0.3695	1.118
5	6694	0.2	0.99	0	0	1.826	0.4234	1.826
6	1934	0.2	1	0	0	2.165	0.4689	2.165
7	110	0.2	1	0	0	2.149	0.4146	2.149
8	365	0.2	1	0	0	2.450	0.4467	2.450
9	1005	0.2	1	0	0	2.438	0.4206	2.438
10	1842	0.2	1	0	0	3.130	0.4206	3.130

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	24800	0.2	0.1	0	0	0.584	0.0540	0.584
3	.	0.2	0.5	0	0	0.805	0.2614	0.805
4	.	0.2	0.96	0	0	1.050	0.3695	1.050
5	.	0.2	0.99	0	0	1.452	0.4234	1.452
6	.	0.2	1	0	0	2.198	0.4689	2.198
7	.	0.2	1	0	0	2.358	0.4146	2.358
8	.	0.2	1	0	0	2.288	0.4467	2.288
9	.	0.2	1	0	0	2.520	0.4206	2.520
10	.	0.2	1	0	0	3.130	0.4206	3.130

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14300	0.2	0.1	0	0	0.584	0.0540	0.584
3	.	0.2	0.5	0	0	0.805	0.2614	0.805
4	.	0.2	0.96	0	0	1.050	0.3695	1.050
5	.	0.2	0.99	0	0	1.364	0.4234	1.364
6	.	0.2	1	0	0	1.748	0.4689	1.748
7	.	0.2	1	0	0	2.393	0.4146	2.393
8	.	0.2	1	0	0	2.510	0.4467	2.510
9	.	0.2	1	0	0	2.354	0.4206	2.354
10	.	0.2	1	0	0	3.130	0.4206	3.130

Input units are thousands and kg - output in tonnes

Table 2.4.15 Faroe Haddock. Management option table - Results

MFDP version 1
Run: farhad-mopt1
Index file 05/05/2003
Time and date: 14:56 5/7/03
Fbar age range: 3-7

2003				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
138400	96294	1	0.3875	31294

2004					2005	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
124790	95560	0	0	0	135975	118758
.	95560	0.1	0.0388	3709	131877	114746
.	95560	0.2	0.0775	7286	127930	110884
.	95560	0.3	0.1163	10734	124128	107165
.	95560	0.4	0.155	14060	120464	103583
.	95560	0.5	0.1938	17267	116934	100134
.	95560	0.6	0.2325	20360	113532	96812
.	95560	0.7	0.2713	23344	110255	93612
.	95560	0.8	0.31	26223	107096	90530
.	95560	0.9	0.3488	29000	104051	87561
.	95560	1	0.3875	31679	101116	84701
.	95560	1.1	0.4263	34265	98288	81946
.	95560	1.2	0.4651	36760	95561	79291
.	95560	1.3	0.5038	39168	92931	76733
.	95560	1.4	0.5426	41492	90397	74268
.	95560	1.5	0.5813	43736	87952	71893
.	95560	1.6	0.6201	45902	85596	69605
.	95560	1.7	0.6588	47993	83323	67399
.	95560	1.8	0.6976	50012	81130	65273
.	95560	1.9	0.7363	51963	79016	63223
.	95560	2	0.7751	53846	76976	61248

Input units are thousands and kg - output in tonnes

Table 2.4.16 Faroe Haddock Long –term Prediction Input data

MFYPR version 1
Run: farhad-ypr1
Index file 05/05/2003
Time and date: 15:22 5/7/03
Fbar age range: 2-10

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.558	0.0759	0.558
3	0.2	0.46	0	0	0.823	0.2650	0.823
4	0.2	0.91	0	0	1.106	0.3695	1.106
5	0.2	0.99	0	0	1.443	0.3811	1.443
6	0.2	1.00	0	0	1.757	0.4558	1.757
7	0.2	1.00	0	0	2.052	0.5776	2.052
8	0.2	1.00	0	0	2.260	0.6538	2.260
9	0.2	1.00	0	0	2.504	0.4923	2.504
10	0.2	1.00	0	0	2.836	0.4923	2.836

Weights in kilograms

Table 2.4.17 Faroe Haddock Long –term Prediction Results

MFYPR version 1
Run: farhad-ypr1
Time and date: 15:22 5/7/03
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0.0000	0.0000	0.0000	5.5167	8.7665	4.0696	7.8024	4.0696	7.8024
0.1	0.0418	0.1480	0.2633	4.7798	6.9250	3.3386	5.9667	3.3386	5.9667
0.2	0.0836	0.2475	0.4122	4.2849	5.7427	2.8496	4.7900	2.8496	4.7900
0.3	0.1254	0.3194	0.5012	3.9281	4.9284	2.4983	3.9812	2.4983	3.9812
0.4	0.1673	0.3741	0.5565	3.6571	4.3378	2.2328	3.3959	2.2328	3.3959
0.5	0.2091	0.4174	0.5917	3.4431	3.8919	2.0243	2.9552	2.0243	2.9552
0.6	0.2509	0.4527	0.6144	3.2690	3.5443	1.8555	2.6126	1.8555	2.6126
0.7	0.2927	0.4822	0.6292	3.1239	3.2661	1.7155	2.3393	1.7155	2.3393
0.8	0.3345	0.5073	0.6387	3.0006	3.0384	1.5973	2.1164	1.5973	2.1164
0.9	0.3763	0.5290	0.6447	2.8941	2.8485	1.4958	1.9313	1.4958	1.9313
1	0.4181	0.5480	0.6483	2.8010	2.6878	1.4075	1.7752	1.4075	1.7752
1.1	0.4599	0.5649	0.6503	2.7185	2.5498	1.3299	1.6417	1.3299	1.6417
1.2	0.5018	0.5800	0.6511	2.6449	2.4300	1.2609	1.5263	1.2609	1.5263
1.3	0.5436	0.5936	0.6510	2.5786	2.3249	1.1993	1.4255	1.1993	1.4255
1.4	0.5854	0.6059	0.6504	2.5186	2.2319	1.1437	1.3368	1.1437	1.3368
1.5	0.6272	0.6172	0.6495	2.4638	2.1490	1.0934	1.2580	1.0934	1.2580
1.6	0.6690	0.6276	0.6482	2.4135	2.0745	1.0476	1.1876	1.0476	1.1876
1.7	0.7108	0.6372	0.6467	2.3673	2.0073	1.0056	1.1243	1.0056	1.1243
1.8	0.7526	0.6461	0.6451	2.3245	1.9462	0.9670	1.0671	0.9670	1.0671
1.9	0.7945	0.6543	0.6434	2.2848	1.8905	0.9314	1.0152	0.9314	1.0152
2	0.8363	0.6620	0.6417	2.2478	1.8395	0.8985	0.9679	0.8985	0.9679

Reference point	F multiplier	Absolute F
Fbar(2-10)	1.0000	0.4181
FMax	1.2461	0.5211
F0.1	0.4472	0.1870
F35%SPR	0.5628	0.2353
Flow	-99	
Fmed	0.5520	0.2308
Fhigh	1.9955	0.8344

Weights in kilograms

Table 2.4.18 Faroe haddock (Division Vb) Stock Summary Table

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1961	51279	47797	20831	0.5624
1962	38537	51875	27151	0.6506
1963	47362	49547	27571	0.7002
1964	30110	44128	19490	0.4753
1965	22644	45555	18479	0.5260
1966	20206	43953	18766	0.5288
1967	25356	41959	13381	0.4030
1968	54843	45379	17852	0.4377
1969	31968	53422	23272	0.4853
1970	35582	59858	21361	0.4762
1971	15450	62908	19393	0.4564
1972	33176	61975	16485	0.3964
1973	23690	61578	17976	0.2894
1974	52334	64631	14773	0.2206
1975	70053	75405	20715	0.1799
1976	55969	89220	26211	0.2475
1977	26191	96373	25555	0.3873
1978	35099	97226	19200	0.2781
1979	2784	85394	12418	0.1551
1980	4944	81902	15016	0.1779
1981	3491	75846	12233	0.1813
1982	15835	56804	11937	0.3308
1983	19615	51811	12894	0.2654
1984	40781	53820	12378	0.2284
1985	39422	62602	15143	0.2761
1986	26448	65604	14477	0.2237
1987	9421	67294	14882	0.2643
1988	18733	61882	12178	0.2010
1989	14464	51703	14325	0.2854
1990	9048	43711	11726	0.2726
1991	2927	34663	8429	0.2752
1992	2660	26892	5476	0.2109
1993	1821	23067	4026	0.1889
1994	6336	21427	4252	0.2073
1995	89045	22389	4948	0.2330
1996	39810	47520	9642	0.3269
1997	7526	75143	17924	0.3860
1998	2998	73269	22210	0.5665
1999	15214	53552	18482	0.5561
2000	23023	42004	15821	0.3671
2001	97493	49741	16339	0.4015
2002	47542	73029	25584	0.4499
2003	47400	96290		0.3875
Average	29270	57910	16219	0.3516

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3-7	Yield/R	SSB/R
Average Current	0.406	0.648	1.788
Fmax	0.511	0.651	1.478
F0.1	0.183	0.575	3.173

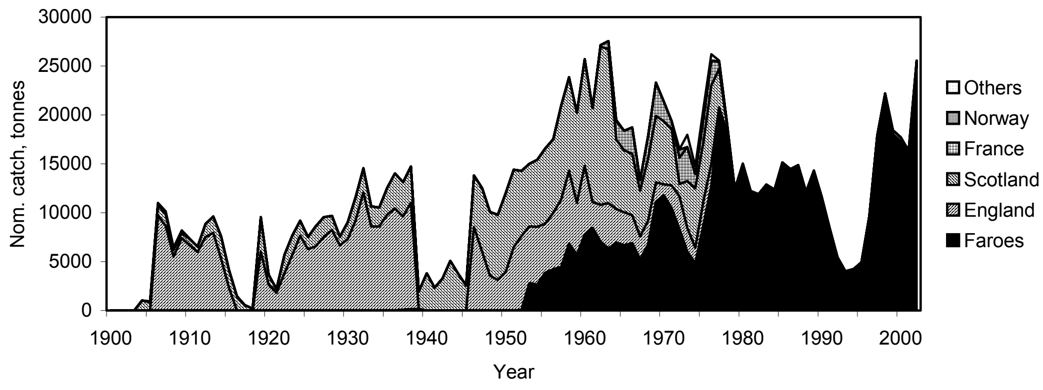


Figure 2.4.1 Faroe Haddock. Landings by all nations since 1903.

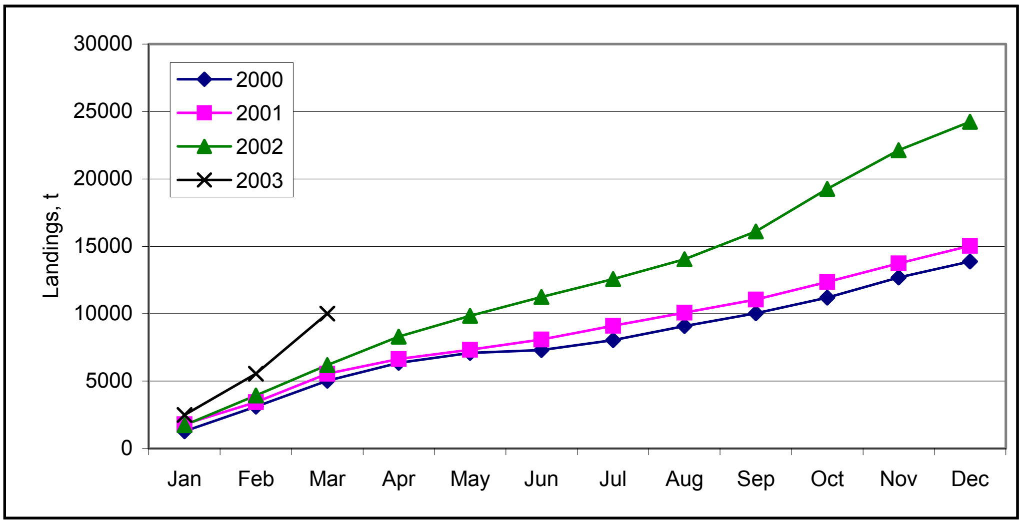
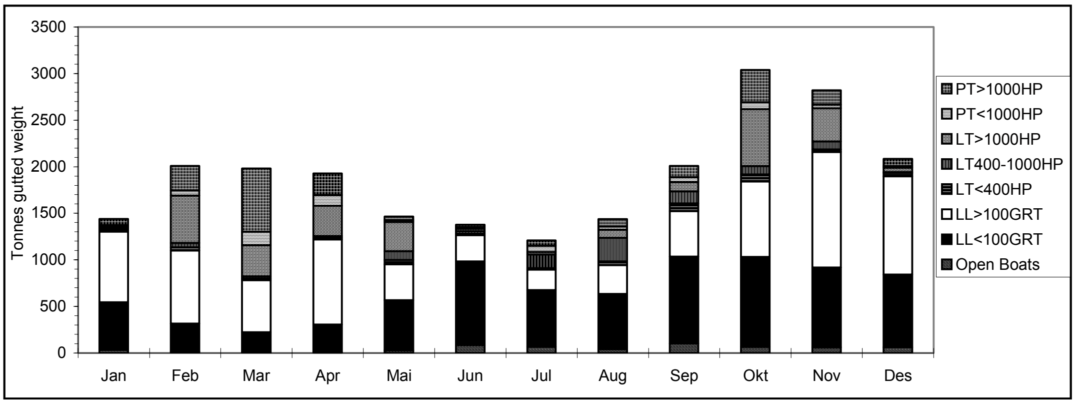


Figure 2.4.2 Faroe Haddock. Cumulative landings



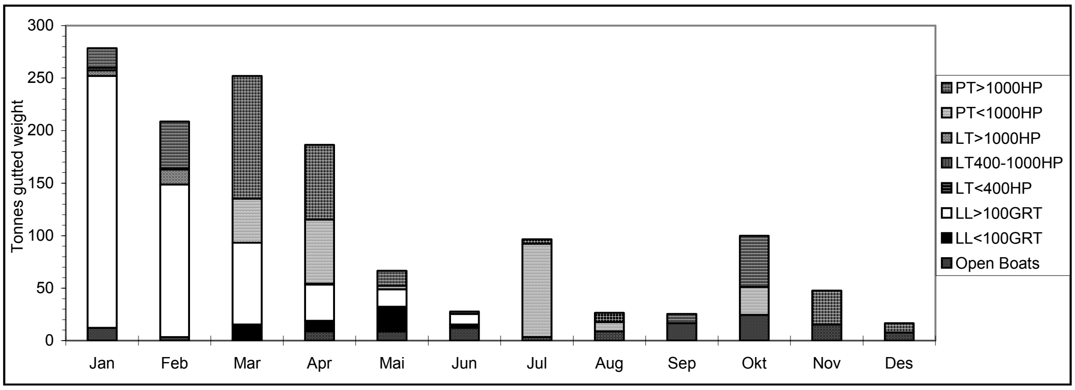


Figure 2.4.3 Faroe Haddock. Faroese landings from A) Vb1 and B) Vb2 in 2002 by fleet. Tonnes ungutted weight.

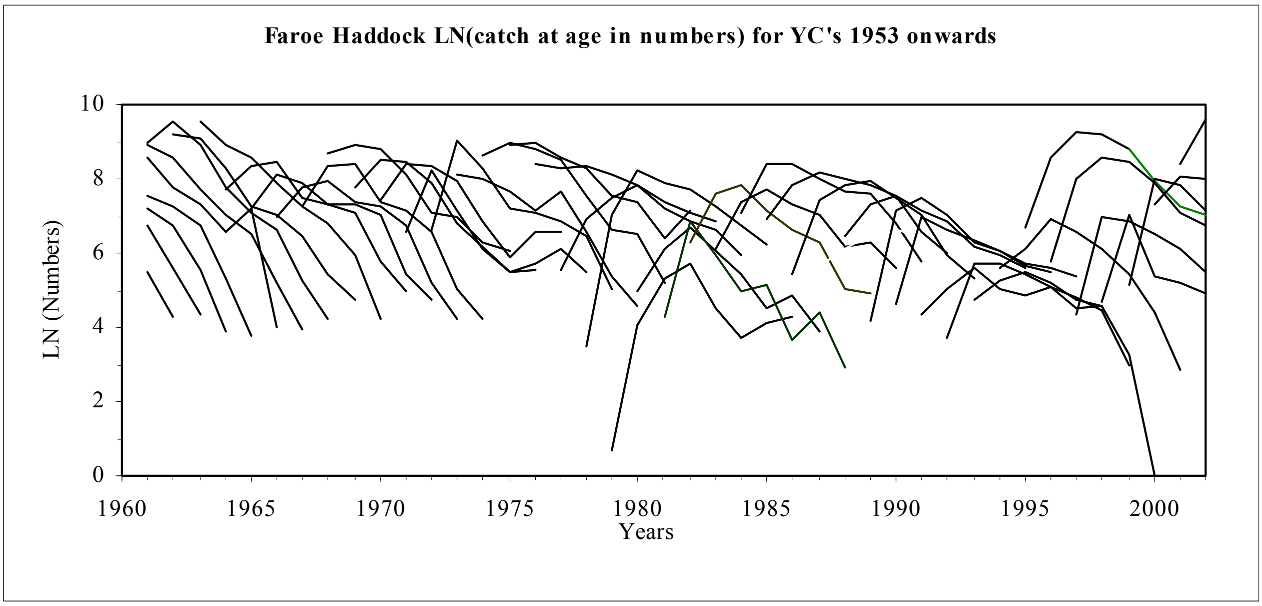


Figure 2.4.4 Faroe Haddock. LN (catch-at-age in numbers) for YC’s 1953 onwards.

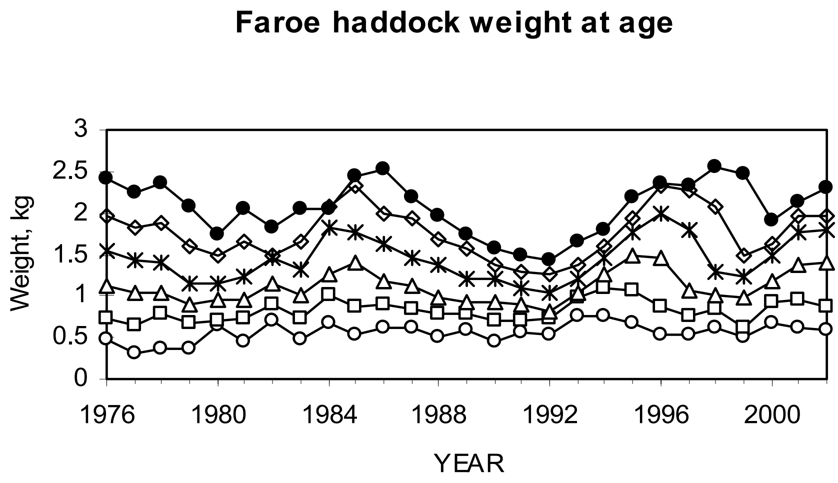


Figure 2.4.5 Faroe Haddock. Mean weight-at-age (2-7).

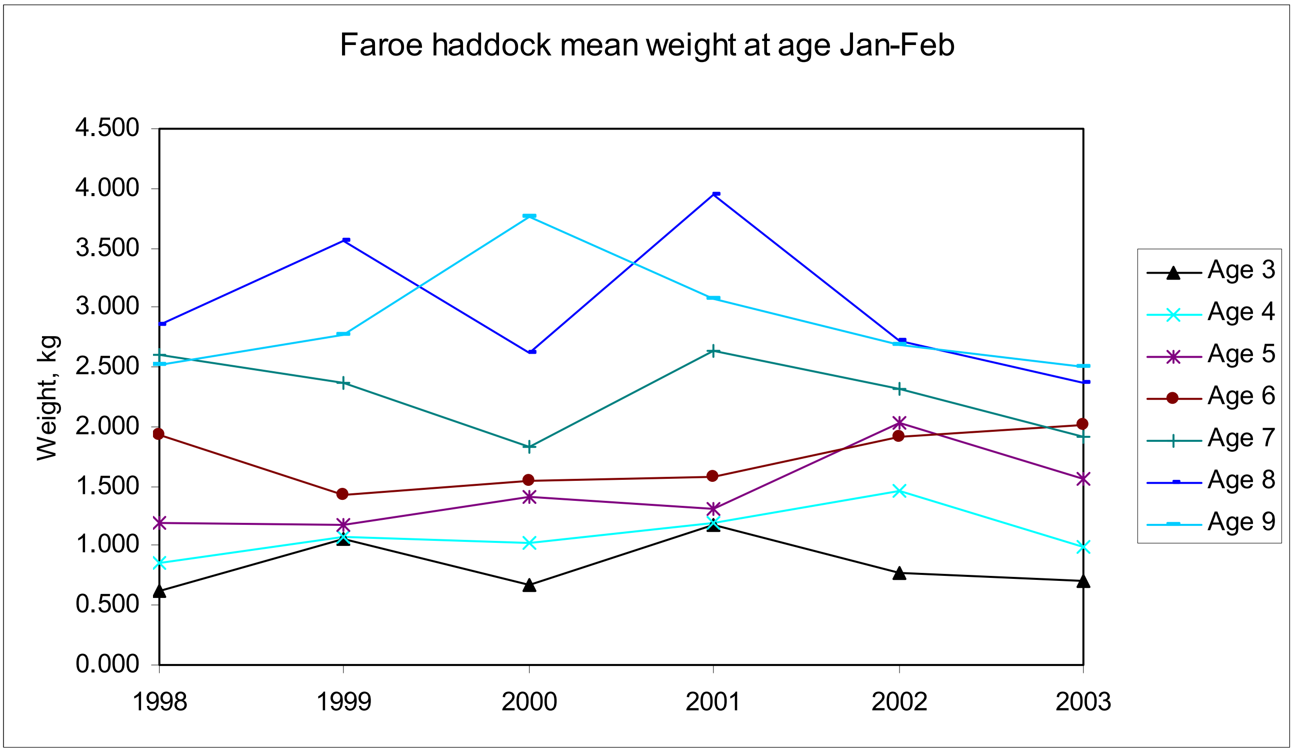
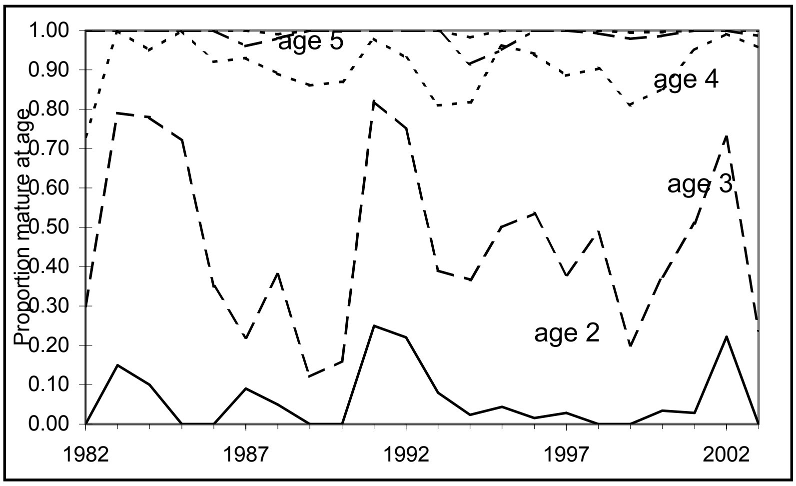
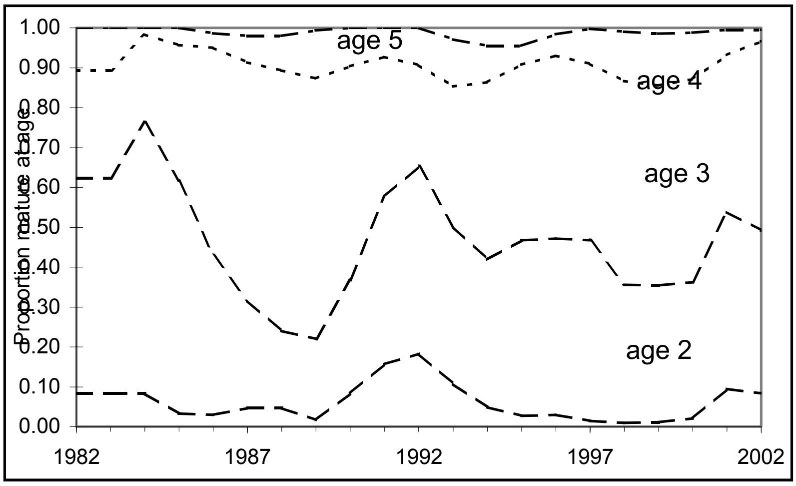


Figure 2.4.6 Faroe Haddock. Mean weight-at-age Jan-Feb.



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



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

Figure 2.4.7 Faroe Haddock. Maturity-at-age.

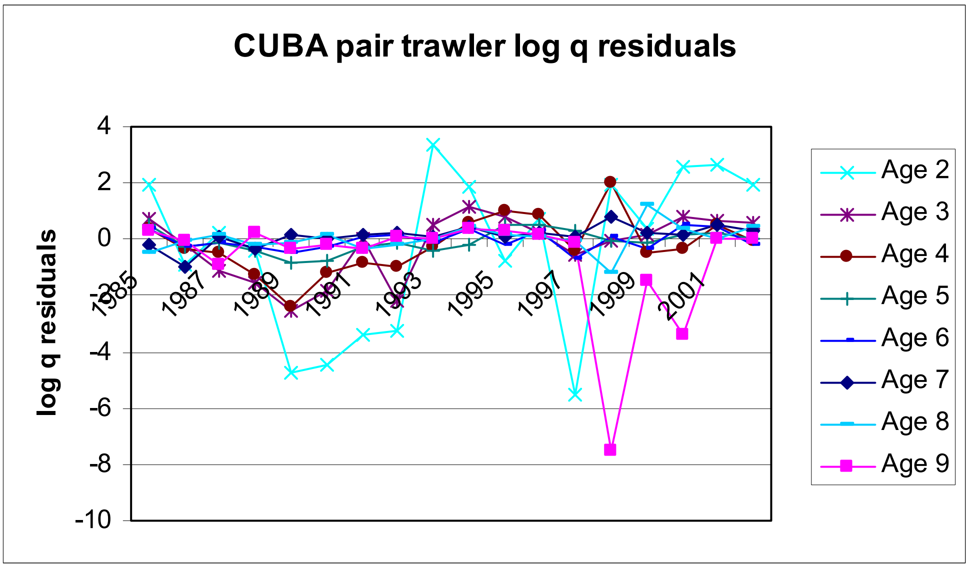


Figure 2.4.8A. Faroe Haddock.

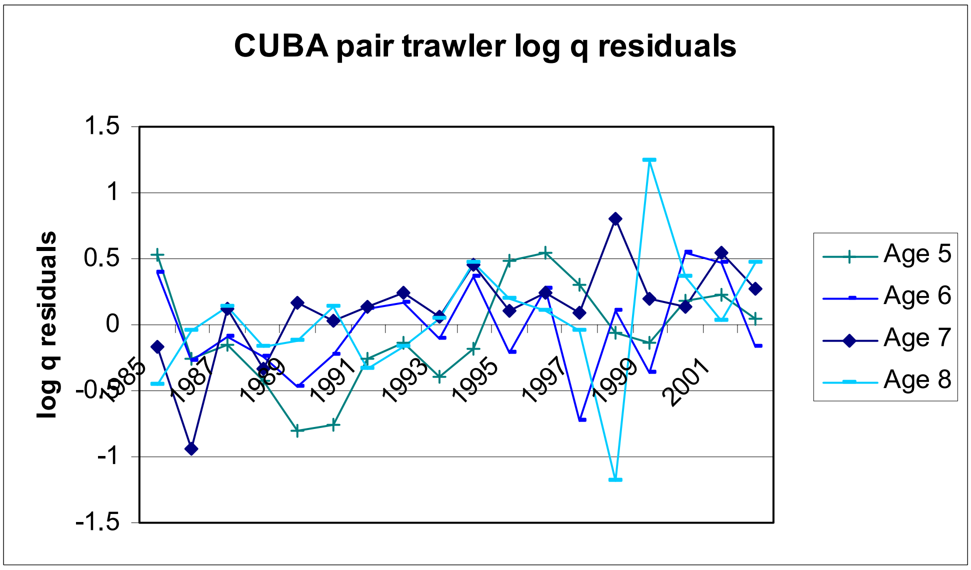


Figure 2.4.8B. Faroe Haddock.

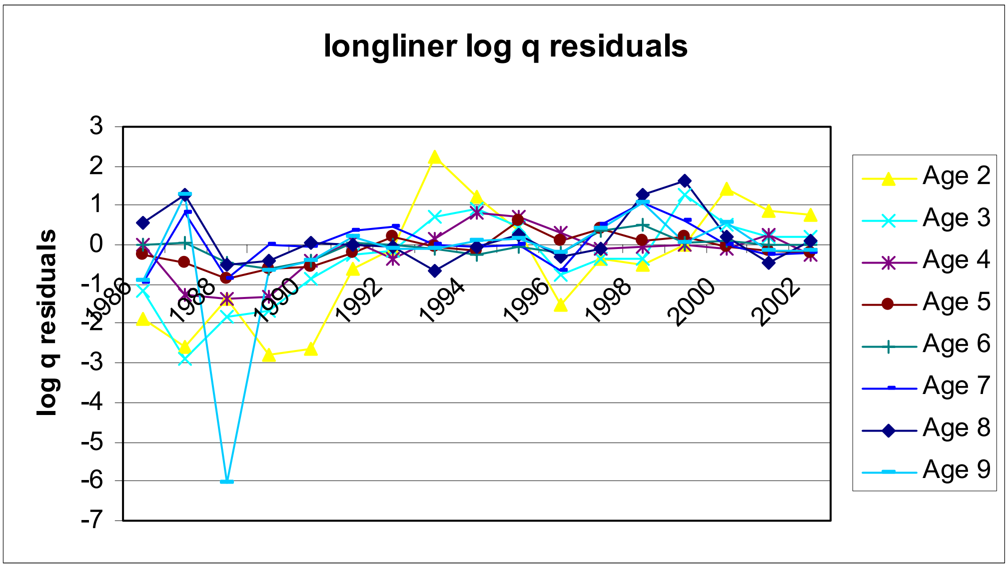


Figure 2.4.9A. Faroe Haddock.

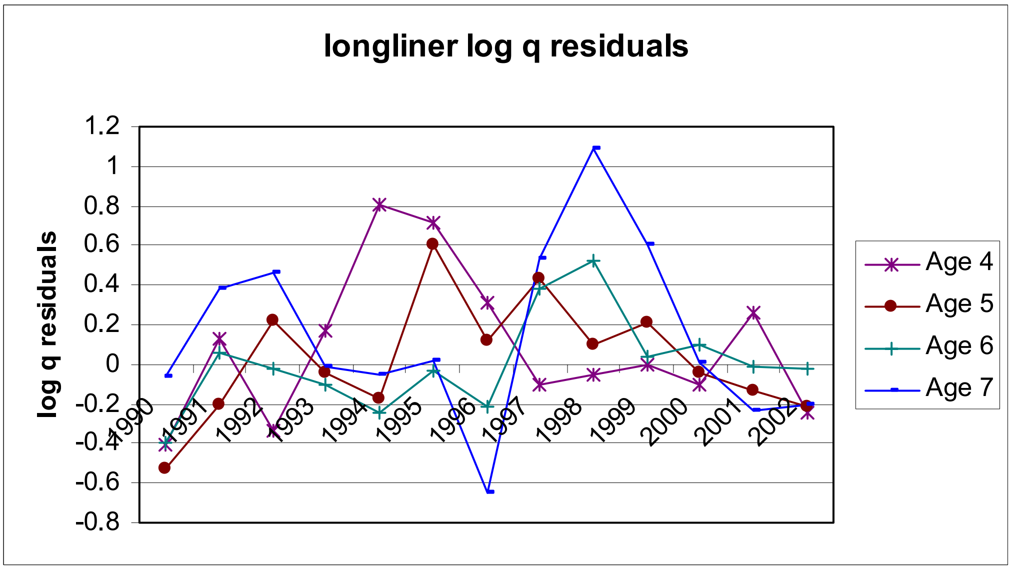


Figure 2.4.9B. Faroe Haddock.

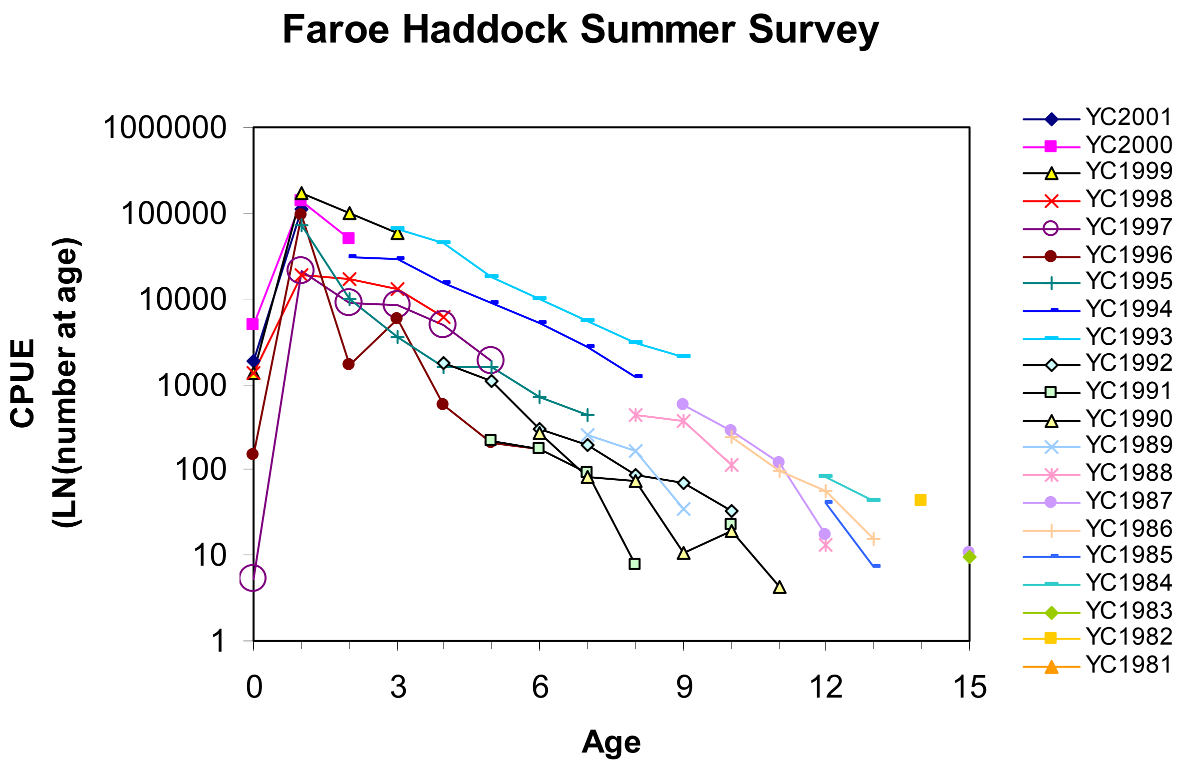
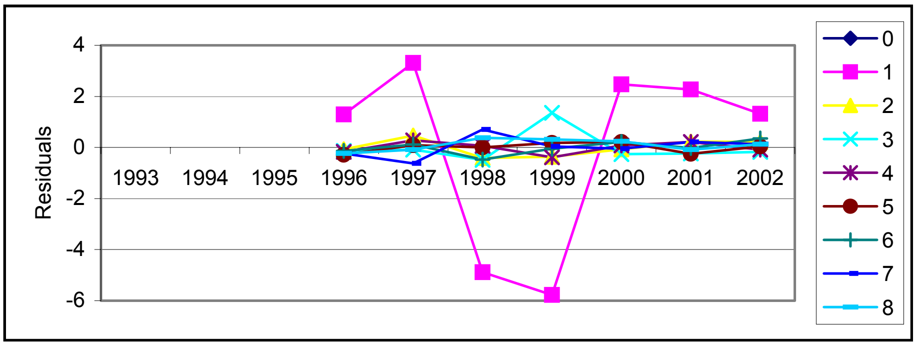


Figure 2.4.10 Faroe haddock. LN(catch-at-age in numbers).



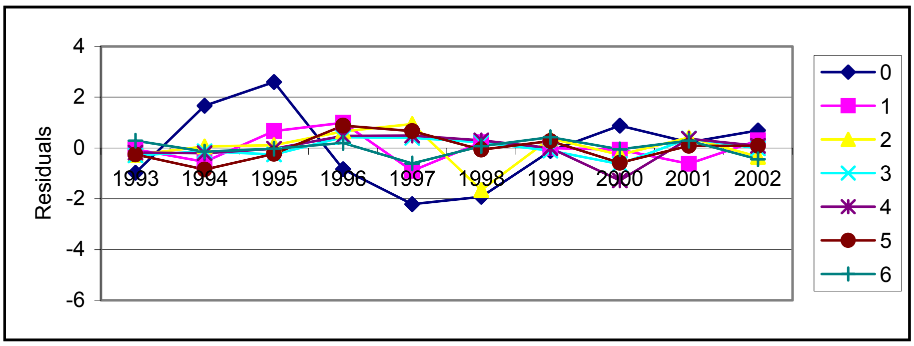


Figure 2.4.11 Log q Residuals from the accepted runs. Upper figure is the summer survey and the lower figure is the spring survey.

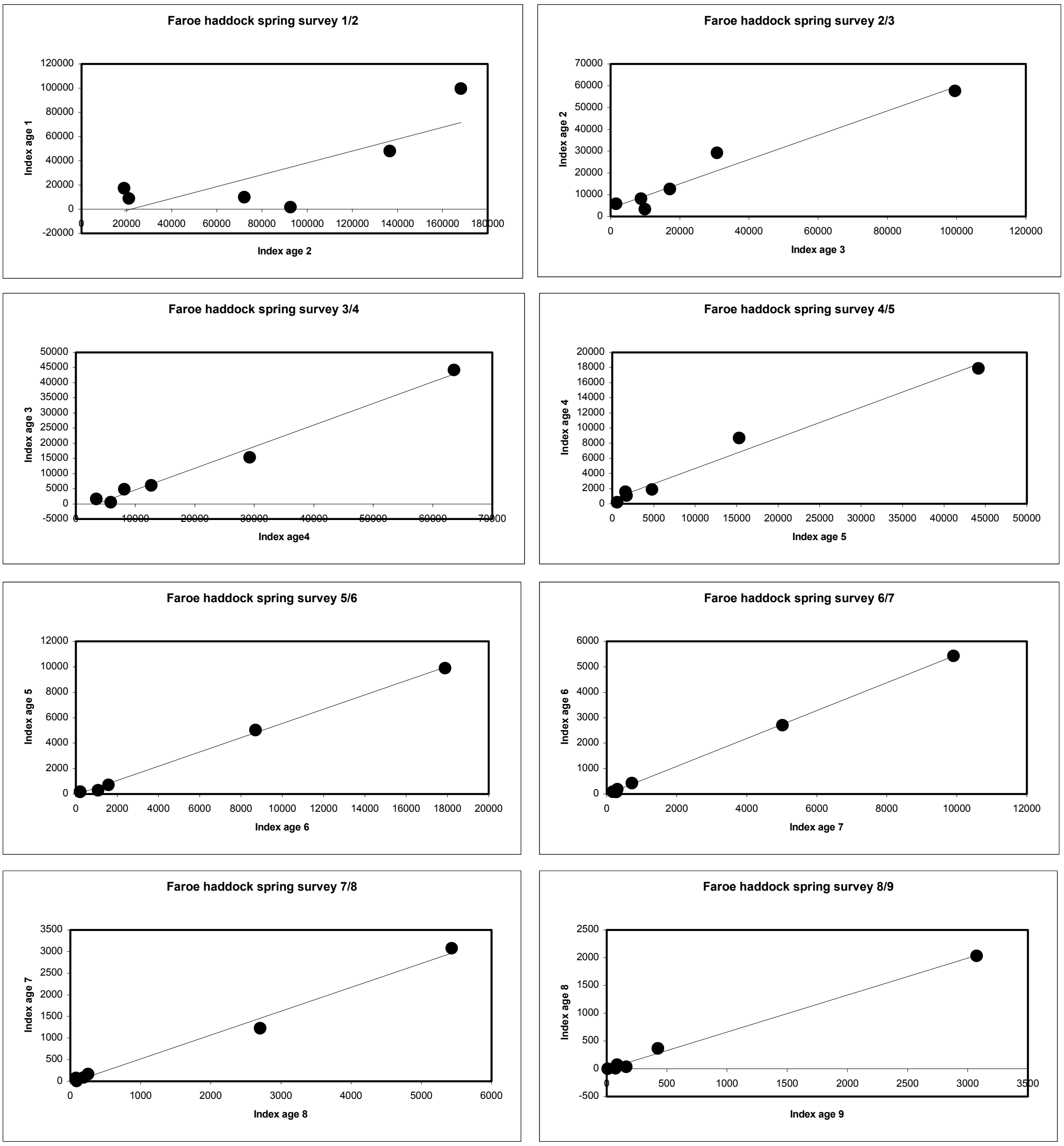


Figure 2.4.12 Relationship between indices age a and age a+1 for the same year class in the summer survey

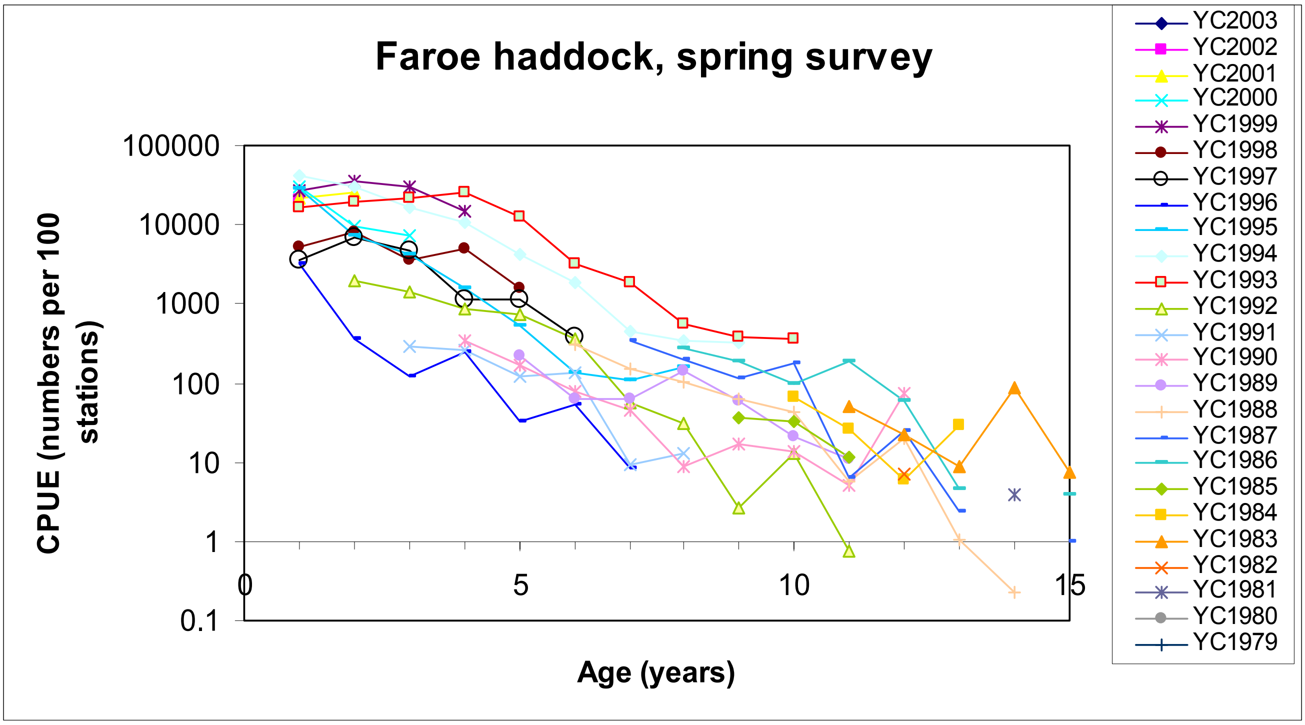


Figure 2.4.13 Faroe haddock. LN(catch-at-age in numbers).

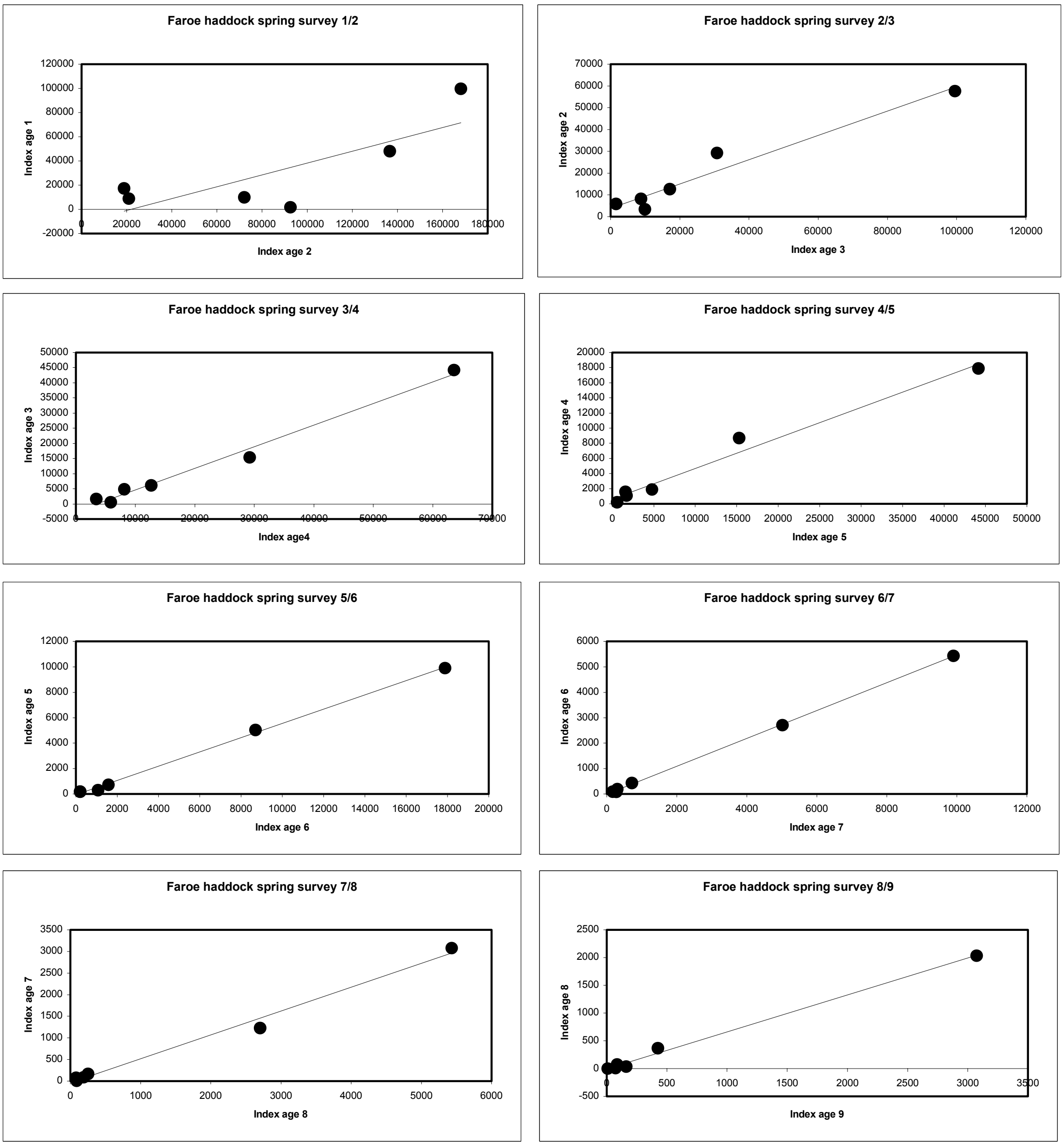


Figure 2.4.14 Relationship between indices age a and age a+1 for the same year class in the spring survey

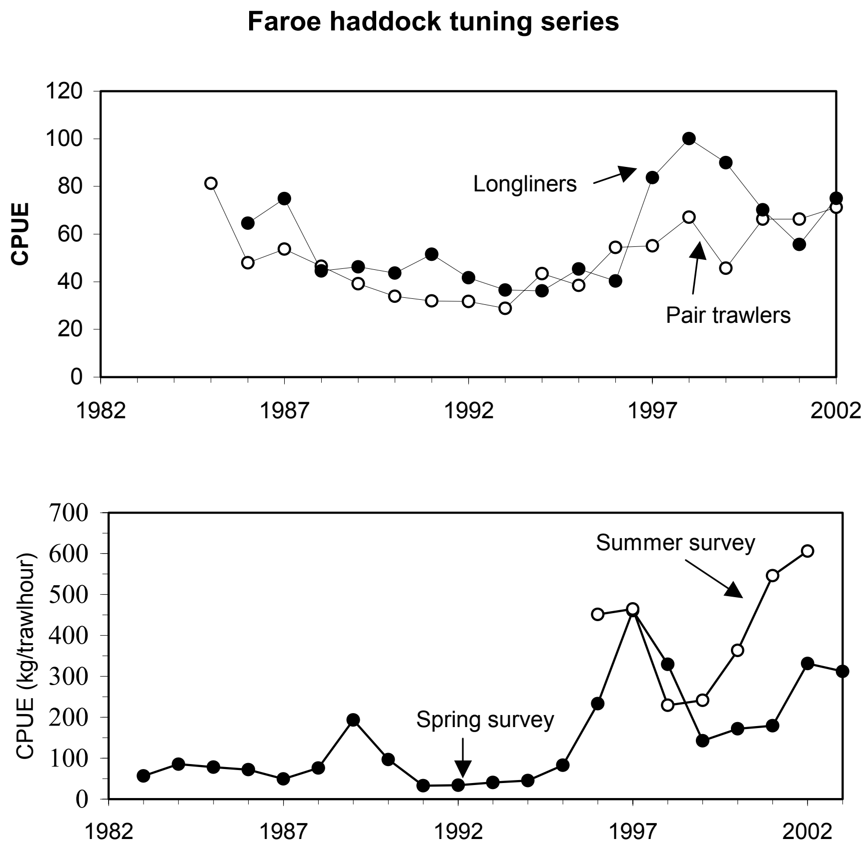


Figure 2.4.16 Faroe haddock. Age-aggregated tuning series.

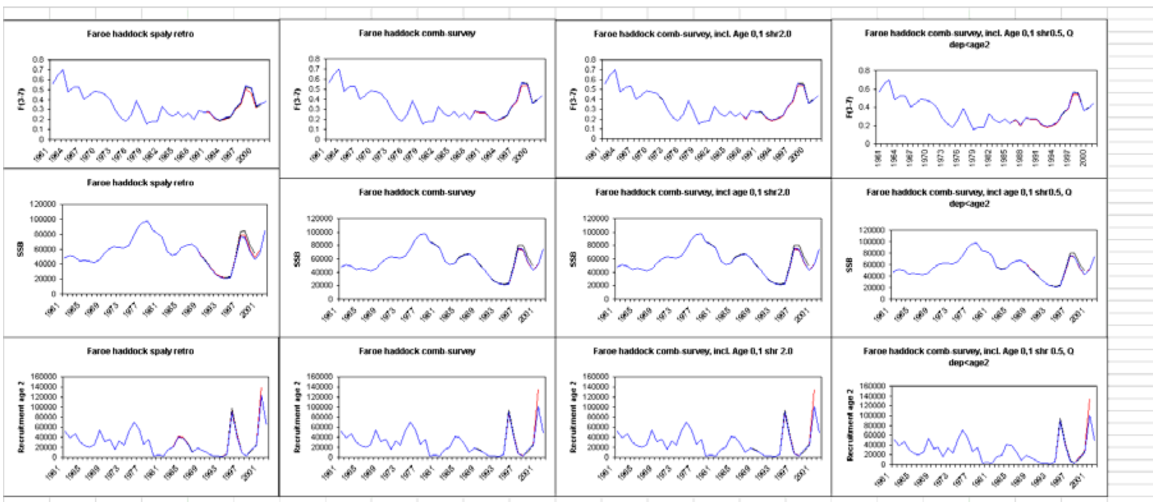


Figure 2.4.17 Faroe haddock. Retrospective analysis

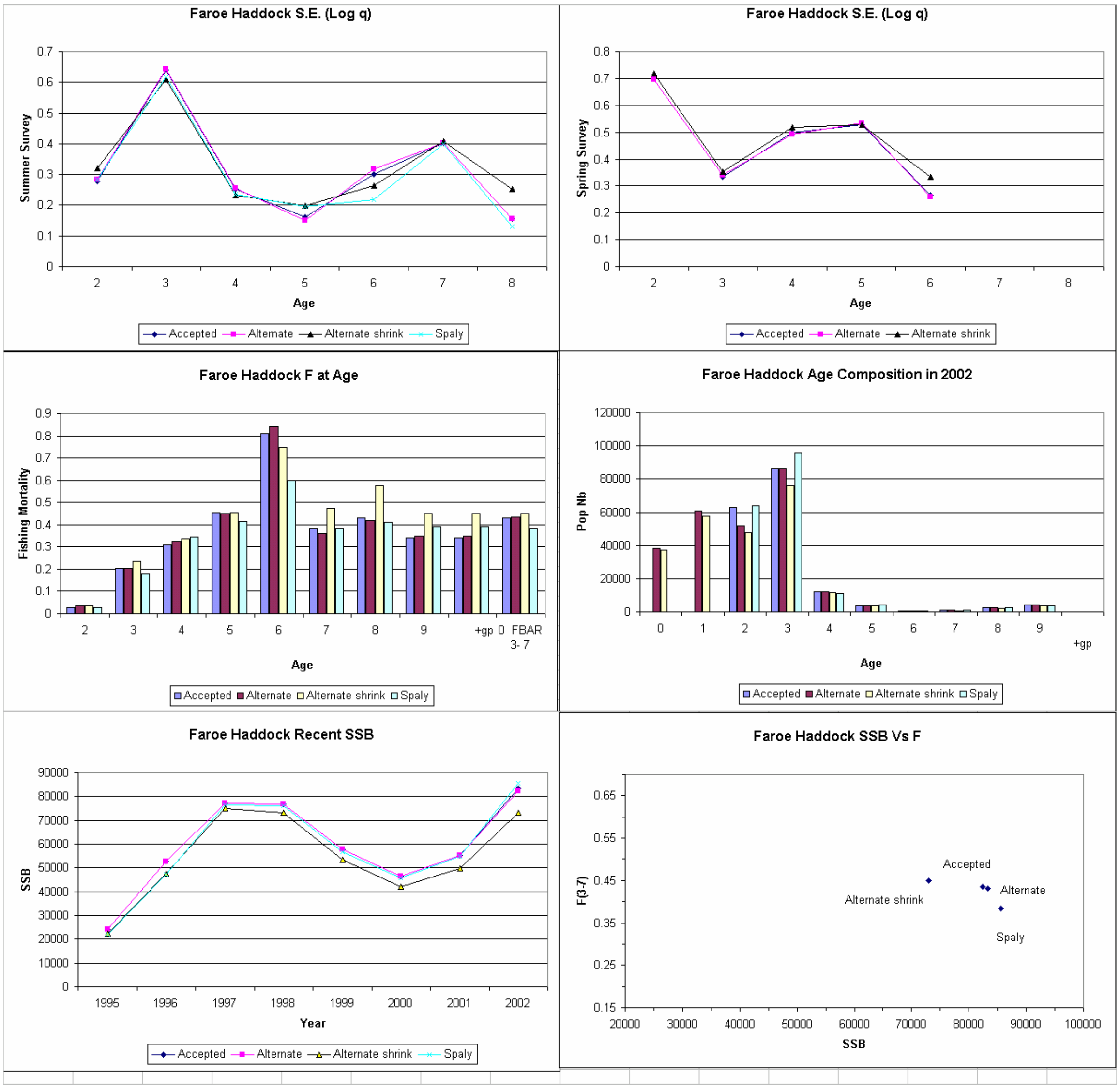


Figure 2.4.18 Comparison of the four different XSA runs shown in Figure 2.4.17.

Assessment	Run	SSB	F
Spaly 2.0 stock indep	1	85538	0.3847
Sum-0.5 stock indep	2	71163	0.4365
Spring-0.5 stock indep	3	69192	0.474
LL-0.5 stock dep<3	4	61157	0.5159
CUBA-0.5 stock dep<3	5	76956	0.355
4Fleets-0.5 stock dep<3	6	68807	0.4213
3Fleets-0.5 stock dep<3	7	71721	0.4291
4Fleets-2.0 stock indep	8	85279	0.3936
4Fleets-2.0 stock indep, -tapw	9	86638	0.384
4Fleets-0.5 stock indep, -tapw	10	74632	0.4289
4Fleets-0.5 stock indep, +tapw	11	72876	0.4424

Red diamond	1
Open square	2
Pink triangle	3
Turquoise x	4
Blue dot	5
Open circle	6
Open diamond	7
Grey -	8
Black square	9
Green diamond	10
Open triangle	11

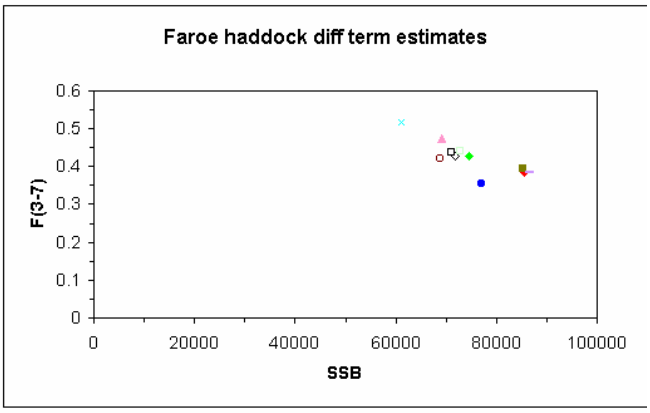
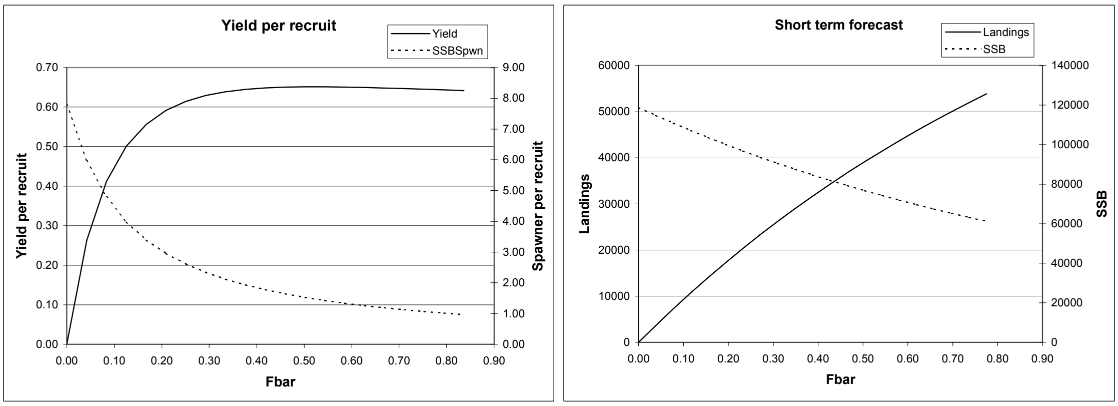


Figure 2.4.19 Faroe haddock. Comparison of 11 different XSA runs.



MFYPR version 1
Run: farhad-ypr1
Time and date: 15:22 5/7/03

Reference point	F multiplier	Absolute F
Fbar(2-10)	1.0000	0.4181
FMax	1.2461	0.5211
F0.1	0.4472	0.1870
F35%SPR	0.5628	0.2353
Flow	-99.0000	
Fmed	0.5520	0.2308
Fhigh	1.9955	0.8344

Weights in kilograms

MFDP version 1
Run: farhad-mopt1
Index file 05/05/2003
Time and date: 14:56 5/7/03
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.4.21. Faroe haddock predictions

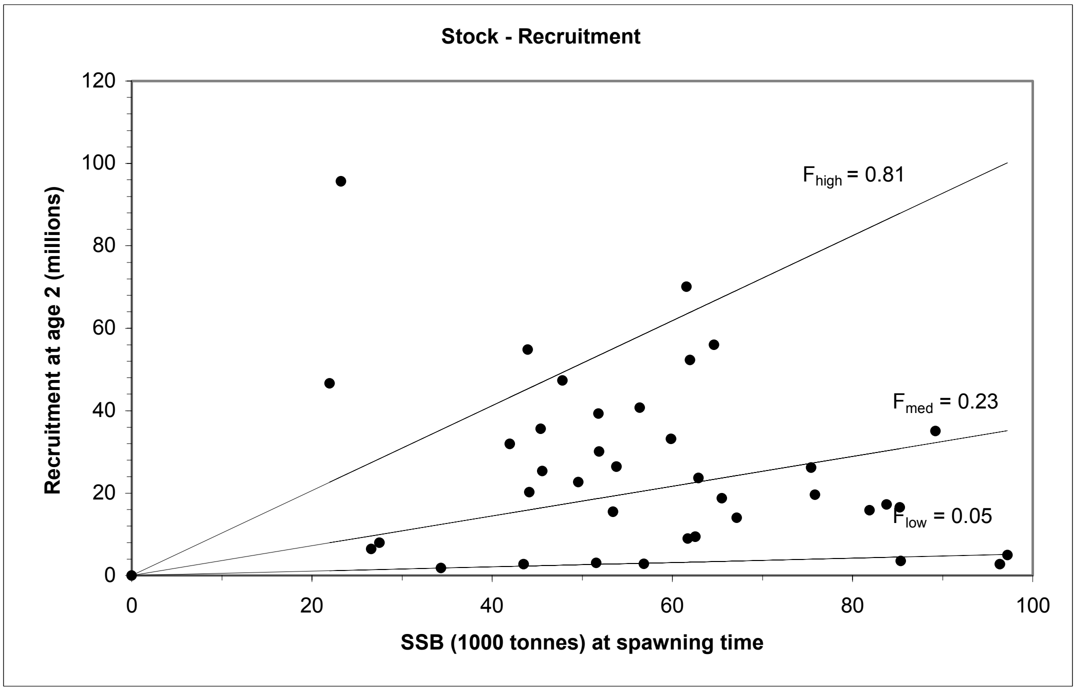


Figure 2.4.22 Faroe haddock stock recruitment plot.

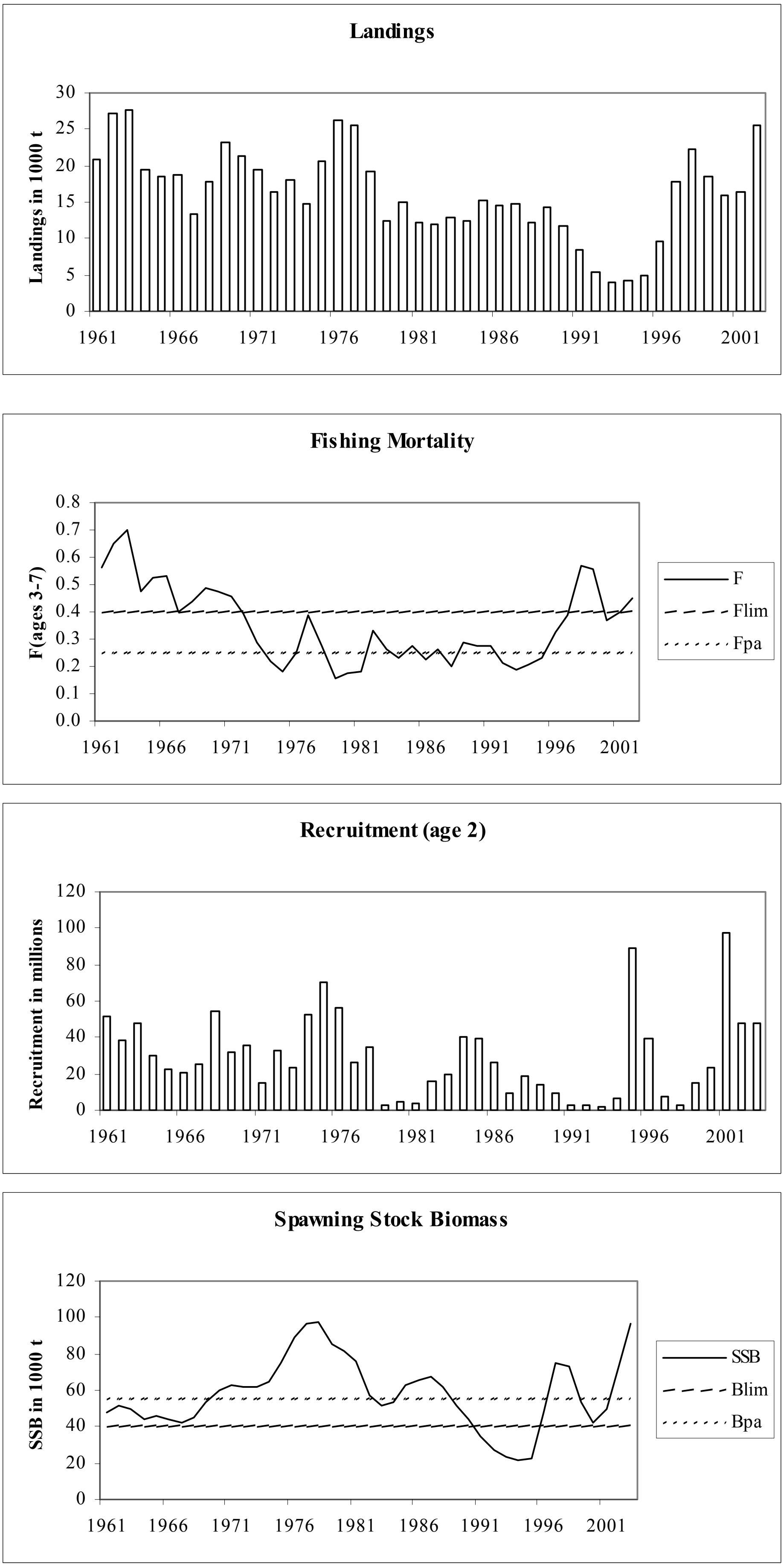
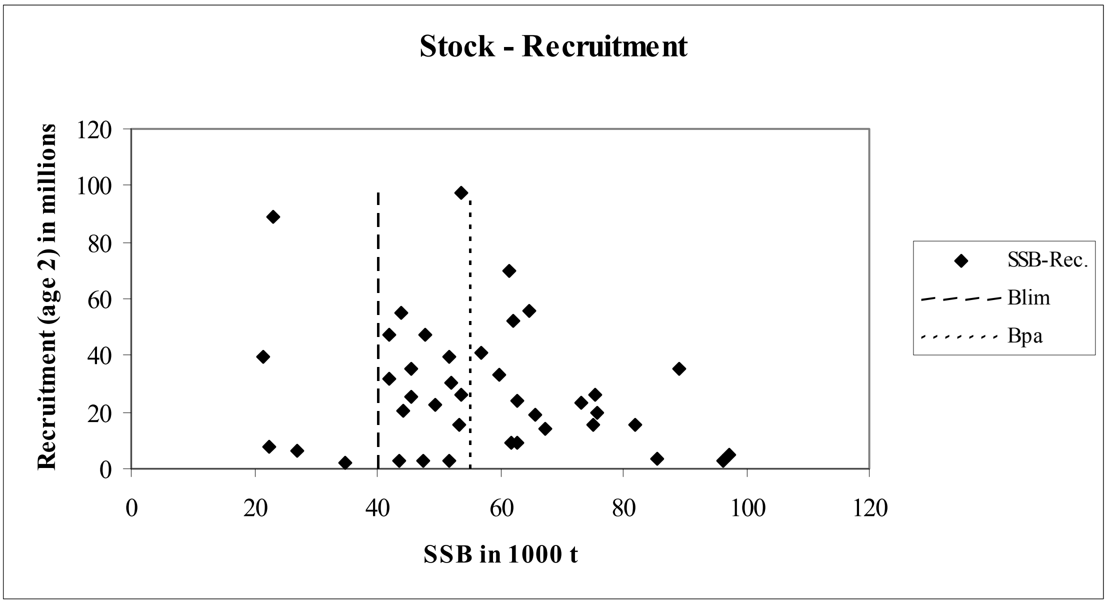
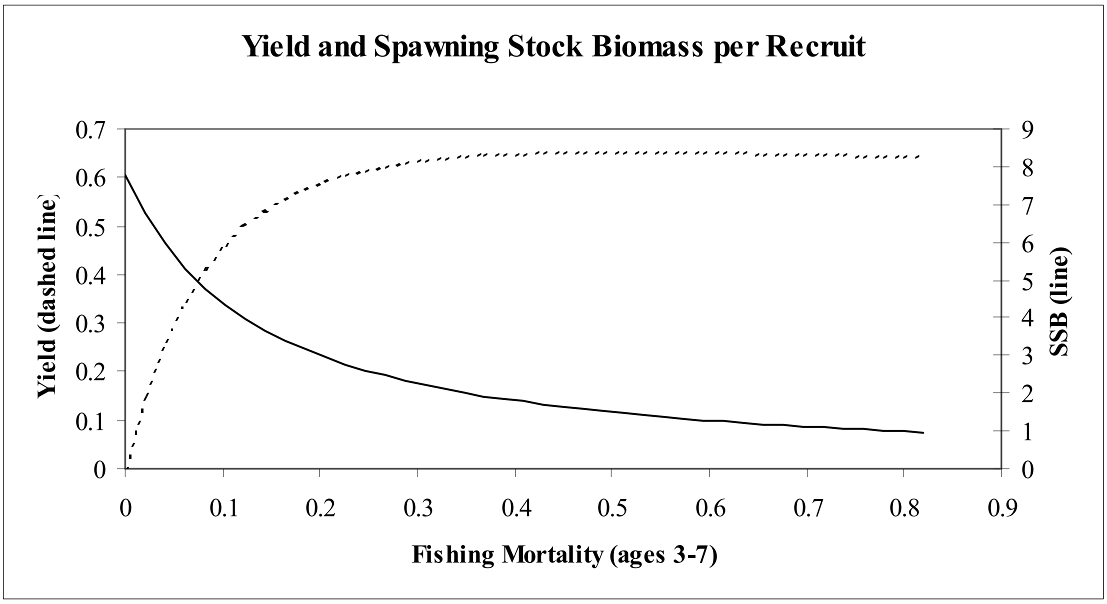


Figure 2.4.23 Faroe haddock (Division Vb). In the text the figures are labelled A-G





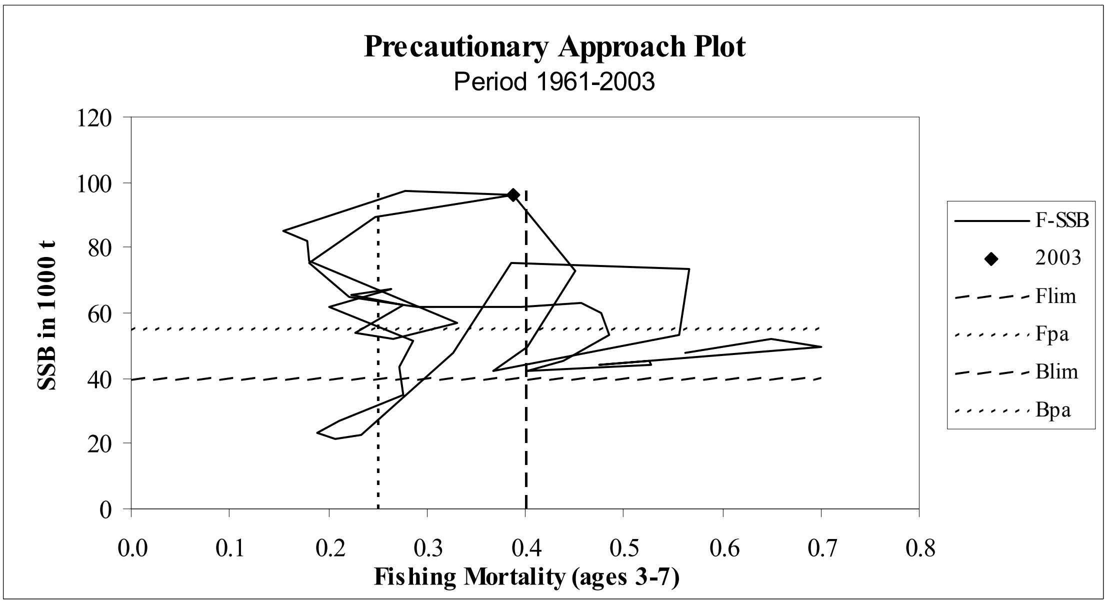


Figure 2.4.23 (Cont'd)

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, 51 800 tonnes in 2001 and to 56 700 tonnes in 2002 (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 1993-2002 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) have a more mixed fishery and they account for about 10-20% of the total landings of saithe in 1993-2002. 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 bycatch.

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. Little discarding is thought to occur in this fishery.

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 statistics 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 2002 was similar to that in 2001:

Fleet	Samples	Lengths	Otoliths	Weights
Jiggers	5	1197	120	120
Single trawlers 1000 – 1499 HP	3	641	61	0
Single trawlers 1500 - 1999 HP	16	4037	480	360
Single trawlers > 2000 HP	18	4557	750	60
Pair trawlers 400 – 699 HP	4	975	120	120
Pair trawlers 700 – 999 HP	16	4074	302	120
Pair trawlers 1000 – 1499 HP	127	30761	3001	2760
Total	**189**	**46242**	**4834**	**3540**

2.5.3 Weight-at-age

Mean weights-at-age have varied by a factor of about 2 during 1961-2002. For example, the mean weights-at-age 5 varied between about 1.6 kg in 1973 and 3.3 kg in 1980, while at age 7 it varied between 2.6 kg in 1991 and 5.3 kg in 1985 (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 decrease since then. The SOP for 2002 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 1983-2002 (Table 2.5.4.1 and Figure 2.5.4.1).

For the GLM maturity model, weight is the mean weight-at-age in the catch and year-class strength is from the final XSA run in assessment year 2002. Because ages 3 and 4 are generally not derived directly from the assessment, the following estimates are used in XSA runs:

- Year-class strength at age 3 is the geometric mean for period 1983 – 2002
- Year-class strength at age 4 is the recruitment estimate of age 3 in year 2002.

In 2003 the maturity data for the period 1994-1997 were corrected according to WD 14, NWWG 2003. The GLM model was used on these corrected data. The maturity estimates from the model based on the corrected data are essentially identical to those using the uncorrected data.

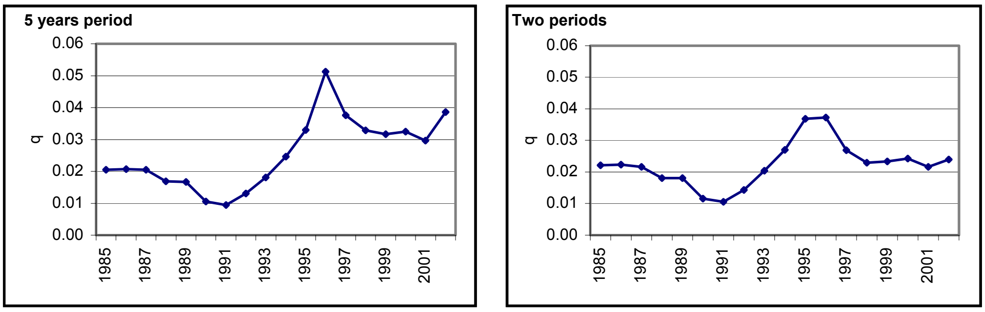
2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

The summer survey (1996-2002), similar to last year, showed large standard errors of log q, and there was a marked trend in residuals. The results of a spring survey (1994-2002) were investigated but showed poor internal consistency. The Working Group re-iterates its recommendation that the survey data be further investigated to improve the usefulness of the survey series as indices of stock size.

The single CPUE series used in the assessment since 2000 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 5 000-10 000 t of saithe each year (described in annex). 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 Working Group was concerned that the catchability of the tuning series may have changed over time. Catchability was estimated by dividing the CPUE (in kg per hour) by exploitable biomass, that is biomass multiplied by a selection pattern reaching a value of 1 for the fully exploited age groups. Two sets of smoothed selection pattern were used: one estimated by a five-year period, the other estimated for two periods: 1961 to 1979 and 1980 to 2002. The exploitation pattern shows an increasing trend from 1991 to 1996, but the estimates have been reasonably stable for the period 1997-2002 (shown in the figures below). The estimates, however, are calculated from an assessment calibrated with the CPUE series, and recent values are dependent on the CPUE series. The Working Group accepted the XSA calibrated with the Cuba trawler CPUE series, considering that no other usable index of stock size is aviable.



The final XSA run in the current assessment was made with the same parameters as in 2002. 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-year 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 1961-2002 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 0.38 in 2002.

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). The 1998 year class is unusually large as can be seen in the modal length progression in the summer survey from 1999 to 2002 (Figure 2.5.5.8). 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, 1996 and 1998 year classes. SSB was estimated to be 122 000 t in 2002, which is about the same as 2001, and well above the average SSB (94 000 t) in the 1980s. The relation between stock and recruitment is shown 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 1998 year class from the calibration was higher than the highest observed. Both the survey and the commercial cpues indicate that this year class is very abundant (Figure 2.5.5.8). The size was reset to approximately the highest observed (1996 year class at age 3 in 1999 = 80 000) and the fishing mortality in 2001 on those year classes was adjusted accordingly. There was also a projection with management options done based on the predicted 1998 year class from the XSA assessment.

Year	YC	XSA	Value used	Basis
2001	**1998**	103 872	80 000	Max Obs
2002	**1999**	29 540	29 540	XSA
2003	**2000**		29 650	Geomean77-99yc
2004	**2001**		29 650	Geomean77-99yc
2005	**2002**		29 650	Geomean77-99yc

Population numbers for the short-term prediction up to the 1999 year class are from the final VPA run, whereas values for the 2000-2002 year classes are the geometric mean of the 1977 to 1999 year classes. Mean weights for the stock and for the catches are the same for 2003-2005, the arithmetic mean for 2000-2002. In the long-term prediction (yield-per-recruit) mean weights for 1961-2002 were used.

In the short-term prediction the fitted proportion mature values from the model for 2003 were used for that year and for 2004 and 2005 the average of fitted values for 2001-2003 was used. In the long-term prediction the average of fitted values for 1983-2003 was used.

For all three years in the short-term prediction the average exploitation pattern in the final VPA for 2000-2002, not rescaled to Fbar (ages 4-8) in 2002 in view of a retrospective problem (as suggested from ACFM), was used. In the long-term prediction the exploitation pattern was set equal to the average of exploitation patterns for 1961-2002.

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 2002 average fishing mortality of 0.33 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 last 3 years	0.413	1.494	3.112
$\mathbf{F}_{max}$	0.418	1.494	3.072
$\mathbf{F}_{0.1}$	0.158	1.330	7.073
$\mathbf{F}_{med}$	0.336	1.488	3.787

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 0.33 over the time period, that F has been above $\mathbf{F}_{lim}$ in 13 out of 42 years (30%). Fishing mortality of F = 0.40 therefore does not appear to be associated with a high probability of stock collapse. Fishing mortality has been above $\mathbf{F}_{pa}$ every year except one since the 1980. There does appear, however, to be 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 0.33, the average over the available time-series, do not appear associated with a high probability of stock collapse as implied by $\mathbf{F}_{lim}$. Given the history of the stock and the possible influence of changes in productivity on Faroese stocks, F = 0.33 could be considered as $\mathbf{F}_{pa}$, with $\mathbf{F}_{lim}$ derived using the usual formula of $\mathbf{F}_{lim} = F_{pa}e^{1.645xs}$ where s could be 0.40 resulting in an $\mathbf{F}_{lim}$ = 0.64, a value exceeded only once in the history of the fishery. The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested that the existing $\mathbf{B}_{lim}$ for Faroe saithe could be a candidate for $\mathbf{B}_{pa}$ instead. Considering that ACFM is unlikely to define and use new $\mathbf{B}_{lim}$ points, the Working Group will consider the issue further during its 2004 meeting.

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 $\mathbf{B}_{lim} = B_{pa}e^{1.645xs}$ where s could be 0.30.

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 67 000 t in 2003 and 66 000 t in 2004. The spawning stock biomass would be about 1.7 times higher than $\mathbf{B}_{pa}$ in 2002 and 2003.

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 2003 and weight composition in SSB by year classes in 2004 is presented in Figure 2.5.6.4. The catch in 2003 is predicted to rely on the four most recent year classes (84%). In 2004 the 1996, 1997 and 1998 year classes are expected to contribute over 80% of the SSB.

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 is still 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 will hopefully add valuable information on saithe stocks in the north Atlantic and migrations between management units.

The 2003 assessment has been calibrated in a way very similar to the 2002 assessment. The results indicate that the point estimator of biomass is lower than was estimated in the 2002 assessment (2002 SSB = 120 000 t compared with 140 000 t) and that fishing mortality is almost the same. In the 2001 assessment, recent year classes were assumed to be equal to a gm mean of recent year classes. In the 2003 assessment, the estimates from the XSA calibration, adjusted down to the highest previously observed, were used.

2.5.9 Annex

Stock definition

Saithe are widely distributed around the Faroes, from the shallow inshore waters to depths of 350 m. The main spawning areas are found at 150-250 meters depth east and north of the Faroes. Spawning takes place from January to April, with the main spawning in the second-half of February. The pelagic eggs and larvae drift with the anti-cyclonic current around the islands until May/June, when the juveniles, at lengths of 2.5-3.5 cm, migrate inshore. The nursery areas during the first two years of life are in very shallow waters in the littoral zone. Young saithe are also distributed in shallow depths, but at increasing depths with increasing age. Saithe enter the adult stock at the age of 3 or 4 years (Jákupsstovu 1999). Tagging experiments of saithe has demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999).

Description of the Cuba pair-trawlers

The tuning fleet called Cuba-trawlers consists of trawlers that were built in East-Germany in 1970 as part of a help-programme for Cuba (explaining the name). In 1973 “Faroe Ship” bought 8 of these trawlers and brought them to Faroe Islands. Today they are kept by the Runavik Trawl Company “Beta”, which is the company that has operated the trawlers during all these years and has registered the catches.

The Cuba-fleet first operated in the North Sea as a standby supply service for drilling rigs. This was, however, not very profitable and during 1977-1978 the trawlers were altered and adjusted for fishing saithe, cod and haddock in Faroese waters. The vessels were equipped with new gear and other equipment. Engine, winch and equipment for the navigating bridge were replaced principally by Norwegian equipment. Except for the fact that 4 of the trawlers are equipped with bigger winches (to be able to fish in deep waters) the 8 trawlers are identical. The gears used are mainly from the same producers and the vessels are similar with respect to construction. However, improvements have been carried out when needed (*e.g.* winch and engines). Engine power is more than 1 000 HP. Total length is about 37-38 m. Since 1985, the mesh size in the trawl is mainly 135 mm (occasionally 145 mm). Loading capacity is approximately 2 000 boxes of fish corresponding to *ca*. 100 tons catch per vessel. The trawlers have conducted demersal fisheries around Faeroe Islands since 1977 when the 200 nm boundary was introduced. The Cuba-trawlers started as single trawlers. However, since 1983 the trawlers have operated as pair-trawlers to reduce costs (meaning a reduction of *ca.* 45% with respect to fuel and *ca*. 15% with respect to fishing gear). The catch is stored on ice on board the trawlers and landed as fresh fish.

The data on which the tuning series are based originate from all available logbooks from the Cuba-trawlers since 1985. The data are stored in the database at the Faroese Fisheries Laboratory in Torshavn, and they are corrected and quality controlled.

The effort obtained from the logbooks is estimated as the number of fishing (trawling) hours, which is the time from when the trawl meets the bottom and until hauling starts. It is not possible to get effort as fishing days because the logbooks do not tell when the trip ends (day and time).

References

ICES C.M. 1993/Assess:18.

Jákupsstovu, S. March 1999. The Fisheries in Faroese Waters. Fleets, activities, distribution and potential conflicts of interest with an offshore oil industry.

Steingrund, P. April 2003. Correction of the maturity stages from Faroese spring groundfish survey. WD 14, NWWG 2003.

Table 2.5.1.1 Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1989-2002, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995
Denmark	-	2	-	-	-	-	-
Faroe Islands	43,624	59,821	53,321	35,979	32,719	32,406	26,918
France [3]	-	-	-	120	75	19	10
German Dem.Rep.	9	-	-	5	2	1	41
German Fed. Rep.	20	15	32		-	-	-
Netherlands	22	67	65	-	32		
Norway	51	46	103	85	279	156	10
UK (Eng. & W.)	-	-	5	74	425	151	21
UK (Scotland)	9	33	79	98		438	200
USSR/Russia [2]	-	30	-	12	-	-	-
Total	43,735	60,014	53,605	36,373	33,532	33,171	27,200
Working Group estimate [4,5]	44,477	61,628	54,858	36,487	33,543	33,182	27,209

Country	1996	1997	1998	1999	2000	2001	2002 [1]
Estonia	-	16	-	-	-	-	
Faroe Islands	19,297	21,721	25,995	32,439			
France	12	9	17	-	273	943	705
Germany	3	5	-	100	230	667	422
Greenland	-	-	-	-			
Irland						5	
Norway	16	67	53	160	97	80	136
Russia	18	28	-	-	20	1	10
UK (E/W/NI)	53	-	19	67	32	80	
UK (Scotland)	580	460	337	441	534	708	
United Kingdom							618
Total	19,979	22,306	26,421	33,207	1,186	2,484	1,891
Working Group estimate [4,5,6]	20,029	22,306	26,421	33,207	39,045	51,795	56,759

[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 1985-2002 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 round weight (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
2002	0.1	0.2	0.1	0.0	1.4	0.1	23.9	9.5	54.8	0.1	0.0	0.0	53698
Average	0.3	0.2	0.1	0.1	7.0	2.3	15.9	20.8	51.7	0.2	0.7	0.1	38499

Table 2.5.2.1 Saithe in the Faroes (Division Vb). Catch in number-at-age by fleet categories (calculated from gutted weigths).

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	0	0	0	0	0	0	0
3	10	97	58	133	1	307	13	320
4	107	2977	1181	3976	39	8505	398	8903
5	75	1199	723	3964	35	6160	160	6320
6	144	1737	1039	6888	63	10141	232	10373
7	22	264	46	520	4	879	35	914
8	33	429	113	682	6	1300	57	1357
9	12	177	20	246	2	469	24	493
10	8	151	18	177	2	364	20	384
11	1	4	3	25	0	34	1	35
12	1	10	2	23	0	37	1	38
13	0	0	0	7	0	8	0	8
14	0	1	0	0	0	1	0	1
15	0	0	0	0	0	0	0	0
Total No.	414	7045	3204	16639	152	28205	941	29146
Catch, t.	871	14151	5628	32465	294	54868	1891	56759

Notes: Numbers in 1000'

Catch, round weight in tonnes

ST- single trawlers and PT- pair trawlers

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  2/05/2003  17:00
Table  1    Catch numbers-at-age                              Numbers*10**-3
```

YEAR	1961	1962
AGE		
3	183	562
4	379	542
5	483	617
6	403	495
7	216	286
8	129	131
9	116	129
10	82	113
11	45	71
+gp	82	105
0 TOTALNUM	2118	3051
TONSLAND	9592	10454
SOPCOF %	108	93

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	614	684	996	488	595	614	1191	1445	2857	2714
4	340	1908	850	1540	796	1689	2086	6577	3316	1774
5	340	1506	1708	1201	1364	1116	2294	1558	5585	2588
6	415	617	965	1686	792	1095	1414	1478	1005	2742
7	406	572	510	806	1192	548	1118	899	828	1529
8	202	424	407	377	473	655	589	730	469	1305
9	174	179	306	294	217	254	580	316	326	1017
10	158	150	201	205	190	128	239	241	164	743
11	94	100	156	156	97	89	115	86	100	330
+gp	274	174	285	225	140	187	190	132	100	210
0 TOTALNUM	3017	6314	6384	6978	5856	6375	9816	13462	14750	14952
TONSLAND	12693	21893	22181	25563	21319	20387	27437	29110	32706	42663
SOPCOF %	96	99	92	98	104	102	97	96	109	100

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	2515	3504	2062	3178	1609	611	287	996	411	387
4	6253	4126	3361	3217	2937	1743	933	877	1804	4076
5	7075	4011	3801	1720	2034	1736	1341	720	769	994
6	3478	2784	1939	1250	1288	548	1033	673	932	1114
7	1634	1401	1045	877	767	373	584	726	908	380
8	693	640	714	641	708	479	414	284	734	417
9	550	368	302	468	498	466	247	212	343	296
10	403	340	192	223	338	473	473	171	192	105
11	215	197	193	141	272	407	368	196	92	88
+gp	186	265	298	287	330	535	691	786	1021	902
0 TOTALNUM	23002	17636	13907	12002	10781	7371	6371	5641	7206	8759
TONSLAND	57431	47188	41576	33065	34835	28138	27246	25230	30103	30964
SOPCOF %	120	113	116	107	104	100	102	99	96	96

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	2483	368	1224	1167	1581	866	451	294	1030	521
4	1103	11067	3990	1997	5793	2950	5981	3833	5125	4067
5	5052	2359	5583	4473	3827	9555	5300	10120	7452	3667
6	1343	4093	1182	3730	2785	2784	7136	9219	5544	2679
7	575	875	1898	953	990	1300	793	5070	3487	1373
8	339	273	273	1077	532	621	546	477	1630	894
9	273	161	103	245	333	363	185	123	405	613
10	98	52	38	104	81	159	83	61	238	123
11	98	65	26	67	43	27	55	60	128	63
+gp	540	253	275	158	97	60	39	79	118	108
0 TOTALNUM	11904	19566	14592	13971	16062	18685	20569	29336	25157	14108
TONSLAND	39176	54665	44605	41716	40020	45285	44477	61628	54858	36487
SOPCOF %	100	100	94	94	96	99	97	98	99	105

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
3	1316	690	398	297	344	163	321	812	1125	320
4	2611	3961	1019	1087	832	1689	655	2832	2452	8903
5	4689	2663	3468	1146	2440	1934	3096	1485	8438	6320
6	1665	2368	1836	1449	1767	3475	2550	4372	2155	10373
7	858	746	1177	1156	1335	1379	4113	2227	3681	914
8	492	500	345	521	624	683	915	2727	1539	1357
9	448	307	241	132	165	368	380	348	1334	493
10	245	303	192	77	71	77	146	186	293	384
11	54	150	104	64	29	32	23	56	90	35
+gp	52	49	117	82	100	73	69	25	56	47
0 TOTALNUM	12430	11737	8897	6011	7707	9873	12268	15070	21163	29146
TONSLAND	33543	33182	27209	20029	22306	26421	33207	39045	51795	56759
SOPCOF %	102	102	102	103	100	102	102	102	100	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  2/05/2003  17:00

       Table  2    Catch weights-at-age (kg)
       YEAR        1961     1962
       AGE
         3        1.4300   1.2730
         4        2.3020   2.0450
         5        3.3480   3.2930
         6        4.2870   4.1910
         7        5.1280   5.1460
         8        6.1550   5.6550
         9        7.0600   6.4690
        10        7.2650   6.7060
        11        7.4970   7.1500
       +gp        9.3399   9.0237
0    SOPCOFAC     1.0779    .9342

       YEAR        1963     1964     1965     1966     1967     1968     1969     1970     1971     1972
       AGE
         3        1.2800   1.1750   1.1810   1.3610   1.2730   1.3020   1.1880   1.2440   1.1010   1.0430
         4        2.1970   2.0550   2.1250   2.0260   1.7800   1.7370   1.6670   1.4450   1.3160   1.4850
         5        3.2120   3.2660   2.9410   3.0550   2.5340   2.0360   2.3020   2.2490   1.8180   2.0550
         6        4.5680   4.2550   4.0960   3.6580   3.5720   3.1200   2.8530   2.8530   2.9780   2.8290
         7        5.0560   5.0380   4.8780   4.5850   4.3680   4.0490   3.6730   3.5150   3.7020   3.7910
         8        5.9320   5.6940   5.9320   5.5200   5.3130   5.1830   5.0020   4.4180   4.2710   4.1750
         9        6.2590   6.6620   6.3210   6.8370   5.8120   6.2380   5.7140   5.4440   5.3880   4.8080
        10        8.0000   6.8370   7.2880   7.2650   6.5540   7.5200   6.4050   5.7330   5.9720   5.2940
        11        7.2650   7.6860   8.0740   7.6620   7.8060   8.0490   6.5540   6.6620   6.4900   6.9480
       +gp        8.8589   8.5591   8.9035   9.2233   8.1494   9.0925   8.0870   8.5844   8.0047   7.5146
0    SOPCOFAC      .9590    .9933    .9220    .9769   1.0357   1.0194    .9663    .9634   1.0935   1.0043

       YEAR        1973     1974     1975     1976     1977     1978     1979     1980     1981     1982
       AGE
         3        1.0880   1.4300   1.1140   1.0880   1.2230   1.4930   1.2200   1.2300   1.3100   1.3370
         4        1.4610   1.5250   1.6580   1.6760   1.6410   2.3240   1.8800   2.1200   2.1300   1.8510
         5        1.5820   2.2070   2.2600   2.8780   2.6600   3.0680   2.6200   3.3200   3.0000   2.9510
         6        2.2490   2.5000   3.1200   3.0810   3.7900   3.7460   3.4000   4.2800   3.8100   3.5770
         7        3.6870   3.1200   3.5570   4.2870   4.2390   4.9130   4.1800   5.1600   4.7500   4.9270
         8        4.3850   4.6010   4.0960   4.3520   5.5970   4.3680   4.9500   6.4200   5.2500   6.2430
         9        5.1280   5.5590   5.1280   4.7900   5.3500   5.2760   5.6900   6.8700   5.9500   7.2320
        10        5.2760   5.7140   6.0940   5.9120   5.9120   5.8320   6.3800   7.0900   6.4300   7.2390
        11        6.7270   6.2590   7.1960   6.6190   6.8370   6.0530   7.0200   7.9300   7.0000   8.3460
       +gp        8.0307   8.0104   8.5982   7.8941   7.7085   7.5756   8.6262   9.2153   8.9618  10.0411
0    SOPCOFAC     1.2006   1.1296   1.1607   1.0680   1.0442   1.0049   1.0248    .9937    .9564    .9632

       YEAR        1983     1984     1985     1986     1987     1988     1989     1990     1991     1992
       AGE
         3        1.2080   1.4310   1.4010   1.7180   1.6090   1.5000   1.3090   1.2230   1.2400   1.2640
         4        2.0290   1.9530   2.0320   1.9860   1.8350   1.9750   1.7350   1.6330   1.5680   1.6020
         5        2.9650   2.4700   2.9650   2.6180   2.3950   1.9780   1.9070   1.8300   1.8640   2.0690
         6        4.1430   3.8500   3.5960   3.2770   3.1820   2.9370   2.3730   2.0520   2.2110   2.5540
         7        4.7240   5.1770   5.3360   4.1860   4.0670   3.7980   3.8100   2.8660   2.6480   3.0570
         8        5.9010   6.3470   7.2020   5.5890   5.1490   4.4190   4.6670   4.4740   3.3800   4.0780
         9        6.8110   7.8250   6.9660   6.0500   5.5010   5.1150   5.5090   5.4240   4.8160   5.0120
        10        7.0510   6.7460   9.8620   6.1500   6.6260   6.7120   5.9720   6.4690   5.5160   6.7680
        11        7.2480   8.6360  10.6700   9.5360   6.3430   9.0400   6.9390   6.3430   6.4070   7.7540
       +gp       10.0547  10.0976  11.9501  10.2181  10.2439   9.3369   9.9364   8.2869   7.7285   8.2297
0    SOPCOFAC      .9997    .9991    .9415    .9419    .9620    .9928    .9698    .9811    .9938   1.0506

       YEAR        1993     1994     1995     1996     1997     1998     1999     2000     2001     2002
       AGE
         3        1.4080   1.5030   1.4560   1.4320   1.4760   1.3880   1.3740   1.4770   1.3300   1.1420
         4        1.8600   1.9510   2.1770   1.8750   1.7830   1.7110   1.7120   1.6060   1.5900   1.4600
         5        2.3230   2.2670   2.4200   2.4960   2.0320   1.9540   1.9050   2.0770   1.7850   1.6520
         6        3.1310   2.9360   2.8950   3.2290   2.7780   2.4050   2.3960   2.3600   2.5860   1.9690
         7        3.7300   4.2140   3.6510   3.7440   3.5980   3.3000   2.8450   2.9770   3.0590   3.1300
         8        4.3940   4.9710   5.0640   4.9640   4.7660   4.2200   4.1240   3.4800   3.8710   3.5890
         9        5.2090   5.6570   5.4400   6.3750   5.9820   4.9990   5.2560   4.8510   4.3740   4.5130
        10        6.5400   5.9500   6.1670   6.7450   7.6580   6.3910   5.5260   5.2680   5.5650   5.1380
        11        8.4030   6.8910   7.0800   7.4660   7.8820   6.6650   6.9560   6.5230   6.7030   6.4220
       +gp        8.0501   9.1086   7.5392   7.9806   9.2453   8.4847   8.5237   5.9024   6.9076   7.5408
0    SOPCOFAC     1.0169   1.0240   1.0205   1.0319    .9994   1.0221   1.0187   1.0155   1.0018   1.0004
```

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  2/05/2003  17:00
```

Table 5 Proportion mature-at-age

YEAR	1961	1962
AGE		
3	.0400	.0400
4	.2600	.2600
5	.5700	.5700
6	.8200	.8200
7	.9100	.9100
8	.9800	.9800
9	1.0000	1.0000
10	1.0000	1.0000
11	1.0000	1.0000
+gp	1.0000	1.0000

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
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	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
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	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	.1000	.1200	.1100	.1500	.1300	.1200	.1100	.1000	.1000	.1000
4	.2800	.2800	.2800	.2800	.2700	.2800	.2500	.2300	.2200	.2200
5	.6100	.5100	.6200	.5500	.5000	.4400	.4200	.4100	.4100	.4400
6	.8800	.8600	.8300	.8000	.7800	.7500	.6800	.6200	.6400	.6900
7	.9600	.9700	.9700	.9400	.9300	.9200	.9200	.8500	.8300	.8700
8	.9900	.9900	1.0000	.9900	.9800	.9700	.9800	.9700	.9400	.9700
9	1.0000	1.0000	1.0000	1.0000	.9900	.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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
AGE										
3	.1100	.1200	.1200	.1100	.1200	.1100	.1100	.1100	.1200	.1100
4	.2600	.2700	.3000	.2600	.2500	.2600	.2700	.2400	.2200	.2200
5	.4900	.4800	.5100	.5200	.4400	.5100	.5100	.4100	.4400	.3900
6	.7700	.7500	.7400	.7900	.7200	.7500	.7800	.6700	.6500	.6900
7	.9100	.9400	.9100	.9100	.9000	.9100	.9300	.8400	.8600	.8600
8	.9700	.9800	.9800	.9800	.9800	.9800	.9800	.9700	.9400	.9600
9	.9900	.9900	.9900	1.0000	1.0000	.9900	1.0000	.9900	.9900	.9800
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 commercial Cuba Logbook pair trawlers.

```
Faroe Saithe (ICES Div. Vb) age3+5-11
102
Cuba Logbook age3
1985 2002
1 1 0 1
3 3
3200    30
3565    63
6470   117
6975    65
6635    51
7892    23
7762    34
7884    11
7747    81
7290    78
8067    70
5345    32
7306    79
8302    19
11639   57
9845   138
11007  231
9648    41
Cuba Logbook age5-11
1985 2002
1 1 0 1
5 11
3200    386   81  100   13   5    1   2
3565    332  238   66   70  17    6   3
6470    391  311  116   61  32    7   5
6976    865  304  123   51  35    8   1
6635    497  628   72   42  14    8   5
7892    737  713  392   36  10    4   4
7762    491  397  250  123  15   14  10
7884    271  229  115   67  58   11   6
7747    514  185   99   59  43   25   6
7290    356  334  107   75  49   45  21
8067    852  349  215   72  36   28  20
5345    169  174  213  163  79   20  11
7306    406  298  229  104  24   12   4
8302    306  532  226  112  63   12   4
11639   668  608  988  240 105   35   6
9845    301  905  463  571  70   39  12
11007  1865  439  700  282 234   48  11
9648   1225 2129  161  210  76   54   8
```

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

```
Lowestoft VPA Version 3.1

   2/05/2003  16:59

 Extended Survivors Analysis

 FAROE SAITHE (ICES Division Vb)                 SAI_IND


 CPUE data from file D:\Stovnsmeting\Ices2003\Koyringar\Xsa\saithetun.DAT


 Catch data for  42 years. 1961 to 2002. Ages  3 to  12.

      Fleet            First  Last  First  Last  Alpha   Beta
                        year  year   age    age
 Cuba Logbook age3       1985  2002    3      3    .000   1.000
 Cuba Logbook age5-11    1985  2002    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   18 iterations


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



Fishing mortalities
    Age   1993   1994   1995   1996   1997   1998   1999   2000   2001   2002

      3   .063   .047   .011   .014   .011   .013   .004   .014   .012   .012
      4   .205   .274   .090   .039   .050   .069   .069   .049   .054   .125
      5   .553   .333   .411   .139   .114   .157   .175   .220   .203   .193
      6   .604   .607   .404   .301   .328   .237   .320   .402   .571   .413
      7   .520   .606   .707   .483   .502   .463   .489   .515   .710   .509
      8   .417   .664   .636   .812   .526   .523   .648   .714   .841   .627
      9   .492   .502   .809   .536   .663   .690   .629   .551   .973   .726
     10   .500   .744   .688   .666   .628   .768   .657   .741  1.409   .864
     11   .625   .663   .621   .516   .571   .656   .548   .572  1.047   .600
```

Table 2.5.5.2. (Continued)

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10	11
1993	2.38E+04	1.56E+04	1.22E+04	4.06E+03	2.34E+03	1.59E+03	1.27E+03	6.89E+02	1.28E+02
1994	1.67E+04	1.83E+04	1.04E+04	5.75E+03	1.81E+03	1.14E+03	8.60E+02	6.38E+02	3.42E+02
1995	3.91E+04	1.31E+04	1.14E+04	6.10E+03	2.57E+03	8.11E+02	4.80E+02	4.27E+02	2.48E+02
1996	2.34E+04	3.17E+04	9.79E+03	6.17E+03	3.34E+03	1.04E+03	3.51E+02	1.75E+02	1.75E+02
1997	3.44E+04	1.89E+04	2.49E+04	6.98E+03	3.74E+03	1.69E+03	3.76E+02	1.68E+02	7.37E+01
1998	1.35E+04	2.78E+04	1.47E+04	1.82E+04	4.11E+03	1.85E+03	8.16E+02	1.59E+02	7.35E+01
1999	7.98E+04	1.09E+04	2.13E+04	1.03E+04	1.18E+04	2.12E+03	9.00E+02	3.35E+02	6.03E+01
2000	6.35E+04	6.50E+04	8.33E+03	1.46E+04	6.11E+03	5.91E+03	9.08E+02	3.93E+02	1.42E+02
2001	1.04E+05	5.13E+04	5.07E+04	5.47E+03	8.00E+03	2.99E+03	2.37E+03	4.28E+02	1.53E+02
2002	2.95E+04	8.40E+04	3.97E+04	3.39E+04	2.53E+03	3.22E+03	1.06E+03	7.33E+02	8.57E+01

Estimated population abundance at 1st Jan 2003

0.00E+00	2.39E+04	6.07E+04	2.68E+04	1.83E+04	1.25E+03	1.41E+03	4.18E+02	2.53E+02

Taper weighted geometric mean of the VPA populations:

3.35E+04	2.68E+04	1.72E+04	9.37E+03	4.14E+03	1.96E+03	8.15E+02	3.43E+02	1.28E+02

Standard error of the weighted Log(VPA populations) :

.6269	.6468	.5981	.6308	.5753	.5577	.5404	.5265	.5291

Log-catchability residuals.

Fleet : Cuba Logbook age3

Age	1985	1986	1987	1988	1989	1990	1991	1992
3	.89	.71	.99	.15	.33	-.68	-.28	-1.63
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	.97	1.34	.18	.18	.61	-.59	-1.33	.36	.42	-.52
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	1.38	-.898	17.14	.36	18	.87	-15.30

Fleet : Cuba Logbook age5-11

Age	1985	1986	1987	1988	1989	1990	1991	1992
3	No data for this fleet at this age							
4	No data for this fleet at this age							
5	.85	.71	.37	-.02	-.37	.21	.32	.17
6	-.17	.55	.23	.24	-.20	-.04	.02	-.04
7	-.05	-.15	-.15	-.21	-.64	-.25	-.31	-.51
8	-.58	.23	-.28	-.42	-.57	-1.03	-.56	-.90
9	-.81	.41	-.22	-.10	-.93	-1.57	-1.09	-.48
10	-1.80	-.05	.01	-.84	-.74	-1.84	-.47	-.48
11	-.33	-.12	.04	-.95	-.43	-.97	-.16	-.28

Table 2.5.5.2. (Continued)

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	.51	.26	.98	-.20	-.59	-.45	-.37	-.04	-.14	-.19
6	.08	.38	.17	-.17	-.05	-.60	-.20	.05	.27	.09
7	-.27	.16	.45	.50	.15	-.10	-.01	.07	.19	-.09
8	-.58	.17	.36	1.41	.04	-.11	.24	.27	.19	-.14
9	-.63	-.04	.26	1.66	.14	.21	.26	-.02	.30	.01
10	-.55	.28	.08	1.04	.24	.23	.16	.32	.59	.09
11	-.25	.10	.25	.37	-.06	-.15	.07	.08	.01	.21

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	-12.2750	-11.7431	-11.5094	-11.3835	-11.3869	-11.3869	-11.3869
S.E(Log q)	.4379	.2589	.3005	.5924	.7078	.6296	.3260

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	1.42	-1.407	13.34	.52	18	.60	-12.28
6	1.19	-1.339	12.24	.83	18	.30	-11.74
7	1.03	-.186	11.61	.78	18	.32	-11.51
8	1.32	-.749	12.61	.35	18	.80	-11.38
9	1.69	-1.035	14.60	.18	18	1.19	-11.39
10	1.35	-.700	13.27	.29	18	.87	-11.36
11	.89	.627	10.74	.78	18	.30	-11.44

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	14172.	.922	.000	.00	1	.154	.020
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	26768.	.65				.316	.011
F shrinkage mean	25989.	.50				.530	.011

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
23895.	.36	.40	3	1.105	.012

Age 4 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	92161.	.988	.000	.00	1	.116	.084
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	17188.	.60				.364	.384
F shrinkage mean	133719.	.50				.520	.058

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60739.	.36	.74	3	2.070	.125

Table 2.5.5.2. (Continued)

Age 5 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
Cuba Logbook age3	38268.	.943	.000	.00	1	.098	.139
Cuba Logbook age5-11	22207.	.456	.000	.00	1	.449	.229
F shrinkage mean	29957.	.50				.453	.175

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
26824.	.32	.15	3	.456	.193

Age 6 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	4870.	.919	.000	.00	1	.042	1.074
Cuba Logbook age5-11	18944.	.252	.102	.40	2	.684	.402
F shrinkage mean	20689.	.50				.275	.374

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
18342.	.22	.17	4	.762	.413

Age 7 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	692.	.994	.000	.00	1	.016	.787
Cuba Logbook age5-11	1297.	.206	.118	.57	3	.725	.493
F shrinkage mean	1155.	.50				.258	.540

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1246.	.20	.09	5	.432	.509

Age 8 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	2594.	.943	.000	.00	1	.014	.388
Cuba Logbook age5-11	1443.	.205	.103	.51	4	.619	.616
F shrinkage mean	1324.	.50				.367	.656

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1409.	.22	.08	6	.336	.627

Table 2.5.5.2. (Continued)

Age 9 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	503.	.946	.000	.00	1	.010	.635
Cuba Logbook age5-11	402.	.223	.090	.41	5	.499	.746
F shrinkage mean	433.	.50				.491	.708

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
418.	.27	.06	7	.210	.726

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	302.	.973	.000	.00	1	.005	.765
Cuba Logbook age5-11	242.	.285	.140	.49	6	.385	.890
F shrinkage mean	260.	.50				.610	.849

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
253.	.32	.08	8	.235	.864

Age 11 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	147.	1.018	.000	.00	1	.001	.195
Cuba Logbook age5-11	47.	.280	.054	.19	7	.593	.514
F shrinkage mean	29.	.50				.406	.746

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
39.	.26	.12	9	.457	.600

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 2/05/2003 19:19

Traditional vpa using screen input for terminal F with backwards extension

Table 8 Fishing mortality (F) at age

YEAR	1961	1962
AGE		
3	.0226	.0466
4	.0556	.0862
5	.0993	.1206
6	.1213	.1399
7	.0928	.1186
8	.0847	.0748
9	.0964	.1142
10	.0907	.1282
11	.0906	.1057
+gp	.0906	.1057
0 FBAR 4- 8	.0907	.1080

YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
AGE										
3	.0307	.0477	.0495	.0250	.0248	.0321	.0329	.0480	.0887	.0937
4	.0359	.1259	.0771	.1006	.0518	.0909	.1450	.2544	.1479	.0730
5	.0715	.2193	.1586	.1486	.1215	.0953	.1715	.1536	.3565	.1648
6	.1113	.1791	.2131	.2319	.1382	.1354	.1679	.1593	.1402	.2972
7	.1629	.2204	.2205	.2771	.2552	.1338	.1993	.1531	.1258	.3268
8	.1150	.2553	.2411	.2518	.2600	.2172	.2079	.1935	.1115	.2975
9	.1345	.1414	.2960	.2749	.2249	.2168	.3039	.1643	.1239	.3726
10	.1993	.1643	.2331	.3309	.2873	.2006	.3254	.1991	.1202	.4546
11	.1496	.1870	.2567	.2859	.2574	.2116	.2790	.1856	.1186	.3749
+gp	.1496	.1870	.2567	.2859	.2574	.2116	.2790	.1856	.1186	.3749
0 FBAR 4- 8	.0993	.2000	.1821	.2020	.1653	.1345	.1783	.1828	.1764	.2318

YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
AGE										
3	.1277	.2296	.1510	.2059	.1484	.0840	.0376	.0931	.0138	.0287
4	.3223	.3174	.3592	.3702	.2979	.2374	.1781	.1542	.2424	.1841
5	.4563	.3535	.5426	.3152	.4241	.2885	.2898	.2029	.1965	.2042
6	.3470	.3264	.2885	.3430	.4130	.1918	.2785	.2310	.4375	.4819
7	.2903	.2288	.1952	.2046	.3661	.2003	.3210	.3222	.5550	.3200
8	.2411	.1761	.1745	.1762	.2532	.4109	.3565	.2550	.6296	.5384
9	.1968	.1948	.1177	.1657	.2018	.2634	.3859	.3121	.5557	.5662
10	.2472	.1795	.1475	.1195	.1731	.2997	.4659	.5066	.5173	.3270
11	.2284	.1834	.1466	.1538	.2094	.3247	.4028	.3579	.5675	.4772
+gp	.2284	.1834	.1466	.1538	.2094	.3247	.4028	.3579	.5675	.4772
0 FBAR 4- 8	.3314	.2804	.3120	.2818	.3509	.2658	.2848	.2331	.4122	.3457

YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
AGE										
3	.0699	.0159	.0634	.0213	.0371	.0220	.0178	.0160	.0474	.0301
4	.1066	.4962	.2379	.1396	.1397	.0901	.2070	.2056	.4168	.2654
5	.3640	.3464	.5039	.4563	.4294	.3581	.2311	.6386	.7700	.5988
6	.4656	.5674	.2925	.7601	.5777	.6441	.4975	.7926	.9052	.7128
7	.4947	.6360	.5666	.4064	.4634	.5901	.3797	.8130	.8173	.5935
8	.5269	.4641	.4154	.7481	.4182	.5989	.5326	.4142	.6807	.5074
9	.8384	.5150	.3185	.8229	.5477	.5651	.3561	.2163	.7535	.5952
10	.3695	.3678	.2171	.6168	.7266	.5538	.2399	.1896	.8326	.5422
11	.5783	.4489	.3170	.7293	.5642	.5726	.3762	.2734	.7556	.5482
+gp	.5783	.4489	.3170	.7293	.5642	.5726	.3762	.2734	.7556	.5482
0 FBAR 4- 8	.3916	.5020	.4032	.5021	.4057	.4563	.3696	.5728	.7180	.5356

YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	FBAR **-**
AGE											
3	.0636	.0469	.0114	.0143	.0112	.0135	.0045	.0143	.0156	.0156	.0152
4	.2065	.2750	.0906	.0390	.0503	.0699	.0692	.0496	.0545	.1648	.0896
5	.5552	.3356	.4122	.1395	.1153	.1581	.1765	.2205	.2039	.1933	.2059
6	.6063	.6114	.4085	.3021	.3299	.2385	.3218	.4031	.5706	.4132	.4623
7	.5242	.6092	.7152	.4902	.5036	.4648	.4906	.5170	.7093	.5091	.5785
8	.4394	.6720	.6417	.8295	.5393	.5259	.6501	.7153	.8402	.6266	.7274
9	.5183	.5444	.8270	.5467	.6950	.7201	.6337	.5553	.9720	.7261	.7511
10	.5069	.8172	.7995	.6992	.6485	.8457	.7157	.7504	1.4000	.8645	1.0049
11	.4882	.6778	.7561	.6918	.6276	.6972	.6665	.6736	1.0707	.6003	.7816
+gp	.4882	.6778	.7561	.6918	.6276	.6972	.6665	.6736	1.0707	.6003	
0 FBAR 4- 8	.4663	.5006	.4537	.3601	.3077	.2914	.3417	.3811	.4757	.3814	

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 2/05/2003 19:19

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	1962
	AGE		
	3	9032	13619
	4	7722	7230
	5	5631	5980
	6	3884	4175
	7	2685	2816
	8	1750	2004
	9	1391	1316
	10	1042	1034
	11	572	779
	+gp	1043	1153
0	TOTAL	34753	40106

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

	YEAR	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
	AGE										
	3	22363	16181	22750	21787	26822	21451	40612	34010	37084	33414
	4	10643	17755	12630	17727	17397	21423	17008	32175	26541	27785
	5	5430	8407	12816	9574	13125	13525	16016	12045	20426	18742
	6	4340	4139	5528	8954	6756	9516	10067	11047	8458	11708
	7	2972	3179	2833	3657	5814	4818	6804	6968	7713	6019
	8	2048	2067	2088	1861	2269	3688	3451	4564	4895	5568
	9	1522	1495	1311	1343	1184	1433	2430	2295	3079	3585
	10	961	1090	1062	798	835	774	944	1468	1594	2227
	11	745	645	757	689	470	513	519	558	985	1157
	+gp	2170	1122	1383	994	678	1078	857	857	985	737
0	TOTAL	53195	56080	63158	67384	75350	78219	98707	105988	111760	110942

	YEAR	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
	AGE										
	3	23106	18771	16196	18780	12842	8357	8567	12346	33021	15097
	4	24909	16650	12215	11402	12515	9064	6291	6755	9210	26664
	5	21148	14775	9925	6983	6447	7607	5853	4310	4741	5918
	6	13013	10971	8495	4723	4171	3454	4667	3586	2881	3189
	7	7121	7530	6481	5212	2744	2260	2334	2892	2331	1523
	8	3554	4361	4905	4365	3478	1558	1514	1386	1716	1095
	9	3386	2287	2994	3372	2997	2210	846	868	880	748
	10	2022	2277	1541	2179	2340	2005	1391	471	520	413
	11	1157	1293	1558	1088	1583	1611	1217	715	232	254
	+gp	1001	1739	2405	2216	1921	2118	2284	2865	2577	2602
0	TOTAL	100418	80655	66714	60321	51037	40243	34964	36195	58107	57503

	YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
	AGE										
	3	40553	25707	21951	61014	47827	43910	28200	20449	24543	19372
	4	12011	30961	20715	16867	48901	37730	35169	22681	16477	19165
	5	18160	8839	15434	13370	12010	34816	28230	23410	15119	8892
	6	3950	10332	5118	7634	6936	6400	19924	18344	10120	5731
	7	1613	2030	4796	3128	2923	3187	2752	9919	6798	3351
	8	905	805	880	2228	1706	1506	1446	1541	3602	2458
	9	523	438	414	476	863	919	677	695	834	1493
	10	348	185	214	247	171	409	428	388	458	321
	11	244	197	105	141	109	68	192	275	263	163
	+gp	1344	766	1111	333	246	150	136	363	242	280
0	TOTAL	79650	80260	70737	105438	121691	129095	117155	98065	78457	61227

	YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	GMST 61-**	AMST 61-**
	AGE													
	3	23548	16587	38708	23153	34050	13367	79201	63192	79999	22756	0	23737	27288
	4	15390	18092	12957	31332	18688	27567	10797	64554	51004	64482	18342	17554	20294
	5	12033	10250	11251	9689	24671	14550	21046	8249	50296	39545	44773	11404	12986
	6	4000	5655	6000	6100	6900	17999	10170	14443	5417	33583	26686	6866	7837
	7	2300	1786	2512	3265	3692	4062	11610	6035	7902	2506	18189	3778	4312
	8	1516	1115	795	1006	1637	1827	2089	5820	2947	3183	1233	2080	2427
	9	1212	800	466	343	359	782	884	893	2330	1041	1393	1131	1401
	10	674	591	380	167	162	147	311	384	420	722	412	635	874
	11	153	332	214	140	68	70	52	125	148	85	249	359	550
	+gp	147	109	240	179	234	159	155	56	92	114	89		
0	TOTAL	60974	55316	73522	75374	90462	80528	136314	163749	200555	168016	111366		

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

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

    At  2/05/2003  19:19

        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	236417	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	155790	113860	34835	.3059	.3509
1978	8357	136872	95807	28138	.2937	.2658
1979	8567	112662	83398	27246	.3267	.2848
1980	12346	124362	88748	25230	.2843	.2331
1981	33021	141447	76135	30103	.3954	.4122
1982	15097	149398	83124	30964	.3725	.3457
1983	40553	177824	92868	39176	.4218	.3916
1984	25707	188593	96051	54665	.5691	.5020
1985	21951	188334	109372	44605	.4078	.4032
1986	61014	233026	98143	41716	.4251	.5021
1987	47827	247283	94536	40020	.4233	.4057
1988	43910	256264	100171	45285	.4521	.4563
1989	28200	225255	99274	44477	.4480	.3696
1990	20449	188887	93772	61628	.6572	.5728
1991	24543	147107	71052	54858	.7721	.7180
1992	19372	121718	59186	36487	.6165	.5356
1993	23548	130691	61828	33543	.5425	.4663
1994	16587	124455	59908	33182	.5539	.5006
1995	38708	150564	62435	27209	.4358	.4537
1996	23153	158785	68859	20029	.2909	.3601
1997	34050	180059	75916	22306	.2938	.3077
1998	13367	165206	87637	26421	.3015	.2914
1999	79201	241457	103622	33207	.3205	.3417
2000	63192	293940	107199	39045	.3642	.3811
2001	79999	341019	124784	51795	.4151	.4757
2002	22756	280661	122102	56759	.4648	.3814
Arith. Mean	28436	186472	100217	34243	.3540	.3301
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.5.6.1 Saithe in the Faroes (Division Vb). Predictions with management table. **A)** input data based on the run where 1998 year class was reset to approximately the highest observed **B)** input data based on the predicted 1998 year-class strength from the XSA.

A)
MFDP version 1a
Run: man9
Time and date: 09:25 07/05/03
Fbar age range: 4-8

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29649	0.2	0.09	0	0	1.316	0.015	1.316
4	18342	0.2	0.21	0	0	1.552	0.090	1.552
5	44773	0.2	0.38	0	0	1.838	0.206	1.838
6	26686	0.2	0.60	0	0	2.305	0.462	2.305
7	18189	0.2	0.88	0	0	3.055	0.578	3.055
8	1233	0.2	0.95	0	0	3.647	0.727	3.647
9	1393	0.2	0.99	0	0	4.579	0.751	4.579
10	412	0.2	1.00	0	0	5.324	1.005	5.324
11	249	0.2	1.00	0	0	6.549	0.782	6.549
12	89	0.2	1.00	0	0	6.784	0.782	6.784

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29649	0.2	0.11	0	0	1.316	0.015	1.316
4	.	0.2	0.22	0	0	1.552	0.090	1.552
5	.	0.2	0.40	0	0	1.838	0.206	1.838
6	.	0.2	0.65	0	0	2.305	0.462	2.305
7	.	0.2	0.87	0	0	3.055	0.578	3.055
8	.	0.2	0.95	0	0	3.647	0.727	3.647
9	.	0.2	0.99	0	0	4.579	0.751	4.579
10	.	0.2	1.00	0	0	5.324	1.005	5.324
11	.	0.2	1.00	0	0	6.549	0.782	6.549
12	.	0.2	1.00	0	0	6.784	0.782	6.784

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29649	0.2	0.11	0	0	1.316	0.015	1.316
4	.	0.2	0.22	0	0	1.552	0.090	1.552
5	.	0.2	0.40	0	0	1.838	0.206	1.838
6	.	0.2	0.65	0	0	2.305	0.462	2.305
7	.	0.2	0.87	0	0	3.055	0.578	3.055
8	.	0.2	0.95	0	0	3.647	0.727	3.647
9	.	0.2	0.99	0	0	4.579	0.751	4.579
10	.	0.2	1.00	0	0	5.324	1.005	5.324
11	.	0.2	1.00	0	0	6.549	0.782	6.549
12	.	0.2	1.00	0	0	6.784	0.782	6.784

Input units are thousands and kg - output in tonnes

Table 2.5.6.1. Continued

B)
MFDP version 1a
Run: man9a
Time and date: 09:33 07/05/03
Fbar age range: 4-8

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30520	0.2	0.09	0	0	1.316	0.013	1.316
4	23895	0.2	0.21	0	0	1.552	0.076	1.552
5	60739	0.2	0.38	0	0	1.838	0.205	1.838
6	26824	0.2	0.60	0	0	2.305	0.462	2.305
7	18342	0.2	0.88	0	0	3.055	0.578	3.055
8	1246	0.2	0.95	0	0	3.647	0.727	3.647
9	1409	0.2	0.99	0	0	4.579	0.750	4.579
10	418	0.2	1.00	0	0	5.324	1.005	5.324
11	253	0.2	1.00	0	0	6.549	0.739	6.549
12	90	0.2	1.00	0	0	6.784	0.739	6.784

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30520	0.2	0.11	0	0	1.316	0.013	1.316
4	.	0.2	0.22	0	0	1.552	0.076	1.552
5	.	0.2	0.40	0	0	1.838	0.205	1.838
6	.	0.2	0.65	0	0	2.305	0.462	2.305
7	.	0.2	0.87	0	0	3.055	0.578	3.055
8	.	0.2	0.95	0	0	3.647	0.727	3.647
9	.	0.2	0.99	0	0	4.579	0.750	4.579
10	.	0.2	1.00	0	0	5.324	1.005	5.324
11	.	0.2	1.00	0	0	6.549	0.739	6.549
12	.	0.2	1.00	0	0	6.784	0.739	6.784

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	30520	0.2	0.11	0	0	1.316	0.013	1.316
4	.	0.2	0.22	0	0	1.552	0.076	1.552
5	.	0.2	0.40	0	0	1.838	0.205	1.838
6	.	0.2	0.65	0	0	2.305	0.462	2.305
7	.	0.2	0.87	0	0	3.055	0.578	3.055
8	.	0.2	0.95	0	0	3.647	0.727	3.647
9	.	0.2	0.99	0	0	4.579	0.750	4.579
10	.	0.2	1.00	0	0	5.324	1.005	5.324
11	.	0.2	1.00	0	0	6.549	0.739	6.549
12	.	0.2	1.00	0	0	6.784	0.739	6.784

Input units are thousands and kg - output in tonnes

Table 2.5.6.2 Saithe in the Faroes (Division Vb). Yield-per-recruit. **A)** input data based on the run where 1998 year class was reset to approximately the highest observed **B)** input data based on the predicted 1998 year-class strength from the XSA.

A)
MFYPR version 2a
Run: yr2
Index file 3/5/2003
Time and date: 19:46 05/05/03
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.11	0	0	1.316	0.053	1.316
4	0.2	0.26	0	0	1.822	0.173	1.822
5	0.2	0.48	0	0	2.444	0.294	2.444
6	0.2	0.74	0	0	3.183	0.376	3.183
7	0.2	0.91	0	0	4.040	0.395	4.040
8	0.2	0.98	0	0	4.956	0.412	4.956
9	0.2	0.99	0	0	5.754	0.421	5.754
10	0.2	1.00	0	0	6.465	0.439	6.465
11	0.2	1.00	0	0	7.327	0.421	7.327
12	0.2	1.00	0	0	8.652	0.421	8.652

Weights in kilograms

B)
MFYPR version 2a
Run: yr5a
Index file 3/5/2003
Time and date: 19:50 05/05/03
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.11	0	0	1.316	0.052	1.316
4	0.2	0.26	0	0	1.822	0.172	1.822
5	0.2	0.48	0	0	2.444	0.295	2.444
6	0.2	0.74	0	0	3.183	0.378	3.183
7	0.2	0.91	0	0	4.040	0.397	4.040
8	0.2	0.98	0	0	4.956	0.417	4.956
9	0.2	0.99	0	0	5.754	0.431	5.754
10	0.2	1.00	0	0	6.465	0.449	6.465
11	0.2	1.00	0	0	7.327	0.442	7.327
12	0.2	1.00	0	0	8.652	0.442	8.652

Weights in kilograms

Table 2.5.6.3 Saithe in the Faroes (Division Vb). Yield-per-recruit. **A)** summary table based on the run where 1998 year class was reset to approximately the highest observed **B)** summary table based on the predicted 1998 year-class strength from the XSA.

MFYPR version 2a
Run: yr2
Time and date: 19:46 05/05/03
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.5268	3.4792	18.7235	3.4792	18.7235
0.1000	0.0330	0.1228	0.5760	4.9050	18.1525	2.8908	14.4189	2.8908	14.4189
0.2000	0.0660	0.2104	0.9164	4.4695	15.2017	2.4774	11.5339	2.4774	11.5339
0.3000	0.0990	0.2763	1.1262	4.1421	13.1010	2.1712	9.4956	2.1712	9.4956
0.4000	0.1321	0.3279	1.2592	3.8860	11.5434	1.9353	7.9971	1.9353	7.9971
0.5000	0.1651	0.3697	1.3452	3.6793	10.3506	1.7481	6.8603	1.7481	6.8603
0.6000	0.1981	0.4042	1.4014	3.5086	9.4128	1.5960	5.9758	1.5960	5.9758
0.7000	0.2311	0.4334	1.4382	3.3646	8.6590	1.4699	5.2727	1.4699	5.2727
0.8000	0.2641	0.4584	1.4621	3.2412	8.0416	1.3637	4.7036	1.3637	4.7036
0.9000	0.2971	0.4802	1.4773	3.1341	7.5277	1.2731	4.2358	1.2731	4.2358
1.0000	0.3301	0.4994	1.4866	3.0399	7.0939	1.1949	3.8460	1.1949	3.8460
1.1000	0.3632	0.5164	1.4917	2.9564	6.7231	1.1267	3.5172	1.1267	3.5172
1.2000	0.3962	0.5317	1.4940	2.8815	6.4026	1.0666	3.2370	1.0666	3.2370
1.3000	0.4292	0.5455	1.4943	2.8141	6.1229	1.0134	2.9959	1.0134	2.9959
1.4000	0.4622	0.5581	1.4932	2.7528	5.8766	0.9660	2.7867	0.9660	2.7867
1.5000	0.4952	0.5696	1.4911	2.6968	5.6581	0.9234	2.6037	0.9234	2.6037
1.6000	0.5282	0.5801	1.4884	2.6454	5.4629	0.8849	2.4426	0.8849	2.4426
1.7000	0.5612	0.5899	1.4851	2.5980	5.2873	0.8500	2.2999	0.8500	2.2999
1.8000	0.5943	0.5989	1.4816	2.5541	5.1284	0.8182	2.1726	0.8182	2.1726
1.9000	0.6273	0.6074	1.4779	2.5132	4.9840	0.7890	2.0586	0.7890	2.0586
2.0000	0.6603	0.6153	1.4741	2.4751	4.8520	0.7623	1.9560	0.7623	1.9560

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3301
FMax	1.2671	0.4183
F0.1	0.4792	0.1582
F35%SPR	0.5321	0.1757
Flow	0.3152	0.1041
Fmed	1.0585	0.3494
Fhigh	2.4647	0.8137

Weights in kilograms

A)

B)

MFYPR version 2a
Run: yr1a
Time and date: 18:48 03/05/03
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.4316	3.4792	18.6509	3.4792	18.6509
0.1000	0.0373	0.1371	0.6386	4.8341	17.5654	2.8226	13.8619	2.8226	13.8619
0.2000	0.0747	0.2305	0.9876	4.3695	14.4558	2.3826	10.8248	2.3826	10.8248
0.3000	0.1120	0.2988	1.1889	4.0304	12.3248	2.0669	8.7619	2.0669	8.7619
0.4000	0.1493	0.3513	1.3090	3.7704	10.7879	1.8292	7.2893	1.8292	7.2893
0.5000	0.1867	0.3931	1.3823	3.5636	9.6353	1.6436	6.1973	1.6436	6.1973
0.6000	0.2240	0.4274	1.4272	3.3944	8.7433	1.4946	5.3625	1.4946	5.3625
0.7000	0.2613	0.4561	1.4547	3.2528	8.0349	1.3725	4.7083	1.3725	4.7083
0.8000	0.2987	0.4806	1.4710	3.1321	7.4600	1.2704	4.1849	1.2704	4.1849
0.9000	0.3360	0.5019	1.4801	3.0278	6.9849	1.1838	3.7585	1.1838	3.7585
1.0000	0.3733	0.5205	1.4845	2.9364	6.5859	1.1095	3.4059	1.1095	3.4059
1.1000	0.4107	0.5370	1.4857	2.8555	6.2462	1.0450	3.1104	1.0450	3.1104
1.2000	0.4480	0.5518	1.4849	2.7832	5.9534	0.9885	2.8598	0.9885	2.8598
1.3000	0.4853	0.5652	1.4827	2.7181	5.6985	0.9386	2.6451	0.9386	2.6451
1.4000	0.5227	0.5773	1.4796	2.6591	5.4745	0.8942	2.4595	0.8942	2.4595
1.5000	0.5600	0.5884	1.4760	2.6052	5.2759	0.8544	2.2977	0.8544	2.2977
1.6000	0.5973	0.5986	1.4719	2.5558	5.0985	0.8186	2.1556	0.8186	2.1556
1.7000	0.6347	0.6080	1.4677	2.5103	4.9391	0.7862	2.0299	0.7862	2.0299
1.8000	0.6720	0.6167	1.4633	2.4681	4.7949	0.7567	1.9182	0.7567	1.9182
1.9000	0.7093	0.6249	1.4590	2.4289	4.6638	0.7298	1.8182	0.7298	1.8182
2.0000	0.7467	0.6324	1.4546	2.3923	4.5439	0.7051	1.7283	0.7051	1.7283

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3733
FMax	1.1041	0.4122
F0.1	0.413	0.1542
F35%SPR	0.4667	0.1742
Flow	0.2757	0.1029
Fmed	0.935	0.3491
Fhigh	2.1934	0.8189

Weights in kilograms

Table 2.5.6.4 Saithe in the Faroes (Division Vb). Prediction with management table. **A)** based on the run where 1998 year class was reset to approximately the highest observed **B)** based on the predicted 1998 year-class strength from the XSA.

A)

MFDP version 1a
Run: man9
Index file 3/5/2003
Time and date: 09:25 07/05/03
Fbar age range: 4-8

2003				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
282175	141588	1.0000	0.4127	67423

2004					2005	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
249405	139504	0.0000	0.0000	0	292020	185174
.	139504	0.1000	0.0413	8230	282703	176854
.	139504	0.2000	0.0825	16035	273880	168996
.	139504	0.3000	0.1238	23441	265524	161572
.	139504	0.4000	0.1651	30470	257606	154556
.	139504	0.5000	0.2064	37144	250102	147924
.	139504	0.6000	0.2476	43484	242987	141654
.	139504	0.7000	0.2889	49508	236238	135723
.	139504	0.8000	0.3302	55235	229835	130112
.	139504	0.9000	0.3715	60681	223758	124803
.	139504	1.0000	0.4127	65862	217987	119777
.	139504	1.1000	0.4540	70793	212506	115018
.	139504	1.2000	0.4953	75489	207299	110511
.	139504	1.3000	0.5366	79961	202349	106240
.	139504	1.4000	0.5778	84223	197642	102193
.	139504	1.5000	0.6191	88285	193165	98357
.	139504	1.6000	0.6604	92160	188905	94719
.	139504	1.7000	0.7016	95857	184849	91269
.	139504	1.8000	0.7429	99385	180987	87995
.	139504	1.9000	0.7842	102755	177308	84888
.	139504	2.0000	0.8255	105974	173801	81939

Input units are thousands and kg - output in tonnes

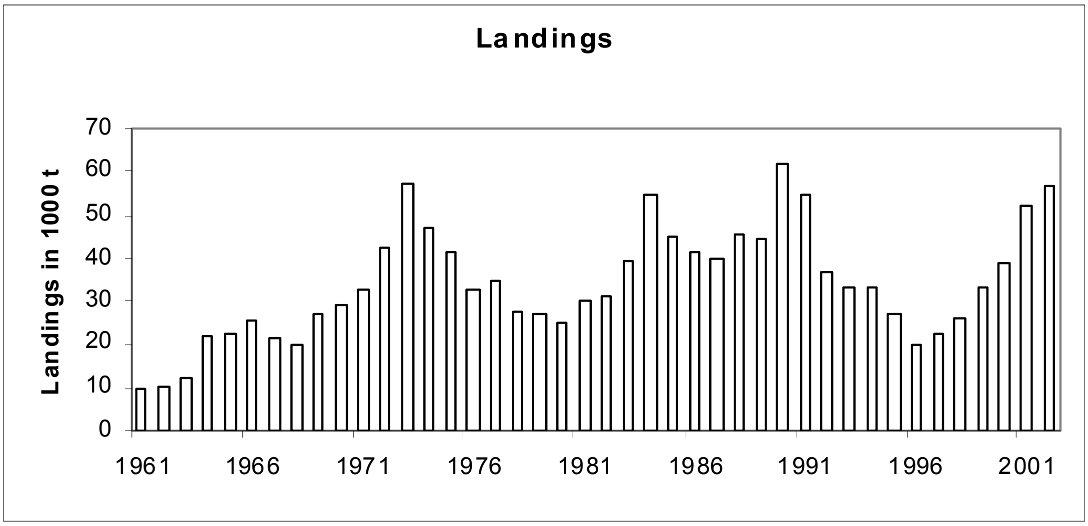
Table 2.5.6.4. Continued

B)
MFDP version 1a
Run: man9a
Index file 3/5/2003
Time and date: 09:33 07/05/03
Fbar age range: 4-8

2003 Biomass	SSB	FMult	FBar	Landings
322257	155437	1.0000	0.4097	72844

2004 Biomass	SSB	FMult	FBar	Landings	2005 Biomass	SSB
285017	159676	0.0000	0.0000	0	331006	215199
.	159676	0.1000	0.0410	9367	320333	205710
.	159676	0.2000	0.0819	18263	310215	196733
.	159676	0.3000	0.1229	26713	300618	188239
.	159676	0.4000	0.1639	34743	291513	180200
.	159676	0.5000	0.2049	42377	282873	172589
.	159676	0.6000	0.2458	49637	274671	165381
.	159676	0.7000	0.2868	56544	266882	158554
.	159676	0.8000	0.3278	63116	259483	152085
.	159676	0.9000	0.3688	69374	252453	145954
.	159676	1.0000	0.4097	75333	245770	140143
.	159676	1.1000	0.4507	81010	239416	134631
.	159676	1.2000	0.4917	86421	233372	129404
.	159676	1.3000	0.5326	91579	227622	124445
.	159676	1.4000	0.5736	96500	222149	119738
.	159676	1.5000	0.6146	101194	216938	115271
.	159676	1.6000	0.6556	105675	211975	111028
.	159676	1.7000	0.6965	109953	207247	106999
.	159676	1.8000	0.7375	114040	202740	103171
.	159676	1.9000	0.7785	117945	198444	99534
.	159676	2.0000	0.8195	121679	194346	96076

Input units are thousands and kg - output in tonnes



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

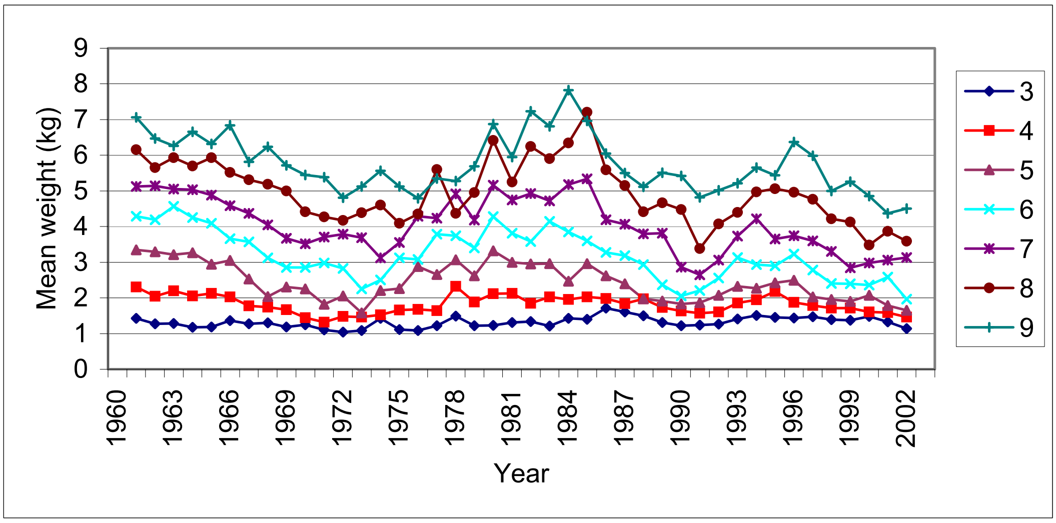


Figure 2.5.3.1 Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2002.

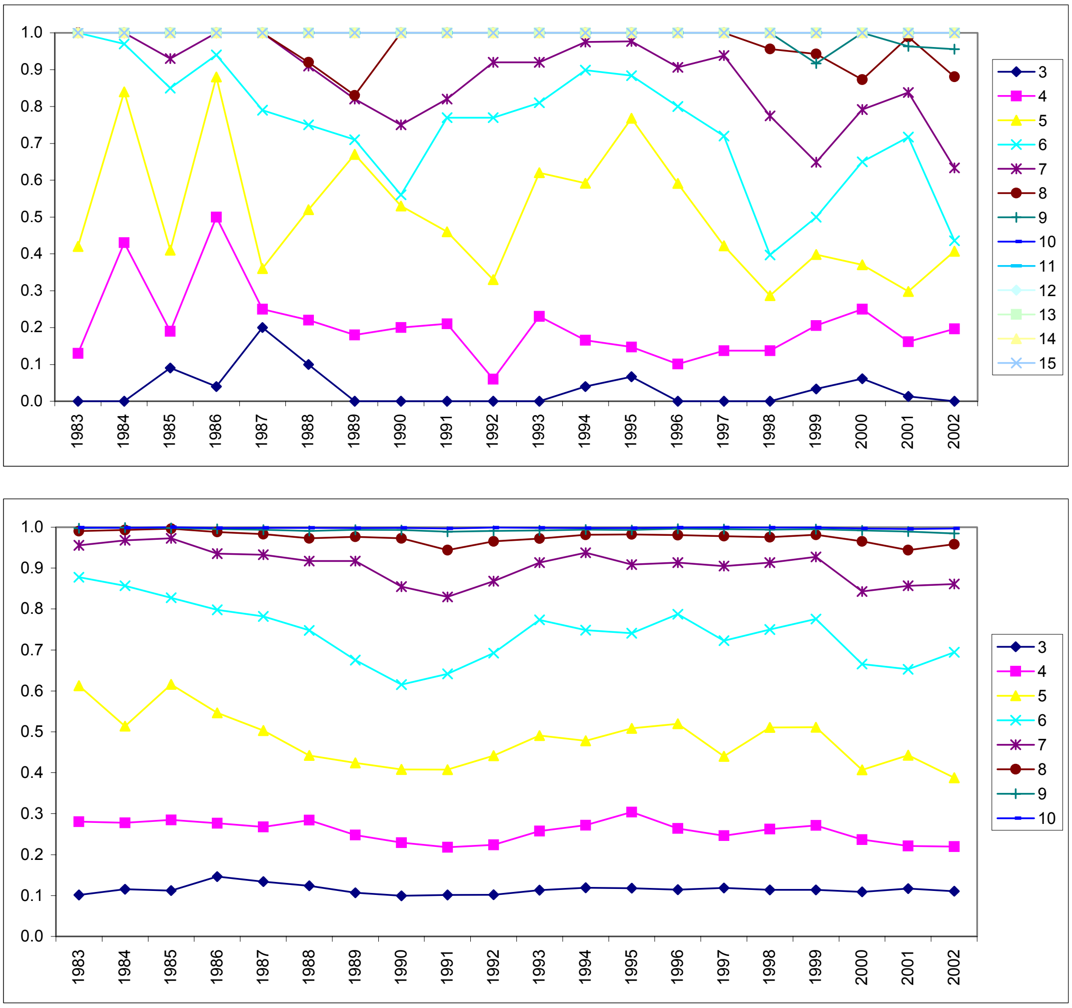


Figure 2.5.4.1 Saithe in the Faroes (Division Vb). Observed (upper figure) and fitted values (lower figure) proportion mature-at-age for the period 1983-2002.

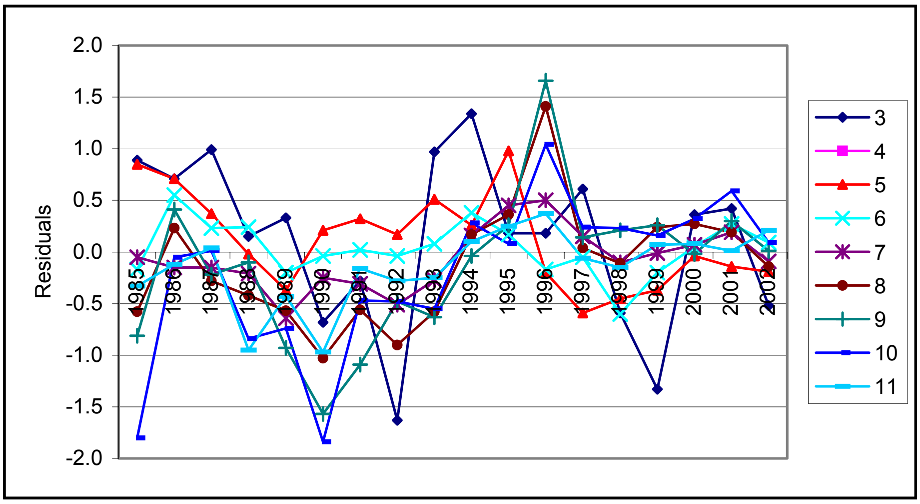


Figure 2.5.5.1 Saithe in the Faroes (Division Vb). Log-catchability residuals for age groups 3 and 5-11 from XSA.

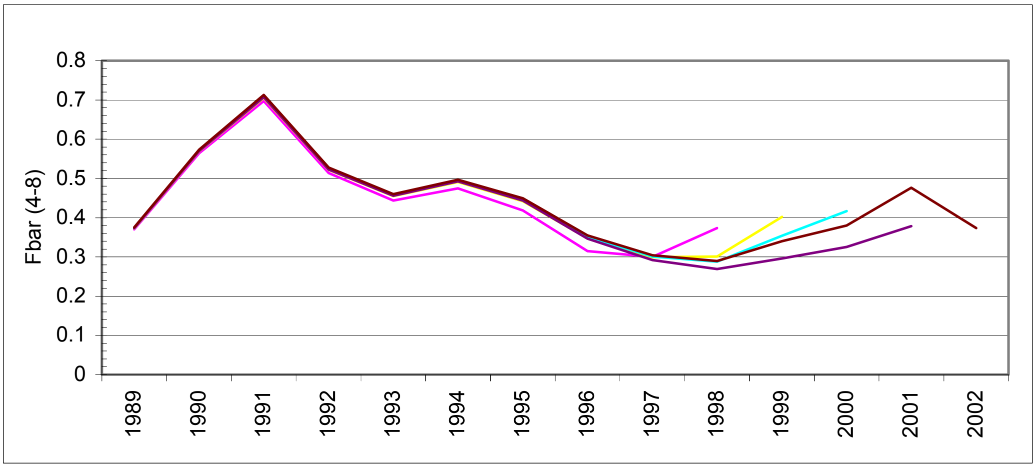


Figure 2.5.5.2 Saithe in the Faroes (Division Vb). Retrospective analysis of average fishing mortality of age groups 4-8 from XSA for the years 1996-2002.

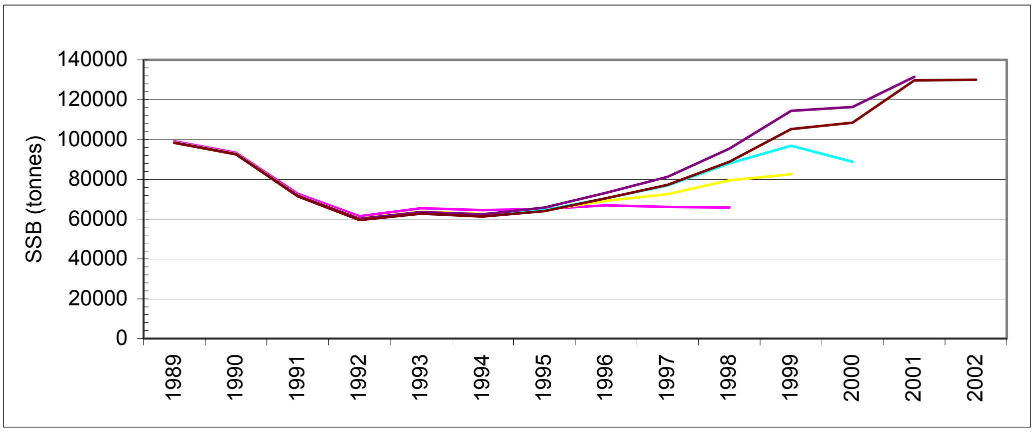


Figure 2.5.5.3 Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from XSA for the years 1996-2002.

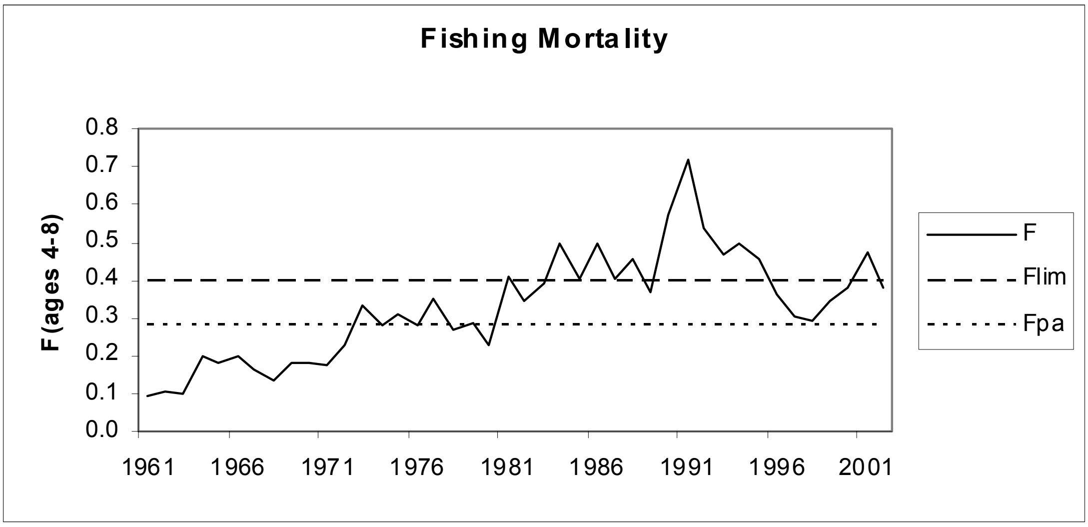


Figure 2.5.5.4 Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

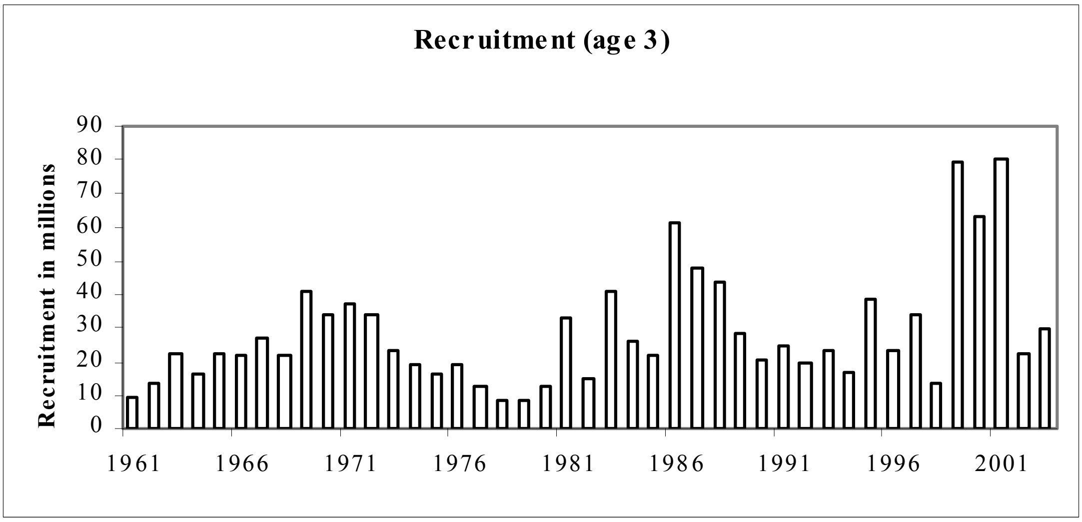


Figure 2.5.5.5 Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

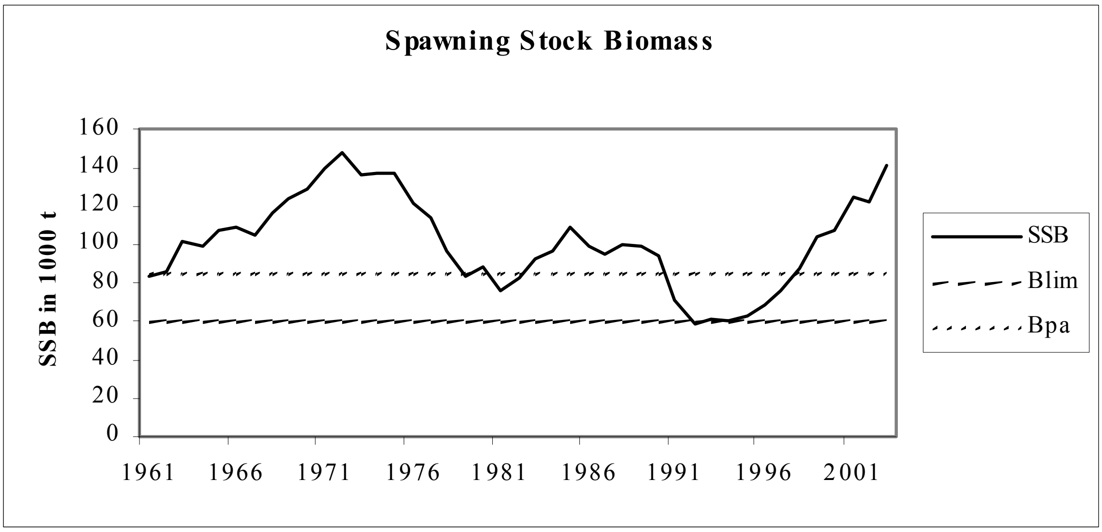


Figure 2.5.5.6 Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes).

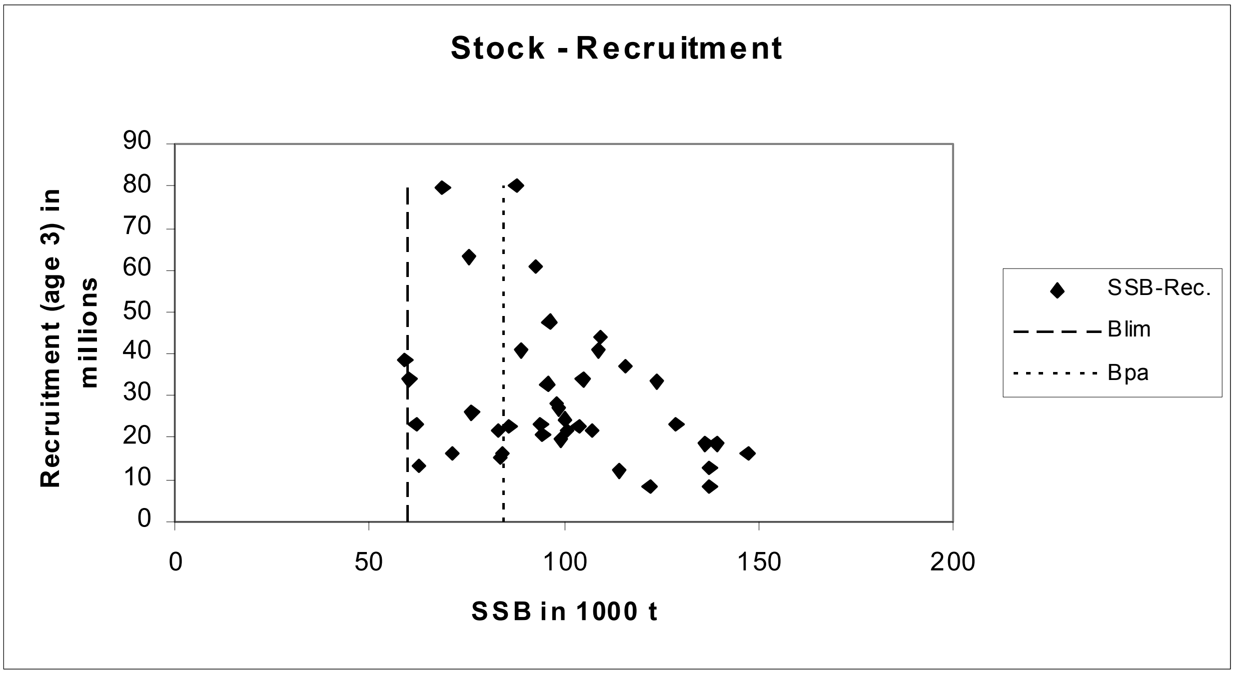


Figure 2.5.5.7 Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

SPRING SURVEY **SUMMER SURVEY**

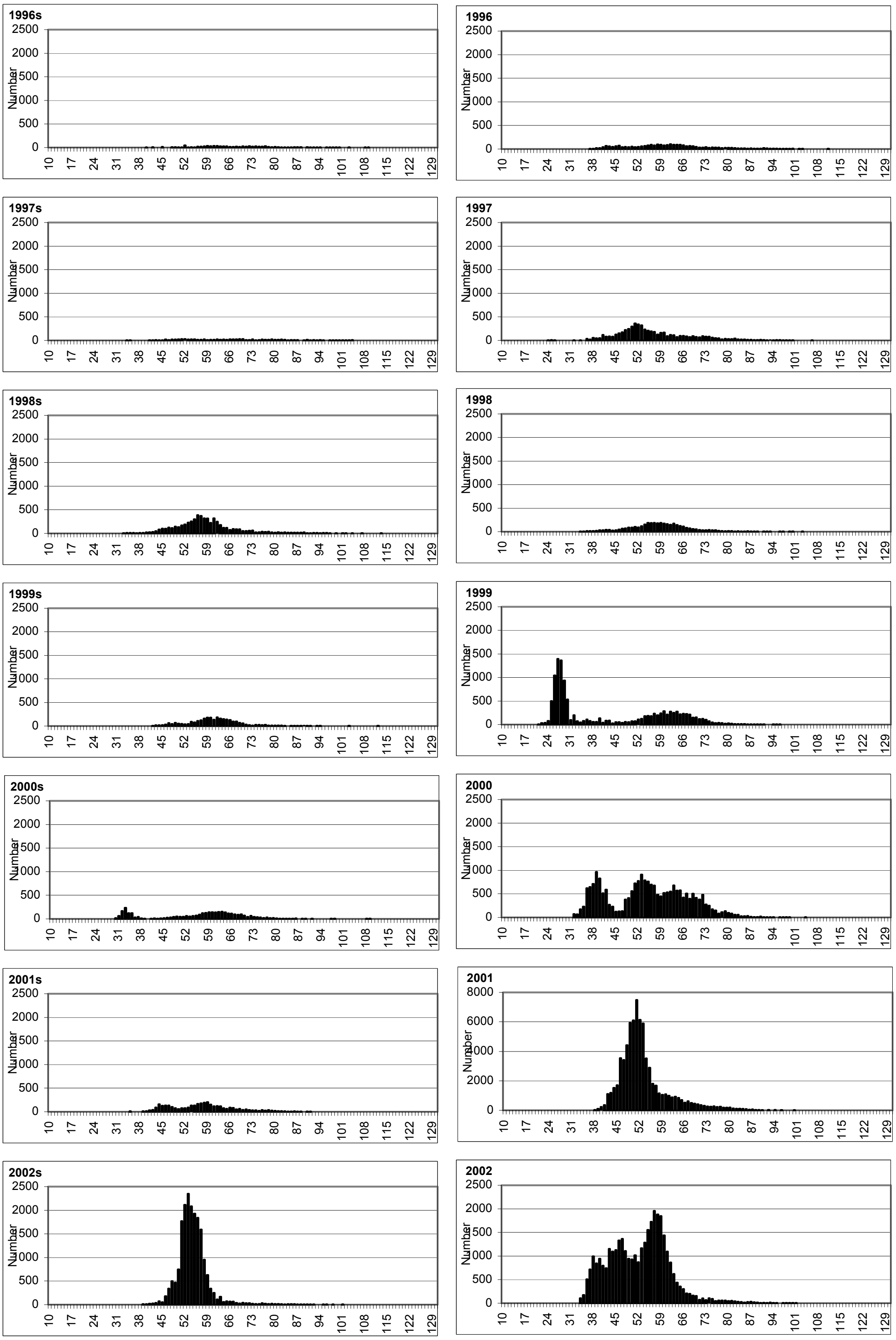
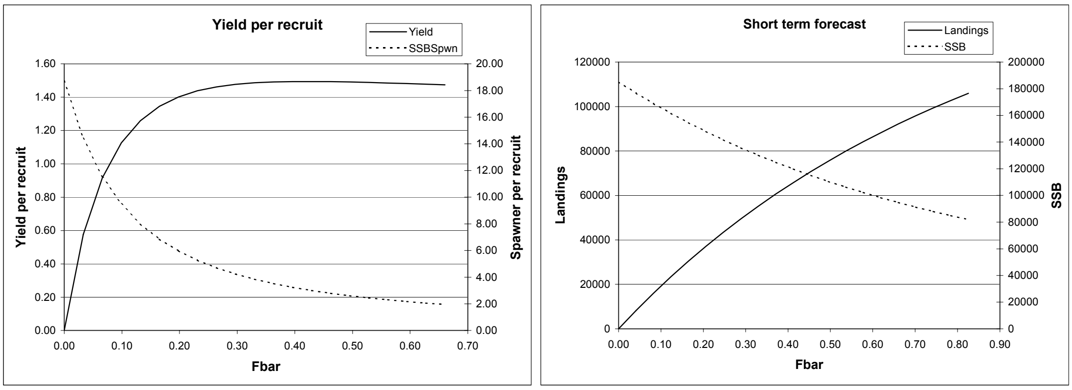


Figure 2.5.5.8 Saithe in the Faroes (Division Vb). Length distribution from spring (s) and summer survey 1996-2002. NB! Different scale for year 2001 summer survey.



MFYPR version 2a
Run: yr2
Time and date: 19:46 05/05/03

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.3301
FMax	1.2671	0.4183
F0.1	0.4792	0.1582
F35%SPR	0.5321	0.1757
Flow	0.3152	0.1041
Fmed	1.0585	0.3494
Fhigh	2.4647	0.8137

Weights in kilograms

MFDP version 1a
Run: man9
Index file 3/5/2003
Time and date: 09:25 07/05/03
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.

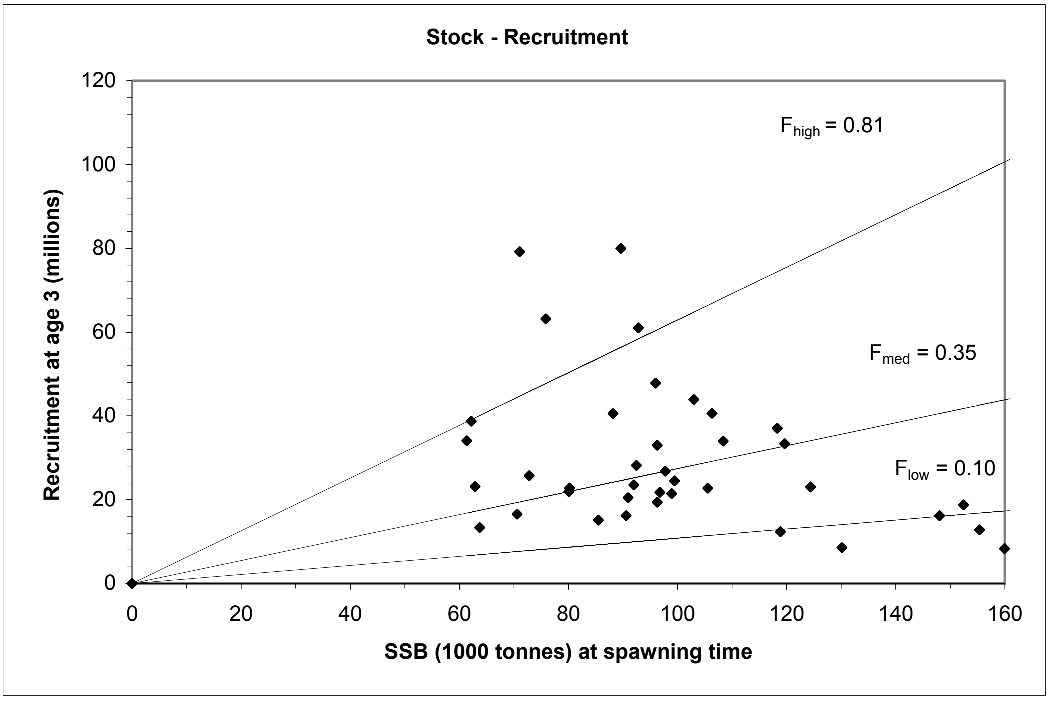


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

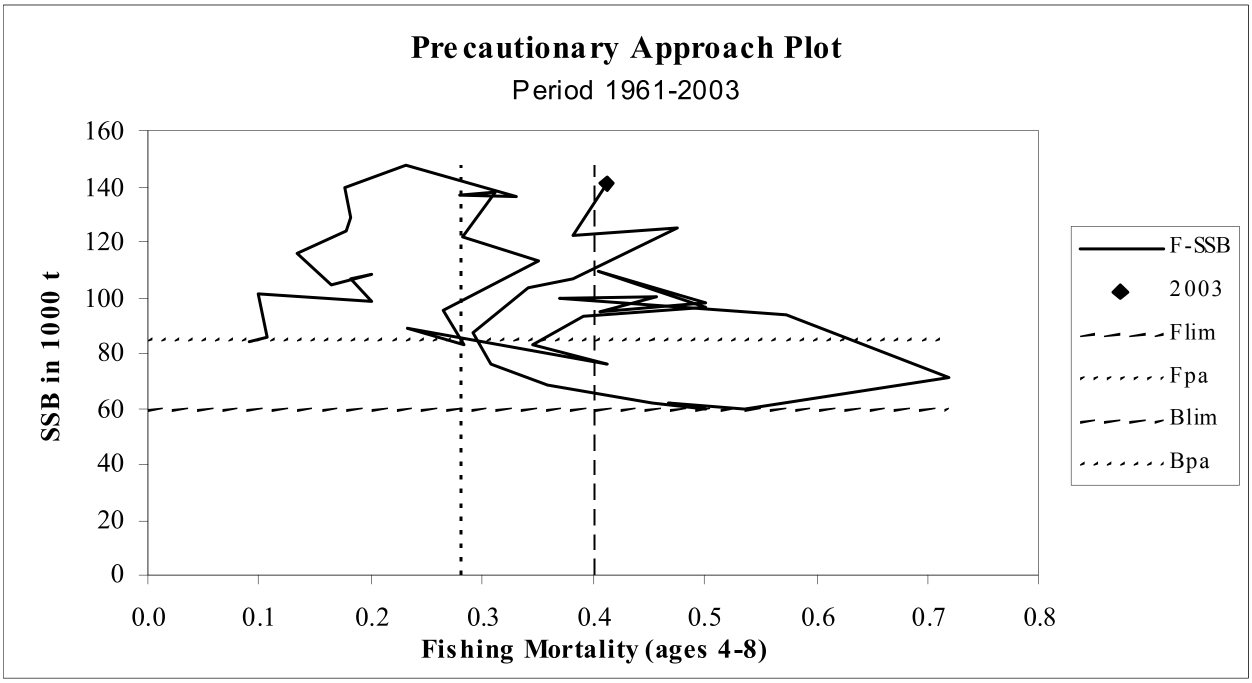
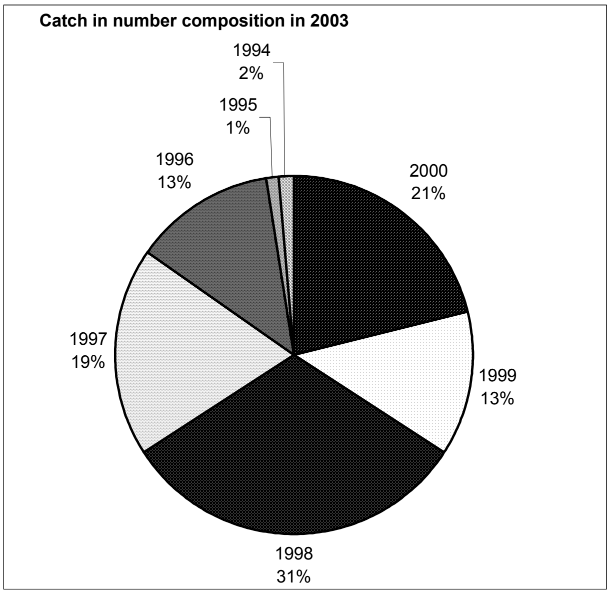


Figure 2.5.6.3 Saithe in the Faroes (Division Vb). The history of the stock/fishery in relation to the four reference points.



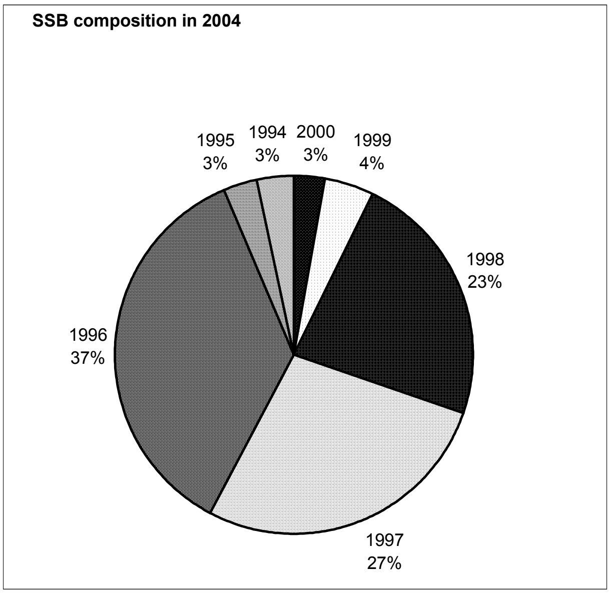


Figure 2.5.6.4 Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2002 (left figure) and the composition in SSB in 2003 by year classes (right figure).

3 DEMERSAL STOCKS AT ICELAND (DIVISION VA)

3.1 Introduction

3.1.1 Description of the fisheries

Demersal fisheries take place all around Iceland including variety of gears and boats of all sizes. The most important fleets targeting demersal fish stocks are given below and the spatial distribution of the fisheries are shown in figure 3.1. to 3.3.

- Large and small trawler using demersal trawl. This fleet is the most important one fishing cod, haddock, saithe, redfish as well as a number of other species. This fleet is operating year around, mostly outside 12 nautical miles form the shore.

- Boats (< 300 GRT) using gillnets. These boats are mostly targeting cod but cod haddock and a number of other species are included. This fleet is mostly operating close to the shore.

- Boats using longlines. These boats are both small boats (< 10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but a number of less important species are also caught, some of them in directed fisheries.

- Boats using handlines. These are small boats around 10 GRT and about 300 < 6 GRT boats operating in a effort control system where each boat is allocated certain number of days for each year. Cod is the most important target species of this fleet with saithe following as the second most important species.

- Boats using danish seine. (20-300 GRT) The most important species for this fleet are cod and haddock but this fleet is the most important fleet fishing for a variety of flat fishes like plaice, dap and witch.

In addition to those fleets a number of other fleets targeting inverberates and pelagic fishes can affect demersal fish stocks, both through discard other hidden mortality.

3.1.2 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. Since 1998 a mesh size of 135 is allowed in the codend in all trawl fisheries not using "Polish cover". In 1977 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 by directives 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 the following year. This was done to meet the needs of the fishing industry.

3.1.3 Discards

In recent years discards have received increased attention. Discard has always been a part of the Icelandic fisheries but in recent years, both the magnitude and the age composition of the discards could have been changing, because of changes in economic constraints of the fisheries. Discard is illegal in Icelandic waters except small handliners have been allowed to discard undersized cod.

Since 2000 systematic data collection to estimate discards in demersal fisheries has been carried out. Prior to 2000 discards have been be estimated by comparing length distributions from observers aboard the vessels and from landings. Pálsson (2003) summarises the estimated discard of haddock 1988-2000 and Pálsson et al (2002 and 2003) summarize the discards in Icelandic waters in the main gears targeting cod, haddock, saithe and redfish. The main results of those reports are presented in Tables 3.1 and 3.3.

Tables 3.1 and 3.2 show that estimated discard of cod in 2002 is 1% of landed catch, decreasing from 1.8% from last year. Comparison with limited data from earlier years indicates that the discard in 2001 and 2002 is considerably less than in preceding years. The results indicate that the danish seine and gillnet fleet are discarding larger cod than the bottom trawl and longliner fleet.

Estimated haddock discard increased from 2001 to 2002 but is still much less than it was in most years from 1989 to 2000. (Table 3.3). Contradicting trend in Haddock discards in the longline and bottom trawl fishery from 2001 to 2002 is a point of concern as is the high percentage discarded in the danish seine fishery which is also the fleet with highest discard percentage for cod.

Data from 2002 indicates that discard of saithe and redfish was negligible. Discard of golden redfish is a problem in some years but in recent years large areas where small redfish is to be expected have been permanently closed.

A number of fleets that in some years do contribute to discarding are not included in the these studies.

The nephrops fishery takes place off the south coast (Figure 3.1). Small haddock as well as a number of flatfish species are known to have been discarded in this fishery.

The shrimp fishery takes place in many areas around Iceland (Figure 3.3). Small redfish used to be bycatch in the fishery for shrimp off the north coast but since 1995 sorting grid has been mandatory in this fishery. In the last decade no redfish recruitment has on the other hand been seen in those areas. In the shallow water areas off the north coast as well as in the areas off the south west and west coast bycatch of small cod and haddock has often caused a problem in this fishery. For a number of years the inshore shrimp fishery has not been opened if the number of young cod and haddock exceeds certain limit. In the last 3 – 5 years the shrimp fishery in most of these areas except the two fjords off the north-west coast has been closed as the shrimp stocks have collapsed, mostly due to cod predation. (anon 2002).

Discards from handliners is not included in the presented studies but handliners are allowed to discard fish below certain size. Recent research (Pálsson et.al 2003a) has though shown that the mortality of cod discarded from handlines is high.

Bycatch of saithe and juvenile cod and haddock is a potential problem in pelagic trawl fisheries. (Figure 3.3). Saithe is by catch in the fishery for blue whiting off the south east coast but small cod and haddock can be a problem in herring fishery in shallower water.

3.1.4 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 stategies 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.

3.1.5 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 was supposed to deliver a preliminary report before the start of the fishing year 2002/2003 but at present no report has been presented.

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., 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.

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.).

Pálsson Ó.K, Karlsson G, Arason A, Gíslason G, Jóhannesson G and Aðalsteinsson S 2002
Mælingar á brottkasti á Þorski og ýsu 2001. Hafrannsóknastofnun fjölrit nr. 90.

Pálsson Ó.K, Karlsson G, Arason A, Gíslason G, Jóhannesson G and Aðalsteinsson S 2003
Mælingar á brottkasti botnfiska 2002. Hafrannsóknastofnunin Fjölrit nr 94.

Pálsson Ó.K 2003. A length based analysis of haddock discards in Icelandic fisheries.
Fisheries Research 59: 437-446 (www.sciencedirect.com).

Pálsson Ó.K, Einarsson H, Björnsson H, 2003a Survival of undersized cod in Fisheries research ??….

Table 3.1 Landings, discards in numbers (thousand fishes) and weight (tonnes) and as a proportion (%) of landings, by species and gear for the year 2001. From Pálsson et.al (2002).

Species	Gear	Discards (Thous. Fishes)	Discard (tons)	DL_{50} cm	Discard-Percentage weight
Cod	Longlines	600	464	43.7	1.0
Cod	Gillnets	560	1620	53.9	3.0
Cod	Danish seine	903	1259	53.7	7.6
Cod	Bottom trawl	649	471	42.8	0.5
Cod	**Total**	**2712**	**3814**		**1.8**
Haddock	Longlines	1391	560	35.7	4.6
Haddock	Bottom trawl	989	456	37.9	2.1
Haddock	**Total**	**2380**	**1016**		**3.0**

Table 3.2 Landings, discards in numbers (thousand fishes) and weight (tonnes) and as a proportion (%) of landings, by species and gear for the year 2002. From Pálsson et.al (2003)

Species	Gear	Catch (tonn)	Discards (Thous. Fishes)	Discard (tons)	DL_{50} cm	Discard-Percentage
Cod	Longlines	42154	220	124	40.4	0.3
Cod	Gillnets	44162	220	515	48.3	1.2
Cod	Danish seine	13575	694	987	49.6	7.3
Cod	Bottom trawl	85740	323	196	41.7	0.2
Cod	**Total**	**185631**	**1457**	**1822**		**1.0**
Haddock	Longline	13568	311	151	37.2	1.1
Haddock	Danish seine	3582	466	382	40.5	10.7
Haddock	Bottom trawl	29883	2908	1782	41.1	6.0
Haddock	**Total**	**47033**	**3685**	**2315**		**4.9**
Saithe	Bottom trawl	35260	+	+		+
Redfish	Bottom trawl	51633	0	0		0

Table 3.3 Haddock discards in the Icelandic demersal trawl fishery 1988-2000 From Pálsson (2002).

Year	Discards by numbers		Discards by weight		DL_{50}	Year class[5]	Stocksize[5]	Landings[5]	Landings
	(millions)	(%)[1]	(tons)	(%)[2]	(cm)	(age 2)[3]	(age 3+)[4]	Numbers[3]	Tons
1988	2.9	11.7	1481	3.8	40.1	47	151	24.8	39088
1989	2.6	9.9	1499	3.4	41.0	24	168	26.3	44215
1990	1.1	3.5	364	0.8	37.1	22	145	31	47158
1991	6.9	37.7	3349	9.7	43.8	79	120	18.3	34661
1992	8.4	47.5	3858	13.3	39.3	169	106	17.7	29093
1993	5.7	25.1	2414	8.0	38.5	37	129	22.7	30132
1994	8.9	29.6	4236	10.7	40.4	41	127	30.1	39474
1995	12.8	44.1	8397	19.6	42.2	75	119	29	42829
1996	10.2	39.4	4577	11.6	41.1	38	108	25.9	39466
1997	8.3	50.6	6160	22.3	44.4	89	89	16.4	27643
1998	5.4	34.6	2501	10.3	40.3	18	96	15.6	24191
1999	2.6	14.1	1349	5.2	38.8	80	91	18.4	25960
2000	3.4	21.8	1930	8.4	40.5	80	86	15.6	22990
2001	1.0		456	2.1					
2002	2.9		1782	6.0					29883

With reference to numbers[1] or weights[2] landed. [3]Millions. [4]Thousand tons. [5]Source: Anon. (2000) The 2001 and 2002 values are obtained from Pálsson et.al (2002 and 2003).

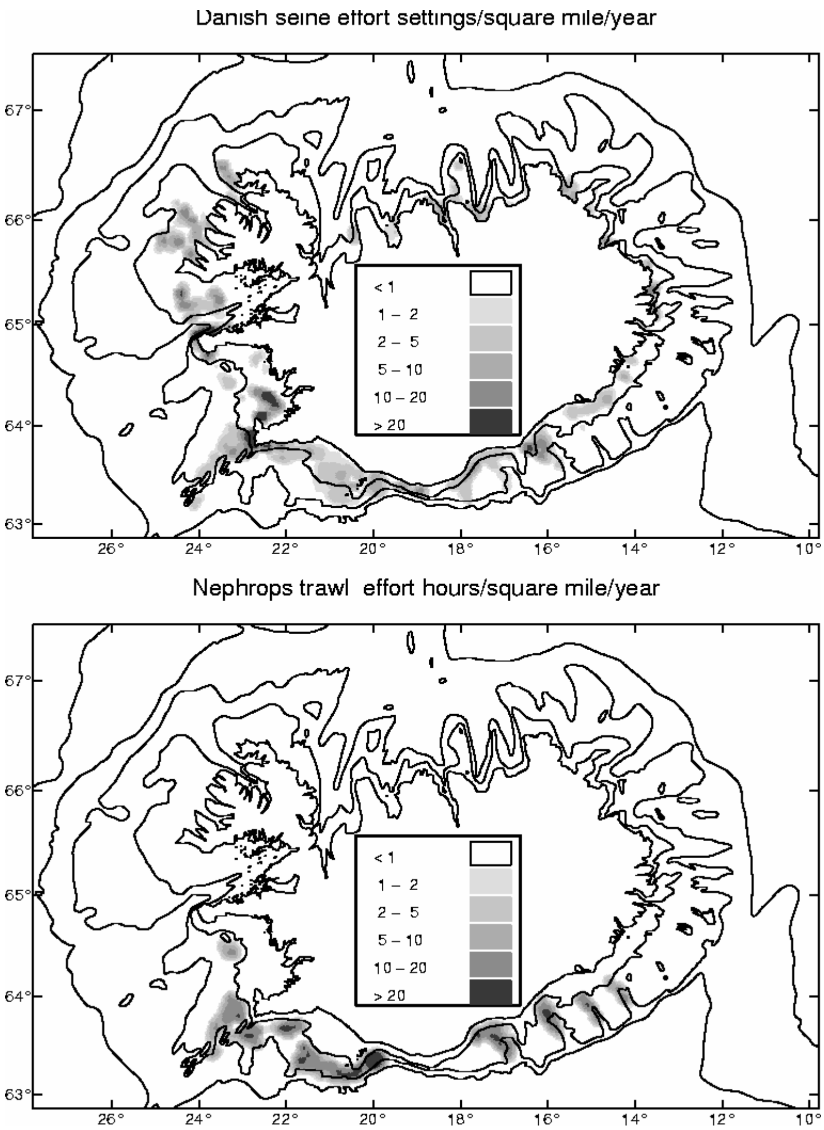


Figure 3.1 Distribution of effort in the Icelandic Danish seine and *Nephrops* fishery 1993-2002.

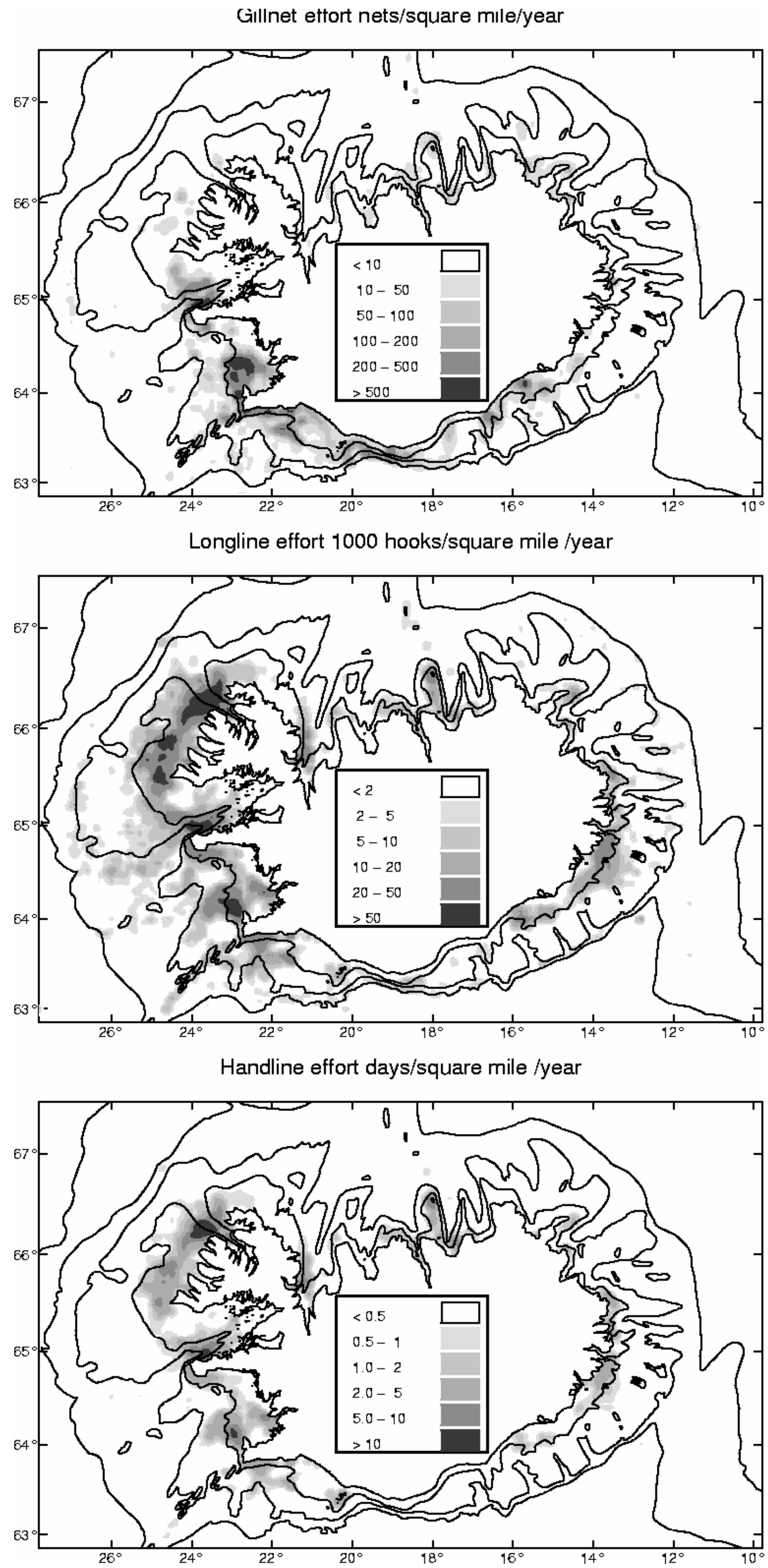


Figure 3.2 Distribution of effort in the Icelandic gillnet fishery 1993 – 2002, longline fishery 2000-2002 and handline fishery 2000-2002

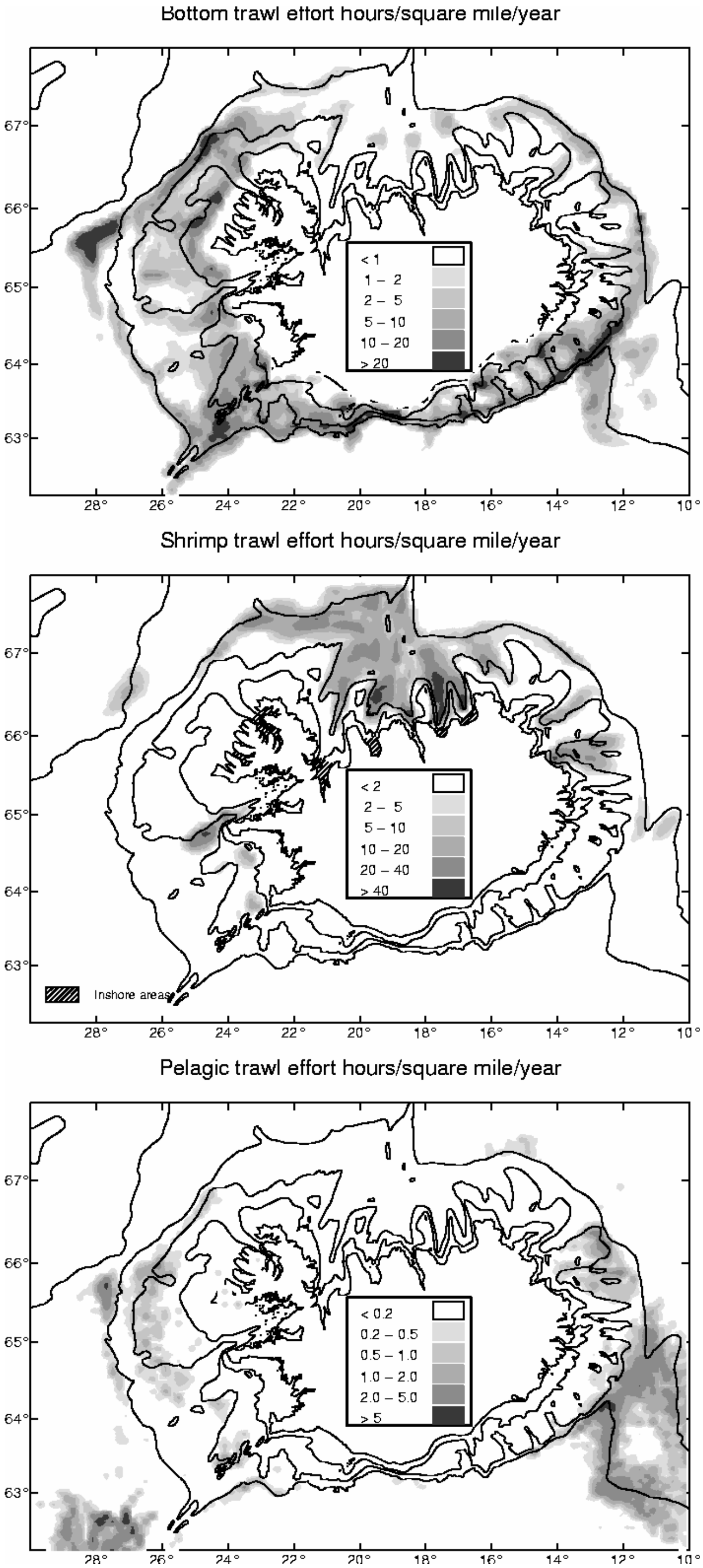


Figure 3.3 Distribution of effort in the Icelandic bottom trawl fishery 1993 – 2002, shrimp fishery 1993-2002 and pelagic trawl fishery 2000-2002.

3.2 Saithe in Icelandic waters

This stock was not assessed by the working group this year

3.3 Icelandic cod (Division Va)

3.3.1 Stock definition

The Icelandic cod stock is distributed all around Iceland and in the assessment it is assumed to be a single homogenous unit. Main spawning takes place in late winter mainly off the southwest coast but smaller regional spawning components have also been observed off the west, north, and east coasts. The pelagic eggs and larvae from the main spawning grounds drift clockwise around the island to the main nursery grounds off the north coast. A larval drift to Greenland waters has been recorded in some years and substantial immigrations of mature cod from Greenland have been observed in some years which are assumed to be of Icelandic origin. Such migration was last observed in 1990 from the 1984 year class, about 30 millions 6 years old in 1990. Extensive tagging in the last century and during recent years shows no indication of significant emigration from Iceland to other areas.

3.3.2 Fishery

The fleet fishing for cod at Iceland operates throughout the year. The fishing vessels can 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 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. During the last 4 years the bulk of the gillnet catches are taken in 8 and 9 inches mesh size (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. Landings by gear since 1982 are shown in figure 3.3.2.

3.3.3 Data

3.3.3.1 Fishery dependent data

3.3.3.1.1 Landings

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 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 since 1942. From 1995 catches increased continuously to 1999 when the estimated landings were 260 000 tonnes but decreased to 235 000 tonnes in the years 2000 and 2001 and the recorded landings in 2002 were 209 000 tonnes.

3.3.3.1.2 Sampling intensity

The data samples comprising the age-length keys for 2002 are given in the following table:

Gear	Season	Area	No. length samples	No. length measured	No.age samples	no.aged aged	No. wt samples
Bottom trawl	Jan-May	South	138	16270	16	770	526
Bottom trawl	Jan-May	North	46	6666	8	449	298
Danish seine	Jan-May	South	211	35594	2570	3916	3667
Danish seine	Jan-May	North	29	4282	1005	1487	1437
Handlines	Jan-May	South	0	0	0	0	0
Handlines	Jan-May	North	1	150	1	50	50
Gillnet	Jan-May	South	106	7521	6	299	299
Gillnet	Jan-May	North	14	524	0	0	0
Longline	Jan-May	South	487	24048	28	1369	690
Longline	Jan-May	North	620	69459	41	2180	698
Bottom trawl	June-Dec	South	99	5944	14	665	422
Bottom trawl	June-Dec	North	150	17562	16	795	446
Danish seine	June-Dec	South	48	4964	5	264	264
Danish seine	June-Dec	North	2	435	0	0	0
Handlines	June-Dec	South	9	1320	3	147	50
Handlines	June-Dec	North	39	8096	6	276	228
Gillnet	June-Dec	South	138	5776	6	296	296
Gillnet	June-Dec	North	63	4762	1	50	50
Longline	June-Dec	South	312	4198	16	777	532
Longline	June-Dec	North	641	62958	55	2759	1034
Total			**3153**	**280529**	**3797**	**16549**	**10987**

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").

3.3.3.1.3 Catch in numbers-at-age

Catch in number-at-age is calculated by splitting the landings by 5 fleets, 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. In some cases samples are not available for a cell or are to few to give reliable keys. In those cases otolith samples from "related" cells are used. Notably hand lines are included with long lines in the same area and season.

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 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.

3.3.3.1.4 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 mean weights-at-age in the landings 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 been used as a predictor of weights in the landings since 1991. 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 high in 1994 to 1998 but have been around long-term average since 1999. The observed mean weights-at-age in 2002 were about same as in 2001.

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.

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).

3.3.3.1.5 Mean weight-at-age in the landings at spawning time

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 decreased in 1999 and 2000 after being very high in 1996 to 1998. In 2001 and 2002 an increase was observed for all relevant age groups and the mean weights in 2002 are around long-term average (1974-2001). 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.

3.3.3.1.6 Maturity-at-age at spawning time

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 and about the same values were observed in 2002.

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.

3.3.3.1.7 CPUE

Logbooks were kept on voluntary basis until 1991 and only part of the fleet, mainly trawlers, did send in logbooks. After 1991 logbooks are available from all vessel and gears except for boats less than 10 GRT which kept logbooks on voluntary basis until 1999 but since then also mandatory. Substantial linear trend in catchability in cpue from commercial fleets has been observed (WD-31, NWWG 2002) and they are therefore not used for calibration of assessment models.

The unstandardised CPUE indices and effort from the commercial fleets since 1991 is presented in Figures 3.3.9. A and Tables 3.3.2. In the years 1993 - 1995 a marked reduction in effort and increase in CPUE was observed with the adoption of the HCR. The largest reduction was by the trawlers who diverted their effort to other species and other areas. The effort increased and CPE decreased in all gears in 1998 - 2001. In 2002 a decrease in effort and increase in CPUE was observed for all gears expect for gillnets where small decrease in 2002 is observed in CPUE. The increase in effort in 1998-2001 can be explained by overestimation of the stock and the amendment of the HCR in the year 2000.

3.3.3.2 Fishery independent data

3.3.3.2.1 Survey abundance indices

Since 1985 the Icelandic groundfish survey (IGS) has been carried out annually in March, covering the continental shelf waters around Iceland with 540-600 "semi randomly" distributed fixed stations (Pálsson et al, 1989). The survey design was based on historical information about spatial distribution of cod. Each year 4-5 similar commercial trawlers have been hired to cover the stations using standardised 105-feet bottom trawl. The horizontal net opening is estimated to be about 17 m and vertical opening about 2.5 m. The standard towing distance is 4 nautical miles.

A conventional Cochran type method was used for calculating survey indices. The strata used follow depth contours. The Cochran indices were calculated separately for two areas: Northern and Southern area and 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 show 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.

3.3.3.2.2 Mean weight and maturity-at-age in survey

The calculated annual mean weight-at-age in the IGS show similar pattern as the weights in landings although survey weights for age 3 to 5 are always considerably lower than weights from the catches from in the same period. The same applies to the maturity-at-age were much lower values are observed for the younger ages in the survey

Data collected in the Icelandic groundfish survey (IGS) 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.

3.3.4 Stock Assessment

3.3.4.1 Recent assessment and reviews

The 2000 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 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 around 15-25% overestimation in biomass in the years 1998-2000. In 2001 the results from XSA using one survey fleet for calibration was adopted as a final run by ICES. Various other assessment models tried 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 delivered a final report in July 2002 (http://brunnur.stjr.is/interpro/sjavarutv/sjavarutv.nsf/pages/a_rosenberg.html).

The main question posed to the group was "Could this situation have been forseen and prevented?". The main results of the Rosenberg group that assessment of Icelandic cod in the years under revision were driven by high survey indices confirming the conclusion reached by Pope and "it does not seem as if there was any obvious early warning signal of the problems that arose in 1999 and 2000". Simulation studies conducted using XSA with and without shrinkage indicated that a systematic bias was introduced by the usage of shrinkage showing ubiquitous retrospective patterns. Removal of shrinkage, hence bias, improved the retrospective pattern and lowered the precision. The group recommended to use a variety of different assessment methods and test the sensitivity of parameters settings, the use simulation studies and to review the results using retrospective analysis. The group also concluded that the overestimation in recent years should be taken into account in future management consideration.

3.3.4.2 Current assessment

Consistent with the above and the results of a study done by Gudmundsson and Jónsson (WD-31, NWWG-2002), showing substantial linear trend in catchability in cpue form commercial fleets, only survey indices were used for calibration of assessment models in the 2002 assessment and six different assessment models were applied. The same approach was followed in the current assessment and five different models were used: **XSA** and **TSA** as last year, **AD-**

CAM- AD-Model builder statistical Catch-at-age Model written and developed at the MRI (WD-33, NWWG-2002), **EX-CAM-**Statistical Catch-at-age Model written in Excel developed at the MRI (Working Document no. 33), **Coleraine**-a general statistical catch-at-age model developed at the University of Washington (Working Document no. 31). The last three methods are essentially implementations of closely related models.

3.3.4.3 Estimates of fishing mortality

The five 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

Two runs were made by XSA using the same settings. Firstly a run using age groups 3-9 from survey for tuning as in last years assessment and secondly a run using age groups 1-9. To use the latest information available for tuning, the 2003 survey indices were moved three months back in time i.e. to end of December 2002. The resulting tuning diagnostic and terminal F's are presented in Table 3.3.10a and Table 3.3.10b respectively, 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 **0.72.**

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 **0.66**.

AD-CAM

The input parameters settings, 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 **0.76.**

EX-CAM

The estimated parameters and results of the EX-CAM run are presented in Table. 3.3.13 as well as the residuals of prediction errors of catches and survey indices seems 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 **0.58.**

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 **0.40.**

3.3.4.4 The selection of a final run

In Table 3.3.15 and Figures 3.3.19 and Figure 3.3.20 a summary of the resulting terminal fishing mortalities and estimated, biomass and stock in numbers in 2003 from the five different models are presented. The estimated stock in weight (4+) in the beginning of 2003 from the XSA, TSA, AD-CAM and EX-CAM are similar or in the range of 766-795 thous. tonnes . Those four models also show similar fishing mortality pattern but TSA and EX-CAM estimate somewhat lower F values for the older age groups. The difference in the terminal reference fishing mortalities, 0.58-0.76, is reflecting the difference in the older ages. Coleraine gives the lowest value for the reference fishing mortalities, 0.4 but there seem to be model configuration problem in this model which could not be resolved. This is reflected in the differences in stock size estimates back in time compared to the results of the other models used (Figure 3.3.21, Working Document no 31).

Comparison of the retrospective results from the various models (Figure 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 does show the second best consistency and the other models do show somewhat more inconsistent pattern.

In last year assessment the resulting F values from the TSA were used for traditional VPA backwards calculations for the final estimate of the stock in number in the beginning of the assessment year using the RCT3 program to estimate the youngest age groups. This procedure is in many cases unsuitable as the estimates of different age groups are correlated in many models.

In this year the results of the TSA and XSA, the two models used here who have been formally accepted by ICES, give very similar results as the AD-CAM model. The estimated stock in numbers in the beginning of 2003 from TSA and XSA are well within one standard error of the AD-CAM results (Figure 3.3.24).

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 is also a natural extension of this type of model approach. Furthermore the AD-CAM model can handle migrations and survey indices in the assessment year and is designed and run by a member of the working group. For these reasons, and for convenience, the AD-CAM run was adopted as a point estimate for forward projections.

The estimated Biomass (4+) in 2003 from the AD-CAM model is 766 thous. tonnes with standard error of 40. The resulting fishing mortalities are given in Table 3.3.16 and in Figure 3.3.22B. 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 fishing mortality dropped markedly in 1995 and 1996 but has increased since then to 0.76-0.78 in 2000-2002.

3.3.4.5 Stock and recruitment estimates

The resulting stock size in numbers and stock in weight from the final run are given in Tables 3.3.17 and 3.3.19. In the stock in numbers table. The recruitment in the most recent years is estimated by the AD-CAM model. Parameters setting and assumptions made are described in Table 3.3.12.

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 pre-recruits 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 3.3.20 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 2003. For the year 2004 onwards, the average capelin stock size over the years 1979–2003 is used for prediction. (Table 3.3.24). In the most recent period maturity-at-age has been decreasing but a marked increase was observed in 2001 and 2002. For the short-term predictions the average for the years 2000–2002 has been used for the years 2003-2005. The exploitation pattern used for the short-term predictions was taken as the average of the years 2000–2002.

Based on the reported landings for the first month of the 2002/2003 fishing year and an assumption of the use of amended harvest control rule for the coming fishing year the expected catch in 2003 will be 210,000 t corresponding to F=0.58.

A TAC constraint is used for this stock since the TAC forecasts have historically been relatively good. The use of last three years average exploitation pattern and a status quo F in 2003 compared to 2002 results in estimated reference fishing mortality of 0.76 and corresponding catches of about 260 thous. tonnes in 2003. This procedure will certainly overestimate the landings in 2003 and most likely also overestimate the F. That would also have been the case if F constraints would have been applied in the two previous assessments by the working group. Further investigation back in time where not done at the meeting. A detailed analysis that takes into account the accuracy and bias of the present estimate is needed to resolve the issue whether a TAC or an F constraint is more appropriate to carry the stock size into the advisory year.

The results from the AD-CAM model were used for recruitment prediction. The RCT3 program was also run with same settings as last year. The combined Cochran survey indices, age groups 1-4 and recruitment estimates from the AD-CAM, for the year classes 1981-1998, were used as input for the RCT3 recruitment prediction. The input is given in Table 3.3.22. and the output in Table 3.3.23. The size of the year classes 1998–2002 as estimated by the various models give all very similar estimates, see Table 3.3.15.

3.3.6.2 Short-term prediction results

Input data to the short-term prediction and results from projections up to the year 2005 with different management options are presented in Table 3.3.24 and Figure 3.3.23A.

If the buffer of the amended catch control rule (with an upper limit of between year changes in TACs of 30 thous. tonnes) will be applied the resulting TAC in the 2003/2004 fishing year will be 209,000 tonnes. The SSB will increase to about 440 thous. tonnes in 2004 and the resulting reference fishing mortality are about 0.49. The estimated age distribution of the catches and SSB are shown in figure 3.3.23B

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 1982–2002 has been used as input (Table 3.3.25).

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 0.38 and 0.20 respectively. Yield-per-recruit at the $\mathbf{F}_{max}$- is 1.76 kg. (Figure 3.3.25 Table 3.3.26).

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.26. When using the period 1955–1998, the reference points $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ are about 0.54 and 0.87, respectively.

The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested a candidate for $\mathbf{B}_{lim}$ "somewhere in the range of 400kt". Considering that ACFM is unlikely to define and use new $\mathbf{B}_{lim}$ points, the Working Group will consider the issue further during its 2004 meeting.

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 is of major concern.

3.3.7 Medium-term simulation

The AD-CAM model was used for medium-term simulations using the following premises:

- The amended Harvest Control law was followed.
- Assessment error was assumed to be lognormal with CV of 15% and autocorrelation 0.2.
- Deviations in weights-at-age were assumed to be lognormal with CV 0.1 and autocorrelation 0.35. The same deviations were applied to all age groups in the same year. The values are based on examination of weight-at-age in the catches 1980-2002. Errors in weights-at-age and assessment errors were not correlated but it is likely that sudden reduction in weight-at-age will not be predicted and lead to too high catches.

The results of the simulations are shown in figure 3.3.27. The results indicate low probability that the catchable biomass will at the low level observed in the last decade.

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% catchrule by limiting the allowed changes in TAC between years to 30 thousand tonnes. The catch control rule has been in a reviewing process since 2001 by a group scientists appointed by the Ministry of Fisheries. This group is supposed to deliver a final report in this year.

Since the implementation of the catch rule in 1995 realised reference fishing mortalities have been in the range of 0.55-0.78, in last three years about 0.75. The expected long-term fishing mortality by the application of catch rule was 0.4.

At present fishing mortality is high (F5-10 in the year 2003 about 0.6) and age 6 and younger fish account for more than 86% of the fishable biomass(4+). This will be reflected in the age composition of the catches in 2004, age group 7 and younger will represent about 88% of the landings. The age composition of the spawning stock is highly skewed. Spawners at age 6 and younger will constitute to about 70% of the spawning stock biomass in 2004 and fishes older than ten years old less than 2%. 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.

The working group noticed that before The Ministry of Fisheries allocates the national TAC between vessels, catches of about 2000 tonnes are assumed to be taken by about 300 small jiggers operating in an effort control system. In recent years this amount has been exceeded considerable and in the fishing year 2001/2002 the catches of this fleet was about 12 400 t. This is taken into account by the working group estimate of the total annual catch in the assessment year.

3.3.9 Comments on the assessment

The current assessment and last year assessment are more consistent with previous years assessments compared to the assessments in 1998-2000 were substantial overestimation was observed. As in two previous years 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 study by Guðmundsson and Jónsson (WD-31, 2002) revealing marked trend in catchability 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 taken as an important source of information on the state of the stock. The commercial cpue series 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 2002 was estimated at 680 thous. tonnes in last years assessment compared to 704000t in the current assessment. This difference of 24 000t, or less than 4%, is well within the error limits of last years point estimate. The SSB is now estimated to have been 357 000t at spawning time in the year 2002. The last years estimate was markedly lower or only 285 000t. Higher observed maturity-at-age in 2002 than assumed for age groups 3-6 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 relatively high maturity-at-age of younger age groups sampled from the catches at spawning time result in unrealistic high estimate of The SSB especially when strong year classes are entering the fishery. At present a new approach for SSB calculation using maturity and mean weight-at-age from survey is being considered.

The year classes 1998-2001 were estimated 165, 175, 210 and 80 millions respectively in last years assessment compared to 165, 165, 205 and 70 in the current assessment.

The main causes of the 13-24% 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 year’s assessment is not corrected for possible changes in parameters of this kind.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1988- 2002 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	365	309	260	548	222	145	136	-
Faroe Islands	1,966	2,012	1,782	1,323	883	664		739
Germany	-	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-	-
Iceland	375,741	353,985	333,348	306,697	266,662	251,170	177,919	168,685
Norway	4	3	-	-	-	-	-	-
UK	-	-	-	-	-	-	-	-
Total	378,076	356,309	335,390	308,568	267,767	251,979	178,809	169,424
WG estimate	-	-	-	-	-	-	-	-

Country	1996	1997	1998	1999	2000	2001	2002[1]
Belgium	-	-	-	-	-	-	-
Faroe Islands	599	408	1,078	1,247	1,176	1,129	1,188
Germany	-	-	9	21	15	11	15
Greenland	-	-	-	25	-	-	-
Iceland	181,052	202,745	241,545	258,658	234,362	233,875	206,745
Norway	7	-	-	85	60	129	76
UK	-	-	-	16	10	20	32
Total	181,658	203,153	242,632	260,052	235,623	235,164	208,056
WG estimate	-	-	-	-	-	-	208,830

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 1991-2002 (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	139
2000	103289	126270	54	818	110
2001	98067	109877	47	892	120
2002	88059	84340	36	1044	140

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	72	129
1999	47648	781	74	61	110
2000	47989	842	79	57	102
2001	53943	1124	106	48	86
2002	44560	990	93	45	81

Long line

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	172
1999	53380	1570	78	34	153
2000	50085	1727	86	29	130
2001	47092	1811	90	26	117
2002	42155	1405	70	30	135

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
1983	3.554	10.910	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.750	31.553	19.420	15.326	8.082	7.336	2.680	0.512	0.538	0.195	0.090	0.036
1985	6.457	24.552	35.392	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.330	26.644	30.839	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.040
1987	11.002	62.130	27.192	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323	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	50.059	31.455	6.010	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179	44.534	17.037	2.573	0.609	0.322	0.118	0.050	0.015	0.020
1991	8.554	25.131	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	20.500	33.078	15.195	13.281	3.583	2.785	2.707	1.181	0.180	0.034	0.011	0.013
1994	6.160	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.770	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	9.430	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.442	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	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.934	18.482	24.297	6.874	8.943	2.227	1.353	0.689	0.123	0.040	0.041	0.002

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
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
2002	1294	1926	2656	3680	4720	6369	7808	9002	10422	13402	9008	16893

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
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		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
2002	1004	1701	2464	3673	4982	6780	8328	9328	10789	13983	14457	16893

Table 3.3.7 Cod at Iceland. Division Va. Maturity-at-age in the SSB.

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
2002	0.12	0.41	0.59	0.84	0.85	0.99	0.99	0.98	1.00	1.00	1.00	1.00

Table 3.3.8 CPUE from bottom trawl survey 1985-2003 as used in the XSA tuning. Sum of North and South (stratified mean) areas indices.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	16.54	111.07	34.85	48.09	64.30	22.57	14.86	4.85	3.21	1.52	0.30	0.30	0.10
1986	15.08	60.56	95.56	22.43	21.23	26.36	6.64	2.48	0.83	0.74	0.27	0.07	0.06
1987	3.65	28.86	103.10	82.03	21.08	12.22	12.02	2.57	0.90	0.40	0.45	0.23	0.15
1988	3.44	7.36	71.69	101.61	66.75	7.81	5.88	6.14	0.58	0.25	0.11	0.12	0.05
1989	4.04	16.45	21.97	77.70	67.59	34.20	4.20	1.45	1.14	0.24	0.17	0.06	0.01
1990	5.56	11.79	26.15	14.07	26.97	32.38	14.22	1.51	0.53	0.42	0.13	0.00	0.04
1991	3.95	16.27	17.93	30.17	15.24	18.09	20.93	4.23	0.80	0.32	0.24	0.00	0.11
1992	0.72	17.13	33.26	18.87	16.27	6.54	5.70	5.11	1.29	0.22	0.04	0.04	0.04
1993	3.57	4.82	30.76	36.41	13.24	9.93	2.13	1.75	1.17	0.34	0.11	0.03	0.03
1994	14.38	15.01	8.97	26.66	21.90	5.77	3.62	0.70	0.48	0.43	0.14	0.02	0.03
1995	1.18	29.03	24.78	8.99	23.88	17.69	3.78	1.76	0.35	0.17	0.21	0.12	0.02
1996	3.72	5.48	42.60	29.44	12.84	14.62	13.99	3.81	1.05	0.19	0.06	0.22	0.09
1997	1.21	22.39	13.57	56.18	29.05	9.48	8.71	6.59	0.56	0.36	0.15	0.04	0.12
1998	8.06	5.56	29.98	16.06	61.77	28.33	6.51	5.20	3.05	0.66	0.13	0.00	0.02
1999	7.39	32.98	7.01	42.27	13.02	23.66	11.12	2.35	1.32	0.66	0.15	0.06	0.00
2000	18.79	27.90	54.74	6.94	30.00	8.28	8.18	4.14	0.51	0.30	0.07	0.03	0.04
2001	12.16	21.72	36.78	37.60	4.91	15.24	3.33	1.97	0.79	0.23	0.10	0.09	0.04
2002	0.92	38.07	41.12	40.16	36.16	7.10	8.33	1.49	0.72	0.30	0.00	0.01	0.00
2003	11.17	4.44	46.36	38.55	31.51	19.09	4.11	4.71	1.08	0.23	0.09	0.02	0.06

Table 3.3.9 CPUE from bottom trawl survey 1985-2003 as used in the TSA runs. Weighted geometric mean of North and South (stratified mean) areas indices.

Year/age	4	5	6	7	8	9
1985	18705	19615	9483	4147	1973	1369
1986	9273	8933	10327	2941	813	381
1987	31777	7042	5180	4004	1163	349
1988	39727	25703	3673	1976	1681	284
1989	30658	27853	16330	1989	636	391
1990	4033	12061	16118	6125	727	269
1991	11804	6284	8785	10237	2059	384
1992	8485	6575	2829	2834	2772	677
1993	17146	6249	4572	907	870	552
1994	13392	9484	2732	1296	292	235
1995	4516	10885	8169	1696	728	166
1996	14321	5733	7050	6093	1525	500
1997	21384	11060	4014	3560	2422	261
1998	6127	18163	10267	2393	1666	1211
1999	15378	5269	11090	4955	1182	488
2000	3106	12299	3798	3392	2064	255
2001	16395	2157	6363	1297	735	393
2002	18763	16991	3594	3082	712	311
2003	14976	13062	8562	2034	1133	347

Table 3.3.10 a XSA Tuning diagnostic. Survey indices agegroups 3-9.

```
 Lowestoft VPA Version 3.1

   12/04/2003  18:00

 Extended Survivors Analysis

 "ICELANDIC COD (Div. Va); data from 1972-2002"

 CPUE data from file codvarnt.dat

 Catch data for  32 years. 1971 to 2002. Ages  3 to  14.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SMB. Tot           ,    1984, 2002,    3,     8,   .990,  1.000
 SMB. Tot a3 on a3  ,    1985, 2002,    3,     3,   .170,   .250


 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   14 iterations

1


 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,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      3,  .167,  .095,  .076,  .036,  .022,  .024,  .049,  .068,  .080,  .043
      4,  .323,  .304,  .199,  .143,  .148,  .132,  .182,  .175,  .228,  .182
      5,  .501,  .324,  .360,  .246,  .247,  .357,  .416,  .451,  .401,  .361
      6,  .782,  .454,  .372,  .489,  .372,  .508,  .709,  .624,  .626,  .589
      7,  .808,  .652,  .534,  .507,  .621,  .659,  .733,  .876,  .754,  .670
      8, 1.130,  .761,  .524,  .602,  .713,  .796,  .777,  .872,  .892,  .788
      9, 1.237,  .800,  .426,  .581,  .768,  .991,  .853,  .837,  .915,  .931
     10,  .951,  .823,  .616,  .564,  .837,  .956,  .744,  .984, 1.064,  .981
     11,  .904,  .625,  .652,  .561,  .822, 1.009,  .794,  .835, 1.306,  .998
     12,  .577,  .671,  .752,  .631,  .413, 1.141,  .693, 1.527,  .915, 1.051
     13,  .567,  .702, 1.174,  .763,  .945, 1.331,  .640,  .876, 1.483, 1.007
     14,  .759,  .710,  .805,  .636,  .764, 1.123,  .724, 1.070, 1.206, 1.021


1
```

Table 3.3.10.a (Cont'd)

XSA population numbers (Thousands)

```
                                AGE
 YEAR ,          3,             4,             5,             6,             7,             8,             9,
10,           11,           12,

 1993 ,    1.47E+05, 1.32E+05, 4.26E+04, 2.71E+04, 7.14E+03, 4.55E+03, 4.21E+03, 2.13E+03, 3.34E+02, 8.57E+01,
 1994 ,    7.48E+04, 1.02E+05, 7.85E+04, 2.11E+04, 1.01E+04, 2.61E+03, 1.20E+03, 1.00E+03, 6.73E+02, 1.11E+02,
 1995 ,    1.63E+05, 5.57E+04, 6.15E+04, 4.64E+04, 1.10E+04, 4.33E+03, 9.97E+02, 4.42E+02, 3.60E+02, 2.95E+02,
 1996 ,    1.68E+05, 1.23E+05, 3.73E+04, 3.51E+04, 2.62E+04, 5.27E+03, 2.10E+03, 5.33E+02, 1.96E+02, 1.54E+02,
 1997 ,    8.61E+04, 1.32E+05, 8.75E+04, 2.39E+04, 1.76E+04, 1.29E+04, 2.36E+03, 9.61E+02, 2.48E+02, 9.15E+01,
 1998 ,    1.62E+05, 6.89E+04, 9.35E+04, 5.60E+04, 1.35E+04, 7.76E+03, 5.19E+03, 8.97E+02, 3.41E+02, 8.93E+01,
 1999 ,    5.81E+04, 1.30E+05, 4.95E+04, 5.36E+04, 2.76E+04, 5.72E+03, 2.87E+03, 1.58E+03, 2.82E+02, 1.02E+02,
 2000 ,    1.78E+05, 4.53E+04, 8.86E+04, 2.67E+04, 2.16E+04, 1.09E+04, 2.15E+03, 1.00E+03, 6.13E+02, 1.04E+02,
 2001 ,    1.63E+05, 1.36E+05, 3.11E+04, 4.62E+04, 1.17E+04, 7.36E+03, 3.72E+03, 7.63E+02, 3.06E+02, 2.18E+02,
 2002 ,    1.54E+05, 1.23E+05, 8.86E+04, 1.71E+04, 2.02E+04, 4.51E+03, 2.47E+03, 1.22E+03, 2.15E+02, 6.80E+01,

 Estimated population abundance at 1st Jan 2003

    ,     0.00E+00, 1.21E+05, 8.40E+04, 5.06E+04, 7.75E+03, 8.48E+03, 1.68E+03, 7.96E+02, 3.74E+02, 6.50E+01,

 Taper weighted geometric mean of the VPA populations:

    ,     1.62E+05, 1.26E+05, 8.25E+04, 4.51E+04, 2.21E+04, 9.37E+03, 3.67E+03, 1.43E+03, 5.15E+02, 1.92E+02,

 Standard error of the weighted Log(VPA populations) :

    ,        .4313,    .4281,    .4340,    .4734,    .5278,    .6514,    .7516,    .8145,    .7490,    .7016,
```

```
                            AGE
 YEAR ,          13,           14,

 1993 ,    2.81E+01, 2.70E+01,
 1994 ,    3.94E+01, 1.30E+01,
 1995 ,    4.64E+01, 1.60E+01,
 1996 ,    1.14E+02, 1.17E+01,
 1997 ,    6.69E+01, 4.34E+01,
 1998 ,    4.96E+01, 2.13E+01,
 1999 ,    2.34E+01, 1.07E+01,
 2000 ,    4.17E+01, 1.01E+01,
 2001 ,    1.86E+01, 1.42E+01,
 2002 ,    7.14E+01, 3.46E+00,

 Estimated population abundance at 1st Jan 2003

    ,     1.94E+01, 2.13E+01,

 Taper weighted geometric mean of the VPA populations:

    ,     7.15E+01, 2.33E+01,

 Standard error of the weighted Log(VPA populations) :

    ,        .7035,   1.1420,
1

 Log catchability residuals.


 Fleet : SMB. Tot

  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990,  1991,  1992
    3 ,   .28,  -.25,  -.24,   .06,   .39,   .00,   .03,   .03,  -.10
    4 ,   .14,  -.05,  -.14,  -.10,   .00,  -.10,   .18,  -.17,   .05
    5 ,   .27,   .04,   .07,  -.54,   .18,  -.18,   .10,  -.19,  -.01
    6 ,   .62,  -.29,   .04,   .22,  -.23,   .00,   .12,  -.19,  -.33
    7 ,   .28,  -.29,  -.15,   .55,  -.03,  -.33,  -.23,  -.14,  -.07
    8 ,   .65,  -.45,  -.06,  -.34,   .57,   .15,   .16,  -.32,  -.28


  Age  ,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002
    3 ,  -.07,  -.14,  -.16,   .20,   .05,   .04,  -.08,  -.10,   .04,   .04
    4 ,  -.20,   .11,   .21,  -.05,   .40,  -.04,  -.06,  -.27,   .06,   .03
    5 ,  -.30,   .03,   .12,   .07,   .31,   .18,  -.18,  -.12,   .12,   .02
    6 ,  -.14,  -.18,   .26,   .18,   .16,  -.02,  -.08,  -.37,   .00,   .25
    7 ,  -.43,  -.01,   .57,   .22,   .49,   .00,  -.07,  -.43,  -.22,   .30
    8 ,   .08,  -.05,   .31,  -.44,   .47,   .22,  -.44,  -.55,  -.23,   .56
```

Table 3.3.10.a (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,	-7.9049,	-7.7982,	-7.8016,	-7.9110,
S.E(Log q),	.2092,	.2482,	.3151,	.3897,

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,	.64,	3.840,	9.48,	.87,	19,	.17,	-8.16,
4,	.69,	3.475,	9.09,	.88,	19,	.17,	-7.98,

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,	.92,	.779,	8.17,	.84,	19,	.19,	-7.90,
6,	.94,	.512,	7.97,	.81,	19,	.24,	-7.80,
7,	.93,	.433,	7.93,	.72,	19,	.30,	-7.80,
8,	1.06,	-.288,	7.86,	.58,	19,	.42,	-7.91,

1

Fleet : SMB. Tot a3 on a3

Age ,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992
3 ,	99.99,	.05,	-.14,	.09,	.36,	.30,	-.05,	-.02,	-.16
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 ,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002
3 ,	-.02,	-.16,	-.28,	.04,	-.04,	-.16,	-.07,	.15,	-.02,	.10
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,	.65,	3.811,	9.60,	.88,	18,	.17,	-8.38,

1

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. Tot ,	125999.,	.300,	.000,	.00,	1,	.346,	.042
SMB. Tot a3 on a3 ,	133861.,	.300,	.000,	.00,	1,	.346,	.039
P shrinkage mean ,	125792.,	.43,,,,				.178,	.042
F shrinkage mean ,	78983.,	.50,,,,				.130,	.066

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
121044.,	.18,	.10,	4,	.590,	.043

Table 3.3.10.a (Cont'd)

```
1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1998

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     86904.,   .212,      .003,    .01,   2,  .499,     .176
 SMB. Tot a3 on a3   ,     82366.,   .300,      .000,    .00,   1,  .240,     .185

   P shrinkage mean  ,     82518.,    .43,,,,                       .149,     .185

   F shrinkage mean  ,     77339.,    .50,,,,                       .112,     .196

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     84030.,       .15,      .02,    5,    .136,   .182


 Age  5   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
 SMB. Tot            ,     50423.,   .175,      .046,    .26,   3,  .668,     .362
 SMB. Tot a3 on a3   ,     58755.,   .300,      .000,    .00,   1,  .196,     .318

   F shrinkage mean  ,     41457.,    .50,,,,                       .136,     .425

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     50592.,       .15,      .06,    5,    .395,   .361


1
 Age  6   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
 SMB. Tot            ,      8144.,   .155,      .115,    .74,   4,  .700,     .567
 SMB. Tot a3 on a3   ,      7224.,   .300,      .000,    .00,   1,  .135,     .621

   F shrinkage mean  ,      6665.,    .50,,,,                       .164,     .659

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7754.,       .14,      .08,    6,    .586,   .589


 Age  7   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
 SMB. Tot            ,      9302.,   .156,      .084,    .54,   5,  .701,     .626
 SMB. Tot a3 on a3   ,      7238.,   .300,      .000,    .00,   1,  .085,     .750

   F shrinkage mean  ,      6655.,    .50,,,,                       .215,     .796

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8475.,       .16,      .09,    7,    .557,   .670
```

Table 3.3.10.a (Cont'd)

```
Age  8   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
SMB. Tot             ,      1786.,  .169,      .165,     .98,   6,  .642,     .755
SMB. Tot a3 on a3    ,      1618.,  .300,      .000,     .00,   1,  .055,     .809

  F shrinkage mean   ,      1489.,    .50,,,,                        .303,     .856

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1681.,       .19,      .12,    8,    .630,   .788


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

Year class = 1993

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot             ,       696.,  .178,      .115,     .65,   6,  .392,    1.015
SMB. Tot a3 on a3    ,       830.,  .300,      .000,     .00,   1,  .031,     .907

  F shrinkage mean   ,       871.,    .50,,,,                        .577,     .878

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      796.,       .30,      .09,    8,    .292,   .931


1
Age 10   Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot             ,       316.,  .158,      .126,     .80,   6,  .240,    1.090
SMB. Tot a3 on a3    ,       284.,  .300,      .000,     .00,   1,  .023,    1.161

  F shrinkage mean   ,       399.,    .50,,,,                        .736,     .941

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      374.,       .37,      .09,    8,    .255,   .981


Age 11   Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
    ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SMB. Tot             ,        60.,  .151,      .109,     .72,   6,  .126,    1.044
SMB. Tot a3 on a3    ,        56.,  .300,      .000,     .00,   1,  .013,    1.099

  F shrinkage mean   ,        66.,    .50,,,,                        .861,     .989

Weighted prediction :

Survivors,         Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       65.,       .43,      .05,    8,    .108,   .998


1
```

Table 3.3.10.a (Cont'd)

Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1990

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. Tot ,	25.,	.160,	.072,	.45,	6,	.035,	.904
SMB. Tot a3 on a3 ,	19.,	.300,	.000,	.00,	1,	.003,	1.066
F shrinkage mean ,	19.,	.50,,,,				.963,	1.057

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
19.,	.48,	.08,	8,	.176,	1.051

Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1989

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. Tot ,	26.,	.150,	.096,	.64,	6,	.033,	.888
SMB. Tot a3 on a3 ,	18.,	.300,	.000,	.00,	1,	.003,	1.111
F shrinkage mean ,	21.,	.50,,,,				.965,	1.011

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
21.,	.48,	.07,	8,	.136,	1.007

1
Age 14   Catchability constant w.r.t. time and age (fixed at the value for age) 11

Year class = 1988

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. Tot ,	1.,	.160,	.175,	1.09,	6,	.004,	.000
SMB. Tot a3 on a3 ,	1.,	.300,	.000,	.00,	1,	.000,	.000
F shrinkage mean ,	1.,	.50,,,,				.995,	1.021

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1.,	.50,	.02,	8,	.038,	1.021

Table 3.3.10b XSA Tuning diagnostic. Survey indices agegroups 1-9.

```
Lowestoft VPA Version 3.1

   14/04/2003   9:26

 Extended Survivors Analysis

 "ICELANDIC COD (Div. Va); data from 1972-2002"

 CPUE data from file codvarnt.dat

 Catch data for  32 years. 1971 to 2002. Ages  0 to  14.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                      ,    year, year,  age ,  age
 SMB. Tot             ,    1984, 2002,    0,     8,   .990,  1.000


 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   14 iterations

1


 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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.167	.095	.076	.036	.022	.024	.048	.066	.078	.038
4	.323	.304	.199	.143	.148	.132	.183	.169	.224	.176
5	.501	.324	.360	.246	.247	.357	.417	.454	.383	.352
6	.782	.454	.372	.489	.372	.508	.709	.626	.635	.547
7	.808	.652	.534	.507	.621	.659	.733	.874	.760	.688
8	1.130	.761	.524	.602	.713	.796	.777	.873	.888	.802
9	1.237	.800	.426	.581	.768	.992	.853	.838	.919	.919
10	.951	.823	.616	.564	.837	.956	.744	.984	1.066	.990
11	.904	.625	.652	.561	.822	1.009	.794	.836	1.306	1.000
12	.577	.671	.752	.631	.413	1.141	.693	1.527	.915	1.052
13	.567	.702	1.174	.763	.945	1.331	.640	.877	1.484	1.009
14	.759	.710	.805	.636	.764	1.123	.724	1.070	1.207	1.024

1

Table 3.3.10.b (Cont'd)

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1993	3.05E+05	2.42E+05	9.14E+04	1.47E+05	1.32E+05	4.26E+04	2.71E+04	7.14E+03	4.55E+03	4.21E+03
1994	1.57E+05	2.50E+05	1.98E+05	7.48E+04	1.02E+05	7.85E+04	2.11E+04	1.01E+04	2.61E+03	1.20E+03
1995	2.94E+05	1.28E+05	2.05E+05	1.62E+05	5.57E+04	6.15E+04	4.64E+04	1.10E+04	4.33E+03	9.97E+02
1996	1.09E+05	2.41E+05	1.05E+05	1.68E+05	1.23E+05	3.73E+04	3.51E+04	2.62E+04	5.27E+03	2.10E+03
1997	3.29E+05	8.93E+04	1.97E+05	8.60E+04	1.32E+05	8.75E+04	2.39E+04	1.76E+04	1.29E+04	2.36E+03
1998	3.04E+05	2.69E+05	7.32E+04	1.62E+05	6.88E+04	9.35E+04	5.60E+04	1.35E+04	7.76E+03	5.19E+03
1999	3.17E+05	2.49E+05	2.20E+05	5.99E+04	1.29E+05	4.94E+04	5.36E+04	2.76E+04	5.72E+03	2.87E+03
2000	3.61E+05	2.59E+05	2.04E+05	1.80E+05	4.67E+04	8.81E+04	2.67E+04	2.16E+04	1.08E+04	2.15E+03
2001	1.42E+05	2.95E+05	2.12E+05	1.67E+05	1.38E+05	3.23E+04	4.58E+04	1.17E+04	7.38E+03	3.71E+03
2002	3.45E+05	1.17E+05	2.42E+05	1.74E+05	1.26E+05	9.04E+04	1.80E+04	1.99E+04	4.46E+03	2.49E+03

Estimated population abundance at 1st Jan 2003

	0.00E+00	2.82E+05	9.54E+04	1.98E+05	1.37E+05	8.68E+04	5.20E+04	8.55E+03	8.17E+03	1.64E+03

Taper weighted geometric mean of the VPA populations:

	2.89E+05	2.40E+05	2.00E+05	1.63E+05	1.26E+05	8.26E+04	4.52E+04	2.21E+04	9.36E+03	3.67E+03

Standard error of the weighted Log(VPA populations) :

	.4350	.4489	.4304	.4293	.4259	.4315	.4699	.5281	.6517	.7514

YEAR	AGE 10	11	12	13	14
1993	2.13E+03	3.34E+02	8.57E+01	2.81E+01	2.70E+01
1994	1.00E+03	6.73E+02	1.11E+02	3.94E+01	1.30E+01
1995	4.42E+02	3.60E+02	2.95E+02	4.64E+01	1.60E+01
1996	5.33E+02	1.96E+02	1.54E+02	1.14E+02	1.17E+01
1997	9.61E+02	2.48E+02	9.15E+01	6.69E+01	4.35E+01
1998	8.97E+02	3.41E+02	8.93E+01	4.96E+01	2.13E+01
1999	1.58E+03	2.82E+02	1.02E+02	2.34E+01	1.07E+01
2000	1.00E+03	6.13E+02	1.04E+02	4.16E+01	1.01E+01
2001	7.62E+02	3.06E+02	2.18E+02	1.86E+01	1.42E+01
2002	1.21E+03	2.15E+02	6.79E+01	7.13E+01	3.45E+00

Estimated population abundance at 1st Jan 2003

	8.12E+02	3.69E+02	6.47E+01	1.94E+01	2.13E+01

Taper weighted geometric mean of the VPA populations:

	1.43E+03	5.15E+02	1.92E+02	7.15E+01	2.33E+01

Standard error of the weighted Log(VPA populations) :

	.8145	.7491	.7016	.7036	1.1421

1

Log catchability residuals.

Fleet : SMB. Tot

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
0	-.15	.32	.36	-.13	.21	-.18	-.16	-.28	-.31
1	.12	-.03	.08	.05	.02	.11	-.26	-.05	-.06
2	.07	-.12	.11	.38	.32	-.03	-.01	-.15	-.02
3	.29	-.24	-.23	.07	.40	.00	.04	.04	-.09
4	.14	-.05	-.13	-.10	.00	-.10	.18	-.17	.05
5	.28	.05	.07	-.54	.19	-.17	.11	-.19	-.01
6	.62	-.29	.05	.22	-.23	.00	.12	-.18	-.32
7	.27	-.29	-.16	.55	-.03	-.33	-.23	-.15	-.07
8	.65	-.45	-.06	-.34	.57	.15	.16	-.32	-.29

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	.31	-.19	-.28	.18	-.03	.00	.40	.07	-.21	.07
1	-.22	.10	-.13	.00	.24	.10	.08	-.09	.08	-.15
2	-.15	-.26	.06	-.02	-.13	-.09	.15	-.03	.00	-.05
3	-.06	-.13	-.15	.21	.06	.05	-.11	-.11	.02	-.07
4	-.19	.12	.22	-.05	.40	-.03	-.05	-.29	.04	.00
5	-.30	.03	.12	.07	.32	.18	-.17	-.10	.07	.00
6	-.14	-.18	.26	.19	.16	-.02	-.08	-.36	.02	.16
7	-.43	-.01	.56	.21	.49	.00	-.08	-.43	-.21	.34
8	.08	-.05	.31	-.44	.47	.22	-.44	-.55	-.24	.58

Table 3.3.10.b (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,	-7.9087,	-7.8021,	-7.7991,	-7.9100,
S.E(Log q),	.2074,	.2433,	.3170,	.3918,

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
0,	.47,	3.809,	11.60,	.75,	19,	.24,	-10.66,
1,	.54,	6.766,	10.61,	.93,	19,	.13,	-9.20,
2,	.65,	3.953,	9.71,	.88,	19,	.16,	-8.44,
3,	.64,	3.782,	9.49,	.87,	19,	.17,	-8.17,
4,	.69,	3.450,	9.11,	.88,	19,	.17,	-7.98,

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,	.91,	.912,	8.21,	.85,	19,	.19,	-7.91,
6,	.92,	.715,	8.03,	.82,	19,	.23,	-7.80,
7,	.94,	.420,	7.93,	.71,	19,	.30,	-7.80,
8,	1.06,	-.307,	7.85,	.58,	19,	.43,	-7.91,

1

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2002

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	303496.,	.300,	.000,	.00,	1,	.691,	.000
P shrinkage mean ,	240294.,	.45,,,,				.309,	.000
F shrinkage mean ,	0.,	.50,,,,				.000,	.000

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
282388.,	.25,	.13,	2,	.520,	.000

Age 1 Catchability dependent on age and year class strength

Year class = 2001

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	79679.,	.212,	.032,	.15,	2,	.805,	.000
P shrinkage mean ,	200200.,	.43,,,,				.195,	.000
F shrinkage mean ,	0.,	.50,,,,				.000,	.000

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
95403.,	.19,	.29,	3,	1.518,	.000

1

Age 2 Catchability dependent on age and year class strength

Year class = 2000

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	204326.,	.173,	.043,	.25,	3,	.860,	.000
P shrinkage mean ,	163382.,	.43,,,,				.140,	.000
F shrinkage mean ,	0.,	.50,,,,				.000,	.000

Table 3.3.10.b (Cont'd)

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    198028.,       .16,      .06,    4,    .362,   .000


 Age  3   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,    145278.,   .150,       .116,    .77,   4,  .818,     .036

   P shrinkage mean  ,    126060.,    .43,,,,                         .105,     .042

   F shrinkage mean  ,     80935.,    .50,,,,                         .077,     .064

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    136855.,       .14,      .11,    6,    .812,   .038


1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     88149.,   .134,       .019,    .14,   5,  .824,     .174

   P shrinkage mean  ,     82645.,    .43,,,,                         .101,     .184

   F shrinkage mean  ,     78652.,    .50,,,,                         .075,     .193

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     86829.,       .12,      .02,    7,    .167,   .176


 Age  5   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
 SMB. Tot            ,     53254.,   .123,       .036,    .30,   6,  .903,     .346

   F shrinkage mean  ,     42000.,    .50,,,,                         .097,     .421

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     52048.,       .12,      .04,    7,    .359,   .352


1
 Age  6   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
 SMB. Tot            ,      8859.,   .117,       .070,    .60,   7,  .877,     .532

   F shrinkage mean  ,      6616.,    .50,,,,                         .123,     .663

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8548.,       .12,      .07,    8,    .604,   .547
```

Table 3.3.10.b (Cont'd)

```
 Age  7   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
 SMB. Tot            ,      8572.,   .124,       .075,    .61,   8,  .812,     .665

   F shrinkage mean  ,      6636.,    .50,,,,                        .188,     .797

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      8169.,       .14,      .07,    9,    .540,   .688


1
 Age  8   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
 SMB. Tot            ,      1700.,   .139,       .122,    .88,   9,  .721,     .782

   F shrinkage mean  ,      1491.,    .50,,,,                        .279,     .855

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1639.,       .17,      .10,   10,    .585,   .802


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

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,       749.,   .148,       .094,    .64,   9,  .459,     .968

   F shrinkage mean  ,       869.,    .50,,,,                        .541,     .879

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       812.,       .28,      .07,   10,    .252,   .919

1
 Age 10   Catchability constant w.r.t. time and dependent on age

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,       305.,   .128,       .089,    .69,   9,  .292,    1.112

   F shrinkage mean  ,       399.,    .50,,,,                        .708,     .942

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       369.,       .36,      .09,   10,    .246,   .990

 Age 11   Catchability constant w.r.t. time and dependent on age

 Year class = 1991

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        59.,   .123,       .079,    .64,   9,  .159,    1.060

   F shrinkage mean  ,        66.,    .50,,,,                        .841,     .990

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        65.,       .42,      .04,   10,    .106,  1.000
```

Table 3.3.10.b (Cont'd)

```
1
 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1990

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        23.,  .134,       .067,    .50,   9,  .042,     .940

   F shrinkage mean  ,        19.,    .50,,,,                        .958,    1.057

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        19.,       .48,      .06,   10,    .129,  1.052
```

```
 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1989

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        24.,  .124,       .088,    .71,   9,  .041,     .939

   F shrinkage mean  ,        21.,    .50,,,,                        .959,    1.012

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        21.,       .48,      .04,   10,    .087,  1.009
```

```
1
 Age 14   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1988

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,         1.,  .135,       .127,    .94,   9,  .005,     .000

   F shrinkage mean  ,         1.,    .50,,,,                        .995,    1.024

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
         1.,       .50,      .01,   10,    .021,  1.024
```

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) 1985–2003.

Estimated stock in numbers and total biomass:

Year/age	4	5	6	7	8	9	10	11	BIOM(4-11)
1984	183673.	76923.	40551.	18322.	13818.	4980.	992.	986.	879.7
1985	109394.	121966.	45023.	19717.	7805.	4732.	1706.	341.	902.6
1986	107960.	67190.	66715.	20919.	7965.	2918.	1685.	596.	831.9
1987	246689.	69095.	31789.	26508.	7064.	2521.	913.	533.	993.8
1988	228463.	148296.	32818.	11772.	8274.	2079.	748.	272.	1041.7
1989	135473.	147546.	73365.	11868.	3479.	1853.	486.	180.	1022.6
1990	64412.	84643.	102641.	32302.	4524.	1185.	645.	168.	821.0
1991	102415.	41660.	43613.	43779.	11908.	1580.	410.	223.	686.6
1992	77035.	60898.	19835.	15947.	13997.	3878.	502.	126.	532.2
1993	133864.	43115.	26043.	6637.	4481.	4256.	1343.	172.	575.1
1994	100764.	79742.	20832.	9959.	2226.	1242.	1110.	351.	576.6
1995	56234.	61799.	46324.	10641.	4357.	868.	485.	436.	558.2
1996	121108.	37566.	35533.	25226.	5229.	2078.	411.	226.	675.9
1997	132120.	85831.	23526.	18089.	12222.	2337.	933.	183.	792.7
1998	67608.	92966.	54538.	12997.	8056.	4970.	897.	356.	722.0
1999	127193.	47888.	53845.	26722.	5476.	2940.	1589.	293.	725.5
2000	46939.	85735.	25606.	21927.	10446.	2081.	1125.	614.	564.0
2001	147489.	32255.	45627.	10929.	7713.	3673.	747.	405.	683.8
2002	132133.	98772.	17868.	19967.	4093.	2688.	1246.	251.	737.7
2003	126433.	91111.	58164.	8814.	8263.	1498.	962.	444.	799.0

Standard deviation of stock estimate:

2002	9316.	5467.	935.	1138.	279.	247.	152.	38.	32.1
2003	11279.	7572.	4373.	746.	865.	214.	180.	92.	45.9

Estimated fishing mortality rates:

Year/age	4	5	6	7	8	9	10	11	FBAR(5-10)
1984	0.209	0.336	0.520	0.653	0.871	0.870	0.863	0.871	0.685
1985	0.286	0.403	0.567	0.705	0.784	0.832	0.852	0.855	0.690
1986	0.246	0.538	0.723	0.886	0.949	0.957	0.949	0.953	0.834
1987	0.306	0.543	0.785	0.962	1.022	1.015	1.009	1.015	0.889
1988	0.237	0.500	0.809	1.019	1.259	1.218	1.191	1.197	0.999
1989	0.261	0.454	0.612	0.747	0.874	0.852	0.856	0.874	0.733
1990	0.236	0.454	0.651	0.798	0.851	0.862	0.863	0.869	0.746
1991	0.320	0.540	0.775	0.917	0.912	0.938	0.961	0.945	0.841
1992	0.378	0.649	0.890	1.023	0.962	0.857	0.871	0.888	0.875
1993	0.318	0.526	0.760	0.893	1.041	1.092	1.105	1.099	0.903
1994	0.276	0.343	0.472	0.627	0.742	0.738	0.734	0.742	0.609
1995	0.203	0.340	0.408	0.510	0.538	0.540	0.558	0.562	0.482
1996	0.143	0.268	0.447	0.522	0.595	0.597	0.606	0.606	0.506
1997	0.149	0.254	0.393	0.576	0.691	0.742	0.749	0.750	0.567
1998	0.145	0.338	0.514	0.661	0.758	0.874	0.844	0.823	0.665
1999	0.194	0.426	0.680	0.737	0.761	0.740	0.731	0.738	0.679
2000	0.174	0.431	0.651	0.831	0.842	0.821	0.815	0.816	0.732
2001	0.201	0.382	0.623	0.770	0.851	0.878	0.888	0.874	0.732
2002	0.172	0.330	0.504	0.680	0.799	0.821	0.825	0.821	0.660

Standard deviations of log(F):

2002	0.09	0.08	0.09	0.09	0.12	0.14	0.15	0.15	0.087

Table 3.3.11 (Continued)

Standardized catch prediction errors:

Year/age	4	5	6	7	8	9	10	11
1985	1.47	0.91	1.04	-0.64	0.60	-1.16	0.85	0.75
1986	-0.53	1.03	1.55	1.19	0.19	1.29	-0.61	0.63
1987	1.78	1.31	-1.25	0.61	0.19	0.34	0.98	-0.30
1988	-1.72	1.07	1.94	-1.14	0.68	0.23	0.24	2.05
1989	-0.79	-0.86	-0.49	0.25	-0.52	-2.27	-1.86	-0.84
1990	0.02	-1.95	-0.68	1.18	1.78	0.15	-0.02	0.83
1991	1.29	1.56	-0.38	0.47	-0.27	0.54	0.44	0.23
1992	0.95	1.21	1.28	-0.73	-1.01	-1.06	-0.75	-1.51
1993	0.10	-1.41	-0.19	-0.61	-1.21	-0.55	1.82	1.72
1994	0.39	-0.58	-0.67	0.36	1.75	-0.94	-1.04	0.81
1995	-0.60	-1.57	-0.98	-0.46	-1.24	-1.33	-0.87	-0.74
1996	-0.36	-0.89	-1.16	0.36	0.08	0.27	1.40	-0.18
1997	-0.87	0.63	0.00	-1.17	0.88	0.17	0.91	1.61
1998	-0.21	0.97	2.02	1.09	-1.46	0.76	0.00	0.04
1999	1.94	1.85	0.35	1.06	0.30	-1.60	-1.90	-1.58
2000	-0.09	1.08	0.67	-0.88	0.66	0.08	-0.68	-0.49
2001	0.36	0.11	-0.25	0.52	-1.08	0.11	0.49	-0.46
2002	-0.77	-1.53	0.24	-0.18	1.29	0.10	0.46	-0.10

Skewness and kurtosis (Standardized normal distribution)**:** 0.817 -1.904

Correlation between cohorts aages and years: 0.28 0.31 -0.10

Standardized prediction errors of cpue:

Year/age	4	5	6	7	8	9
1985	2.01	0.30	0.85	0.64	1.34	0.8
1986	-0.99	-0.42	-0.52	-0.66	-1.59	-0.35
1987	-0.08	-0.65	-0.96	-0.19	0.28	-0.02
1988	0.67	1.49	-0.85	-0.46	0.58	-0.29
1989	1.38	0.94	1.91	1.12	0.39	-0.11
1990	-1.03	-1.50	-0.65	1.65	0.94	0.88
1991	0.54	1.70	-0.47	1.29	0.16	1.09
1992	0.86	-0.72	-0.72	-1.12	-0.37	-0.25
1993	0.73	0.54	0.41	-0.97	-0.67	-1.09
1994	-0.75	-0.68	-0.89	-1.08	-0.78	-0.56
1995	-0.44	-0.54	0.21	-0.18	0.01	0.30
1996	0.75	1.04	-0.96	1.76	2.23	1.21
1997	0.11	0.14	-0.17	-1.32	-0.08	-1.68
1998	-0.24	0.06	0.10	-0.15	-0.83	0.43
1999	0.87	-0.36	-0.79	0.18	0.40	-1.25
2000	0.10	0.39	-0.24	-1.46	0.24	-1.17
2001	-0.38	-0.84	-0.81	-1.03	-1.99	-1.15
2002	0.44	0.93	2.77	0.53	1.05	-0.35
2003	-0.32	-0.14	-0.78	2.29	-0.02	1.28

Skewness and kurtosis (Standardized normal distribution)**:** 0.011 -0.473

Correlation within cohorts: 0.10

Correlation between ages and years: 0.35 -0.14

Table 3.3.12 AD Model Builder -Statistical Catch-at-age Model- AD-CAM - diagnostic and resul**ts.**

Input data and estimated parameters:

- The model used catchdata from 1955 to 2002 and survey data from 1985 – 2003. Age groups included are 1-10 in the survey and 3 – 14 in the catches.

Parameter settings and assumptions used:

- Fishing mortality was estimated for every year and age.
- Recruitment was assumed to be lognormally distributed around a Ricker curve with the CV of the lognormal distribution estimated. Timetrend in R_{max} of the Ricker curve was allowed and CV of the residuals in the SSB-recruitment relationship depend on stock size. The SSB – recruitment relationship was based on spawning stock based on maturity-at-age from the survey, predicting the survey maturitity at age backwards in time from the observations from the catches.
- Migrations for specified years in specified ages are estimated.
- Catchability in the survey was dependent on stocksize for ages 1-5.
- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated seperately for each age in the survey (change from last year when it was also a 2nd order polynomial) Correlation of residuals of different agegroups in the survey was estimated as a 1st order AR model.
- 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 be larger for the older age groups.
- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error must be specified.

Some non-traditional of the assemssment model are.

- Rmax decrease by 0.9% per year from 1955 to 1995 so precdicted recruitment in 1995 is expected to be 67% of what it was in 1995 for the same spawing size of the spawing stock. At lesat part of this trend is considered to be due to different composition of the spawning stock with higher percentage of young fish in the spawing stock in recent years. Using catch maturity-at-age gives 1.5% trend per year.
- CV in recruitment. increases with reduced spawning stock as expected.
- Spawning stock giving maximum recruitment at about 400 kT. (500-550 kT using catch maturity-at-age)

Age	M	Survey sigma	Survey lnQ	Survey Power	Meansel	Progsel	Sigma
1	0.2	0.364	-22.716	2.028	-1.000	-1.000	-1.000
2	0.2	0.138	-18.866	1.839	-1.000	-1.000	-1.000
3	0.2	0.183	-15.571	1.607	0.148	0.033	0.182
4	0.2	0.198	-13.552	1.476	0.502	0.117	0.145
5	0.2	0.167	-11.499	1.331	0.773	0.249	0.122
6	0.2	0.139	-7.703	1.000	0.953	0.397	0.110
7	0.2	0.168	-7.548	1.000	1.185	0.481	0.105
8	0.2	0.207	-7.516	1.000	1.400	0.531	0.106
9	0.2	0.238	-7.650	1.000	1.473	0.561	0.114
10	0.2	0.234	-7.623	1.000	1.573	0.597	0.130
11	0.2	-1.000	-1.000	-1.000	1.520	0.584	0.157
12	0.2	-1.000	-1.000	-1.000	1.355	0.612	0.202
13	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.276
14	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.401

Table 3.3.12 (Continued)

Estimated fishing mortality rates:

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.086	0.088	0.149	0.101	0.067	0.037	0.026	0.029	0.051	0.066	0.069	0.044
4	0.318	0.387	0.312	0.294	0.185	0.147	0.146	0.146	0.186	0.193	0.218	0.177
5	0.548	0.590	0.504	0.323	0.359	0.274	0.265	0.367	0.406	0.439	0.400	0.357
6	0.797	0.843	0.734	0.561	0.394	0.454	0.445	0.526	0.696	0.657	0.645	0.610
7	0.906	1.022	0.865	0.732	0.525	0.531	0.614	0.664	0.724	0.870	0.792	0.749
8	0.884	1.002	1.072	0.927	0.566	0.614	0.680	0.765	0.774	0.860	0.915	0.877
9	0.815	0.817	1.018	0.953	0.575	0.626	0.725	0.834	0.844	0.868	0.927	0.952
10	0.781	0.789	0.853	0.854	0.785	0.800	0.838	0.874	0.897	0.943	0.986	1.007
11	0.696	0.702	0.720	0.720	0.857	0.871	0.891	0.904	0.905	0.919	0.936	0.939
12	0.655	0.653	0.655	0.657	0.955	0.952	0.955	0.964	0.966	0.971	0.966	0.957
13	0.463	0.463	0.463	0.463	1.578	1.578	1.578	1.578	1.576	1.574	1.572	1.572
14	0.463	0.463	0.463	0.463	1.578	1.578	1.578	1.578	1.576	1.574	1.572	1.572
F(5-10)	**0.788**	**0.844**	**0.841**	**0.725**	**0.534**	**0.550**	**0.594**	**0.672**	**0.723**	**0.773**	**0.778**	**0.759**

Estimated stock in numbers (millions):

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	215.680	110.887	221.084	270.184	121.910	232.422	86.610	274.916	247.375	248.890	308.868	103.404	291.359
2	202.306	176.583	90.787	181.008	221.208	99.812	190.291	70.911	225.082	202.534	203.774	252.880	84.660
3	107.719	165.634	144.574	74.330	148.197	181.110	81.719	155.797	58.057	184.281	165.821	166.836	207.040
4	100.148	80.933	124.133	101.950	55.008	113.487	142.924	65.170	123.969	45.182	141.272	126.674	130.668
5	43.325	59.642	44.983	74.422	62.216	37.425	80.194	101.122	46.128	84.247	30.493	93.043	86.862
6	44.697	20.516	27.066	22.238	44.107	35.561	23.306	50.378	57.369	25.170	44.456	16.738	53.290
7	38.486	16.495	7.232	10.637	10.386	24.352	18.488	12.230	24.386	23.424	10.681	19.097	7.449
8	12.310	12.739	4.862	2.493	4.190	5.028	11.719	8.193	5.156	9.683	8.037	3.960	7.390
9	1.554	4.165	3.831	1.363	0.807	1.948	2.229	4.862	3.120	1.947	3.353	2.635	1.349
10	0.455	0.563	1.507	1.133	0.430	0.372	0.853	0.884	1.728	1.098	0.669	1.086	0.833
11	0.304	0.171	0.210	0.526	0.395	0.161	0.137	0.302	0.302	0.577	0.350	0.204	0.325
12	0.098	0.124	0.069	0.084	0.209	0.137	0.055	0.046	0.100	0.100	0.188	0.112	0.065
13	0.056	0.042	0.053	0.029	0.035	0.066	0.043	0.017	0.014	0.031	0.031	0.059	0.035
14	0.039	0.029	0.021	0.027	0.015	0.006	0.011	0.007	0.003	0.002	0.005	0.005	0.010

Table 3.3.12 (Continued)

Residuals:

Log(Cay-observed/Cay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	0.00	0.08	-0.06	-0.02	-0.12	-0.03	0.06	-0.04	0.12	-0.05	0.21
4	0.04	-0.04	0.03	-0.04	-0.10	-0.11	0.01	-0.09	0.09	0.02	0.07
5	-0.02	-0.01	0.05	-0.03	0.10	-0.14	-0.08	0.09	-0.07	0.05	-0.02
6	0.01	0.01	-0.05	0.18	-0.11	0.08	-0.05	0.06	0.03	-0.23	0.00
7	-0.08	0.10	0.03	-0.06	-0.04	-0.05	0.17	0.03	-0.07	-0.14	0.06
8	-0.06	0.01	0.02	0.05	-0.17	0.06	-0.04	0.11	-0.06	-0.10	-0.04
9	-0.11	0.09	0.03	0.18	-0.30	-0.05	0.13	-0.06	0.18	-0.25	-0.03
10	0.03	-0.09	0.10	0.12	-0.25	-0.17	0.07	-0.09	0.40	-0.16	-0.15
11	-0.03	0.08	-0.22	0.44	-0.29	0.09	-0.11	-0.54	0.60	0.13	-0.29
12	-0.25	0.08	-0.07	0.17	0.09	-0.14	0.38	-0.53	0.11	0.28	0.17
13	0.31	-0.31	0.33	0.78	-0.15	-0.55	-0.54	-0.44	-0.49	0.59	0.10
14	0.35	0.13	0.08	0.39	-1.68	-0.12	-0.10	-0.20	0.59	-0.43	-0.34

Year/age	1996	1997	1998	1999	2000	2001	2002
3	-0.10	-0.11	-0.11	0.05	0.00	0.12	-0.10
4	0.05	-0.07	-0.04	0.10	-0.07	0.00	-0.01
5	-0.10	0.02	-0.11	0.07	0.08	0.02	-0.05
6	0.04	-0.13	0.07	-0.03	0.03	0.01	-0.02
7	0.03	-0.05	0.08	0.06	-0.08	0.05	-0.03
8	0.02	0.12	-0.04	-0.01	0.12	-0.12	0.05
9	0.01	0.08	0.16	-0.16	0.08	0.08	-0.10
10	0.10	0.10	0.05	-0.08	-0.07	0.15	0.08
11	-0.12	0.53	0.17	-0.16	0.00	0.03	0.07
12	-0.18	-0.11	0.74	-0.13	0.27	0.09	-0.47
13	0.12	0.15	0.95	-0.06	0.00	-0.56	-0.05
14	0.13	0.94	0.88	0.84	1.21	0.84	-0.66

Table 3.3.12 (Continued)

Log(Uay-observed/Uay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.39	0.55	0.63	-0.24	0.29	-0.27	-0.33	-0.68	-0.48	0.50	-0.38
2	0.21	-0.15	0.04	0.04	0.10	0.10	-0.37	-0.07	-0.11	-0.24	0.05
3	0.20	-0.27	0.01	0.46	0.47	0.01	-0.07	-0.15	0.01	-0.16	-0.27
4	0.43	-0.28	-0.32	0.03	0.53	-0.09	0.12	-0.02	-0.01	-0.04	-0.25
5	0.25	-0.07	-0.05	-0.07	-0.05	-0.19	0.22	-0.13	0.01	-0.20	0.13
6	0.30	0.05	0.02	-0.43	0.11	-0.14	0.09	-0.14	-0.02	-0.40	0.00
7	0.53	-0.23	0.04	0.13	-0.24	-0.04	0.25	-0.18	-0.37	-0.25	-0.23
8	0.23	-0.32	-0.12	0.52	-0.17	-0.28	-0.24	-0.06	-0.16	-0.44	-0.11
9	0.50	-0.37	-0.07	-0.24	0.27	0.09	0.28	-0.23	-0.20	-0.07	0.06
10	0.56	0.00	-0.12	-0.29	-0.02	0.28	0.56	-0.03	-0.56	-0.04	-0.02

Year/age	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.54	0.33	-0.11	0.01	0.94	0.06	-0.30	0.10
2	-0.16	0.06	0.48	0.14	0.17	-0.10	0.07	-0.07
3	-0.06	0.07	-0.17	-0.03	0.17	-0.06	0.04	-0.19
4	-0.14	0.16	0.07	0.10	-0.22	-0.20	0.01	-0.08
5	0.17	-0.03	0.44	-0.06	-0.02	-0.49	0.01	-0.05
6	0.04	0.03	0.37	0.09	-0.15	-0.11	0.10	-0.10
7	0.23	0.05	0.18	0.04	-0.20	-0.33	0.00	0.20
8	0.49	0.21	0.35	0.02	-0.03	-0.58	-0.16	0.32
9	0.29	-0.45	0.48	0.09	-0.38	-0.48	-0.33	0.69
10	0.24	0.06	0.64	-0.03	-0.35	-0.12	-0.33	-0.39

Table 3.3.12 (Continued)

Summary:

Year	F5-10	SSB	Bio4+	N3	HarvestRatio	Landings
1955	0.31	1166	2323	154700	0.40	545
1956	0.30	1094	2071	182232	0.39	487
1957	0.31	1102	1934	170017	0.38	455
1958	0.31	1292	1996	218965	0.40	517
1959	0.33	1071	1812	301029	0.42	459
1960	0.35	912	1792	152184	0.45	470
1961	0.34	749	1422	196010	0.43	332
1962	0.38	789	1511	132986	0.46	389
1963	0.44	673	1286	172384	0.53	409
1964	0.52	594	1203	276699	0.60	437
1965	0.56	461	1130	247052	0.63	387
1966	0.55	425	1211	269545	0.57	353
1967	0.56	501	1382	312476	0.50	336
1968	0.58	582	1503	170555	0.50	382
1969	0.54	669	1489	253916	0.52	403
1970	0.57	662	1418	185905	0.61	475
1971	0.61	495	1160	185795	0.73	447
1972	0.66	421	1008	139494	0.76	391
1973	0.69	431	830	282957	0.87	369
1974	0.74	330	916	177179	0.91	368
1975	0.76	335	883	260858	0.89	365
1976	0.72	287	949	391593	0.76	346
1977	0.65	329	1327	139528	0.61	340
1978	0.54	394	1331	224158	0.52	330
1979	0.49	507	1421	243663	0.53	366
1980	0.52	541	1479	146789	0.58	432
1981	0.61	428	1306	144442	0.66	465
1982	0.71	263	965	133815	0.76	380
1983	0.72	221	805	224560	0.73	298
1984	0.66	229	917	140922	0.70	282
1985	0.68	267	927	136228	0.77	323
1986	0.77	266	840	342946	0.89	365
1987	0.83	255	1038	301229	0.90	390
1988	0.85	201	1101	181450	0.83	378
1989	0.73	286	1104	86342	0.81	363
1990	0.73	336	837	128886	0.88	335
1991	0.79	218	676	107725	1.00	308
1992	0.84	236	539	165646	1.05	265
1993	0.84	220	572	144582	0.99	251
1994	0.73	256	581	74331	0.76	178
1995	0.53	324	548	148206	0.61	169
1996	0.55	270	656	181142	0.55	181
1997	0.59	353	794	81738	0.56	203
1998	0.67	294	720	155886	0.69	244
1999	0.72	323	730	58125	0.81	265
2000	0.77	242	559	184586	0.85	239
2001	0.78	325	663	166110	0.79	234
2002	0.76	357	704	167018	0.69	208
2003	0.57	376	766	207175	0.57	
Mean	**0.61**	**477**	**1125**	**188811**	**0.67**	**352**

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 SSRC and SSRI 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 and .the weight for the survey and catch matrices were set to unity.

The input data that went into the model where:

1) catch-in-number matrix was based on ages 3 to 14 for years 1985 to 2002, Ca for ages 1 and 2 were assuemd 0 (thus 216 input values).
2) aged survey indices for ages 1 to 9 for years 1985-2003 (171 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) 19 estimates of N_{1y} for y = 1985, 1986, …. , 2003
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) 18 estimates of Fy for y = 1985, 1986, …. , 2002
6) estmates of a_{50} and a_{95}

or a total of 68 parameter estimates.

Table 3.3.13 (Continued)

Estimated fishing mortality rates:

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.079	0.087	0.087	0.061	0.050	0.047	0.047	0.055	0.065	0.068	0.067	0.055
4	0.245	0.267	0.269	0.188	0.155	0.145	0.145	0.170	0.201	0.209	0.207	0.170
5	0.540	0.589	0.594	0.415	0.342	0.319	0.319	0.376	0.443	0.461	0.457	0.375
6	0.789	0.860	0.867	0.606	0.499	0.466	0.467	0.549	0.648	0.674	0.668	0.548
7	0.898	0.979	0.987	0.689	0.568	0.531	0.531	0.624	0.737	0.767	0.760	0.623
8	0.931	1.015	1.023	0.715	0.589	0.550	0.550	0.648	0.764	0.795	0.788	0.646
9	0.940	1.025	1.033	0.722	0.595	0.556	0.556	0.654	0.772	0.803	0.796	0.653
10	0.943	1.028	1.036	0.724	0.597	0.557	0.557	0.656	0.774	0.805	0.798	0.654
11	0.944	1.028	1.037	0.725	0.597	0.558	0.558	0.656	0.774	0.806	0.799	0.655
12	0.944	1.029	1.037	0.725	0.597	0.558	0.558	0.656	0.774	0.806	0.799	0.655
13	0.944	1.029	1.037	0.725	0.597	0.558	0.558	0.656	0.774	0.806	0.799	0.655
14	0.944	1.029	1.037	0.725	0.597	0.558	0.558	0.656	0.774	0.806	0.799	0.655
F(5-10)	**0.840**	**0.916**	**0.923**	**0.645**	**0.532**	**0.497**	**0.497**	**0.584**	**0.690**	**0.717**	**0.711**	**0.583**

Estimated stock in numbers:

Year/age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	184.87	113.14	230.91	261.69	135.56	251.88	95.98	281.38	258.25	265.34	305.91	100.84	304.365
2	215.807	150.465	92.040	187.829	213.286	110.574	205.503	78.309	229.430	210.416	216.145	249.210	82.219
3	106.331	172.814	120.249	73.542	151.186	172.192	89.352	166.062	63.133	184.455	169.045	173.674	200.922
4	103.404	80.412	129.759	90.227	56.650	117.716	134.517	69.802	128.657	48.429	141.121	129.405	134.571
5	47.819	66.260	50.402	81.157	61.199	39.719	83.385	95.284	48.195	86.146	32.164	93.892	89.380
6	44.700	22.808	30.102	22.789	43.880	35.597	23.631	49.607	53.578	25.326	44.465	16.667	52.837
7	43.094	16.619	7.898	10.352	10.177	21.802	18.279	12.134	23.458	22.950	10.568	18.660	7.890
8	12.855	14.377	5.114	2.411	4.253	4.721	10.501	8.804	5.321	9.193	8.730	4.046	8.194
9	1.818	4.147	4.265	1.505	0.966	1.932	2.229	4.958	3.772	2.029	3.398	3.249	1.736
10	0.550	0.581	1.218	1.242	0.598	0.436	0.907	1.047	2.111	1.427	0.744	1.255	1.385
11	0.343	0.175	0.170	0.354	0.493	0.270	0.204	0.426	0.445	0.797	0.522	0.274	0.534
12	0.092	0.109	0.051	0.049	0.140	0.222	0.126	0.096	0.181	0.168	0.292	0.192	0.117
13	0.035	0.029	0.032	0.015	0.020	0.063	0.104	0.059	0.041	0.068	0.061	0.107	0.082
14	0.016	0.011	0.009	0.009	0.006	0.009	0.030	0.049	0.025	0.015	0.025	0.023	0.046

Table 3.3.13. (Continued)

Residuals:

Log(Uay-observed/Uay-predicted)

Year\Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.27	0.64	0.55	-0.32	0.37	-0.39	0.06	-0.55	-0.53	0.59	-0.46
2	0.17	0.02	0.13	-0.12	0.01	0.12	-0.47	0.25	-0.09	-0.29	0.13
3	0.10	-0.26	0.21	0.58	0.35	-0.06	-0.06	-0.22	0.29	-0.16	-0.30
4	0.56	-0.37	-0.43	0.19	0.65	-0.11	0.06	-0.01	-0.12	0.15	-0.18
5	0.21	-0.03	-0.14	-0.26	0.12	-0.15	0.19	-0.25	-0.03	-0.27	0.25
6	0.27	0.05	0.02	-0.45	0.04	-0.29	0.06	-0.18	-0.08	-0.31	0.06
7	0.53	-0.28	0.07	0.22	-0.21	-0.14	-0.07	-0.23	-0.32	-0.12	-0.05
8	0.22	-0.29	-0.11	0.64	-0.15	-0.30	-0.25	-0.17	-0.21	-0.38	-0.02
9	0.68	-0.42	-0.03	-0.24	0.25	0.02	0.22	-0.13	-0.25	-0.10	0.02

Year\Age	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.68	0.33	-0.15	-0.05	0.82	0.07	-0.05	0.00
2	-0.31	-0.06	0.35	0.12	0.11	-0.19	0.11	0.03
3	0.04	-0.06	-0.26	-0.16	0.18	-0.08	-0.01	-0.12
4	-0.18	0.25	0.06	0.04	-0.19	-0.22	-0.02	-0.12
5	0.31	-0.03	0.51	0.02	-0.05	-0.32	0.00	-0.06
6	0.11	0.15	0.39	0.12	-0.07	-0.10	0.26	-0.07
7	0.34	0.08	0.28	0.03	-0.25	-0.23	0.01	0.33
8	0.65	0.39	0.33	0.04	0.06	-0.63	-0.14	0.31
9	0.43	-0.34	0.55	-0.01	-0.34	-0.42	-0.47	0.56

Log(CNay-observed/CNay-predicted)

Year\Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	-0.23	-0.11	-0.58	-0.54	-0.76	-0.30	0.15	-0.06	0.81	0.45
4	0.41	-0.06	0.13	0.00	0.23	0.03	0.21	0.24	0.17	0.54
5	-0.07	0.06	-0.06	-0.10	0.13	-0.03	-0.16	-0.02	-0.31	-0.25
6	-0.06	0.00	-0.13	0.12	-0.13	0.00	-0.04	-0.06	-0.19	-0.31
7	-0.05	0.08	0.14	0.01	-0.04	0.07	0.06	0.05	-0.24	-0.07
8	-0.05	0.04	0.06	0.34	-0.05	0.08	-0.12	-0.02	-0.08	0.11
9	0.01	-0.10	-0.04	0.16	-0.37	-0.18	-0.12	-0.20	0.07	-0.17
10	0.03	-0.19	-0.15	0.04	-0.42	-0.35	-0.24	-0.29	0.49	-0.14
11	-0.11	-0.13	-0.30	0.43	-0.20	-0.04	-0.43	-0.81	0.57	0.53
12	0.03	-0.03	-0.10	0.47	0.38	0.07	0.19	-0.70	0.11	0.74
13	0.03	-0.26	0.22	0.93	0.26	-0.34	-0.58	-0.37	-0.55	0.94
14	0.01	-0.07	0.52	0.86	-0.99	0.65	0.30	0.19	0.93	0.31

Year\Age	1996	1997	1998	1999	2000	2001	2002
3	-0.29	-0.77	-0.82	-0.36	-0.04	0.13	-0.35
4	0.03	0.00	-0.25	-0.09	-0.23	0.04	0.00
5	-0.29	-0.18	-0.07	-0.03	0.00	-0.15	-0.10
6	0.02	-0.18	0.05	0.05	-0.01	-0.02	0.07
7	0.14	0.07	0.13	0.14	0.01	0.08	0.12
8	0.17	0.38	0.00	0.07	0.19	-0.11	0.23
9	0.11	0.28	0.30	-0.22	0.07	0.16	-0.05
10	0.20	0.33	0.08	-0.33	-0.25	0.18	0.22
11	-0.33	0.45	0.04	-0.45	-0.25	-0.27	0.02
12	-0.29	-0.57	0.26	-0.66	-0.14	-0.22	-0.75
13	0.80	-0.10	0.23	-0.70	-0.45	-0.87	-0.14
14	0.37	0.59	-0.50	-0.91	-0.26	-0.34	-1.61

Table 3.3.13. (Continued)

Summary:

Year	F5-10	SSB	Bio4+	N3
1985	0.67	265	902	146
1986	0.81	256	837	344
1987	0.89	242	1031	268
1988	0.82	198	1039	170
1989	0.72	269	1006	94
1990	0.70	342	844	135
1991	0.84	231	716	106
1992	0.92	250	571	173
1993	0.92	229	613	120
1994	0.65	258	573	74
1995	0.53	322	550	151
1996	0.50	266	660	172
1997	0.50	355	783	89
1998	0.58	348	720	166
1999	0.69	329	729	63
2000	0.72	250	571	184
2001	0.71	334	674	169
2002	0.58	354	717	174
2003		396	795	201

Table 3.3.14 COLERAINE - diagnostic and results

Input data and estimated parameters:

Data: Catch-at-age 1971–2002 and spring trawl survey indices 1985–2003.

Dimensioning_Parameters

StartYear	1971
EndYear	2003
Nsexes	1
Nages	10
Nmethods	1
NCPUEindex	1
Nsurveyindex	1
First_length	1
Length_class_increment	1
Number_of_length_classes	1

Likelihoods

CPUE		0
Survey_Index		6.63272
C@A_Commercial		-412.003
C@A_survey		-254.033
C@L_Commercial		0
C@L_no_sex_data_survey		0
C@L_data_survey		0
Prior_penalties	4.94652	

Parameters

R0	475635										
h	0.9										
Sex_specific											
M	0.2										
Rinit	0.662874										
uinit	0.29777										
plusscale	1										
Method_specific											
Sfullest	5.32393										
log_varLest	0.890819										
log_varRest	15										
Method_specific_and_annual											
errSfull		0	0	0	0	0	0	0	0	0	0
errvarL		0	0	0	0	0	0	0	0	0	0
errvarR		0	0	0	0	0	0	0	0	0	0
CPUE_index_specific											
log_qCPUE	0										
CPUE_index_specific_and_annual											
qCPUEerr		0									
q		1	1	1	1	1	1	1	1	1	1
Survey_index_specific											
log_qsurvey	-7.88422										
surveySfull	4.45519										
log_surveyvarL	1.61629										
log_surveyvarR	15										

Table 3.3.14 cont'd)

Recruitment_residuals

log_InitialDev	-0.276004	-0.133551	-0.08248	0.087969	-0.161992	0.19093	0.323306	0.082165		
log_RecDev	0.904468	0.03708	0.544025	0.98496	-0.145333	0.411873	0.501718	-0.107777	-0.090379	-0.329944

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	490000
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	0.7
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	0.7
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	-7.9
surveySfull_prior	3	2	10	0	0	0	4.4
p_surveySfulldelta	-1	-5	5	0	0	0	0
log_surveyvarL_prior	3	-5	5	0	0	0	1.6
log_surveyvarR_prior	-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	15	1	0	1	0

Age-structured_values

Mean_Length_by_sex_and_age

9.06346	16.484	22.5594	27.5336	31.606	34.9403	37.6702	39.9052	41.7351	43.2332

cv_of_Length_by_sex_and_age

1.10E-05	6.07E-06	4.43E-06	3.63E-06	3.16E-06	2.86E-06	2.65E-06	2.51E-06	2.40E-06	2.31E-06

Table 3.3.14 cont'd)

Estimated fishing mortality rates:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.057	0.061	0.060	0.042	0.036	0.035	0.033	0.038	0.045	0.048	0.050	0.041
4	0.283	0.305	0.303	0.206	0.173	0.166	0.157	0.183	0.218	0.234	0.246	0.200
5	0.662	0.728	0.720	0.455	0.375	0.358	0.336	0.398	0.487	0.527	0.560	0.440
6	0.704	0.777	0.768	0.481	0.396	0.377	0.353	0.420	0.515	0.558	0.593	0.465
7	0.704	0.777	0.768	0.481	0.396	0.377	0.353	0.420	0.515	0.558	0.593	0.465
8	0.704	0.777	0.768	0.481	0.396	0.377	0.353	0.420	0.515	0.558	0.593	0.465
9	0.704	0.777	0.768	0.481	0.396	0.377	0.353	0.420	0.515	0.558	0.593	0.465
10+	0.704	0.777	0.768	0.481	0.396	0.377	0.353	0.420	0.515	0.558	0.593	0.465
F5-10	**0.697**	**0.768**	**0.760**	**0.476**	**0.392**	**0.374**	**0.350**	**0.416**	**0.510**	**0.553**	**0.588**	**0.461**

Estimated stock in numbers:

Y/a	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	97.655	173.406	154.780	68.823	161.698	201.626	75.361	151.433	44.450	177.419	170.582	175.601	229.330
4	100.481	75.547	133.613	119.317	54.003	127.672	159.420	59.698	119.350	34.796	138.482	132.845	137.941
5	39.925	62.012	45.582	80.831	79.530	37.178	88.524	111.593	40.717	78.562	22.552	88.663	89.064
6	46.645	16.863	24.510	18.160	41.990	44.740	21.275	51.810	61.374	20.488	37.965	10.549	46.737
7	41.884	18.888	6.351	9.312	9.195	23.148	25.117	12.233	27.882	30.030	9.598	17.173	5.425
8	19.456	16.961	7.114	2.413	4.715	5.069	12.995	14.442	6.583	13.643	14.069	4.342	8.832
9	2.867	7.878	6.388	2.703	1.222	2.599	2.846	7.472	7.772	3.221	6.391	6.364	2.233
10+	3.444	2.556	3.930	3.920	3.353	2.522	2.875	3.289	5.791	6.637	4.618	4.980	5.834

Residuals

Log(Cay-observed/Cay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
3	0.24	0.18	-0.41	-0.10	-0.13	0.05	0.51	0.23	0.83	0.85	0.69
4	0.19	-0.04	0.04	-0.18	0.14	0.05	0.06	0.14	-0.04	0.16	0.12
5	-0.16	-0.17	0.04	-0.06	-0.12	-0.29	-0.17	-0.14	-0.42	-0.33	-0.33
6	0.35	0.16	0.03	0.68	0.12	0.24	-0.04	0.28	0.02	0.09	0.01
7	0.08	0.40	0.33	0.27	0.38	0.05	0.21	0.04	0.06	0.29	0.38
8	0.07	-0.07	0.24	0.45	-0.11	0.07	-0.39	-0.05	-0.30	0.39	0.10
9	-0.45	-0.26	-0.33	0.21	-0.62	-0.71	-0.43	-0.70	-0.22	-0.46	-0.18
10+	-0.92	-1.16	-0.99	-0.45	-0.95	-1.14	-1.30	-1.32	-0.38	-0.47	-0.69

Y/a	1996	1997	1998	1999	2000	2001	2002
3	-0.08	-0.14	-0.32	0.33	0.29	0.36	-0.04
4	-0.10	-0.13	-0.09	-0.11	-0.05	-0.13	-0.12
5	-0.25	-0.17	-0.20	0.04	-0.05	0.02	-0.12
6	0.04	0.27	0.30	0.07	0.30	0.19	0.70
7	0.43	0.20	0.51	0.22	-0.07	0.32	0.48
8	0.47	0.64	-0.08	0.13	0.01	-0.42	0.46
9	0.19	0.51	0.31	-0.67	-0.17	-0.30	-0.42
10+	-0.49	0.02	-0.18	-0.83	-1.01	-0.90	-0.22

Table 3.3.14 (Continued)

Log(Uay-observed/Uay-predicted)

Y/a	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	-0.49	0.41	-0.13	-0.79	-0.38	-0.27	-0.56	-1.31	-0.57	0.64	-0.96
2	0.40	0.22	0.10	-0.51	-0.23	0.08	-0.24	0.07	-0.40	-0.07	0.29
3	-0.28	0.06	0.19	0.34	-0.02	0.03	-0.14	0.05	0.08	-0.30	-0.22
4	-0.23	-0.47	-0.20	-0.04	0.26	-0.23	-0.02	-0.07	0.01	-0.14	-0.52
5	-0.02	-0.30	-0.10	-0.06	-0.09	-0.07	0.18	-0.06	0.04	0.01	0.03
6	0.15	0.14	-0.02	-0.33	-0.03	0.19	0.19	0.33	0.37	0.17	0.37
7	0.20	0.00	0.23	0.05	-0.21	0.13	0.45	0.08	0.18	0.37	0.34
8	-0.19	-0.51	-0.08	0.36	-0.61	-0.20	-0.39	0.08	-0.13	0.08	0.24
9	-0.51	-0.88	-0.66	-0.76	-0.59	-0.58	-0.14	-0.53	-0.43	-0.41	-0.02
10+	-1.04	-1.24	-0.71	-1.27	-1.14	-0.76	-0.50	-0.74	-0.77	-0.53	-0.63

Y/a	1996	1997	1998	1999	2000	2001	2002	2003
1	-0.55	-0.60	-0.24	-0.18	0.62	0.21	-1.20	0.16
2	-0.44	0.12	-0.20	0.30	0.07	0.08	0.18	-0.47
3	0.05	-0.26	-0.32	-0.43	0.14	0.06	-0.04	-0.06
4	-0.24	0.03	-0.39	0.00	-0.68	-0.09	-0.17	-0.12
5	0.12	-0.08	0.29	-0.15	-0.07	-0.35	0.09	0.07
6	0.07	0.23	0.28	0.04	-0.01	0.26	0.59	0.22
7	0.68	-0.02	0.25	0.07	-0.41	0.12	0.26	0.84
8	0.90	0.36	-0.14	-0.04	-0.30	-0.79	-0.08	0.49
9	0.28	-0.59	-0.02	-0.78	-0.95	-0.92	-1.19	0.39
10+	-0.32	-0.42	-0.52	-0.90	-1.82	-1.13	-1.79	-1.57

Total survey index residuals

Year	Obs	Fit	log(Obs/Fit)
1985	548.4	384.1	0.4
1986	402.2	419.8	0.0
1987	493.1	464.8	0.1
1988	561.3	459.5	0.2
1989	522.0	424.9	0.2
1990	307.0	346.7	-0.1
1991	291.9	285.9	0.0
1992	203.8	252.2	-0.2
1993	220.3	259.7	-0.2
1994	177.8	237.6	-0.3
1995	224.2	256.4	-0.1
1996	325.9	313.9	0.0
1997	347.0	329.7	0.1
1998	422.6	322.6	0.3
1999	282.2	288.1	0.0
2000	251.9	263.4	0.0
2001	236.1	292.2	-0.2
2002	310.0	298.5	0.0
2003	344.5	342.3	0.0

Table 3.3.14 (Continued)

Summary

Year	F5-10	Bio4+	N3
1985	0.49	1020	124
1986	0.65	900	354
1987	0.70	1090	340
1988	0.57	1190	185
1989	0.46	1200	78
1990	0.55	913	129
1991	0.70	763	98
1992	0.77	599	173
1993	0.76	631	155
1994	0.48	642	69
1995	0.39	613	162
1996	0.37	738	202
1997	0.35	906	75
1998	0.42	829	151
1999	0.51	817	44
2000	0.55	623	177
2001	0.59	701	171
2002	0.46	737	176
2003		809	229

Table 3.3.15 Comparison of the results from the variuos methods.

Estimated fishing mortality rate in 2002:

Age	XSA	TSA	AD-CAM	EX-CAM	ADAPT	Coleraine
3	0.04		0.04	0.06	0.04	0.04
4	0.18	0.17	0.18	0.17	0.18	0.18
5	0.35	0.33	0.36	0.37	0.34	0.38
6	0.55	0.50	0.61	0.55	0.56	0.40
7	0.69	0.68	0.75	0.62	0.69	0.40
8	0.80	0.80	0.88	0.65	0.87	0.40
9	0.92	0.82	0.95	0.65	1.25	0.40
10	0.99	0.83	1.01	0.65	2.19	0.40
11	1.00	0.82	0.94	0.65	2.31	
12	1.05		0.96	0.65	0.37	
13	1.01		1.57	0.65	3.54	
14	1.02		1.57	0.65	3.54	
F(5-10)	**0.72**	**0.66**	**0.76**	**0.58**	**0.98**	**0.40**

Estimated stock in numbers in 2003:

Age	XSA	TSA	AD-CAM	EX-CAM	ADAPT	Coleraine
3	198.028	187.000	207.040	200.922	206.202	229.330
4	136.855	126.372	130.668	134.571	132.559	137.941
5	86.829	90.966	86.862	89.380	86.201	89.064
6	52.048	58.054	53.290	52.837	54.105	46.737
7	8.548	8.785	7.449	7.890	8.351	5.425
8	8.169	8.225	7.390	8.194	8.111	8.832
9	1.639	1.488	1.349	1.736	1.451	2.233
10	0.812	0.956	0.833	1.385	0.490	5.834
11	0.369	0.441	0.325	0.534	0.079	
12	0.065		0.065	0.117	0.012	
13	0.019		0.035	0.082	0.081	
14	0.021		0.010	0.046	0.001	

Recruitment:

Year class	RCT3	XSA	AD-CAM	EX-CAM	Coleraine	ADAPT	TSA
1998	167	167	166	169	171	166	171
1999	177	173	167	174	176	168	164
2000	202	198	207	201	229	206	187
2001	69		69	66	59	72	75
2002	195		195	201		192	187

Estimated stock in weight (4+, Thous. tonnes) in 1990-2003

Year	XSA	TSA	AD-CAM	EX-CAM	ADAPT	Coleraine
1990	847	821	837	844	845	913
1991	711	687	676	716	709	763
1992	554	532	539	571	553	599
1993	588	575	572	613	587	631
1994	584	577	581	573	584	642
1995	562	558	548	550	561	613
1996	688	676	656	660	681	738
1997	805	793	794	783	800	906
1998	735	722	720	720	729	829
1999	738	726	730	729	747	817
2000	575	564	559	571	571	623
2001	669	684	663	674	669	701
2002	706	738	704	717	708	737
2003	**783**	**799**	**766**	**795**	**772**	**809**

Table 3.3.16 Cod at Iceland. Division Va. Resulting fishing mortality using final F from

AD-CAM using catch-at-age and spring trawl survey indices

Year/Age	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	0.106	0.114	0.065	0.027	0.029	0.032	0.030	0.020	0.025	0.022
4	0.384	0.303	0.263	0.179	0.171	0.180	0.173	0.151	0.196	0.144
5	0.505	0.527	0.386	0.337	0.261	0.246	0.328	0.384	0.408	0.408
6	0.524	0.556	0.555	0.412	0.359	0.354	0.398	0.462	0.543	0.578
7	0.739	0.685	0.671	0.707	0.548	0.508	0.522	0.602	0.623	0.701
8	0.875	0.880	0.868	0.748	0.678	0.579	0.594	0.676	0.875	0.843
9	0.800	0.931	0.902	0.867	0.687	0.617	0.631	0.783	0.976	0.911
10	0.985	0.981	0.937	0.815	0.697	0.641	0.664	0.779	0.830	0.854
11	0.974	0.955	0.881	0.796	0.750	0.716	0.702	0.705	0.665	0.653
12	0.757	0.756	0.733	0.707	0.694	0.687	0.686	0.683	0.656	0.647
13	0.397	0.399	0.402	0.405	0.414	0.424	0.433	0.443	0.451	0.457
14	0.397	0.399	0.402	0.405	0.414	0.424	0.433	0.443	0.451	0.457
F(5-10)	**0.738**	**0.760**	**0.720**	**0.647**	**0.538**	**0.491**	**0.523**	**0.614**	**0.709**	**0.716**

Year/Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.046	0.053	0.063	0.044	0.043	0.038	0.052	0.086	0.088	0.149
4	0.196	0.269	0.249	0.289	0.211	0.272	0.251	0.318	0.387	0.312
5	0.351	0.397	0.559	0.545	0.496	0.383	0.487	0.548	0.590	0.505
6	0.557	0.605	0.691	0.768	0.752	0.645	0.620	0.797	0.843	0.734
7	0.663	0.724	0.853	0.930	0.921	0.804	0.834	0.906	1.022	0.865
8	0.856	0.820	0.932	1.047	1.166	0.960	0.870	0.884	1.002	1.072
9	0.787	0.802	0.834	0.924	0.975	0.851	0.812	0.815	0.817	1.019
10	0.770	0.748	0.744	0.744	0.762	0.735	0.752	0.781	0.789	0.853
11	0.643	0.644	0.651	0.657	0.681	0.680	0.688	0.696	0.702	0.720
12	0.633	0.628	0.631	0.635	0.647	0.652	0.653	0.656	0.653	0.655
13	0.462	0.465	0.465	0.468	0.469	0.466	0.464	0.463	0.463	0.463
14	0.462	0.465	0.465	0.468	0.469	0.466	0.464	0.463	0.463	0.463
F(5-10)	**0.664**	**0.683**	**0.769**	**0.826**	**0.846**	**0.730**	**0.729**	**0.788**	**0.844**	**0.841**

Year/Age	1994	1995	1996	1997	1998	1999	2000	2001	2002
3	0.101	0.067	0.037	0.026	0.029	0.051	0.066	0.069	0.044
4	0.294	0.185	0.147	0.146	0.146	0.186	0.193	0.217	0.177
5	0.323	0.359	0.274	0.265	0.367	0.406	0.439	0.399	0.356
6	0.561	0.394	0.454	0.445	0.526	0.696	0.657	0.644	0.608
7	0.732	0.525	0.531	0.614	0.664	0.723	0.869	0.791	0.747
8	0.927	0.566	0.614	0.680	0.765	0.774	0.860	0.914	0.875
9	0.953	0.575	0.626	0.725	0.834	0.844	0.868	0.926	0.948
10	0.854	0.785	0.800	0.838	0.875	0.898	0.943	0.986	1.007
11	0.720	0.857	0.871	0.891	0.904	0.905	0.919	0.936	0.939
12	0.657	0.956	0.952	0.956	0.964	0.966	0.971	0.966	0.957
13	0.463	1.580	1.580	1.580	1.580	1.578	1.576	1.574	1.574
14	0.463	1.580	1.580	1.580	1.580	1.578	1.576	1.574	1.574
F(5-10)	**0.725**	**0.534**	**0.550**	**0.594**	**0.672**	**0.723**	**0.773**	**0.777**	**0.757**

Table 3.3.17 Cod at Iceland. Division Va. Resulting Stock in numbers using final F from AD-CAM using catch-at-age and spring trawl survey indices.

Y/A	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	584.188	208.152	334.404	363.502	218.983	215.482	199.628	335.005	210.231	203.229
2	318.613	478.293	170.420	273.787	297.611	179.288	176.422	163.442	274.279	172.122
3	*177.179*	*260.858*	*391.593*	*139.528*	*224.158*	*243.663*	*146.789*	*144.442*	*133.815*	*224.560*
4	202.658	130.455	190.475	300.475	111.196	178.197	193.282	116.615	115.960	106.842
5	61.236	112.971	78.895	119.871	205.660	76.694	121.807	133.118	82.057	78.064
6	43.313	30.262	54.619	43.907	70.087	129.719	49.100	71.843	74.199	44.661
7	18.684	21.002	14.209	25.666	23.815	40.079	74.560	26.996	37.059	35.307
8	10.658	7.307	8.668	5.945	10.363	11.278	19.737	60.535	12.104	16.281
9	3.555	3.637	2.483	2.979	2.304	4.307	5.174	8.921	15.085	4.133
10	4.366	1.308	1.174	0.824	1.025	0.949	1.903	2.253	3.338	4.652
11	2.181	1.335	0.401	0.377	0.299	0.418	0.409	0.802	0.847	1.191
12	0.596	0.674	0.420	0.136	0.139	0.116	0.167	0.166	0.324	0.356
13	0.230	0.229	0.259	0.165	0.055	0.057	0.048	0.069	0.069	0.138
14	0.037	0.126	0.126	0.142	0.090	0.030	0.030	0.025	0.036	0.036

Y/A	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	511.615	449.381	270.692	128.808	192.275	160.707	247.115	215.691	110.888	221.097
2	166.389	418.875	367.922	221.624	105.459	157.422	131.576	202.320	176.593	90.788
3	*140.922*	*136.228*	*342.946*	*301.229*	*181.450*	*86.342*	*128.886*	*107.725*	*165.646*	*144.582*
4	179.829	110.175	105.733	263.611	236.111	142.364	68.037	100.156	80.937	124.142
5	75.758	121.086	68.904	67.500	161.710	156.565	88.836	43.326	59.644	44.984
6	42.498	43.649	66.679	32.253	32.036	80.591	96.856	44.697	20.515	27.066
7	20.514	19.929	19.521	27.355	12.250	12.368	34.605	38.486	16.494	7.232
8	14.346	8.657	7.907	6.812	8.835	3.993	4.531	12.310	12.739	4.862
9	5.734	4.989	3.120	2.548	1.958	2.253	1.252	1.554	4.165	3.831
10	1.361	2.137	1.831	1.110	0.828	0.604	0.788	0.455	0.563	1.506
11	1.621	0.516	0.828	0.712	0.432	0.316	0.237	0.304	0.171	0.210
12	0.507	0.698	0.222	0.353	0.302	0.179	0.131	0.098	0.124	0.069
13	0.153	0.221	0.305	0.097	0.153	0.130	0.076	0.056	0.041	0.053
14	0.071	0.079	0.113	0.157	0.050	0.079	0.067	0.039	0.029	0.021

Y/A	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	270.233	121.939	232.554	86.713	275.369	247.807	249.161	309.069	103.448	291.515
2	181.019	221.248	99.835	190.399	70.994	225.453	202.887	203.996	253.045	84.696
3	*74.331*	*148.206*	*181.142*	*81.738*	*155.886*	*58.125*	*184.586*	*166.110*	*167.018*	*207.175*
4	101.955	55.009	113.494	142.950	65.186	124.042	45.238	141.523	126.912	130.817
5	74.424	62.217	37.425	80.198	101.143	46.141	84.308	30.540	93.262	87.067
6	22.237	44.107	35.561	23.306	50.380	57.385	25.181	44.508	16.778	53.486
7	10.637	10.386	24.351	18.487	12.230	24.385	23.435	10.689	19.137	7.477
8	2.493	4.190	5.028	11.718	8.192	5.156	9.685	8.048	3.968	7.421
9	1.363	0.807	1.948	2.228	4.861	3.120	1.947	3.355	2.643	1.354
10	1.133	0.430	0.372	0.853	0.884	1.728	1.099	0.669	1.089	0.839
11	0.525	0.395	0.161	0.137	0.302	0.302	0.577	0.350	0.204	0.326
12	0.083	0.209	0.137	0.055	0.046	0.100	0.100	0.188	0.112	0.065
13	0.029	0.035	0.066	0.043	0.017	0.014	0.031	0.031	0.059	0.035
14	0.027	0.015	0.006	0.011	0.007	0.003	0.002	0.005	0.005	0.010

Table 3.3.18 Cod at Iceland. Division Va. Resulting SSB using final F from AD-CAM using catch-at-age and spring trawl survey indices.

Y/A	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	2.446	1.682	22.091	0.013	10.745	0.026	10.396	0.013	2.910	0.019
4	29.951	24.413	16.076	22.412	8.569	5.135	6.886	4.736	8.830	12.683
5	39.463	106.171	48.214	60.971	97.126	32.846	47.727	20.557	19.063	23.972
6	94.703	54.512	97.504	92.803	104.107	237.620	76.892	55.553	40.834	35.311
7	62.347	77.665	35.569	97.804	96.320	141.013	255.363	60.773	65.597	54.661
8	46.321	32.159	36.889	26.187	48.978	53.782	94.158	223.165	37.159	42.650
9	17.335	17.296	13.277	14.134	14.273	24.685	28.949	42.599	58.559	15.286
10	20.217	6.820	7.243	5.141	7.577	5.805	13.834	12.917	19.131	22.396
11	10.823	7.040	2.968	3.082	2.568	3.653	3.518	5.833	6.773	8.840
12	3.906	4.377	3.248	1.284	1.222	1.032	1.939	1.415	3.034	3.281
13	2.029	1.814	2.832	2.209	0.821	0.588	0.587	0.623	0.903	1.494
14	0.423	0.982	1.517	2.744	1.494	0.438	0.595	0.279	0.461	0.508
Total	329.965	334.932	287.428	328.784	393.798	506.622	540.845	428.463	263.254	221.101

Y/A	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	0.013	3.939	1.918	7.360	8.169	0.008	0.010	0.011	9.864	10.984
4	10.503	9.248	9.151	19.832	6.937	9.545	6.170	10.066	22.441	43.120
5	28.175	48.184	37.325	36.509	70.014	74.169	48.380	17.193	59.881	44.684
6	49.566	67.041	99.986	60.080	41.494	130.373	154.679	55.509	34.194	53.417
7	44.520	55.740	49.279	75.306	29.147	38.004	91.976	78.713	43.115	22.614
8	43.212	32.186	28.791	25.099	26.167	14.804	17.811	41.625	41.997	17.519
9	24.629	23.680	15.345	11.586	7.934	9.785	6.868	7.251	17.760	16.441
10	8.438	13.124	11.066	7.568	4.480	3.770	5.346	2.654	3.024	8.162
11	12.131	4.090	6.087	5.427	2.945	2.601	1.965	2.328	1.358	1.567
12	4.917	6.529	2.132	2.637	1.994	1.073	1.412	0.974	1.164	0.578
13	1.792	2.577	3.207	1.168	1.652	1.034	0.892	0.604	0.489	0.581
14	0.893	1.136	1.598	1.969	0.412	0.854	0.876	0.605	0.247	0.300
Total	228.791	267.474	265.884	254.541	201.344	286.020	336.386	217.536	235.534	219.967

Y/A	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	8.029	6.426	16.935	6.915	5.778	2.822	7.159	22.892	19.514	20.210
4	45.182	36.411	16.592	65.162	19.747	49.444	11.020	86.672	81.834	65.118
5	88.717	107.937	44.281	93.059	79.997	49.056	68.327	39.051	118.191	101.249
6	52.534	110.852	84.016	54.749	81.785	101.192	40.837	89.618	40.882	117.718
7	35.436	32.686	75.054	66.513	36.461	68.850	59.644	33.601	57.957	24.242
8	9.024	18.187	19.299	49.173	40.058	21.370	34.672	30.188	17.225	31.962
9	6.316	4.425	8.727	11.113	22.697	16.447	9.458	15.750	13.222	7.351
10	5.383	2.783	2.278	4.363	4.909	10.673	6.178	3.611	5.850	5.177
11	3.785	2.702	1.140	0.892	2.039	2.088	3.621	1.937	1.341	2.219
12	0.731	1.427	1.061	0.357	0.421	0.755	0.702	1.119	0.947	0.519
13	0.323	0.208	0.396	0.212	0.142	0.096	0.184	0.144	0.381	0.239
14	0.363	0.103	0.043	0.076	0.053	0.020	0.019	0.033	0.040	0.085
Total	255.823	324.147	269.822	352.584	294.086	322.814	241.821	324.613	357.382	376.092

Table 3.3.19 Cod at Iceland. Division Va. Resulting stock weight using final F from

AD-CAM using catch-at-age and spring trawl survey indices

Y/A	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	186.038	286.944	528.651	175.666	288.940	343.078	204.330	170.442	134.618	245.893
4	346.545	230.905	339.046	574.208	203.822	348.553	359.891	192.531	179.738	170.840
5	148.804	314.059	209.072	342.352	602.378	202.624	332.899	300.847	184.301	177.597
6	165.457	113.787	223.940	178.659	277.195	518.746	185.010	236.579	230.313	134.921
7	97.902	114.463	72.039	148.271	136.365	222.357	392.112	121.023	157.796	144.617
8	70.984	48.883	58.334	39.449	70.528	76.168	137.783	352.371	65.193	89.233
9	25.420	27.534	20.481	22.894	20.828	35.745	41.582	69.038	100.801	29.130
10	33.882	11.223	11.278	8.021	11.138	8.838	20.422	21.227	30.511	37.811
11	17.864	11.760	4.633	4.407	3.906	5.491	5.034	9.122	10.128	13.115
12	5.829	6.595	4.805	1.961	1.666	1.550	2.891	2.124	4.615	4.981
13	2.843	2.309	3.644	2.888	1.049	0.770	0.709	0.863	1.187	2.188
14	0.550	1.391	2.034	3.424	1.923	0.598	0.581	0.482	0.602	0.663
4+	**916.08**	**882.91**	**949.31**	**1326.53**	**1330.80**	**1421.44**	**1478.91**	**1306.21**	**965.19**	**805.10**

Y/A	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	181.508	191.673	500.358	396.417	260.925	102.402	166.263	141.012	213.518	201.258
4	310.205	217.155	207.342	515.623	426.180	258.106	115.934	190.196	143.097	234.256
5	196.667	311.918	195.962	181.306	416.565	405.503	211.696	107.232	147.262	124.695
6	152.185	159.319	239.577	125.594	112.734	315.512	293.860	141.199	67.536	101.821
7	89.665	99.168	90.479	129.007	60.393	64.436	160.015	145.938	72.474	35.652
8	83.180	55.161	48.667	42.621	53.016	27.520	29.546	69.918	71.107	29.433
9	42.756	40.942	23.412	18.776	13.988	18.103	11.127	11.256	28.445	28.539
10	13.403	22.055	16.635	10.260	7.305	5.942	8.342	4.460	4.576	13.018
11	17.916	6.290	8.574	7.618	4.309	3.792	2.607	2.964	2.163	2.284
12	7.275	10.241	3.388	3.754	3.545	1.790	1.912	1.400	1.663	0.866
13	2.333	3.569	4.431	1.535	2.171	1.634	1.201	0.792	0.652	0.779
14	1.190	1.501	1.704	1.973	0.646	1.260	1.151	0.794	0.324	0.361
4+	**916.77**	**927.32**	**840.17**	**1038.07**	**1100.85**	**1103.60**	**837.39**	**676.15**	**539.30**	**571.70**

Y/A	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	107.259	199.782	263.924	121.299	191.272	78.411	241.438	248.833	216.121	283.208
4	210.333	107.762	219.043	268.317	114.076	217.942	80.614	290.122	244.433	238.741
5	190.674	181.673	117.214	230.810	248.609	115.214	196.436	80.870	247.705	229.160
6	81.367	159.888	147.256	93.875	179.302	199.815	81.888	151.905	61.742	193.245
7	54.429	53.756	119.857	99.867	63.752	117.147	109.910	50.932	90.326	36.419
8	15.610	26.881	30.212	74.831	63.382	33.262	57.083	52.367	25.271	45.535
9	10.519	6.391	14.423	16.366	38.097	25.957	15.207	25.229	20.635	10.439
10	10.075	4.421	3.633	7.281	8.223	15.945	10.112	6.062	9.801	7.620
11	5.699	4.351	1.694	1.477	3.250	3.220	5.906	3.081	2.131	3.197
12	1.075	2.388	1.852	0.635	0.685	1.188	1.116	1.794	1.507	0.744
13	0.434	0.464	0.902	0.452	0.289	0.215	0.411	0.347	0.529	0.393
14	0.476	0.230	0.097	0.142	0.110	0.044	0.042	0.073	0.089	0.160
4+	**580.69**	**548.21**	**656.18**	**794.05**	**719.78**	**729.95**	**558.73**	**662.78**	**704.17**	**765.65**

Table 3.3.20 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	3304
1994	3350
1995	4139
1996	5005
1997	4298
1998	3450
1999	3566
2000	3719
2001	3636
2002	3705
2003	3175
Average	3231

Table 3.3.21 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), Harvest Ratio and total biomass ('000 tonnes).

Year	F5-10	SSB	Bio4+	Recruitment	HarvestRatio	Landings
1955	0.31	1166	2323	219	0.23	545
1956	0.30	1094	2071	301	0.24	487
1957	0.31	1102	1934	152	0.24	455
1958	0.31	1292	1996	196	0.26	517
1959	0.33	1071	1812	133	0.25	459
1960	0.35	912	1792	172	0.26	470
1961	0.34	749	1422	277	0.23	332
1962	0.38	789	1511	247	0.26	389
1963	0.44	673	1286	270	0.32	409
1964	0.52	594	1203	312	0.36	437
1965	0.56	461	1130	171	0.34	387
1966	0.55	425	1211	254	0.29	353
1967	0.56	501	1382	186	0.24	336
1968	0.58	582	1503	186	0.25	382
1969	0.54	669	1489	139	0.27	403
1970	0.57	662	1418	283	0.33	475
1971	0.61	495	1160	177	0.39	447
1972	0.66	421	1008	261	0.39	391
1973	0.69	431	830	392	0.44	369
1974	0.74	330	916	140	0.40	368
1975	0.76	335	883	224	0.41	365
1976	0.72	287	949	244	0.36	346
1977	0.65	329	1327	147	0.26	340
1978	0.54	394	1331	144	0.25	330
1979	0.49	507	1421	134	0.26	366
1980	0.52	541	1479	225	0.29	432
1981	0.61	428	1306	141	0.36	465
1982	0.71	263	965	136	0.39	380
1983	0.72	221	805	343	0.37	298
1984	0.66	229	917	301	0.31	282
1985	0.68	267	927	181	0.35	323
1986	0.77	266	840	86	0.43	365
1987	0.83	255	1038	129	0.38	390
1988	0.85	201	1101	108	0.34	378
1989	0.73	286	1104	166	0.33	363
1990	0.73	336	837	145	0.40	335
1991	0.79	218	676	74	0.46	308
1992	0.84	236	539	148	0.49	265
1993	0.84	220	572	181	0.44	251
1994	0.73	256	581	82	0.31	178
1995	0.53	324	548	156	0.31	169
1996	0.55	270	656	58	0.28	181
1997	0.59	353	794	185	0.26	203
1998	0.67	294	720	166	0.34	244
1999	0.72	323	730	167	0.36	265
2000	0.77	242	559	207	0.43	239
2001	0.78	325	663	69	0.35	234
2002	0.76	357	704	195	0.30	208
Mean	**0.61**	**478**	**1133**	**188**	**0.33**	**352**

Table 3.3.22 Cod at Iceland. Division Va. Input file used for RCTR3

```
Iceland Cod: VPA and groundfish survey data,N+S
4 22 2
'Yearcl'  'VPAage3'  'Surv4'  'Surv3'  'Surv2'  'Surv1'
1981     141    4809      -11      -11      -11
1982     136    2243     3485      -11      -11
1983     343    8203     9556    11107      -11
1984     301   10161    10310     6056     1654
1985     181    7770     7169     2886     1508
1986      86    1407     2197      736      365
1987     129    3017     2615     1645      344
1988     108    1887     1793     1179      404
1989     166    3641     3326     1627      556
1990     145    2666     3076     1713      395
1991      74     899      897      482       72
1992     148    2944     2478     1501      357
1993     181    5618     4260     2903     1438
1994      82    1606     1357      548      118
1995     156    4227     2998     2239      372
1996      58     694      701      556      121
1997     185    3760     5474     3298      806
1998     166    4016     3378     2790      739
1999     -11    3855     4112     2172     1879
2000     -11     -11     4636     3807     1216
2001     -11     -11      -11      444       92
2002     -11     -11      -11      -11     1117
```

Table 3.3.23 Cod at Iceland. Division Va. Output from RCT3

Analysis by RCT3 ver3.1 of data from file :

in_2003.dat

Iceland Cod: VPA and groundfish survey data,N+S

Data for 4 surveys over 22 years : 1981 - 2002

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.

Year class = 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
Surv4	.65	-.23	.17	.888	17	8.30	5.13	.185	.268
Surv3	.65	-.25	.15	.915	16	8.13	5.03	.165	.268
Surv2	.56	.74	.12	.949	15	7.93	5.22	.132	.268
Surv1	.52	1.74	.24	.783	14	6.61	5.18	.273	.144
					VPA Mean =		4.94	.459	.051

Year class = 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
Surv4	.65	-.23	.16	.889	18	8.26	5.10	.178	.269
Surv3	.65	-.27	.15	.913	17	8.32	5.16	.162	.269
Surv2	.56	.76	.12	.948	16	7.68	5.07	.128	.269
Surv1	.52	1.75	.23	.787	15	7.54	5.66	.277	.140
					VPA Mean =		4.95	.447	.054

Year class = 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
Surv4									
Surv3	.65	-.27	.15	.913	17	8.44	5.24	.163	.362
Surv2	.56	.76	.12	.948	16	8.24	5.38	.130	.362
Surv1	.52	1.75	.23	.787	15	7.10	5.43	.266	.204
					VPA Mean =		4.95	.447	.072

Year class = 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	.56	.76	.12	.948	16	6.10	4.18	.137	.583
Surv1	.52	1.75	.23	.787	15	4.53	4.10	.278	.301
					VPA Mean =		4.95	.447	.117

Table 3.3.23 (Cont'd)

Year class = 2002

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	.52	1.75	.23	.787	15	7.02	5.39	.265	.740
					VPA Mean =		4.95	.447	.260

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1998	167	5.12	.10	.04	.16	167	5.12
1999	177	5.18	.10	.10	.93		
2000	202	5.31	.12	.07	.37		
2001	69	4.25	.15	.18	1.45		
2002	195	5.28	.23	.19	.70		

Table 3.3.24 Short-term prediction (Management option table)

Calculation were done with a spreadsheet: codpr2002.xls

Input data:

Sexual maturity at spawning time:

age\year	2002	2003	2004	2005	2006	AV00-02	Av75-02	Av85-02
3	0.12	0.098	0.098	0.098	0.098	0.098	0.039	0.050
4	0.41	0.334	0.334	0.334	0.334	0.334	0.142	0.193
5	0.59	0.548	0.548	0.548	0.548	0.548	0.343	0.425
6	0.84	0.754	0.754	0.754	0.754	0.754	0.587	0.670
7	0.85	0.857	0.857	0.857	0.857	0.857	0.794	0.834
8	0.99	0.935	0.935	0.935	0.935	0.935	0.909	0.920
9	0.99	0.979	0.979	0.979	0.979	0.979	0.956	0.958
10	0.98	0.982	0.982	0.982	0.982	0.982	0.968	0.963
11	1.00	1.000	1.000	1.000	1.000	1.000	0.995	0.996
12	1.00	1.000	1.000	1.000	1.000	1.000	0.983	0.979
13	1.00	1.000	1.000	1.000	1.000	1.000	0.988	0.982
14	1.00	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	2002	2003	2004	2005	2006	00-02
3	1.025	1.050	1.050	1.050	1.050	1.050
4	1.498	1.607	1.607	1.607	1.607	1.607
5	2.159	2.391	2.385	2.385	2.385	2.347
6	3.236	3.532	3.477	3.473	3.473	3.381
7	4.655	4.955	4.852	4.810	4.806	4.830
8	5.957	6.397	6.382	6.296	6.259	6.428
9	7.881	8.048	8.048	8.048	8.048	8.048
10	9.458	9.327	9.327	9.327	9.327	9.327
11	10.231	10.035	10.035	10.035	10.035	10.035
12	11.736	11.873	11.873	11.873	11.873	11.873
13	13.172	12.660	12.660	12.660	12.660	12.660
14	17.442	16.070	16.070	16.070	16.070	16.070

Mean weights in the catch

age\year	2002	2003	2004	2005	2006	98-00
3	1.294	1.367	1.367	1.367	1.367	1.367
4	1.926	1.825	1.859	1.859	1.859	1.919
5	2.656	2.632	2.583	2.602	2.602	2.545
6	3.680	3.613	3.600	3.561	3.577	3.448
7	4.720	4.871	4.819	4.807	4.772	4.725
8	6.369	6.136	6.251	6.214	6.205	6.257
9	7.808	7.712	7.712	7.712	7.712	7.712
10	9.002	9.087	9.087	9.087	9.087	9.087
11	10.422	9.819	9.819	9.819	9.819	9.819
12	13.402	11.367	11.367	11.367	11.367	11.367
13	9.008	11.130	11.130	11.130	11.130	11.130
14	16.893	16.070	16.070	16.070	16.070	16.070

Table 3.3.24 (Continued)

Selection pattern from AD-CAM:

age\year	1997	1998	1999	2000	2001	2002	00-02	Used
3	0.044	0.042	0.070	0.085	0.089	0.058	0.078	0.078
4	0.246	0.217	0.258	0.250	0.280	0.234	0.255	0.255
5	0.446	0.546	0.561	0.568	0.514	0.471	0.518	0.518
6	0.748	0.782	0.962	0.850	0.829	0.803	0.828	0.828
7	1.033	0.988	1.000	1.125	1.019	0.988	1.044	1.044
8	1.144	1.139	1.070	1.113	1.177	1.156	1.149	1.149
9	1.220	1.242	1.167	1.123	1.192	1.255	1.190	1.190
10	1.409	1.302	1.240	1.220	1.268	1.327	1.271	1.271
11	1.499	1.346	1.251	1.189	1.204	1.237	1.210	1.637
12	1.607	1.435	1.335	1.256	1.242	1.261	1.253	1.637
13	2.655	2.349	2.178	2.036	2.022	2.072	2.043	1.637
14	2.655	2.349	2.178	2.036	2.022	2.072	2.043	1.637
Ave(5-10)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Natural Mortality

age\year	2002	2003	2004	2005	2006
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 3.3.24 (Continued)

Given stock numbers

Mortality proportions before spawning

age\year	2003	2004	2005	2006	F	M
3	207.175	69.00	195.00	180.00	0.085	0.250
4	130.817				0.180	0.250
5	87.067				0.248	0.250
6	53.486				0.296	0.250
7	7.477				0.382	0.250
8	7.421				0.437	0.250
9	1.354				0.477	0.250
10	0.839				0.477	0.250
11	0.326				0.477	0.250
12	0.065				0.477	0.250
13	0.035				0.477	0.250
14	0.010				0.477	0.250

Table 3.3.24 (Continued)

Icelandic COD. Division Va.

Prognosis - Summary

Catch, '000 tonnes

	1999	2000	2001	2002	2003	2004	2005	2006
Opt1	265	239	234	208	210	180	180	180
Opt2	265	239	234	208	210	210	223	231
Opt3	265	239	234	208	210	190	190	190
Opt4	265	239	234	208	210	220	220	220
Opt5	265	239	234	208	210	250	250	250

Average fishing mortality of 5-10 years old

	1999	2000	2001	2002	2003	2004	2005	2006
Opt1	0.720	0.770	0.780	0.760	0.583	0.405	0.328	0.273
Opt2	0.720	0.770	0.780	0.760	0.583	0.485	0.444	0.414
Opt3	0.720	0.770	0.780	0.760	0.583	0.431	0.355	0.300
Opt4	0.720	0.770	0.780	0.760	0.583	0.513	0.446	0.398
Opt5	0.720	0.770	0.780	0.760	0.583	0.600	0.554	0.526

Fishable stock, 4+ in '000 tonnes at the beginnig of the year

	1999	2000	2001	2002	2003	2004	2005	2006
Opt1	730	559	663	704	766	914	902	1069
Opt2	730	559	663	704	766	914	867	980
Opt3	730	559	663	704	766	914	890	1044
Opt4	730	559	663	704	766	914	855	971
Opt5	730	559	663	704	766	914	819	897

Spawning stock in '000 at the time of spawning

	1999	2000	2001	2002	2003	2004	2005	2006
Opt1	323	242	325	357	374	448	531	628
Opt2	323	242	325	357	374	440	492	541
Opt3	323	242	325	357	374	445	519	605
Opt4	323	242	325	357	374	437	484	537
Opt5	323	242	325	357	374	428	448	471

Table 3.3.24 (Continued)

Icelandic COD. Division Va.

Prognosis - Summary table (nwwg2003)

2003				2004				2005				2006			
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)*
210	766	374	0.583	180	914	448	0.405	180	902	531	0.328	180	1069	628	0.273
				210	914	440	0.485	223	867	492	0.444	231	980	541	0.414
				190	914	445	0.431	190	890	519	0.355	190	1044	605	0.300
				220	914	437	0.513	220	855	484	0.446	220	971	537	0.398
				250	914	428	0.600	250	819	448	0.554	250	897	471	0.526

The shaded option corresponds to the harvest control rule.

Table 3.3.25 Cod at Iceland. Division Va. Yield-per-recruit input data

```
MFYPR version 1
Run: final
Cod Va (NWWG 2003)
Time and date: 11:50 03/05/2003
Fbar age range: 5-10
Age M   Mat PF  PM  SWt Sel CW
3   0.2 0.044  0.085  0.25   1.3228 0.079  1.3228
4   0.2 0.174  0.18   0.25   1.8442 0.314  1.8442
5   0.2 0.388  0.248  0.25   2.5961 0.581  2.5961
6   0.2 0.621  0.296  0.25   3.5406 0.860  3.5406
7   0.2 0.797  0.382  0.25   4.7361 1.052  4.7361
8   0.2 0.900  0.437  0.25   6.1747 1.200  6.1747
9   0.2 0.948  0.477  0.25   7.6166 1.169  7.6166
10  0.2 0.964  0.477  0.25   9.3120 1.138  9.3120
11  0.2 0.994  0.477  0.25   10.87101.051  10.8710
12  0.2 0.980  0.477  0.25   12.90501.055  12.9050
13  0.2 0.984  0.477  0.25   14.29711.060  14.2971
14  0.2 1      0.477  0.25   15.91371.050  15.9137
```

Weights in kilograms

Table 3.3.26 Cod at Iceland. Division Va. Yield-per-recruit summary.

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average Current	0.76	1.67	2.20
F$_{max}$	0.38	1.76	4.45
F$_{0.1}$	0.20	1.63	7.68
F$_{med}$	0.54	1.73	3.13

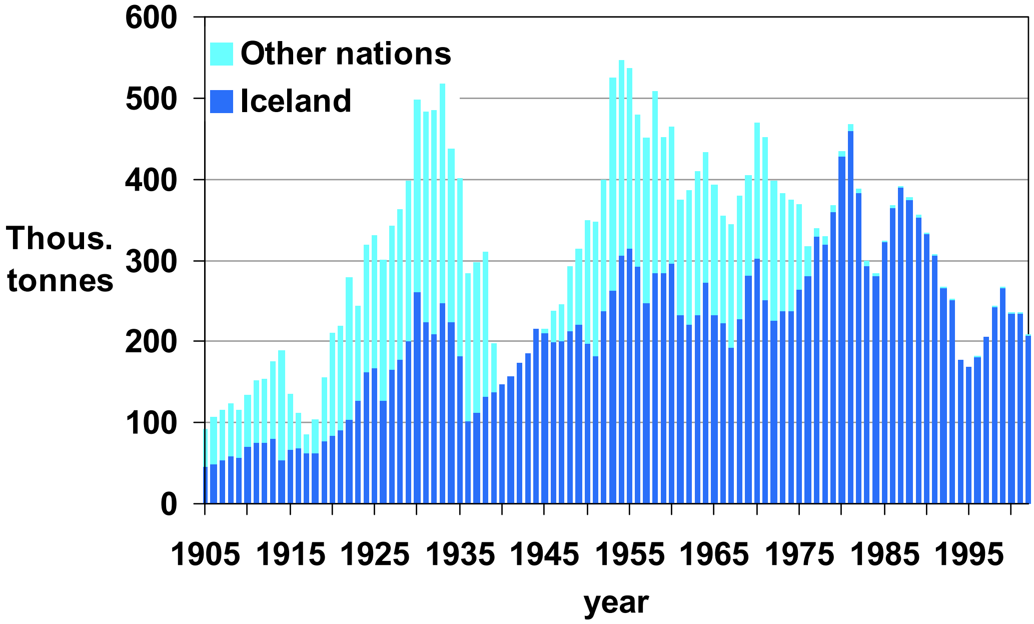


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.

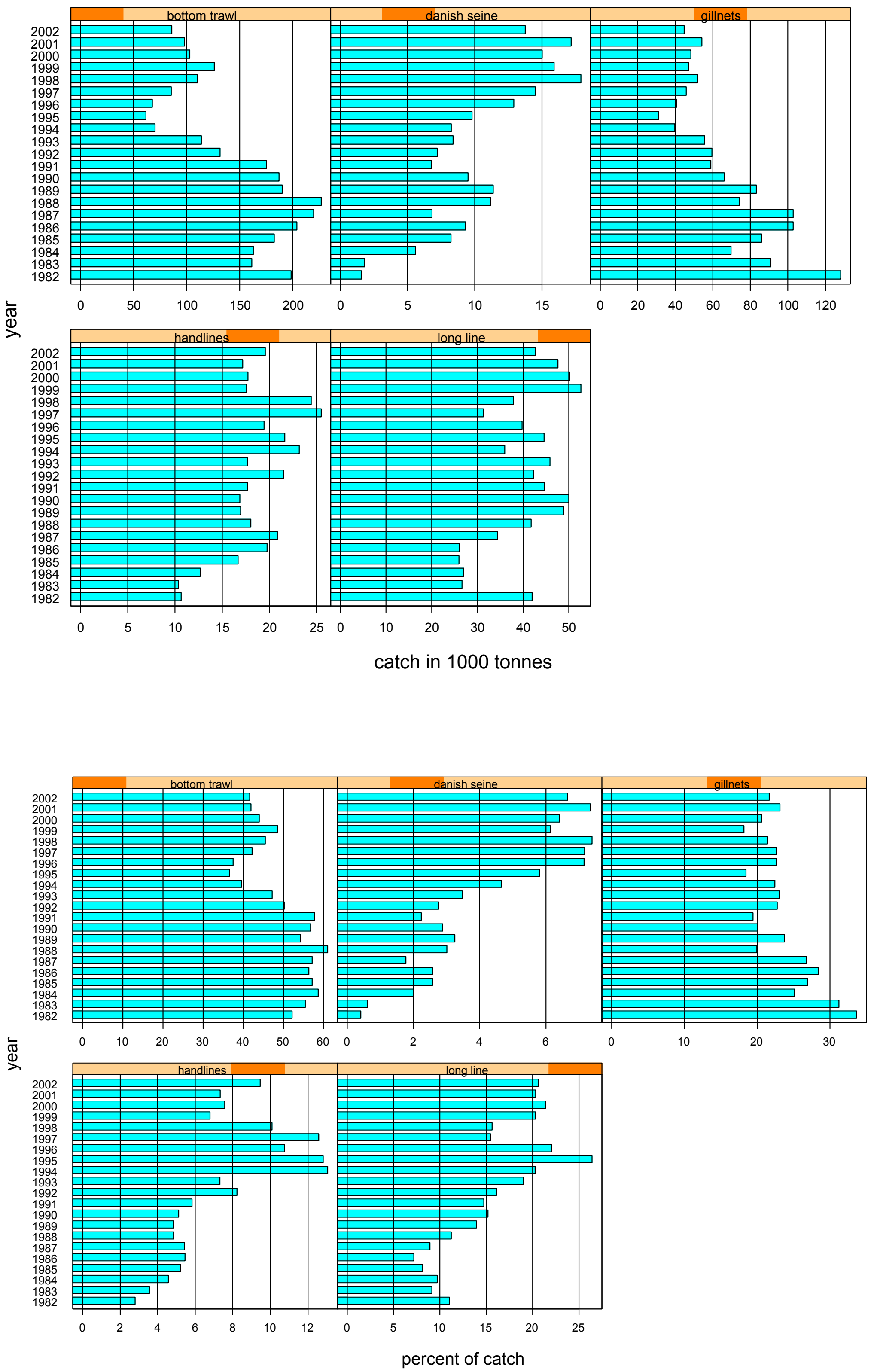


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes and lower in percentages.

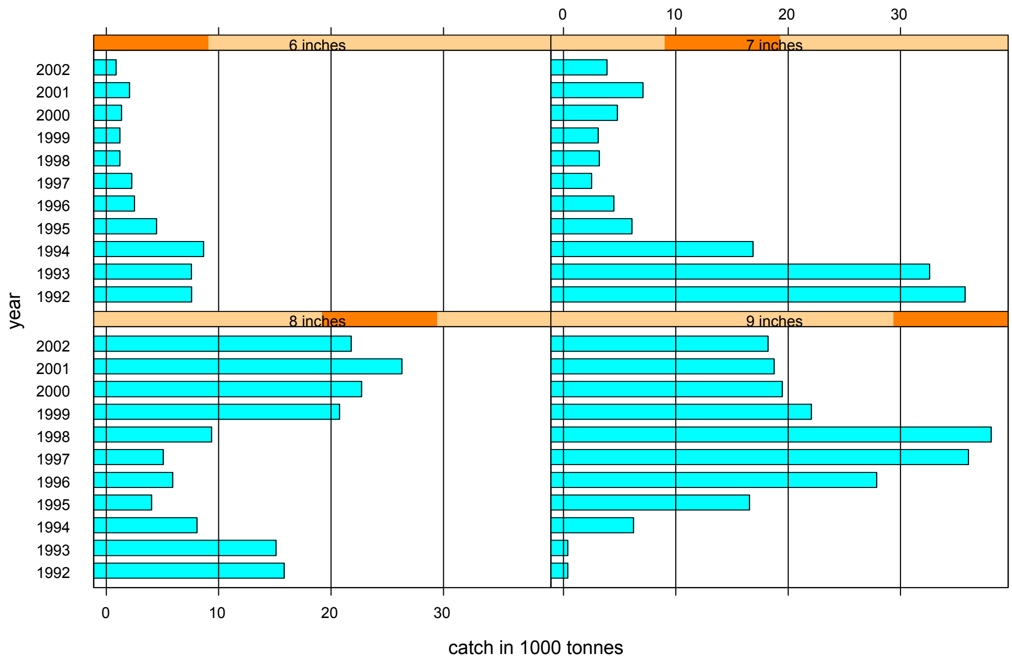


Figure 3.3.3 Cod in division Va. Gillnet landings by mesh size and year.

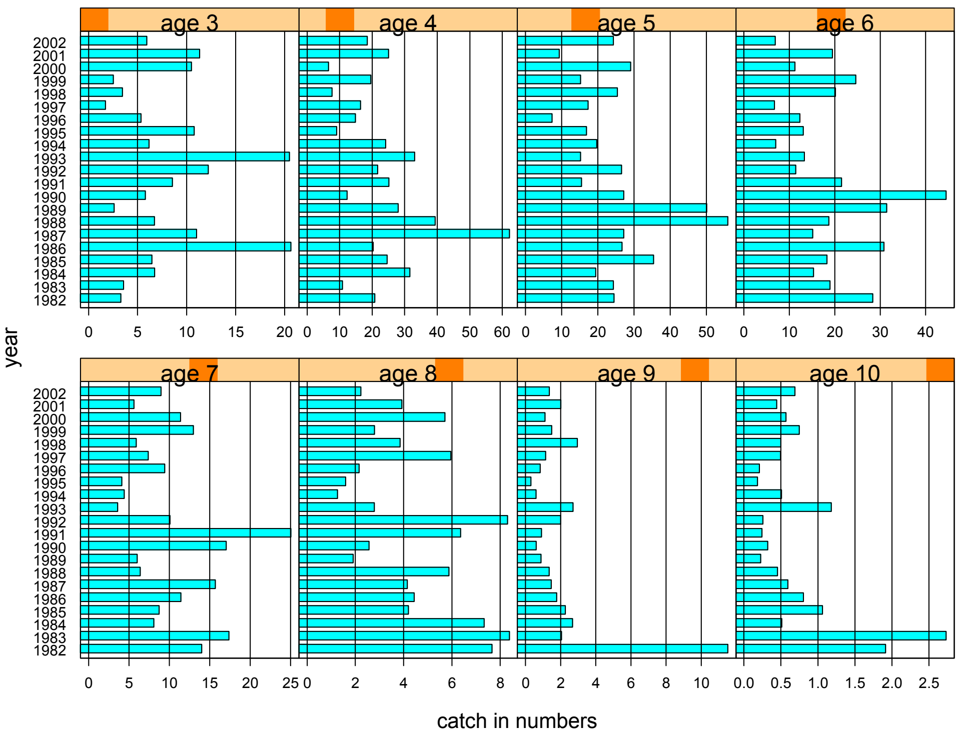


Figure 3.3.4 Cod in division Va. Catch in numbers by year and age.

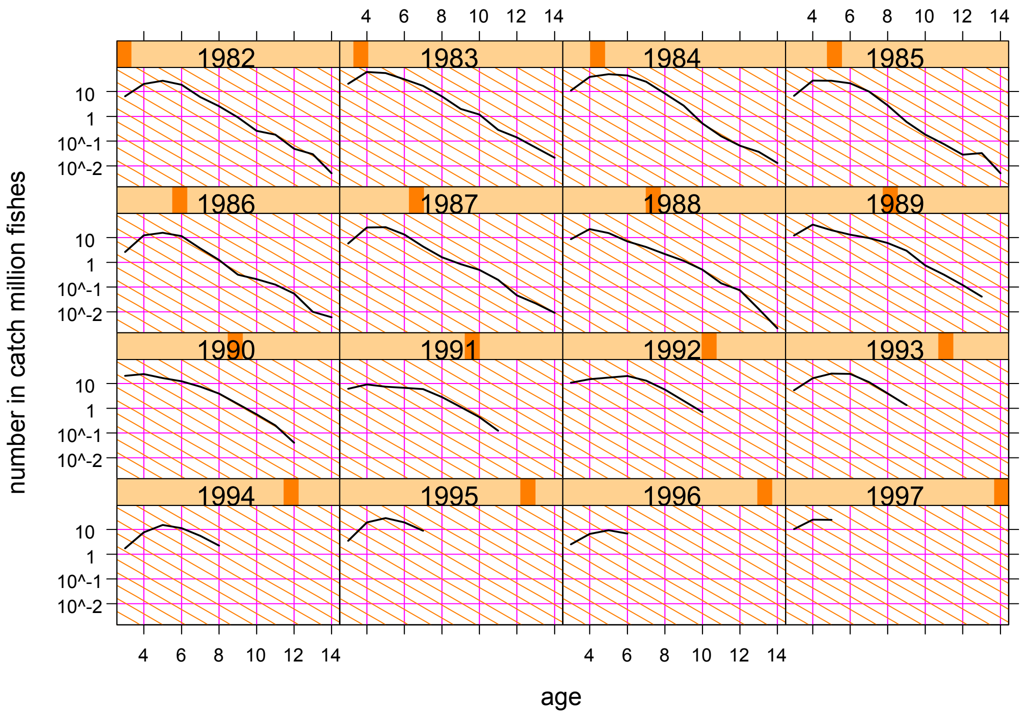


Figure 3.3.5 Icelandic cod. Catch curves. Grey lines show Z = 1.

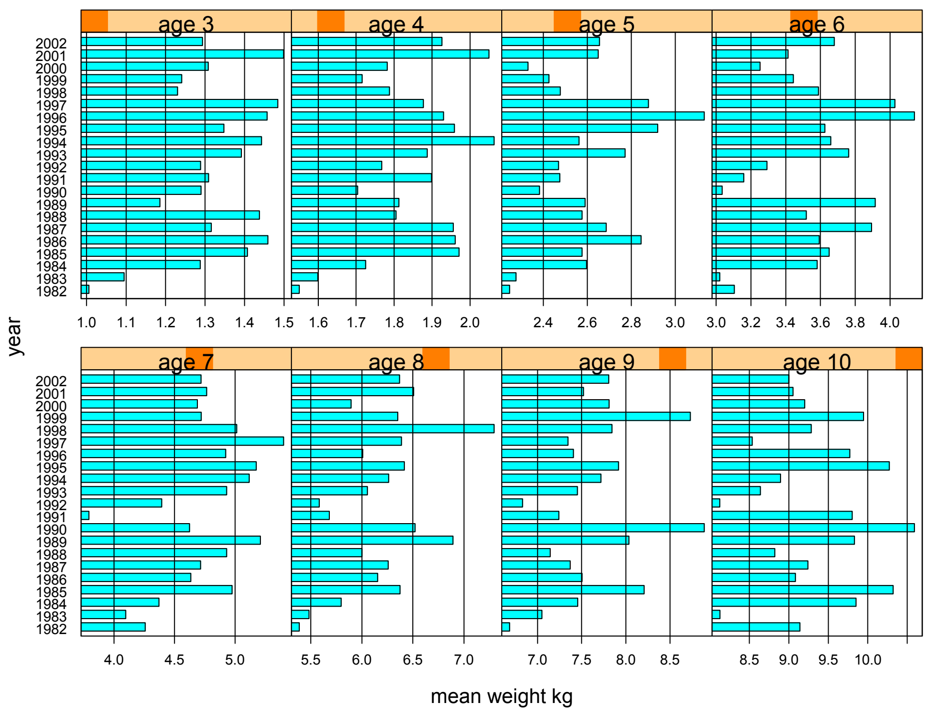


Figure 3.3.6 Cod in division Va. Maturity-at-age in the catches.

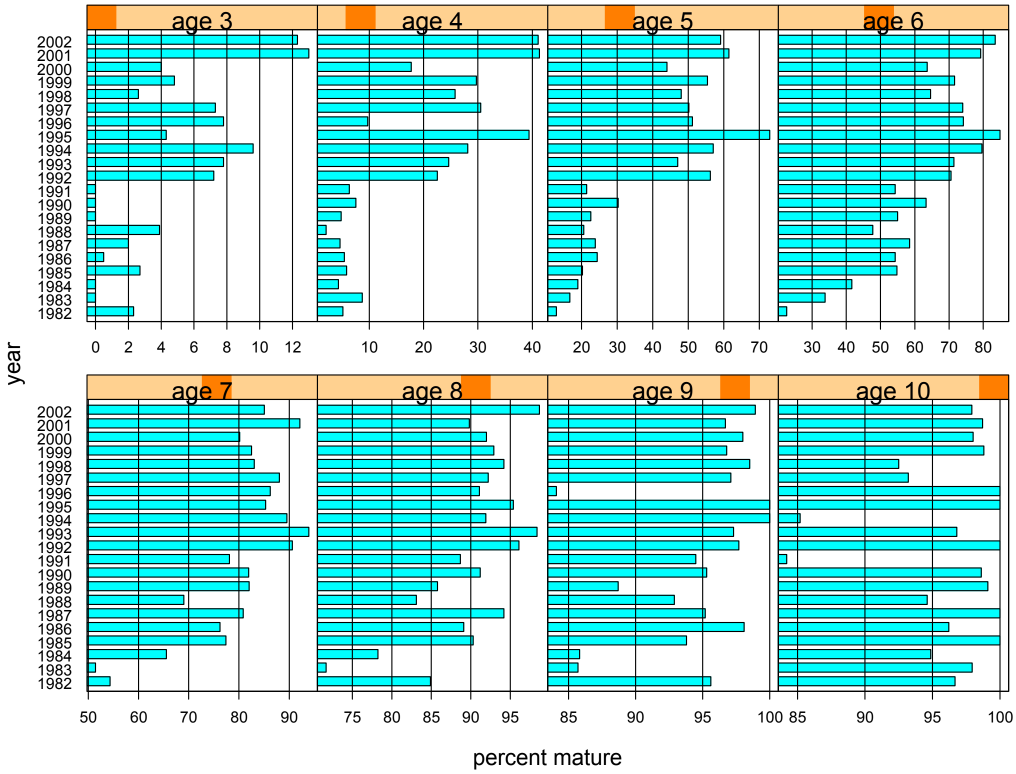


Figure 3.3.7 Cod in division Va. Mean weight-at-age in the catches.

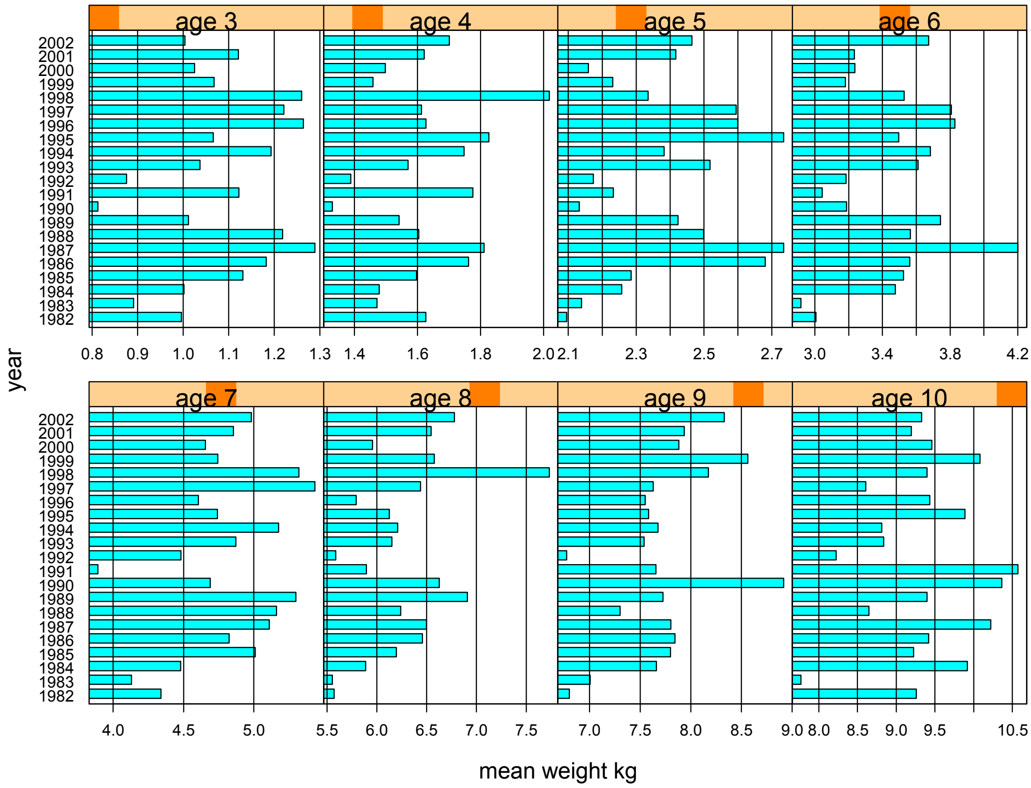


Figure 3.3.8 Cod in division Va. Mean weight-at-age in the SSB.

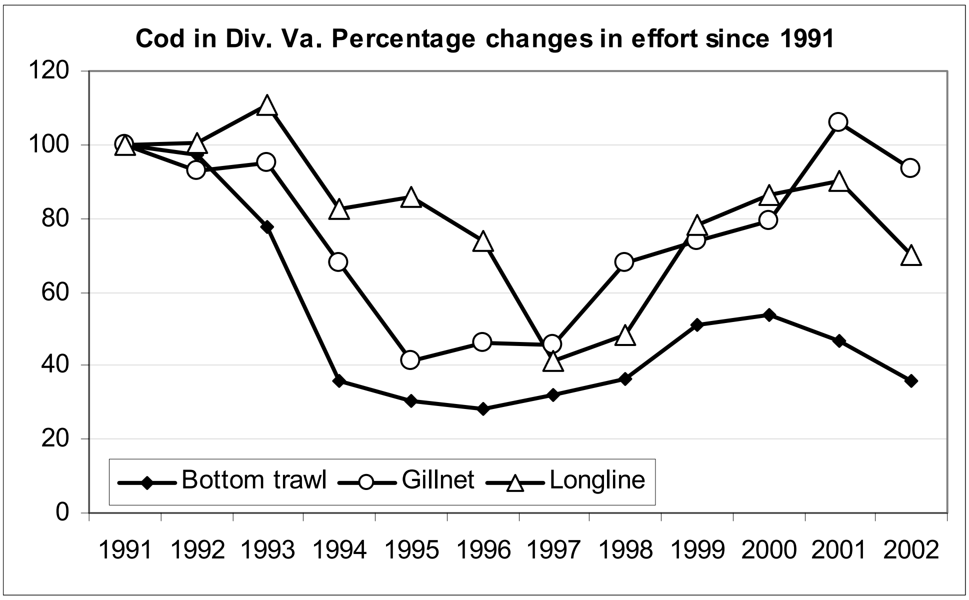


Figure 3.3.9.A Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

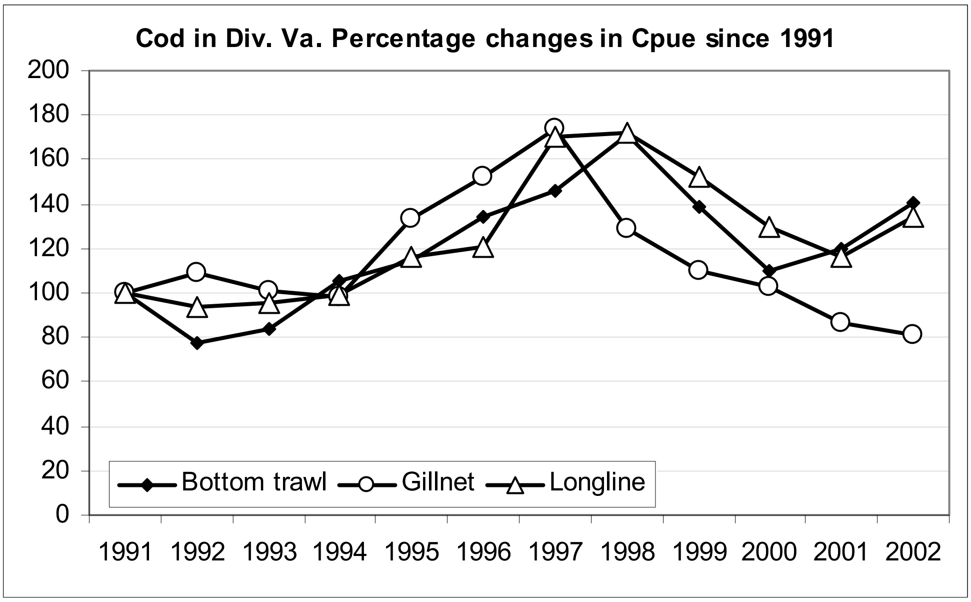


Figure 3.3.9.B Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

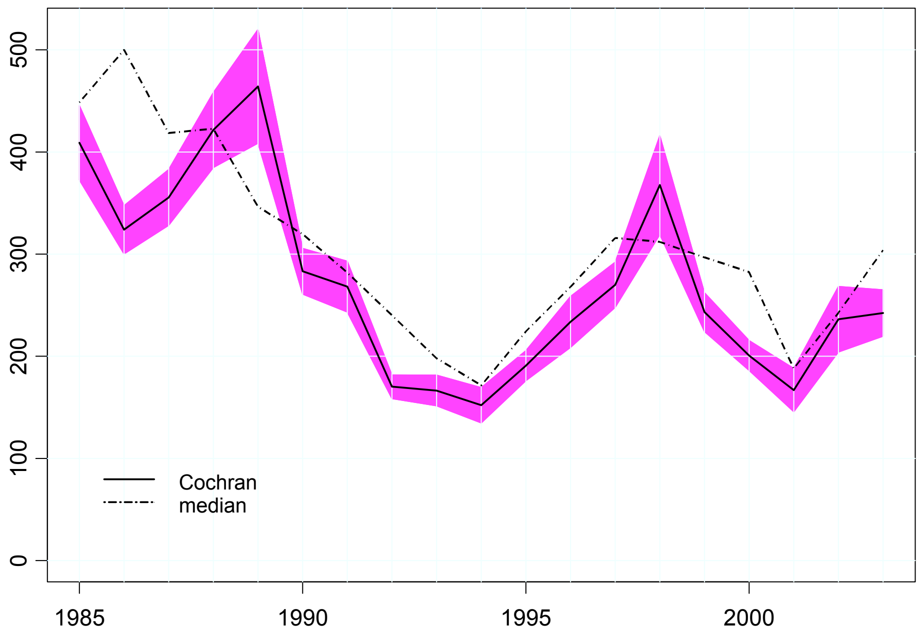


Figure 3.3.10 Cod in division Va. Total biomass index from the groundfish survey. Index base on the median of all stations where cod was caught is shown for comparison. The scale is 100 thousand tonnes.

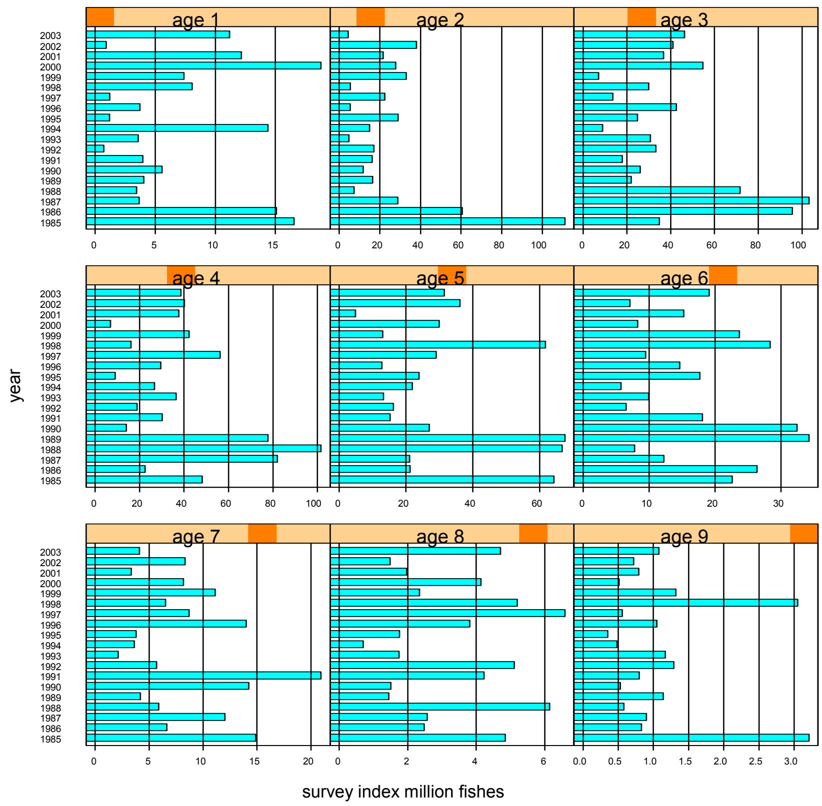


Figure 3.3.11 Cod in division Va. Survey indices from the March survey. Numbers by year and age.

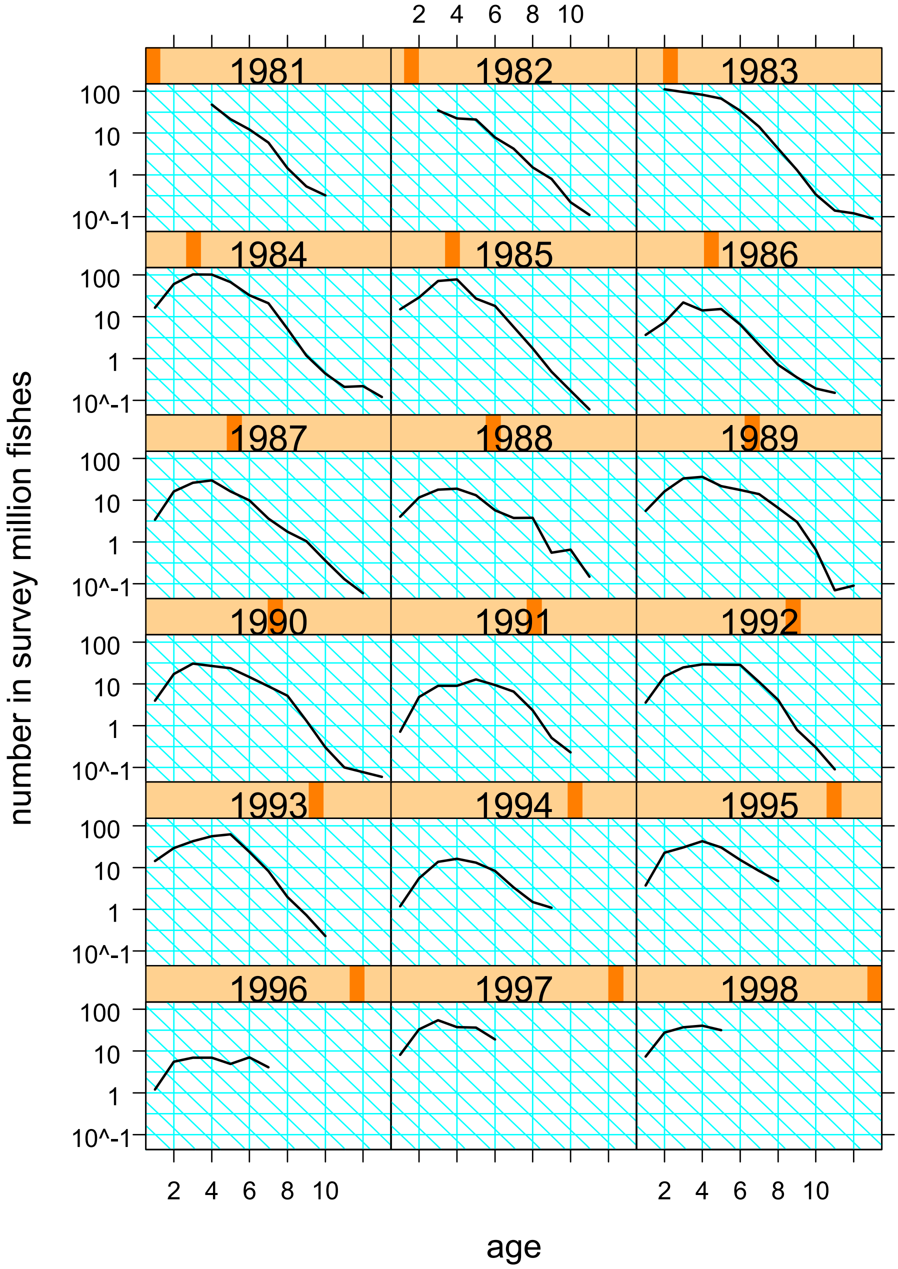


Figure 3.3.12 Cod in division Va. Catchcurves from the survey. The grey lines show Z=1

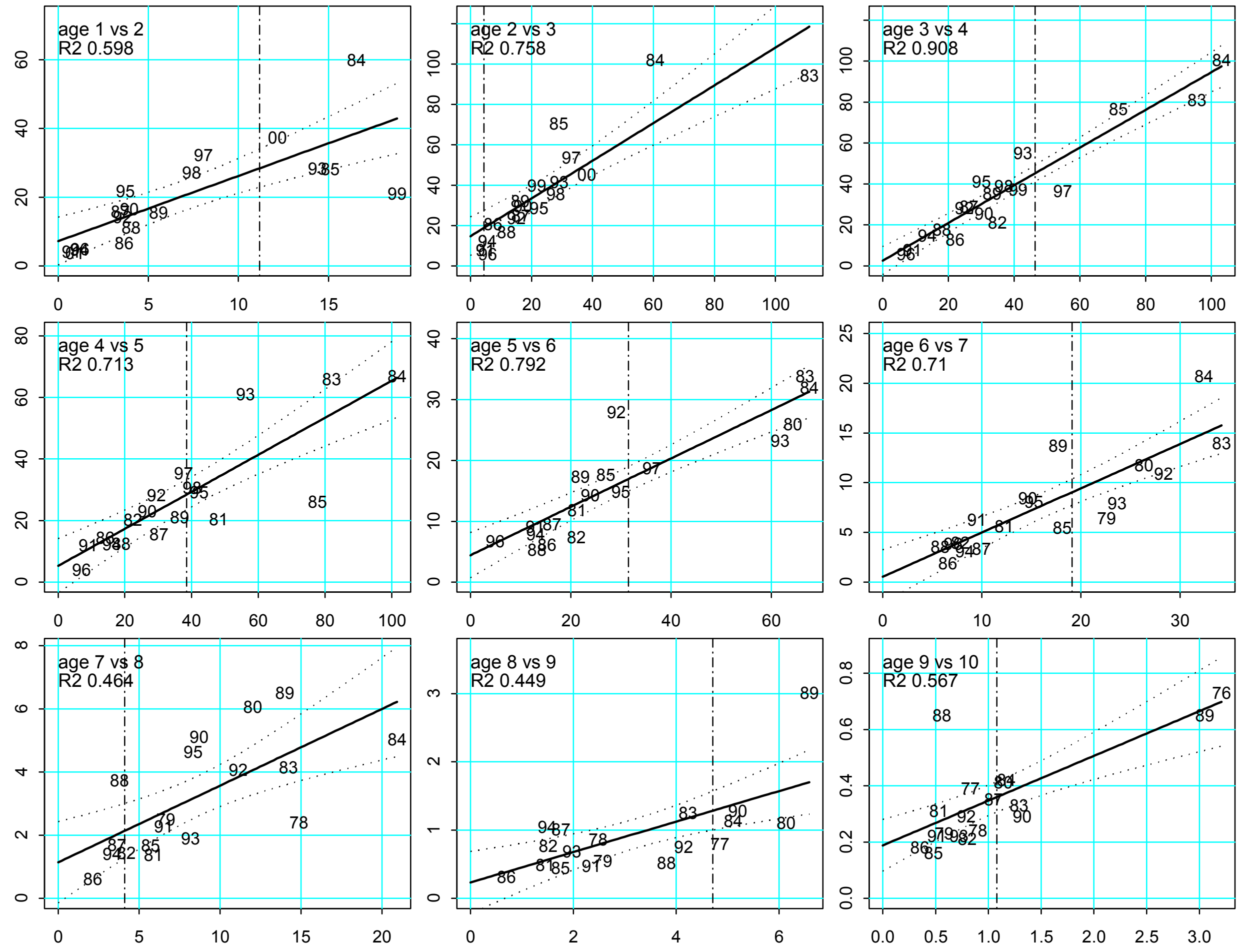


Figure 3.3.13 Cod in division Va. Indices from the groundfish survey vs. index of the same year class in survey a year later.

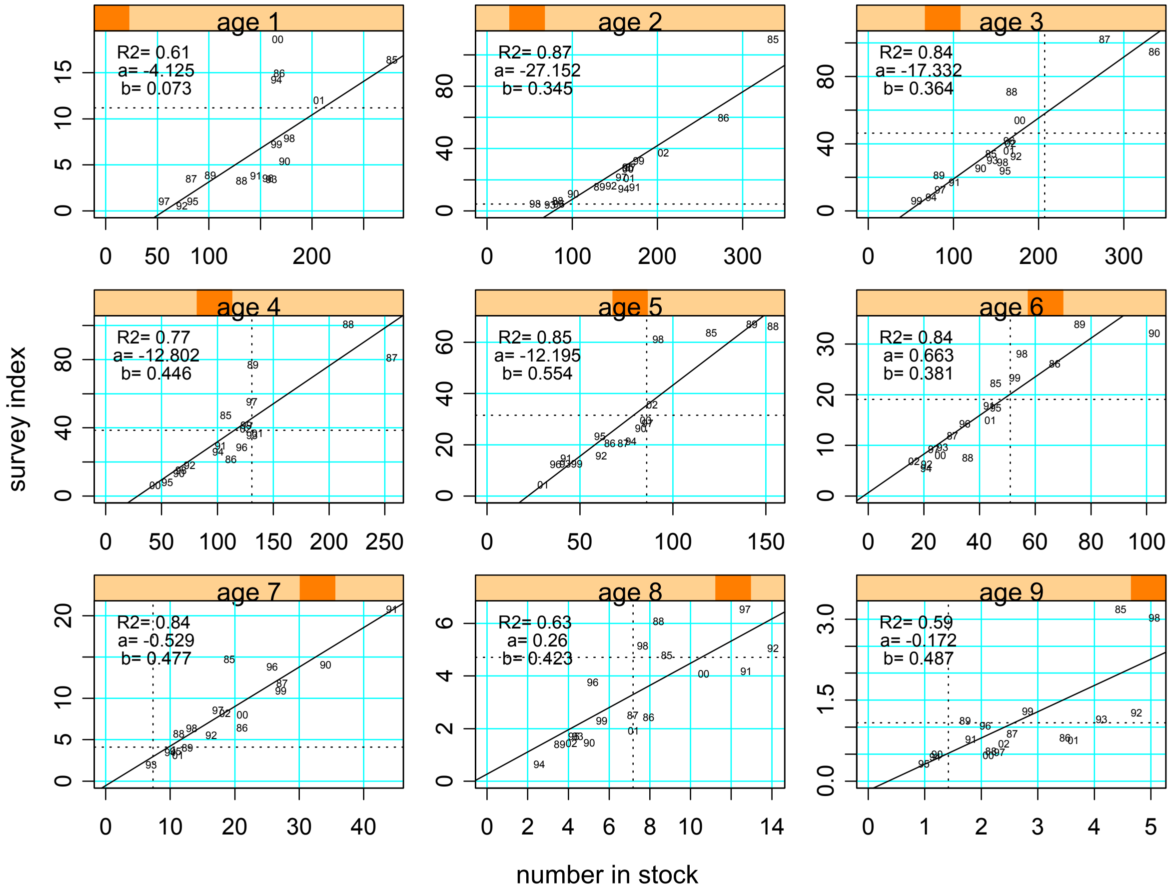


Figure 3.3.14 Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale

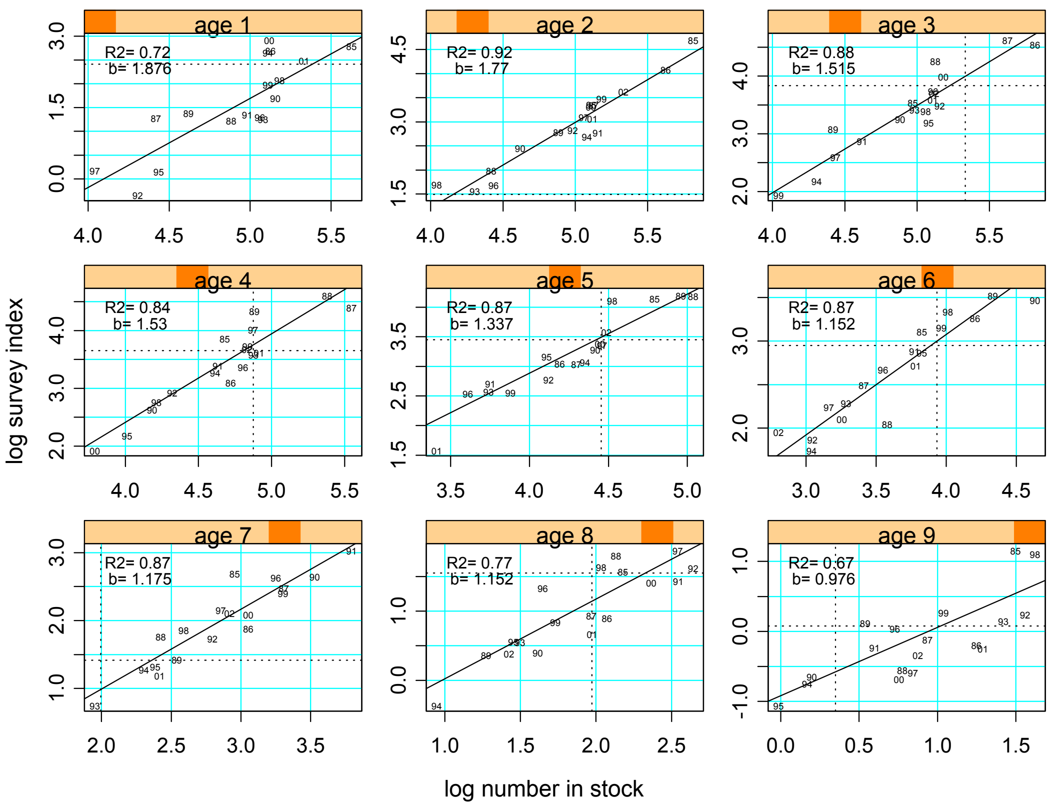


Figure 3.3.15 Cod in division Va. Survey indices vs. number in stock. Line fitted on logscale (power curve)

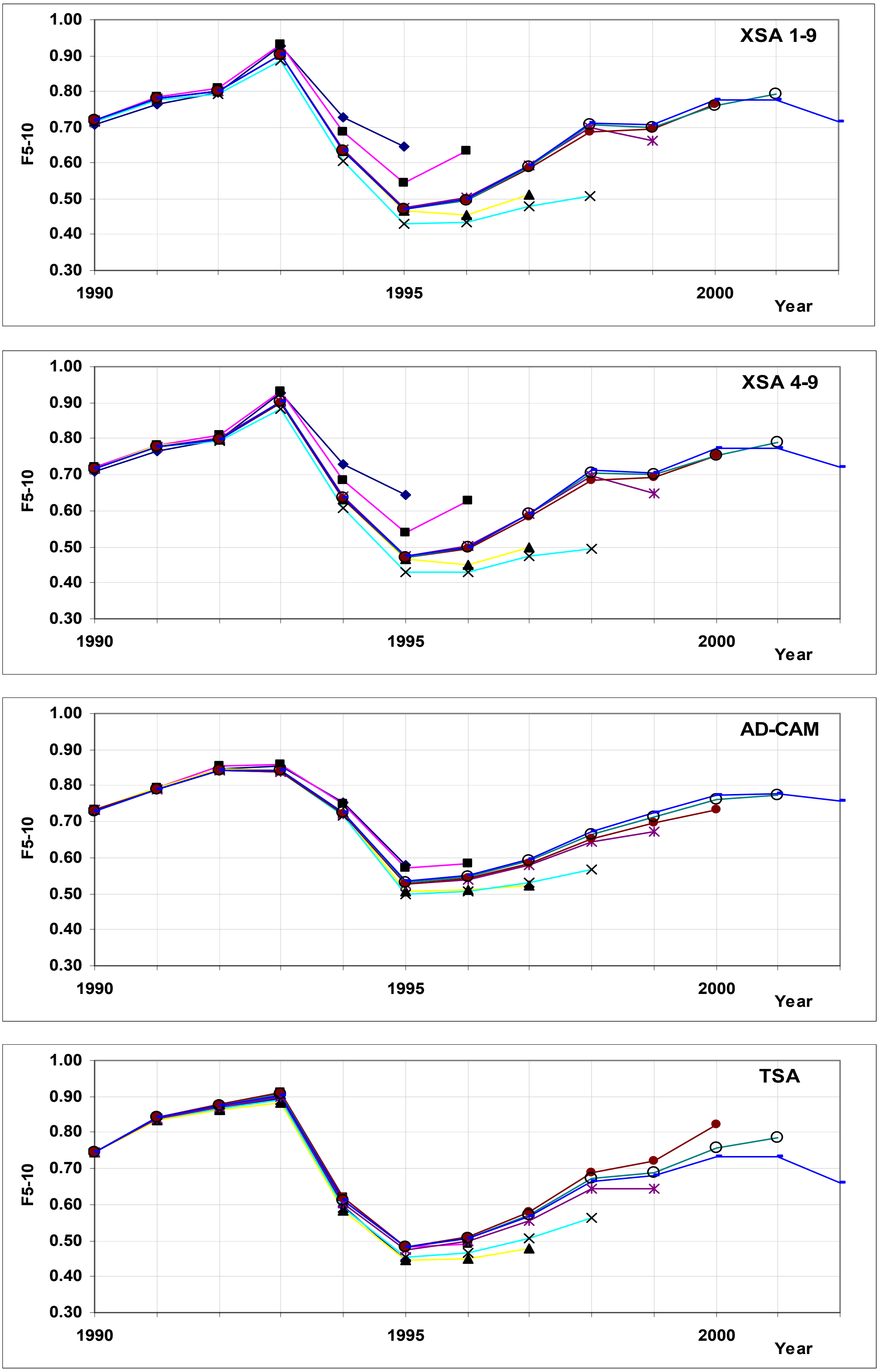


Figure 3.3.16 Retrospective pattern from assessment runs. The figures show mean fishing mortality of ages 5 to 10.

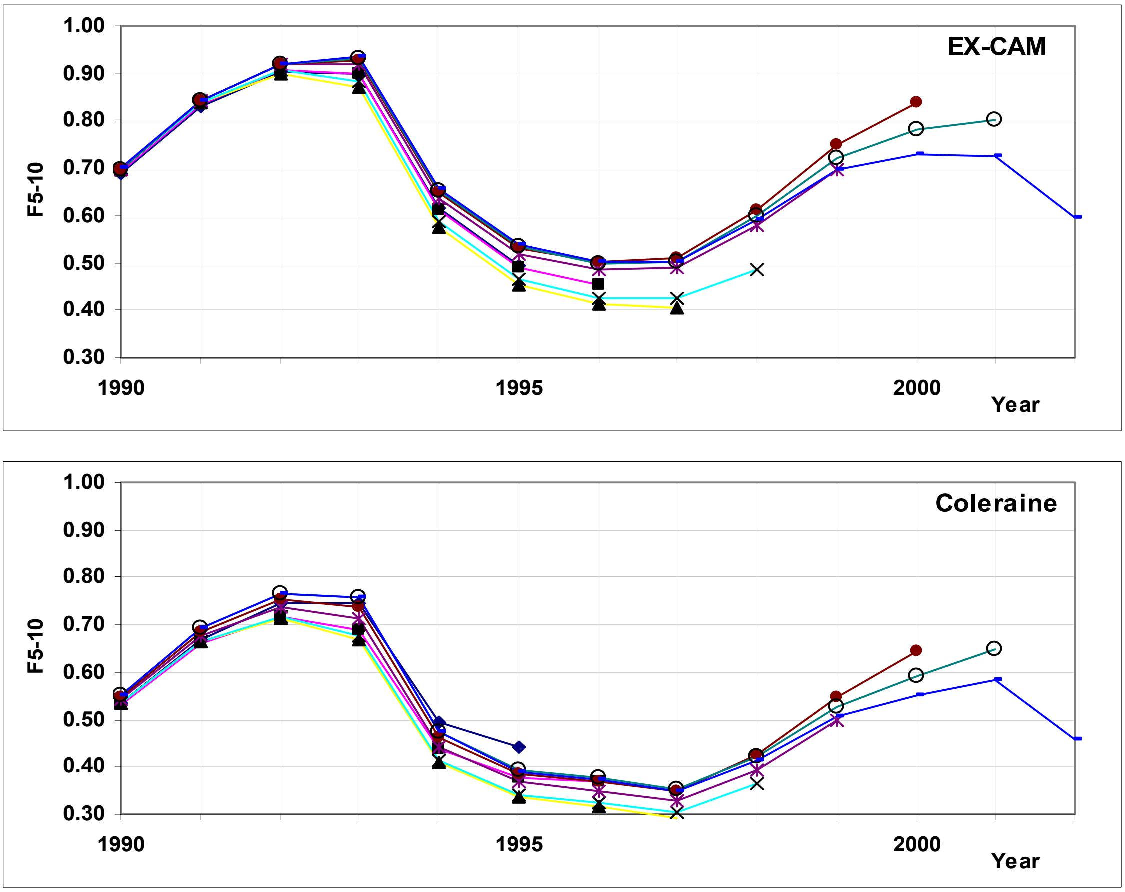


Figure 3.3.16. (Continued)

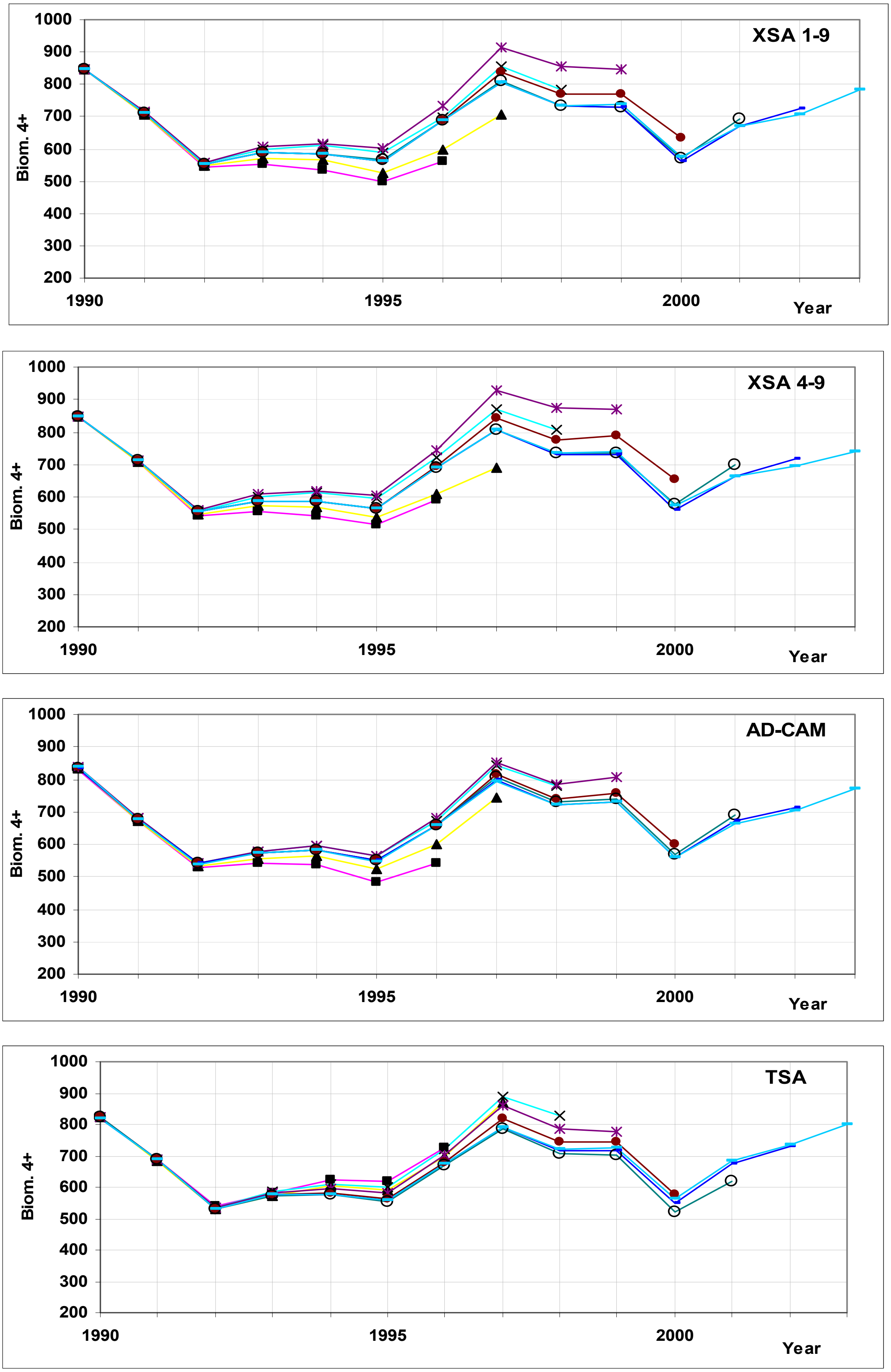
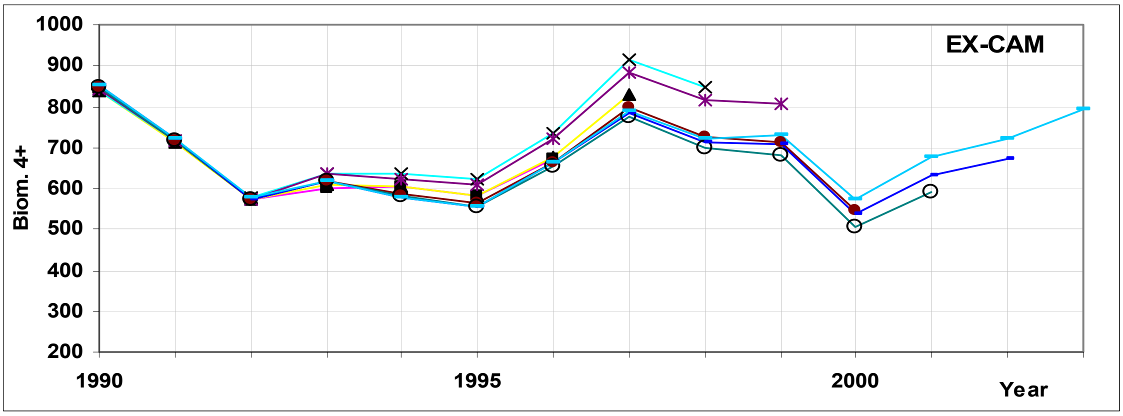


Figure 3.3.17 Retrospective patterns from assessment runs. The figures show number of age 4 and older multiplied by the weight in the catches.



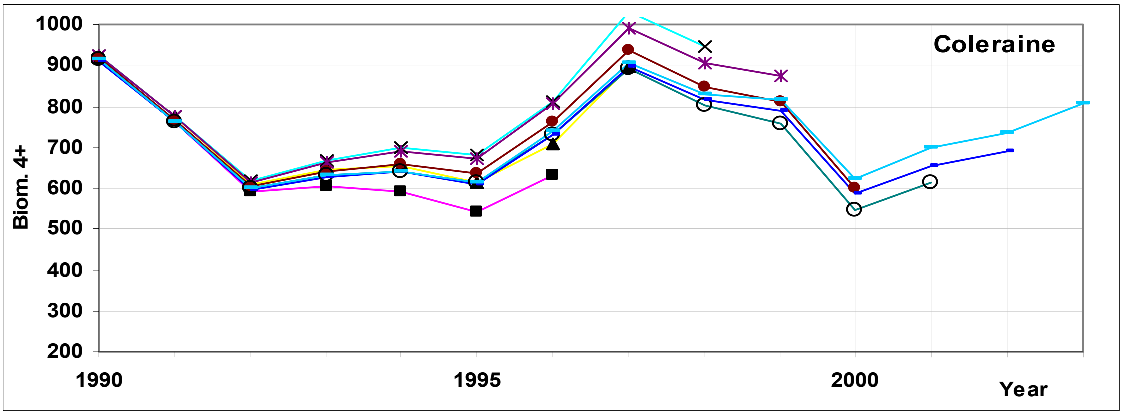
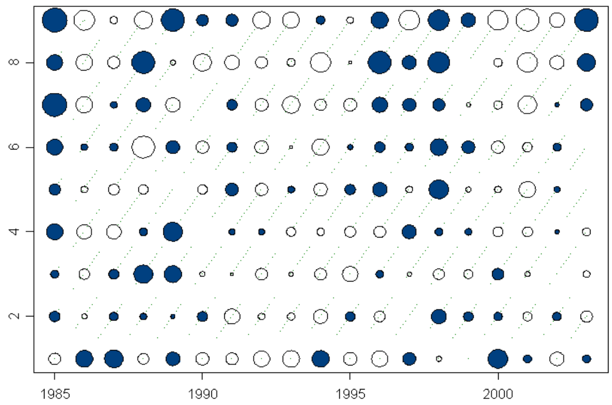
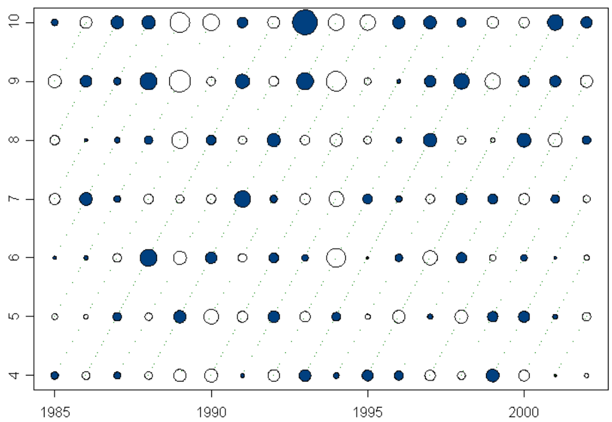


Figure 3.3.17. (Continued)

XSA-Log catchability residuals



AD-CAM ln(CNay-observed/CNay-predicted)



AD-CAM ln(Uay-observed/Uay-predicted)

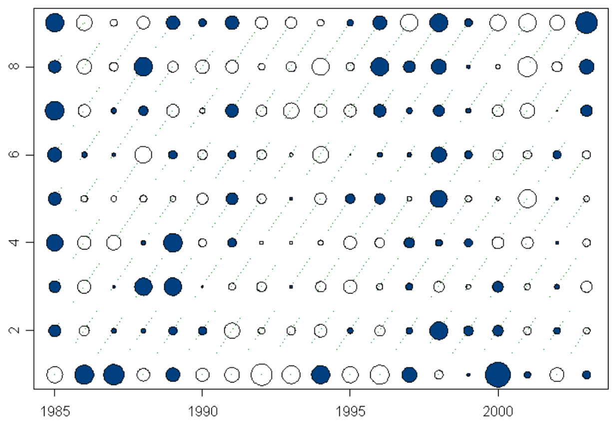
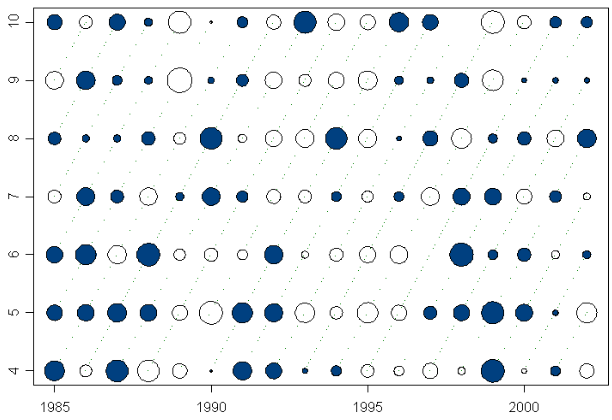
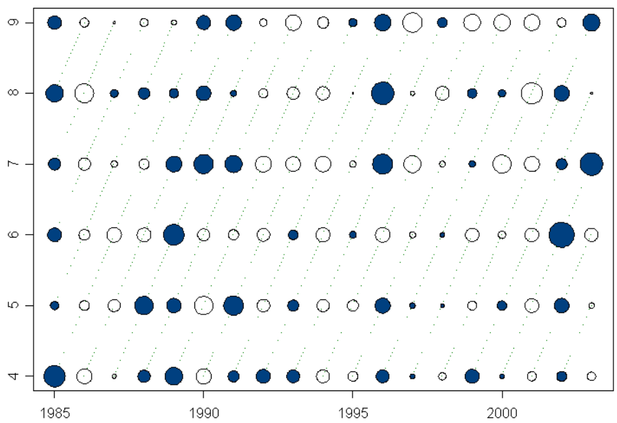


Figure 3.3.18 Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

TSA - Standardized catch prediction errors



TSA - Standardized prediction errors of survey cpue



EX-CAM ln(CNay-observed/CNay-predicted)

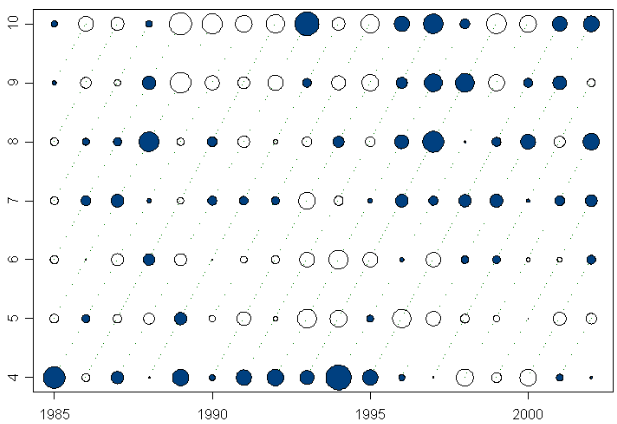
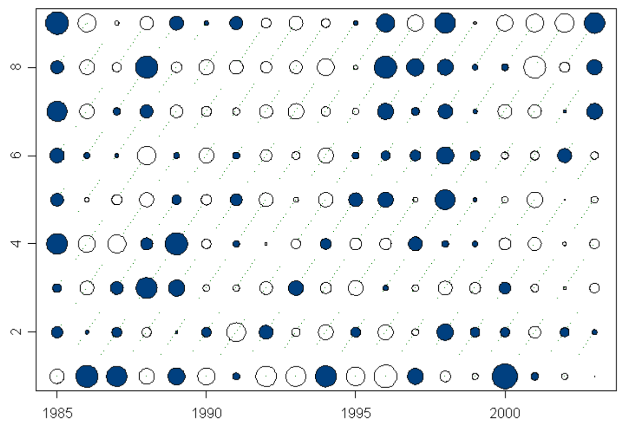
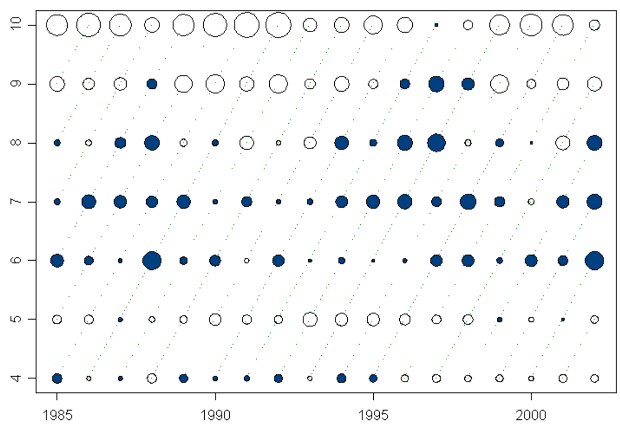


Figure 3.3.18. (Continued)

EX-CAM ln(Uay-observed/Uay-predicted)



Coleraine ln(CNay-observed/CNay-predicted)



Coleraine ln(Uay-observed/Uay-predicted)

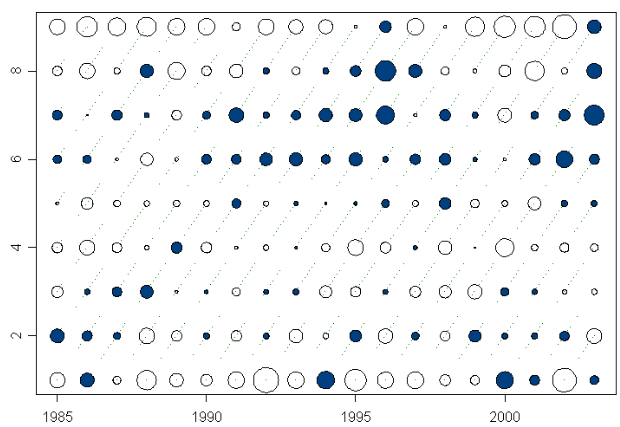


Figure 3.3.18. (Continued)

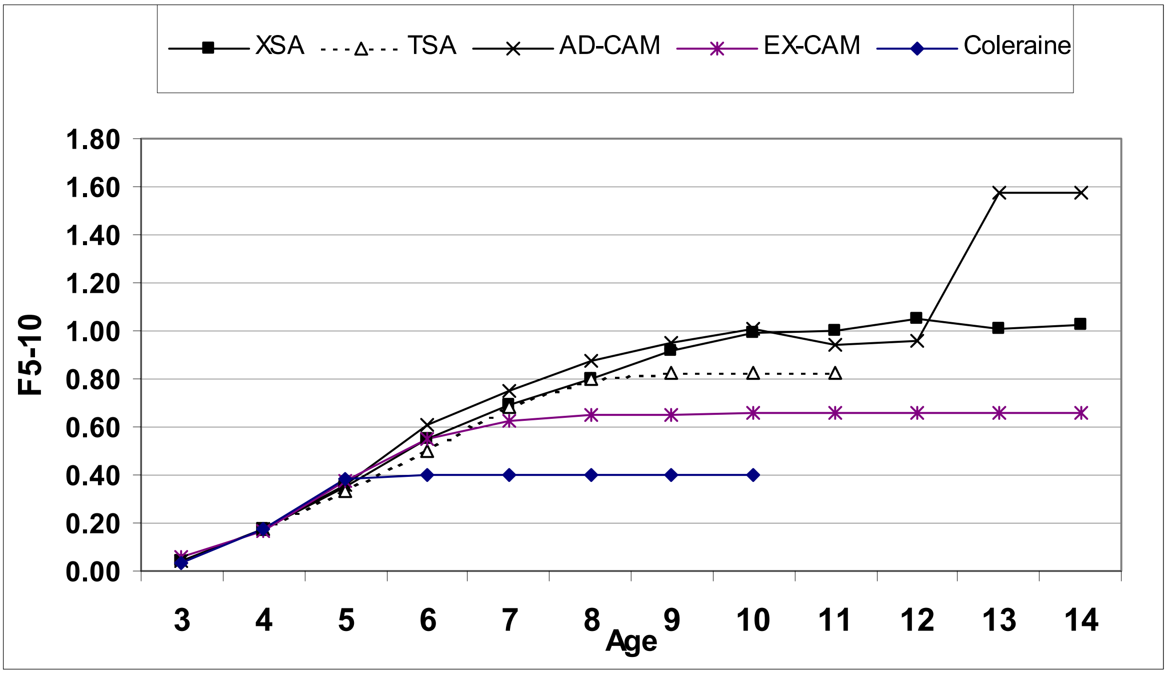


Figure 3.3.19 Comparison of estimated fishing mortalities in 2002 from different assessment runs.

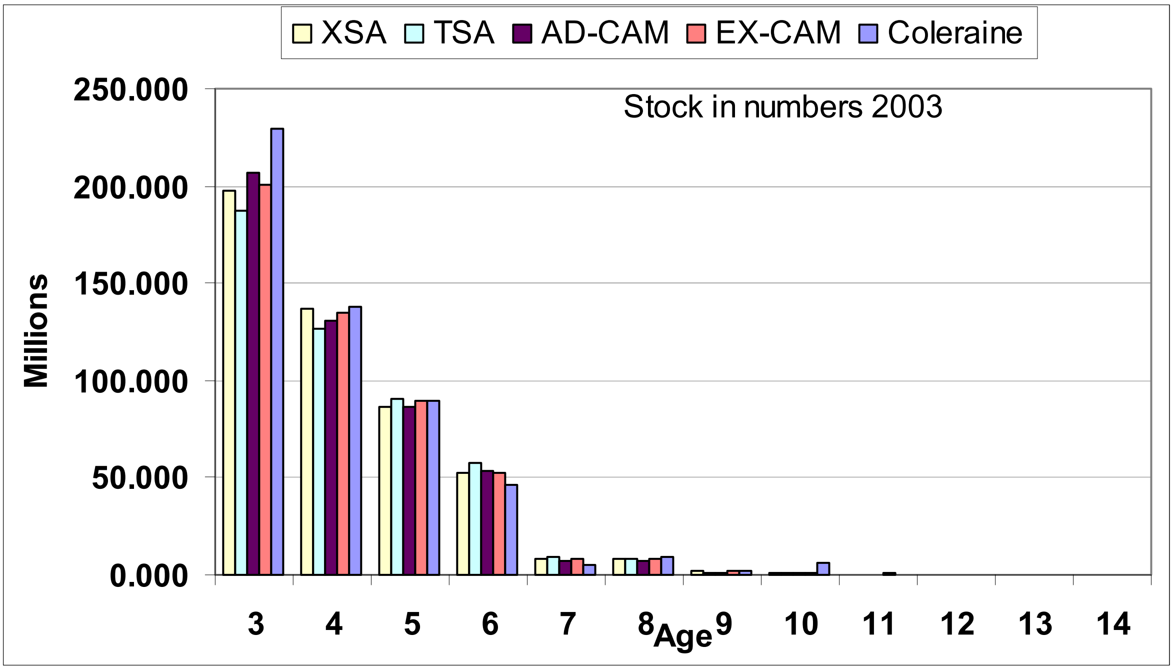


Figure 3.3.20 Comparison of estimated stock in numbers in 2003 from different assessment runs.

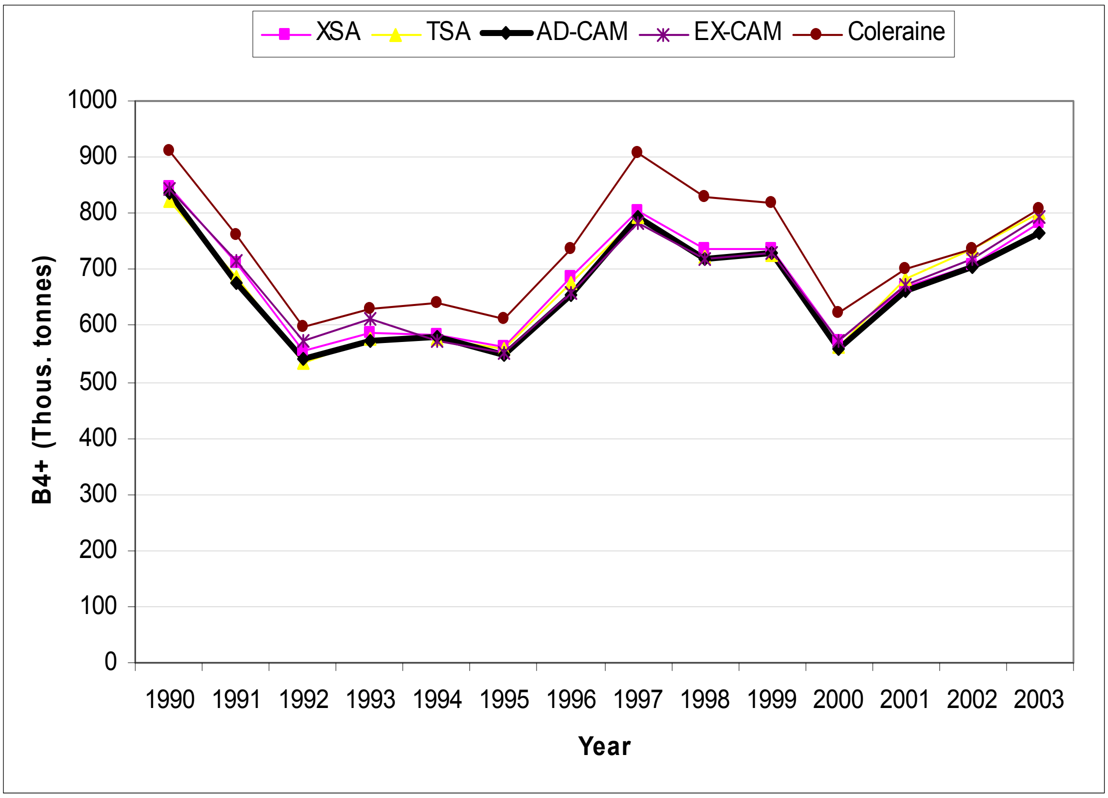


Figure 3.3.21 Estimated 4+ biomass from the various assessment models.

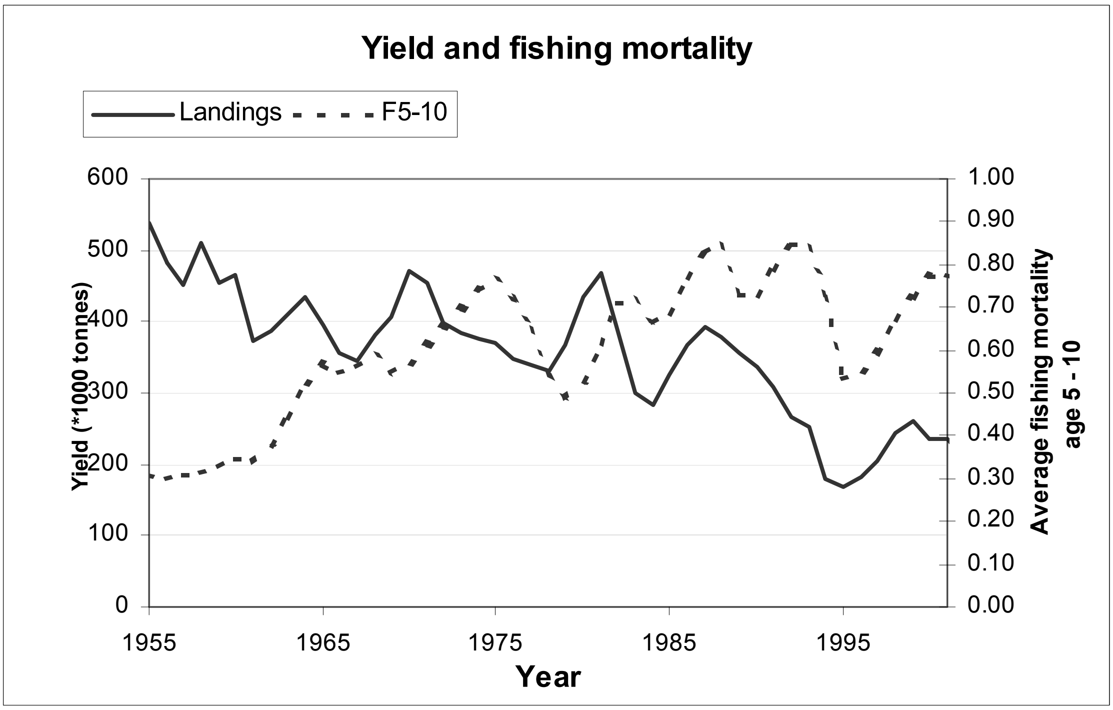


Figure 3.3.22A Yield and fishing mortality

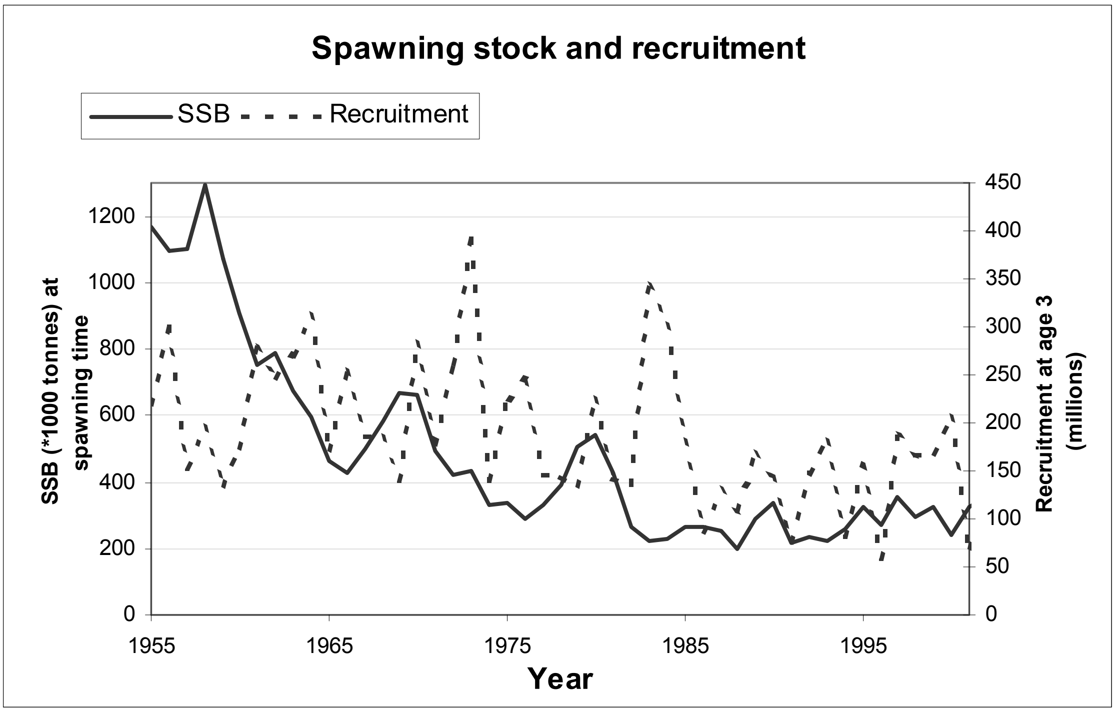


Figure 3.3.22B Spawning stock and recruitment.

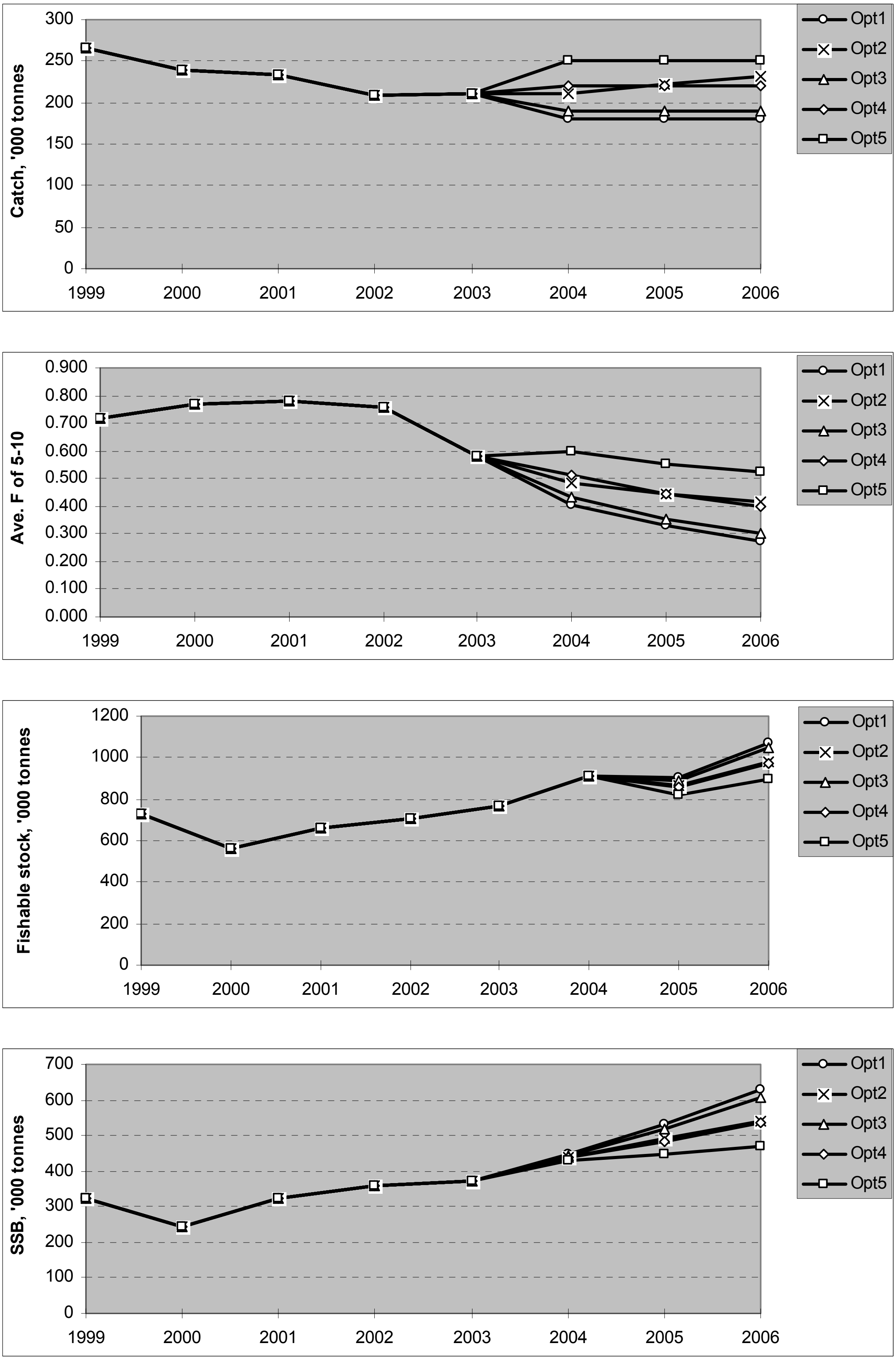
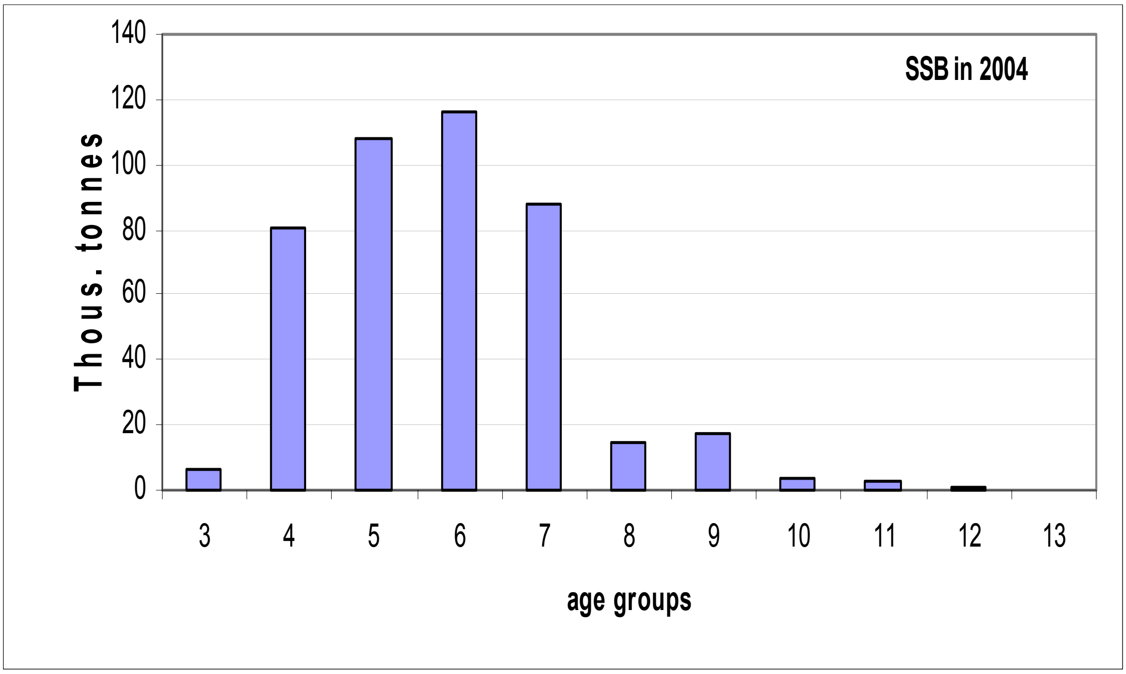


Figure 3.3.23A Results of different management options.



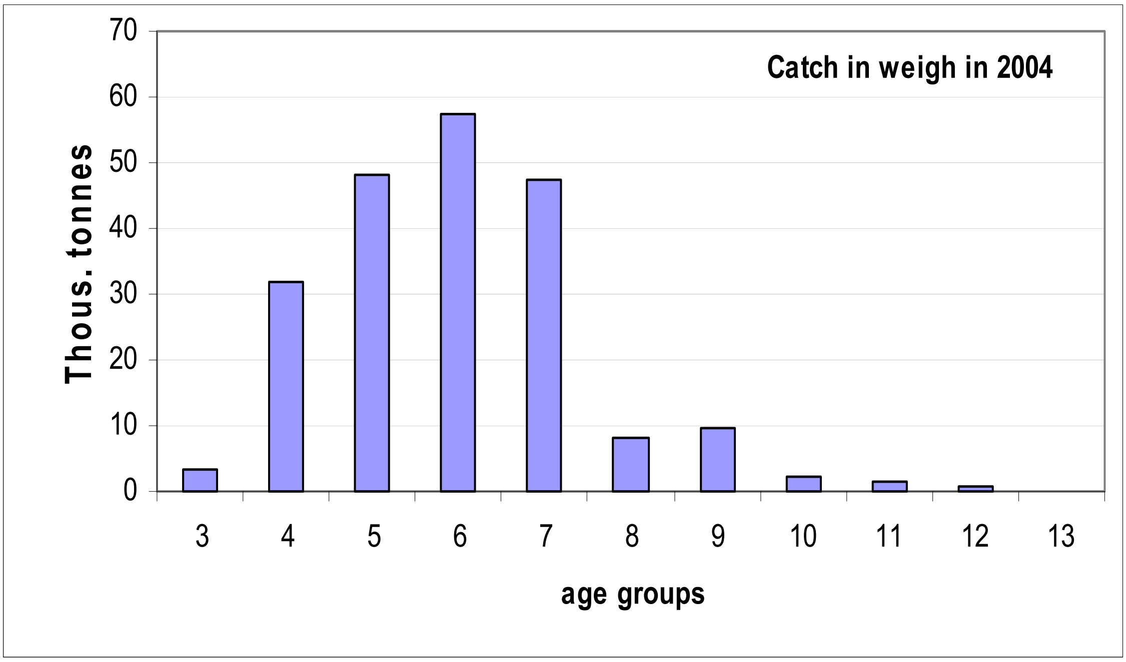


Figure 3.3.23B Estimed age composition of the SSB and the catches in 2004.

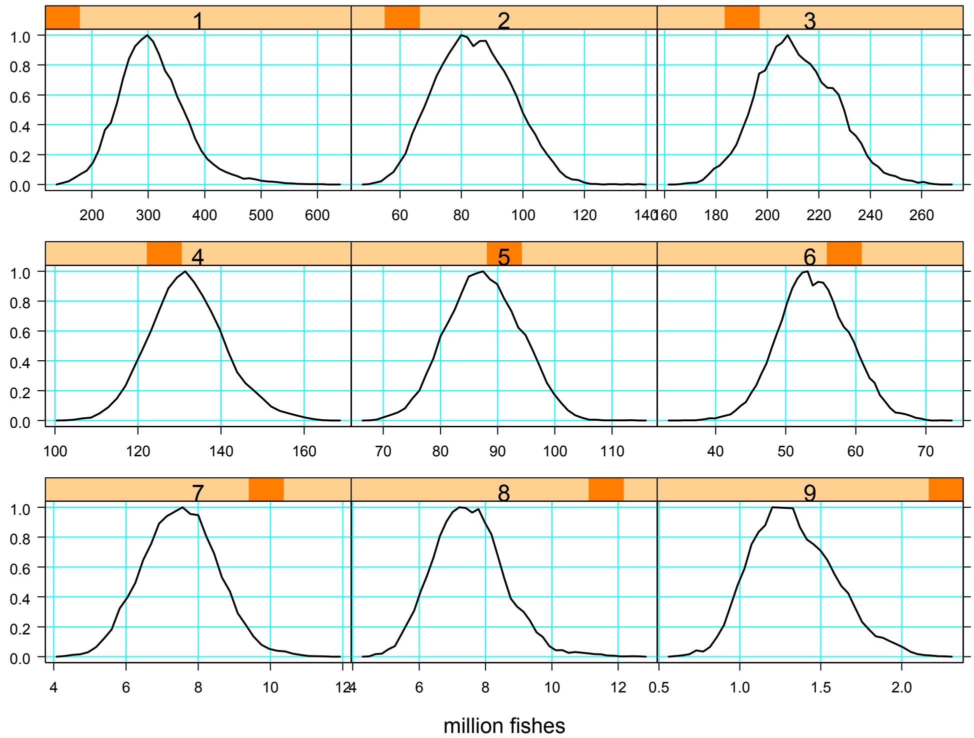


Figure 3.3.24 Cod in division Va. Posterior distribution of number in stock at the start of 2003.

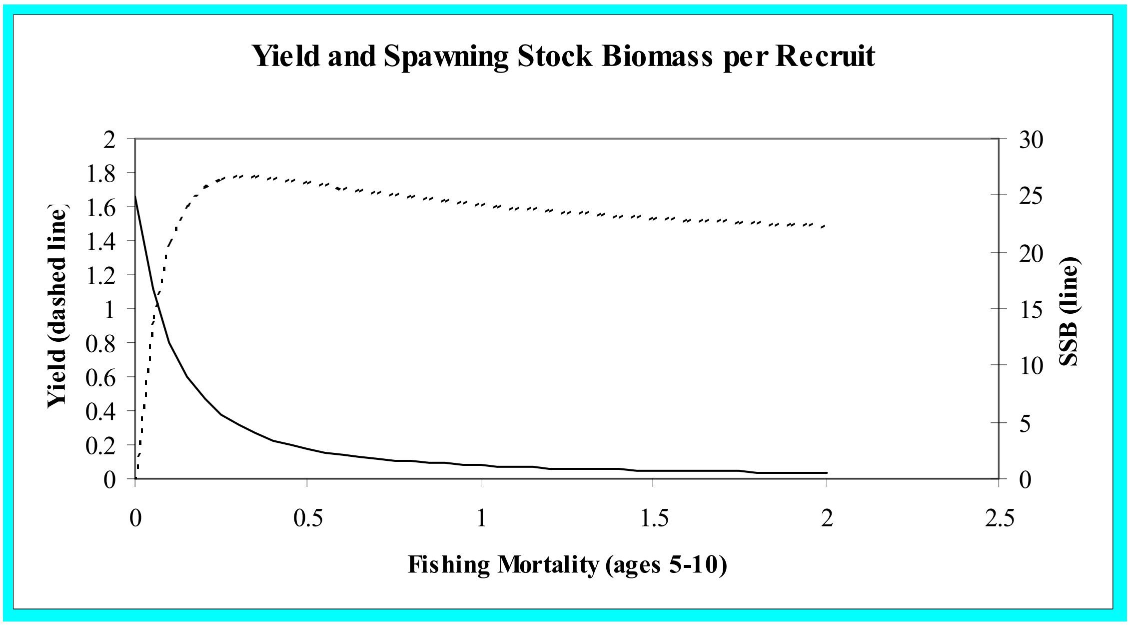


Figure 3.3.25 Yield-per-recruit

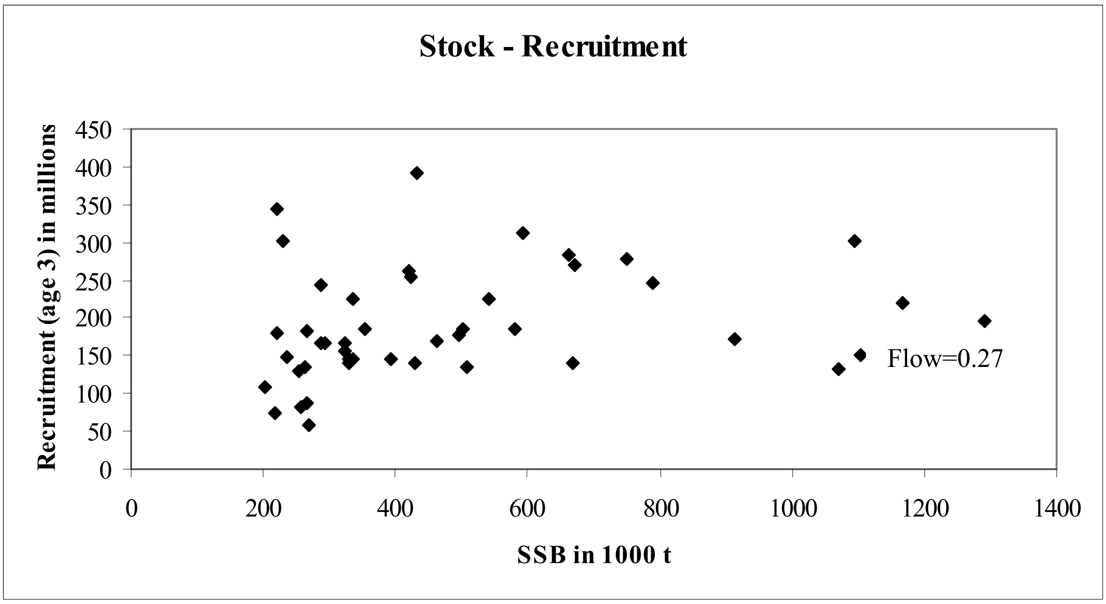


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

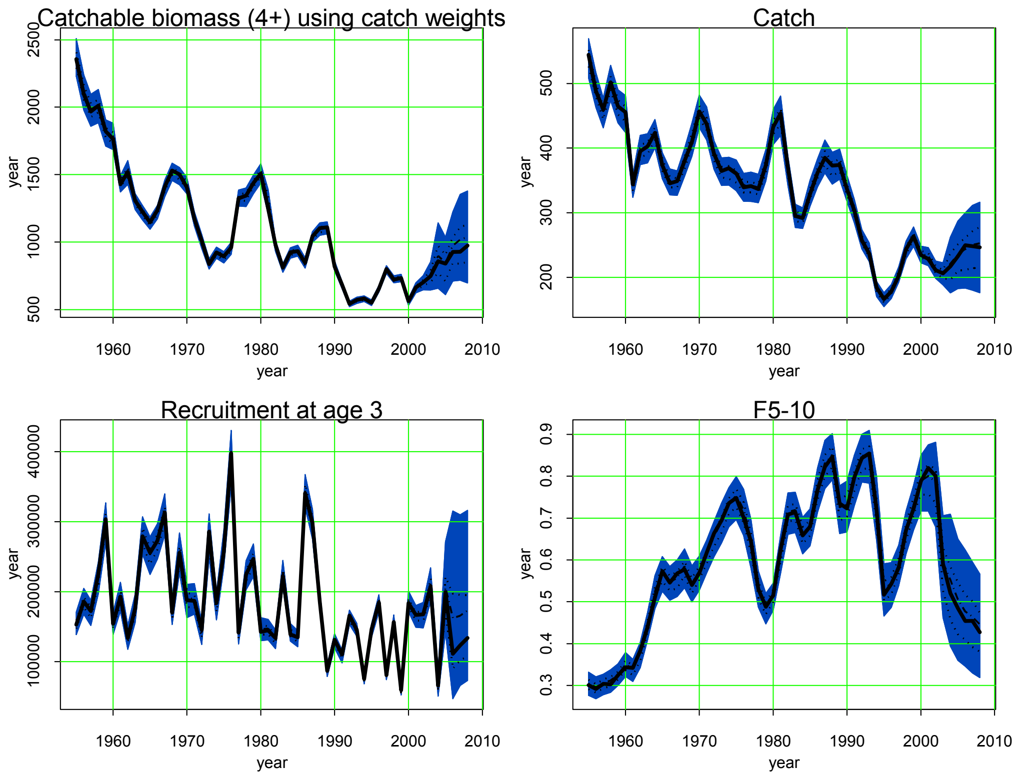


Figure 3.2.27 Cod in division Va. Stock estimate and medium-term prognosis according to the ammended catchrule (errors inmw@age and assessment error included).

3.4 Icelandic haddock

3.4.1 Introductory comment

Haddock (*Melanogrammus aeglefinus*) in Icelandic waters is only connected with other haddock stocks due to 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, in fairly shallow waters (50-200 m depth). Haddock is also found off the North coast and in warm periods a large part of the immature fish can be found in that area. In warm periods the area inhabited by the stock in considerably larger than in cold period. Recent years have been relatively warm and since 1998 recruitment has been exceptionally good with 4 of 5 most recent year classes being strong, something which has not been observed in 40 years. This is probably due to favourable environmental conditions for haddock north of Iceland.

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 early sixties haddock landings were around 100 000 tonnes for five 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 2002 are estimated as 50 400 tonnes, increasing from 39 600 tonnes in 2001. In last year the forecasted landings for the year 2002 were 45 000 tonnes.

In 2002, 61% of landings were by demersal trawl, 7% by Danish seine, 28% by long line and 4% by gillnets. The share of bottom trawl increased from 2001 but the share of longline decreased, but is still high as it has been since 1998.

3.4.3 Catch-at-age

Catch-at-age for 2002 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 gillnets, 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 2002 are given in the table below.

Gear	Season	Region	No of length samples	Number length measured	Number of age samples	Number. aged	Number weighed
Bottom trawl	Jan-May	South	138	10 897	20	1 041	839
Bottom trawl	Jan-May	North	46	687	3	149	149
Bottom trawl	June-Dec	South	99	7 041	19	927	786
Bottom trawl	June-Dec	North	150	10 644	13	599	498
Danish seine	Jan-May	South	211	614	5	249	249
Danish seine	Jan-May	North	29	348	2	100	50
Danish seine	June-Dec	South	48	801	6	294	294
Gillnet	Jan-May	South	106	2 416	8	392	391
Gillnet	Jan-May	North	14	394	0	0	0
Gillnet	June-Dec	South	138	1 136	7	350	350
Gillnet	June-Dec	North	63	3 581	0	0	0
Longline	Jan-May	South	487	28 876	36	1 818	1 240
Longline	Jan-May	North	620	13 999	17	840	495
Longline	June-Dec	South	312	13 650	31	1 639	1 286
Longline	June-Dec	North	641	26 244	39	1 959	987

For comparison the calculations of catch in numbers by age were done by 3 gears, 2 regions (North and South) and 2 time intervals giving identical results.

Catch-at-age in 2002 deviated more from last years predictions than is usual for this stock. As may be seen in the table below the deviations are not large except for the year class 1995 (age 7) where the proportion caught exceeded predictions by 75%.

Age	2	3	4	5	6	7	8	9
Forecast %	6.1	33.5	38.3	13.8	2.1	4.8	0.5	0.4
Catch %	2.7	28.2	43	13.6	3.0	8.3	0.7	0.5

Figure 3.4.3.1 shows the catch in number plotted on log scale. The curves indicate that total mortality was high or close to 1 for the oldest haddock but is possibly decreasing in the most recent years. 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 23% for age groups 3-8.

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 1982–2002 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 1993–2003. 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. Four of the most recent year classes are large so drop in mean weights would not be unexpected in coming years. No drop is seen in the catch weights from 2002 but the survey weights drop in 2003 for age groups 3 to 5 which are the most abundant age groups.

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 and maturity-at-age increased from 2002 to 2003. 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 in March, being caught in large number-at-age 1 and becoming fully recruited at age 2 or 3. Age disaggregated indices from the March survey are given in table 3.4.5.11 and indices from the fall survey in table 3.4.5.2.

The index of total biomass from the Icelandic groundfish survey in March 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 2003 the highest since the series started. The increase between 2002 and 2003 is much larger than predicted and the catch curves and Hjörleifsson Pálsson plot (Figures 3.4.5.4 and 3.4.5.3) suggest that the 2003 survey is an outlier for year classes 1998 and 1999. The median index shown in figure 3.4.5.1, calculated as the number of stations where haddock is found, times the median of the haddock catch at those stations shows similar increase as the traditional Cochran index showing that the increase is not only at the stations with most haddock.

Figure 3.4.5.2 shows the total index from the autumn survey. The autumn survey does not decrease as much in 2000 and shows less increase in the most recent years.

In figure 3.4.5.5 survey indices from the March survey 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 measure of stock size and the relationship between survey index and number in stock is close to linear for all agegroups. The most recent estimates are shown as intersection of dashed.

The survey indicates that in some of recent years unusually high proportion of the incoming year classes have been in the northern part of the survey area (figure 3.4.5.6) in areas where fishing effort has been relatively light. As described in WD#34 the relatively little overlap of the recruiting year classes and the fishery in recent years can explain why discards have reduced in recent years and recent year classes have progressively become stronger in every new survey.

CPUE from the commercial fleet is shown in figure 3.4.5.7. The figure is calculated from records where more than 50% of the catch is haddock and shows increase from 2001 to 2002, especially for danish seine and bottom trawl. Effort by the most important fleets, fishing haddock decreased between 2001 and 2002 (figure 3.4.5.8).

3.4.6 Stock Assessment

Last years assessment was based on XSA, using groundfish survey indices for age 2-9 for tuning but in addition a number of other models and tuning data were explored. This year the same procedure was used i.e to examine many different models and tuning data. To have more than 1 person running the assessments was also considered important and therefore 4 scientists made an assessment of Icelandic haddock this year.

3.4.6.1 Tuning and estimation of fishing mortality

The SPALY (Same Procedure As Last Year) XSA run used survey indices from age 1985-2003, ages 2-9 for tuning. Shrinkage was set to 2 years and 2 ages with SE = 0.5 Catchability of all age groups was independent of stock size. In addition to the SPALY a number of other models and settings were used. The results of some of the runs are shown in the table below.

	F4-7 2002	Biomass 3+	Std. Err in 3+ bio	N8-2003	N4-2003	N3-2003
Spaly XSA survey 2-9	0.61	209		1.8	93	150
XSA No shrinkage survey 2-9	0.55	235		2	104	190
XSA Bottom trawl CPUE+ Age 2 from March survey	0.511	182		3.3	68	153
XSA Survey from age 1	0.61	192		1.9	82	132
TSA	0.62	197	14	2.0	73	146
Excam	0.45	258		2	113	173
Adapt like program	0.6	201		1.7	88	134
ADCAM	0.63	192	21	1.6	84	127
ADCAM EXCAM weights	0.55	235		2	106	164
ADCAM Variable M	0.61	225	25	1.6	98	161
ADCAM Autumn survey	0.66	141	22	1.5	57	70
Autumn survey Variable M	0.64	178		1.5	69	117

The EXCAM is a is a statistical catch-at-age model implemented in Excel (Described in working paper 32)

The ADCAM is a statistical catch-at-age model written in AD-model builder (described in working paper 33 last year) was used. The settings used for 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. This term can be looked at as the P-shrinkage in the model. The estimate was of the CV was 0.8 to be compared with estimated CV of the survey shown in figure 3.4.6.2.

- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated separately for each age in the survey (change from last year when it was also a 2nd order polynomial (Figure 3.4.6.2). Correlation of residuals of different age groups in the survey was estimated as a 1st order AR model.

- Catchability in survey was independent of stock size for all ages.

- 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 (variability in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups. This could be looked at as an F shrinkage term in the model.

- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error can not be estimated.

A Cohort model where the survivors were estimated and the stock back calculated by Popes equation was also used. In this model (referred to as ADAPT like) in the table above the parts involving the survey, SSB-recruitment and prognosis were the same as in the catch-at-age model but the model does not include any kind of F-shrinkage term.

In addition to the standard model different alternatives were tested, checking the effect of different shrinkage terms, weighting of survey age groups and hidden mortality.

The results presented in the table vary considerably with biomass (3+) ranging from 190 to 260 thousand tonnes in 2003 if the March survey is used for tuning but 140-180 if the autumn survey is used for tuning. For comparison the 2003 March survey indicates on its own that the biomass (3+) in 2003 exceeds 300 kT. Figure 3.4.6.4 show the residuals from the ADCAM run using the March survey (giving 190 kT) and figure 3.4.6.5 observed vs. predicted survey biomass from the same run. Both figures show the large positive residuals in the 2003 survey and that the model does not follow the data. The same positive residuals in 2003 can be seen in the SPALY-XSA output (table 3.4.6.2) as well as in most of the other runs Included with the TSA results from Guðmundur Guðmundsson was a sentence that the "results from the 2003 survey were outliers, specially for the 1998 and 1999 year classes and should be treated with care". Figure 3.4.6.5 indicates that the models are not following the 2003 survey very closely.

As expected the results from the model are not driven by the name of the model but the assumptions behind the model. Therefore it should not be surprising that results of the ADCAM results using as far as possible the same assumptions as in the EXCAM model give similar results. What is most important here is the relative weight on different age groups in the survey . All the year classes 1998 – 2000 have progressively become stronger in the survey so reducing weight of younger ages in the survey is going to give higher estimate of these year classes. The relative weights used in the EXCAM were estimated last year assuming that they followed a 2nd degree polynomial in age while this year the relative weights are estimated for each age group in the ADCAM model. The same feature can be seen by comparing the stock estimates from XSA using ages 2-9 for tuning and XSA using ages 1-9 for tuning, including the indices at age 1 leads to lower stock estimates. Whether it is more appropriate to estimate the weights on different age groups independently or assume a 2nd order polynomial is not obvious. Estimating the weight on different age groups independently can in some cases lead to shift in the weights if a new year with contradicting data is added, possibly introducing things like can happen in multifleet XSA runs.

Inclusions of terms similar to P and F shrinkage is questionable for stock like the Icelandic haddock where reasonable survey indices are available from age 1. As the situation is now with good recruitment and possibly reducing F, the effect of shrinkage terms is to reduce estimated stock sizes.

The ADCAM runs where the hidden mortality of the youngest age groups is a function of the overlap between the fisheries (WD#34) and the spatial distribution from the surveys, explains part of the discrepancy seen in the surveys in recent years when large part of the recruiting year classes have been observed in areas with relatively little fishing effort. The model does though only explain the discrepancy from age 1 to 3 but the discrepancy between the years 2002 and 2003 for age year classes 1998 and 1999 (figure 3.4.5.3) are not explained by this model. The model findings that "hidden mortality" was much reduced in recent years is supported by discard data (table ???) so there are indications that hidden mortality caused by the fisheries is important for this stock.

Using the autumn survey for tuning gives lower stock estimates and higher fishing mortality than using the March survey. Figures 3.4.6.6 and 3.4.4.7 do on the other hand indicate show positive residuals in the 2002 survey indicating an underestimate of the stock. (Direct estimate by the 2002 autumn survey gives B3+ ≈165kT at the start of 2003)

The standard error of the Biomass (3+) by some of the models is given in the table above. It is smaller than the largest difference between different models and it is clearly an underestimate of the "real uncertainty" in the assessment. The presence of the "outliers" from 2003 is not reflected in the standard errors but a use of a distribution with heavier tails than the normal distribution would probably help in getting more realistic confidence intervals.

So, how to select the "final run"? All of the presented runs seem equally plausible and there is no way to point to any result being the most likely one. In last year the SPALY XSA run was used but RTC3 results were used for the youngest age groups. This year results from the AD-model builder program ADCAM were selected for prognosis. As seen in the table above the results given by that model is on the conservative side regarding results using the March survey but higher than estimates using CPUE from the trawler fleet or the autumn survey. The main reason for selecting this model for point estimates is "the convenience" of having the recruitment, assessment and prognosis in the same package allowing to carry the uncertainity in assessment and recruitment into the prognosis. Also the procedure of selecting some age groups out of one model and other age groups out of another model is questionable as the estimates of different age groups within a model are correlated. It is though again emphasised that **all the models presented here were used to select a point estimator**.

3.4.7 Recruitment estimates

The discussion about recruitment estimates has been treated in last section under stock assessment. Many of the models used for stock assessment also give recruitment estimates but in addition to those model 2 recruitment models, RTC3 and a time-series model from Guðmundur Guðmundsson were used. The table below shows results of the various models. The results of different models differ considerably, especially for year class 1999 but estimates of this year class in the survey vary considerably from 1 survey to another. This year class does on the other hand hardly belong to the group "recruitment" although it is included in the table.

Recruitment (million 2 year old.)									
year class	RTC3	EXCAM	XSA Age 1	TSA REC	ADCAM	ADCAM reduced P-shrink	Survey 2002	Survey 2003	Last years estimate
1998	83						116	166	
1999	113	188	138	120	141	152	134	234	112
2000	164	213	162	158	156	173	199	187	155
2001	48	55	53	55	40	43		78	29
2002	123	223	148	144	113	130		170	170

Input to the RTC3 model is shown in table 3.4.7.1 and output from the model in table 3.4.7.2

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 2003 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. The procedure is then repeated between the years 2003 and 2004.

For the stock weights survey weights for the year 2003 were used for that year but for the year 2004 mean weight-at-age was predicted from the mean weight of the same year class in the survey in 2003

The exploitation pattern was taken as the mean exploitation pattern from 1998–2002.

Maturity is taken to be the mean of the 2001-2003 values.

Stock in number in the year 2003 and recruitment in 2004 – 2005 was obtained from the ADCAM model and the prognosis were done by the ADCAM model and an Excel spreadsheet that has been used at the MRI in Reykjavík for a number of years.

A TAC constraint of 65 000 tonnes was applied to the prediction for the year 2003. The estimate was the sum of the TAC for the fishing year starting September 1st 2002 that was remaining in the beginning of 2003 and 27% of the estimated TAC for the fishing year 2003-2004 but 27% of the TAC for the fishing year 2002-2003 was taken in the year 2002. In the prognosis last year a TAC constraint of 45 000 was used for the year 2002 while the estimated landings now were 50 000 tonnes. The picture now is that F_{4-7} did not change from 2001 to 2002 so status quo F would have been a better assumption? But the problem is not so simple as last year F_{4-7} in 2001 was considered to be 0.75 compared to 0.63 this year so does $\mathbf{F_{sq}}$ help. The year before the prognosis of TAC in the assessment year was an underestimate. Figure 3.4.6.3 shows retros of in predictions 4 years F_{4-7} ahead using the observed catches and they do not indicate a big problem if "the landings are correctly estimated". For information $\mathbf{F_{sq}}$ will lead to catches of 80 000 t in 2003

The short-term prognosis were done using the ADCAM model and also the MFDP program at Ices. In the ADCAM prognosis the proposed $\mathbf{F_{pa}}$ of 0.47 was used for the years 2004 and 2005. Assessment error was assumed to be lognormal with 15% CV and no autocorrelation. Variations in stock and catch weights were assumed to be lognormal with 13% CV and an autocorrelation of 0.35 between years The same deviations in weights were applied to all age groups the same year. Errors in weight-at-age and assessment errors were not correlated which they probably should be. The ADCAM model was also used for deterministic prognosis to see if the results were identical to MFDP.

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 $F_{4\text{–}7} = 0.63$ for 2002, $\mathbf{F}_{max} = 0.45$ and $\mathbf{F}_{0.1} = 0.18$.

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 $F_{4\text{–}7}$ has exceeded $\mathbf{F}_{max}$ and for only 4 years since 1960 has $F_{4\text{–}7}$ been lower than $\mathbf{F}_{pa}$.

The SGPRP proposed $\mathbf{B}_{loss}$ as candidate for $\mathbf{B}_{pa}$ at its meeting in February 2003. The working group did not discuss this matter further.

TAC for Icelandic fish stock is given for fishery years which are from September 1st. each year to August 3rd the following year. 1/3rd of the fishing year 2003/2004 falls within the calendar year 2003 and 2/3rd within the calendar year 2004. The TAC for the next fishing year will therefore be 1/3rd of the landings in 2003 plus 2/3rd of the advice for 2004.

3.4.8.3 Projection of catch and biomass

At the beginning of 2003, the biomass of age 3+ is predicted to be 190 000 t with a spawning stock of 129 000 t. (Tables 3.4.8.4)

With a catch of 65 000 t in 2003, fishing mortality is estimated to be 0.48, the biomass of age 3+ is predicted to be 205 000 t in the beginning of the year 2003 and the spawning stock biomass 147 000 t

The predictions indicate that the annual catches could be around or above 80 000 tonnes for at least the next 2-4 years if the F=0.47 will be used as HCR. F=0.47 leads to 80 000 for the **calendar year 2004** (Fishing year??)

Figures 3.4.8.3 and 3.4.8.4 show the output of the short-term prognosis including errors in mean weight-at-age and assessment errors.

3.4.9 Management considerations

For more than a decade fishing mortality on haddock has been high with $F_{4\text{–}7}$ between 0.6 and 0.8 since 1986. The advice for 2003 was based on F_{med}.

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 are not included in these predictions.

As described in working paper 34 and in section 3.4..?? discard and other hidden mortality, most likely caused by the fisheries might be a potential problem for this stock. The model described predicts that hidden mortality by mobile fishing gear might be important for age 1 and 2 haddock and if it proceeds being low, catches exceeding 100 000 would not be unrealistic in coming years. An important management consideration is how to reduce this possibly hidden mortality. Distribution of recruits is something out of our control but the amount and distribution of the fishing effort can be controlled. The first option would be to reduce the total effort towards haddock and hence the fishing fleet would be able to catch their allowable quota outside the areas where the smallest haddock might be found. If the premises of the prognosis hold, fishing effort will already be reduced considerably in 2003. Another way could be area closure to protect the recruits. Part of the problem might come from fisheries which are not targeting haddock, both the *nephrops* fishery and demersal fisheries where cod, saithe or flatfishes are the main target species. In those fisheries the same applies, effort reduction should reduce this problem.

The model runs including variable M predict catches around 100 kT in 2004 assuming F=0.47. If the model predictions of hidden mortality caused by the fisheries are correct "optimal" F is most likely lower than 0.47 so the advice of 80 kT based on the base run and F=0.47 should not be changed.

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 $F_{4-7} = 0.63$ in 2002 which is the same as the estimate for 2001. Last year the estimate for F_{4-7} in 2001 was 0.75.

This years assessment gives a more optimistic view of the stock than last years assessment with the changes driven by the results of the 2003 March survey. The biomass of age 3+ at the start of 2003 is now predicted to be 190 000 t (SSB 129 000 t) but was predicted to be 168 000 t (SSB 98 000 t) in last years assessment. This is in spite of higher than predicted catches in 2002 (50 kT vs. 45 kT)

In this years assessment a number of different models were used and the range of results investigated. The point estimates selected for prognosis come from a model called ADCAM. Those estimates are close to estimates done by many other models (XSA, TSA) but the results from the most recent survey indicate that the stock in larger as do some of the assessment models that were explored.

Table 3.4.2.1 Haddock in Division Va Landings by nation

Table 1.1. Icelandic haddock. Landings by nation.

Country	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	1010	1144	673	377	268	359	391	257
Faroe Islands	2161	2029	1839	1982	1783	707	987	1289
Iceland	52152	47916	61033	67038	63889	47216	49553	47317
Norway	11	23	15	28	3	3	+	
€UK								
Total	55334	51112	63560	69425	65943	48285	50933	48863

HADDOCK Va

Country	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	238	352	483	595	485	361	458	248
Faroe Islands	1043	797	606	603	773	757	754	911
Iceland	39479	53085	61792	66004	53516	46098	46932	58408
Norway	1	+						1
UK								
Total	40761	54234	62881	67202	53774	47216	48144	59567

HADDOCK Va

Country	1995	1996	1997	1998	1999	2000	2001	2002
Belgium								
Faroe Islands	758	664	340	639	624	968	609	878
Iceland	60061	56223	43245	40795	44557	41199	39038	49591
Norway	+	4						
UK								
Total	60819	56891	43585	41434	45481	42167	39647	50469

Table 3.4.3.1 Haddock in division Va. Catch in number by year and age.

year/age	2	3	4	5	6	7	8	9
1981	0	0.5	4.9	17	6	2.8	1.81	0.17
1982	0	0.3	2.7	10.7	14.1	2.3	1.17	0.82
1983	0	0.7	1.5	4.6	10.3	8.8	0.87	0.24
1984	0.1	0.8	5	1.2	4.9	3.8	4.45	0.17
1985	0.4	1.8	5	6.1	0.8	1.6	2.48	2.21
1986	0.2	3.7	3.8	4.9	5.8	0.5	0.85	0.9
1987	2.2	7.6	7.5	2.7	2.2	1.2	0.15	0.21
1988	0.1	10.1	15.9	5.6	1.3	1	0.58	0.06
1989	0.1	2.6	23.1	9.7	3.1	0.5	0.51	0.14
1990	0.4	2.6	8	23.8	6.7	0.9	0.17	0.07
1991	2.5	1.3	3.9	6.7	13.6	3	0.4	0.05
1992	2.7	7.3	4.2	4.2	4	5.9	1.31	0.13
1993	0.2	11.6	12.6	3.2	1.8	1.5	2.26	0.38
1994	0.3	3	27	10.7	1.6	0.8	0.4	0.7
1995	2.4	6.3	5.7	23.4	5.6	0.6	0.26	0.21
1996	1.5	9	7.1	4.8	14	2.4	0.23	0.09
1997	1.4	3.7	11.1	4.9	2.5	5	0.69	0.05
1998	0.2	8.1	6	8.4	2.4	1.5	1.88	0.21
1999	1.1	1.5	16.9	4.8	5	0.9	0.59	0.51
2000	2.4	6.5	2.3	13.8	2.1	1.8	0.36	0.2
2001	2.2	11.3	7.1	1.5	6.2	0.7	0.48	0.1
2002	1	10.6	16.2	5.1	1.1	3.1	0.24	0.18

Table 3.4.4.1 Haddock in division Va Weight-at-age in the catches.

Year/ age	2	3	4	5	6	7	8	9
1982	330	819	1365	1649	2329	3012	3384	3965
1983	655	958	1436	1827	2355	2834	3569	4308
1984	980	1041	1476	2105	2460	3028	3014	3807
1985	599	1002	1783	2201	2727	3431	3783	4070
1986	867	1187	1755	2377	2710	3591	3760	4135
1987	446	1048	1629	2373	2984	3550	4483	4667
1988	468	808	1474	2230	2934	3545	3769	4574
1989	745	856	1170	2010	2879	4109	4035	4706
1990	357	716	1039	1542	2403	3458	4186	4969
1991	409	868	1111	1546	2035	2849	3464	4642
1992	320	856	1253	1597	2088	2529	3133	4022
1993	420	756	1372	1870	2360	2888	2975	3442
1994	568	720	1058	1742	2380	2785	3447	3156
1995	457	874	1145	1366	2079	2853	3251	3899
1996	387	841	1189	1528	1816	2641	3499	3526
1997	450	829	1192	1663	1934	2360	3059	3010
1998	689	777	1166	1692	2312	2379	2882	3417
1999	616	866	1096	1638	2205	2681	2863	3229
2000	518	951	1314	1461	2096	2679	3181	3438
2001	542	933	1451	1759	1836	2309	2966	3123
2002	573	918	1256	1741	2192	2224	2844	3392

Table 3.4.4.2 Haddock in division Va Weight-at-age in the stock

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	35	244	567	1187	1673	2372	2768	3199	3334	3718
1986	35	239	671	1134	1944	2400	3192	3295	3731	3675
1987	31	162	550	1216	1825	2605	3031	3644	3838	4099
1988	37	176	456	974	1831	2697	3104	3483	3321	4357
1989	26	182	440	886	1510	2382	3011	3502	3198	3681
1990	29	184	456	839	1234	1966	2677	3055	3269	
1991	31	176	500	1002	1406	1885	2498	3757	3656	5458
1992	28	157	503	894	1365	1892	2326	2938	3684	5120
1993	41	169	384	879	1487	1766	2548	2538	3227	
1994	33	179	401	696	1242	1683	1641	2693	1991	
1995	37	164	444	763	1071	1856	2667	5312	1313	
1996	41	174	447	806	1072	1474	2160	2407	4803	2186
1997	50	173	423	818	1224	1426	1917	2397	3694	3573
1998	41	202	404	742	1232	1738	2015	2333	3081	
1999	34	205	479	719	1198	1967	2381	2798	2929	5313
2000	29	179	552	888	1167	1777	2620	2924	3155	3668
2001	36	188	487	1052	1433	1502	2165	2758		3900
2002	63	172	474	891	1465	1955	2143	1998	3662	4981
2003	40	230	412	801	1268	1873	3139	2343	3301	4191

Table 3.4.4.3 Haddock in division Va Sexual maturity-at-age in the stock and the survey.

Year/ age	1	2	3	4	5	6	7	8	9
1985	0	1.6	14.4	53.6	57.8	76.5	76.6	96.1	93.4
1986	0	2.1	20.5	41.3	67.3	84.5	88.4	95.2	98.6
1987	0	2.2	13.7	42.6	53.5	77.8	77.6	100	96.9
1988	0	1.3	22.1	39.4	76.7	79.4	92.8	91.4	100
1989	0	4.1	20.2	53.2	72.7	81.8	99.8	100	100
1990	0	11.4	33.4	63.4	81.5	84.3	91.8	88.2	100
1991	0	6.3	22.4	59.3	73.9	81.7	89.4	49.5	100
1992	0	5	22.7	42	79.9	90.1	90.1	85.8	100
1993	0.5	12.4	36.4	48.8	67.4	90.6	97.7	91	86.8
1994	3.5	25.6	31.7	59.9	78.5	85.9	100	87.8	100
1995	0	12.9	48	39.2	75.3	75.4	61.3	98.5	100
1996	0	19.8	37.9	59.7	65.1	78.8	74	94.7	89.7
1997	1.5	9.3	43.4	58.4	68.2	75	78.4	87.9	100
1998	0	3.1	48.5	68	77.5	73.6	85.2	89.9	100
1999	0	5	39.5	67.9	72.3	75	89.6	76.3	92
2000	0	10.6	25.6	62.7	80.5	86.7	87.3	100	77.7
2001	0.2	10	37.8	52	75.2	89.7	92.1	91.7	
2002	0	4.7	28.4	63	80	93.5	92.8	100	100
2003	0.5	6.2	34.7	68.5	86.7	92.2	94.6	100	100

Table 3.4.5.1 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in March

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	28.15	32.72	18.34	23.65	26.54	3.73	10.98	4.88	5.64	0.51
1986	123.95	108.51	59.07	12.8	16.38	13.2	0.98	2.77	1.26	2.32
1987	22.22	296.28	163.63	57.08	13.17	11.17	8.09	0.58	1.28	0.84
1988	15.77	40.71	184.77	88.86	22.86	1.36	2.25	1.87	0.18	0.28
1989	10.58	23.35	41.53	146.71	44.9	12.74	0.85	0.84	0.41	0.28
1990	70.48	31.86	27.25	39.06	91.79	30.87	3.44	0.9	0.23	0
1991	89.73	145.95	41.55	17.83	20.27	32.55	7.67	0.3	0.1	0.11
1992	18.15	211.43	138.4	35.54	16.56	13.14	15.93	2.21	0.18	0.07
1993	29.99	37.65	245.06	87.3	11.15	3.86	1.66	4.46	0.88	0
1994	58.54	61.34	39.83	142.62	42.41	6.93	2.89	1.42	4.07	0
1995	35.89	82.53	48.09	19.74	68.41	7.66	1.31	0.11	0.34	0
1996	95.25	66.3	121	36.93	19.11	39.77	5.84	0.62	0.13	0.12
1997	8.57	119.13	50.88	52.99	10.86	7.28	10.58	1.37	0.06	0.03
1998	23.12	18.07	108.27	28.25	23.32	4.64	3.47	4.57	0.33	0
1999	80.73	86.21	25.8	98.18	12.9	9.6	1.42	1.7	1.03	0.03
2000	60.58	90.44	45.03	8.54	24.63	2.94	1.62	0.41	0.15	0.45
2001	81.33	148.06	115.04	22.16	4.09	10.56	0.93	0.57	0	0.1
2002	21.14	298.28	201	112.78	23.25	3.52	7	0.31	0.34	0.11
2003	111.96	97.85	282.83	244.83	112.28	18.05	2.58	4.43	0.48	0.85

Table 3.4.5.2 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in October.

Year/age		1	2	3	4	5	6	7	8	9	10
1995	93.95	162.64	184.92	51.4	24.27	42.47	5.74	0.56	0	0.07	0
1996	12.45	347.52	93.69	77.33	16.52	6.35	15.27	1.28	0	0	0
1997	49.84	29.63	200.21	59.25	39.34	7.12	5.79	6.35	0.29	0	0
1998	183.18	79.7	33.41	138.33	19.47	13.6	4.52	4.36	1.68	0	0
1999	204.63	343.81	57.78	26.55	96.25	10.51	8.97	0.45	1.49	0.31	0
2000	56.59	157.27	240.32	41.42	7.05	26.77	1.8	2.73	0.07	0.21	0.28
2001	50.18	331.24	253.85	155.73	31.35	3.53	12.14	0.64	0.95	0	0.2
2002	137.95	76.53	213.48	171.33	84.46	16.88	2.49	2.14	0.85	0.09	0

Table 3.4.6.1 Haddock in division Va. Input data for tuning.

Groundfish survey age 3 1985 – 2002

1985	32.7
1986	108.5
1987	296.3
1988	40.7
1989	23.4
1990	31.9
1991	146.0
1992	212.3
1993	37.2
1994	61.2
1995	83.2
1996	71.3
1997	120.4
1998	18.2
1999	86.5
2000	91.0
2001	148.1
2002	298.3

Groundfish survey age 2-8 shifted.

1984	18.3	23.7	26.5	3.7	11.0	4.9	5.6
1985	59.1	12.8	16.4	13.2	1.0	2.8	1.3
1986	163.6	57.1	13.2	11.2	8.1	0.6	1.3
1987	184.8	88.9	22.9	1.4	2.3	1.9	0.2
1988	41.5	146.7	44.9	12.7	0.9	0.8	0.4
1989	27.3	39.1	91.8	30.9	3.4	0.9	0.2
1990	41.6	17.8	20.3	32.6	7.7	0.3	0.1
1991	138.4	35.5	16.6	13.2	15.9	2.2	0.2
1992	245.1	87.3	11.2	3.9	1.7	4.5	0.9
1993	39.8	142.6	42.4	6.9	2.9	1.4	4.1
1994	48.1	19.7	68.4	7.7	1.3	0.1	0.3
1995	121.0	36.9	19.1	39.8	5.8	0.6	0.1
1996	50.9	53.0	10.9	7.3	10.6	1.4	0.1
1997	108.3	28.3	23.3	4.6	3.5	4.6	0.3
1998	25.8	98.2	12.9	9.6	1.4	1.7	1.0
1999	45.0	8.5	24.6	2.9	1.6	0.4	0.2
2000	115.0	22.2	4.1	10.6	0.9	0.6	0.0
2001	201.0	112.8	23.3	3.5	7.0	0.3	0.3
2002	282.8	244.8	112.3	18.1	2.6	4.4	0.5

Table 3.4.6.2 Haddock Va. Output from XSA.

```
Lowestoft VPA Version 3.1

   24/04/2003  12:08

 Extended Survivors Analysis

 Icelandic Haddock. Run 3.

 CPUE data from file glm.dat

 Catch data for  21 years. 1982 to 2002. Ages  2 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 2ara CPU            ,   1985, 2002,   2,     2,  0.170,  0.250
 SUR CPU             ,   1984, 2002,   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   19 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,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002

      2, 0.006, 0.008, 0.038, 0.047, 0.015, 0.016, 0.025, 0.022, 0.016, 0.006
      3, 0.098, 0.116, 0.234, 0.196, 0.161, 0.119, 0.148, 0.205, 0.141, 0.098
      4, 0.369, 0.348, 0.331, 0.446, 0.397, 0.426, 0.389, 0.375, 0.363, 0.308
      5, 0.657, 0.619, 0.578, 0.513, 0.642, 0.596, 0.744, 0.644, 0.441, 0.485
      6, 0.768, 0.810, 0.793, 0.848, 0.576, 0.787, 0.895, 0.848, 0.686, 0.712
      7, 0.928, 0.910, 0.916, 1.036, 0.872, 0.828, 0.843, 1.007, 0.809, 0.932
      8, 0.852, 0.697, 0.997, 1.152, 0.989, 1.029, 0.958, 0.979, 0.853, 0.764
      9, 0.874, 0.709, 1.022, 1.173, 0.924, 0.959, 0.913, 1.072, 0.868, 0.903

1
 XSA population numbers (Thousands)

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

 1993 , 3.75E+04, 1.37E+05, 4.53E+04, 7.27E+03, 3.68E+03, 2.75E+03, 4.36E+03, 7.19E+02
 1994 , 4.13E+04, 3.05E+04, 1.02E+05, 2.57E+04, 3.09E+03, 1.40E+03, 8.89E+02, 1.52E+03
 1995 , 7.07E+04, 3.35E+04, 2.22E+04, 5.88E+04, 1.13E+04, 1.12E+03, 4.61E+02, 3.63E+02
 1996 , 3.50E+04, 5.57E+04, 2.17E+04, 1.31E+04, 2.70E+04, 4.19E+03, 3.68E+02, 1.39E+02
 1997 , 9.89E+04, 2.74E+04, 3.75E+04, 1.14E+04, 6.41E+03, 9.46E+03, 1.22E+03, 9.53E+01
 1998 , 1.45E+04, 7.97E+04, 1.91E+04, 2.06E+04, 4.91E+03, 2.95E+03, 3.24E+03, 3.71E+02
 1999 , 4.86E+04, 1.17E+04, 5.80E+04, 1.02E+04, 9.31E+03, 1.83E+03, 1.05E+03, 9.49E+02
 2000 , 1.18E+05, 3.88E+04, 8.25E+03, 3.22E+04, 3.97E+03, 3.12E+03, 6.44E+02, 3.31E+02
 2001 , 1.55E+05, 9.49E+04, 2.59E+04, 4.64E+03, 1.38E+04, 1.39E+03, 9.32E+02, 1.98E+02
 2002 , 1.84E+05, 1.25E+05, 6.75E+04, 1.47E+04, 2.44E+03, 5.70E+03, 5.07E+02, 3.25E+02
```

Table 3.4.6.2 (Cont'd)

Estimated population abundance at 1st Jan 2003

, 0.00E+00, 1.50E+05, 9.28E+04, 4.06E+04, 7.43E+03, 9.82E+02, 1.84E+03, 1.93E+02

Taper weighted geometric mean of the VPA populations:

, 5.62E+04, 3.94E+04, 2.68E+04, 1.54E+04, 7.86E+03, 3.22E+03, 1.15E+03, 3.93E+02

Standard error of the weighted Log(VPA populations) :

, 0.7595, 0.7961, 0.7463, 0.7588, 0.8737, 0.8754, 0.9454, 1.0346

Log catchability residuals.

Fleet : 2ara CPU

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	99.99	-0.46	-0.02	0.35	-0.37	-0.35	0.14	0.39	0.01
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	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-0.22	0.18	-0.05	0.50	-0.02	0.01	0.37	-0.48	-0.26	0.27
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	-4.3463
S.E(Log q)	0.3073

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	0.97	0.256	4.52	0.87	18	0.31	-4.35

Fleet : SUR CPU

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992
2	-0.35	0.09	0.34	-0.16	-0.40	-0.24	0.38	0.31	0.12
3	-0.20	-0.30	0.46	0.13	-0.03	-0.11	-0.25	0.58	0.26
4	0.04	0.01	0.42	0.21	0.10	0.04	-0.16	0.26	0.09
5	0.34	0.08	0.56	-0.87	0.54	0.47	-0.16	0.27	-0.20
6	0.89	-0.13	0.96	-0.10	-0.31	0.38	0.00	0.06	-0.71
7	-0.06	0.51	0.59	0.61	-0.03	0.96	-1.01	-0.17	-0.08
8	0.09	-0.31	0.92	0.52	0.43	0.23	-0.11	-0.30	0.11

Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
2	-0.20	-0.11	0.31	0.15	-0.16	0.33	-0.32	-0.27	0.01	0.17
3	-0.05	-0.51	0.14	-0.05	0.00	0.14	-0.36	-0.55	0.12	0.58
4	0.16	-0.19	0.04	-0.39	-0.22	-0.11	-0.61	-0.47	0.11	0.67
5	0.54	-0.65	0.13	-0.13	-0.33	-0.23	-0.57	-0.53	0.10	0.63
6	0.50	-0.09	0.09	-0.12	-0.06	-0.50	-0.90	-0.67	-0.03	0.74
7	0.34	-1.64	0.37	0.02	0.24	0.36	-0.59	-0.55	-0.64	0.76
8	0.88	-0.30	-0.45	-0.07	-0.33	-0.06	-0.62	99.99	-0.19	0.84

Table 3.4.6.2 (Cont'd)

```
 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,   -4.1397,   -4.2151,   -4.2642,   -4.3486,   -4.3769,   -4.4967,   -4.4967,
 S.E(Log q),    0.2636,    0.3265,    0.3049,    0.4579,    0.5186,    0.6557,    0.4768,

 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,    0.100,      4.20,    0.90,     19,    0.27,   -4.14,
  3,    0.87,    1.512,      5.06,    0.89,     19,    0.27,   -4.22,
  4,    0.99,    0.100,      4.33,    0.84,     19,    0.31,   -4.26,
  5,    1.05,   -0.342,      4.08,    0.72,     19,    0.49,   -4.35,
  6,    0.99,    0.089,      4.44,    0.70,     19,    0.53,   -4.38,
  7,    0.94,    0.329,      4.71,    0.62,     19,    0.63,   -4.50,
  8,    0.97,    0.269,      4.50,    0.83,     18,    0.47,   -4.42,
1


 Terminal year survivor and F summaries :

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

 Year class = 2000

 Fleet,                Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 2ara CPU           ,    195660.,  0.316,      0.000,   0.00,   1, 0.399,    0.005
 SUR CPU            ,    177365.,  0.300,      0.000,   0.00,   1, 0.442,    0.005

   F shrinkage mean  ,     47951.,   0.50,,,,                      0.160,    0.019

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    149626.,      0.20,     0.38,    3,   1.927,  0.006


 Age  3   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           ,     71527.,  0.316,      0.000,   0.00,   1, 0.289,    0.126
 SUR CPU            ,    120844.,  0.223,      0.284,   1.27,   2, 0.581,    0.076

   F shrinkage mean  ,     50595.,   0.50,,,,                      0.129,    0.174

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     92781.,      0.17,     0.23,    4,   1.358,  0.098


1
 Age  4   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           ,     25206.,  0.316,      0.000,   0.00,   1, 0.206,    0.458
 SUR CPU            ,     49151.,  0.182,      0.286,   1.57,   3, 0.662,    0.261

   F shrinkage mean  ,     32566.,   0.50,,,,                      0.132,    0.371

 Weighted prediction :
```

Table 3.4.6.2 (Cont'd)

```
 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     40576.,      0.15,     0.22,    5,   1.419,  0.308


 Age  5   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             ,     10705.,  0.316,      0.000,   0.00,   1, 0.159,    0.360
 SUR CPU              ,      7096.,  0.174,      0.241,   1.39,   4, 0.655,    0.503

   F shrinkage mean  ,      6372.,   0.50,,,,                       0.186,    0.547

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7425.,      0.16,     0.17,    6,   1.085,  0.485


1
 Age  6   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             ,       996.,  0.316,      0.000,   0.00,   1, 0.124,    0.705
 SUR CPU              ,      1032.,  0.173,      0.226,   1.31,   5, 0.609,    0.687

   F shrinkage mean  ,       870.,   0.50,,,,                       0.268,    0.775

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       982.,      0.17,     0.15,    7,   0.849,  0.712


 Age  7   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             ,      1806.,  0.316,      0.000,   0.00,   1, 0.072,    0.942
 SUR CPU              ,      1800.,  0.203,      0.215,   1.06,   6, 0.465,    0.944

   F shrinkage mean  ,      1880.,   0.50,,,,                       0.464,    0.918

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1837.,      0.25,     0.12,    8,   0.496,  0.932


1
 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 2ara CPU             ,       319.,  0.316,      0.000,   0.00,   1, 0.028,    0.527
 SUR CPU              ,       256.,  0.282,      0.260,   0.92,   7, 0.463,    0.624

   F shrinkage mean  ,       145.,   0.50,,,,                       0.509,    0.926
```

Table 3.4.6.2 (Cont'd)

```
Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      193.,      0.29,     0.21,    9,   0.740,  0.764


Age  9   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            ,       103.,  0.316,      0.000,   0.00,   1, 0.014,    0.931
SUR CPU             ,        84.,  0.294,      0.104,   0.36,   7, 0.237,    1.058

  F shrinkage mean  ,       117.,   0.50,,,,                       0.749,    0.857

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      108.,      0.38,     0.11,    9,   0.279,  0.903
```

Table 3.4.6.2 (Cont'd)

```
Run title : Icelandic Haddock. Run 3.

 At 24/04/2003  12:08

                Terminal Fs derived using XSA (With F shrinkage)

       Table  8    Fishing mortality (F) at age
```

YEAR	1982	1983	1984	1985
AGE				
2	0.0013	0.0000	0.0033	0.0114
3	0.0404	0.0228	0.0344	0.1284
4	0.1339	0.3063	0.2217	0.3310
5	0.3459	0.3584	0.4211	0.4613
6	0.4489	0.6653	0.8044	0.6073
7	0.8749	0.5654	0.5493	0.6617
8	1.1687	1.0573	0.6323	0.8836
9	1.0336	0.8197	0.5959	0.7676
FBAR4-7	0.4509	0.4738	0.4991	0.5154

```
       Table  8    Fishing mortality (F) at age
```

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE									
2	0.0024	0.0148	0.0031	0.0032	0.0223	0.0345	0.0178	0.0064	0.0075
3	0.1282	0.1218	0.0857	0.0769	0.1418	0.0824	0.1368	0.0984	0.1163
4	0.4473	0.4163	0.4054	0.2884	0.3563	0.3310	0.4190	0.3686	0.3478
5	0.6437	0.6655	0.6362	0.4652	0.5467	0.5777	0.7040	0.6568	0.6193
6	1.1422	0.6995	0.7759	0.9288	0.6856	0.7124	0.8387	0.7681	0.8099
7	0.9190	0.7767	0.8095	0.9543	0.7218	0.7645	0.8026	0.9283	0.9101
8	0.9787	0.8294	1.1814	1.4489	0.9214	0.9169	0.9761	0.8518	0.6972
9	0.9919	0.6837	0.9316	1.1667	0.8150	0.8565	0.9372	0.8739	0.7087
FBAR4-7	0.7880	0.6395	0.6568	0.6592	0.5776	0.5964	0.6911	0.6804	0.6718

```
Run title : Icelandic Haddock. Run 3.

    At 24/04/2003  12:08

                Terminal Fs derived using XSA (With F shrinkage)

Table8  Fishingmortality(F) at age
```

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	FBAR* *-**
AGE									
2	0.0375	0.0474	0.0155	0.0159	0.0248	0.0222	0.0159	0.0061	0.0147
3	0.2338	0.1961	0.1614	0.1192	0.1481	0.2047	0.1411	0.0984	0.1481
4	0.3308	0.4460	0.3972	0.4259	0.3890	0.3753	0.3628	0.3083	0.3488
5	0.5783	0.5134	0.6422	0.5963	0.7444	0.6441	0.4411	0.4854	0.5235
6	0.7931	0.8480	0.5764	0.7875	0.8948	0.8482	0.6863	0.7119	0.7488
7	0.9156	1.0358	0.8716	0.8282	0.8428	1.0068	0.8094	0.9320	0.9160
8	0.9965	1.1521	0.9889	1.0285	0.9581	0.9792	0.8531	0.7645	0.8656
9	1.0219	1.1726	0.9239	0.9593	0.9133	1.0715	0.8677	0.9034	0.9475
0FBAR 4-7	0.6545	0.7108	0.6219	0.6595	0.7178	0.7186	0.5749	0.6094	

Table 3.4.6.2 (Cont'd)

```
Run title : Icelandic Haddock. Run 3.

At 24/04/2003  12:08

                 Terminal Fs derived using XSA (With F shrinkage)
```

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

YEAR	1982	1983	1984	1985	1986	1987
AGE						
2	42211	30160	19932	41756	89202	167933
3	7980	34515	24692	16265	33800	72855
4	23796	6275	27620	19533	11712	24343
5	40447	17041	3782	18117	11485	6131
6	43132	23431	9749	2032	9351	4940
7	4336	22541	9863	3571	906	2443
8	1871	1480	10486	4662	1509	296
9	1400	476	421	4562	1578	464
TOTAL	165174	135920	106545	110498	159543	279404

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

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996
AGE									
2	47637	26666	22362	80244	170353	37502	41275	70693	35049
3	135467	38882	21762	17905	63471	137007	30506	33540	55746
4	52809	101801	29478	15462	13499	45322	101660	22235	21735
5	13144	28825	62467	16902	9092	7269	25667	58779	13077
6	2580	5696	14820	29606	7765	3682	3086	11313	26990
7	2010	972	1842	6113	11888	2748	1398	1124	4191
8	920	732	307	733	2330	4362	889	461	368
9	106	231	141	100	240	719	1524	363	139
TOTA	254673	203806	153179	167064	278640	238610	206006	198507	157295

```
Run title : Icelandic Haddock. Run 3.

At 24/04/2003  12:08

                 Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1997	1998	1999	2000	2001	2002	2003	GMST82-00	**AMST82-00
AGE									
2	98918	14495	48557	118479	155171	183881	0	50058	63338
3	27368	79743	11680	38780	94875	125042	149626	35429	46419
4	37513	19068	57951	8247	25873	67455	92781	25617	33687
5	11393	20645	10197	32157	4639	14737	40576	16488	21401
6	6407	4907	9311	3966	13826	2443	7425	8109	11724
7	9463	2948	1828	3116	1390	5699	982	3263	4911
8	1218	3241	1054	644	932	507	1837	1210	1977
9	95	371	949	331	198	325	193	412	748
TOTAL	192376	145419	141527	205720	296905	400088	293421		

Table 3.4.6.2 (Cont'd)

```
Run title : Icelandic Haddock. Run 3.                                              ,

    At 24/04/2003  12:08

        Table 16    Summary     (without SOP correction)
```

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR4-7
	Age2					
1982	42212	198062	111696	69325	0.6207	0.4509
1983	30160	161861	101889	65943	0.6472	0.4738
1984	19932	125029	79753	48285	0.6054	0.4991
1985	41756	115975	59913	50933	0.8501	0.5154
1986	89202	114856	56359	48863	0.8670	0.7880
1987	167933	131172	41613	40801	0.9805	0.6395
1988	47637	161578	65960	54236	0.8223	0.6568
1989	26666	175049	99582	62979	0.6324	0.6592
1990	22362	151032	110530	67200	0.6080	0.5776
1991	80244	135817	91392	54732	0.5989	0.5964
1992	170353	133821	63383	47212	0.7449	0.6911
1993	37502	137297	69456	48844	0.7032	0.6804
1994	41275	135715	83215	59345	0.7132	0.6718
1995	70693	131819	86967	61131	0.7029	0.6545
1996	35049	113629	68509	56958	0.8314	0.7108
1997	98918	103023	61651	44053	0.7146	0.6219
1998	14495	97529	63533	41434	0.6522	0.6595
1999	48557	97845	62532	45481	0.7273	0.7178
2000	118479	105562	58152	42167	0.7251	0.7186
2001	155171	137018	59530	39647	0.6660	0.5749
2002	183881	191856	90775	50496	0.5563	0.6094
Arith.						
Mean	73451	135978	75542	52384	0.7128	0.6270
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 20 2
 'Yearcl' 'VPAage2'  'Surv3'   'Surv2'     'Surv1'
1983         42         591       327        -11
1984         89        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        1387      1460        705
1990        169        2451      2114        897
1991         37         398       377        181
1992         41         481       613        300
1993         70        1210       825        585
1994         35         509       663        359
1995         98        1083      1191        953
1996         14         258       182         86
1997         48         450       862        231
1998        117        1150       901        807
1999        -11        2010      1481        606
2000        -11        2828      2983        813
2001        -11         -11       979        211
2002        -11         -11       -11        1120
```

Table 3.4.7.2 Haddock in division Va. Output from the RTC3 model.
Analysis by RCT3 ver3.1 of data from file :

Recrun03.dat

Iceland Haddock: VPA and groundfish survey data

Data for 3 surveys over 20 years : 1983 - 2002

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.

Year class = 1995

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
Surv3	.94	-2.20	.25	.887	12	6.99	4.37	.292	.406
Surv2	.89	-1.79	.27	.869	12	7.08	4.50	.320	.338
Surv1	.98	-1.68	.35	.807	11	6.86	5.02	.444	.175
					VPA Mean =		4.02	.657	.080

Year class = 1996

Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I		I-----------Prediction			---------I
Surv3	.97	-2.35	.25	.881	13	5.56	3.02	.318	.386
Surv2	.91	-1.91	.26	.872	13	5.21	2.81	.344	.330
Surv1	.93	-1.45	.33	.812	12	4.47	2.70	.451	.192
					VPA Mean =		4.07	.647	.093

Year class = 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
Surv3	1.04	-2.84	.27	.893	14	6.11	3.50	.312	.328
Surv2	.93	-2.09	.25	.902	14	6.76	4.21	.294	.371
Surv1	.92	-1.43	.31	.864	13	5.45	3.61	.364	.242
					VPA Mean =		3.95	.734	.059

Year class = 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
Surv3	1.04	-2.82	.28	.873	15	7.05	4.50	.330	.309
Surv2	.94	-2.19	.26	.890	15	6.80	4.22	.299	.374
Surv1	.92	-1.37	.30	.858	14	6.69	4.77	.367	.249
					VPA Mean =		3.93	.703	.068

Table 3.4.7.2 (Cont'd)

Year class = 1999

Survey/ Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression			----------I	I-----------Prediction			---------I	
Surv3	1.08	-3.09	.29	.870	16	7.61	5.15	.362	.298
Surv2	1.03	-2.73	.32	.848	16	7.30	4.80	.378	.273
Surv1	.92	-1.37	.29	.875	15	6.41	4.50	.333	.352
					VPA Mean =		3.99	.715	.076

Year class = 2000

Survey/ Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv3	1.09	-3.16	.29	.870	16	7.95	5.54	.395	.288
Surv2	1.05	-2.86	.32	.846	16	8.00	5.54	.435	.238
Surv1	.91	-1.36	.28	.879	15	6.70	4.75	.341	.387
					VPA Mean =		3.99	.718	.087

Year class = 2001

Survey/ Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv3									
Surv2	1.07	-3.00	.33	.844	16	6.89	4.38	.390	.375
Surv1	.91	-1.35	.28	.884	15	5.36	3.52	.333	.516
					VPA Mean =		3.98	.722	.109

Year class = 2002

Survey/ Series	Slope	Intercept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv3									
Surv2									
Surv1	.91	-1.35	.28	.888	15	7.02	5.02	.362	.802
					VPA Mean =		3.98	.727	.198

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	89	4.50	.19	.15	.69	99	4.60
1996	19	2.99	.20	.21	1.16	15	2.71
1997	45	3.81	.18	.19	1.07	48	3.89
1998	83	4.42	.18	.14	.62	118	4.77
1999	113	4.74	.20	.20	.98		
2000	164	5.10	.21	.29	1.90		
2001	48	3.89	.24	.28	1.42		
2002	123	4.81	.32	.41	1.64		

Table 3.4.8.1 Haddock Va. Input data for short-term prediction.

MFDP version 1
Run: had-iceg
Time and date: 17:28 07/05/03
Fbar age range: 4-7

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	40129	0.2	0.062	0	0	0.23	1.63E-02	0.542
3	126781	0.2	0.347	0	0	0.412	0.135159	0.885
4	83629	0.2	0.685	0	0	0.801	0.352525	1.321
5	40738	0.2	0.867	0	0	1.268	0.555264	1.673
6	7355	0.2	0.922	0	0	1.873	0.746709	2.242
7	868	0.2	0.946	0	0	3.139	0.866501	2.656
8	1551	0.2	1	0	0	2.343	0.944449	2.814
9	134	0.2	1	0	0	3.301	0.944449	3.318

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	113545	0.2	0.07	0	0	0.197	1.63E-02	0.542
3	.	0.2	0.31	0	0	0.592	0.135159	0.873
4	.	0.2	0.61	0	0	0.758	0.352525	1.28
5	.	0.2	0.81	0	0	1.222	0.555264	1.737
6	.	0.2	0.89	0	0	1.754	0.746709	2.17
7	.	0.2	0.92	0	0	2.517	0.866501	2.702
8	.	0.2	0.97	0	0	2.646	0.944449	3.098
9	.	0.2	1	0	0	3.123	0.944449	3.318

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	51754	0.2	0.07	0	0	0.197	1.63E-02	0.542
3	.	0.2	0.31	0	0	0.502	0.135159	0.873
4	.	0.2	0.61	0	0	1.098	0.352525	1.265
5	.	0.2	0.81	0	0	1.175	0.555264	1.701
6	.	0.2	0.89	0	0	1.716	0.746709	2.237
7	.	0.2	0.92	0	0	2.375	0.866501	2.636
8	.	0.2	0.97	0	0	2.646	0.944449	3.129
9	.	0.2	1	0	0	3.123	0.944449	3.318

Input units are thousands and kg - output in tonnes

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 a Haddock in division Va. Output from short term prediction using ADCAM. Tac constraint of 65 000 tonnes for 2003.

Output from short-term prognosis not exactly the same weights in 2005 as in MFDP.

2003			
SSB	Biom 3+	Landings	F_{4-7}
129	191	65	0.477

	2004				2005			
FMult	SSB	Biom 3+	Landings	F_{4-7}	SSB	Biom 3+	Landings	F_{4-7}
0.15	148	204	19	0.095	208	281	26	0.095
0.2	148	204	25	0.126	203	275	34	0.126
0.25	148	204	31	0.158	198	270	41	0.158
0.3	148	204	36	0.189	194	265	47	0.189
0.35	148	204	42	0.221	190	260	53	0.221
0.4	148	204	47	0.252	185	255	58	0.252
0.45	148	204	52	0.284	181	250	63	0.284
0.5	148	204	57	0.315	177	246	67	0.315
0.55	148	204	62	0.347	174	241	71	0.347
0.6	148	204	67	0.378	170	237	75	0.378
0.65	148	204	72	0.41	166	232	78	0.41
0.7	148	204	77	0.441	163	228	81	0.441
0.75	148	204	81	0.473	159	224	84	0.473
0.8	148	204	85	0.504	156	220	87	0.504
0.85	148	204	90	0.536	152	217	89	0.536
0.9	148	204	94	0.567	149	213	91	0.567
0.95	148	204	98	0.599	146	209	93	0.599
1	148	204	102	0.63	143	206	94	0.63
1.05	148	204	106	0.662	140	202	96	0.662
1.1	148	204	109	0.693	137	199	97	0.693
1.15	148	204	113	0.725	135	196	98	0.725
1.2	148	204	117	0.756	132	193	99	0.756
1.25	148	204	120	0.788	129	189	100	0.788
1.3	148	204	124	0.819	127	186	101	0.819
1.35	148	204	127	0.851	124	184	101	0.851
1.4	148	204	130	0.882	122	181	102	0.882
1.45	148	204	133	0.914	119	178	102	0.914
1.5	148	204	136	0.945	117	175	103	0.945

Table 3.4.8.4 b Haddock in division Va. Output from short term prediction using MFDP. Tac constraint of 65 000 tonnes for 2003.

MFDP version 1
Run: had-iceg
Index file 6/5/2002
Time and date: 17:28 07/05/03
Fbar age range: 4-7

2003				
Biomass	SSB	FMult	FBar	Landings
200683	128724	0.7593	0.4785	65000

2004					2005	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
226658	147805	0	0	0	302365	220461
.	147805	0.1	0.063	12733	290884	210480
.	147805	0.2	0.1261	24806	280025	201054
.	147805	0.3	0.1891	36260	269750	192150
.	147805	0.4	0.2521	47129	260023	183736
.	147805	0.5	0.3151	57447	250813	175782
.	147805	0.6	0.3782	67248	242087	168260
.	147805	0.7	0.4412	76559	233818	161145
.	147805	0.8	0.5042	85410	225979	154411
.	147805	0.9	0.5672	93825	218544	148037
.	147805	1	0.6303	101831	211490	142001
.	147805	1.1	0.6933	109450	204795	136282
.	147805	1.2	0.7563	116703	198438	130863
.	147805	1.3	0.8193	123610	192400	125726
.	147805	1.4	0.8824	130192	186663	120854
.	147805	1.5	0.9454	136465	181209	116233
.	147805	1.6	1.0084	142447	176022	111847
.	147805	1.7	1.0714	148153	171088	107683
.	147805	1.8	1.1345	153598	166393	103729
.	147805	1.9	1.1975	158797	161923	99972
.	147805	2	1.2605	163761	157665	96402

Input units are thousands and kg – output in tonnes

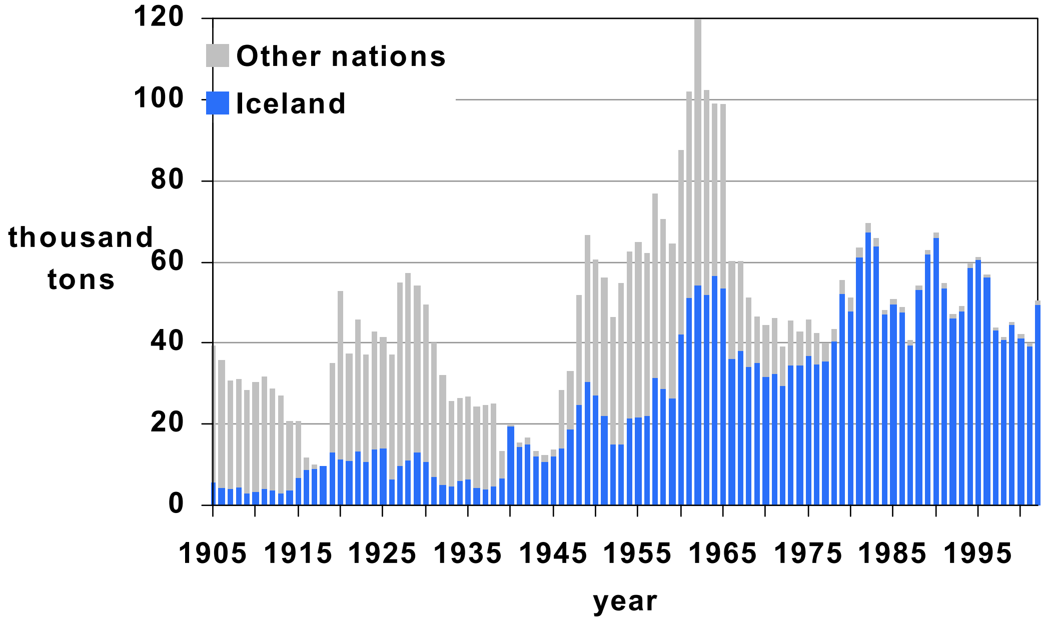


Figure 3.4.2.1 Haddock Division VA. Nominal landings (tonnes) 1905 – 2002.

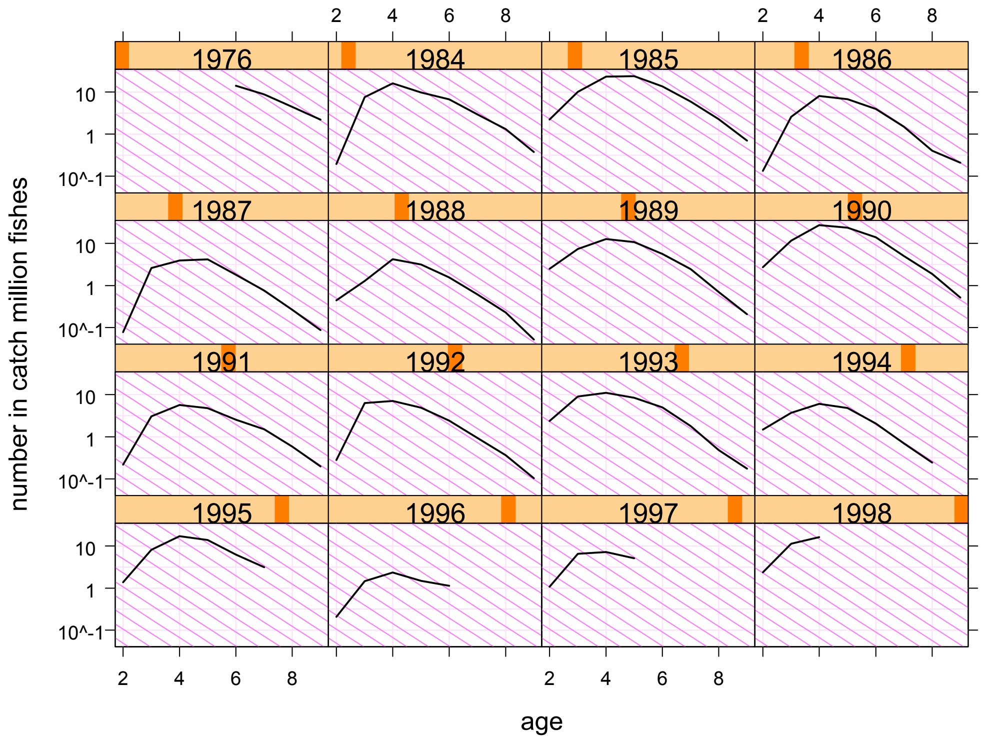


Figure 3.4.3.1 Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

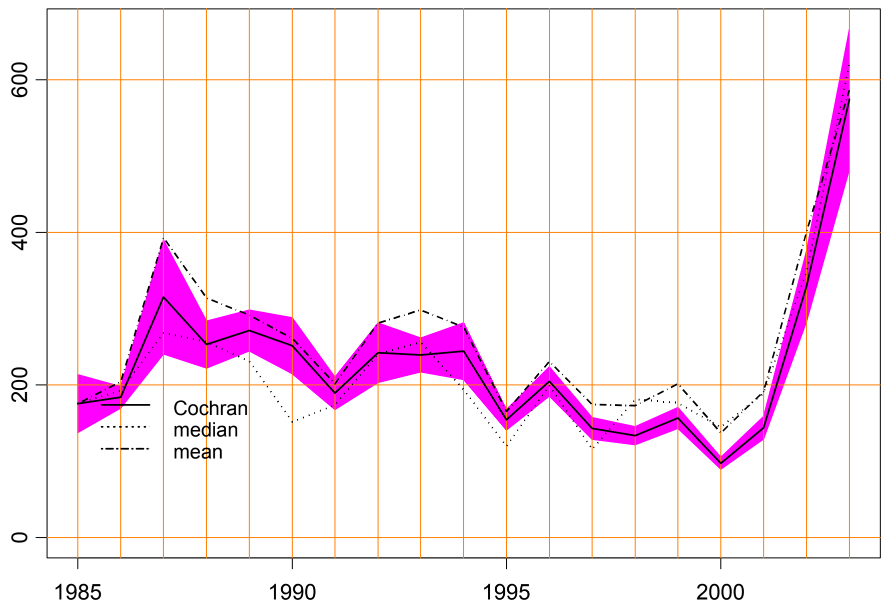


Figure 3.4.5.1 Haddock in division va. Total biomass index from the groundfish survey 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices. Indices based on unweighed mean of all stations and number of stations with haddock times median of the haddock catch at those stations are shown for comparison.

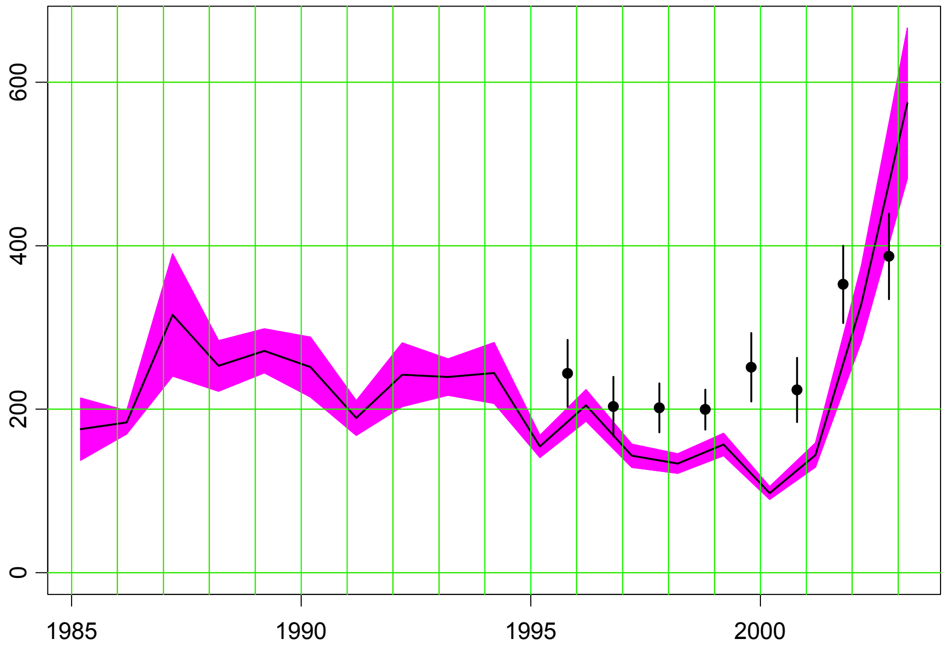


Figure 3.4.5.2 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

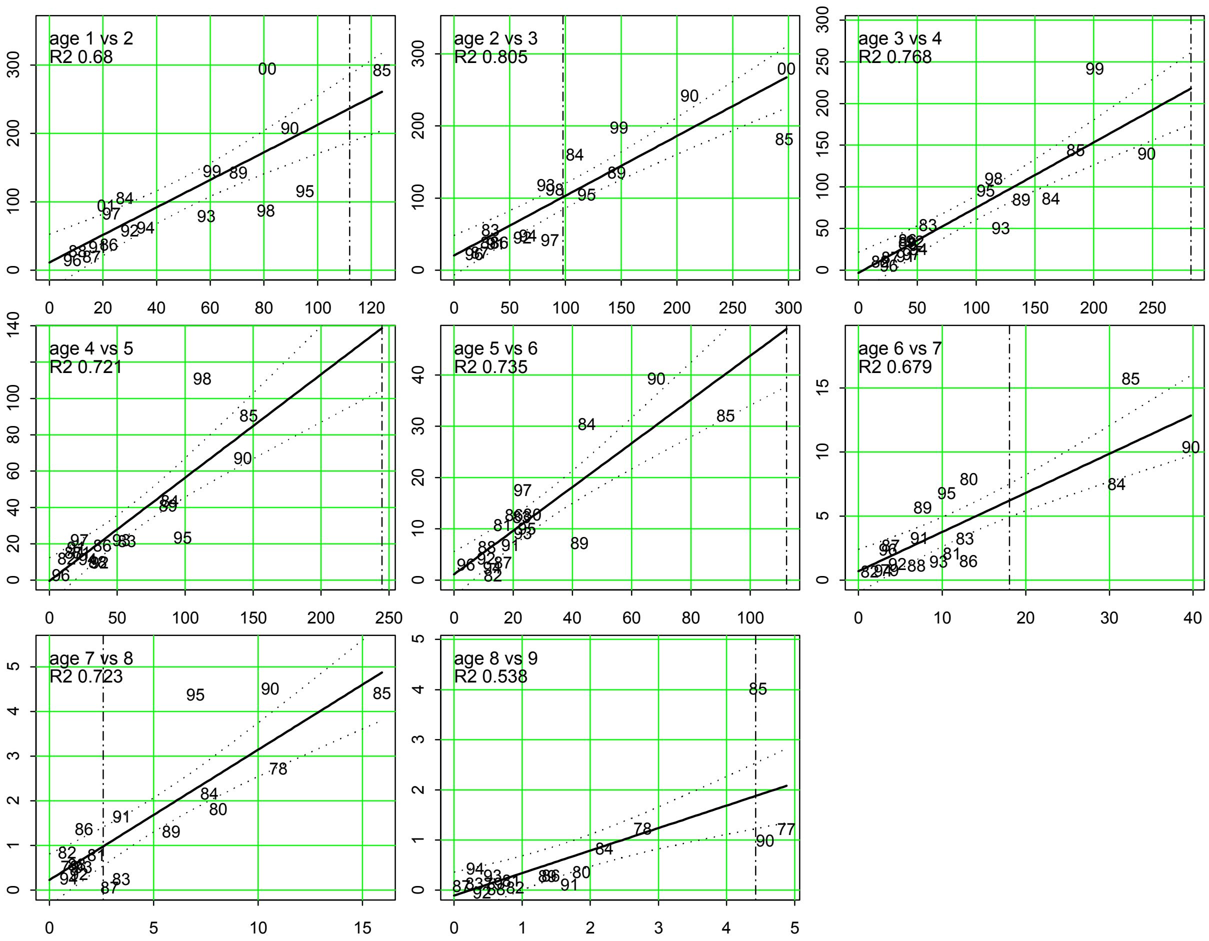


Figure 3.4.5.3 Haddock in division Va. Survey indices plotted against survey indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.

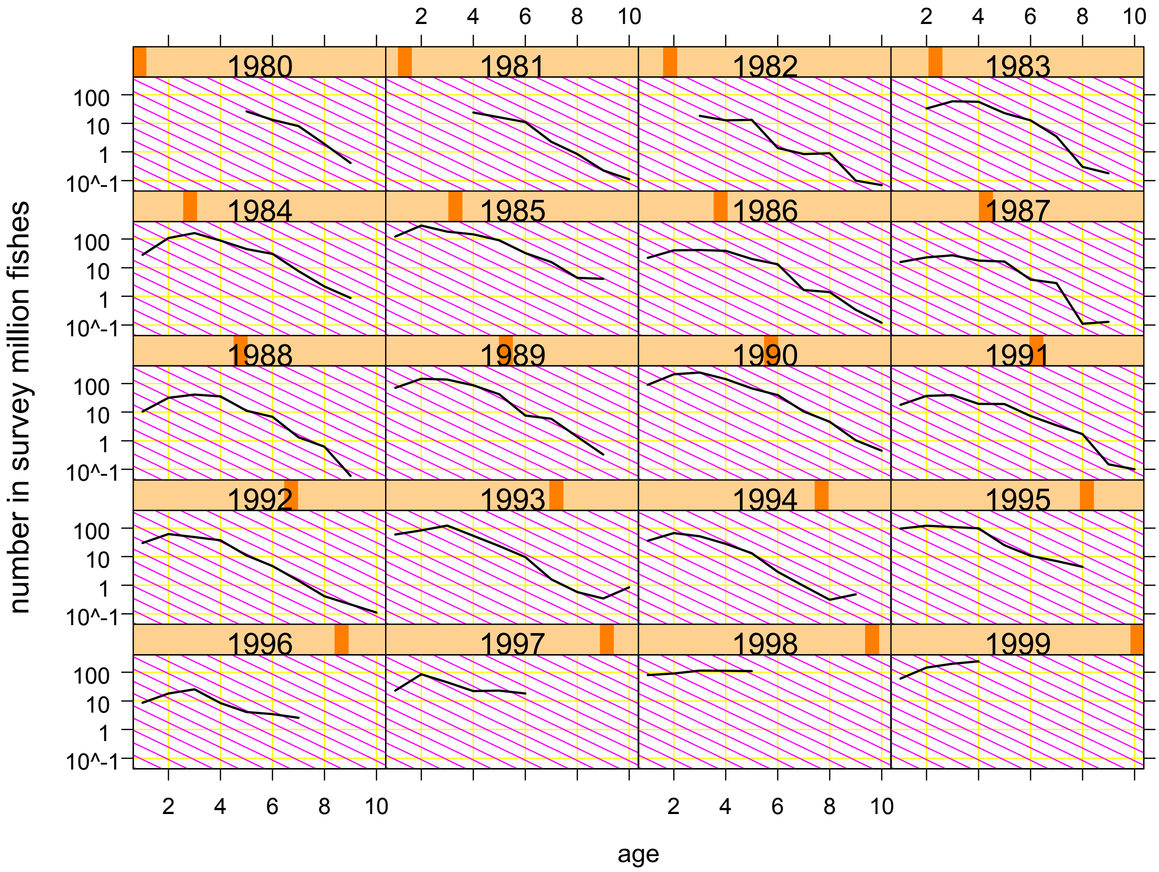


Figure 3.4.5.4 Catchcurves from the groundfish survey. Grey lines show Z=1.

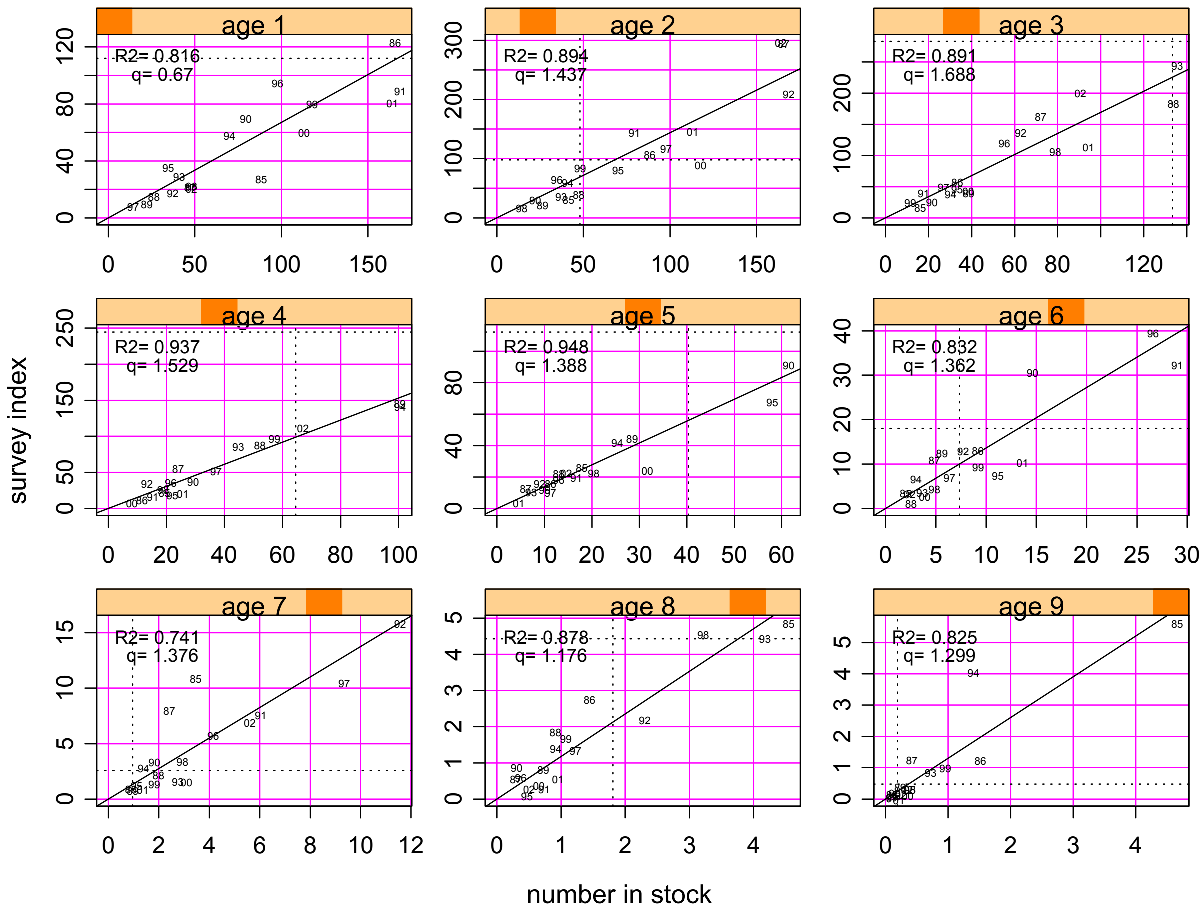


Figure 3.4.5.5 Icelandic haddock. Survey indices vs. number in stock. Line fitted through origin on original scale. . The fitted line uses the data until 1999. Dashed lines show most recent estimates.

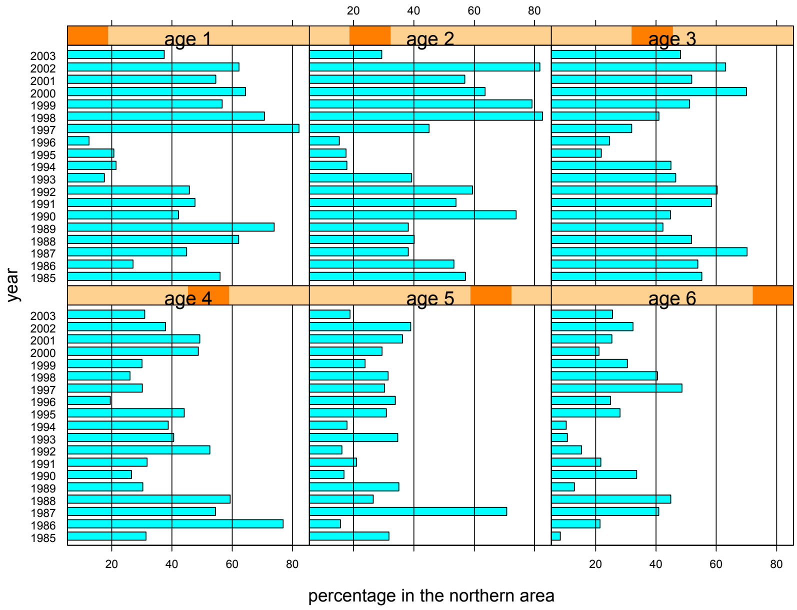


Figure 3.4.5.6 Percentage of survey index in the northern area

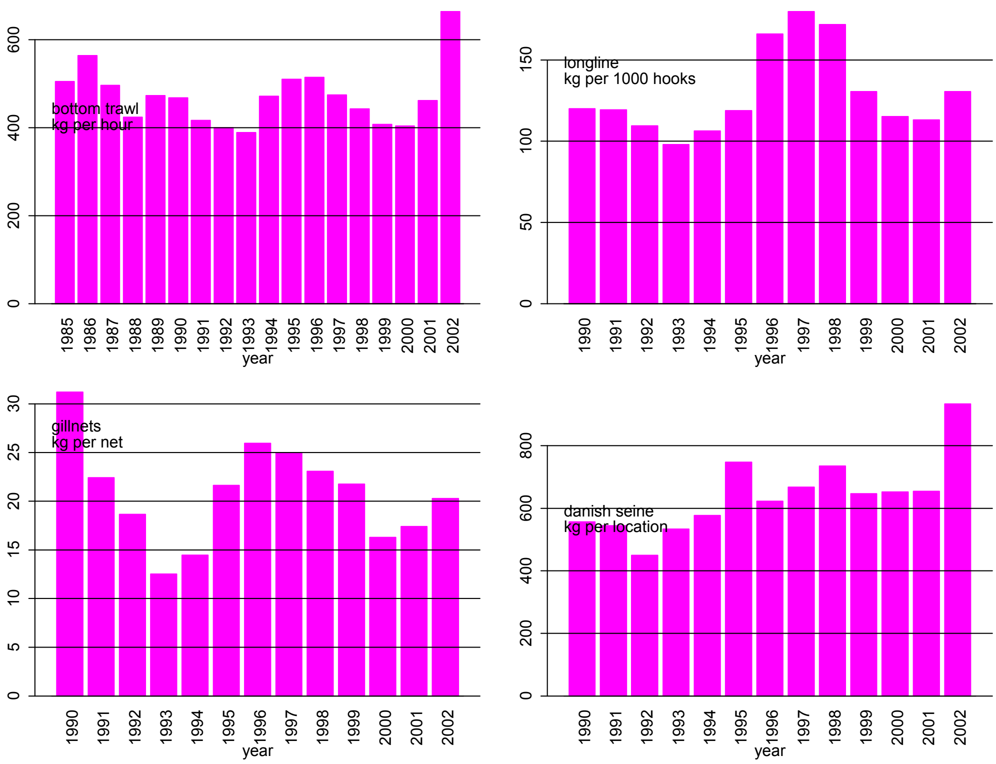


Figure 3.4.5.7 Catch per unit effort in the most important gear types. The figure is based on locations where more than 50% of the catch is haddock. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

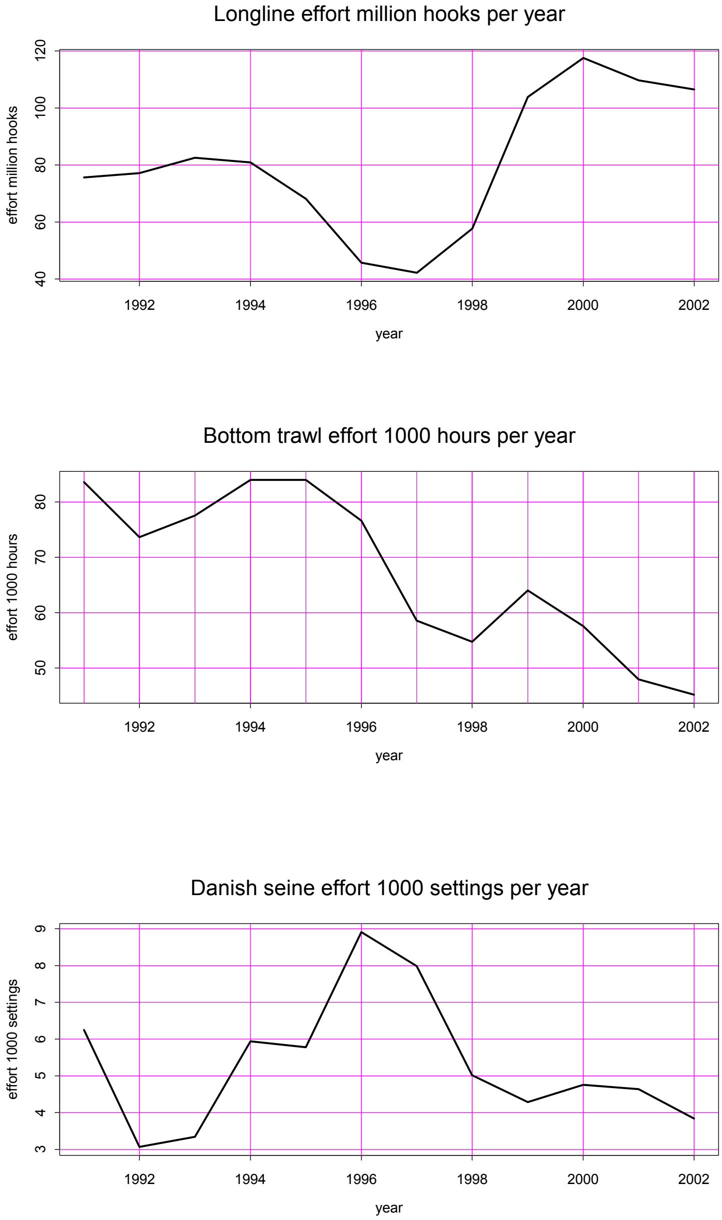


Figure 3.4.5.8 Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch.

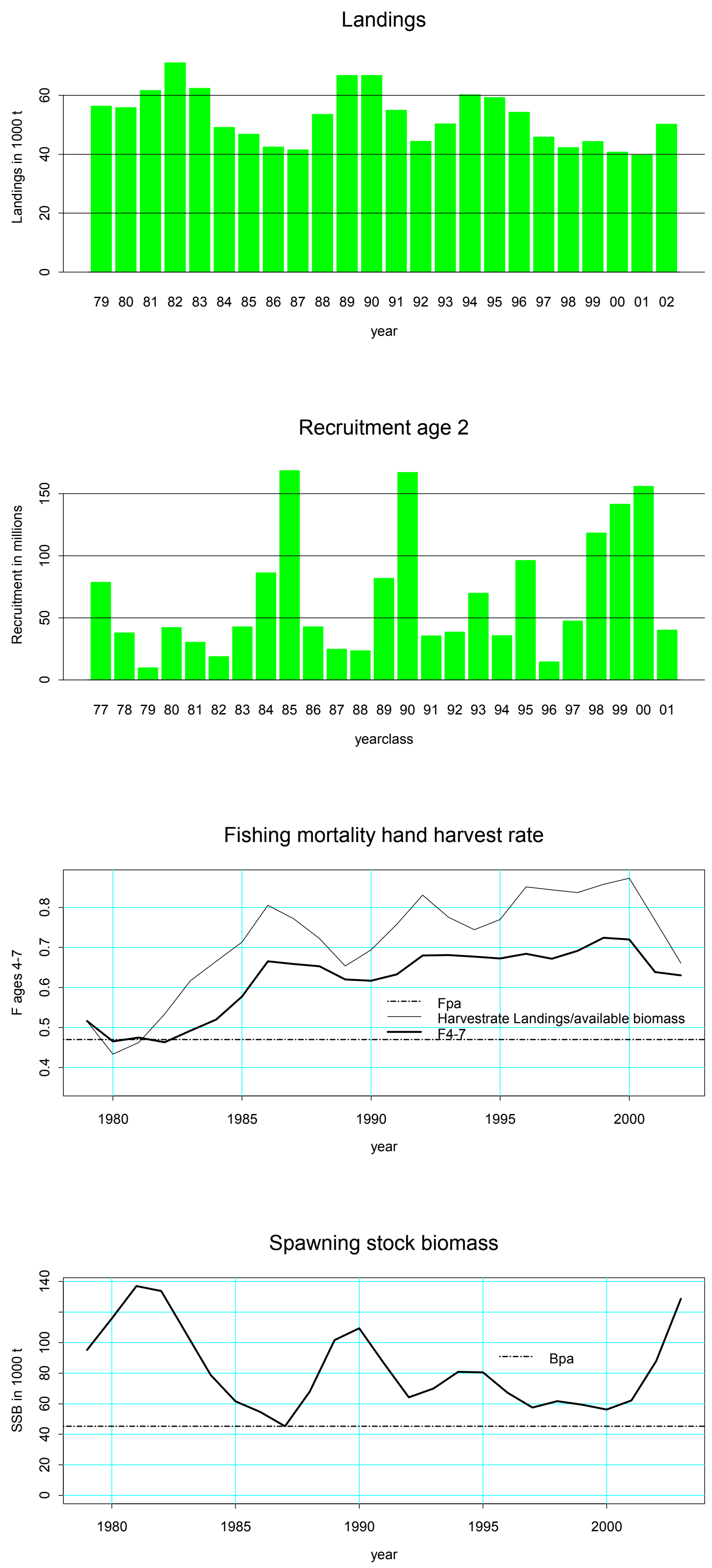


Figure 3.4.6.1 Haddock in division Va. Summary plots.

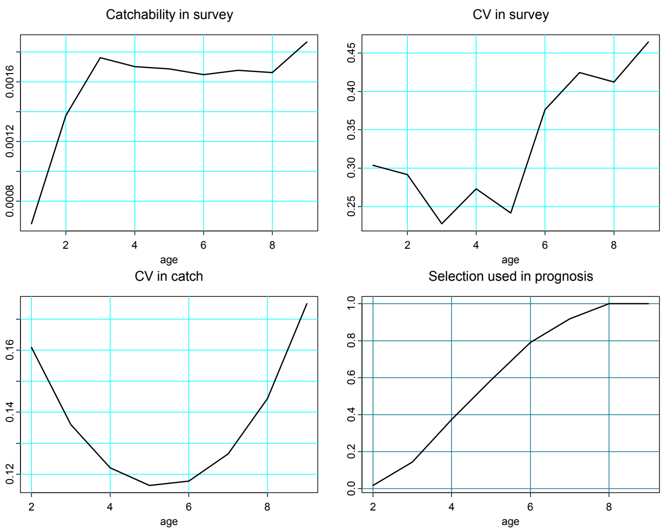


Figure 3.4.6.2 Haddock in division Va. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

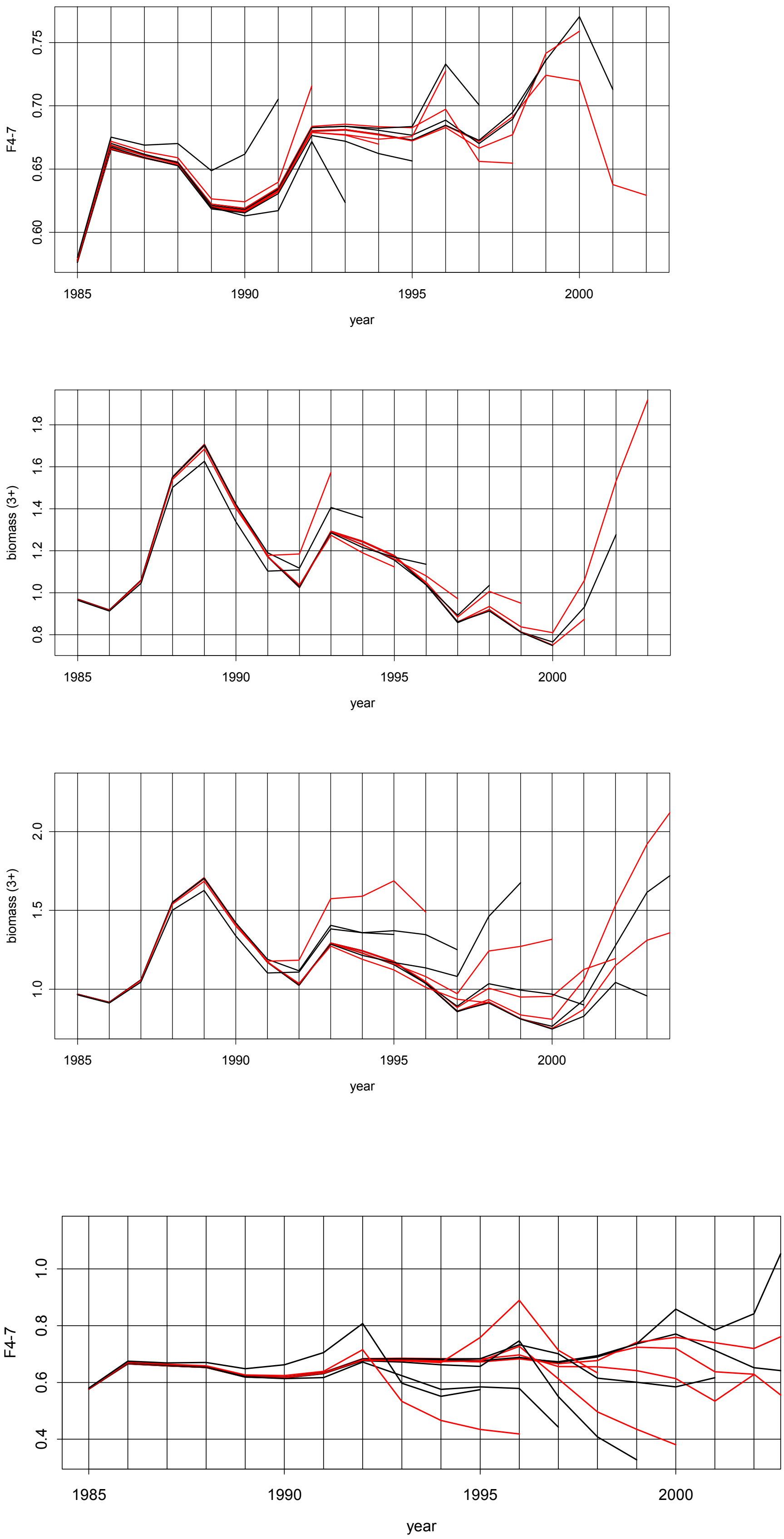


Figure 3.4.6.3 Haddock in division Va. Retrospective pattern from the ADCAM run using indices from age 1 to 9. The last 2 figures shows retrospective pattern with predictions 4 years ahead using the observed catches.

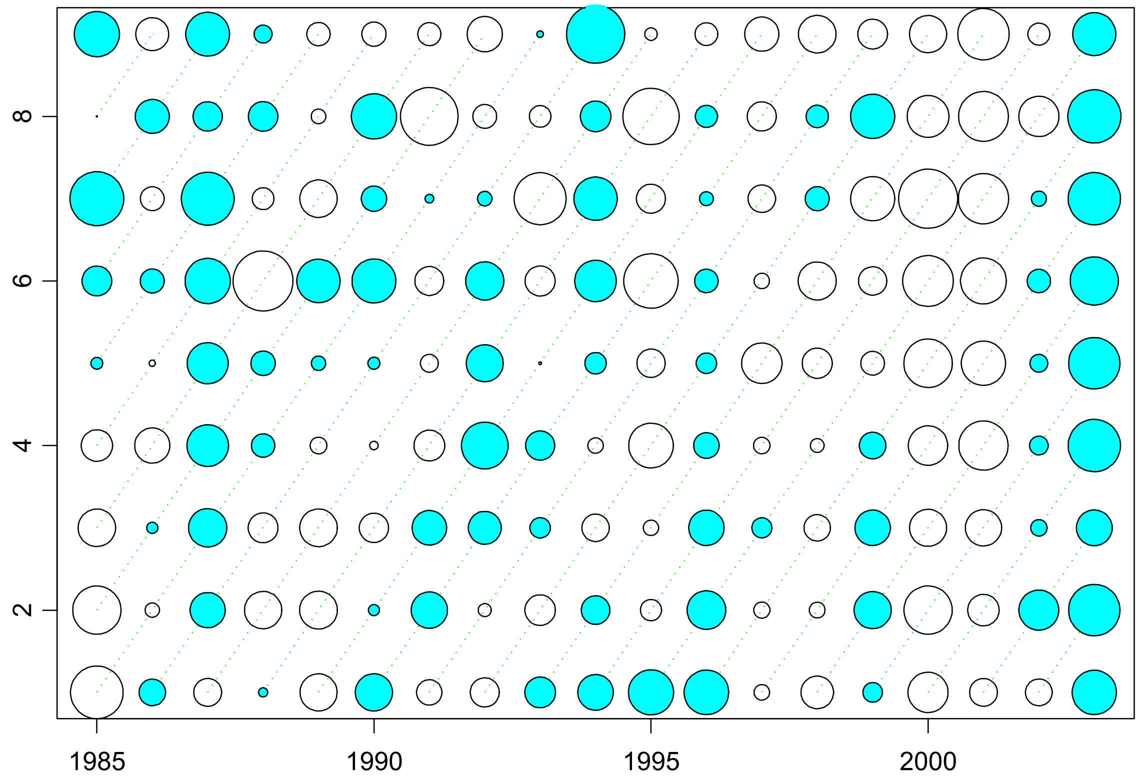


Figure 3.4.6.4 Residuals from the fit to survey data . $\frac{\log(I_{ay}+\varepsilon_{age})}{\log(I_{ay}+\varepsilon_{age})}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles

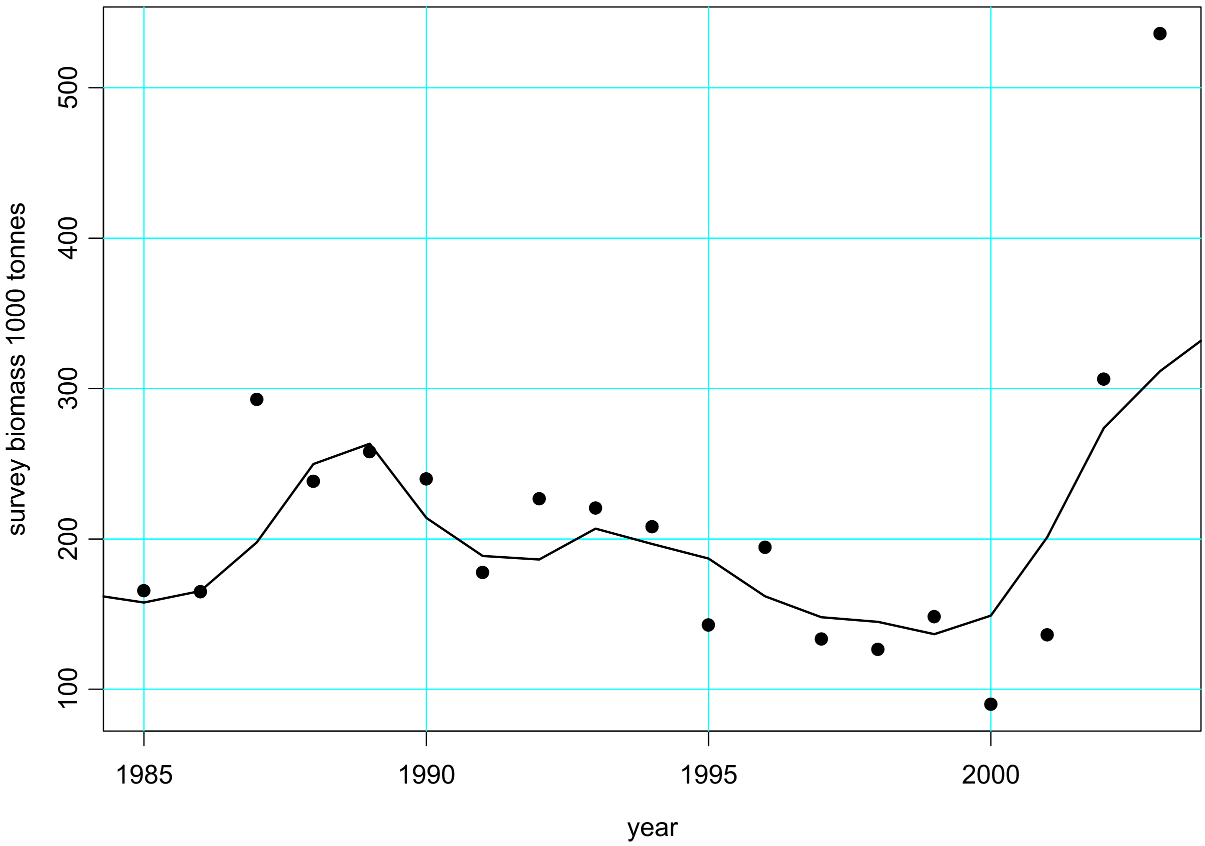


Figure 3.4.6.5 Haddock in division Va. Observed (points) and modelled (lines) survey biomass.

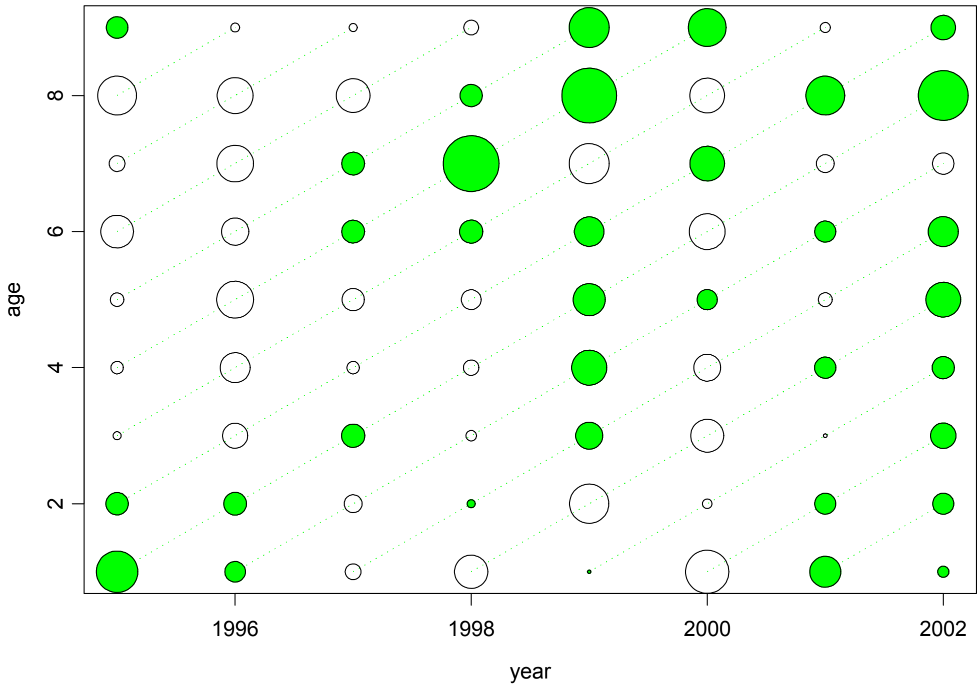
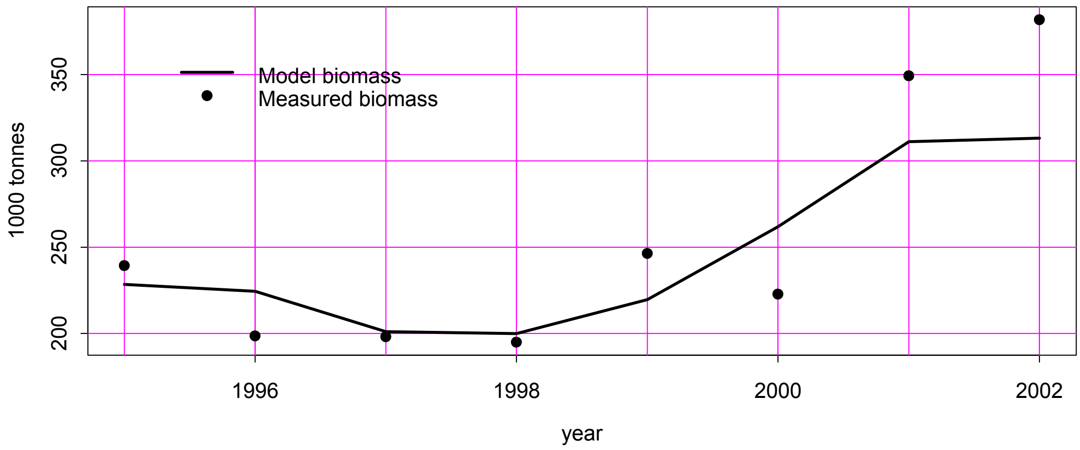


Figure 3.4.6.6 Residuals from the fit to autumn survey data . $\frac{\log(I_{ay}+\varepsilon_{age})}{\log(I_{ay}+\varepsilon_{age})}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 1 and residuals are proportional to the area of the circles



.

Figure 3.4.6.7 Haddock in division Va. Assessment using the autumn survey. Observed (points) and modelled (lines) survey biomass

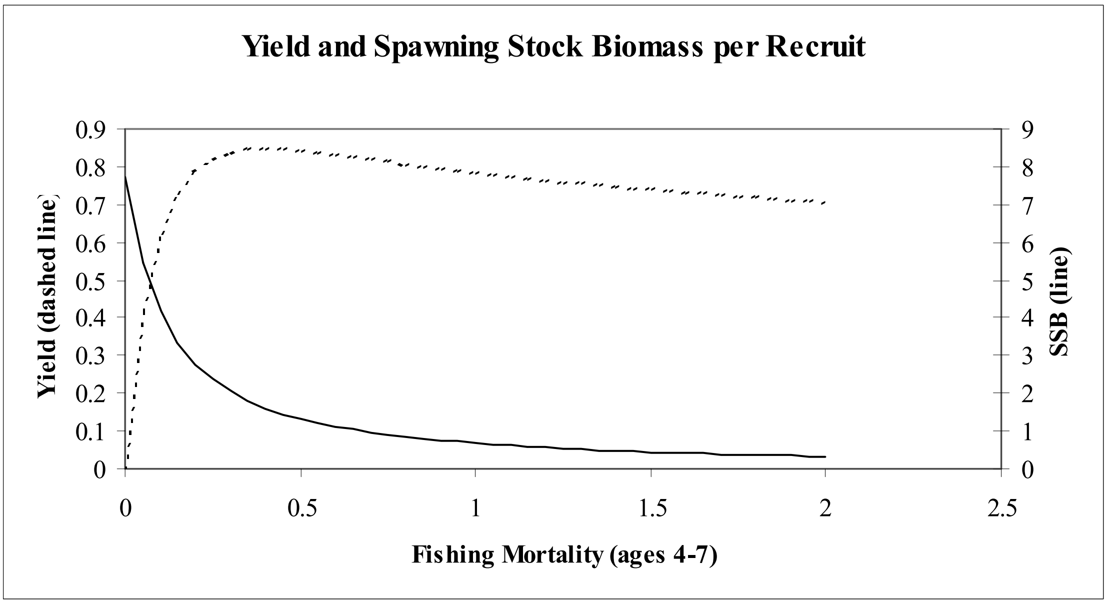


Figure 3.4.8.1 Haddock in division Va. Yield-per-recruit.

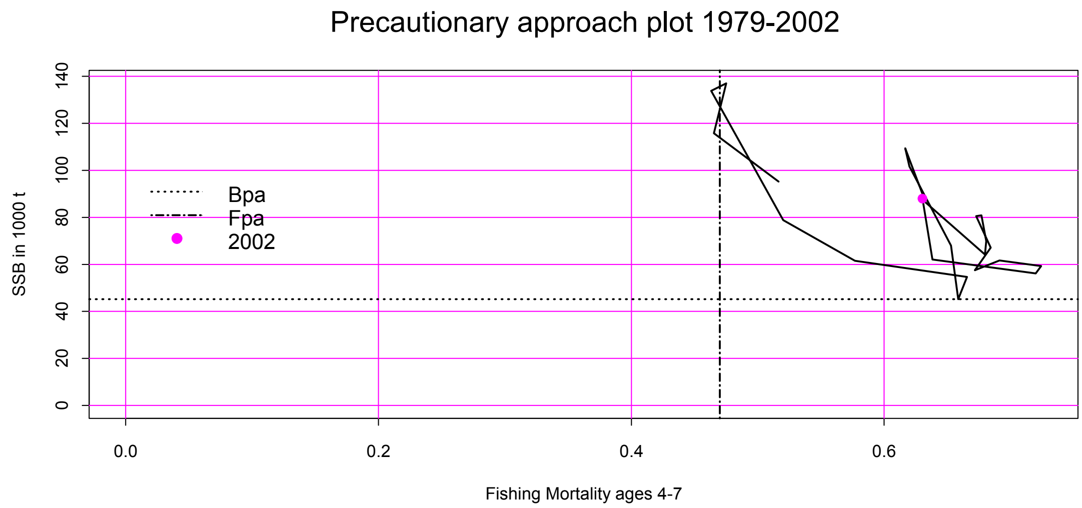


Figure 3.4.8.2 Haddock in division Va. Spawning stock vs. fishing mortality. .

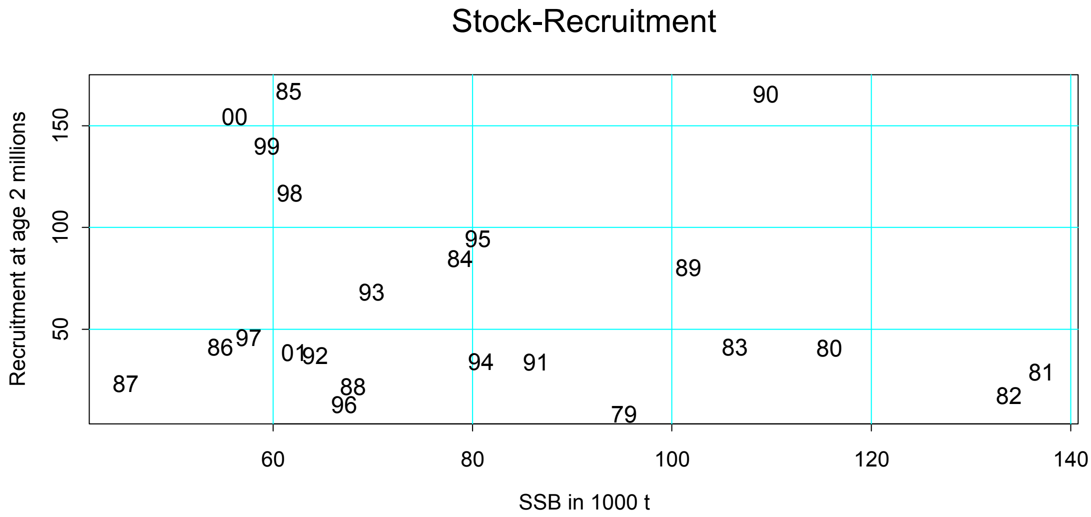


Figure 3.4.8.3 Haddock in division Va. Spawning stock vs. recruitment. . The labels in the figure show year classes.

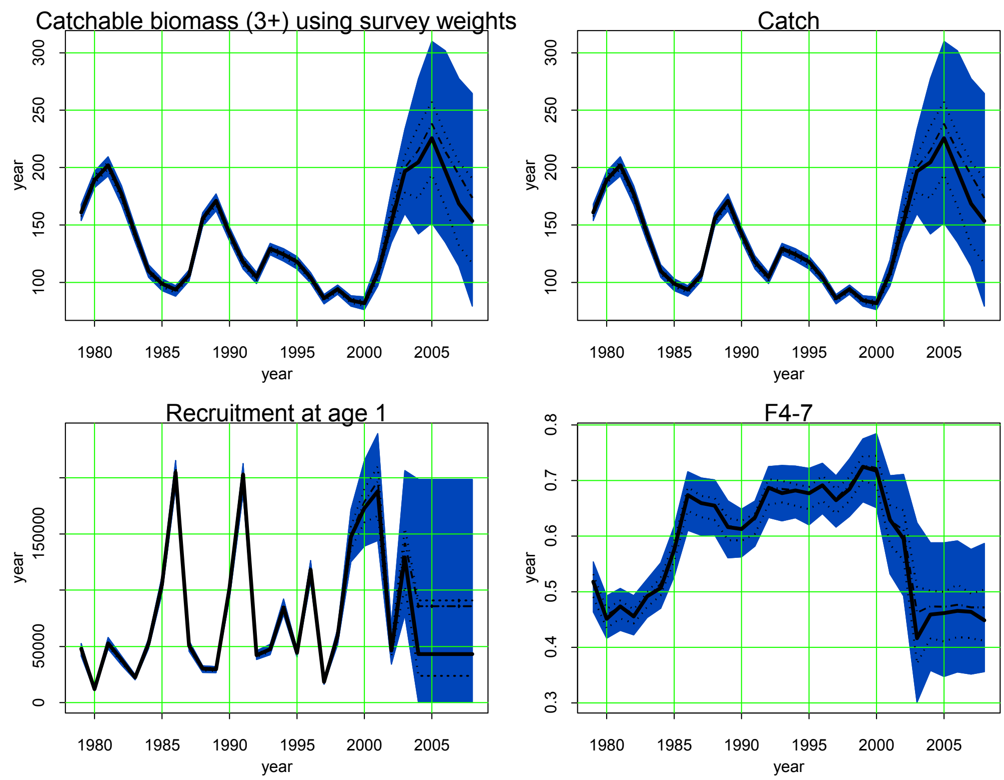


Figure 3.4.8.3 (Cont'd) Haddock in division Va. Results from short-term simulations assuming fishing at F=0.47 after 2003.

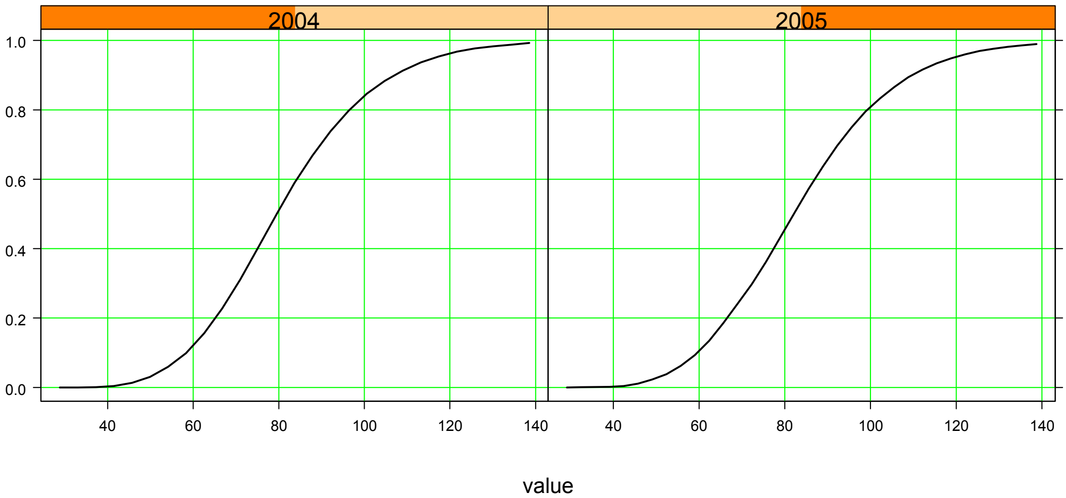


Figure 3.4.8.4 Haddock in division Va. Cumulative probability profiles of the catch in 2004 and 2005 assuming F=0.47.

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 and Iceland (Tåning, 1937; Hansen, 1949; and Anon. 1971). The immature East Greenland cod seem not to emigrate to Iceland, but in some years immature cod migrate to the West Greenland stock (Anon. 1971). Tagging experiments at Iceland show that migration of mature 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 homing migration.

In egg and larval surveys cod eggs have been found in an almost continuos 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 2002 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 0-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, 1994) and it cannot therefore be ignored in the assessments.

References

Hansen, P.M. 1949. Studies on the biology of the cod in Greenland waters. Rapp. P.-v. Réun. Cons. int. Explor. Mer 123: 1-77.

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.

Schopka, S.A. 1994. Fluctuations in the cod stock off Iceland during the twentieth century in relation to changes in the fisheries and environment. *In* Jakobsson, J. *et al.* (Eds). Cod and Climate, ICES mar. Sci. Symp., 198: 175-193.

Tåning, Å.V. 1937. Some features in the migration of cod. J. Cons. int. Explor. Mer 12: 1-35.

Vilhjálmsson, H., and E. Friðgeirsson 1976. A review of 0-group surveys in the Iceland-East Greenland area in the years 1970 - 1975. ICES Coop. Res. Rep. 54: 1-34.

Vilhjálmsson, H., and J. V. Magnússon 1984. Report on the 0-group fish survey in Icelandic and East-Greenland waters, August 1984. ICES C.M. 1984/H:66, 26 pp.

Table 4.1.1 Abundance indices of O-group cod from international and Icelandic O-group surveys (Sveinbjörnsson and Hjörleifsson, 2002) in the East Greenland/Iceland area, 1971-2002 (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
2002[2]		180	8	157	4106	702	5153

[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. Information on the historic VPA is available in ICES 2001/Assess:20. Therefore, the present report only includes 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 respectively and includes the inshore catches. Landings as used by the working group are listed in Table 5.1.3 by inshore areas for West Greenland and offshore areas for both West and East Greenland, their trends being illustrated in Fig. 5.1.1. In 1924 the offshore fishery at West Greenland took off and until 1929 the landings increased from 200t to 22 000t and exceeded the level of 120 000t in 1931. The next 10 years landings were fluctuating in the range of 60 000 –130 000t (Horsted 2000). During World War II catches decreased by 1/3 as only Greenland and Portugal participated in the fishery. Less is known about cod fisheries at East Greenland waters, but since 1954 landing statistics have been available. In the next 15 years the East Greenland landings were only contributing between 2-10 % of the total offshore landings. During a period from the mid 1950'ties to 1960 annual landings taken offshore averaged about 270 000 t. In 1962 the offshore catches calumniated with landings of 440 000t. After this historic high landings decreased sharply by 90% to 46 000 t in 1974 and even further down in 1977. The level of 40 000 t was only exceeded during the periods 1982–83 and 1988–1990. Large changes in effort started in 1970, 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 1989–90, the landings decreased from 85 000 t by more than 85% to 11 000 t. Since 1992 no directed cod fishery has taken place offshore in West Greenland, although very high quota are available. In the same period the reported landings varied between 120 t and 750 t in East Greenland. In 2002 a total offshore catch amounted to 448 t, less than 5% was reported as by-catch. No reports on discards have been available.

Miscellaneous gears, mainly long lines and gillnets, contributed 30–40% until 1977 but have disappeared since then (ICES 2002/Assess:20). At the moment otter trawl board catches (OTB) are the only operating fishing gear and have been the most important throughout the time-series for offshore fisheries.

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 ICES 1993/Assess:18 and Working Doc. 3/2003. 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 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 and in 1995 and 2002 in West Greenland partly due to technical problems (Working Doc. 3/2003).

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 1982–2002. Trends of the biomass estimates for West and East Greenland are shown in Figures 5.1.3, including the spawning stock. These Figure 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 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 2002 survey results confirmed the severely depleted status of the stock, although they represent the highest stock size in 11 years (less than 5% of the abundance in 1987). The total abundance and biomass indices amounted to 14 million individuals and 22 000 t, respectively, were 70% of the stock were distributed off East Greenland.

5.1.2.1.2 Age composition

Age disaggregated abundance indices for West, East Greenland and total are listed in Tables 5.1.5–7, respectively, and are based on 1 242 individual age determinations. The recruiting year classes 1998-2001 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. Indeed, at age 3 the 1999 year class was the most frequent age group in 2002. The 0-and 1-group indices are considered unrepresentative of year class strength at age 3 due to gear specifications while the age group 2 seems to be quantitatively estimated and to represent a reasonable recruitment index. (Figure 5.1.5).

5.1.2.1.3 Mean length-at-age

The trends of the mean length of the age groups 1–10 years for West and East Greenland are illustrated in Figure 5.1.6 and 5.1.7 respectively for the period 1982–2002. They reveal pronounced area and temperature effects. Age groups 2–10 years off East Greenland were found to be significant longer 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 length-at-age at ages 3 to 8 years increased significantly and remained at that high level until 2000, when low values were recorded. The values for West Greenland illustrate a stable period the last three years. The 2002 values for East Greenland indicate a small decrease in length for the youngest age classes and a stable length for the older age classes. Mean weight-at-age can be obtained from regression $f(x)= 0.00895x^{3.00589}$, X=length in cm, the equation has been determined on the basis of historic measurements.

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 stratified-random trawl survey off West Greenland from July to September (Working Doc. 16/2003). The main purpose of the survey is to evaluate the biomass and abundance of Northern shrimp (*Pandalus borealis*), but since 1992 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 (Figure 5.1.8). The survey area is divided into 6 NAFO Divisions, and further subdivided into three depth strata (0-200, 201-400 and 401-600 m) on basis of depth contour lines. A minimum of two hauls per stratum is always planned. Due to lack of information of the bottom topography Div. 1AN and Disko Bay are considered as two single strata. The trawl is a Skjervoy 3000/20 with bobbin gear and double bag. The mesh size in the codend is 20 mm. and standard trawling time offshore is 15-30 minutes at a mean towing speed of 2.5 knots. Cod smaller than approximately 20 cm are caught insufficiently due to the trawl distance between net and bottom. 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

The biomass indices for cod were estimated to be between 4-7000t in the period 1988-1990. In 1992 the biomass decreased with more than 95% to only 217t and remained at this low level until recent years. In 2001 a slight improvement was detected with a biomass index at a little more than 600t and in 2002 the biomass level was estimated to be close to 2000t figure 5.1.4. Abundance was estimated to be 4.3 millions which is the highest number in the time-series (1992-2002) (Table 5.1.8 and 5.1.9).

5.1.2.2.2 Age composition

Age disaggregated abundance indices are listed in Table 5.1.10. In 2001, the recruiting year classes 1997, 1998 and 1999 dominated the stock by 94% with equal shares. In 2002 year class 1998 and 1999 contributed to nearly 80% of the total abundance. Their abundance at ages 3 and 4 represent highest values of the time-series. Age disaggregated abundance indices for West Greenland indicates occurrence of few year classes and a dominance of year class 1998 and 1999. In 2002 year class 2000 gave the secound highest value in the time serie. This indicates three year classes in row with high abundence. In 2002, age length keys were determined on the basis of 562 otoliths.

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 State of the stock

A historic XSA tuning was run in 1996 with the final year as 1992 and the output is illustrated in Figures 5.1.8. and 5.1.9. The plots indicate the very high and fluctuating fishing mortality as well as periodic good year classes.

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.

5.1.5 Stock projection

Cod is described a common species in the Greenland fauna, although reaching here its ecological northern boundary. Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. However, even with sizeable SSBs present and spawning occurring, water temperature may be so cold that eggs and larvae will not survive. 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. 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).

5.1.6 Estimation of management reference points

Total abundance from the German survey was rescaled to the historic VPA abundance by a linear equation on a log-log scale (r^2=0.82) Figure 5.1.11. The relationship between the abundance of 4+ cod and corresponding 3 years recruits indicates that abundance 4+ should exceed more than 60 mill. before a decent recruitment is reached. In 2002 the rescaled numbers of 4+ from the German survey was estimated to be 17.5 mill, which is considered beyond safe limits Figure 5.1.12.

5.1.7 Management considerations

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 gillnets 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.

References

Buch, E., Horsted, S.A., and Hovgård, H. 1994. Fluctuations in the occurrence of cod in Greenland waters and their possible causes. ICES Mar. Sci. Symp. 198: 158-174.

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 2000 Report of the North Western Working Group. ICES CM 2000/ACFM:19.

ICES 2001 Report of the North Western Working Group. ICES CM 2001/ACFM:20

ICES 2002 Report of the North Western Working Group. ICES CM 2002/ACFM:20

Hansen, P.M. 1949. Studies on the biology of the cod in Greenland waters. Rapp. P.-v. Réun. Cons. int. Explor. Mer 123: 1-77.

Hjørleifsson, E. 2003. Excel Statistical Catch-at-age Model (EXCAM) analysis of Greenland cod. Working document 32, ICES North Western Working Group 2003.

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

Horsted, S.A. 2000. A review of the cod fisheries at Greenland, 1910-1995. J.Northw.Atl.Fish.Sci. 28: 1-112.

Hovgård, H. and Christensen, S. 1990. Population structure and migration patterns of Atlantic cod at West Greenland waters based on tagging experiments from 1946 to 1964. NAFO Sci. Coun. Studies 14: 45-50.

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

Rätz, H.-J. 2003. Groundfish survey results for cod off Greenland (offshore component) 1982-2002. Working document 3, ICES North Western Working Group 2003.

Smidt, E. 1979. Annual cycles of primary production and of zooplankton at Southwest Greenland. Meddelser om Grønland, Bioscience 1: 1-53.

Storr-Paulsen, M. 2003. Cod stock investigations off West Greenland. Working document 16, ICES North Western Working Group 2003.

Wieland, K. and H. Hovgård, 2002. Distribution and of Atlantic cod (*Gadus morhua*) eggs and larvae in Greenland offshore waters. J. Northw. Atl. Fish. Sci. 30: 61-76.

Table 5.1.1 Nominal catch (t) of Cod in NAFO Subarea 1, 1988-2002 as officially reported to ICES.

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	2001	2002[1]
Faroe Islands	-	-	-					
Germany	-	-	-					
Greenland	1.710	948	904	319	622	764	1680	3698
Japan	-	-	-					
Norway	-	-	-					
UK	-	-	-					
Total	1.710	948	904	319	622	764	1680	3698
WG estimate	-	-	-	-	-	-	-	

[1]) Provisional data reported by Greenland authorities
[2]) Includes 3,000 t reported to be caught in ICES Subarea XIV
[3]) Includes 2,741 t reported to be caught in ICES Subarea XIV
[4]) Includes 29,513 t caught inshore

Table 5.1.2 Nominal catch (t) of cod in ICES Subarea XIV, 1988-2002 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	2002[5]
Faroe Islands	-	-	-	-	6			164
Germany	22	5	39	128	13	3	92	5
Greenland	29	5	32	37 [5]	+ [5]		4	232
Iceland	1	-	-		-	-	210	
Norway	+	1	-	+	2	- [5]	43	13
Portugal				31	-	-	278	
Russia	-	-	-					
UK (E/W/NI)	232	181	284	149	95	149	129	
UK (Scotland)	-	-	-					
United Kingdom								34
Total	284	192	355	345	116	152	756	448
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 Subarea 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. Catches (t) from 1924 – 2002 as used by the Working Group, inshore and offshore by NAFO div 1Band 1D offshore divided into East and West Greenland. Based on Horsted (1994, 2000).

Cod	Inshore			Offshore			Total
Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1924	131	221	843		200	200	1043
1925	122	318	1024		1871	1871	2895
1926	97	673	2224		4452	4452	6676
1927	282	982	3570		4427	4427	7997
1928	426	1153	4163		5871	5871	10034
1929	1479	1335	7080		22304	22304	29384
1930	2208	1681	9658		94722	94722	104380
1931	1905	1520	9054		120858	120858	129912
1932	1713	1042	9232		87273	87273	96505
1933	1799	1148	8238		54351	54351	62589
1934	2080	952	9468		88122	88122	97590
1935	1870	769	7526		65846	65846	73372
1936	2039	705	7174		125972	125972	133146
1937	1982	854	6961		90296	90296	97257
1938	1743	703	5492		90042	90042	95534
1939	2256	896	7161		89807	89807	96968
1940	2478	1061	8026		43122	43122	51148
1941	3229	823	8622		35000	35000	43622
1942	3831	1332	12027		40814	40814	52841
1943	5056	1240	13026		47400	47400	60426
1944	4322	1547	13385		51627	51627	65012
1945	4987	1207	14289		45800	45800	60089
1946	5210	1438	15262		44395	44395	59657
1947	5261	2096	18029		63458	63458	81487
1948	5660	1657	18675		109058	109058	127733
1949	4580	2110	17050		156015	156015	173065
1950	6358	2357	21173		179398	179398	200571
1951	5322	2571	18200		222340	222340	240540
1952	4443	2437	16726		317545	317545	334271
1953	5030	5513	22651		225017	225017	247668
1954	6164	3275	18698	4321	286120	290441	309139
1955	5523	4061	19787	5135	247931	253066	272853
1956	5373	5127	21028	12887	302617	315504	336532
1957	6146	5257	24593	10453	246042	256495	281088
1958	6178	5456	25802	10915	294119	305034	330836
1959	6404	5009	27577	19178	207665	226843	254420
1960	6741	3614	27099	23914	215737	239651	266750
1961	6569	4178	33965	19690	313626	333316	367281
1962	7809	3824	35380	17315	425278	442593	477973
1963	4877	2804	23269	23057	405441	428498	451767
1964	3311	8766	21986	35577	327752	363329	385315
1965	5209	6046	24322	17497	342395	359892	384214
1966	8738	7022	29076	12870	339130	352000	381076
1967	5658	6747	27524	24732	401955	426687	454211
1968	1669	6123	20587	15701	373013	388714	409301
1969	1767	7540	21492	17771	193163	210934	232426
1970	1469	3661	15613	20907	97891	118798	134411
1971	1807	3802	13506	32616	107674	140290	153796
1972	1855	3973	14645	26629	95974	122603	137248
1973	1362	3682	9622	11752	53320	65072	74694
1974	926	2588	8638	6553	39396	45949	54587

Table 5.1.3 Cod off Greenland. Continued.

Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1975	1038	1269	6557	5925	41352	47277	53834
1976	644	904	5174	13027	28114	41141	46315
1977	580	2946	13999	8775	23997	32772	46771
1978	1587	2614	19679	7827	18852	26679	46358
1979	1768	6378	35590	8974	12315	21289	56879
1980	2303	7781	38571	11244	8291	19535	58106
1981	2810	6119	39703	10381	13753	24134	63837
1982	2448	7186	26664	20929	30342	51271	77935
1983	2803	7330	28652	13378	27825	41203	69855
1984	3908	5414	19958	8914	13458	22372	42330
1985	2936	1976	8441	2112	6437	8549	16990
1986	1038	1209	5302	4755	1301	6056	11358
1987	2995	8110	18486	6909	3937	10846	29332
1988	6294	2992	18791	12457	36824	49281	68072
1989	8491	8212	38529	15910	70295	86205	124734
1990	9857	9826	28799	33508	40162	73670	102469
1991	8641	2782	18311	21596	2024	23620	41931
1992	2710	1070	5723	11349	4	11353	17076
1993	323	968	1924	1135	0	1135	3059
1994	332	914	2115	437	0	437	2552
1995	521	332	1710	284	0	284	1994
1996	211	164	948	192	0	192	1140
1997	446	99	1186	370	0	370	1556
1998	118	78	323	346	0	346	669
1999	142	336	622	112	0	112	734
2000	266	332	764	100	0	100	864
2001	1183	54	1680	221	0	221	1901
2002	1803	214	3698*	448	0	448	4146*

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, 1982-2002. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	Abundance WEST	EAST	TOTAL	CI	Spawn. St.	Biomass 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
2002	4121	9691	13812	41	11689	2110	19726	21836	51	21299

Table 5.1.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2002. *) 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
2002	12	13	1061	2972	64	0	0	0	0	0	0	0	4122

Table 5.1.6 Cod off East Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2002. *) 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
2002	96	8	415	1824	2026	2080	1952	889	235	83	36	30	9674

Table 5.1.7 Cod off Greenland (total offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2002. *) 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
2002	108	21	1476	4796	2090	2080	1952	889	235	83	36	30	13796

Table 5.1.8 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by stratum, 1991-2002. Confidence intervals (CI) are given in percent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	West.	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	249	86	140	498	210	373	1570	23
2002	0	0	9	75	172	99	3595	102	202	4254	52

Table 5.1.9 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by stratum, 1988-2002. 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	West.	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
2002	0	0	9	59	96	52	1629	38	87	1967	48

Table 5.1.10 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2002.

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
2002	0	603	2323	1078	245	0	4	0	4253

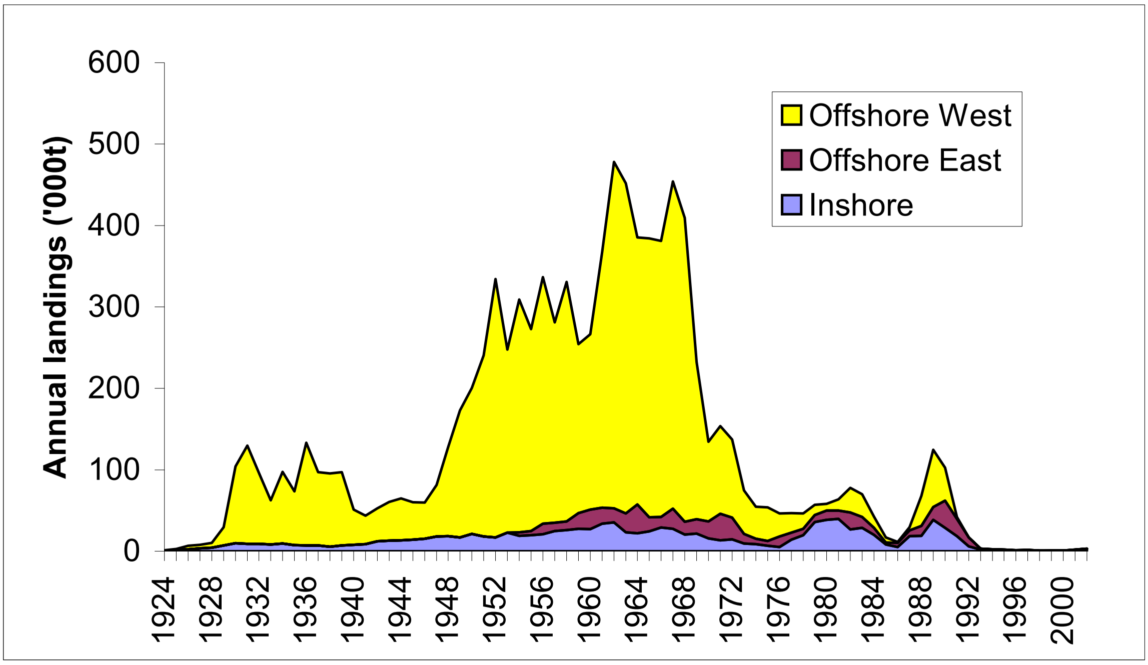


Figure 5.1.1 Cod off Greenland. Catches 1955-2002 as used by the Working Group, inshore and offshore by West and East greenland (Horsted 1994,2000).

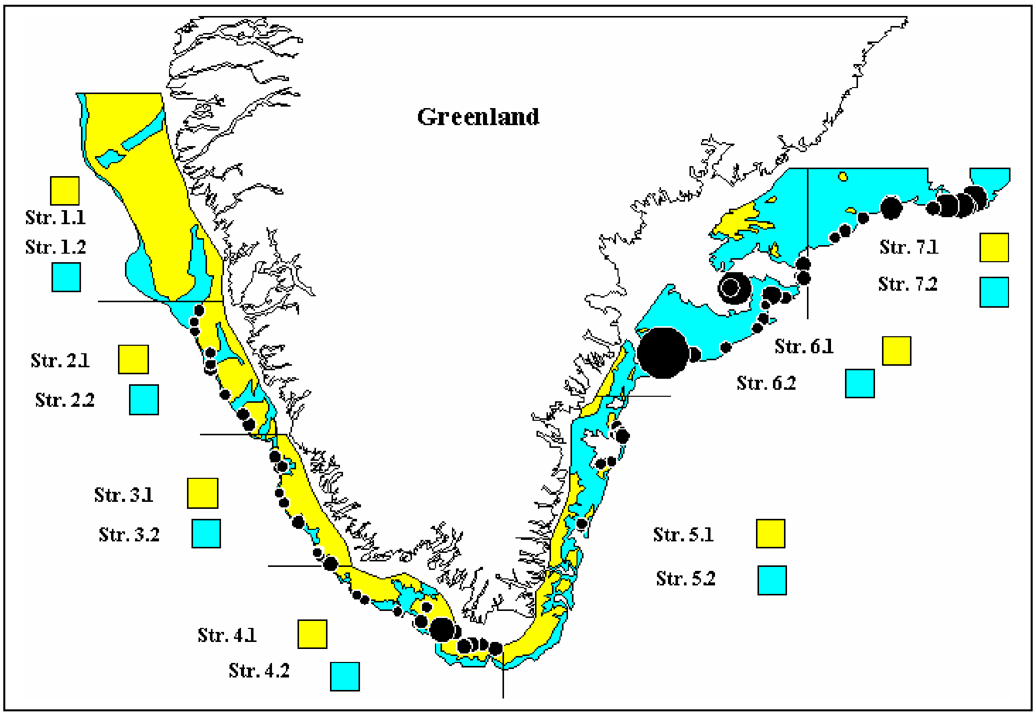


Figure 5.1.2 Cod off Greenland (offshore component), German survey. Survey area, stratification and position of hauls carried out in 2002.

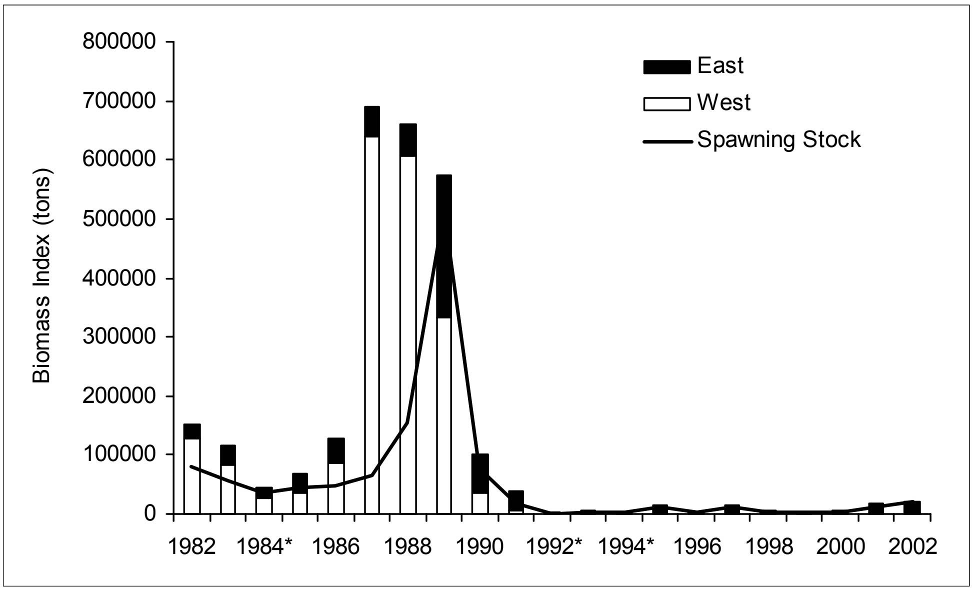


Figure 5.1.3 Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-2002. *)incomplete survey coverage.

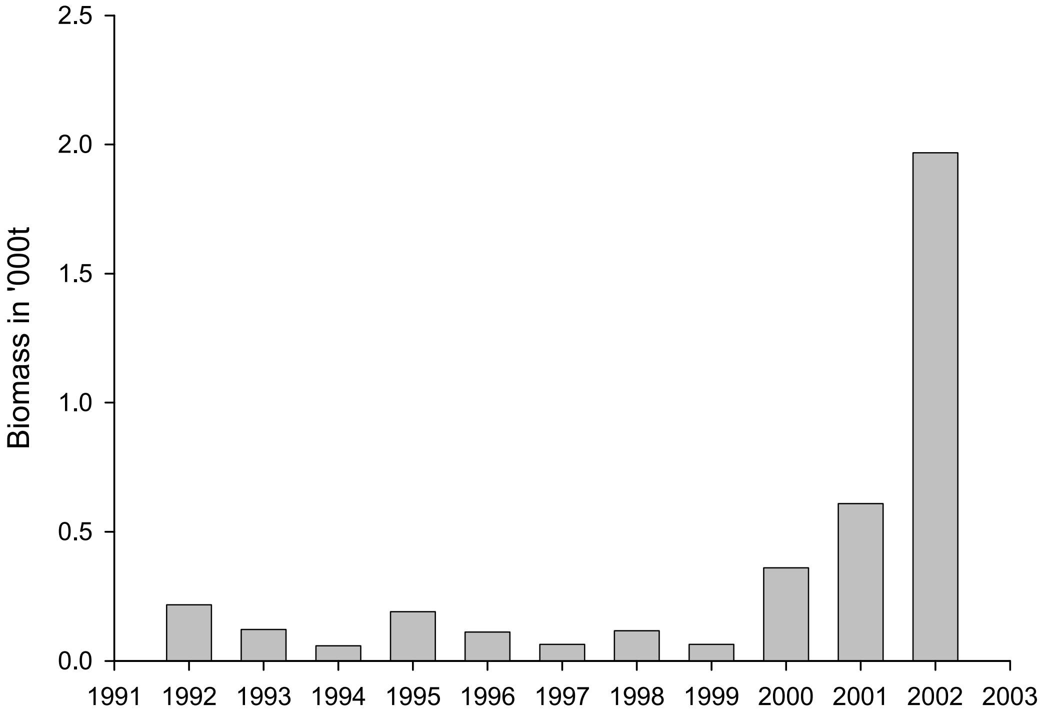


Figure 5.1.4 Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2002.

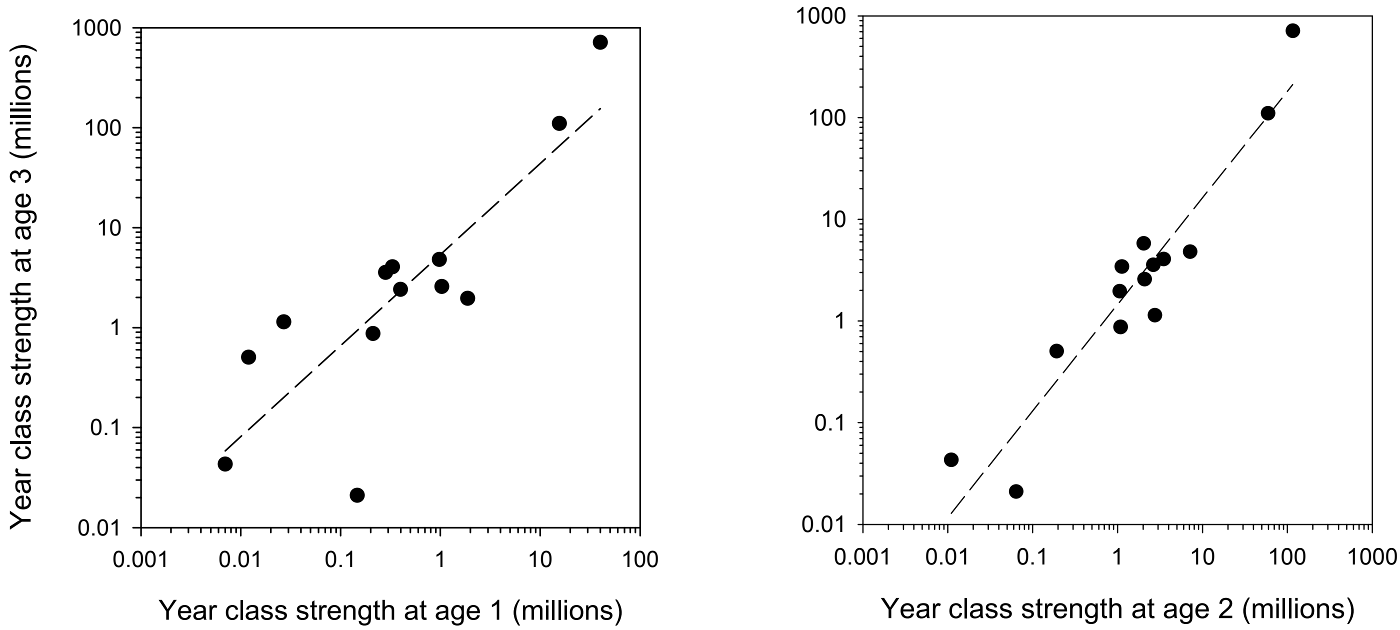


Figure 5.1.5 Comparison of survey estimates of abundance at age 3 in a given year with age 1 two years earlier (r^2= 0.70) and with age 2 one year earlier (r^2= 0.90) for East and West Greenland offshore cod. Years with incomplete coverage off East Greenland omitted. Data derived from Working Doc 3/2003.

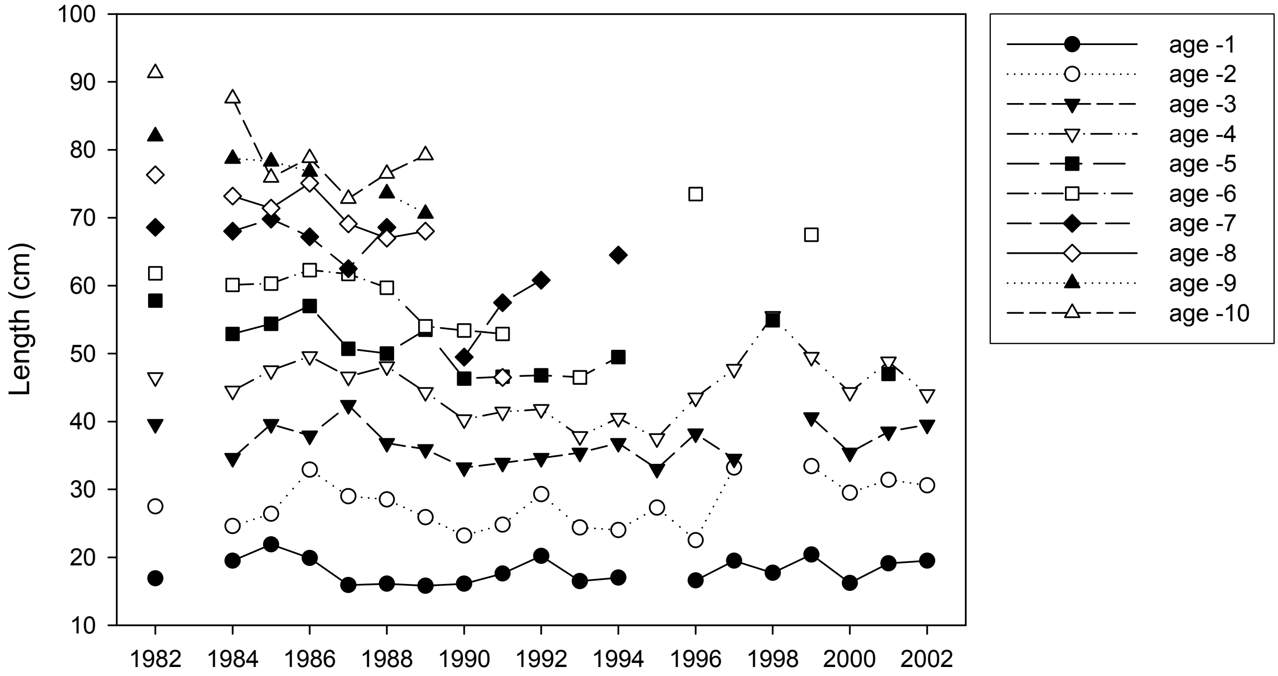


Figure 5.1.6 Weighted mean length-at-age 1-10 years 1982, 1984-2002 sampled in West Greenland (offshore component). Data derived from Working Doc 3/2003.

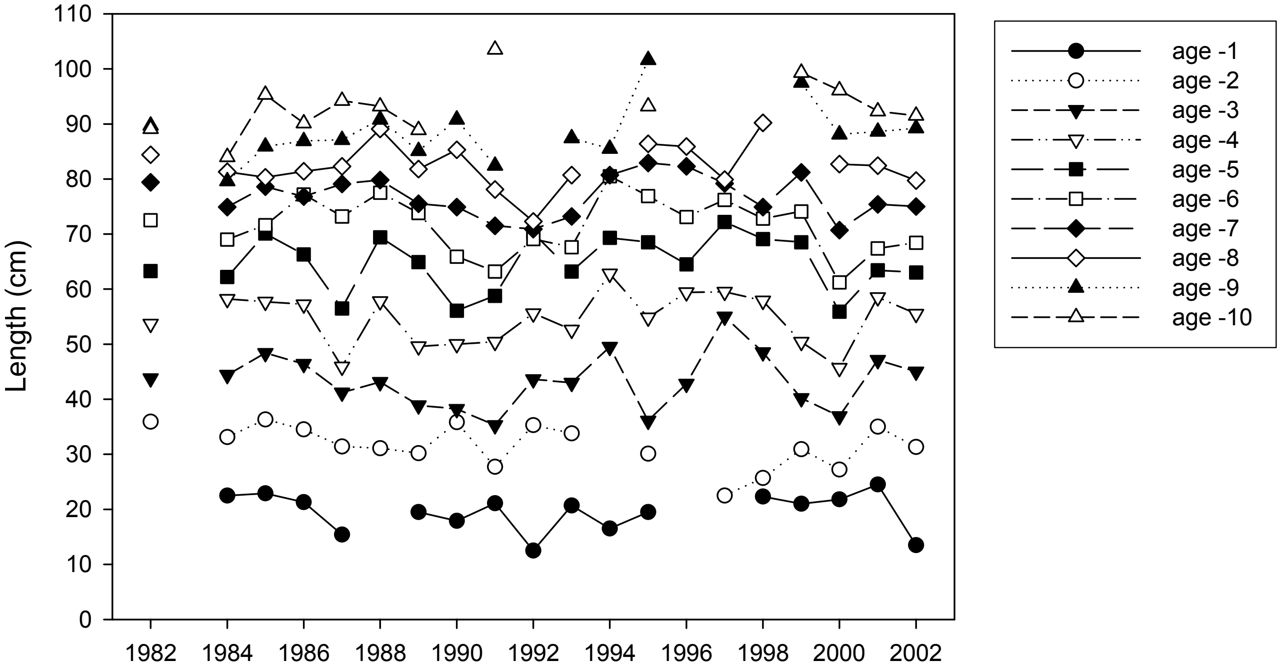


Figure 5.1.7 Weighted mean length-at-age 1-10 years 1982, 1984-2002 sampled in East Greenland (offshore component). Data derived from Working Doc 3/2003.

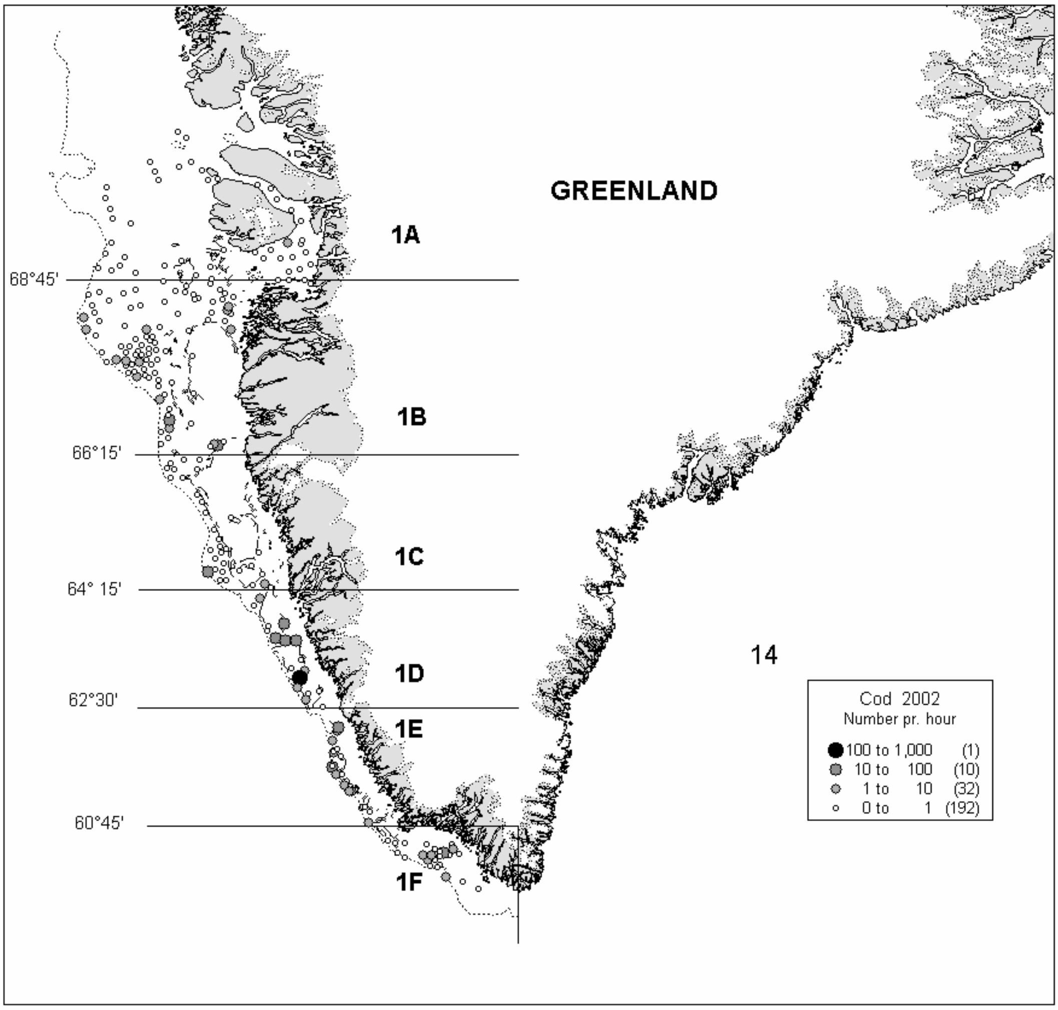


Figure 5.1.8 Number of cod /hour trawl off Greenland (offshore component), Greenland survey. Survey area, stratification and position of hauls carried out in 2002.

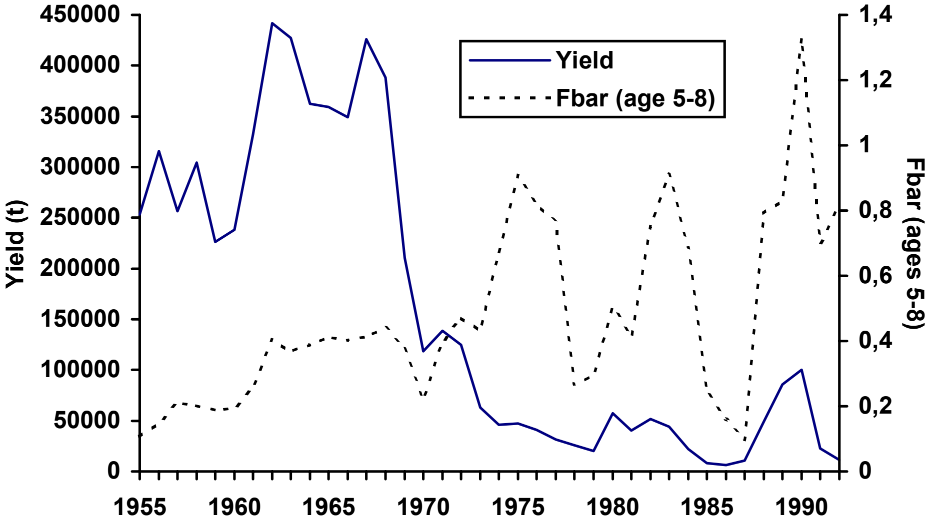


Figure 5.1.9 Greenland cod (offshore component). Trends in yield and fishing mortality.

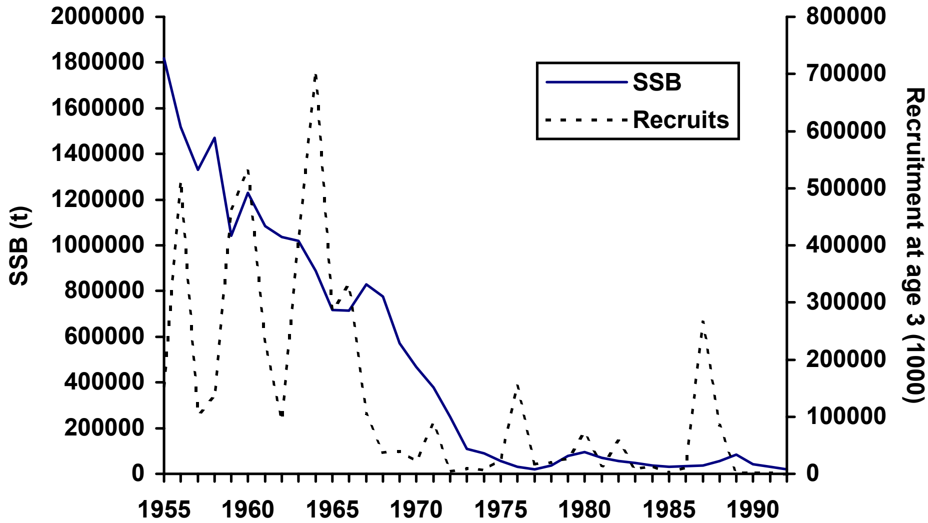


Figure 5.1.10 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

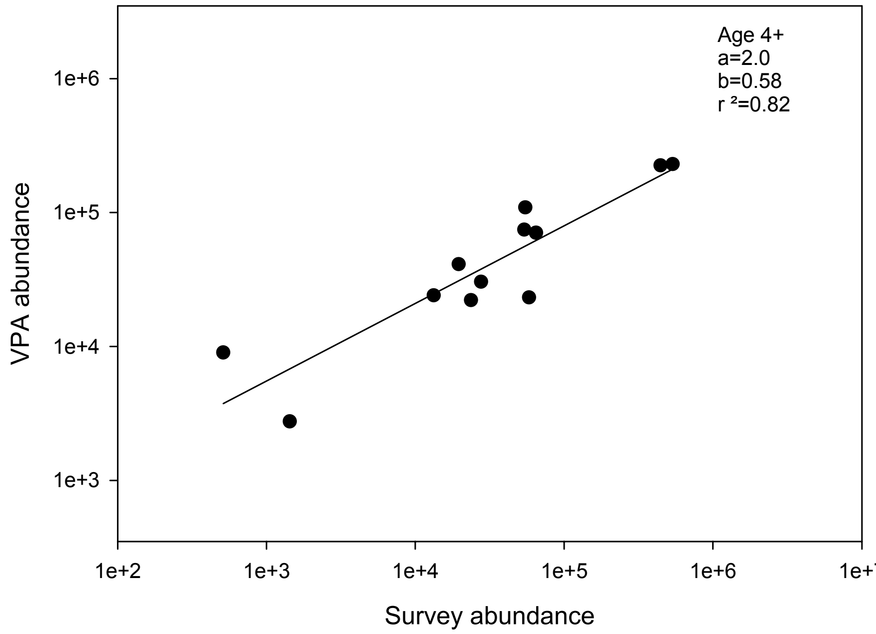


Figure 5.1.11 The relationship between the historic VPA abundance (4+) and survey abundance (4+) in the overlapping time period 1982-1993 (offshore component).

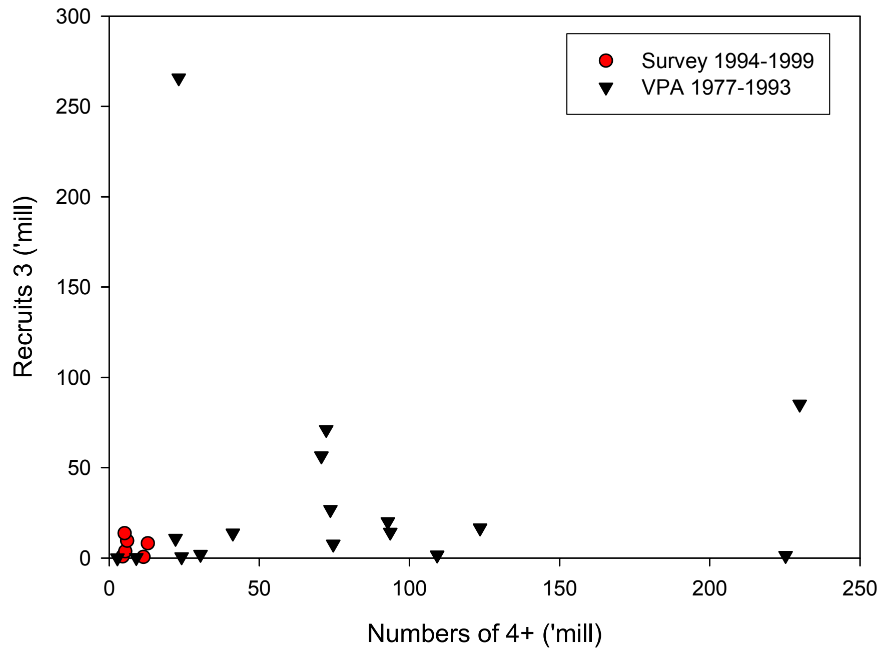


Figure 5.1.12 The relation between the abundance of the 4+ group from the historic VPA and the German survey (converted to the VPA by the regression from figure 5.1.11) versus the 3 years old recruits. The very high recruit number (265 mil.) with corresponding low 4+ group is the 1984-year class from Iceland. The high number of 4+ with corresponding very low recruits is also caused by the 1984 year class homing to Iceland before spawning (offshore component).

5.2 Inshore cod stock off Greenland

Spawning cod is documented for several fjords and costal areas between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al*., 1994). The inshore cod populations are believed to be relatively stationary, as most (82-86%) of the cod recaptured were found in the same area as they were tagged (Hovgård and Christensen 1990). Some interactions between the offshore and inshore cod stocks probably exist as the strong 1984- and partly 1985 year class was registered in the inshore gillnet survey as well as in the inshore landings. These strong year classes are believed to be Icelandic cod spawned off South-western Iceland. Some year's larvae are carried by the Irminger current to settle in South and West Greenland and contribute to the local fjord populations (Wieland and Hovgaard 2002).

5.2.1 Trends in Landings and Effort

The Greenland commercial cod fishery started locally in West Greenland in 1911 at some localities where cod seemed to occur regularly during summer and autumn. It took 15 years to reach 1 000t (Hansen 1949). In 1924 an offshore fishery started and until 1974 the inshore catches have been of limited importance accounting for only 5-15% of the total fishery in Greenland water. Annual catches above 20 000t have been taken inshore during the period 1955-1969 and in 1980 and 1989 catches of approximately 40 000t were landed, partly driven by a few strong year classes entering from the offshore stock (Horsted 2000). Due to the very low offshore catches the importance of the inshore landings has increased accounting for between 50-90% landings in the period 1993 –2002. In the same period the inshore landings have been fluctuating between 500-4 000t.

In 1998 the lowest catch since 1918 was registered with at 326t. Slight improvements have been registered since 1999 with catches increasing to approximately 1 700t in 2001 and the preliminary statistics for the catches in 2002 is close to 4 000t. Especially NAFO division 1 B has experienced an increase, accounting for nearly 70% of the total inshore landings in 2001 (table 5.2.1).

Pound nets, gillnets and handlines are used to take about 95% of the inshore catch.

A commercial pound net CPUE series is available between 1992-1999. The mean catch per pound net setting decreased from 804 t in 1994 to 284 in 1999. No commercial effort data from 2000 to 2002 and catch-at-age data in 1997-1998 and 2000-2001 have been available to the working group.

5.2.2 West Greenland young cod survey

A survey using gangs of gillnets 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 Div. 1F), Nuuk (Div. 1D) and Sisimiut (Div. 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 Greenland and Iceland shows up here. Technical problems caused that only Division 1D was covered in 1999, and again in 2000 only Div. 1D and Div. 1F was covered. A more detailed description of the survey is provided in the 2001 report and WD 16/2003. No survey took place in 2001 and in 2002 Div. 1B and 1D were covered.

The recruitment index of 2-year old cod is shown in Figure 5.2.1 and reveals a strong 1984 -year class, a moderate 1985,1987, 1990- and 1993-year class and four successive weak year classes up to 2000. The very low 1997- and 1998-class year might not be representative due to insufficient survey coverage. An increase in 2-year recruits was observed in 2002 Div 1B, reaching the levels from 1986-87 suggesting a strong 2000 year class in this division however as this area has not been covered during the three previous years, the size of the year class remains uncertain. In Div 1D the depleted status of the stock was confirmed in 2002 being only 7% of the 1984 year class.

5.2.3 Assessment of the stocks

Previously an 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.

Catch-at-age data for the period 1985-1996 and for 1999 and 2002 were available to the working group (Table 5.2.2). A statistical age structured model implemented MS Excel on the inshore cod stock was used as an exploratory tool to estimate the likely historical stock and exploitation dynamics. The model is based on a forward projection of stock in numbers, estimating initial stock size, selectivity by age, fishing mortality of each year and catch-at-age and minimizes the latter with the observed catch-at-age. A natural mortality of 0.2 was used as a scaling factor. The analysis was stabilized by tuning it with age-based survey index for age groups 1 to 4 from the West Greenland young cod survey (Table 5.2.3). The selection pattern was assumed to be the same over the time period. Selectivity was estimated for age groups 2, 3 and 4 but set to unity for older age groups. The relationship between population numbers and survey indices was assumed to be of a simple linear form (i.e. no power function applied). The error structure of the catches and the survey was assumed to be of lognormal form in the minimization function. The age classes where given different weights, the procedure being described in the WD32/2003. Equal weights were given to both input matrices and a penalty was added to force the predicted yield with that observed.

The residuals suggest that the data are relatively noisy (Figure 5.2.2). A positive trend in the survey data compared to the commercial data is observed from the beginning of the series until and including 1998. Applying a simple linear model to the estimator of survey catchability for the period 1985-1998 indicate an increase in survey catchability by about 22% per year. The apparent efficiency increase in the survey needs further investigation.

The historical stock dynamics indicate that the stock is currently around 10% of the maximum (Figure 5.2.3). Fishing mortality of the stock has been relatively low in recent years, but may be increasing. There are indication of improved recruitment relative to that observed in the last decade.

The residual pattern in the survey as well as lack of catch-at-age data in many of the recent years make the current assessment a relatively poor basis for mangement advice. Continous annual measurements and ageing of the catch composition as well as the continuation of the survey may however change that in the forseeable future.

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 regulations. The data presented indicate that the stock has undergone a series of recruitment poor in recent years, but recovery potential is observed in Div 1B in 2002. No fishing should take place at this time until continues increase in recruitment and CPUE is evident.

Table 5.2.1 Cod catches divided to NAFO -divisions, caught inshore from vessels > 50 GRT (Horsted 2000, Statistic Greenland 2002). *Not broken down to NAFO division.

Year\Div	Nafo 1A	Nafo 1B	Nafo 1C	Nafo 1D	Nafo 1E	Nafo 1F	Total
1984	175	3908	1889	5414	1149	1333	19958
1985	149	2936	957	1976	1178	1245	8441
1986	76	1038	255	1209	1456	1268	5302
1987	97	2995	536	8110	4560	1678	8402
1988	333	6294	1342	2992	3346	4484	22829
1989	634	8491	5671	8212	10845	4676	28529
1990	476	9857	1482	9826	1917	5241	29026
1991	876	8641	917	2782	1089	4007	18311
1992	695	2710	563	1070	239	450	5723
1993	333	323	173	968	18	109	1924
1994	209	332	589	914	11	62	2115
1995	53	521	710	332	4	81	1710
1996	41	211	471	164	11	46	948
1997	18	446	198	99	13	130	1186
1998	9	118	79	78	0	38	319
1999	68	142	55	336	8	4	622
2000	154	266	0	332	0	12	764
2001	117	1183	245	54	0	81	1680
2002							3698*

Table 5.2.2 Catch-at-age (abundance in millions) 1985-2002, missing values in 1997,1998,2000 and 2001.

Year\Age	1	2	3	4	5	6	7	8	9
1985				0.742	0.588	2.464	0.154	0.604	0.016
1986				0.172	0.170	1.245	0.117	0.565	0.014
1987		0.043	0.594	7.638	4.153	0.320	0.877	0.229	0.415
1988		0.052	0.214	7.533	6.446	0.421	0.452	0.088	0.184
1989		0.006	0.218	11.813	12.619	1.318	1.369	0.172	0.276
1990		0.002	0.154	10.169	9.340	2.632	0.742	0.137	0.116
1991		0.004	0.125	7.177	8.562	2.499	0.288	0.012	0.003
1992		0.001	0.051	1.767	2.634	0.730	0.126	0.008	0.005
1993		0.000	0.029	0.647	0.706	0.208	0.044	0.006	0.006
1994		0.001	0.053	1.152	0.727	0.079	0.053	0.012	0.003
1995			0.008	0.593	0.729	0.140	0.036	0.001	0.001
1996			0.002	0.148	0.262	0.119	0.056	0.009	0.007
1997									
1998									
1999			0.082	0.396	0.238	0.037	0.004		
2000									
2001									
2002		0.001	0.565	1.952	1.282	0.333	0.091	0.000	0.000

Table 5.2.3 CPUE (number of age 1,2,3 and 4 cod caught per 100 hours net setting) in the Greenland Gillnet cod survey covering West Greenland 1987-2002.

Age	1	2	3	4
1985	107.51	45.36	0.37	2.53
1986	6.22	124.04	11.77	1.26
1987	0.34	75.04	119.82	6.73
1988	0.03	15.27	72.32	34.32
1989	0.11	58.47	37.33	21.67
1990	0.00	24.12	34.95	12.22
1991	63.63	2.40	29.00	12.16
1992	0.10	38.22	13.14	7.69
1993	0.00	6.89	33.20	10.45
1994	0.65	1.40	6.37	4.32
1995	0.23	18.95	3.76	3.16
1996	0.00	7.45	10.32	1.66
1997	1.92	5.88	2.71	0.82
1998	0.32	7.66	13.46	1.28
1999	0.00	0.40	1.20	2.70
2000	0.12	6.96	4.14	0.40
2001	no	survey		
2002	7.25	53.24	19.61	6.89

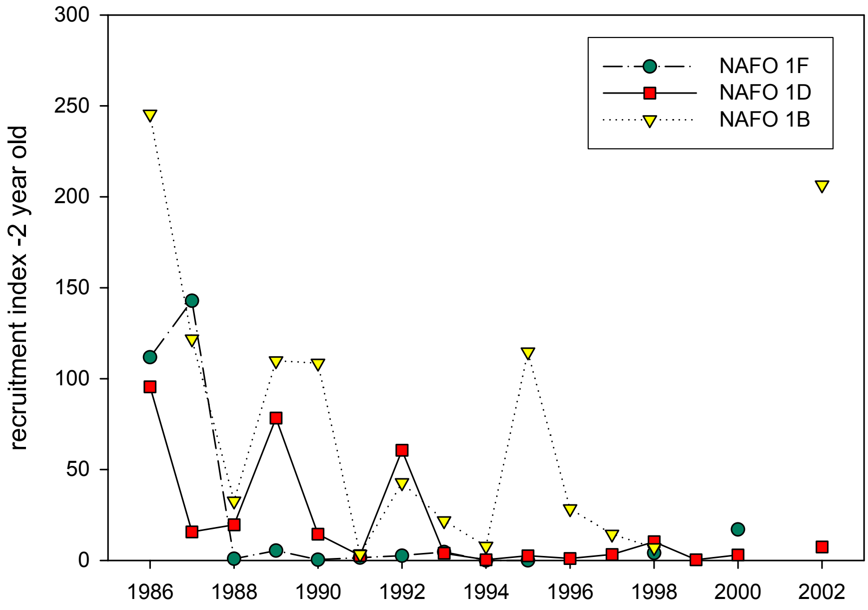
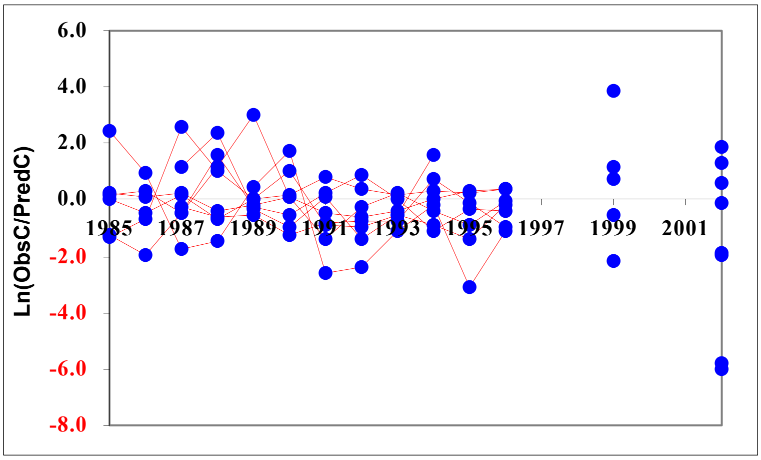


Figure 5.2.1 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland Young cod survey 1985-2002 (inshore component). The three areas covered in the survey are shown in triangel (NAFO 1 B), squares (NAFO 1D) and diamonds (NAFO 1F).



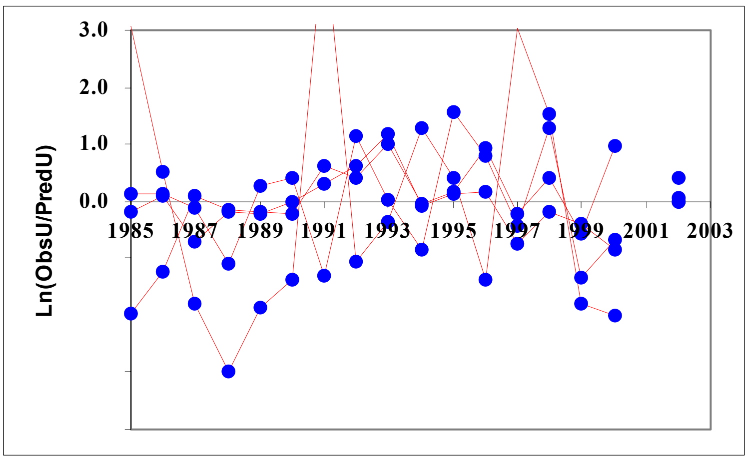


Figure 5.2.2 Greenland cod (inshore component). Catch-at-age model showing the residuals in the two input components survey and catch-at-age matrix.

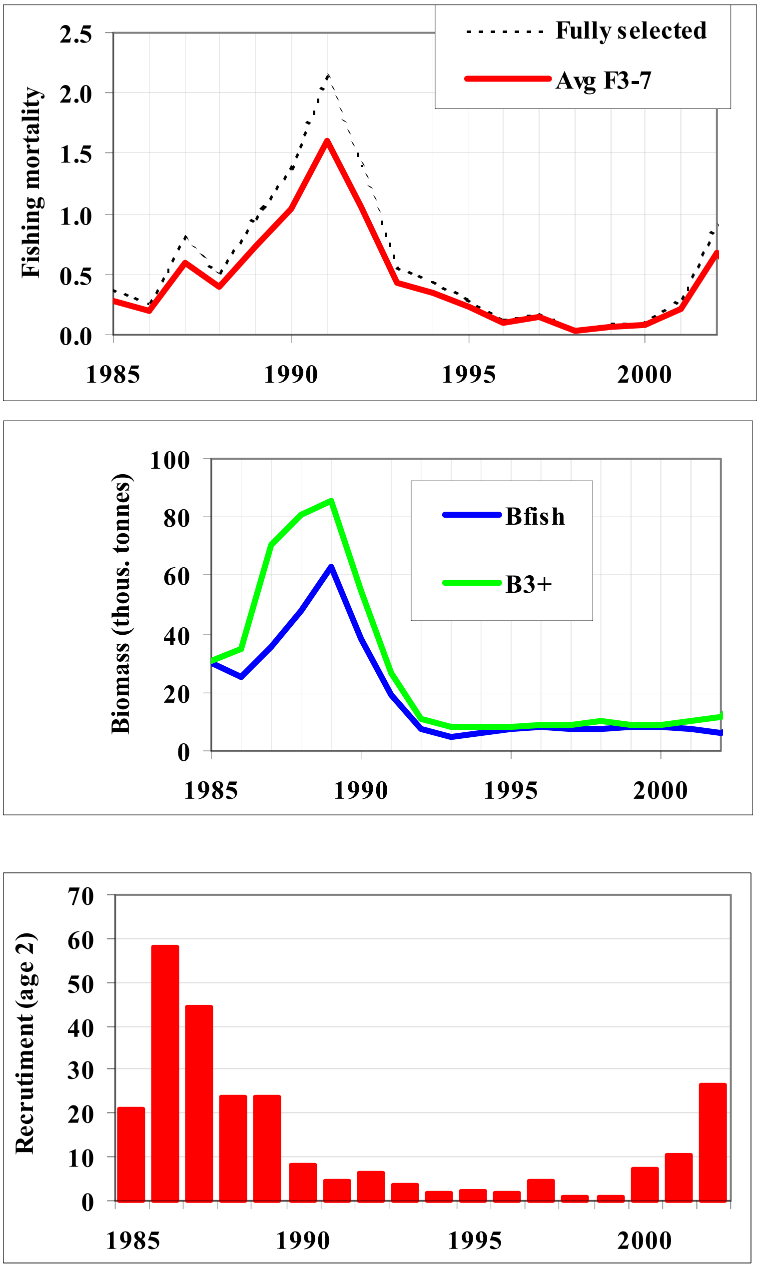


Figure 5.2.3 Greenland cod 1985-2002 (inshore component). Catch-at-age model showing fishing mortality, exploitation rate the residuals between the two input components survey and catch-at-age matrix.

6 GREENLAND HALIBUT IN SUBAREAS V AND XIV

6.1 Landings, Fisheries, Fleet and Stock Perception

Total annual landings in Divisions Va, Vb, and Subareas XII and XIV are presented for the years 1981–2002 in Tables 6.1.1–6.1.5 and since 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 and 29 kt in 2002. 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 have risen again to 14 kt in 2000 and about 16 kt in 2001 and 19 kt in 2002 Faroese catches in Vb increased from 1 kt in 1981–1991 to 6.5 kt in 1996, but was of the order of 4-5 kt in during 1997-2001. In 2002 catches decreased to 2.6 kt. 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 the catches 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 2002. Table 6.1.6 describes the Working Group's best landing estimates for the year 2002 with respect to area and gear. In the Greenland EEZ, only about 50% of the national allocated total quotas were fished.

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 from 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 late summer (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 at 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 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 depths between 500 to 700 meters, in waters of Faroe Islands, as well as along the continental slope off East Greenland. The sizes 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. The 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 1985–2002 (Table 6.2.1, Fig. 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 trawling fleets in Divisions Va, Vb and XIVb were used to estimate the total effort for each year (y) for each of the divisions according to:

$$E_{y,div} = Y_{y,div} / CPUE_{y,div}$$

where E is the total effort and Y is the total reported landings (Table 6.2.1).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1995, but stabilised in 1995–1997. In 1998, an increase of 60% in CPUE was observed for all fishing grounds coinciding with a drastic (60%) reduction in effort (Table 6.2.1, Figure 6.2.1). In 1999 to 2001 CPUE increases annually between 4 – 15% until 2002 when CPUE decreased by 24%. The total effort increased up to 1995, decreased significantly until 2001, but increased again in 2002 by 54 %. Effort during 1998-2001 has been less than half of that in 1995-97.

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2002 (Table 6.2.1), which represents an extension in the time-series back in time as compared to last year (1995-2001). It is a rather 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. Only hauls where G.halibut consisted of more than 50% of the catches and conducted on depths more than 450 meters were selected for the analyses. The logbooks were standardised with a multiplicative model using logCPUE as dependent variable, taking into account locality, vessel, month, and year. The fishery is fairly new in the area and has increased from about 1500 t in 1991 to 5000 t in 2000. CPUE decreased in the early period by about 10% coinciding with a significant increase in effort. Since 1994 CPUE's have been stable and effort has thus followed the development of the catches (Fig. 6.2.1).

For Division XIVb, logbook data was available from German, Norwegian, Faroese, Russian, Japanese and Greenland fleets. Hauls where targeted species was G.halibut and where catch weight exceeds 100 kg were selected as no information on other species caught was available. CPUE from logbooks in the years 1991–2002 were standardised using a multiplicative model taking into account locality, fleet, month and year and logCPUE as dependent variable (Table 6.2.1, Fig.6.2.1). CPUE increased significantly from 1993 to 1994, where after it remains relatively stable. Effort increased continuously until 1997, but declined by 30% until 1999. Since 1999 the effort increased and is high in 2002. 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, and subsequently the increase in CPUE should not be taken indicative for the stock development.

The three CPUE series from Divisions Va, Vb and XIVb show contradictory trends in the period 1991 to 2002 (Fig.6.2.1). CPUE's in Vb and XIVb area stable for the period 1994 to 2002, while those series shows contradicting trends prior to 1994. In XIVb CPUE's increased from 1993 to 1994, while CPUE's decreased for Div. Vb in the same period. The Icelandic CPUE's (Va) shows yet another trend, decreasing since the late 1980'ies until 1996. From 1996 to 2001 CPUE's increased somewhat but decline again in 2002. This could indicate different stock status in the areas, but could also be artefacts, i.e. due to different behaviour of the fleets, migration between areas or/and caused by the different criteria for selection of hauls included in the standardisation. A compilation of an overall database of logbook data from all the areas is undertaken.

6.3 Catch-at-age

Age-length keys for 2002 were from: the Icelandic trawl fleet operating in Icelandic waters (424 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	16337	111	14571	Icelandic bottom trawl
Bottom trawl	Iceland-north & east	1476	13	1199	Icelandic bottom trawl
Bottom trawl	Iceland-southeast	1901	14	1665	Icelandic bottom trawl
Gill Net (&line)	Faroe Islands	1975		1421	Icelandic bottom trawl
Bottom trawl	Faroe Islands	821		449	Icelandic bottom trawl
Long line	East Greenland	795	73	6702	Icelandic bottom trawl
Bottom trawl	East Greenland	3797	19	1953	Icelandic bottom trawl
Total		27102	230	27960	

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	$W = 0.000041* L^{3.245}$	Longline data, 2002, N = 3175

The total catch in numbers (Table 6.3.1) was obtained from the sum of the above weighted with the catch within each group. Data for 1994 and 1996 – 2002 derives from several nations fishing, while only Icelandic data has been available for the remaining years back in time.

6.4 Weight-at-age

The mean weight-at-age in 2002 (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. The suspect weight-at-age pattern as observed in 2002 is due to a change in the age-length key (age-readings). As growth of Greenland halibut is known not to show such variability, the age-readings will be further inspected before included in any age based assessment.

6.5 Maturity-at-age

Maturity data were not updated for 2002 as visual determination of maturity has been questionable as stated in 2001 report. Maturity for 2002 is thus compiled as an average of 1996-2000.

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 6.6.1b). 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. In 2002 abundance of all length groups are below that observed in 2001. Biomass indices have increased in the survey since the beginning in 1996, although variable since 1999 (Fig. 6.6.1a).

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 2002 a total of 40 stations were hauled. No survey took place in 2001. Total estimated biomass in 2002 was estimated at 15 kt, which is a 40% decrease (not significant at the 95% level) from the 2000 biomass estimate (Fig. 6.6.2). The age composition in the survey does indicate a decrease in abundance of juveniles for 2002.

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 has been considered unreliable due to poor diagnostics mainly caused by inconsistent sampling and age readings (see section 6.9), and was thus rejected as a basis for advice. No attempt was made this year to run an age-based assessment due to the questionable input data. In the 2002 report is given the historic trends in log(q) residuals and the retrospective pattern of F. Based on those plots the Working Group in 2002 decided that an XSA model was not a reliable estimator of recent stock history.

6.7.2 Stock production model

A stock-production model approach, ASPIC, was attempted on the various indices and catches. ASPIC 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 Div. Va, (formerly used as a tuning fleet in the XSA), Vb and XIVb, and in addition several survey series (Figure 6.2.1) were available:

Fleet and index	Period	Division
Icelandic trawler CPUE from GLIM	1973-2002	Va
Icelandic fall groundfish survey	1996-2002	Va
Icelandic shrimp fishery	1986-1994	Va
Icelandic shrimp survey	1987-2000	Va
Greenland trawler CPUE from GLIM	1991-2002	XIVb
Greenland spring deepwater bottom-trawl survey	1997-2000, 2002	XIVb
Faroese trawler CPUE from GLIM	1991-2002	Vb

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. The Greenland deepwater survey only consist of a short time-series with lack of a 2001 survey and was therefore not used. A run using the remaining four indices failed due to conflicting trends for the CPUE series in Divs. XIVb and Vb in the early 1990'ies. 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 beginning of the fishery.

ASPIC (BETA vers 4.45) requires starting guesses for *K*, carrying capacity, MSY and B1/K ratio (Initial biomass/K). ASPIC was run fitting a logistic model conditioned on catch as in previous two years. 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 incredibly stable. The parameter estimates from ASPIC are comparable to last year (Table 6.7.2.1.). MSY is estimated to 35 kt and $\mathbf{B}_{MSY}$ to 114 kt. Biomass in 2003 is estimated to be about 22% below $\mathbf{B}_{MSY}$ and fishing mortality in 2002 is estimated to be 10% above $\mathbf{F}_{MSY}$. Observed and estimated CPUE's are provided in Fig. 6.7.2.1.

The state of the stock relative to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$ is given in the Fig 6.7.2.2. Biomass is increasing from a record low in 1998 and in 2003 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 in the 2002 NWWG report 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. ASPIC behaves consistent when contrasting data is available, e.g. back to about 1997.

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 2003 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 2002 and that the Icelandic fleet will catch all its quota, it is anticipated that total landings in the year 2003 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 above $\mathbf{B}_{MSY}$ by 2006. Fishing at $\mathbf{F}_{sq}$ will result in $\mathbf{B}_{MSY}$ never be achieved, although the 80% confidence interval includes attaining $\mathbf{B}_{MSY}$. Fishing at 30 kt annually is expected to allow recovery to $\mathbf{B}_{MSY}$ by 2009, but with a significant risk (80% confidence intervals) that the stock will collapse. Landings in 2004 associated with the trajectories are 20 000 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 $^{1.645\sigma}$, where 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 or even collapse.

6.9 Comments on the Assessment

An analytical assessment (XSA) was previously attempted but rejected due to poor diagnostics and a substantial new perception of the stock size. Both former XSA and the recent 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 trawler CPUE series as previously used in the XSA. Output estimates of biomass and fishing mortality of the production model cannot be taken at face value, but should rather be good estimates of the state of the stock in relation to MSY parameters.

Use of other indices than the currently Icelandic (Va) CPUE series and survey series in the stock production model (ASPIC) should be explored. CPUE series from XIVb and Vb are presently available, but due to different trends than the Icelandic series it impede inclusion in the ASPIC.

Table 6.1.1. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-areas V, XII and XIV 1981-2002, 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 [1]	1997 [1]	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	1 939	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	30 242	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	2002
Denmark		-	0	0
Faroe Islands	3 884	-	0	0
France	-	21	25	20
Germany	3 082	3 271	2 807	2 148
Greenland	200	1 740	1 553	0
Iceland	11 180	14 537	16 590	19 223
Ireland		-	7	
Norway	1 187	1 272	1 483	1 328
Portugal			6	
Russia	138	183	186	44
Spain		8	10	
UK (Engl. and Wales)	261	370	227	
UK (Scotland)	69	121	130	
United Kingdom	-	-		441
Total	20 001	21 523	23 024	23 204
Working Group estimate	20 371	26 839	28 021	29 260

1) Provisional data

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-2002, 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								[1]	[1]
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	2001	2002 [1]
Faroe Islands	9			
Germany	13	22	50	31
Greenland	[1]			
Iceland	11 087	14 507	2 310 [4]	19 223
Norway			6	
UK (E/W/I)	26	73	50	
UK Scottland	3	5	12	
UK				37
Total	11 138	14 607	2 428	19 291
Working Group estimate		14 519 [3]	16 752	19 714

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) 14280 t fished in Icelandic EEZ, previously reported in Va, are in 2002 moved to ICES XIV b.

Table 6.1.3 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-2002, 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 [1]	114 [1]
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]	-	-		-	-	0

Country	1999	2000 [1]	2001	2002 [1]
Denmark				
Faroe Islands	3873			
France		21	25 [1]	20
Germany	22	6	7	
Iceland				
Ireland			+	
Norway	87	110 [1]	53 [1]	48
UK (Engl. and Wales)	9	35	77	
UK (Scotland)	66	116	118	
United Kingdom				202
Total	4057	288	280 2	270
Working Group estimate	2694 [2]	5092 [3]	3 951	2 694

1) Provisional data
2) WG estimate includes additional catches as described in Working Group reports for each year and in the report from 2001.

Table 6.1.4 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-2002, 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 [1,7]
Iceland	-	-	-	19	82	7	-	1 803	148
Norway	8	18	196	511	1 120	1 668	1 881	1 897 [1]	1 253 [1]
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	8 533	5940
Working Group estimate	736 [2]	875 [3]	1 176 [4]	2 249 [5]	3 125 [6]	5 077 [7]	7 283 [8]	8 558 [9]	

Country	1999	2000	2001 [1]	2002 [1]
Denmark				
Faroe Islands	2			
Germany	3047	3243	2 750	2 117
Greenland	200 [1,4]	1740 [8]	1 553 [9]	
Iceland	93	30	14 280	
Ireland			7	
Norway	1100	1162 [1]	1 424	1 280
Portugal			6	
Russia	138	183	186	44
Spain		8	10	
UK (Engl. and Wales)	226	262	100	
UK (Scotland)				
United Kingdom				202
Total	4806	6628	20 316	3 643
Working Group estimate	5376 [11]	6588 [5]	6 588 [6]	6 750

1) Provisional data

2)WG estimate includes additional catches as described in working Group reports for each year and in the report from 2001.

3) Includes 125 t by Faroe Islands and 206 t by Greenland.

4) Excluding 4732 t reported as area unknown.

5) Includes 1523 t by Norway, 102 t by Faroe Islands, 3343 t by Germany, 1910 t by Greenland, 180 t by Russia, as reported to Greenland authorities.

6) Includes 2849 t by Greenland, 142 t by Norway, 2750 t by Germany. Does not include 14280 t by Iceland as those are included in WG estimate of Va.

7) Excluding 138 t reported as area unknown.

8) Excluding 16 t reported as area unknown.

9) Excluding 20 t reported as area unknown

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	2002
Faroe Islands		47					
Norway	2						
Total	2	47	-	-	-		
WG estimate							102 [1]

[1] 102t by Faroe Islands as reported to Faroe Island authorities

Table 6.1.6. 2002 Catch statistics for Greenland halibut in V and XIV.
Working Group best estimates.

Va	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands					0	
Germany, Fed. Rep.		31			31	31
Greenland				424	424	424
Iceland	180	18 307	772		19 259	19 233
Norway					0	
UK (E/W/NI)					0	
UK (Scotland)					0	
UK		37			37	37
Total	180	18 338	772	424	19 714	19 725

Vb	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands		449	1 975		2 424	
France				20	20	20
Germany Fed. Rep.					0	
Norway				48	48	48
UK (England & Wales)					0	
UK (Scotland)					0	
United Kingdom				202	202	202
Total	0	449	1 975	270	2 694	270

XII	Long line	Trawl	Gill Net	Unknown	SUM	SUM
Faroe Islands	0				0	
Total	0	0	0	102	102	0

XIV	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands		193			193	
EU (GER)		2 158			2 158	2 117
Greenland		2 091	91	618	2 800	
Iceland (outside 200 EEZ)					0	
Norway (inside 200 EEZ)	704	715			1 419	1 280
Norway (outside 200 EEZ)					0	
Portugal		130			130	
Russia		50			50	44
Ireland					0	
UK (England & Wales)					0	
UK (Scotland)					0	
United Kingdom					0	201
Total	704	5 337	91	618	6 750	3 642

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM	SUM
	884	24 124	2 838	1 414	**29 260**	23 637

Table 6.2.1. CPUE indices of trawl fleets in Div. Va, Vb and XIVb 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		29,197	29	
	1986	0.91	-9	31,027	34	7
	1987	0.88	-4	44,659	51	50
	1988	0.96	9	49,379	51	-6
	1989	0.91	-5	59,272	65	21
	1990	0.74	-19	37,308	50	-10
	1991	0.75	2	35,413	47	-11
	1992	0.65	-14	31,978	49	19
	1993	0.50	-23	34,134	68	36
	1994	0.41	-19	28,608	70	18
	1995	0.31	-24	27,391	88	28
	1996	0.26	-17	22,073	85	14
	1997	0.29	11	16,792	58	-18
	1998	0.46	61	10,595	23	-56
	1999	0.53	15	11,138	21	-12
	2000	0.59	10	14,519	25	22
	2001	0.61	4	16,752	27	-13
	2002	0.47	-24	19,714	42	54
Greenland, XIVb	1991	1.00		875	0.9	
	1992	0.87	-13	1,176	1.4	54
	1993	0.92	6	2,249	2.4	80
	1994	1.18	28	3,125	2.6	9
	1995	1.13	-5	5,077	4.5	70
	1996	1.14	2	7,283	6.4	41
	1997	1.19	4	8,558	7.2	13
	1998	1.20	0	5,940	5.0	-31
	1999	1.08	-9	5,376	5.0	0
	2000	1.18	8	6,588	5.6	13
	2001	1.11	-5	6,588	5.9	6
	2002	1.11	0	6,750	6.1	3
Faroe Islands, Vb	1991	1.00		1,662	1.7	0
	1992	1.02	2	2,269	2.2	34
	1993	0.95	-6	4,434	4.7	108
	1994	0.90	-6	5,225	5.8	25
	1995	0.89	-1	3,832	4.3	-26
	1996	0.88	0	6,469	7.3	70
	1997	0.86	-2	4,870	5.7	-23
	1998	0.88	2	3,825	4.3	-23
	1999	0.87	-1	2,694	3.1	-29
	2000	0.87	0	5,092	5.9	89
	2001	0.88	1	3,951	4.5	-23
	2002	0.89	1	2,694	3.0	-33

Table 6.3.1 Catch in numbers

GREENLAND HALIBUT ICES V+XIV

At 7/05/2003 11:17

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE								
5,	120,	43,	0,	23,	29,	47,	26,	8,
6,	800,	296,	34,	91,	197,	502,	158,	300,
7,	1775,	584,	671,	347,	1605,	1536,	580,	1140,
8,	1782,	621,	1727,	1037,	2253,	2630,	1160,	2451,
9,	1259,	431,	2289,	1214,	3090,	3126,	1430,	2646,
10,	926,	240,	834,	848,	1693,	2324,	1764,	2456,
11,	464,	121,	420,	567,	880,	1739,	1299,	1803,
12,	459,	86,	423,	312,	394,	849,	664,	963,
13,	279,	37,	174,	232,	246,	578,	435,	609,
14,	193,	32,	120,	218,	189,	306,	252,	331,
15,	137,	14,	28,	114,	147,	143,	176,	195,
16,	39,	6,	86,	112,	101,	82,	114,	82,
0 TOTALNUM,	8233,	2511,	6806,	5115,	10824,	13862,	8058,	12984,
TONSLAND,	23494,	6045,	16578,	14349,	23616,	31252,	19239,	32441,
SOPCOF %,	128,	101,	102,	105,	102,	100,	102,	101,

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

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	10,	83,	125,	245,	182,	129,	499,	188,	289,	17,
6,	240,	277,	441,	612,	3123,	742,	1657,	463,	1225,	421,
7,	1611,	891,	1018,	1033,	4863,	2068,	4485,	1513,	1797,	2023,
8,	2651,	2139,	2295,	1942,	2586,	2985,	5961,	3515,	2866,	3262,
9,	3060,	3568,	3454,	2983,	2156,	3166,	5763,	4186,	2935,	2646,
10,	2443,	2800,	2749,	3097,	3476,	2966,	3246,	3143,	2074,	3019,
11,	1693,	1825,	1452,	1683,	1847,	1848,	1601,	1224,	1130,	1962,
12,	978,	1134,	627,	820,	1829,	1761,	1458,	959,	1072,	1278,
13,	424,	588,	423,	550,	886,	1851,	1237,	568,	924,	509,
14,	174,	363,	137,	202,	243,	701,	506,	358,	554,	144,
15,	37,	92,	36,	59,	31,	216,	362,	137,	342,	36,
16,	17,	13,	46,	30,	1,	246,	145,	61,	82,	56,
0 TOTALNUM,	13338,	13773,	12803,	13256,	21223,	18679,	26920,	16315,	15290,	15373,
TONSLAND,	30891,	34024,	32075,	32984,	46622,	51118,	61396,	39326,	37950,	35423,
SOPCOF %,	102,	100,	103,	101,	98,	101,	100,	100,	101,	100,

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

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	44,	78,	503,	178,	86,	90,	82,	53,	46,	74,
6,	397,	672,	1587,	1488,	549,	550,	366,	313,	176,	391,
7,	1896,	2197,	3031,	2908,	2723,	1882,	1363,	1559,	1016,	2069,
8,	5024,	3815,	3287,	3181,	2579,	2051,	1606,	2279,	2975,	3388,
9,	4324,	3648,	2608,	2119,	2331,	1657,	1828,	1500,	2387,	2621,
10,	2859,	2330,	1963,	1755,	1247,	1067,	1287,	1269,	1574,	1304,
11,	1539,	1715,	1548,	1610,	975,	737,	1018,	1247,	1550,	897,
12,	1412,	990,	1132,	1216,	937,	710,	762,	1016,	1061,	893,
13,	576,	422,	657,	665,	652,	359,	492,	785,	808,	1047,
14,	136,	371,	444,	548,	374,	195,	231,	786,	379,	719,
15,	135,	168,	240,	238,	282,	150,	137,	545,	422,	309,
16,	7,	177,	211,	323,	262,	106,	119,	176,	123,	469,
0 TOTALNUM,	18349,	16583,	17211,	16229,	12997,	9554,	9291,	11528,	12517,	14181,
TONSLAND,	40817,	36958,	36300,	35825,	30267,	20360,	20371,	26839,	28284,	28888,
SOPCOF %,	100,	100,	100,	103,	110,	107,	111,	107,	103,	103,

Table 6.4.1 Catch and stock weight-at-age

Run title : GREENLAND HALIBUT ICES V+XIV

At 7/05/2003 11:17

Table 2 Catch weights-at-age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,
AGE								
5,	.9680,	1.1570,	1.1570,	.9680,	.9110,	1.1250,	1.0710,	1.0100,
6,	1.1990,	1.5850,	1.0460,	1.1990,	.9420,	1.2830,	1.2570,	1.3680,
7,	1.4230,	1.7680,	1.4290,	1.4230,	1.2780,	1.4870,	1.4400,	1.6180,
8,	1.8540,	2.1800,	1.7940,	1.8540,	1.6760,	1.7560,	1.6600,	1.9050,
9,	2.2560,	2.5700,	2.2280,	2.2560,	2.0720,	2.1530,	1.9670,	2.1870,
10,	2.6070,	3.0180,	2.6870,	2.6070,	2.3330,	2.2790,	2.2580,	2.5160,
11,	3.0810,	3.7300,	3.0170,	3.0810,	2.7230,	2.4980,	2.5150,	2.7610,
12,	3.5910,	4.0520,	3.9140,	3.5910,	3.2970,	3.0590,	2.9500,	3.1290,
13,	4.6040,	4.8150,	4.0400,	4.6040,	3.9850,	3.7830,	3.4500,	3.7850,
14,	4.6950,	5.3480,	4.7140,	4.6950,	4.6680,	4.5070,	4.0330,	4.4750,
15,	5.1510,	5.7520,	5.4010,	5.1510,	4.7920,	5.1390,	4.6520,	4.9850,
16,	5.8930,	6.2270,	5.0540,	5.8930,	5.2290,	5.6330,	4.7140,	5.6100,
0 SOPCOFAC,	1.2794,	1.0068,	1.0227,	1.0471,	1.0187,	.9975,	1.0189,	1.0104,

Table 2 Catch weights-at-age (kg)

YEAR,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,
AGE										
5,	.9840,	.9420,	.9950,	1.0300,	1.0300,	1.1290,	.8420,	1.0290,	1.0010,	1.0160,
6,	1.3380,	1.2750,	1.2300,	1.2380,	1.2180,	1.3040,	1.0470,	1.2100,	1.2470,	1.2560,
7,	1.5770,	1.5920,	1.6300,	1.4990,	1.5330,	1.5410,	1.4250,	1.5720,	1.4720,	1.4010,
8,	1.8480,	1.8170,	1.9510,	1.9370,	1.8240,	1.7700,	1.7270,	1.7900,	1.8100,	1.7180,
9,	2.1590,	2.2400,	2.3670,	2.3630,	2.1870,	2.2360,	2.1250,	2.1260,	2.0880,	2.0490,
10,	2.4340,	2.4610,	2.6370,	2.6310,	2.6660,	2.6830,	2.6370,	2.5360,	2.4400,	2.4360,
11,	2.6030,	2.8350,	2.8290,	2.8480,	2.9960,	3.0820,	3.2200,	3.2140,	2.9350,	2.8680,
12,	3.0340,	3.2620,	3.3530,	3.3350,	3.5950,	3.6240,	3.7330,	3.6930,	3.7370,	3.4780,
13,	3.7840,	3.9620,	4.0060,	4.0390,	4.4310,	4.3120,	4.1350,	4.4480,	4.4010,	4.5100,
14,	4.4460,	4.9360,	4.7920,	4.9250,	5.1400,	5.0980,	5.3800,	5.1970,	5.0220,	4.6810,
15,	4.7510,	5.2300,	5.2310,	5.4660,	5.7640,	5.2130,	6.5690,	5.8910,	5.9910,	6.0100,
16,	6.2090,	6.9680,	6.3230,	5.7640,	5.7640,	5.7640,	6.4970,	6.0490,	6.4120,	5.1280,
0 SOPCOFAC,	1.0176,	.9953,	1.0258,	1.0069,	.9792,	1.0063,	.9999,	.9998,	1.0097,	1.0033,

Table 2 Catch weights-at-age (kg)

YEAR,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,
AGE										
5,	.9910,	1.1630,	.9500,	1.1010,	.9190,	.8070,	.8610,	.7700,	.7320,	.7210,
6,	1.2490,	1.2540,	1.2130,	1.1240,	1.1070,	1.0860,	.9530,	.9680,	.8650,	.9850,
7,	1.4010,	1.4880,	1.4130,	1.3460,	1.3340,	1.3630,	1.2880,	1.2720,	1.2190,	1.3550,
8,	1.6850,	1.7360,	1.7030,	1.6490,	1.6400,	1.6580,	1.5650,	1.6070,	1.5770,	1.6290,
9,	1.9820,	2.1500,	2.0280,	1.9250,	1.8810,	1.8860,	1.7390,	1.7690,	1.8510,	1.9910,
10,	2.4250,	2.3520,	2.2790,	2.3420,	2.2400,	2.1670,	2.0120,	2.1220,	2.2020,	2.0890,
11,	2.9520,	2.7360,	2.6430,	2.5950,	2.5380,	2.4150,	2.3510,	2.3140,	2.3990,	2.3270,
12,	3.4290,	3.0820,	2.9920,	3.0130,	2.8460,	2.8440,	2.6340,	2.7220,	2.7000,	2.4720,
13,	4.4790,	3.6070,	3.5680,	3.5150,	3.3850,	3.1730,	3.0310,	3.0100,	3.3110,	2.7220,
14,	6.0430,	4.2420,	4.0680,	4.1230,	4.3590,	4.2370,	3.5320,	3.4230,	4.0720,	2.8710,
15,	5.8320,	5.2930,	5.3020,	4.9960,	4.8510,	4.6560,	3.8740,	4.0660,	4.5500,	2.8660,
16,	5.5120,	6.0870,	5.6860,	5.6930,	5.0910,	5.0800,	4.9370,	4.5730,	5.8670,	2.9010,
0 SOPCOFAC,	1.0010,	1.0001,	1.0042,	1.0329,	1.1044,	1.0674,	1.1142,	1.0710,	1.0306,	1.0259,

Table 6.7.2.1 Output from ASPIC model on CPUE series in Div. Va, total catches V+XIV and Icelandic fall survey indices.

Greenland halibut XIV and V

```
                                                                                         Page 1

ASPIC -- A Surplus-Production Model Including Covariates (BETA Ver. 4.45)
                                                                                     FIT program mode
Author:    Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research  LOGISTIC model mode
           101 Pivers Island Road; Beaufort, North Carolina  28516  USA               YLD conditioning
           Mike.Prager@noaa.gov                                                        SSE optimization

Reference: Prager, M. H. 1994. A suite of extensions to a nonequilibrium         ASPIC User's Manual is available
           surplus-production model.  Fishery Bulletin 92: 374-389.                    gratis from the author.

CONTROL PARAMETERS USED (FROM INPUT FILE)                                      Input file: ghl8502-new.inp
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic model by direct optimization.
Number of years analyzed:                    18          Number of bootstrap trials:                        0
Number of data series:                        2          Lower bound on MSY:                        5.000E+03
Objective function:               Least squares          Upper bound on MSY:                        1.000E+09
Relative conv. criterion (simplex):   1.000E-08          Lower bound on K:                          1.000E+05
Relative conv. criterion (restart):   3.000E-08          Upper bound on K:                          8.000E+09
Relative conv. criterion (effort):    1.000E-04          Random number seed:                          3941285
Maximum F allowed in fitting:             6.000          Monte Carlo search mode, trials:       0           0
Identical convergences required in fitting:   5

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS)                                        error code   0
------------------------------------------------------------------------------------------------------------------------
Normal convergence.
Number of restarts required for convergence:     34

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)
------------------------------------------------------------------------------------------------------------------------
                                  |
 1  input CPUE indices            |   1.000
                                  |      18
                                  |
 2  ICESURVEY indices             |   0.675   1.000
                                  |       7       7
                                   --------------------------------------------------
                                          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 B1 > K                       0.000E+00      1          N/A    0.000E+00          N/A
Loss(1)   input CPUE indices                       8.257E-01     18    5.161E-02    1.000E+00    7.425E-01        0.772
Loss(2)   ICESURVEY indices                        1.153E-01      7    2.305E-02    1.000E+00    1.662E+00        0.312
...........................................................................................
TOTAL OBJECTIVE FUNCTION, MSE, RMSE:          9.40972649E-01          4.705E-02    2.169E-01

Log likelihood:                               5.23370515E+00
Estimated contrast index (ideal = 1.0):               0.4930          C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0):               1.0000          N* = 1 - (min|B-BMSY|c/K)

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------------
Parameter                                           Estimate     User/pgm guess    2nd guess    Estimated   User guess

B1/K      Starting biomass ratio (year 1985)       7.522E-01          5.000E-01    9.000E-01            1            1
MSY       Maximum sustainable yield                3.481E+04          6.000E+04    3.031E+04            1            1
K         Maximum population size                  2.276E+05          1.000E+06    1.819E+05            1            1
phi       Position of BMSY relative to K          5.000E-01               ----         ----           0            0

--------- Catchability Coefficients by Fishery ---------------
q(1)      input CPUE indices                       6.235E-03          1.000E-02    4.750E-01            1            1
q(2)      ICESURVEY indices                        6.049E-03          1.000E-02    4.750E-01            1            1

MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------------
Parameter                                           Estimate               Logistic formula          General formula

MSY         Maximum sustainable yield              3.481E+04                           ----                     ----
BMSY      Stock biomass giving MSY                1.138E+05                            K/2           K*n**(1/(1-n))
FMSY      Fishing mortality rate at MSY           3.059E-01                       MSY/BMSY                 MSY/BMSY

n           Exponent in production function        2.000E+00                           ----                     ----
g           Fletcher's gamma                       4.000E+00                           ----     [n**(n/(n-1))]/[n-1]

B./BMSY   Ratio: B(2003)/BMSY                    7.761E-01                         ----                     ----
F./FMSY   Ratio: F(2002)/FMSY                    1.105E+00                         ----                     ----
FMSY/F.   Ratio: FMSY/F(2002)                    9.053E-01                         ----                     ----

Y.(FMSY)  Yield available at FMSY in 2003       2.702E+04                  MSY*B./BMSY              MSY*B./BMSY
            ...as proportion of MSY                7.761E-01                           ----                     ----
Ye.         Equilibrium yield available in 2003    3.307E+04         4*MSY*(B/K-(B/K)**2)      g*MSY*(B/K-(B/K)**n)
            ...as proportion of MSY                9.499E-01                           ----                     ----

--------- Fishing Effort at MSY in Units of each Fishery -----
FMSY(1)   input CPUE indices                      4.905E+01                    FMSY/q( 1)               FMSY/q( 1)
```

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 $\mathbf{F}_{MSY}$	Ratio of biomass to $\mathbf{B}_{MSY}$
1	1985	0.190	1.712E+05	1.684E+05	3.208E+04	3.208E+04	2.680E+04	6.228E-01	1.504E+00
2	1986	0.202	1.660E+05	1.634E+05	3.298E+04	3.298E+04	2.820E+04	6.601E-01	1.458E+00
3	1987	0.306	1.612E+05	1.526E+05	4.662E+04	4.662E+04	3.072E+04	9.992E-01	1.416E+00
4	1988	0.377	1.453E+05	1.357E+05	5.112E+04	5.112E+04	3.345E+04	1.231E+00	1.276E+00
5	1989	0.543	1.276E+05	1.130E+05	6.140E+04	6.140E+04	3.465E+04	1.776E+00	1.121E+00
6	1990	0.401	1.009E+05	9.814E+04	3.933E+04	3.933E+04	3.415E+04	1.310E+00	8.863E-01
7	1991	0.406	9.569E+04	9.346E+04	3.795E+04	3.795E+04	3.369E+04	1.328E+00	8.407E-01
8	1992	0.392	9.143E+04	9.034E+04	3.542E+04	3.542E+04	3.333E+04	1.282E+00	8.033E-01
9	1993	0.480	8.934E+04	8.498E+04	4.082E+04	4.082E+04	3.256E+04	1.570E+00	7.849E-01
10	1994	0.473	8.108E+04	7.817E+04	3.696E+04	3.696E+04	3.139E+04	1.546E+00	7.124E-01
11	1995	0.502	7.551E+04	7.231E+04	3.630E+04	3.630E+04	3.017E+04	1.641E+00	6.635E-01
12	1996	0.546	6.939E+04	6.557E+04	3.582E+04	3.582E+04	2.854E+04	1.786E+00	6.096E-01
13	1997	0.500	6.210E+04	6.050E+04	3.027E+04	3.027E+04	2.717E+04	1.636E+00	5.457E-01
14	1998	0.324	5.901E+04	6.276E+04	2.036E+04	2.036E+04	2.779E+04	1.061E+00	5.184E-01
15	1999	0.286	6.644E+04	7.126E+04	2.037E+04	2.037E+04	2.992E+04	9.346E-01	5.838E-01
16	2000	0.343	7.599E+04	7.835E+04	2.684E+04	2.684E+04	3.143E+04	1.120E+00	6.677E-01
17	2001	0.339	8.058E+04	8.274E+04	2.802E+04	2.802E+04	3.221E+04	1.107E+00	7.080E-01
18	2002	0.338	8.477E+04	8.661E+04	2.926E+04	2.926E+04	3.282E+04	1.105E+00	7.448E-01
19	2003		8.833E+04						7.761E-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
1	1985	1.000E+03	1.050E+03	0.1905	3.208E+04	3.208E+04	0.04867
2	1986	9.130E+02	1.019E+03	0.2019	3.298E+04	3.298E+04	0.10954
3	1987	8.800E+02	9.511E+02	0.3056	4.662E+04	4.662E+04	0.07775
4	1988	9.610E+02	8.462E+02	0.3766	5.112E+04	5.112E+04	-0.12718
5	1989	9.140E+02	7.048E+02	0.5431	6.140E+04	6.140E+04	-0.25987
6	1990	7.420E+02	6.119E+02	0.4007	3.933E+04	3.933E+04	-0.19275
7	1991	7.540E+02	5.827E+02	0.4061	3.795E+04	3.795E+04	-0.25773
8	1992	6.520E+02	5.633E+02	0.3921	3.542E+04	3.542E+04	-0.14630
9	1993	5.040E+02	5.299E+02	0.4803	4.082E+04	4.082E+04	0.05007
10	1994	4.100E+02	4.874E+02	0.4728	3.696E+04	3.696E+04	0.17286
11	1995	3.120E+02	4.508E+02	0.5020	3.630E+04	3.630E+04	0.36808
12	1996	2.590E+02	4.088E+02	0.5464	3.582E+04	3.582E+04	0.45647
13	1997	2.880E+02	3.772E+02	0.5003	3.027E+04	3.027E+04	0.26986
14	1998	4.640E+02	3.913E+02	0.3244	2.036E+04	2.036E+04	-0.17047
15	1999	5.340E+02	4.443E+02	0.2859	2.037E+04	2.037E+04	-0.18385
16	2000	5.890E+02	4.885E+02	0.3426	2.684E+04	2.684E+04	-0.18712
17	2001	6.120E+02	5.159E+02	0.3387	2.802E+04	2.802E+04	-0.17090
18	2002	4.680E+02	5.400E+02	0.3379	2.926E+04	2.926E+04	0.14307

```
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     0.0487                                             |==
1986     0.1095                                             |====
1987     0.0777                                             |===
1988    -0.1272                                        =====|
1989    -0.2599                                   ==========|
1990    -0.1927                                     ========|
1991    -0.2577                                   ==========|
1992    -0.1463                                       ======|
1993     0.0501                                             |==
1994     0.1729                                             |=======
1995     0.3681                                             |===============
1996     0.4565                                             |==================
1997     0.2699                                             |===========
1998    -0.1705                                      =======|
1999    -0.1838                                      =======|
2000    -0.1871                                      =======|
2001    -0.1709                                      =======|
2002     0.1431                                             |======
                   -------------------------------------------------------------------------------------
```

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
1	1985	0.000E+00	0.000E+00	0.0	*	1.004E+03	0.00000
2	1986	0.000E+00	0.000E+00	0.0	*	9.749E+02	0.00000
3	1987	0.000E+00	0.000E+00	0.0	*	8.788E+02	0.00000
4	1988	0.000E+00	0.000E+00	0.0	*	7.719E+02	0.00000
5	1989	0.000E+00	0.000E+00	0.0	*	6.101E+02	0.00000
6	1990	0.000E+00	0.000E+00	0.0	*	5.788E+02	0.00000
7	1991	0.000E+00	0.000E+00	0.0	*	5.531E+02	0.00000
8	1992	0.000E+00	0.000E+00	0.0	*	5.404E+02	0.00000
9	1993	0.000E+00	0.000E+00	0.0	*	4.905E+02	0.00000
10	1994	0.000E+00	0.000E+00	0.0	*	4.568E+02	0.00000
11	1995	0.000E+00	0.000E+00	0.0	*	4.197E+02	0.00000
12	1996	1.000E+00	1.000E+00	0.0	3.460E+02	3.757E+02	-0.08224
13	1997	1.000E+00	1.000E+00	0.0	4.140E+02	3.569E+02	0.14834
14	1998	1.000E+00	1.000E+00	0.0	4.200E+02	4.019E+02	0.04410
15	1999	1.000E+00	1.000E+00	0.0	5.280E+02	4.597E+02	0.13859
16	2000	1.000E+00	1.000E+00	0.0	3.960E+02	4.874E+02	-0.20770
17	2001	1.000E+00	1.000E+00	0.0	5.570E+02	5.128E+02	0.08276
18	2002	1.000E+00	1.000E+00	0.0	4.720E+02	5.343E+02	-0.12395

* 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    -0.0822                                          ===|
1997     0.1483                                             |======
1998     0.0441                                             |==
1999     0.1386                                             |======
2000    -0.2077                                     ========|
2001     0.0828                                             |===
2002    -0.1239                                        =====|
                   -------------------------------------------------------------------------------------
```

Table 6.7.3 Trajectories from ASPIC assuming 2003 catch eq 30 kt and $F_{2004\text{-}2012}$ eq $\mathbf{F}_{pa}$ (~2/3 $\mathbf{F}_{MSY}$).

Results from ASPICP.EXE, version 3.10 05 May 2003 at 12:41.43

Greenland halibut XIV and V - 85 to 02
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
2003	3.000E+04	TAC
2004	6.000E-01	F/F(2002)
2005	6.000E-01	F/F(2002)
2006	6.000E-01	F/F(2002)
2007	6.000E-01	F/F(2002)
2008	6.000E-01	F/F(2002)
2009	6.000E-01	F/F(2002)
2010	6.000E-01	F/F(2002)
2011	6.000E-01	F/F(2002)
2012	6.000E-01	F/F(2002)

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	1.503E+00	1.669E-01	11.10%	7.412E-01	2.493E+00	1.022E+00	1.917E+00	8.951E-01	0.595
1986	1.457E+00	5.695E-02	3.91%	8.132E-01	2.040E+00	1.076E+00	1.713E+00	6.379E-01	0.438
1987	1.416E+00	1.692E-02	1.20%	9.029E-01	1.787E+00	1.104E+00	1.574E+00	4.698E-01	0.332
1988	1.277E+00	1.815E-03	0.14%	8.736E-01	1.538E+00	1.054E+00	1.393E+00	3.392E-01	0.266
1989	1.122E+00	-2.271E-03	-0.20%	8.340E-01	1.351E+00	9.777E-01	1.235E+00	2.573E-01	0.229
1990	8.889E-01	-5.198E-03	-0.58%	6.850E-01	1.168E+00	7.945E-01	1.022E+00	2.278E-01	0.256
1991	8.436E-01	-4.350E-03	-0.52%	6.558E-01	1.100E+00	7.573E-01	9.632E-01	2.058E-01	0.244
1992	8.066E-01	-2.391E-03	-0.30%	6.368E-01	1.050E+00	7.323E-01	9.206E-01	1.883E-01	0.233
1993	7.879E-01	1.374E-03	0.17%	6.292E-01	1.006E+00	7.196E-01	8.836E-01	1.640E-01	0.208
1994	7.120E-01	4.606E-03	0.65%	5.669E-01	9.320E-01	6.436E-01	8.063E-01	1.627E-01	0.228
1995	6.609E-01	8.335E-03	1.26%	5.292E-01	8.873E-01	5.994E-01	7.586E-01	1.592E-01	0.241
1996	6.067E-01	1.176E-02	1.94%	4.874E-01	8.634E-01	5.473E-01	7.142E-01	1.668E-01	0.275
1997	5.418E-01	1.311E-02	2.42%	4.157E-01	8.327E-01	4.710E-01	6.637E-01	1.927E-01	0.356
1998	5.185E-01	1.184E-02	2.28%	3.692E-01	8.276E-01	4.334E-01	6.550E-01	2.215E-01	0.427
1999	5.830E-01	1.051E-02	1.80%	4.060E-01	8.767E-01	4.822E-01	7.160E-01	2.338E-01	0.401
2000	6.659E-01	1.050E-02	1.58%	4.687E-01	9.457E-01	5.577E-01	8.110E-01	2.533E-01	0.380
2001	7.077E-01	1.090E-02	1.54%	4.927E-01	9.769E-01	5.891E-01	8.349E-01	2.459E-01	0.347
2002	7.439E-01	1.193E-02	1.60%	4.873E-01	9.922E-01	6.005E-01	8.653E-01	2.649E-01	0.356
2003	7.797E-01	1.376E-02	1.76%	4.991E-01	1.015E+00	6.252E-01	8.945E-01	2.693E-01	0.345
2004	8.086E-01	1.596E-02	1.97%	4.880E-01	1.022E+00	6.277E-01	9.232E-01	2.955E-01	0.366
2005	9.346E-01	1.626E-02	1.74%	5.632E-01	1.120E+00	6.894E-01	1.030E+00	3.409E-01	0.365
2006	1.042E+00	1.229E-02	1.18%	6.258E-01	1.218E+00	7.677E-01	1.123E+00	3.550E-01	0.341
2007	1.129E+00	5.830E-03	0.52%	6.787E-01	1.294E+00	8.459E-01	1.200E+00	3.542E-01	0.314
2008	1.195E+00	-7.869E-04	-0.07%	7.944E-01	1.350E+00	9.237E-01	1.265E+00	3.410E-01	0.285
2009	1.243E+00	-6.079E-03	-0.49%	8.598E-01	1.386E+00	1.002E+00	1.310E+00	3.076E-01	0.248
2010	1.277E+00	-9.577E-03	-0.75%	8.999E-01	1.405E+00	1.043E+00	1.336E+00	2.937E-01	0.230
2011	1.301E+00	-1.143E-02	-0.88%	9.627E-01	1.426E+00	1.096E+00	1.363E+00	2.668E-01	0.205
2012	1.317E+00	-1.205E-02	-0.91%	1.004E+00	1.437E+00	1.130E+00	1.380E+00	2.501E-01	0.190
2013	1.328E+00	-1.183E-02	-0.89%	1.031E+00	1.444E+00	1.159E+00	1.391E+00	2.329E-01	0.175

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.
Results from ASPICP.EXE, version 3.10 05 May 2003 at 12:41.43
Greenland halibut XIV and V - 85 to 02
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	6.238E-01	1.115E-02	1.79%	4.588E-01	9.755E-01	5.370E-01	8.297E-01	2.927E-01	0.469
1986	6.609E-01	5.394E-03	0.82%	5.427E-01	9.251E-01	5.971E-01	8.119E-01	2.148E-01	0.325
1987	1.000E+00	4.646E-04	0.05%	8.792E-01	1.315E+00	9.378E-01	1.181E+00	2.433E-01	0.243
1988	1.232E+00	-5.035E-03	-0.41%	1.123E+00	1.571E+00	1.176E+00	1.409E+00	2.328E-01	0.189
1989	1.774E+00	-3.318E-03	-0.19%	1.642E+00	2.133E+00	1.716E+00	1.981E+00	2.652E-01	0.150
1990	1.307E+00	9.672E-04	0.07%	1.177E+00	1.500E+00	1.241E+00	1.401E+00	1.602E-01	0.123
1991	1.324E+00	-3.932E-03	-0.30%	1.209E+00	1.512E+00	1.271E+00	1.422E+00	1.511E-01	0.114
1992	1.281E+00	-1.173E-02	-0.92%	1.198E+00	1.479E+00	1.245E+00	1.389E+00	1.438E-01	0.112
1993	1.586E+00	-2.240E-02	-1.41%	1.491E+00	1.828E+00	1.550E+00	1.712E+00	1.626E-01	0.103
1994	1.561E+00	-2.700E-02	-1.73%	1.439E+00	1.753E+00	1.516E+00	1.662E+00	1.464E-01	0.094
1995	1.650E+00	-3.241E-02	-1.96%	1.404E+00	1.807E+00	1.547E+00	1.718E+00	1.714E-01	0.104
1996	1.800E+00	-2.734E-02	-1.52%	1.423E+00	1.987E+00	1.628E+00	1.920E+00	2.921E-01	0.162
1997	1.615E+00	1.544E-03	0.10%	1.203E+00	1.919E+00	1.415E+00	1.797E+00	3.816E-01	0.236

Table 6.7.3 (Cont'd)

1998	1.062E+00	1.342E-02	1.26%	7.887E-01	1.313E+00	9.145E-01	1.200E+00	2.856E-01	0.269
1999	9.372E-01	7.766E-03	0.83%	7.254E-01	1.164E+00	8.266E-01	1.064E+00	2.369E-01	0.253
2000	1.111E+00	4.234E-03	0.38%	8.847E-01	1.398E+00	9.872E-01	1.269E+00	2.816E-01	0.253
2001	1.109E+00	2.970E-03	0.27%	9.116E-01	1.449E+00	9.965E-01	1.298E+00	3.012E-01	0.272
2002	1.083E+00	1.980E-03	0.18%	9.032E-01	1.471E+00	9.775E-01	1.299E+00	3.218E-01	0.297
2003	1.086E+00	3.430E-03	0.32%	9.047E-01	1.563E+00	9.891E-01	1.381E+00	3.924E-01	0.361
2004	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2005	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2006	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2007	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2008	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2009	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2010	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2011	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297
2012	6.497E-01	1.188E-03	0.18%	5.419E-01	8.828E-01	5.865E-01	7.796E-01	1.931E-01	0.297

TABLE OF PROJECTED YIELDS

2003	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
2004	1.972E+04	1.756E+02	0.89%	1.811E+04	2.212E+04	1.898E+04	2.091E+04	1.923E+03	0.098
2005	2.237E+04	3.185E+02	1.42%	1.967E+04	2.626E+04	2.099E+04	2.427E+04	3.282E+03	0.147
2006	2.457E+04	3.927E+02	1.60%	2.106E+04	2.928E+04	2.270E+04	2.715E+04	4.451E+03	0.181
2007	2.629E+04	4.289E+02	1.63%	2.227E+04	3.228E+04	2.408E+04	2.937E+04	5.290E+03	0.201
2008	2.757E+04	4.631E+02	1.68%	2.320E+04	3.472E+04	2.507E+04	3.092E+04	5.858E+03	0.212
2009	2.849E+04	5.151E+02	1.81%	2.375E+04	3.630E+04	2.578E+04	3.212E+04	6.340E+03	0.223
2010	2.914E+04	5.892E+02	2.02%	2.405E+04	3.740E+04	2.630E+04	3.290E+04	6.604E+03	0.227
2011	2.958E+04	6.814E+02	2.30%	2.449E+04	3.823E+04	2.682E+04	3.368E+04	6.857E+03	0.232
2012	2.989E+04	7.849E+02	2.63%	2.472E+04	3.889E+04	2.708E+04	3.429E+04	7.210E+03	0.241

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

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	1.724E+05	2.555E+04	14.82%	9.578E+04	3.216E+05	1.289E+05	2.400E+05	1.111E+05	0.644
1986	1.671E+05	1.164E+04	6.97%	1.078E+05	2.854E+05	1.347E+05	2.182E+05	8.352E+04	0.500
1987	1.623E+05	6.482E+03	3.99%	1.149E+05	2.641E+05	1.361E+05	2.011E+05	6.494E+04	0.400
1988	1.464E+05	4.621E+03	3.16%	1.067E+05	2.390E+05	1.247E+05	1.813E+05	5.650E+04	0.386
1989	1.287E+05	4.081E+03	3.17%	9.680E+04	2.139E+05	1.108E+05	1.626E+05	5.182E+04	0.403
1990	1.019E+05	3.915E+03	3.84%	7.250E+04	1.773E+05	8.553E+04	1.317E+05	4.613E+04	0.453
1991	9.674E+04	3.811E+03	3.94%	6.974E+04	1.662E+05	8.162E+04	1.248E+05	4.315E+04	0.446
1992	9.249E+04	3.848E+03	4.16%	6.705E+04	1.566E+05	7.803E+04	1.186E+05	4.055E+04	0.438
1993	9.035E+04	4.052E+03	4.49%	6.700E+04	1.507E+05	7.737E+04	1.160E+05	3.864E+04	0.428
1994	8.165E+04	4.369E+03	5.35%	5.980E+04	1.377E+05	6.891E+04	1.061E+05	3.718E+04	0.455
1995	7.578E+04	4.738E+03	6.25%	5.494E+04	1.296E+05	6.337E+04	9.651E+04	3.314E+04	0.437
1996	6.957E+04	5.139E+03	7.39%	4.922E+04	1.219E+05	5.731E+04	8.956E+04	3.225E+04	0.464
1997	6.213E+04	5.448E+03	8.77%	4.156E+04	1.157E+05	5.022E+04	8.474E+04	3.452E+04	0.556
1998	5.946E+04	5.510E+03	9.27%	3.617E+04	1.128E+05	4.603E+04	8.067E+04	3.464E+04	0.583
1999	6.686E+04	5.356E+03	8.01%	4.140E+04	1.215E+05	5.228E+04	8.952E+04	3.724E+04	0.557
2000	7.635E+04	5.155E+03	6.75%	4.871E+04	1.263E+05	6.056E+04	9.874E+04	3.818E+04	0.500
2001	8.116E+04	4.970E+03	6.12%	5.127E+04	1.254E+05	6.381E+04	1.024E+05	3.860E+04	0.476
2002	8.531E+04	4.795E+03	5.62%	5.468E+04	1.269E+05	6.767E+04	1.046E+05	3.696E+04	0.433
2003	8.941E+04	4.642E+03	5.19%	5.830E+04	1.283E+05	7.125E+04	1.071E+05	3.587E+04	0.401
2004	9.272E+04	4.498E+03	4.85%	6.042E+04	1.284E+05	7.392E+04	1.093E+05	3.542E+04	0.382
2005	1.072E+05	4.140E+03	3.86%	7.454E+04	1.423E+05	9.028E+04	1.236E+05	3.337E+04	0.311
2006	1.195E+05	3.598E+03	3.01%	8.821E+04	1.570E+05	1.040E+05	1.378E+05	3.381E+04	0.283
2007	1.295E+05	3.056E+03	2.36%	9.682E+04	1.670E+05	1.141E+05	1.471E+05	3.299E+04	0.255
2008	1.370E+05	2.691E+03	1.96%	1.054E+05	1.771E+05	1.218E+05	1.557E+05	3.385E+04	0.247
2009	1.425E+05	2.581E+03	1.81%	1.097E+05	1.862E+05	1.255E+05	1.615E+05	3.603E+04	0.253
2010	1.464E+05	2.716E+03	1.85%	1.127E+05	1.950E+05	1.287E+05	1.668E+05	3.814E+04	0.260
2011	1.492E+05	3.037E+03	2.04%	1.163E+05	1.998E+05	1.308E+05	1.707E+05	3.995E+04	0.268
2012	1.510E+05	3.481E+03	2.30%	1.184E+05	2.052E+05	1.327E+05	1.735E+05	4.074E+04	0.270
2013	1.523E+05	3.992E+03	2.62%	1.193E+05	2.083E+05	1.338E+05	1.754E+05	4.161E+04	0.273

NOTE: Confidence intervals are approximate.
At least 500 to 1000 trials are recommended when estimating confidence intervals.

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	1.892E-01	1.840E-02	9.73%	1.044E-01	3.100E-01	1.386E-01	2.418E-01	1.032E-01	0.545
1986	2.005E-01	1.559E-02	7.78%	1.200E-01	2.969E-01	1.580E-01	2.440E-01	8.599E-02	0.429
1987	3.033E-01	2.004E-02	6.61%	1.835E-01	4.158E-01	2.436E-01	3.580E-01	1.144E-01	0.377
1988	3.736E-01	2.322E-02	6.22%	2.253E-01	5.089E-01	3.000E-01	4.350E-01	1.349E-01	0.361
1989	5.380E-01	3.891E-02	7.23%	3.149E-01	7.349E-01	4.198E-01	6.301E-01	2.103E-01	0.391
1990	3.964E-01	3.212E-02	8.10%	2.288E-01	5.531E-01	3.064E-01	4.701E-01	1.637E-01	0.413
1991	4.015E-01	3.048E-02	7.59%	2.354E-01	5.562E-01	3.123E-01	4.756E-01	1.633E-01	0.407
1992	3.884E-01	2.584E-02	6.65%	2.309E-01	5.293E-01	3.028E-01	4.577E-01	1.549E-01	0.399
1993	4.810E-01	2.940E-02	6.11%	2.852E-01	6.527E-01	3.716E-01	5.618E-01	1.903E-01	0.396
1994	4.733E-01	2.851E-02	6.02%	2.781E-01	6.495E-01	3.718E-01	5.646E-01	1.928E-01	0.407
1995	5.003E-01	3.045E-02	6.09%	2.886E-01	6.997E-01	3.915E-01	6.017E-01	2.102E-01	0.420
1996	5.460E-01	4.036E-02	7.39%	3.020E-01	7.924E-01	4.120E-01	6.700E-01	2.580E-01	0.472
1997	4.897E-01	5.129E-02	10.47%	2.576E-01	7.667E-01	3.543E-01	6.156E-01	2.613E-01	0.534
1998	3.222E-01	3.930E-02	12.20%	1.735E-01	5.285E-01	2.383E-01	4.144E-01	1.762E-01	0.547
1999	2.842E-01	3.066E-02	10.79%	1.669E-01	4.570E-01	2.180E-01	3.638E-01	1.458E-01	0.513
2000	3.371E-01	3.160E-02	9.37%	2.068E-01	5.263E-01	2.648E-01	4.294E-01	1.646E-01	0.488
2001	3.364E-01	2.887E-02	8.58%	2.124E-01	5.192E-01	2.666E-01	4.198E-01	1.532E-01	0.455
2002	3.284E-01	2.541E-02	7.74%	2.263E-01	5.060E-01	2.719E-01	4.162E-01	1.442E-01	0.439
2003	3.292E-01	2.340E-02	7.11%	2.344E-01	5.017E-01	2.783E-01	4.097E-01	1.314E-01	0.399
2004	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2005	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2006	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2007	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2008	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2009	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2010	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2011	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439
2012	1.970E-01	1.525E-02	7.74%	1.358E-01	3.036E-01	1.632E-01	2.497E-01	8.654E-02	0.439

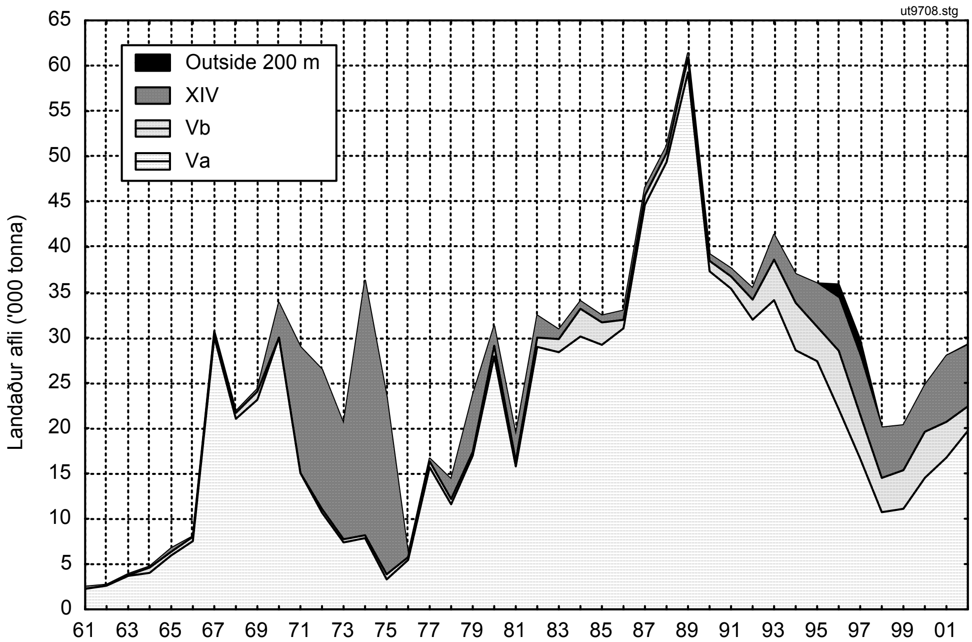


Figure 6.1.1 Landings of Greenland halibut in Divisions Va, Vb and Subarea XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

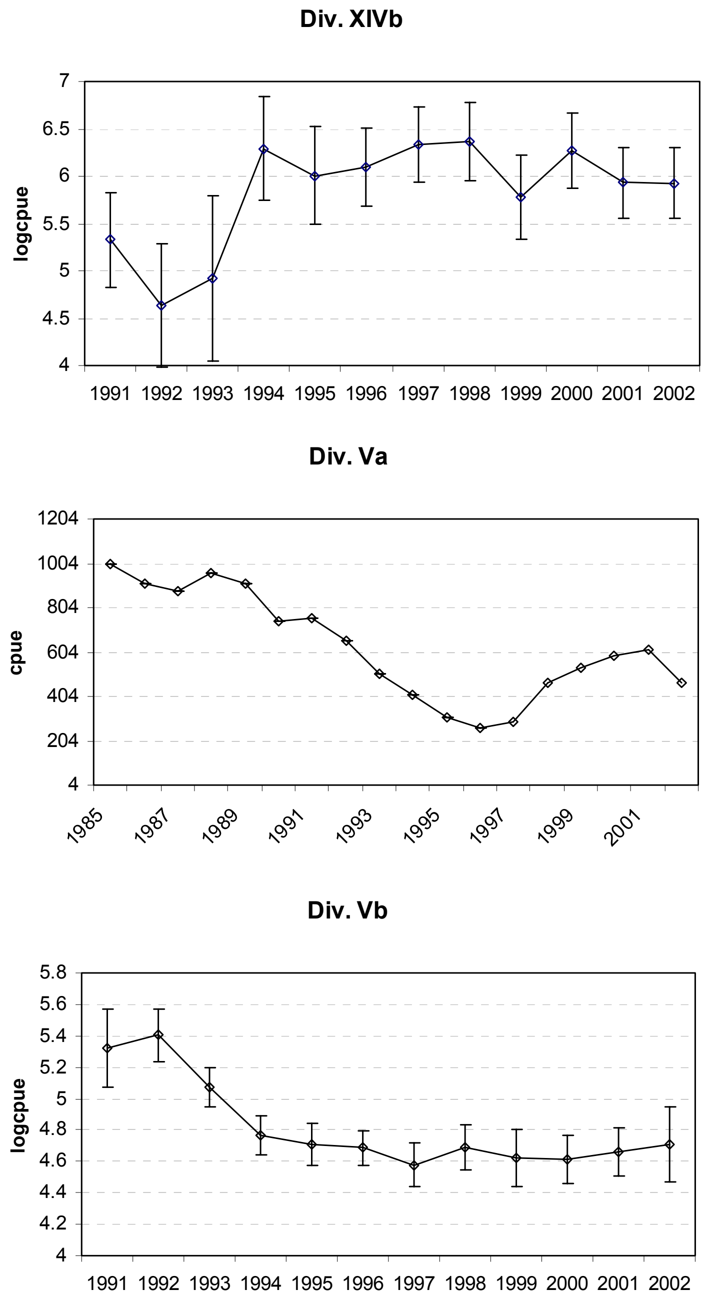


Figure 6.2.1 Standardised CPUE series from fleets in Divisions XIVb, Va and Vb with indication of 95% confidence limits.

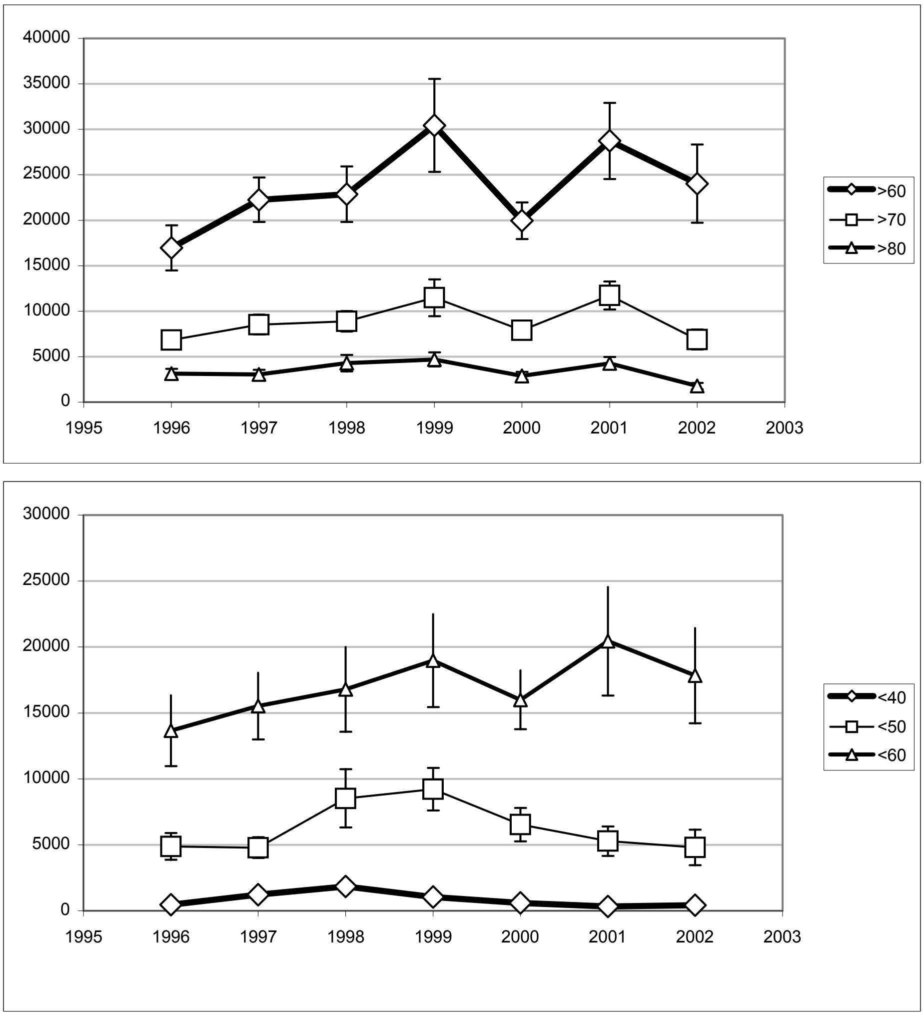


Figure 6.6.1 Greenland halibut in Icelandic fall groundfish survey a) biomass indices of lengths larger than indicated and b) abundance indices by lengths smaller than indicated.

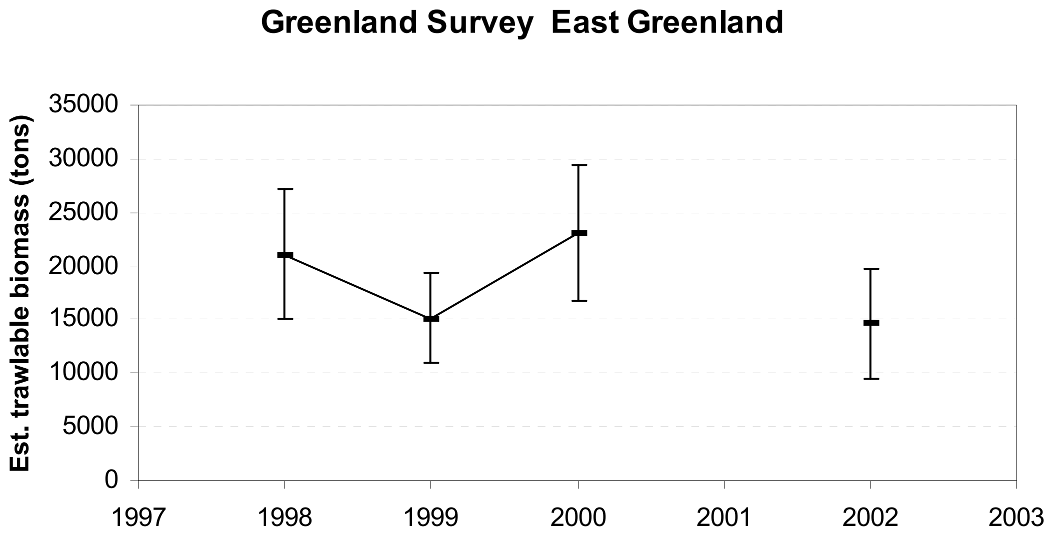


Figure 6.6.2 Estimated trawlable biomass in Division XIVb from the Greenland deep-water trawl survey with 95% confidence limits indicated.

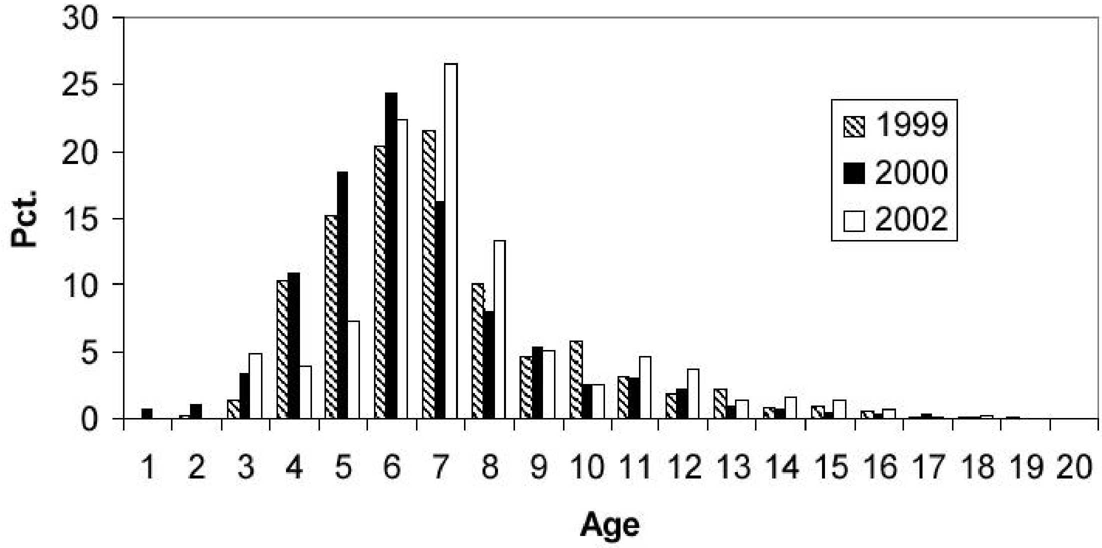
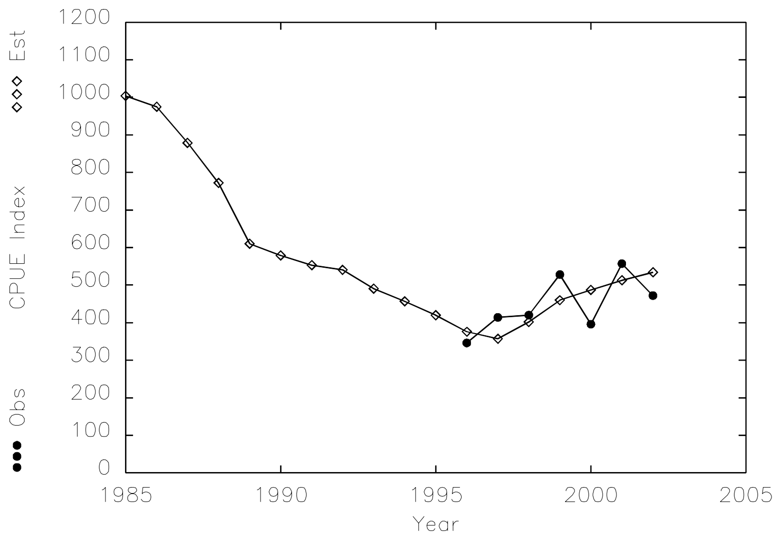


Figure 6.6.3 Age distribution in Greenland deep-water survey in Div. XIVb in 1999, 2000 and 2002.



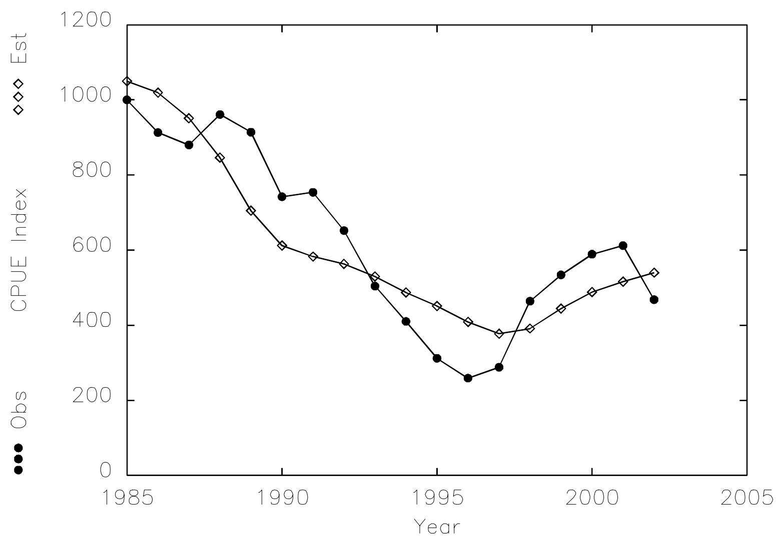


Figure 6.7.2.1 Observed and predicted CPUE's. Upper: Icelandic groundfish survey, Lower: Icelandic trawler CPUE

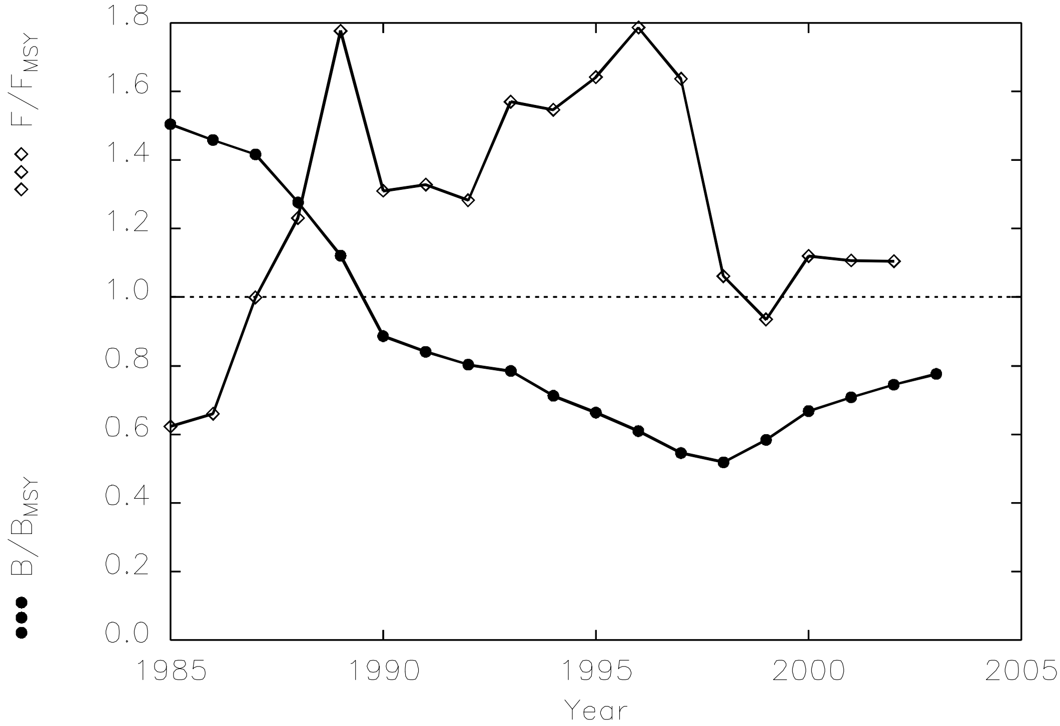
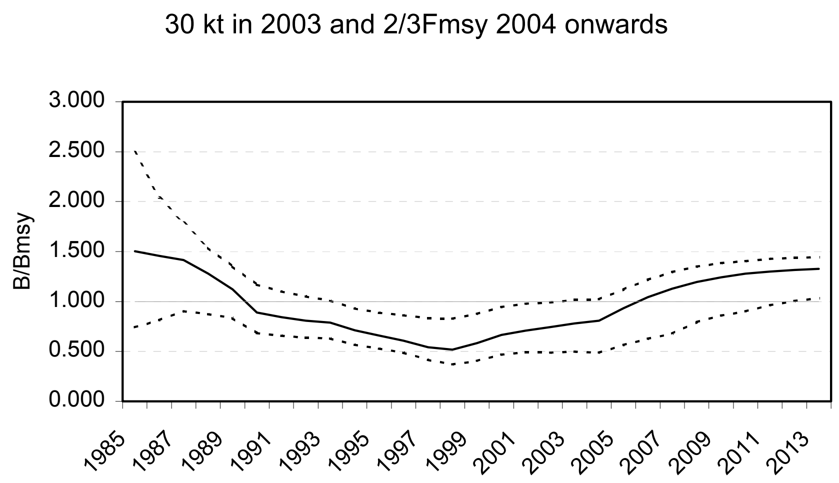
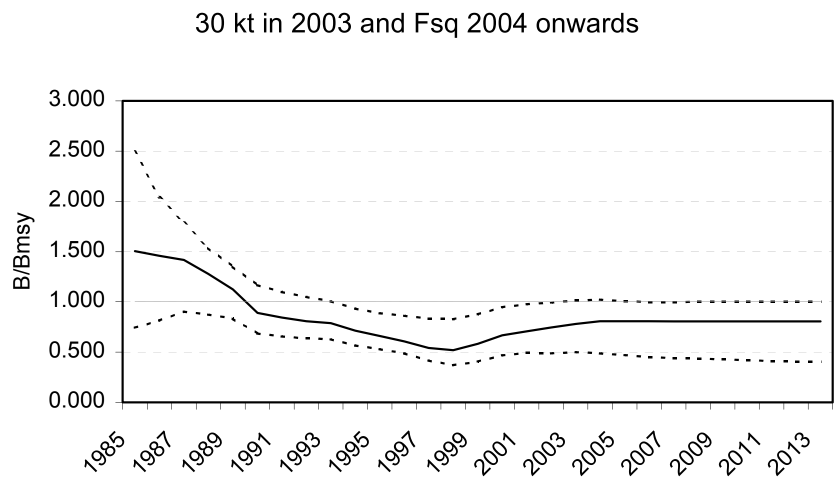


Figure 6.7.2.2 Output from ASPIC (Table 6.7.2.1.) with B/$\mathbf{B}_{MSY}$ and F/$\mathbf{F}_{MSY}$.





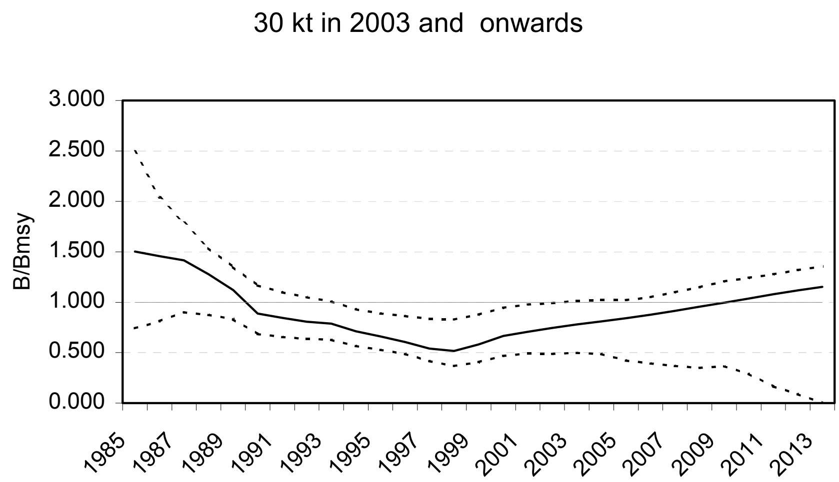


Figure 6.7.3 Biomass (B/$\mathbf{B}_{MSY}$) trajectories under different options as derived from ASPIC-P.

7 REDFISH IN SUBAREAS V, VI, XII AND XIV

Species of the genus *Sebastes* are common and widely distributed in the North Atlantic. They are found off the coast of Great Britain, along Norway and Spitzbergen, in the Barents Sea, off the Faroe Islands, Iceland, East and 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.

There are three species of redfish commercially exploited in ICES Subareas V, VI, XII, and XIV, *S. marinus*, *S. mentella,* and *S. viviparus*. The last one has only been of a minor commercial value in Icelandic waters and is exploited in 2 small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1,160 t in 1994 to 20 t in 2002.

7.1 Problems regarding stock identity of *S. mentella*

The existence of more than one stock of *S. mentella* in the area has been discussed in recent years. Historically, *S. mentella* was fished on the continental shelves and slopes of the Faroe Islands, Iceland, and East Greenland and been considered as one stock. A new pelagic fishery started in the open Irminger Sea in 1982, primarily fishing in waters shallower than 500 m. 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 1990's, the pelagic fishery in the open Irminger Sea moved to layers deeper than 500 m. Some researchers considered that the fish caught pelagically deeper than 500 m differed from the fish caught shallower than 500 m and resembled more to the deep-sea *S. mentella* living on the continental shelves and slopes. *S. mentella* living deeper than 500 m has been called "pelagic deep-sea *S. mentella*". Recently, the distribution of the pelagic *S. mentella* in the upper 500 m has extended significantly more southwest and into the NAFO Convention Areas compared to the early 1990's.

It is not known whether these types represent one stock or several biologically different stocks and different hypotheses have been put forward based on comprehensive studies on growth, maturity, morphometrics, parasites as natural tags, and genetic and fatty acid differentiation of the species:

- **Single-stock hypothesis:** All *S. mentella* from the Faroe Islands to the Grand Banks is one stock and is segregated according to age/size.

- **Two-stock hypothesis:** The *S. mentella* living on the shelves (deep-sea *S. mentella*) and those living in deeper pelagic waters of the Irminger Sea (pelagic deep-sea *S. mentella*) is one stock unit, which is separated from the oceanic *S. mentella* living in the upper layers of the Irminger Sea.

- **Three-stock hypothesis:** The three described components are biologically different stocks.

Despite a lot of effort by the WG, there is not a consensus within the WG regarding which hypothesis is the most likely one. Although the uncertainty regarding stock structure of *S. mentella* is great, extensive research have been done. Currently, several studies are ongoing to answer important questions regarding the biology, population structure, and abundance and demography of this highly migratory and straddling species.

7.2 Nominal catches and splitting of the landings into stocks

The official statistics reported to ICES do not divide catch by species/stocks (Tables 7.2.1-7.2.5). Information from various sources, for example, from samples taken from the catch in different fishing areas and information on products, are used to split catches into species and stocks. The technique and the data used for such splitting were described in the 1998 NWWG report.

7.3 Abundance and distribution of 0-group and juvenile redfish

Available data on the distribution of juvenile *S. marinus* indicate that the nursery grounds are located in Icelandic and Greenland waters. No nursery grounds have been found in Faroese waters. Studies indicate that considerable amounts of juvenile *S. marinus* of East Greenland is mixed with juvenile *S. mentella* (Magnússon et al. 1988; 1990, ICES CM 1998/G:3). The 1983 Redfish Study Group report (ICES CM 1983/G:3) and in Magnússon and Jóhannesson (1997) describes the distribution of 0-group *S. marinus* off East Greenland. The nursery areas for *S. marinus* in Icelandic waters are found all around Iceland, but are mainly located west and north of the island at depths between 50 and 350 m

(ICES C.M.1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). The migration of juveniles is along the north coast towards the most important fishing areas off the west coast.

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 and biomass indices of juvenile (<17 cm) redfish (juveniles were only classified to the genus *Sebastes* spp. due to difficult identification) from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, shows that juveniles were abundant in 1993 and 1995-1998 (Figure 7.3.1). The 1999-2002 survey results indicate low abundance and are similar to those observed in the late 1980s.

7.4 Discards and by-catch of small redfish in East and West Greenland

An offshore shrimp fishery with small-meshed trawl (44 mm in the codend) began in the early 1970s off the west coast of Greenland. This fishery expanded to the east coast in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is by-catch in the shrimp fishery off Greenland. No information was available in recent years to quantify the by-catch and about the length distribution of the fish caught. Since the 1st October 2000, sorting grids have been mandatory to reduce by-catch, but the effect has not been documented.

7.5 Special Requests

There are several questions regarding stock structure, distribution, and fishery information of *S. mentella* in the area in the ToR for the Working Group. The following paragraphs deal with ToR *c*, *e*, and *f* and special requests *b* and *c* from NEAFC. The WG also deals with these questions in some cases in more detail under different redfish Sections.

ToR c). Detailed descriptions of the fishery of different nations are given in Sections 8 for *S. marinus*, 9 for deep-sea *S. mentella*, and 10 for oceanic *S. mentella*, based on various working documents.

The fishery for oceanic *S. mentella* in ICES Subareas Va, XII, and XIV and in NAFO areas shows a persistent seasonal pattern in terms of geographical and depth distribution for the past five years (Figures 7.5.1-7.5.4). The main fishing occurs in the second and third quarter of the year. In the second quarter, the fishery takes place in the area east of 32°W and north of 61°N at depths deeper than 500 m. In the third quarter, the fleet moves towards the southwest to ICES Subarea XII and NAFO Convention areas and the depth of the hauls are in waters shallower than 500 m. There has traditionally been very little fishing activity from November until late March, and in 2002 no activity was reported during that time. The size of the fish caught in the southwest areas in the third quarter of the year is smaller than the fish caught in the northwest area in the second quarter (Figure 7.5.5). The fish caught in all seasons are sexually mature.

Based on the geographical and seasonal distribution of the oceanic *S. mentella*, catches in the Irminger Sea and adjacent waters in 2002 (Figures 7.5.1-7.5.4) it was concluded that the fishing pattern in 2002 was similar as it was in the past five years.

As has been reported in earlier reports of the Working Group, Iceland has classified its pelagic catches between oceanic and pelagic deep-sea redfish. Based on the samples, the results indicated that at depths shallower than 500-600 m, the proportion “oceanic” is between 85-100%, and the proportion deeper than 600 m between 0-20%.

The WG acknowledge information on trawling depth as provided by some nations, but recommends that all nations provide depth information in accordance with the NEAFC logbook format.

ToR e) and NEAFC special requests b) and c). New data presented in various working documents presents results of different methods that were used to investigate the issue of stock structure. Result in one paper (WD9) suggests some difference of the "pelagic deep sea *S. mentella*" and the *S. mentella* caught in the demersal fishery on the slope, concluding that there was "no big exchange between redfish stocks distributed on the south-western slope of Iceland and in the pelagic sea". WD30 describes recent changes in the pelagic fishery, where fishing areas of the pelagic *S. mentella* and deep-sea *S. mentella* on the slope in Division Va are now closer to each other. For management purposes the Icelandic authorities have separated these fisheries with the so-called redfish line (see Chapter 9), but this may not reflect two biologically different stocks. WD 8 suggests that for conservation and rational exploitation of the pelagic redfish stock a single TAC should be kept. Based on limited expertise of the WG it was concluded that the information presented did not justify a change in the perception of the stock structure in relation to the current way management advise is given.

There is consensus that NWWG is primarily an assessment group and does not have sufficient expertise to thoroughly review the scientific research of redfish stock identification. The methodological approaches include various genetic differentiation, morphometrics, parasitology, growth patterns, and trace element analyses. In light of this and in light of the EU project and other relevant data on redfish that is expected to commence this fall, the WG agreed to recommend that a separate ICES group with the appropriate expertise would review both existing and pending scientific material. This could either dealt with in a special study group or possibly within the current ICES **Stock Identification Methods Working Group**. The group should report to the NWWG meeting in 2004.

ToR f). Limited information is available for describing the distribution of the stock(s) in the area throughout the year and the information from the international trawl-acoustic survey in 2001 did 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. A new international acoustic-trawl survey will be conducted in June 2003 and a report will be available before the ACFM fall meeting in 2003. It is not likely that this survey will add to the current knowledge on the issue of ToR f.

Table 7.2.1 REDFISH. Nominal catches (tonnes) by countries, in Division Va 1996-2002, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002*
Faroe Islands	309	242	280	255			
Germany	233	-	284	428	513	844	467
Iceland	67,757	73,976	108,380	81,430	95,118	48,970	66,449
Norway	134	-	-	18	36*	26*	16
UK (E/W/NI)	-	-	-	542	734	1,037	…
UK (Scotland)	-	-	-	149	70	114	…
United Kingdom							704
Total	68,433	74,218	108,944	82,822			

*Preliminary.

Table 7.2.2 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1996-2002, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002*
Faroe Islands	7,286	7,199	6,484	6,191			
France	62	98	110*		250	178*	207
Germany	189	36	-	207	79	88	2
Iceland	-	-	-	-	-	54	-
Ireland	-	-	-	-	-	1	
Norway	33	25	39	37	42*	24*	30
Russia	-	-	-	-	12	-	-
UK (E/W/NI)	40	+	4	15	111	92	…
UK (Scotland)	43	36	27	46	142	116	…
United Kingdom							409
Total	7,653	7,394	6,664				

*Preliminary.

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries, in Division VI 1996-2002, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002*
Estonia	-	-	-	-	-	+	
Faroe Islands	-	12	-	44			
France	489	395	297*		269	210*	96
Germany	9	1	1	+	+	1	-
Ireland	-	10	10	34	54	47	
Norway	7	6	3	8	11*	5*	9
Portugal	-	-	1	-	-	-	-
Russia	-	-	-	243	461	88	19
Spain	-	-	-	38	16	4	
UK (E/W/NI)	54	19	12	4	20	44	…
UK (Scotland)	603	518	364	762	405	485	…
United Kingdom							383
Total	1,162	961	688				

*Preliminary.

Table 7.2.4 REDFISH. Nominal catches (tonnes) by countries, in Subarea XII 1996-2002, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002*
Estonia	7,092	3,720	3,968	2,108	4,000	-	-
Faroe Islands	3,127	3,822	1,793	528			
France	-	-	3*	-*	+	1	+
Germany	4,391	8,866	9,746	8,204	1,128	3,833	3,032
Greenland	3,537	…	1,180*	1,188*	124*	740*	
Iceland	3,613	3,856	1,311	5,072	3,121	11,679	-
Latvia	1,084	-	-	-	-	-	1,144
Norway	1,013	31	602	2,040	2,158*	878*	1,094
Poland	-	662	-	-	-	-	1
Portugal	-	-	-	-	-	387	-1
Russia	606	-	89	7,698	9,243	4,509	6,0382
Spain	410	1,155	2,231	1,723	576	1,332	
UK (E/W/NI)	33	-	+	187	-	-	…
UK (Scotland)	13	-	-	1	+	-	…
United Kingdom							4
Total	24,919	22,112	20,923	28,749			

[*]Preliminary. [1]Included in XIV. [2]See footnote 3 in XIV.

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Subarea XIV 1996-2002, as officially reported to ICES.

Country	1996	1997	1998	1999	2000	2001	2002*
Estonia	-	-	-	-	3,811	599	-
Faroe Islands	298	123	47	2			
Germany	16,996	11,610	9,709	8,935	7,840	6,758	9,576
Greenland	2,699	193	296*	3,152*	3,545*	2,587*	
Iceland	49,381	33,820	6,441	23,7701	17,999	31,786	44,430
Norway	6,453	3,187	525	3,253	3,803*	4,258*	4,215
Poland	-	114	-	-	-	-	-
Portugal	2,379	3,674	4,133	4,302	4,154	2,116	3,0902
Russia	45,142	36,930	25,748	16,652	14,851	23,851	25,5423
Spain	3,897	7,552	4,660	4,175	2,657	4,982	
UK (E/W/NI)	247	28	43	68	45	179	…
UK (Scotland)	6	-	-	-	-	-	…
United Kingdom							33
Total	127,498	97,231	51,602	64,309			

[*]Preliminary. [1]Note Excluding 58 t reported as area unknown. [2]Reported as V/XII/XIV 3,060 t and 30 t as V/XIV/GRN. [3]The catch of Atlantic redfishes total of 31,580 tons by ICES subareas XII and XIV, includes catches in NAFO 1F of 4,820 tons.

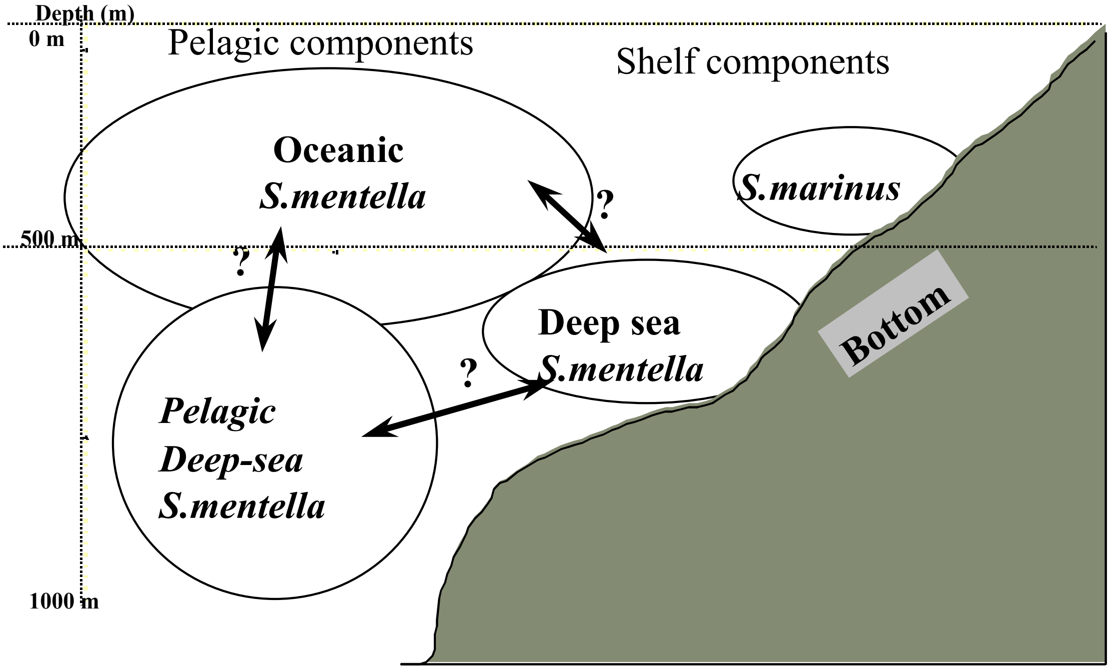


Figure 7.1.1 Possible relationship between different stocks and species *of S. marinus* and *S. mentella* in the Irminger Sea and adjacent waters.

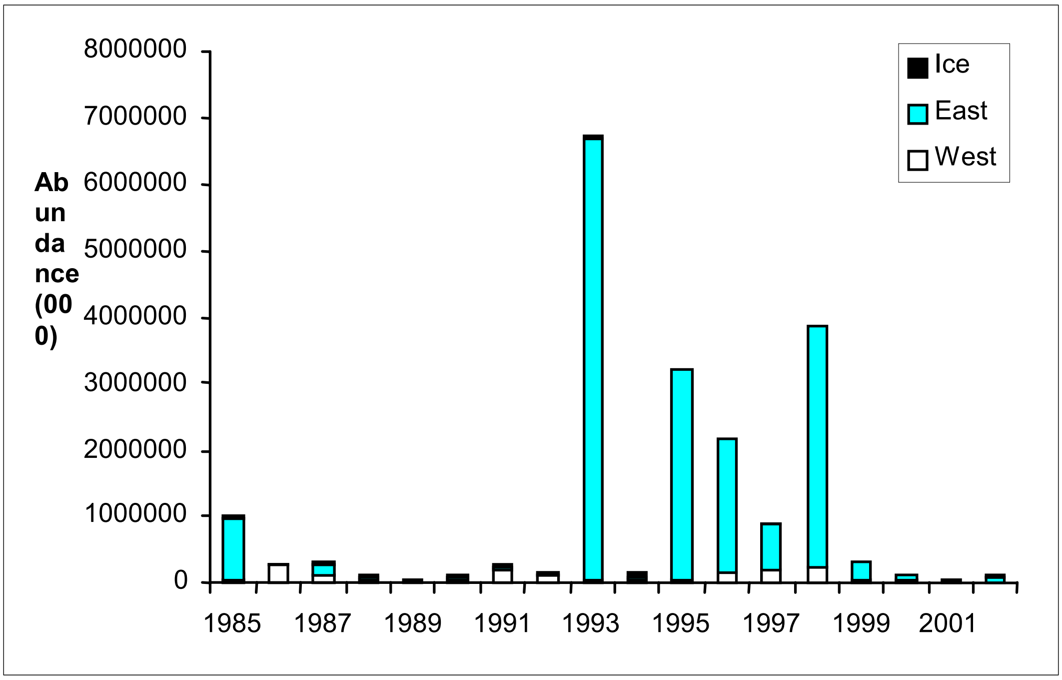


Figure 7.3.1 Survey abundance indices of *Sebastes* spp. (<17 cm) from the German and Icelandic groundfish surveys conducted on the continental shelves of East and West Greenland and Iceland 1985-2001.

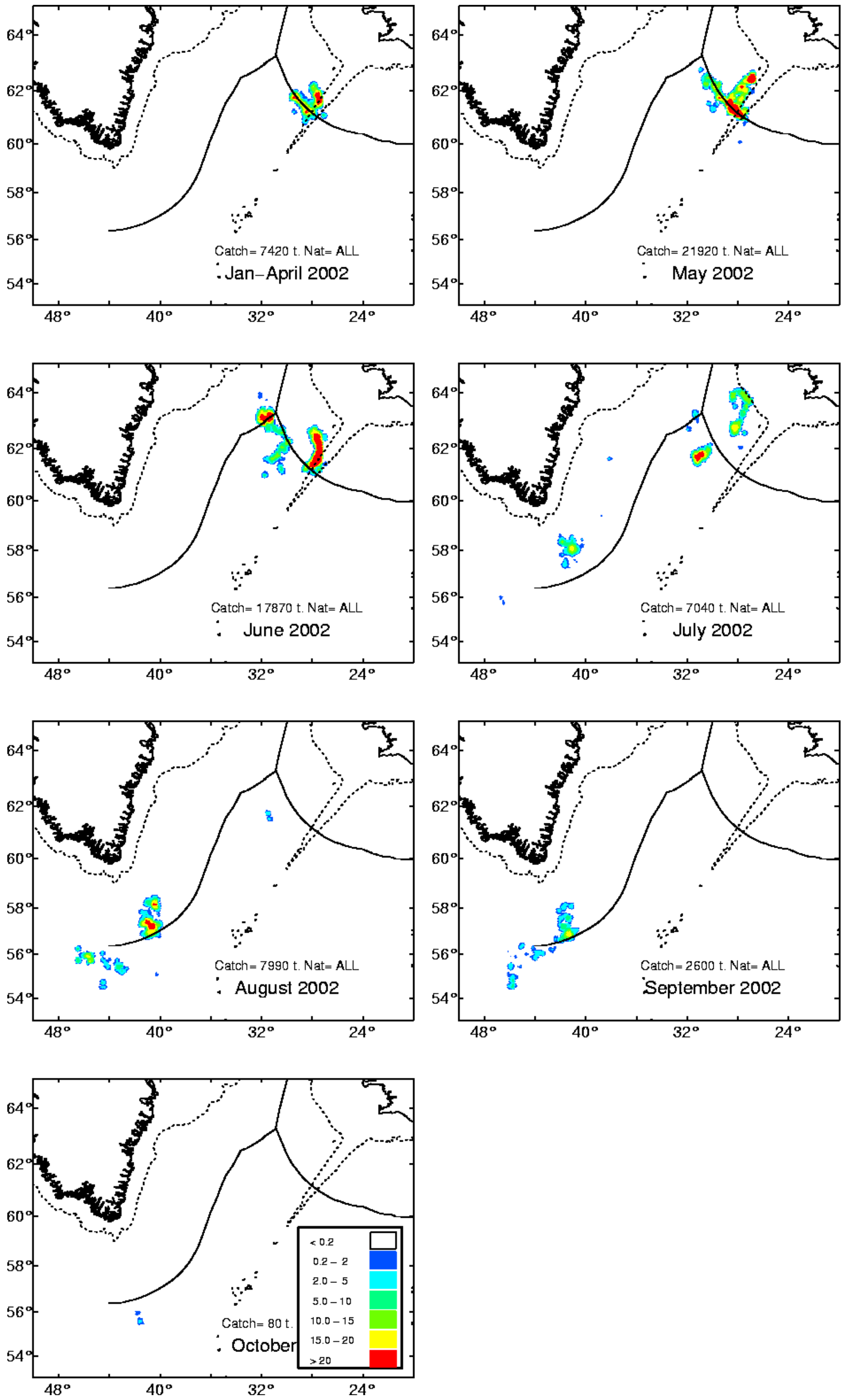


Figure 7.5.1 Fishing areas and total catch of the pelagic redfish (*S. mentella*) by month in 2002, derived from catch statistics provided by Germany, Norway, Iceland, and Greenland. The scale for the catch is in tonnes per squared nautical mile. Total catch for each period is also given.

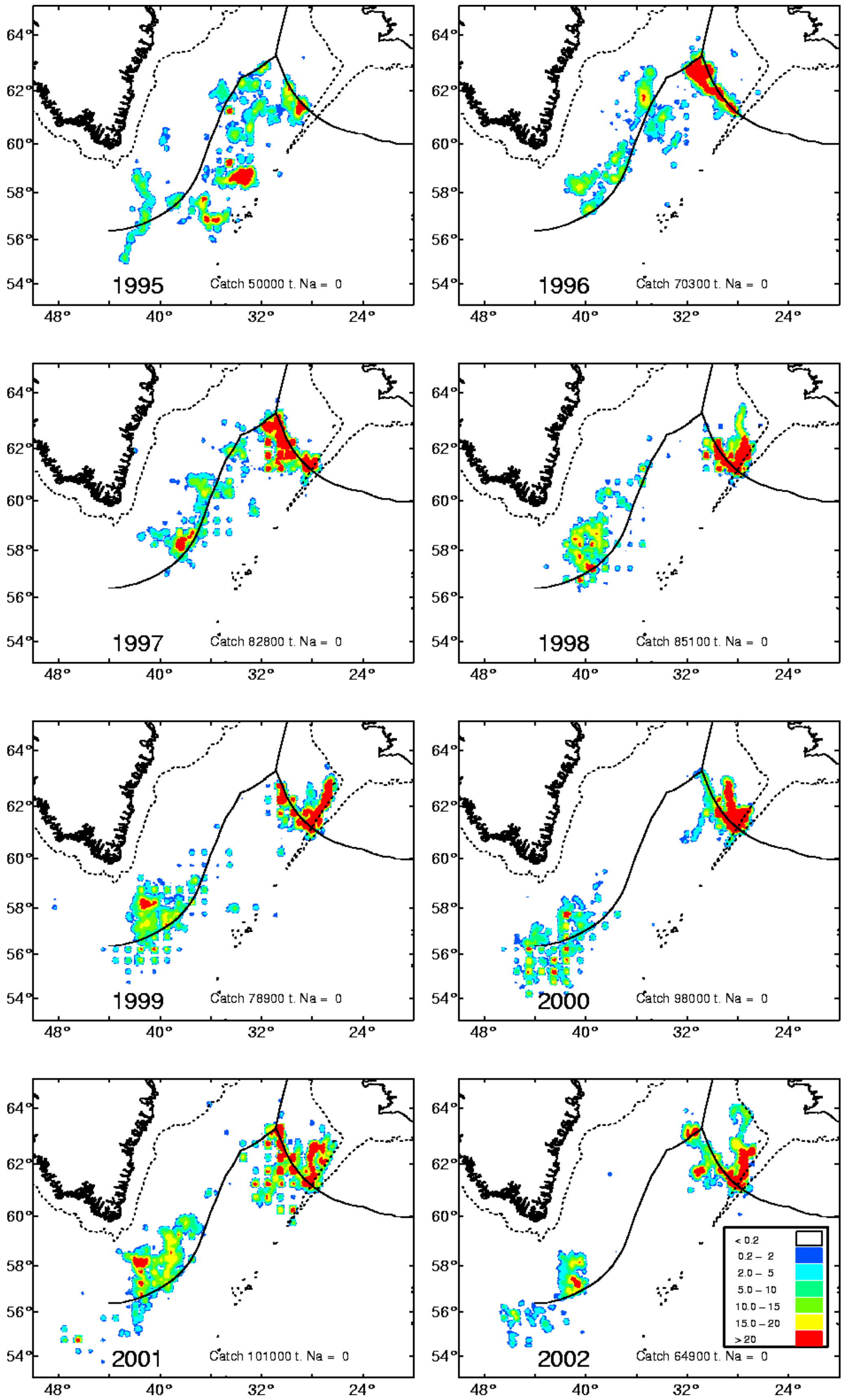


Figure 7.5.2 Fishing areas and total catch of the pelagic redfish (*S. mentella*) in the Irmenger Sea and adjacent waters 1995-2002. Data are from Germany (1995-2002), Norway (1995-2002) Greenland (1999-2002), Russia (1997-2001), Faroese (1995-2001), and Iceland (1995-2002). The scale given is tonnes per square nautical mile.

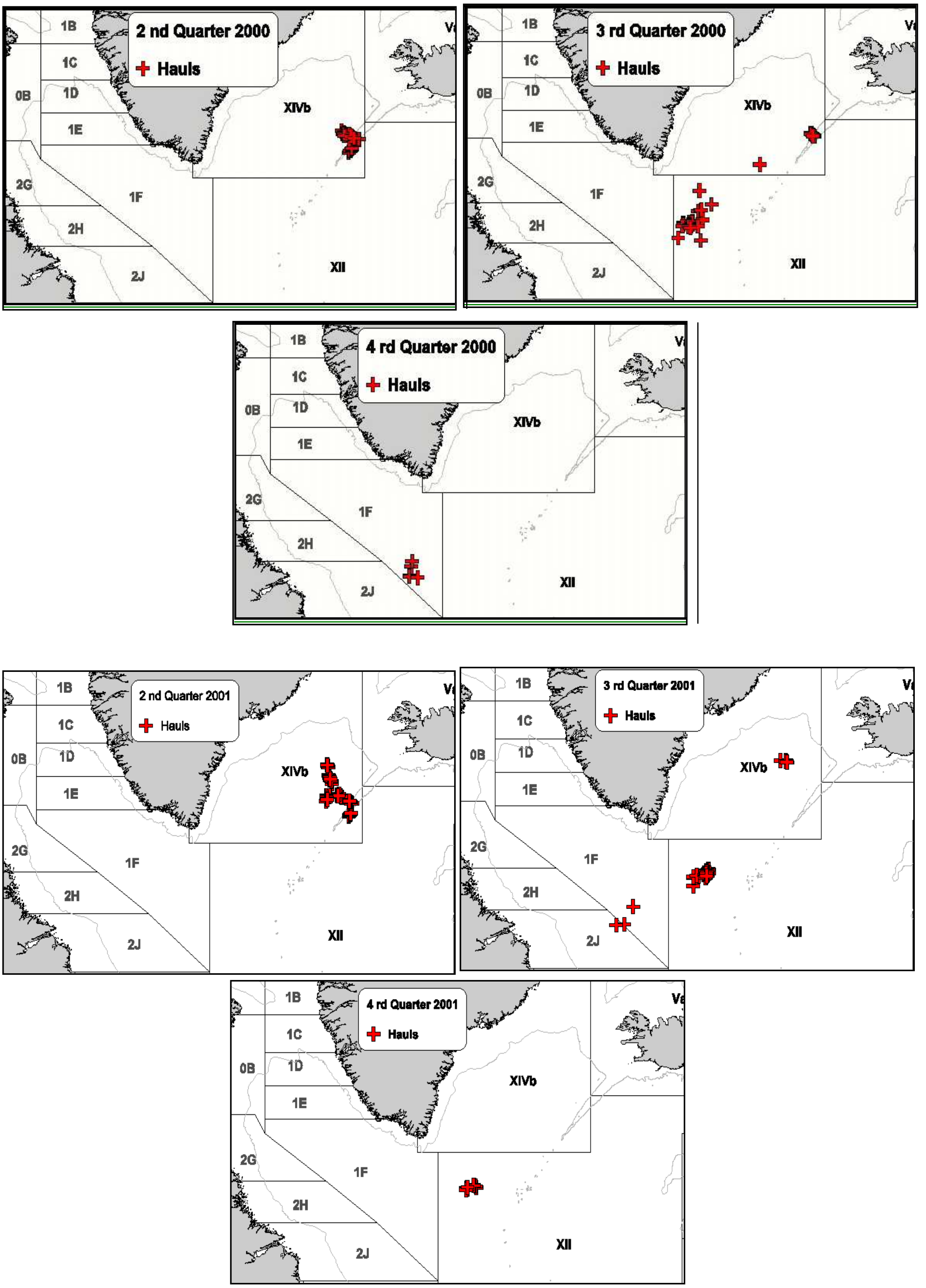


Figure 7.5.3 Distribution of the Spanish fleet fishing for oceanic redfish (*S. mentella*) in 2000-2001, divided by Divisions and quarter.

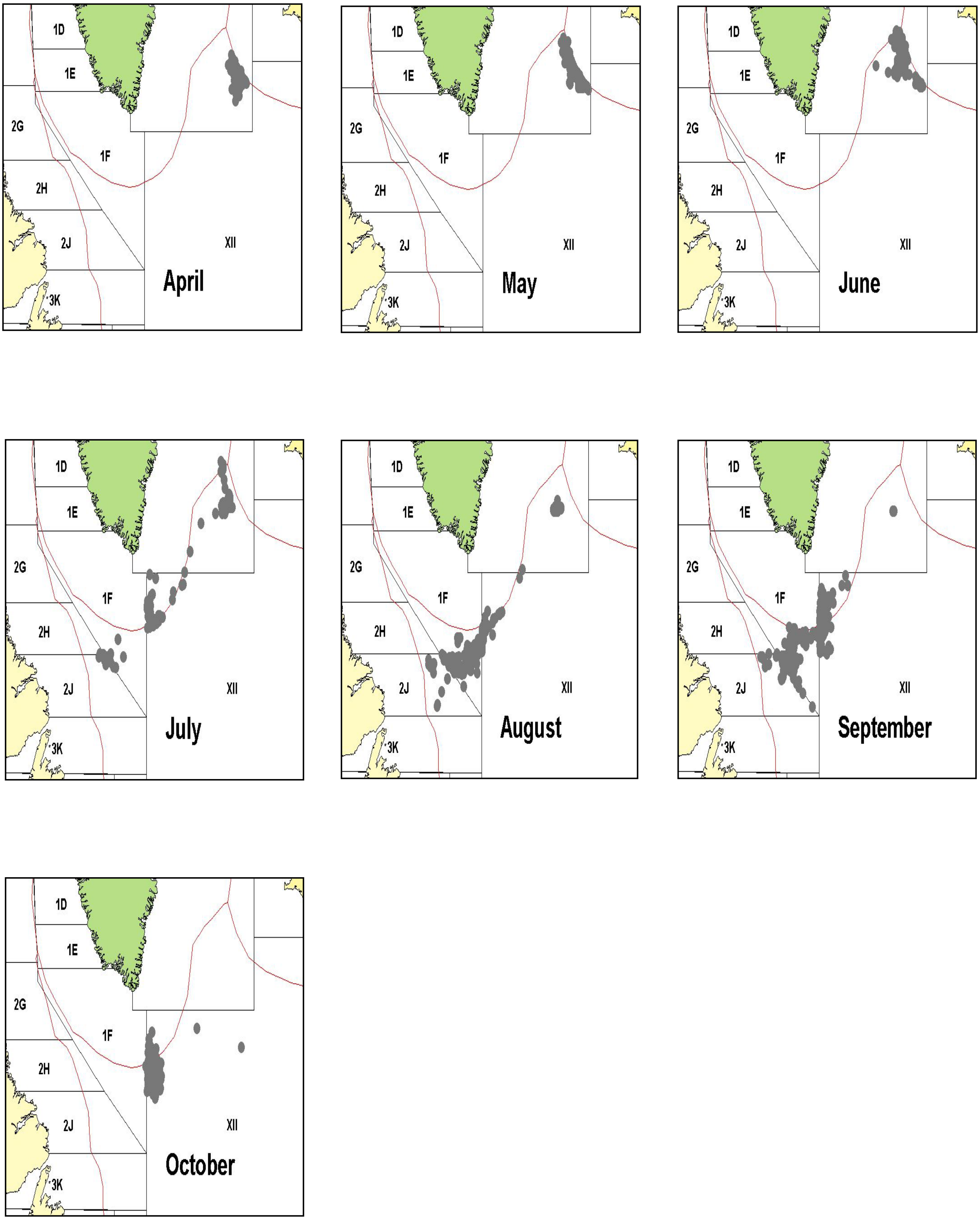


Figure 7.5.4 Position of Russian fleet in the Irminger Sea, divided by month in 2002.

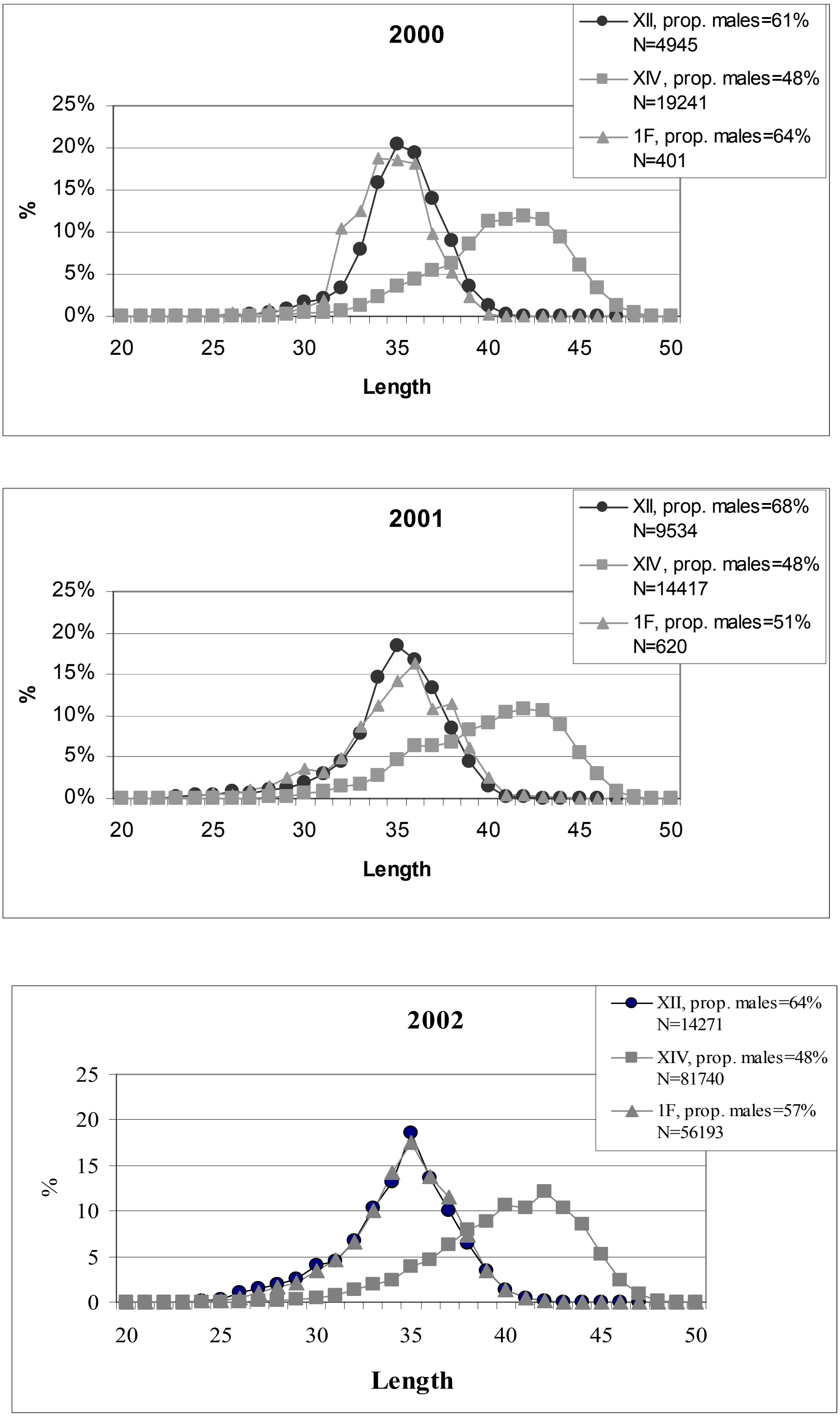


Figure. 7.5.5 Length distribution of the oceanic redfish fishery in ICES Div. XII, XIV and in NAFO Div. 1F by year from 2000-2002. Date from Spain (2000 and 2001) and Russia (2002). The proportion of males is also given.

8 SEBASTES MARINUS

S.marinus in ICES Divisions V and XIV have been considered as one management unit. Caches in VI have traditionally been included in this report and the group continues to do so.

8.1 Landings and trends in the fisheries

Since the early 1980's total catches decreased by more than 70%, from about 130 000 t in 1982 to 37 000 t in 2001 but increased again in 2002 due to increased catches in Division Va (Table 8.1.1).

In subdivision Va, catches of *S. marinus* declined from about 63 000 t in 1990 to a low of 34 000 t in 1996. Since then catches have varied between 35 000 and 49 000 t, with the lowest catch in 2001 and the highest in 2002. 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 redfish. The remainder is taken partly as by-catch in gillnet and longline fishery. In 2002, as in previous years, most of the catches were taken along the shelf W, SW, and SE of Iceland, mostly between 12ºW and 27ºW (Figure 8.1.1). Although there are no direct measurements available, it is assumed that there are not significant discard of *S.marinus* in the fishery due to area closures of the most important nursery grounds.

In subdivision Vb, catches have dropped continuously since 1985, from 9 000 t to 1 500 t in 1999 and has remained at that level since then (Table 8.1.1). Most of the *S. marinus* catches in Vb have been taken by pair trawlers and single trawlers (< 1000 HP).

The catches in Division VI increased since 1978, reaching almost 600 t in 1987, followed by a decline to 1992 and have since increased to about 800 t (Table 8.1.1) but decreased again to about 400 t in 2002.

In Division XIV catches have been more variable than in the other areas. 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. Since 1995 almost no directed fishery for *S. marinus* occurred and the catches have been 150 t or less. Some by-catch is reported from the shrimp fishery in the area.

8.1.1 Biological data form the fishery

The length distributions in the Icelandic landings in 1989-2002 along with measurements from the commercial trawler fleet are shown in Figure 8.1.2. Comparing the length distributions between the catch and landings there are no indications of discard. The numbers of measured fish by statistical square are given in Figure 8.1.3.

Length distribution from the Faroes catches for 2001 and 2002 are shown on Figure 8.1.4. No length data from the catches have been available for last years in Divisions XIV and VI.

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	48,592	341	62,677
Va	Germany/UK	Bottom trawl	12	0	
Va	Faroe	Line/hooks	76	0	
Vb	Faroe	Bottom trawl+gillnets	1,559	29	917
XIV	Germany	Bottom trawl	< 150	0	
VI	UK	Bottom trawl	392	0	

Catch-at-age data from the Icelandic fishery shows that the 1985 year class has dominated the catches from 1995-2001 (Figure 8.2.4 and Table 8.1.2), and in 2002 that year class contributed to 25% of the total catch in Va. The 1990 year class is also strong and that year class contributed with more than 30% to the total weight in the catch in 2002. The average Z, estimated from this 8-year series of catch-at-age data (Figure 8.1.6) is 0.20 for age groups 15+, and about 0.18 for age 20+. This estimation is based on Icelandic age readings, but the ageing can vary between readers. In WD 11, age reading results are compared between readers in terms of bias and precision. There were significant differences between readers and between methods, mainly for the older fish (> 20 years). However, for the medium age range (11-20 years), a fairly good agreement was reached between readers. Precision estimates, involving the high longevity of redfish, were relatively good compared to previous age reading comparisons on redfish species.

8.2 Assessment data

8.2.1 CPUE

CPUE indices for the Icelandic trawl fleet for the period 1985-2002 are estimated from a GLM multiplicative model using summarised data (for each ICES statistical square, vessel,month and year).The model takes into account changes in the Icelandic trawl catches due to vessel, statistical square, month, and year effect. All hauls at depths above 500 m with redfish exceeding 50% of the total catch, were included in the CPUE estimation (Figure 8.2.1).. A considerable increase in the CPUE was observed in 2001 and is supported by the data from 2002. The index is now above 85% of the 1986 value, which is the first year in the series

Unstandardised CPUE from the Fareoese trawler fleet decreased from 1996-1999 by 40% and remained that low until 2001. The CPUE in 2002 is the lowest value on record (Figure 8.2.2).

8.2.2 Survey data

Figure 8.2.3 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). In Table 8.2.1 the contribution of each depth stratum to the index is given. The index indicates a decrease in the fishable biomass from 1985-1995, but an increasing trend since then. The lowest index was in 1995, only about 30% of the maximum in 1987, but the value in 2003 is 65% of the highest observed value.

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 relatively strong year classes (1985 year class and the 1990 year class). This is confirmed by age readings (Figure 8.1.5).

In Division Vb, CPUE of *S. marinus* were available from the Faroes groundfish survey 1994- 2003 (Figure 8.2.5). 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 average of 43 hauls each year (20-61) hauls.

The new Faroes summer survey (see Section 2) that has been conducted since 1996 shows a constant decreasing trend throughout the series. The index in 2000-2002 is only about 1/3 of the CPUE in 1995 and about the same level as in 1999 and 1998 (Figure 8.2.6).

For the period 1982-2002, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm are illustrated in Figures 8.2.7 and 8.2.8. From 1986-1995, an almost continuous reduction in survey biomass has occurred. After a severe depletion of the *S. marinus* stock on the traditional fishing grounds around East Greenland in the early 1990's, the survey estimates show a significant increase in abundance in 2002. This increase indicate a possible recovery, although the values are very low compared with the period before 1990. The length frequencies from the German groundfish survey are illustrated in Figures 8.2.9-8.2.10, along with the length distributions in the IGS. The adults seem to remain almost depleted in East Greenland waters.

8.2.3 Assessment by use of BORMICON model

Since 1999 the working group has discussed an alternative model (BORMICON (BOReal MIgration and CONsumption model) that has been applied to this stock. The model using *S.marinus* as an example is described in SCI. MAR,2002 (67 (Suppl. 1): 301-314).

The BORMICON model was run using the same settings as last year's base case. The simulation period is from 1970 to 2003. Two time steps are used each year. Fixed selection pattern is used prior to 1998, but thereafter it is estimated separately for each year. The estimated value of L_{50} is shown in Table 8.2.4. Results from the runs are shown in Figures 8.2.11 - 8.2.15 and comparison with last year's results in Figure 8.2.16. As may be seen the stock estimate this year is relatively similar, although a little higher, the difference probably driven by the high survey index in 2003. Survey indices have varied much but have in general been increasing since 1993-1995 and reach its highest value in 2003. The survey index used here (Table 8.2.4) is total biomass index and differs therefore form the index of fishable biomass shown in Figure 8.2.3. Indices have been attended with relatively high CV's (Table 8.2.4). The CV of the survey index in 2003 is similar as the average CV in last 10 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 moralities (M=0.1 for age 5+) were tested in 2002. They gave a worse fit and are therefore not tried again this year. 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 the length of the 1985 and 1990 year classes in the groundfish survey.

Figure 8.2.15. shows residuals from the model fit to the survey data, demonstrating large positive residuals in some years, most notably 1993,1999 and in 2003.

The IGS in 2003 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 estimated 80 million (at age 0). Maximum yield-per-recruit is 250 g, 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 few years with an annual catch of 35-40 000 tonnes. This value might have to be reduced every year, though, when no sign of good recruitment is seen. 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 to the fishable stock within the next 10 years.

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. Nevertheless, the proportion of the catch taken in Division Va has 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 at 0.165 using 40 years simulations, and $\mathbf{F}_{0.1}$ was estimated to be 0.09. Here, F is not fishing mortality, but close to it when small time steps are used, or moralities 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 a fixed catch. As may be seen in Figure 8.2.13-8.2.14, 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.

8.2.4 State of the stock

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 the fishable biomass has, however, been seen in the most recent years due to improved recruitment. During the last few years, the 1985 year class has contributed significantly to the fishable stock, and the 1990 year class has also contributed significantly to the fishable biomass in the last 3 years. It is expected that those year classes will dominate the catches in the next few years. However, there is no indication of new, strong year classes after the 1990 year class. In Vb, survey indices as well as CPUE from the fleet do not indicate improved situation in the area and adult fish in Subarea XIV has nearly been exhausted in the most recent years but there are signs of improved recruitment (Figure 8.2.10).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 has increased, and is now inside defined safe biological limits (U_{pa}). A large proportion of the catches in recent years is caught from only two year classes. The fishable stock situation remains bad for Division XIV and Vb.

8.2.5 Catch projections and management considerations

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 8.2.2) 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 a few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions.

By assuming same effort in 2004 as in 2002 (see Section 8.2.1) the predicted catch in Va will be around 48 000 tonnes, using the formula, $Catch_{2004}$ = Average Survey $index_{2001-2003}$ * $Effort_{2002}$. By applying the same method for Vb, using commercial CPUE data (both series combined) instead of survey index, a predicted catch in Vb would be around 1 900 tonnes by assuming the same effort in 2004 as it was in 2002.

The ACFM formulation for advice in last 2 years was to reduce the effort by 25% based on the approach given above. That corresponded to 31 000 tonnes in Division V for 2003. By applying the same method for 2004, the catches would be about 36 000 in Division Va and around 1 400 t in Vb.

Based on the BORMICON model, a decrease in the fishable biomass is expected for all catch options above about 40 000 t. This is due to the poor recruitment after the 1990 year class. The estimated average year class since 1992 is about 80 millions (at age 0) and maximum yield-per-recruit is about 250 gr. A large proportion of the catch is from two year classes from 1985 and 1990. Therefore, after these two strong year classes have passed the fishery, one cannot expect higher yield than about 20 000 t from the year classes that come into the fishable stock in the next years. Based on the results, a TAC below 40 000 t in the next 5 years would provide a fishable stock size above current biomass level, at the end of that period. The approximate F from the model would increase after 2004 but fishing mortality would be above $\mathbf{F}_{max}$. Catches corresponding to $\mathbf{F}_{max}$ in next 5 years would be around 35 000 tonnes.

In order to rebuild the stock further in the near future, effort should be kept low.

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 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 close to U_{pa} during the last years. The survey index series is only available back to 1985.

The group discussed other alternatives to define reference points for this species, such as F or B points based on the BORMICON model. Although the BORMICON model provides candidates for reference points, they are difficult to use as the most important input data to the model is short, compared to the live span of the species and no year class has been followed throughout the fishery. The strong year classes that were observed in the first surveys are still the most dominant year classes in the fishery. Therefore the group considered it not appropriate at this time to change the biological reference points that have been used.

8.4 Comment on the assessment

The BORMICON model used for this stock extracts data directly from the databases at the Marine Research Institute in Reykjavik and intermediate input/output files are not included. This severely reduces the ability of the WG to review data and model results. Relevant intermediate input/output files and model diagnostic should be made available for the next assessment.

There are only available data on nursery grounds of *S.marinus* in Icelandic and Greenlandic waters but no nursery grounds are known in the Faroe Islands area. In Icelandic waters, nursery areas 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 the length (age) increases, migration of young *S.marinus* is anticlockwise from the North coast to the West coast and further to the Southeast fishing areas and to Faroese fishing grounds in Vb. The largest specimens are found in Subdivision Vb and therefore the year classes from 1985 and 1990 might still not have entered into that area. This might explain the inconsistency between different indicators on the status of the stock.

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	41,187	1,498	776	0	89	43,550
2001	34,895	1,489	535	0	93	37,012
2002	48,648	1,559	392	0	189	50,788

Table 8.1.2 *S. marinus*. Catches in Va in weight (tonnes) by age.

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002
7	59	0	33	24	0	0	125	0
8	366	354	229	285	367	118	140	631
9	1572	808	483	598	1492	595	396	653
10	9312	3622	1039	1213	1244	3977	1625	484
11	2698	8943	2704	1134	1820	1894	7757	2661
12	1314	2072	11563	3257	2651	2524	1804	12744
13	3548	1300	2820	12548	2330	1610	1978	2188
14	5684	1459	1366	2086	15703	2292	1249	2160
15	6000	4398	3123	2039	1171	14272	836	1524
16	1743	5641	3621	2411	1235	1778	11649	2379
17	859	921	3024	3410	1884	1234	521	14412
18	371	388	896	2048	2769	1843	784	1646
19	1148	268	644	1015	2317	2379	1064	1325
20	1158	337	960	726	1219	2201	1794	835
21	511	1210	448	521	487	571	966	972
22	684	1033	544	390	231	619	418	833
23	1447	803	691	425	347	226	435	675
24	673	0	595	662	226	124	168	88
25	773	0	753	516	948	585	130	541
26	370	0	271	400	281	503	125	88
27	354	0	140	425	587	248	291	222
28	736	0	208	359	175	493	204	616
29	0	0	155	54	107	471	153	553
30	134	0	31	226	234	451	373	350

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey by depth.

	Depth interv					
Year	< 100m	100-200m	200-400m	400-500m	Total 0 - 400m	Total
1985	7	91	140	24	237	261
1986	2	86	180	12	268	280
1987	2	124	150	10	276	286
1988	1	95	110	4	206	210
1989	1	101	118	11	220	231
1990	2	68	81	22	151	173
1991	2	76	53	8	130	139
1992	1	62	59	9	122	132
1993	1	48	50	17	98	115
1994	1	58	51	1	110	111
1995	0	36	45	11	81	92
1996	1	44	76	21	122	143
1997	1	60	71	34	133	166
1998	2	57	71	3	130	132
1999	1	56	107	44	164	208
2000	2	47	69	8	117	125
2001	2	33	67	6	101	107
2002	2	64	74	11	140	151
2003	9	60	107	29	176	205

Table 8.2.2 *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	34,986	82
2002	590	48,648	82
2003	741		

Table 8.2.3 Results of the BORMICON model. BASE CASE, estimated value of L_{50}.

Year	<1998	1998	1999	2000	2001	2002
L_{50}	34.18	34.81	34.55	34.10	33.67	33.71

Table 8.2.4 Index of total biomass of *S.marinus* from the groundfish survey in March and CV in the estimate.

Year	index	CV
1985	332	0.094
1986	373	0.134
1987	349	0.114
1988	283	0.103
1989	337	0.152
1990	311	0.313
1991	203	0.105
1992	173	0.093
1993	203	0.143
1994	189	0.125
1995	163	0.138
1996	228	0.211
1997	279	0.311
1998	228	0.159
1999	377	0.206
2000	261	0.203
2001	221	0.154
2002	255	0.122
2003	402	0.191

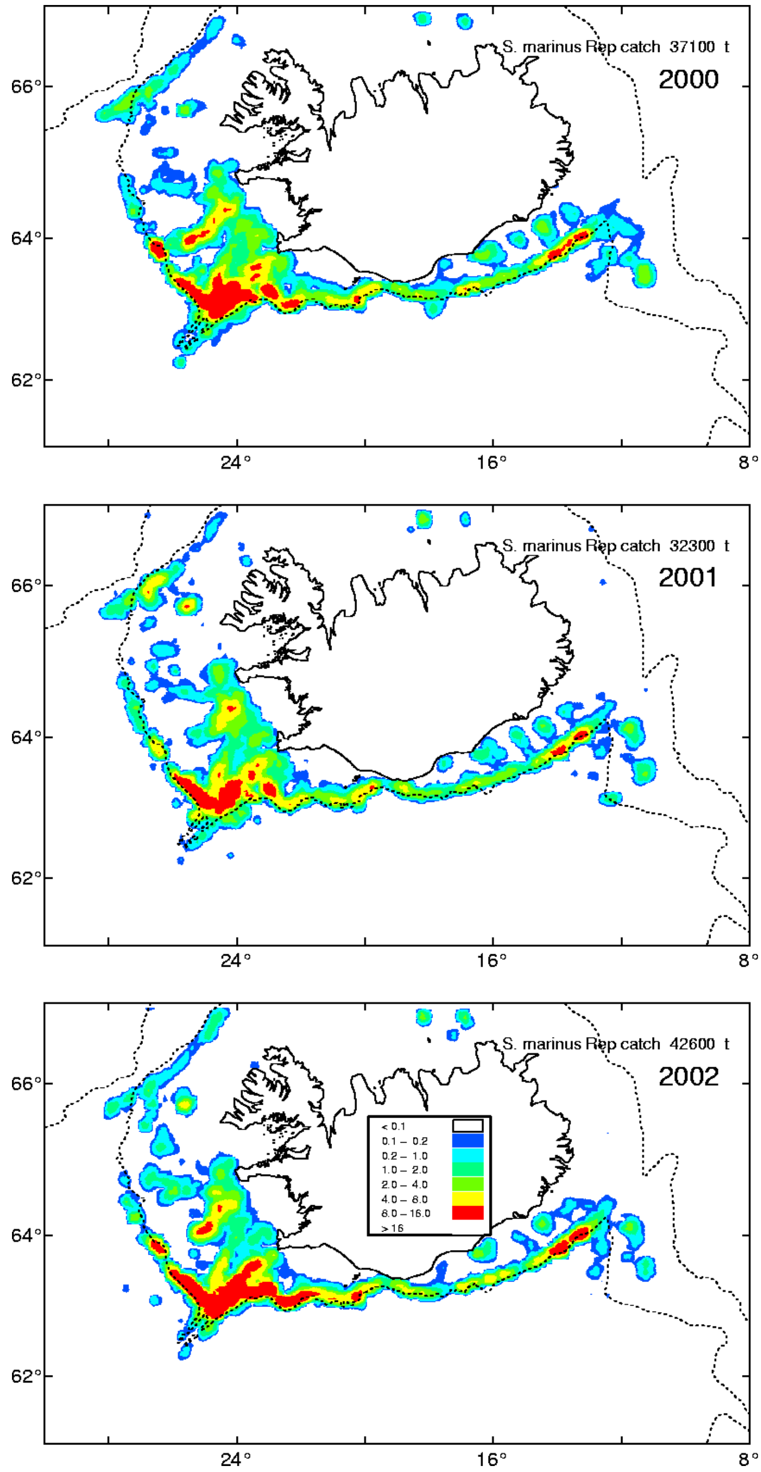


Figure 8.1.1 Distribution of *S.marinus* catches in Division Va from 2000-2002.

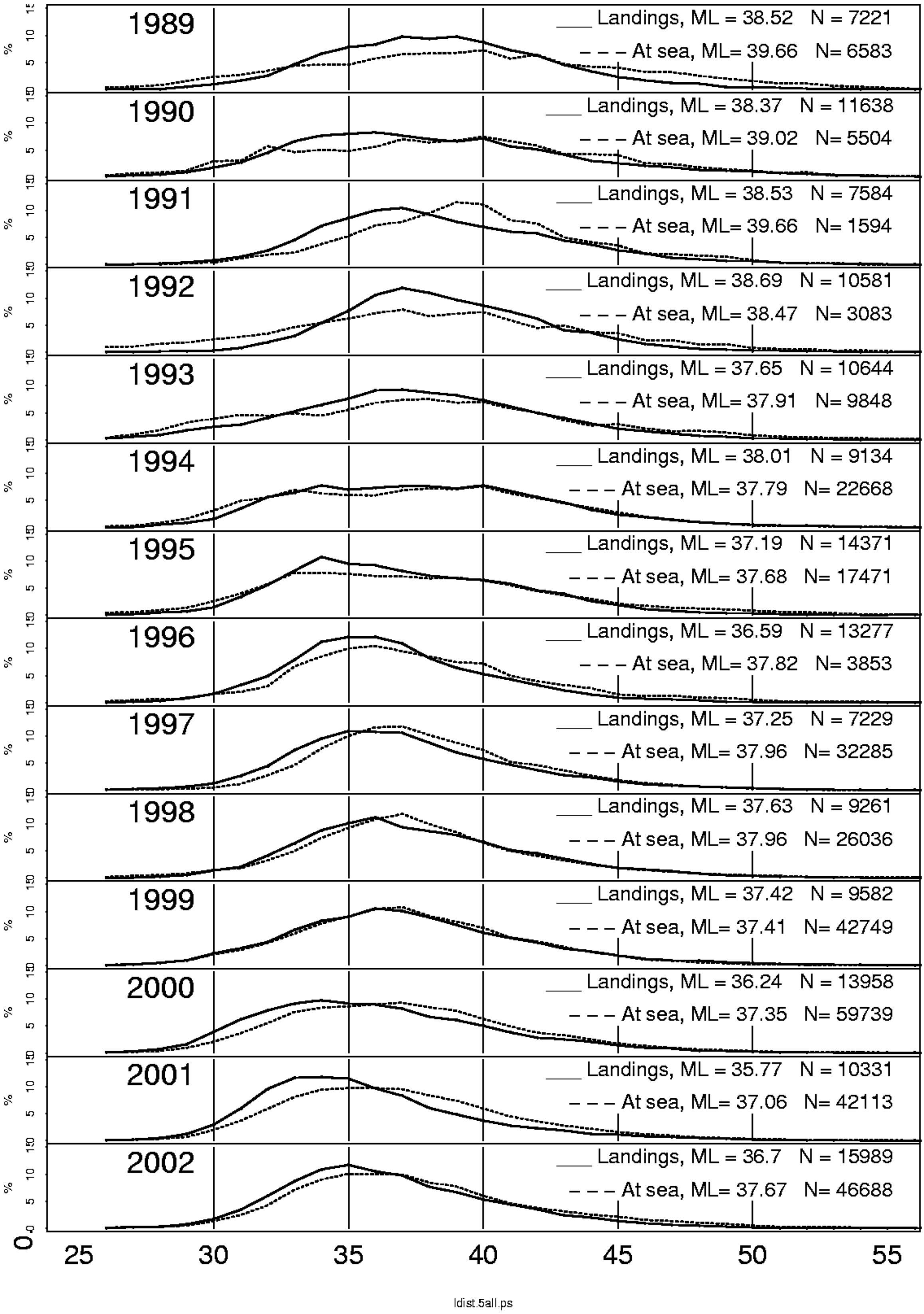


Figure 8.1.2 *S. marinus*. Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-2002.

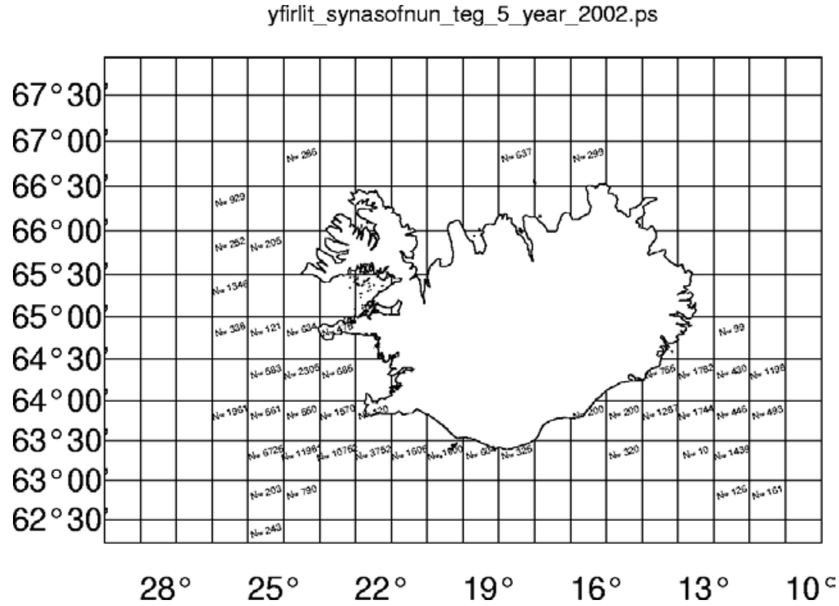


Figure 8.1.3 Number of measured *S. marinus* in 2002 by statistical square.

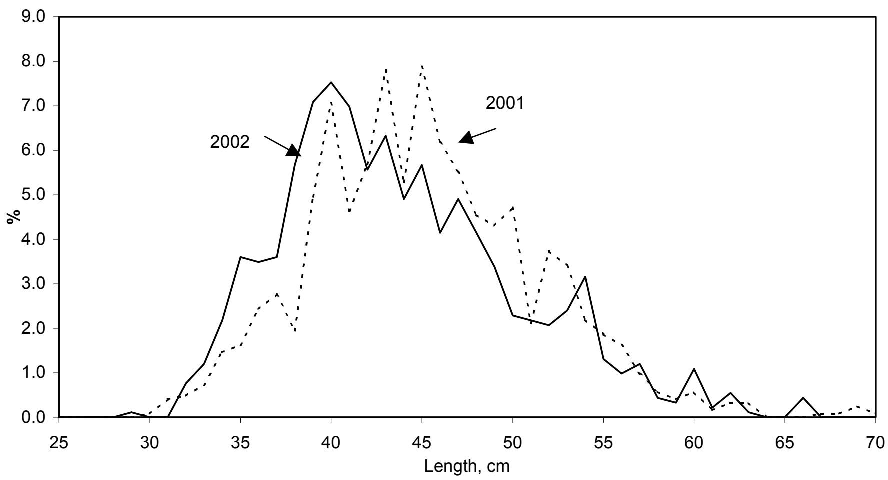


Figure 8.1.4 *S. marinus*. Length distribution from Faroese catches in 2001-2002.

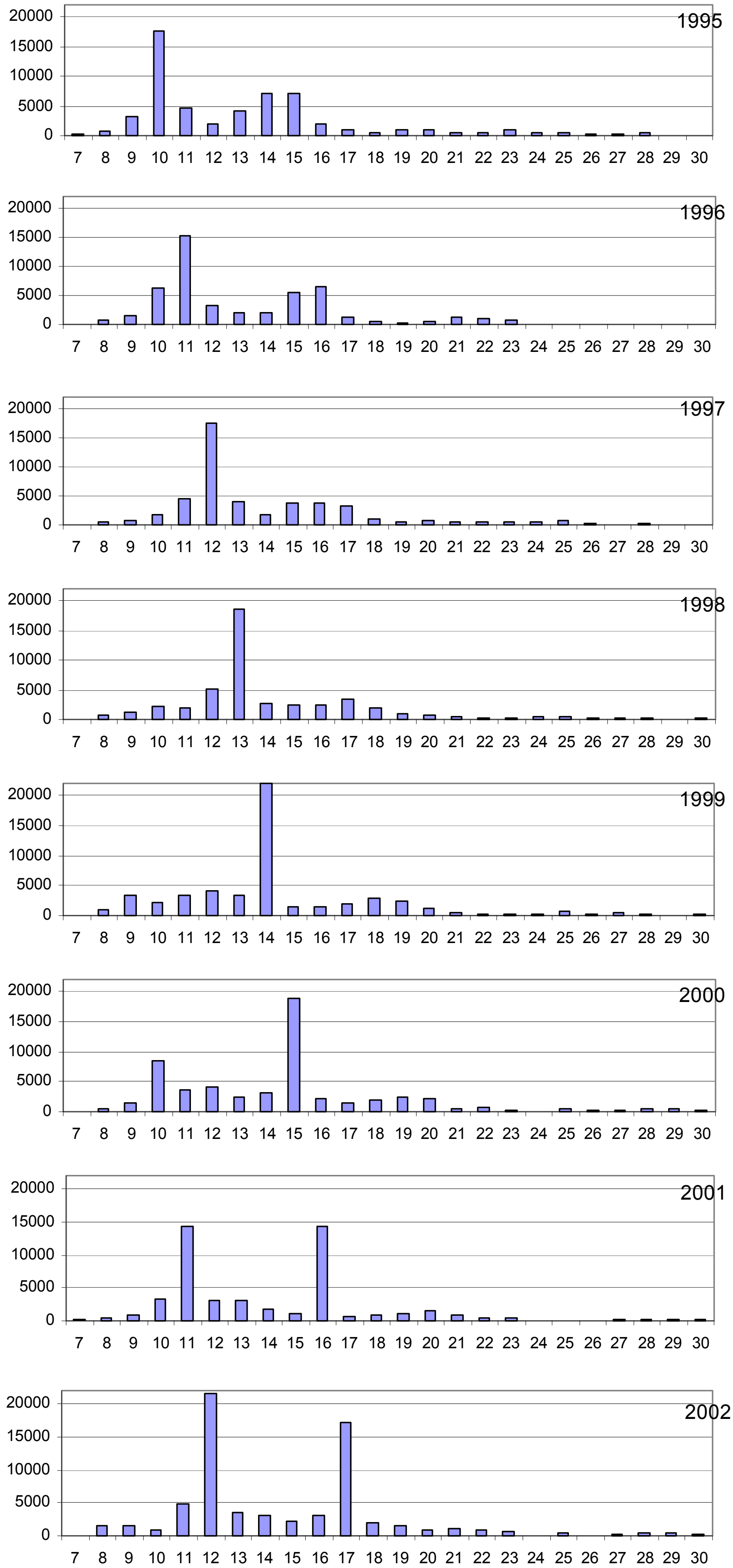


Figure 8.1.5 *S. marinus.* Catch in number by age in ICES Subdivision Va 1995-2002.

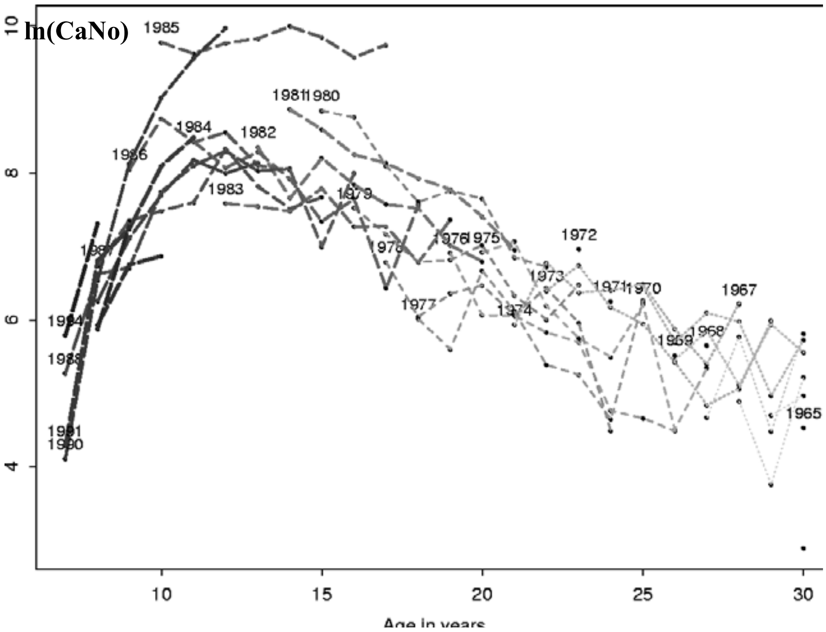


Figure 8.1.6 *S. marinus.* Catch curve based on the catch data in ICES Division Va 1995-2002.

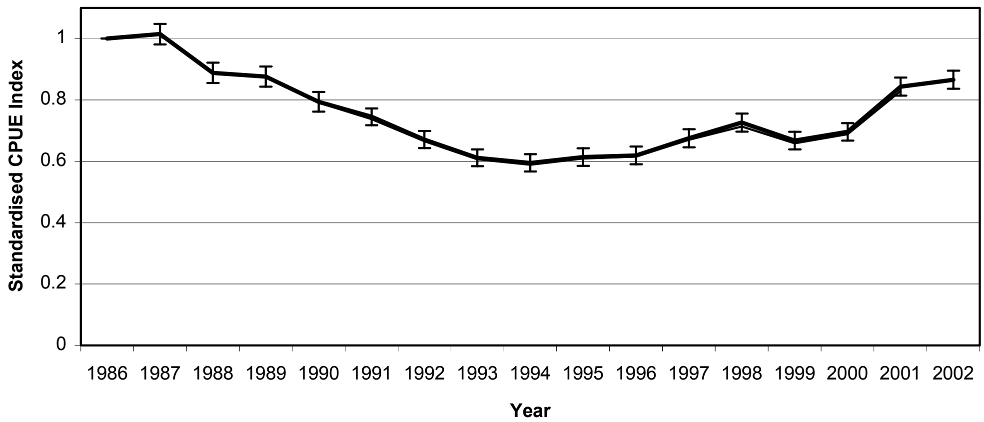


Figure 8.2.1 CPUE in *S. marinus* from Icelandic trawlers, both based on results from the GLM model 1985-2002 with 95% CV where the *S. marinus* catch composed 50% or more of the total catch in each haul.

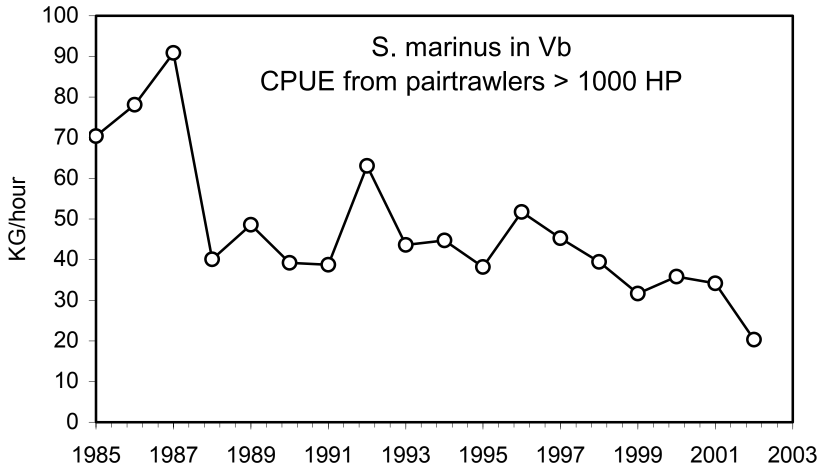


Figure 8.2.2 CPUE from the Faroese pair-trawlers in ICES Division Vb 1985-2002.

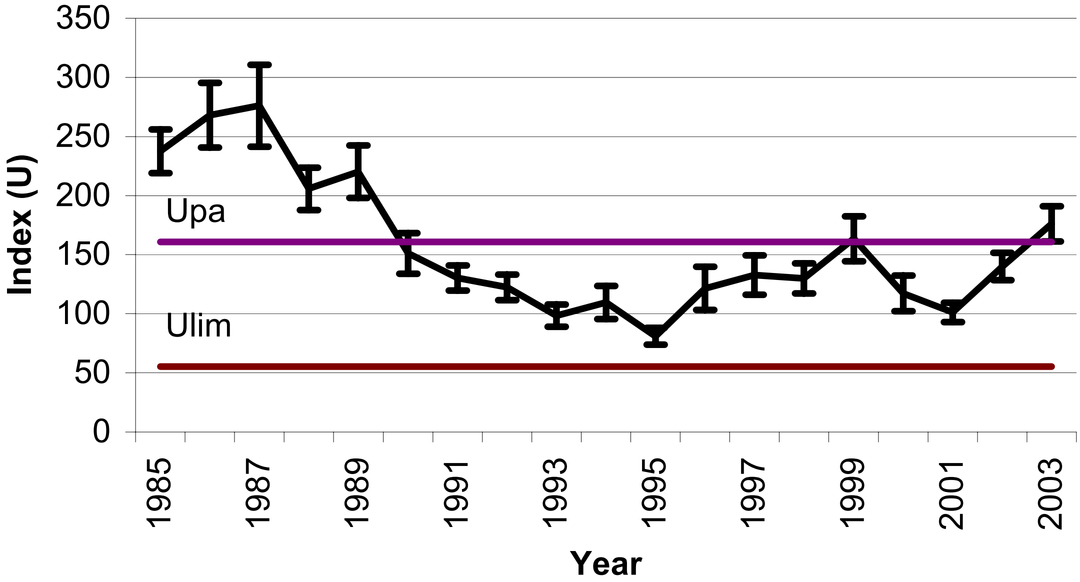


Figure 8.2.3 Index on fishable stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

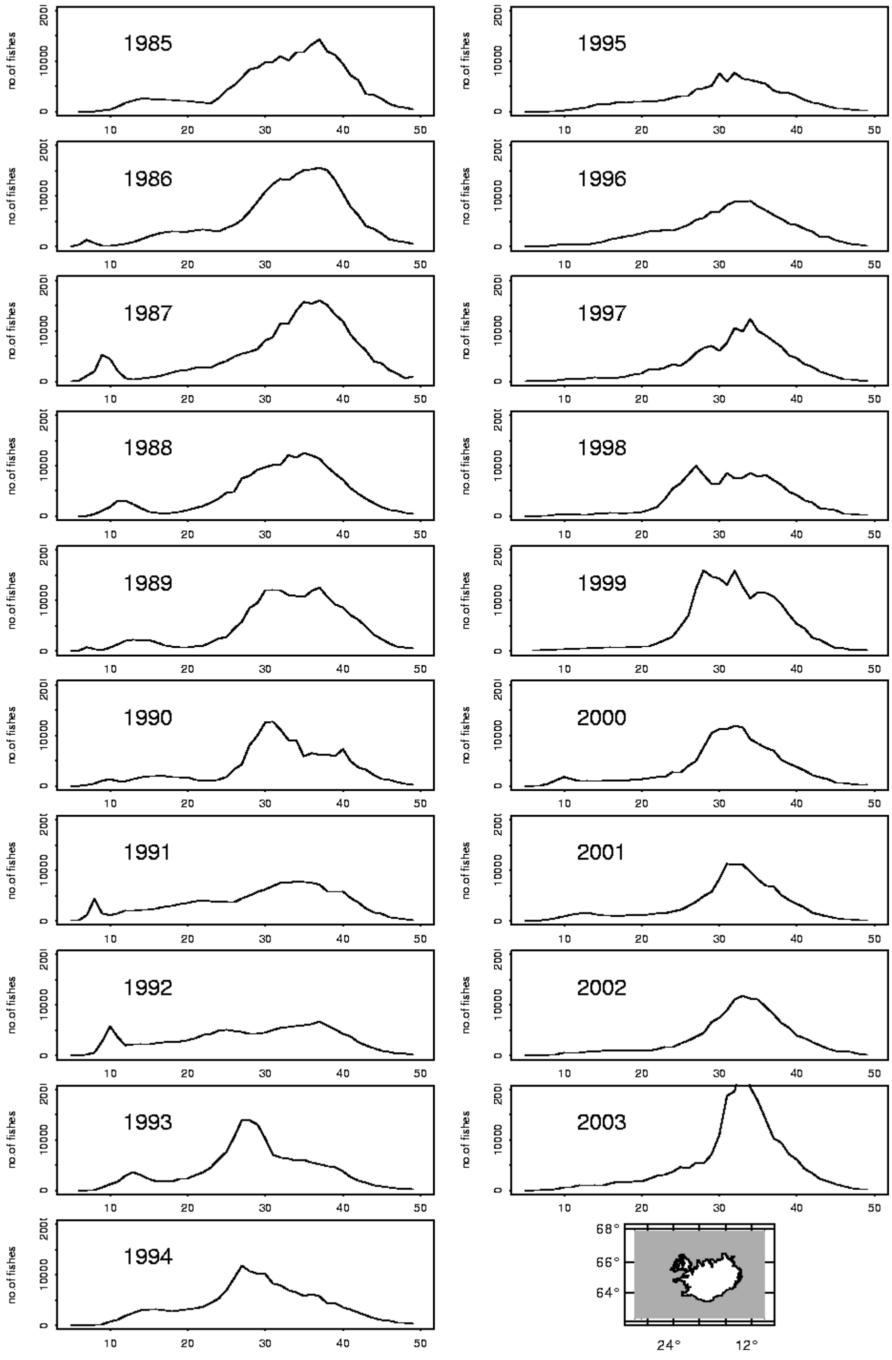


Figure 8.2.4 Length distribution of *S. marinus* in the Icelandic groundfish survey 1985-2003.

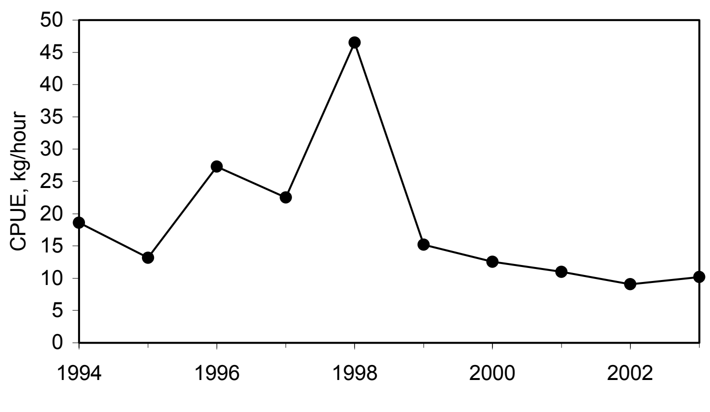


Figure 8.2.5 CPUE of *S.marinus* in the Faroes groundfish survey 1994-2003.

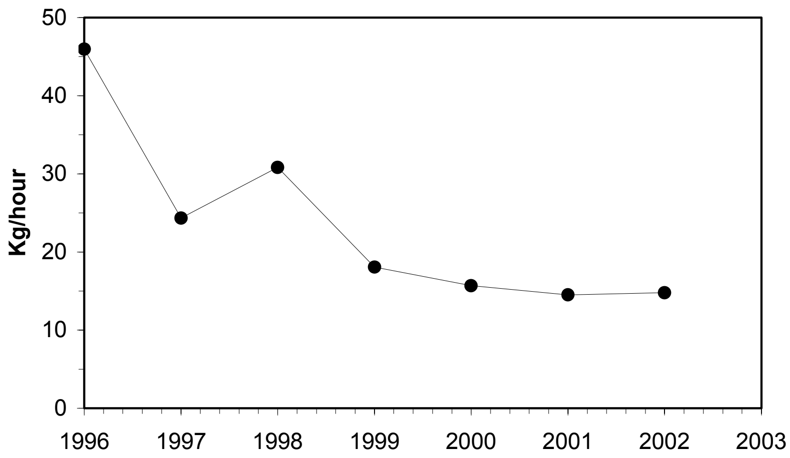


Figure 8.2.6 CPUE of *S. marinus* in the Faroes summer survey in Division Vb1 from 1996-2002.

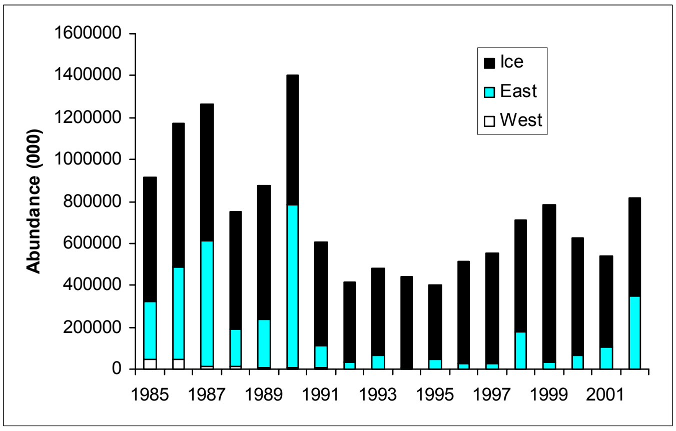


Figure 8.2.7 *S. marinus* (≥17 cm). Survey abundance indices for East, West Greenland and Iceland 1985-2002.

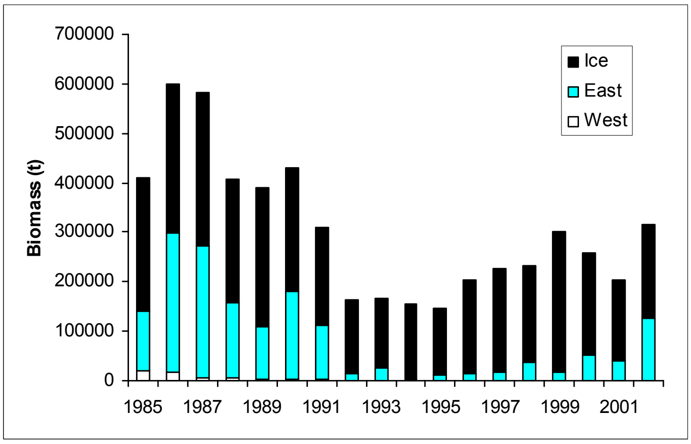


Figure 8.2.8 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland and Iceland, 1985-2002.

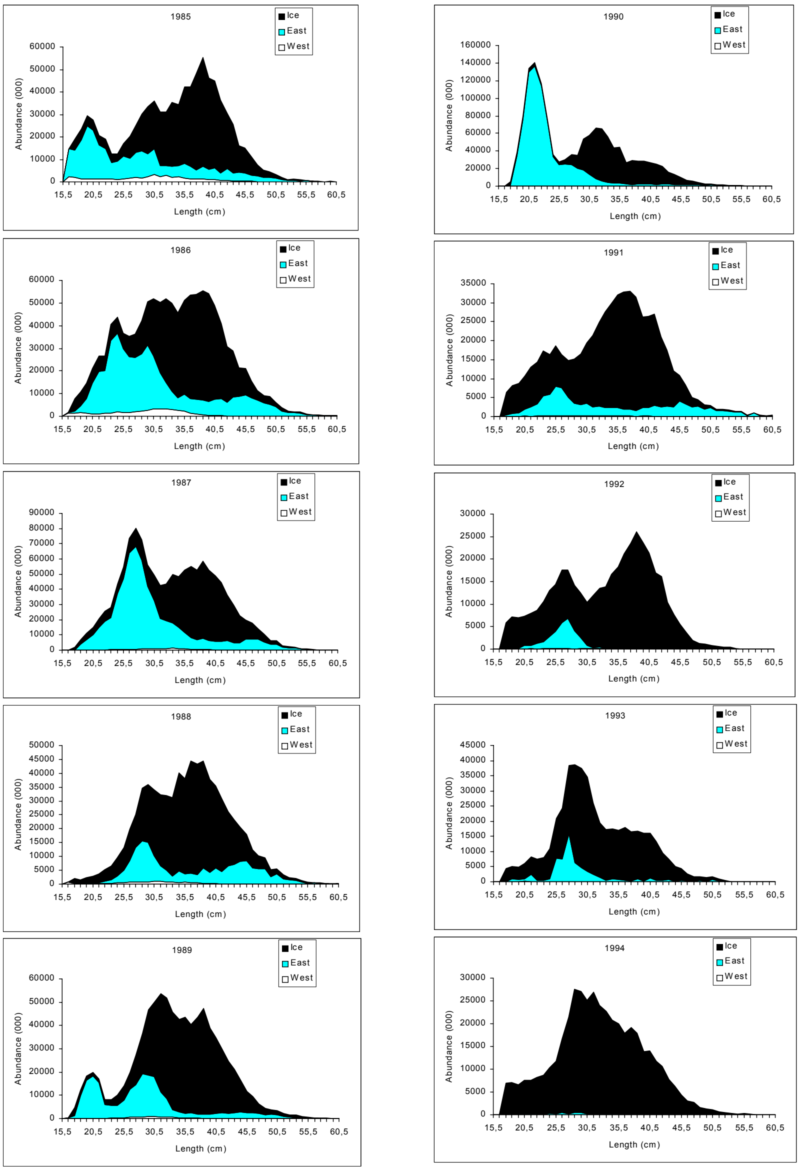


Figure 8.2.9 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland, and Iceland, 1985-1994.

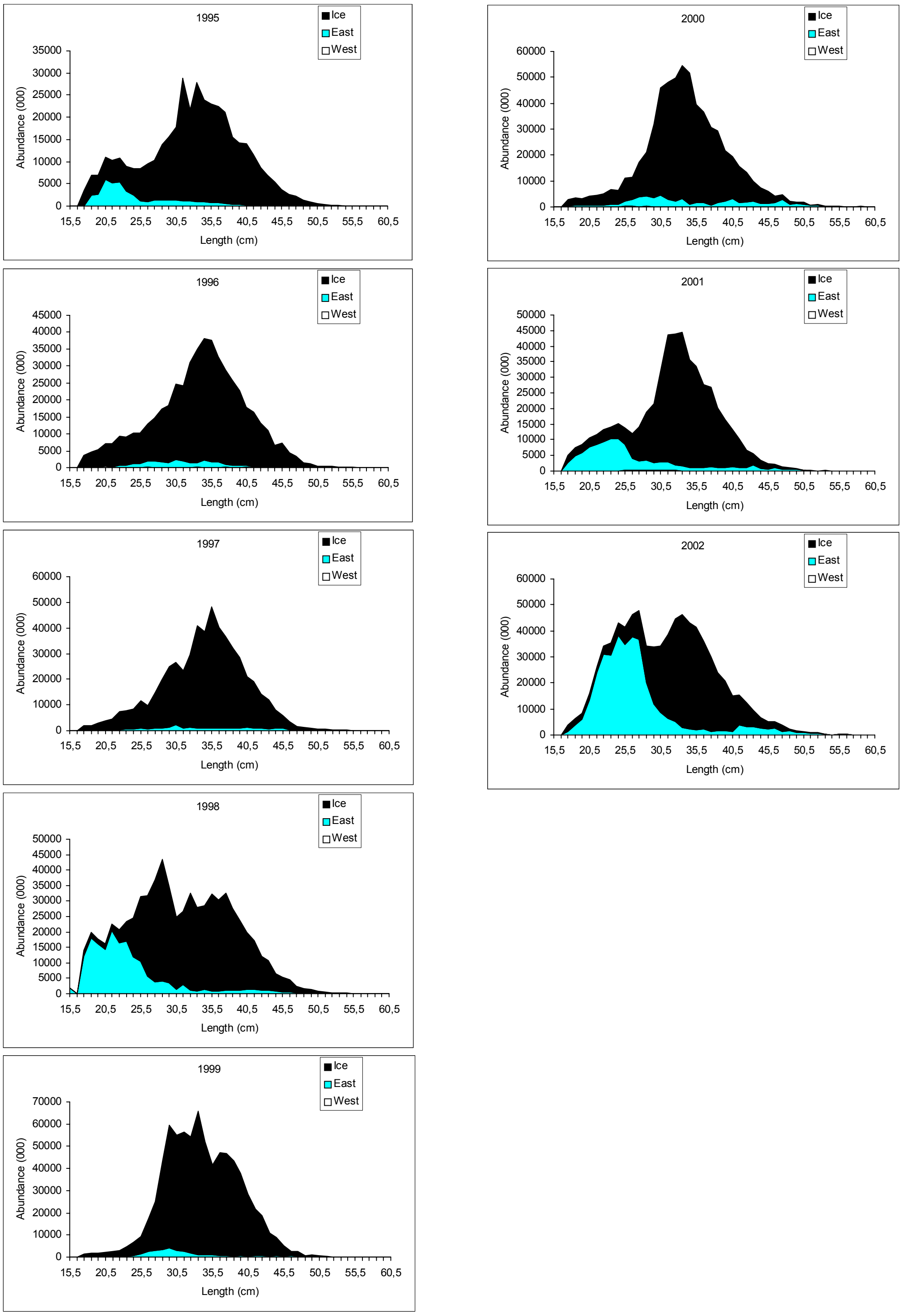


Figure 8.2.10 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland, and Iceland, 1995-2002.

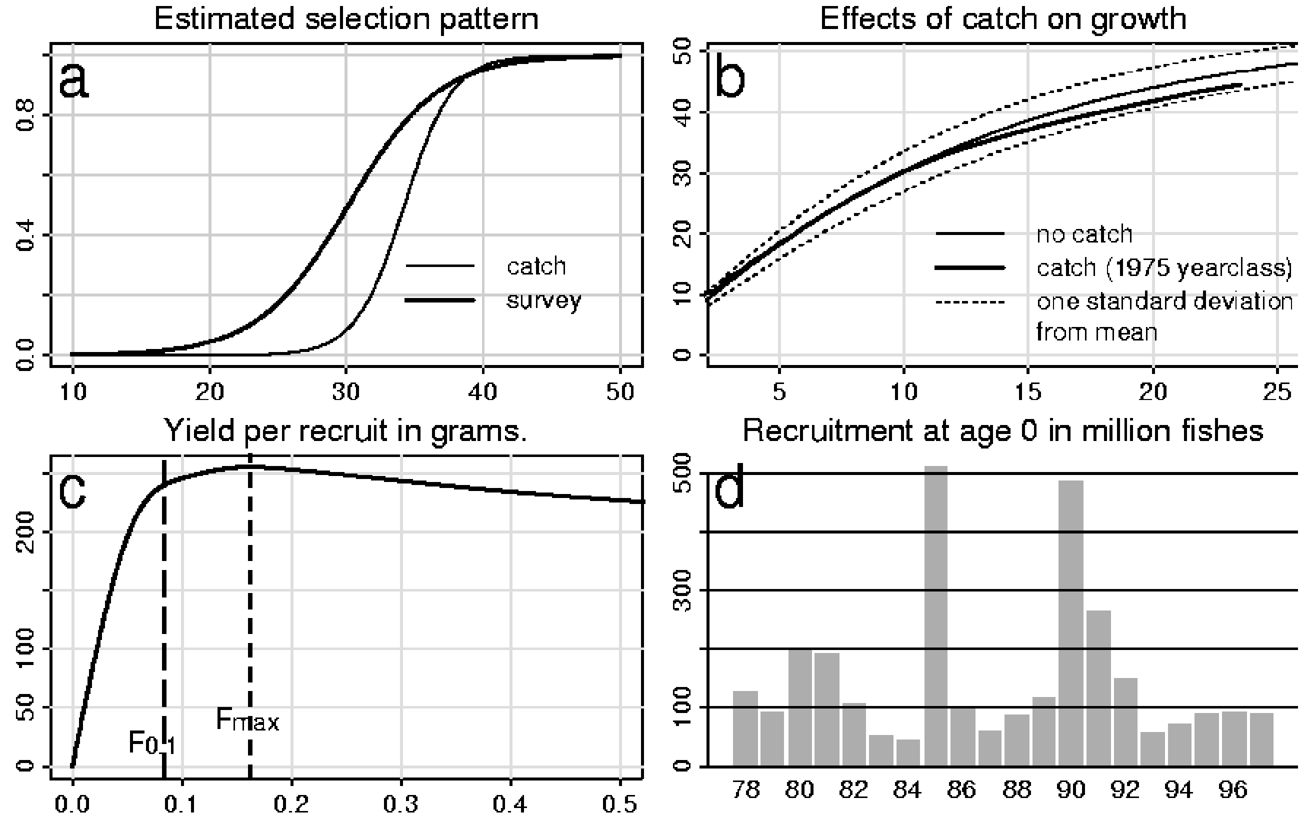


Figure 8.2.11 Results from the BORMICON model-BASE CASE, using catch data from ICES Division Va only. a) Estimated selection pattern of the commercial fleet and the survey, b) Mean length (the Figure also demonstrates the effect of catch on length-at-age), c) Yield-per-recruit, and d) Estimated recruitment at age 0.

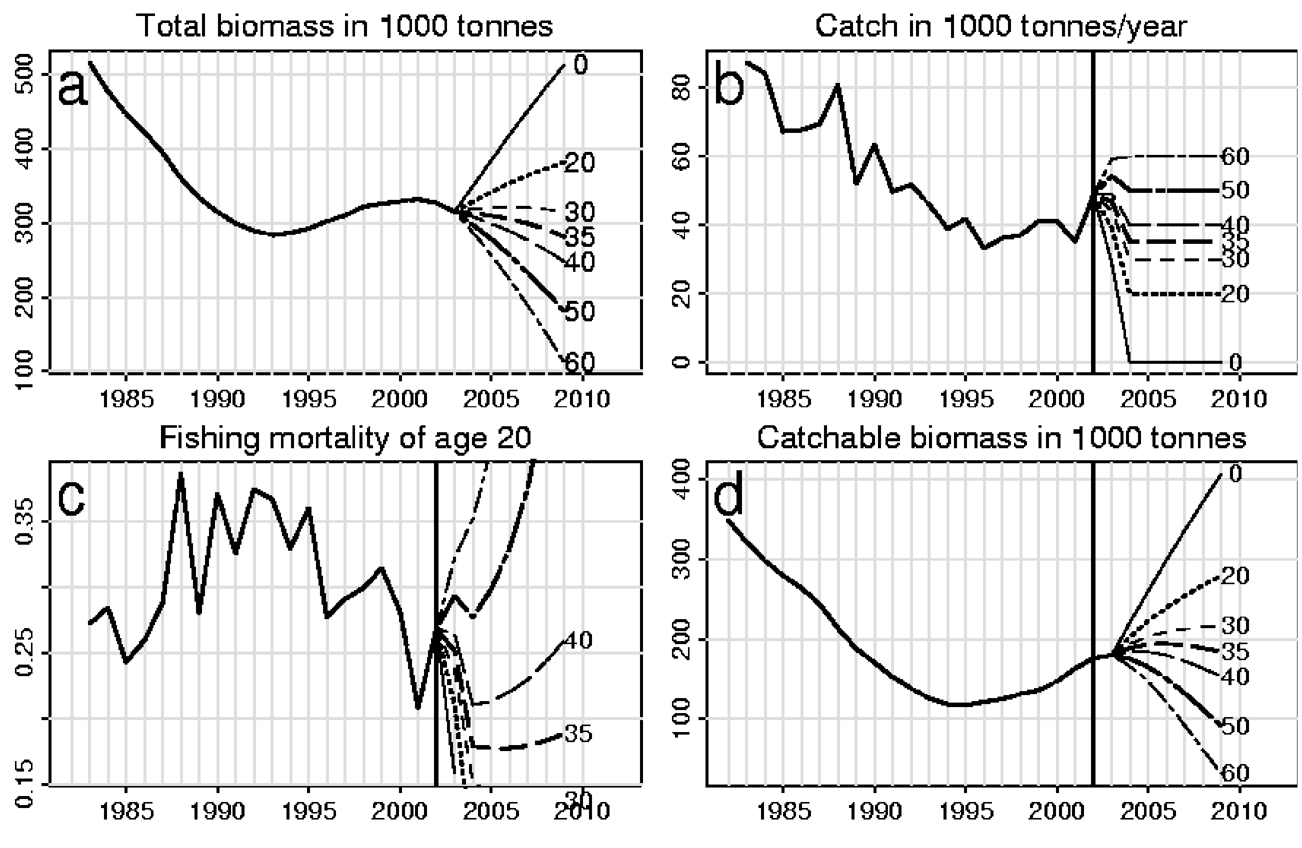


Figure 8.2.12 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figures show the development of biomass and F, using different catch options (0-60 000 t) after 2003.

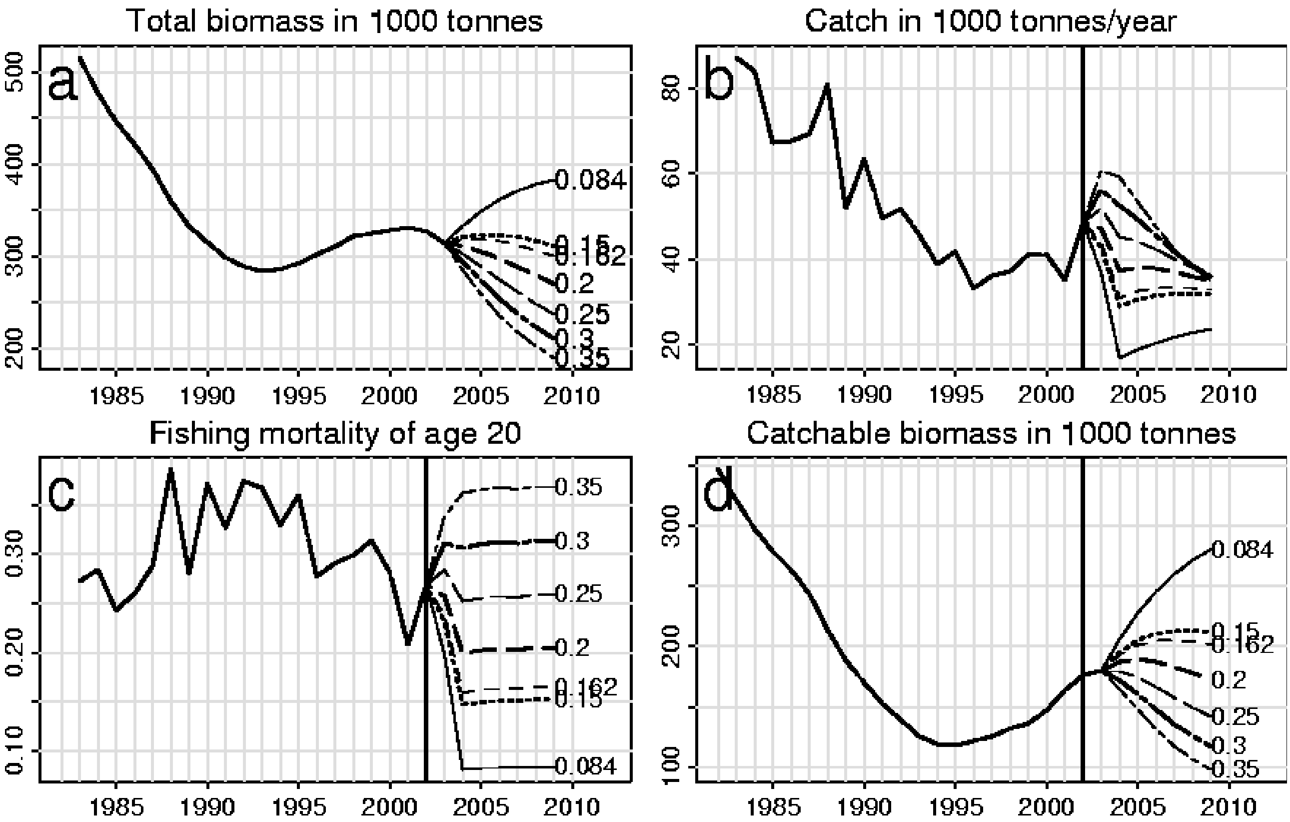


Figure 8.2.13 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figures show the development of biomass and F, using different effort after 2003.

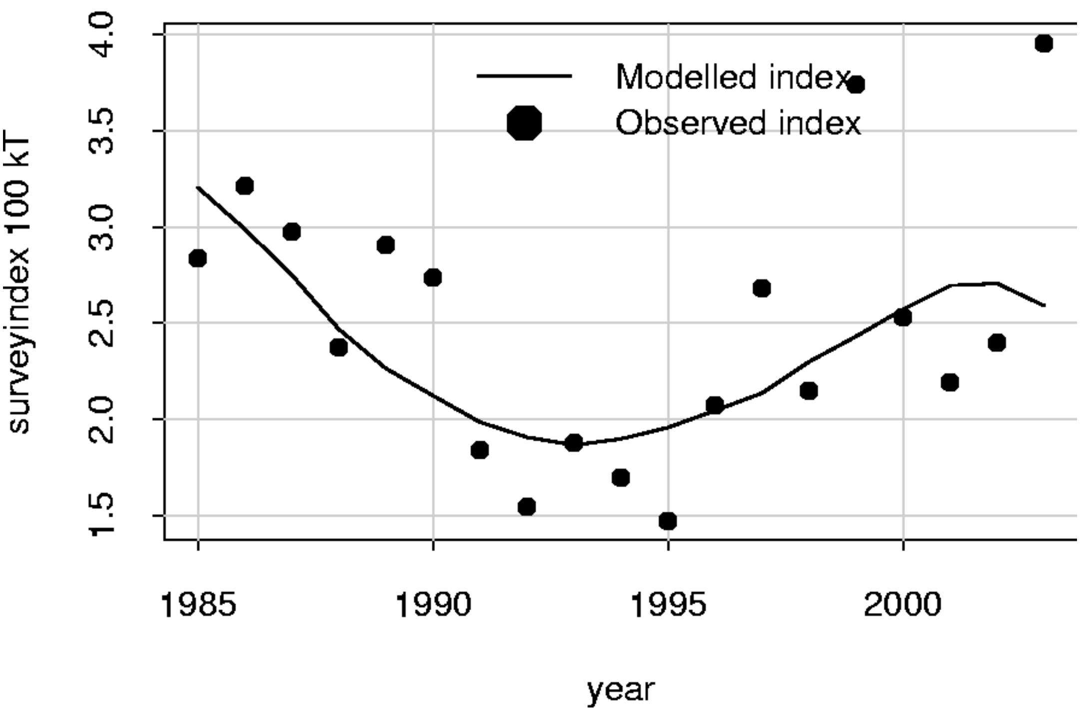


Figure 8.2.14 Results from the BASE CASE run, using only catch data from ICES Division Va. The **Figure** shows comparison of observed and modelled survey biomass (total biomass).

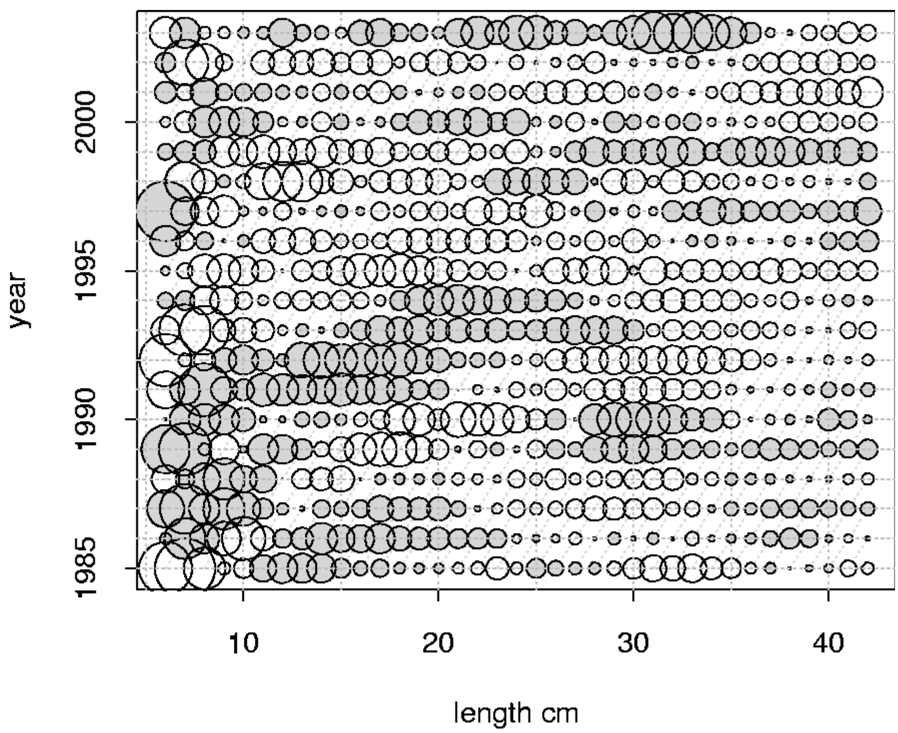


Figure 8.2.15 Results from the BASE CASE run, using only catch data from ICES Division Va. Residuals from fit to survey data log(Isur/Imod). The shaded circles show positive residuals (survey results exceed model prediction).

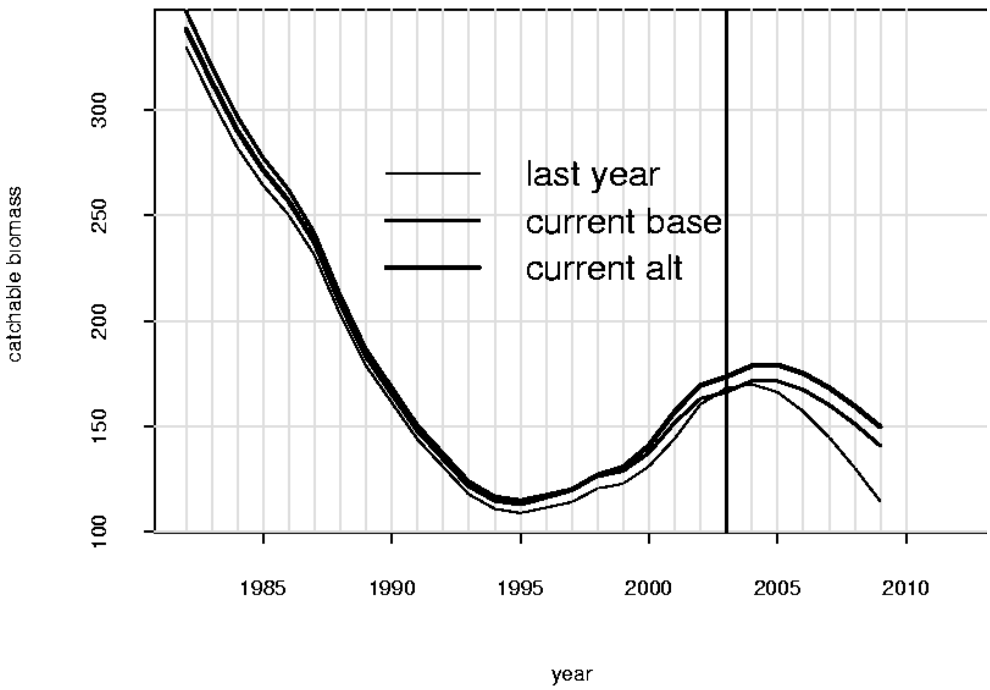


Figure 8.2.16 Comparison of catchable biomass using the data obtained now and last year, for same settings. Results are obtained using only the catch history from ICES Division Va.

9 DEEP-SEA *SEBASTES MENTELLA* ON THE CONTINENTAL SHELF

Deep-sea *S. mentella* on the continental shelves and slopes around the Faroe Islands, Iceland, and East Greenland is treated as one stock unit and separated from the stock fished in the Irminger Sea (oceanic *S. mentella*, see Chapter 10). It is believed to have a common area of larval extrusion southwest of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters off East Greenland, and feeding and copulation areas on the shelves and banks around the Faroe Islands, Iceland, and East-Greenland. The main fishing grounds are in Icelandic waters.

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 between 20,000 and 84,000 t in 1978-1994 (Table 9.1.1). Since 1994, landings gradually decreased and in 2001 catches were 23,000 t, which was the lowest recorded catch since 1979. Catches in 2002 were similar to 2001.

In Division Va, annual landings gradually decreased from a record high of 57,000 t in 1994 to 17,000 t and 19,000 t in 2001 and 2002 respectively. For the past three years most of the catch were taken by bottom trawlers (the pelagic trawl fishery was in 2002 negligible) along the shelf west, southwest, and southeast of Iceland (Figure 9.1.1), east of so called redfish line (Figure 9.1.2). The catches in the third and fourth quarter of the year decreased considerable in 2001 compared with the years before and continued to decrease in 2002 (Figure 9.1.3). The reason for this decrease seems to be associated with decreased effort at that time of year. Some fishermen believe that this is because of much less deep-sea *S. mentella* in the traditional fishing areas west and southwest of Iceland. Length distribution of deep-sea *S. mentella* from the bottom trawl fishery shows an increase in the number of small fish in the catch in recent years (Figure 9.1.4). A peak of about 32 cm in 1994 can be followed by approximately 1 cm annual growth in 1996-2002.

In Division Vb, landings of deep-sea *S. mentella* were 2,700 t in 2002, which is a decrease from 4,200 t in 2001. Maximum annual landings were 15,000 t in 1986. Length distribution from the catch in 2001 and 2002 indicates that the fish caught are larger than 40 cm (Figure 9.1.5).

In Subarea VI, the annual landings varied between 200 t and 1,100 t 1978-2000 (Table 9.1.1). Catch statistics for 2001 and 2002 indicate that the redfish fishery in VI has ceased to a very low level. About 20 t were caught in 2002.

In Subarea XIV, the annual deep-sea *S. mentella* catch has decreased drastically. In 1980-1994, catches varied between 2,000 and 19,000 with the lowest catch in 1989 and the highest in 1994. In the following three years, the annual landings were less than 1,000 t and the redfish was mainly caught as by-catch in the shrimp fishery. In 1998, Germany started a directed fishery for redfish with annual landings around 1,000 t 1998-2001, but landings increased to 1,900 t in 2002. Samples taken from the German fleet indicates that substantial quantities of the fish caught, especially in 2002, are juveniles, i.e. fish less than 30 cm (Figure 9.1.6)

Below is a text table showing the 2002 biological sampling from the catch and landings of deep-sea *S. mentella* from the continental shelf divided by Division and gear type.

Area	Gear	Landings	Nos. samples	Nos. fish measured
Va	Pelagic trawl	44	0	0
Va	Bottom trawl	19,100	172	30,197
Vb	Bottom trawl	2,674	38	4,424
XIVb	Bottom trawl	1,903	1	?

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

Data used to estimate CPUE for deep-sea *S. mentella* in Division Va 1986-2002 were obtained from log-books of the Icelandic trawl fleet. Only bottom trawl tows taken below 500 m depth were used and where *S. mentella* composed at least 50% of the total catch in each tow. Indices of CPUE were estimated from this data set using a GLM multiplicative model. This model takes into account changes in vessels over time as well as difference in vessel size, area (ICES statistical square), and month and year effects.

From 1986 to 1989 CPUE in Division Va was relatively stable, but gradually decreased from 1989 to a record low in 1994 (Figure 9.2.1). From 1995 to 2000, CPUE slightly increased annually, but decreased again in 2001 and 2002. The fishing effort at the time when the stock was considered in stable condition, i.e. from 1986-1990, was 15,000-40,000 hours fishing. From 1991 to 1994, the fishing effort increased drastically, but decreased between 10% and 20% each year to 2001. ICES recommended 25% annual reduction in fishing effort during the same time period. Effort increased between 2001 and 2002 by about 10%.

CPUE indices in Division Vb for deep-sea *S. mentella* and obtained from the Faroese CUBA trawlers decreased from 500 kg/hour in 1991 to of 300 kg/hour in 1993 (Figure 9.2.2). CPUE was at this level until 2002 when it increased to 370 kg/hour. Fishing effort during this period decreased between 2001 and 2002 as recommended by the NWWG in 2002. The summer survey 1996-2002 in Division Vb shows nearly a continuous decrease in the catch rate or from less than 10 kg/hour to about 3 kg/h (except in 1999 when the catches were over 10 kg/h) (Figure 9.2.3).

CPUE data from Division XIV were only available from 1998 when directed fishery for *S. mentella* by Germany started along the continental slope of East Greenland. Fishing effort was similar in the first three years or around 2,200 hours fishing, decreased to 1,000 hours in 20001, and increased again in 2002 to 1,500 hours (Table 9.2.1). At the same time, CPUE decreased between 1998 and 1999, but has since then increased annually.

Surveys conducted on the continental shelf of West and East Greenland and Iceland cover only the distribution of juvenile deep-sea *S. mentella* (recruits). The results indicate that juveniles are most abundant off East Greenland, while negligible part of juveniles are distributed off West Greenland and Iceland (Figure 9.2.4). Figure 9.2.4 shows that the abundance was dominated by a single strong year class recorded for the first time in 1987 at a mean length of 20 cm. Annual growth of this cohort was about 2 cm and fully recruited to the survey gear in 1997 at a length of about 27 cm, when abundance and biomass reached its maximum (total abundance estimated 7 billion individuals and biomass 1.5 million tons). This year class seems to have left the survey area in the following years. In recent years there is an indication of recruiting year classes, but they seem, however, to be significantly less abundant. Abundance (Figure 9.2.5) and biomass (Figure 9.2.6) indices have been gradually increasing since 1999, but are only about 20% of what they were in 1997.

9.2.2 Stock production model

As described in previous report, the group used the ASPIC stock production model (Prager 1992) for the stock, fitted to CPUE indices and catch. It should be noted that he model runs are exploratory and are not used as basis for advice of the stock. The model requires catch data and corresponding fishing effort or CPUE data that are indices of the stock biomass. Corresponding CPUE data were available from the Icelandic trawl fishery 1986-2002 in Division Va and from the Faroese Islands CUBA fishery 1991-2002. The total catch from Divisions V, VI, and XIVb 1986-2002 was used in the model run. Results are given in Table 9.2.2.

MSY was estimated 48,700 t and $\mathbf{B}_{MSY}$ 243,200 t. Biomass in 2002 is estimated to be over 30% above $\mathbf{B}_{MSY}$ and the fishing mortality is estimated to be about 40% below $\mathbf{F}_{MSY}$. Observed and estimated CPUE's are given in Table 9.2.2. State of the stock relative to retrospective runs show rather stable situation, but indicates that B/ $\mathbf{B}_{MSY}$ has been underestimated and F/$\mathbf{F}_{MSY}$ overestimated systematically in recent years (Figure 9.2.7). The biomass is slowly increasing from the record low in 1995. Although the retrospective runs show relatively consistency between years, the parameters that are used as a basis for calculating MSY, $\mathbf{F}_{MSY}$, and $\mathbf{B}_{MSY}$ (K and r) are changing over time (Table 9.2.3). Plot of B-ratio (B/$\mathbf{B}_{MSY}$) along with biomass trajectory is given in Table 9.2.2. Fishing at $\mathbf{F}_{pa}$ (2/3$\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$) 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 around 32,500 t in 2003. Those catches apply to the whole distribution area of *S. mentella*.

The intrinsic rate of population increase, *r*, was estimated 0.40 and it might be too high for such a long-lived and slow-growing species. However, one should not take the estimates of *r* from a production model, such as ASPIC, as informative as of the actual intrinsic rate of increase of a population, as it may be poorly estimated. Simple production models are much better at estimating MSY and effort at MSY ($\mathbf{F}_{MSY}$) than they are at estimating *r*, K, or fishing mortality rate at MSY ($\mathbf{F}_{MSY}$). This arises because for most populations, the data don't reveal whether MSY can be taken as a larger fraction of a smaller population or vice versa (Michael Prager, personal communication). *r* is estimated similar to the value obtained for the species and related species in FishBase..

9.2.3 State of the stock

All CPUE indices in Division Va show a drastic reduction from highs in the late 1980s, but there is an indication that the stock have started a slow recovery since the middle of 1990s, when CPUE was close to 50% of the maximum. Fishermen have, however, reported of less *S. mentella* in the fishing areas southwest and west of Iceland in past two years compared to the most recent years. The increase in the fishable biomass in Division Va since 1996 may 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. There was, however, an increase in CPUE in 2002 compared to the year before.

Based on survey results, the fishable stock of deep-sea *S. mentella* on the continental shelf in area XIV is severely depleted (Figure 9.2.5). The strong recruiting cohort(s) observed in 1993-97 emigrated from the area in 1998-2000 and may have recruited the stock on the shelf.

9.3 Catch projections

It is possible to estimate catch for deep-sea *S. mentella* that corresponds to different effort. Here, this was done by using the formula:

$$\text{Catch}_{2004} = \text{Average CPUE index}_{2000\text{-}2002} * \text{Average Effort}_{2000\text{-}2002}$$

where effort for each year is calculated as: Effort = Catch/CPUE. This formula was applied to catch statistic and CPUE from Va and Vb, giving a catch of 22,314 t in Va and 4,065 t in Vb (Table 9.2.4). This will correspond to a catch of 26,380 t for the whole stock (Table 9.2.4). The above calculation was a basis for the ACFM advice last year.

9.4 Biological reference points

The relative state of the stock can be assessed through CPUE index series (U) from the commercial fishery, which imply a maximum, U_{max}. It has been proposed by ACFM that reference points can 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 is considered above U_{pa}.

9.5 Management considerations

The catch increased between 2001 and 2002 in Division Va, but was considerable lower than the set quota. This could be due to increased effort towards other species, such as *S. marinus*, in relation to depleted stock of *S. mentella*. It should be noted that Icelandic authorities give a joint quota for *S. marinus* and *S. mentella*. The working group recommends that the TAC of demersal redfish stocks (*S. marinus* and deep-sea *S. mentella*) **should be given separately**. There is a strong indication that these two species in Va are spatially separated and therefore, separate quotas for these species can be given.

In recent years, ICES has advised that the fishing effort towards *S. mentella* should kept low and both in Division Va and Vb fishing effort has decreased considerable. The management strategy to reduce the effort has resulted in an increase in the fishable biomass since 1995 according the data from the fishery. The WG recommends that effort in should be kept low and **no higher than it was in 2000-2002**. That corresponds to a catch of 22,314 t in Va in 2004 and 4,065 t in Vb.

The Working Group recommends maximum protection of the juveniles in Division XIV and therefore, **no directed** fishery towards deep-sea *S. mentella* should be allowed.

Table 9.1.1 Deep-sea *S. mentella*. Nominal catch (tonnes) on the continental shelf and slopes divided by ICES area.

	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	4,247	34	0	927	22,521
2002	19,148	2,674	19	0	1,903	23,744

Table 9.2.1 *S. marinus* and deep sea *S. mentella* nominal catch (tonnes) and effort (hours fished) of the German fleet in ICES Divisions Va, Vb, VI and XIVb by year and quarter 1998-2002.

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**
2002	1	564	423	0	0	0	0	0	0	564	423
2002	2	734	669	0	0	2	101	0	0	732	568
2002	3	754	1885	337	1371	0	0	0	0	417	514
2002	4	134	612	130	610	0	0	0	0	4	2
2002		**2186**	**3589**	**467**	**1981**	**2**	**101**	**0**	**0**	**1717**	**1507**

Table 9.2.2 Deep-sea *S. mentella*. An example of a results of an ASPIC fit procedure.

SMEN cpue 86 to 02 — Page 1 — 08 May 2003 at 14:29.32

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:	17	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-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	2.626E-04	1	N/A	1.000E-01	N/A	
Loss(1) ICE CPUE indices 50%	6.571E-02	17	4.381E-03	1.000E+00	1.000E+00	0.913
TOTAL OBJECTIVE FUNCTION:	6.59723293E-02					

NOTE: B1/$\mathbf{B}_{MSY}$ constraint term contributing to loss. Sensitivity analysis advised.

Number of restarts required for convergence:	7	
Est. B/$\mathbf{B}_{MSY}$ coverage index (0 worst, 2 best):	0.9419	< These two measures are defined in Prager
Est. B/$\mathbf{B}_{MSY}$ nearness index (0 worst, 1 best):	0.9419	< et al. (1996), Trans. A.F.S. 125:729

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Starting guess	Estimated	User guess
B1R	Starting B/$\mathbf{B}_{MSY}$, year 1986	2.105E+00	1.000E+00	1	1
MSY	Maximum sustainable yield	4.869E+04	3.000E+04	1	1
r	Intrinsic rate of increase	4.008E-01	5.000E-02	1	1
....	Catchability coefficients by fishery:				
q(1)	ICE CPUE indices 50%	2.227E-03	1.000E-04	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	4.869E+04	Kr/4	
K	Maximum stock biomass	4.859E+05		
$\mathbf{B}_{MSY}$	Stock biomass at MSY	2.430E+05	K/2	
$\mathbf{F}_{MSY}$	Fishing mortality at MSY	2.004E-01	r/2	
F(0.1)	Management benchmark	1.804E-01	0.9*$\mathbf{F}_{MSY}$	
Y(0.1)	Equilibrium yield at F(0.1)	4.820E+04	0.99*MSY	
B./$\mathbf{B}_{MSY}$	Ratio of B(2003) to $\mathbf{B}_{MSY}$	1.399E+00		
F./$\mathbf{F}_{MSY}$	Ratio of F(2002) to $\mathbf{F}_{MSY}$	3.579E-01		
F01-mult	Ratio of F(0.1) to F(2002)	2.515E+00		
Ye./MSY	Proportion of MSY avail in 2003	8.405E-01	2*Br-Br^2	Ye(2003) = 4.092E+04
....	Fishing effort at MSY in units of each fishery:			
$\mathbf{F}_{MSY}$(1)	ICE CPUE indices 50%	8.998E+01	r/2q(1)	f(0.1) = 8.099E+01

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	1986	0.096	5.115E+05	4.862E+05	4.645E+04	4.645E+04	-2.561E+02	4.768E-01	2.105E+00
2	1987	0.083	4.648E+05	4.515E+05	3.757E+04	3.757E+04	1.278E+04	4.153E-01	1.913E+00
3	1988	0.073	4.400E+05	4.333E+05	3.143E+04	3.143E+04	1.881E+04	3.620E-01	1.811E+00
4	1989	0.131	4.274E+05	4.120E+05	5.391E+04	5.391E+04	2.508E+04	6.530E-01	1.759E+00
5	1990	0.113	3.985E+05	3.913E+05	4.420E+04	4.420E+04	3.053E+04	5.638E-01	1.640E+00
6	1991	0.185	3.848E+05	3.678E+05	6.788E+04	6.788E+04	3.577E+04	9.211E-01	1.584E+00
7	1992	0.185	3.527E+05	3.409E+05	6.310E+04	6.310E+04	4.074E+04	9.237E-01	1.452E+00
8	1993	0.236	3.304E+05	3.146E+05	7.420E+04	7.420E+04	4.439E+04	1.177E+00	1.360E+00
9	1994	0.297	3.006E+05	2.814E+05	8.357E+04	8.357E+04	4.738E+04	1.482E+00	1.237E+00
10	1995	0.214	2.644E+05	2.606E+05	5.574E+04	5.574E+04	4.843E+04	1.067E+00	1.088E+00
11	1996	0.161	2.571E+05	2.605E+05	4.186E+04	4.186E+04	4.843E+04	8.019E-01	1.058E+00
12	1997	0.162	2.637E+05	2.663E+05	4.305E+04	4.305E+04	4.823E+04	8.066E-01	1.085E+00
13	1998	0.142	2.688E+05	2.735E+05	3.889E+04	3.889E+04	4.791E+04	7.096E-01	1.107E+00
14	1999	0.123	2.779E+05	2.842E+05	3.499E+04	3.499E+04	4.727E+04	6.144E-01	1.144E+00
15	2000	0.127	2.901E+05	2.948E+05	3.747E+04	3.747E+04	4.647E+04	6.342E-01	1.194E+00
16	2001	0.072	2.991E+05	3.107E+05	2.252E+04	2.252E+04	4.487E+04	3.618E-01	1.231E+00
17	2002	0.072	3.215E+05	3.311E+05	2.374E+04	2.374E+04	4.226E+04	3.579E-01	1.323E+00
18	2003		3.400E+05						1.399E+00

Table 9.2.2 continued.

SMEN cpue 86 to 02 Page 3

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) ICE CPUE indices 50%

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+03	1.083E+03	0.0955	4.645E+04	4.645E+04	0.07949	
2	1987	1.090E+03	1.005E+03	0.0832	3.757E+04	3.757E+04	-0.08074	
3	1988	9.890E+02	9.649E+02	0.0726	3.143E+04	3.143E+04	-0.02472	
4	1989	9.460E+02	9.174E+02	0.1309	5.391E+04	5.391E+04	-0.03068	
5	1990	9.040E+02	8.714E+02	0.1130	4.420E+04	4.420E+04	-0.03676	
6	1991	9.070E+02	8.190E+02	0.1846	6.788E+04	6.788E+04	-0.10208	
7	1992	7.050E+02	7.592E+02	0.1851	6.310E+04	6.310E+04	0.07408	
8	1993	6.360E+02	7.006E+02	0.2358	7.420E+04	7.420E+04	0.09674	
9	1994	5.690E+02	6.267E+02	0.2970	8.357E+04	8.357E+04	0.09653	
10	1995	5.830E+02	5.803E+02	0.2139	5.574E+04	5.574E+04	-0.00461	
11	1996	5.880E+02	5.801E+02	0.1607	4.186E+04	4.186E+04	-0.01359	
12	1997	6.170E+02	5.931E+02	0.1616	4.305E+04	4.305E+04	-0.03947	
13	1998	6.210E+02	6.091E+02	0.1422	3.889E+04	3.889E+04	-0.01940	
14	1999	6.610E+02	6.329E+02	0.1231	3.499E+04	3.499E+04	-0.04344	
15	2000	6.960E+02	6.565E+02	0.1271	3.747E+04	3.747E+04	-0.05840	
16	2001	6.780E+02	6.918E+02	0.0725	2.252E+04	2.252E+04	0.02019	
17	2002	6.760E+02	7.373E+02	0.0717	2.374E+04	2.374E+04	0.08682	

```
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     0.0795                                             |===
1987    -0.0807                                          ===|
1988    -0.0247                                            =|
1989    -0.0307                                            =|
1990    -0.0368                                            =|
1991    -0.1021                                         ====|
1992     0.0741                                             |===
1993     0.0967                                             |====
1994     0.0965                                             |====
1995    -0.0046                                             |
1996    -0.0136                                            =|
1997    -0.0395                                           ==|
1998    -0.0194                                            =|
1999    -0.0434                                           ==|
2000    -0.0584                                           ==|
2001     0.0202                                             |=
2002     0.0868                                             |===
                   -------------------------------------------------------------------------------------
```

SMEN cpue 86 to 02 Page 4

```
                Observed (O) and Estimated (*) CPUE for Data Series # 1 -- ICE CPUE indices 50%
           :
    1200. -:
           :
           :
           :
           :                    *  O
    1050. -:
           :                       *
           :                    O      O
           :                           *  O
           :                              *
     900. -:                                 O   O
           :                                 *
           :
           :                                     *
           :
     750. -:                                        *                                *
           :                                        O
           :                                           *                       O  2  O
           :                                                               O   *
           :                                           O   *         O  O  *
     600. -:                                                     O   *  *
           :                                               O  2  *
           :
           :
           :
     450. -:
           :
           :
           :
           :
     300. -:
           :.........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1980.     1983.     1986.     1989.     1992.     1995.     1998.     2001.     2004.     2007.     2010.
```

Table 9.2.2 continued.

```
                                   Time Plot of Estimated F/FMSY and B/BMSY
           :
      2.4 -:
           :
           :
           :
           :                    B
      2.0 -:
           :                       B
           :                           B
           :                              B
           :                                 B
      1.6 -:                                     B
           :                                               F
           :                                        B
           :                                           B                             B   B
           :
      1.2 -:                                           F   B                   B  B
           :                                                  B      B  B  B
           :                                                  F  B
           :-  -   -  -  -   -  -  -   -  -  -   2  2  -   -  -  -   -  -  -   -  -  -   -  -  -   -  -  -   -  -
           :
      0.8 -:                                                     F   F
           :                                                            F
           :                              F                                F   F
           :                                 F
           :                    F
      0.4 -:                       F   F                                          F
           :                                                                         F
           :
           :
           :
      0.0 -:

:........................................................................................................
            :         :         :         :         :         :         :         :         :         :         :
         1980.     1983.     1986.     1989.     1992.     1995.     1998.     2001.     2004.     2007.     2010.
```

Table 9.2.3 Deep-sea *S. mentella*. Retrospective analysis from a ASPIC stock production model. The table shows MSY, K, r, and K/r for different length of the input series using CPUE data from both the Faroese and Icelandic trawl fleet.

Period	MSY	K	r	K/r
1986-2002	48,690	485,900	0.40	1212325
1986-2001	50,110	426,600	0.47	908046
1986-2000	51,460	382,200	0.54	709485.8
1986-1999	51,850	371,500	0.56	665412.9
1986-1998	52,750	350,600	0.60	582488.8
1986-1997	55,430	296,800	0.75	397269.4
1986-1996	58,150	249600	0.93	267811.2

Table 9.2.4 Deep-sea *S. mentella*. Catch projection for 2004. The table gives the nominal catch (tonnes), CPUE, and fishing effort Va and Vb, the catch for the 2004 fishing year in Va and Vb based on mean CPUE and effort of 2000-2002, and total catch in these two areas.

	Iceland			Faroese Islands		
Year	**Landings**	**CPUE**	**Effort**	**Landings**	**CPUE**	**Effort**
1986	18,898	1000	19			
1987	19,293	1090	18			
1988	14,290	989	14			
1989	40,269	946	43			
1990	28,429	904	31			
1991	47,651	907	53	12,897	501	26
1992	43,414	705	62	12,533	384	33
1993	51,221	636	81	7,801	321	24
1994	56,720	569	100	6,899	308	22
1995	48,708	583	84	5,670	311	18
1996	34,741	588	59	5,337	292	18
1997	37,876	617	61	4,558	337	14
1998	33,125	621	53	4,089	295	14
1999	28,590	661	43	5,294	307	17
2000	30,696	696	44	4,841	289	17
2001	17,313	678	26	4,247	308	14
2002	19,148	676	28	2,674	373	7
Av. 00-02		**683**	**33**		**323**	**13**

Catch 2004 = Mean CPUE(2000-2002)* Mean Effort(2000-2002)			
Level	**Va**	**Vb**	**Total**
120%	26,777	4,878	31,656
100%	22,314	4,065	26,380
75%	16,736	3,049	19,785
50%	11,157	2,033	13,190

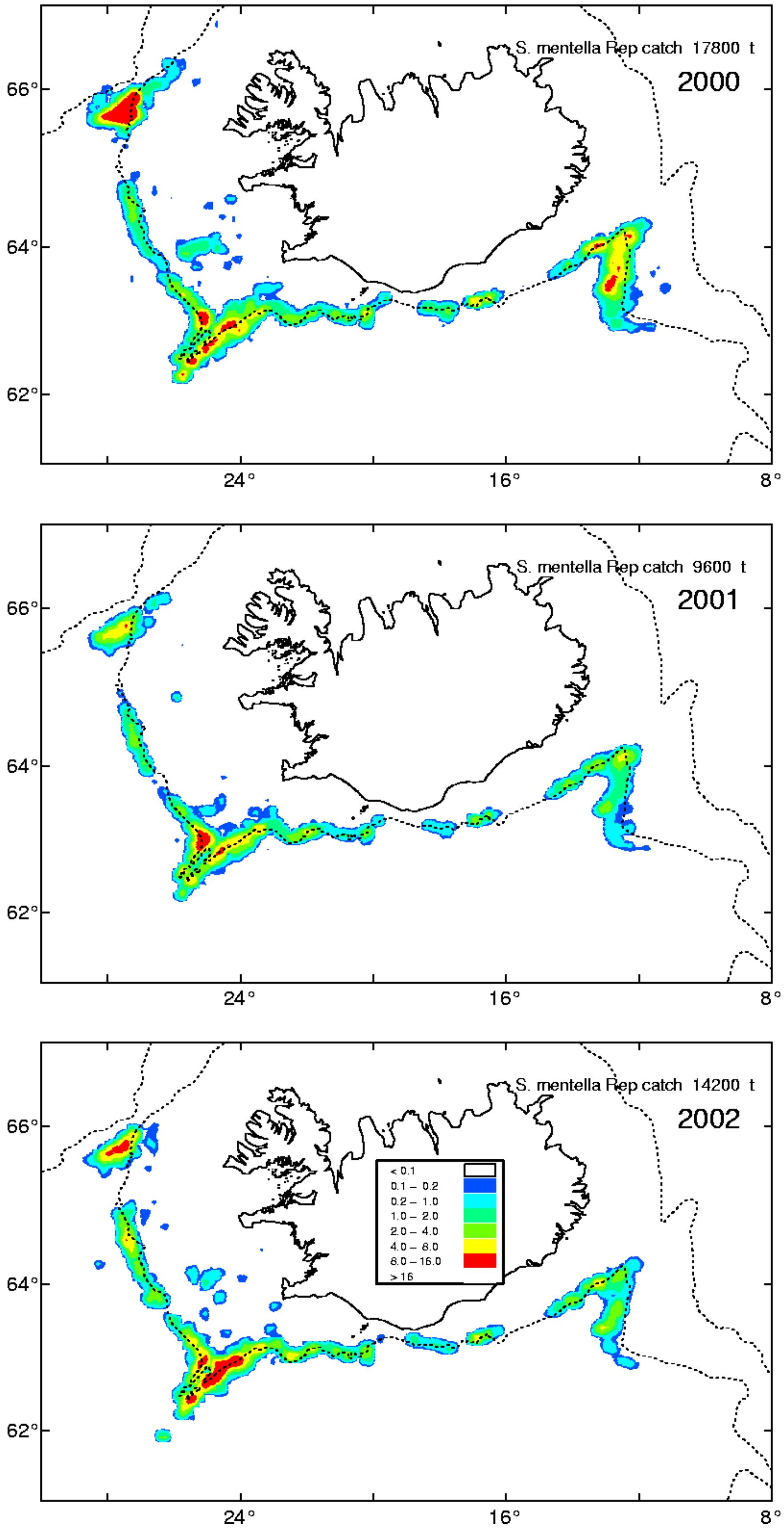


Figure 9.1.1 Deep-sea *S. mentella*. Catch in Icelandic waters 2000-2002.

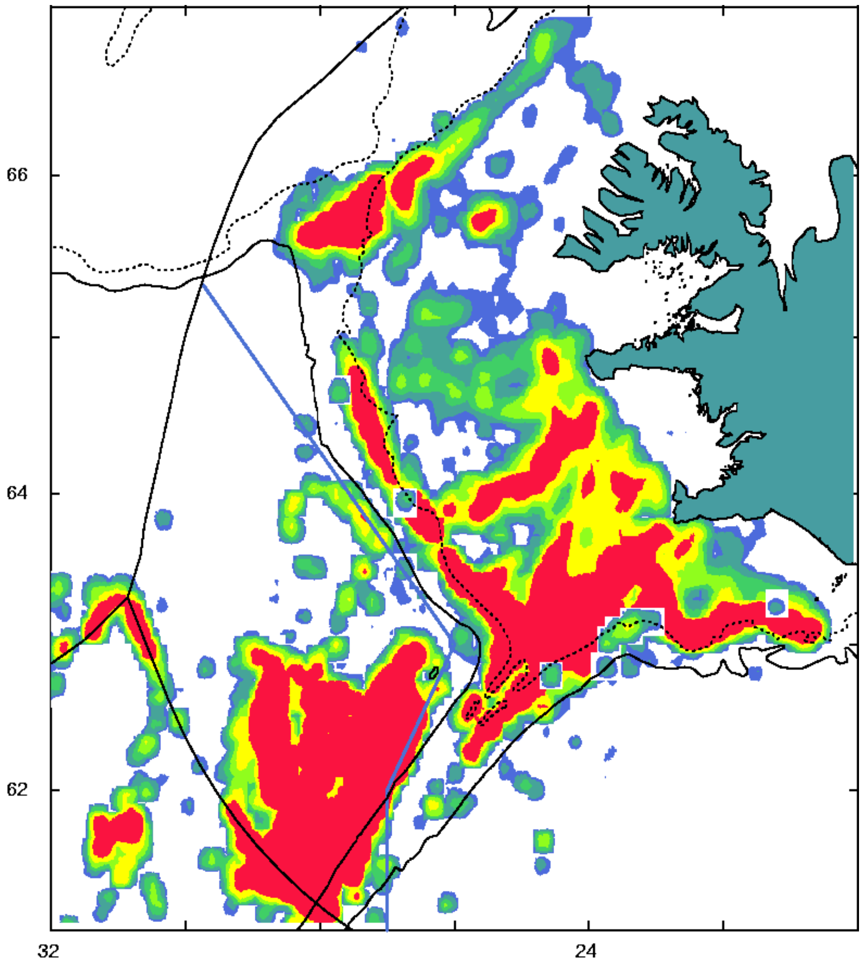


Figure 9.1.2 Redfish (both *S. mentella and S.* marinus) catch in Icelandic waters 2000-2002 (all years combined) as recorded by log-books. The map also shows the line used by the Icelandic authorities to separate the landing statistics between deep-sea *S. mentella* and pelagic deep-sea *S.* mentella. The catches west of the "redfish line" is from the pelagic fishery, whereas the catch north and east of the line is of "shelf type".

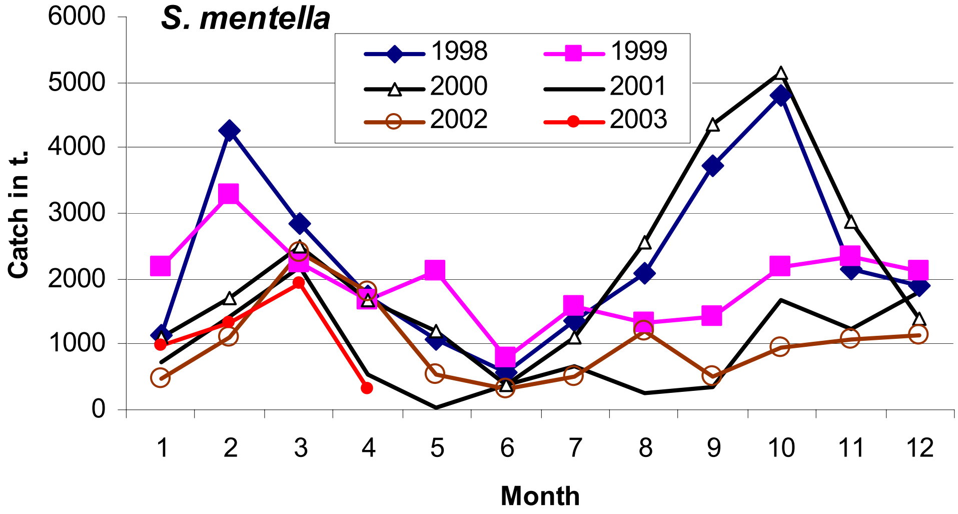


Figure 9.1.3 Deep-sea *S. mentella*. Nominal catch (tonnes) by month in Icelandic waters 1998-2003.

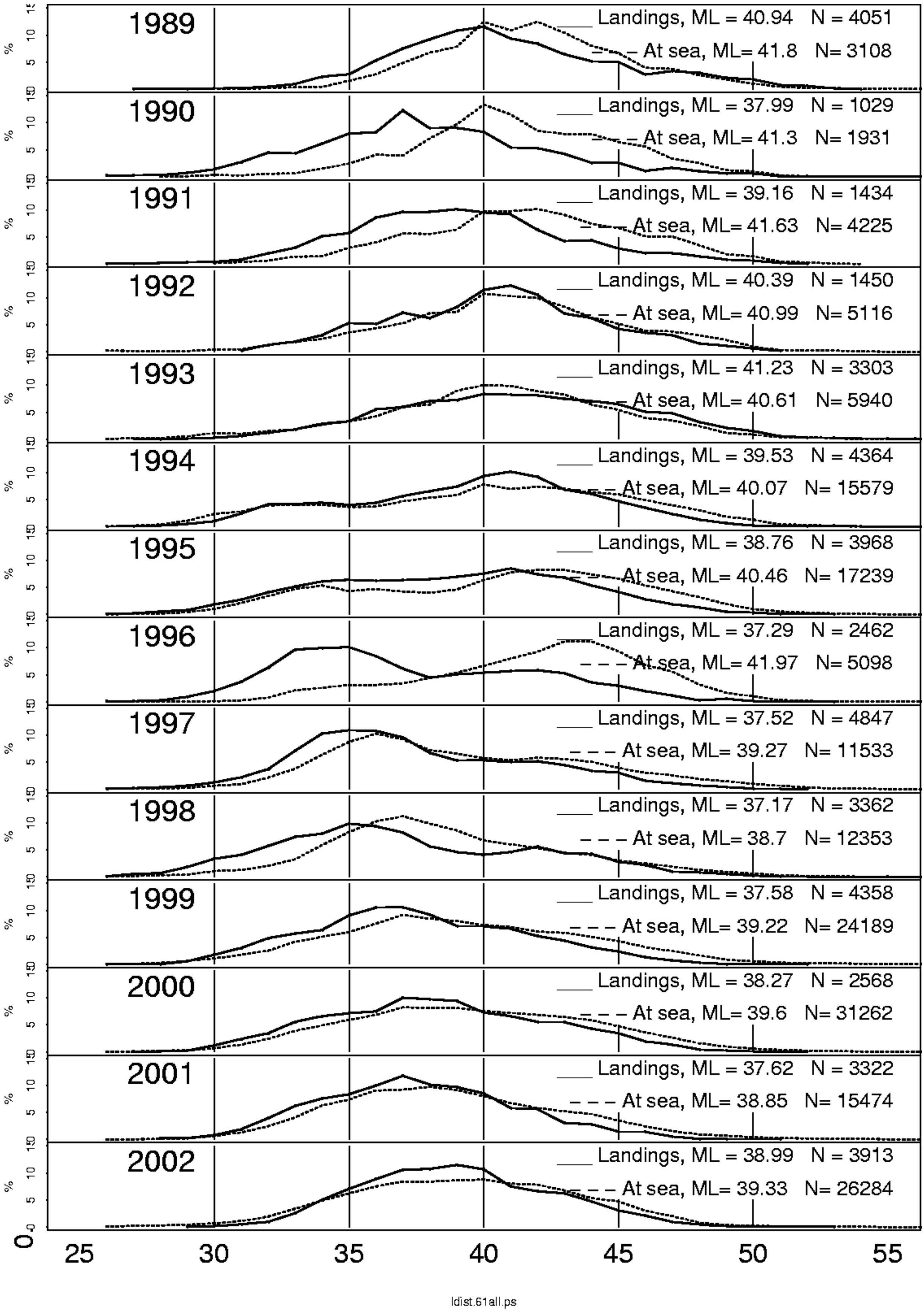


Figure 9.1.4 Deep-sea *S. mentella*. Length distributions from the Icelandic bottom trawl catch and landings in Division Va 1989-2002.

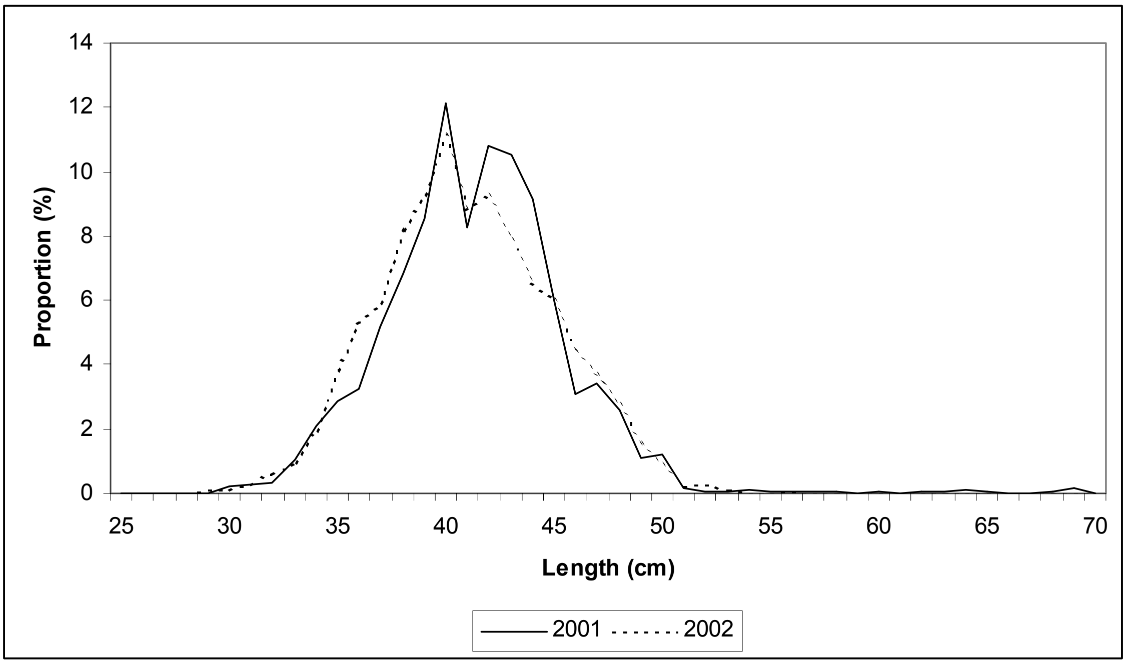


Figure 9.1.5 Deep-sea *S. mentella*. Length distribution from the Faroese fleet catch and landings in Division Vb 2001 and 2002.

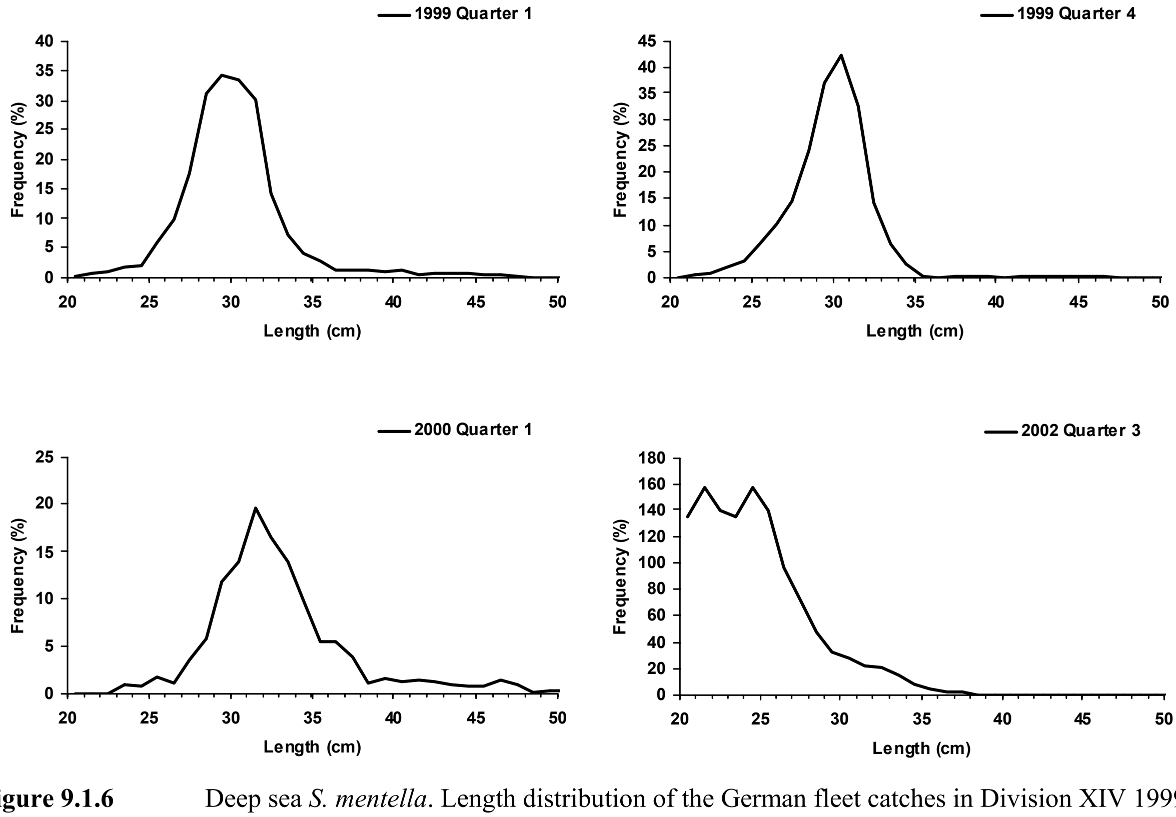


Figure 9.1.6 Deep sea *S. mentella*. Length distribution of the German fleet catches in Division XIV 1999-2002.

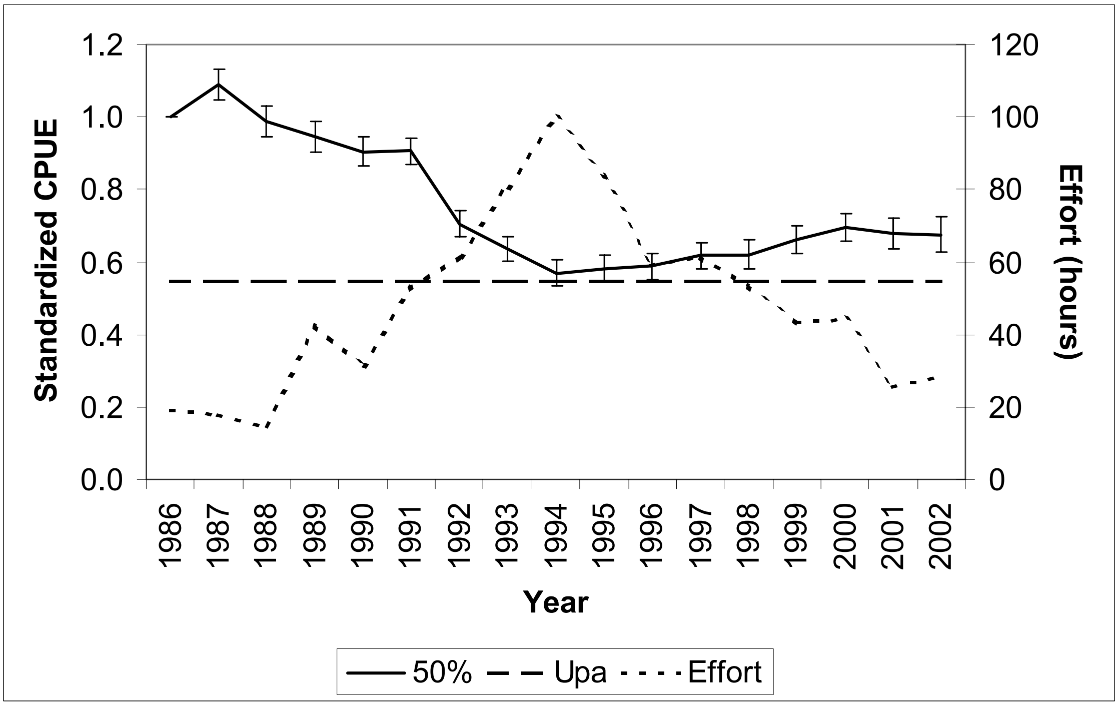


Figure 9.2.1 Deep-sea *S. mentella*. CPUE, relative to 1986, from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was deep-sea *S. mentella*. Also shown is fishing effort (hours fished in thousands).

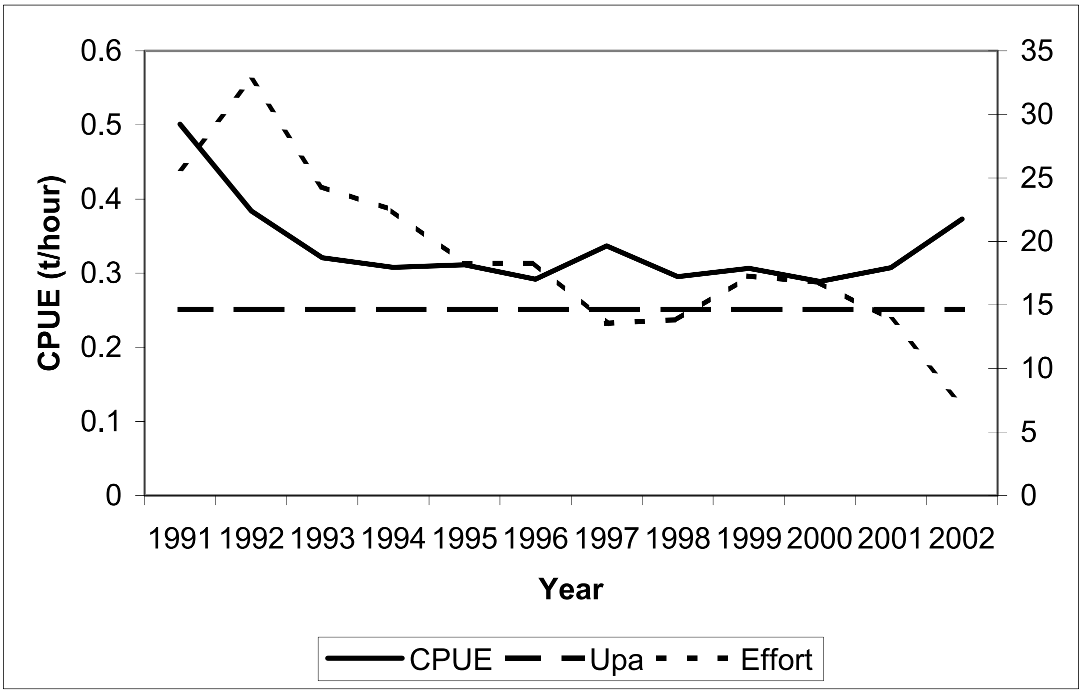


Figure 9.2.2 Deep-sea *S. mentella*.. CPUE (kg/hour) and fishing effort (in thousands) from the Faroese CUBA fleet 1991-2002 and where 70% of the total catch was deep-sea *S. mentella* .

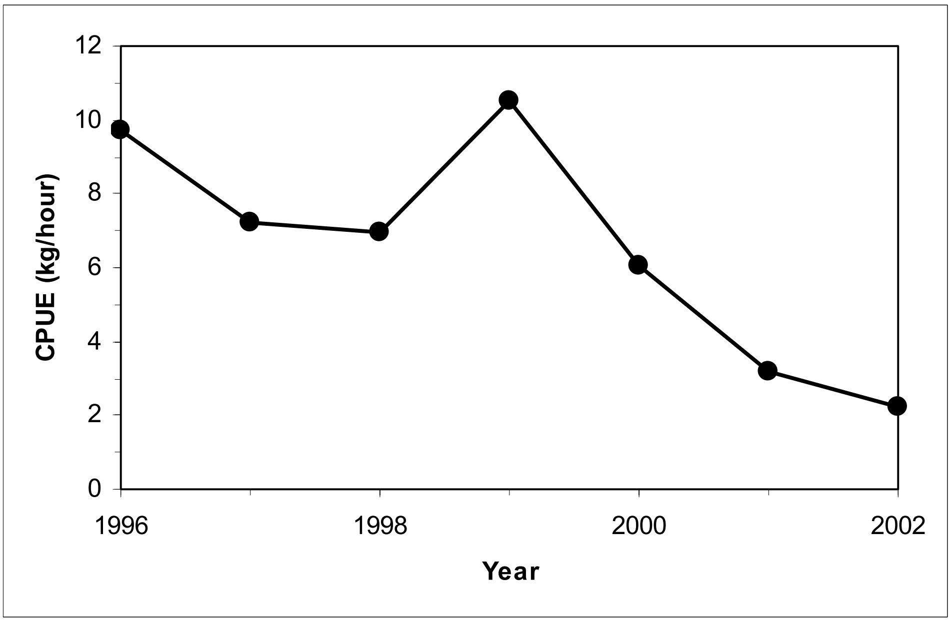


Figure 9.2.3 Deep-sea *S. mentella*. CPUE (kg/hour) from the Faroese summer survey 1996-2002.

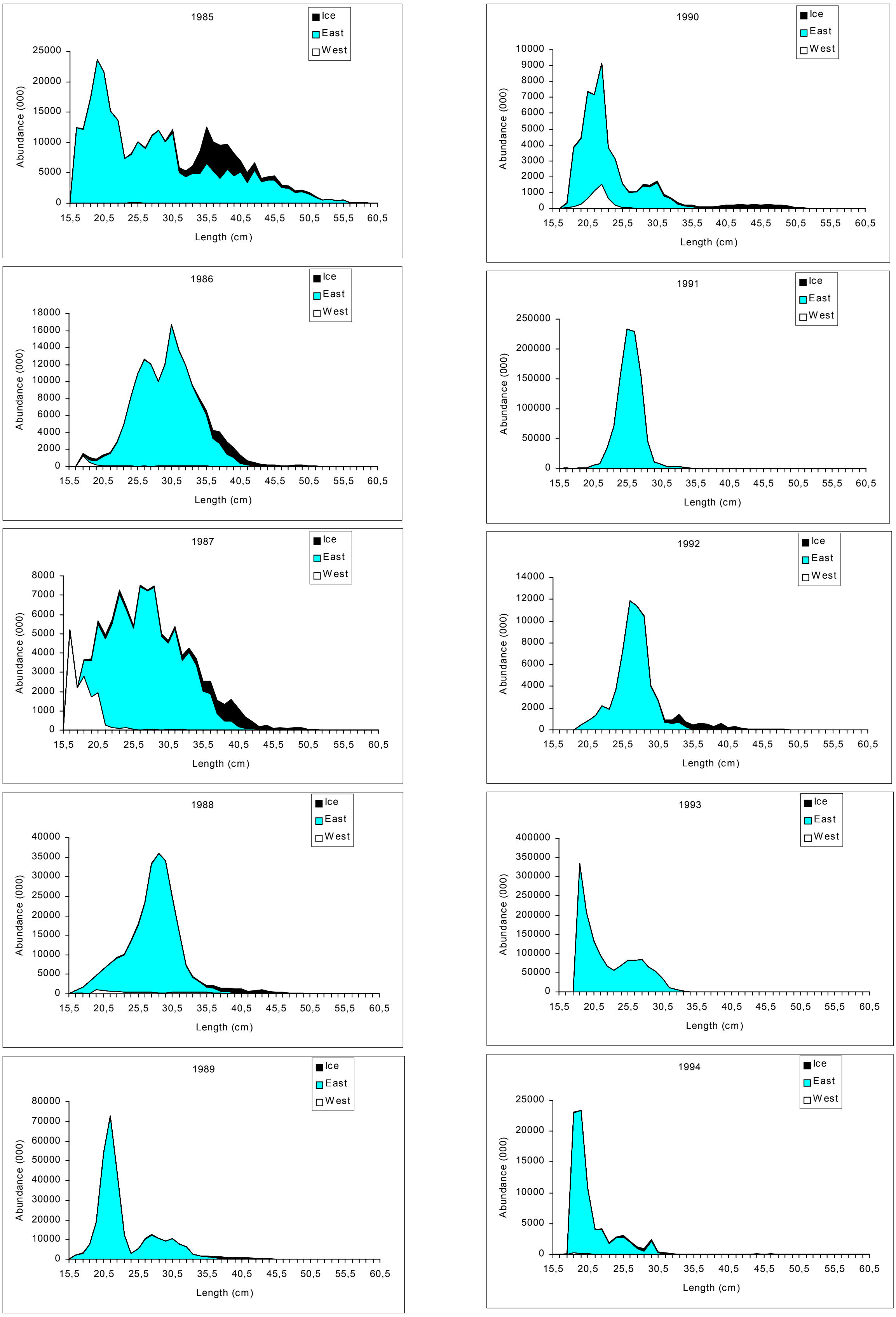


Figure 9.2.4 Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985-1994.

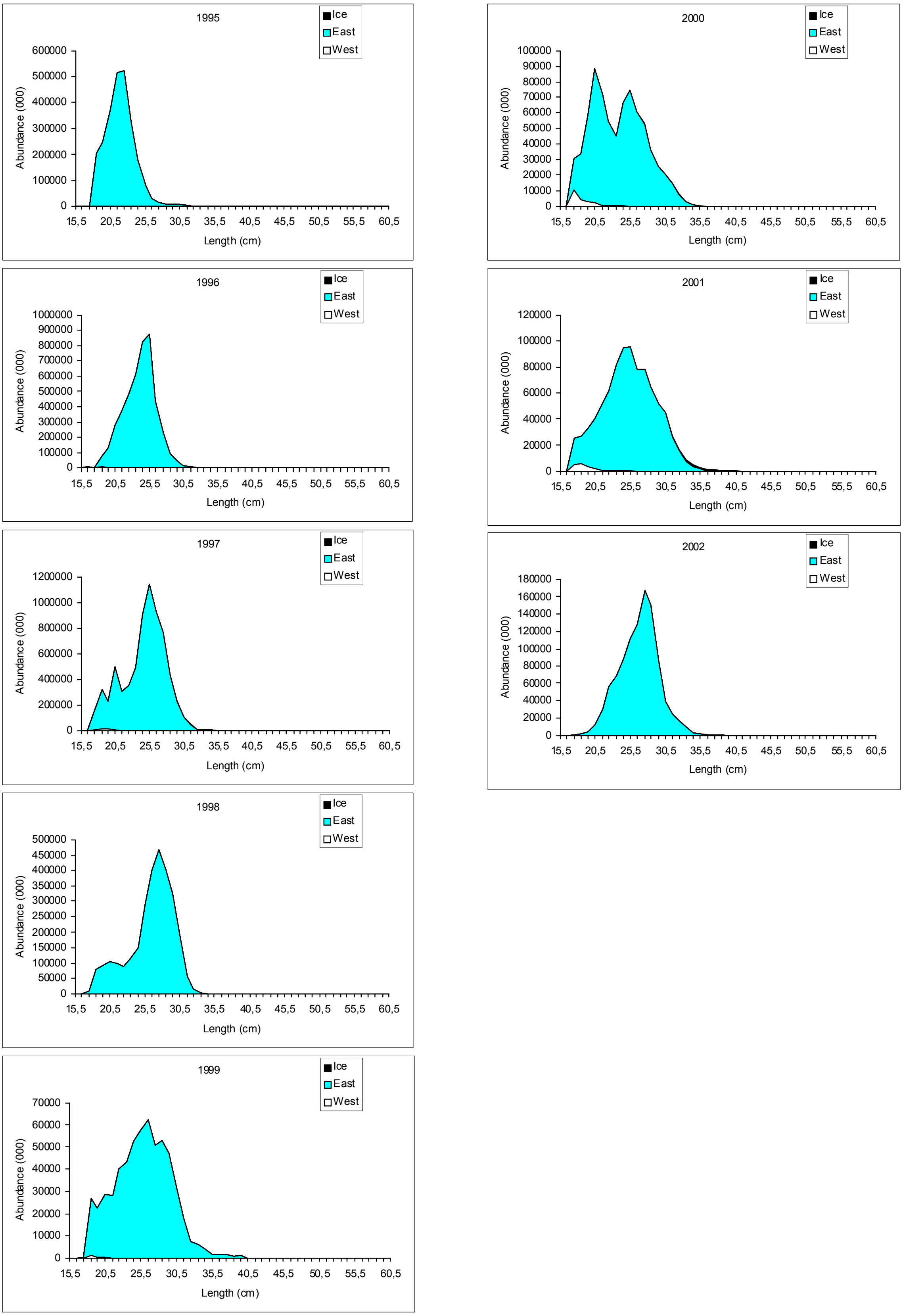


Figure 9.2.4 Continued.

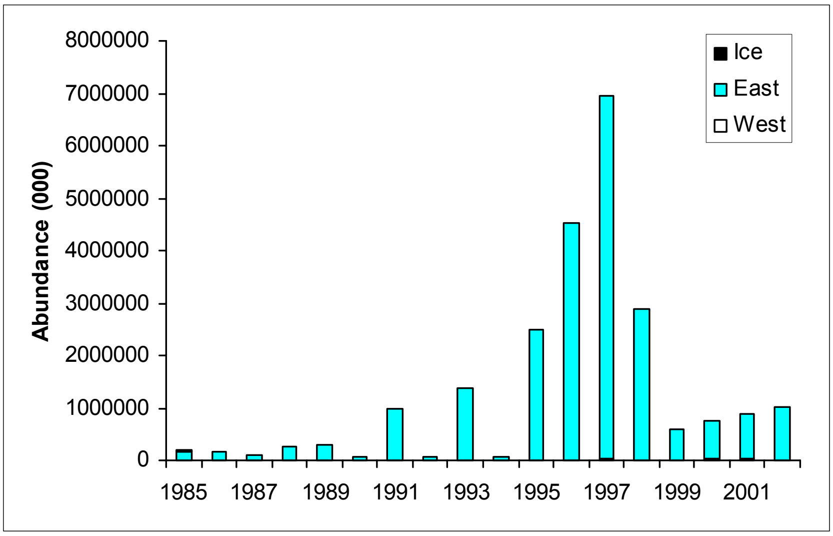


Figure 9.2.5 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland and Iceland derived from the German and Icelandic groundfish surveys, 1985–2002.

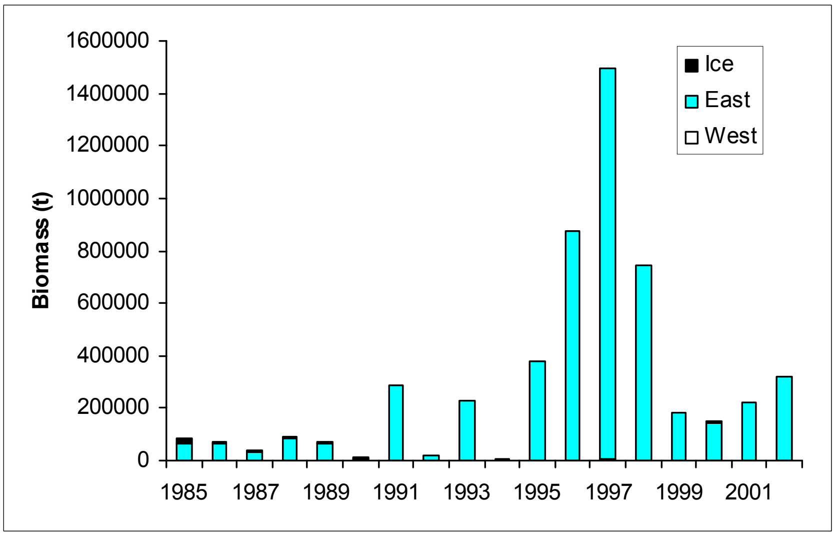


Figure 9.2.6 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland and Iceland derived from the German and Icelandic groundfish surveys, 1985-2002.

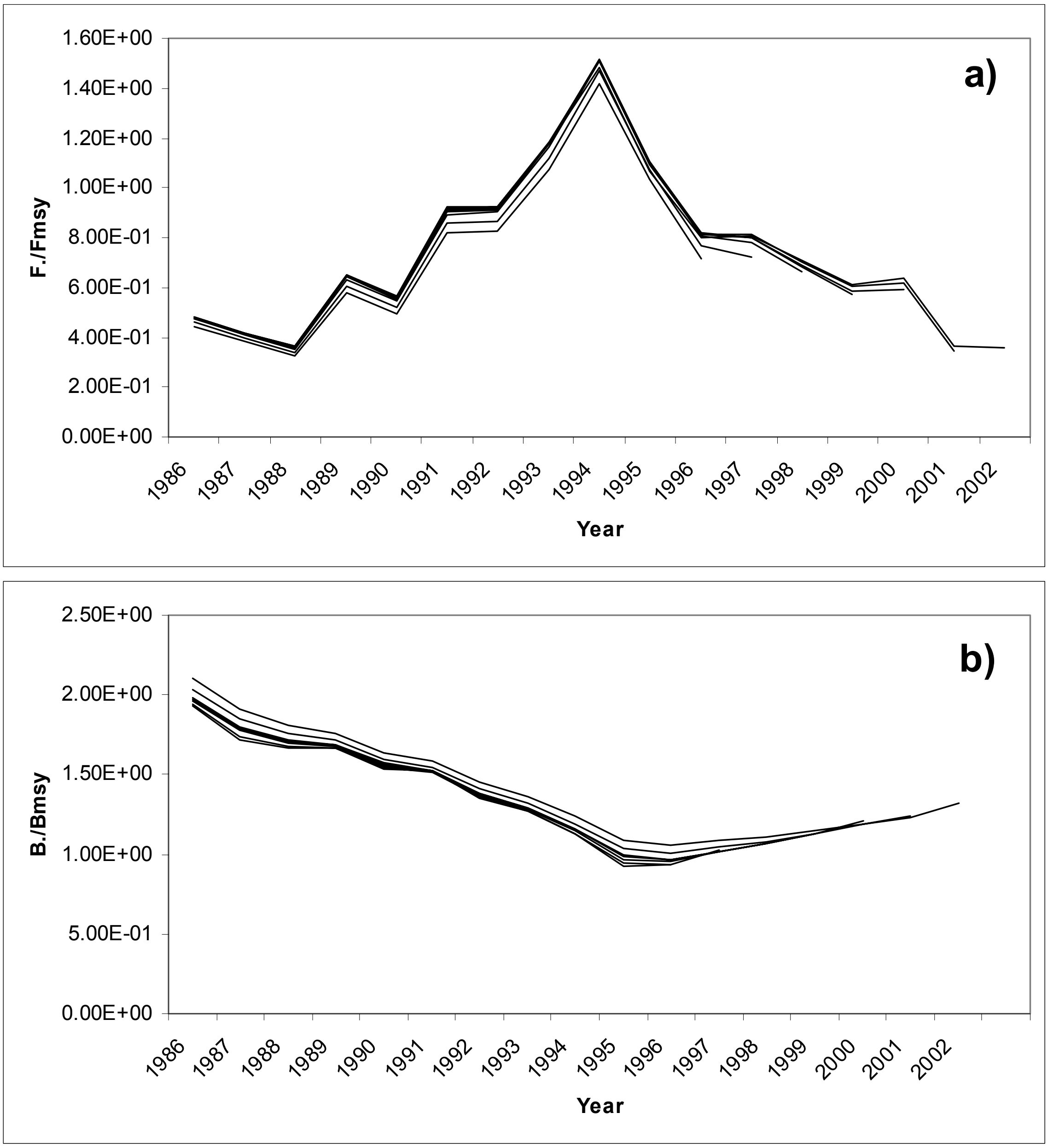


Figure 9.2.7 Deep-sea *S. mentella*. Retrospective analysis of the ASPIC model for F./$\mathbf{F}_{MSY}$ (a) and B./$\mathbf{B}_{MSY}$ (b).

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 identification in the area.

10.1 Fishery

10.1.1 Summary of the development of the fishery

Russian trawlers started fishing pelagic *S. mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from 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 mainly due to effort reduction. Since 1989, the number of countries, participating in the pelagic *S. mentella* fishery gradually increased. As a consequence, total catches also increased after the 1991 minimum and reached a historical high of 180 000 t in 1996 (Tables 10.1.1–10.1.2). Since 2000, the WG estimate of the catch has been between 126 000 and 132 000 t. This is probably an underestimate due to poor reporting of catches from non-ICES countries.

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. Since 1997, the main fishing season occurred during the second quarter. The pattern in the fishery has been reasonably consistent in the last 5 years and can be described as follows: 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 1998-2002 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. Discard is not considered to be significant for this fishery (see 10.1.3).

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2002:

Faroes	3 factory trawlers
Germany	7 factory trawlers
Greenland	1 factory trawler
Iceland	25 factory trawlers and 2 freshfish trawlers
Norway	4 factory trawlers
Russia	29 factory trawlers
Portugal	6 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 1994 onwards, several trawlers have made trips to this area fishing almost exclusively deeper than 500-600 m.

Since 1999 the Faroese fishery started in international waters in the NE part of the Irminger Sea in the middle/late 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 38°W (ICES Division XII), fishing mostly within the Greenlandic EEZ.

Three trawlers participated in 2002. 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 effort in 2002 is the lowest observed in the last eight years and amounted to 12 700 hours only. As observed in previous years, the majority of the 2002 effort was applied during the second and third quarters. During the second quarter in 2002, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Division XIV between the Greenland and Icelandic EEZs. In 2002, there was significant fishing effort exerted in the NAFO Subarea 1F mainly within the NAFO Regulatory Area. The decrease of annual landings discontinued in 2002 with a catch figure of 10 700 tons in 2001. In 2002, 18 % or 2 300 tons of the total landings 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 2000-2002, the CPUE remained at that low level. 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.

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 2001-2002, the fishery started in late April and until middle of July, the fishery was nearly 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. From the middle of July until the end of the fishing season the fishery continued in the area Southeast of Cape Farwell, mostly between 38 and 42°W. Only about 12% of the Icelandic catches in 2002 were taken in the "south-western" fishing area shallower than 400 m depth. 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 and 2002, the fishery started in April, close to the Icelandic 200 miles boundary (Subarea XIV). The fishery continued there until beginning of June and nearly 80-85% of the total catch was caught below 600 m. Then 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 2002, Russian fishery for pelagic *Sebastes mentella* in the Irminger Sea and NAFO Div. 1F lasted from April to October. It was conducted by 29 trawlers of different types. In April, the fishery for spawning concentrations of redfish started on traditional fishing grounds near the Icelandic Economic Zone at 600-900 m depth. During the second quarter of the year the redfish fishery took place in the open part of ICES Subarea XIV where CPUE was 825 kg/h. 51% of total catch and 52% of fishing effort were recorded in June-July. In the third quarter, following the feeding migration of redfish, the fishery shifted south-westwards to ICES Subarea XII and the fishery zone of Greenland (200-650 m in depth). At the same time one Russian vessel conducted successful fishery in Subarea XIV (62°00'N 28°00' N-30°00' W) at 600-850 m depth until middle of September. In late July Russian vessels started redfish fishery in NAFO Div.1F at 250-400 m depth. In July-September CPUE in Div. 1F amounted to 1185 kg/h. The total Russian catch of redfish in 2002 is estimated to be 27349 t in ICES Subareas XII and XIV and 4820 t in NAFO Div.1F (WD 7).

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 trawls, with a maximum vertical opening of 80-120 m. The fishery in ICES Subareas XII and XIV 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 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 Portugal

The Portuguese fleet commenced the fishery in 1994. In 2002, six trawlers participated, fishing with a large pelagic net. Based on the observed vessel and observed period (Div. XII in September and October from 203m to 380m depths, and in Div. XIVb from May to July from 400m to 770m depths), the months with highest catch rates were October in Div. XII, and June in Div. XIVb. Despite the concentration of fishing effort on Div. XIVb, higher CPUE was recorded in Div.XII than in the northern Div. XIV b. In Div. XIVb CPUE at depth shallower than 500m were smaller than those at greater depth were.

In Div. XII, lengths between 32cm and 36cm dominated catches (mean length and weight of 34cm and 555g). In Div. XIVb at depth <500m, lengths between 39cm and 42cm dominated catches (mean length and weight of 39cm and 815g). At depth >500m and for the all Div.XIVb, lengths between 38cm and 43cm dominated catches (mean length and weight of 39cm and 838g).

10.1.2.9 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 from 2000-2002 indicate that discards is 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. Discard of the Spanish fleet were often composed of fish infested with *Sphyrion lumpi*. 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 in the discard is also observed at different depths. The discarded percentage being much larger at depth greater than 500 m. 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.

The level of redfish discarded by the Portuguese fleet, based on the observer reports, has been very small, between 0.6 and 1.0% of the catch.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Trends in landings

Total catches in 2002 is estimated to be about 132 000 t, similar as in 2001 . The catch estimates for 2002 might increase due to the lack of reporting from some countries participating in the fishery. Catches from the beginning of the fishery is given it table 10.1.1-10.1.2

At the beginning of the fishery in 1982, catches of pelagic redfish were reported from both Subareas XII and XIV. Most of the catches were taken in Subarea XII (40 000-60 000 t) prior to 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 and 2002 about 6791 and 7639 t of pelagic *S. mentella* were reported in NAFO Div 1F, 2H and 2J, respectively.

Pelagic *S. mentella* fishery in ICES Div. Va started in 1992. The catch varied from 2 000-14 000 from 1992-1995. From 1995-2000, the catches in Div. Va increased to about 45 000 t (Table 10.1.1). Total catches in 2001 and 2002 were 28 000 and 37 000 t respectively.

10.1.5 Biological sampling from the fishery

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian, Portugese and Spanish commercial catches were reported for 2002 and are given in Figure 10.1.2. A bimodal distribution over the past 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 2002 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	13191	33	?
Iceland	XIV and Va	Pelagic	44430	116	16371
Russia	XII, XIV and NAFO 1F	Pelagic	32169	473	152202
Spain	XII, XIV	Pelagic	8950	57	11262
Portugal	XII, XIV	Pelagic	3164	87	6960

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 (ICES 2002 NWWG -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. If agreement is defined as ± 5 years, approximately 90% agreement would be obtained. A second set of age reading results within an otolith exchange program between Germany, Iceland, Norway and Spain based on material collected in 1998 and 1999 (WD11), shows the same results.

10.2 Assessment

10.2.1 Survey data

There were no surveys conducted in 2002. The main results of the 2001 trawl-acoustic survey (ICES CM 2002/D:08 Ref.ACFM). are described in the report of the NWWG in 2002 and the results are given in Table 10.2.1-10.2.2. There will be new survey in June/July 2003 with participation of Russia, Germany and Iceland (ICES CM 2003/D:2).

10.2.2 CPUE

Non standardised CPUE (Table 10.2.3 and Figure 10.2.3), series for Bulgarian, German, Icelandic, Spanish, Norwegian and Russian 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, along with estimated biomass derived from the international and Russian hydroacoustic surveys. In recent years, there is no trend in CPUE, both shallower and deeper than 500 m (Figures 10.2.3.a-10.2.3.b).

Standardised CPUE (Figure 10.2.3.c), derived from a GLM CPUE model incorporating data from Germany (1995-2002), Iceland (1995-2002), Greenland (1999-2002), Faroe Island (1995-2001), Russia (1997-2001) and Norway (1995-2002) is given. The model takes into account year, month, vessel and area (ICES statistical square). The model was run on as desegregated data as possible from a joint database (WD 18) and the outcomes of 3 model runs are given in Table 10.2.4. The model shows that the index is fluctuating both for the south-western and northeastern fishing area. The value in 2002 has increased for the northeastern part but remains similar for the southwestern area, compares with previous yea. Overall, the GLM model indicates a relatively stable CPUE since 1995 both shallower and deeper than 500 m. The minor changes seen in the series, compared with the run from last year, are because data from new nations have been added to the database (Russia 1997-2001 and Faroe Island form 1995-2001).

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 were relatively stable during 1991 to 1995, but they have declined substantially, 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 biomass estimates are minimum or if they can overestimate stock size.

Adding the trawl biomass estimate below 500m to t he 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.

Available CPUE series show that the pelagic redfish CPUE has remained stable since 1995 for all fishing areas as well as separated above and below 500 m depth. There are great seasonal, geographical and depth changes of the fishing activities and the fishery is on schooling aggregations. Therefore CPUE series might not indicate or reflect actual status of the stocks and might thus be to optimistic. Comparing figures of the fishery in recent years (Figure 7.5.1-7.5.4) with the distribution from the surveys (Figure 10.2.2) it can be seen that the fish accumulates in fishable concentrations in relatively small area, compared with the distribution area.

Taking into account the uncertainty in stock indicators, it is not known if the exploitation rate generated by recent catches is above or below 5% exploitation rate which has been suggested suitable for such a long lived species.

Based on all the available data, the recent exploitation level seems not to cause stock size reduction.

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.

10.4 Management considerations

The working group had again difficulties in obtaining 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 in recent years is a clear distinction between two widely separated grounds fished at different seasons and different depths. Since 2000 the more southwesterly fishing ground extended also 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. NAFO Scientific Council does agree with this conclusion. No new survey results were available to the working group, but 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.

There will be a survey on pelagic redfish in 2003 and the report will be available in September 2003.

Considering the uncertainty related to definition of stock units, action must be taken in accordance with the precautionary approach and attempts be made to manage each stock component separately until better knowledge on the relationship among units are known. Given the current fishing pattern (the deep water fishery in the northeastern area and the upper water fishery in the southwest area), seasonal or geographic separate management regimene could be applied to the fishery. That kind of approach would also account for depth separation. This would reduce the risk of overexploitation or depletion of the possibly separate units, which would occur if they would be managed under a common TAC.

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 Subareas XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	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	28,148			31,751	62,148	5,299	1,284	208	128,838
2002[1]	37,388			23,954	62,684	7,639			131,665

[1]) Provisional data

Table 10.1.2 Pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Subareas 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	0	0	0	0	0	0	0	0	0	0	0	0	0	581	0	60,000	0	0	0	60,581
1983	0	0	0	0	0	155	0	0	0	0	0	0	0	0	0	60,079	0	0	0	60,234
1984	2,961	0	0	0	0	989	0	0	0	0	0	0	0	239	0	60,643	0	0	0	64,832
1985	5,825	0	0	0	0	5,438	0	0	0	0	0	0	0	135	0	60,273	0	0	0	71,671
1986	11,385	0	0	5	0	8,574	0	0	0	0	0	0	0	149	0	84,994	0	0	0	105,107
1987	12,270	0	0	382	0	7,023	0	0	0	0	0	0	0	25	0	71,469	0	0	0	91,169
1988	8,455	0	0	1,090	0	16,848	0	0	0	0	0	0	0	0	0	65,026	0	0	0	91,419
1989	4,546	0	0	226	0	6,797	567	3,816	0	0	0	0	0	112	0	22,720	0	0	0	38,784
1990	2,690	0	0	0	0	7,957	0	4,537	0	0	0	0	7,085	0	0	9,632	0	0	0	31,901
1991	0	0	2,195	115	0	571	0	8,783	0	0	0	0	6,197	0	0	9,747	0	0	0	27,608
1992	628	0	1,810	3,765	2	6,447	9	15,478	0	780	6,656	0	14,654	0	0	15,733	0	0	0	65,962
1993	3,216	0	6,365	7,121	0	17,813	710	22,908	0	6,803	7,899	0	14,990	0	0	25,229	0	0	2,782	115,835
1994	3,600	0	17,875	2,896	606	17,152	0	53,332	0	13,205	7,404	0	7,357	0	1,887	17,814	0	0	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	0	5,125	44,182	4,554	0	3,185	175,842
1996	3,500	650	7,092	6,271	0	21,245	3,537	62,903	415	1,084	10,649	0	6,842	0	2,379	45,748	7,229	260	518	180,322
1997	0	111	3,720	3,945	0	20,476	0	41,276	31	0	0	0	3,179	886	3,674	36,930	8,707	0	0	122,935
1998			3,968	7,474	0	18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577	0		116,968
1999			2,108	4,656	0	16,489	4,269	43,923	0				5,435	6	4,302	17,957	10,332	188		109,665
2000			11,811	2,837	0	12,499	4,204	45,232	0		450		5,194	0	3,731	29,224	10,894	0	0	126,076
2001			887	7,981		10,669	3,309	42,472			15,689		5,222		2,514	30,012	10,083			128,838
2002 [1]				4,246		13,191	4,264	44,430		1,144	14,656		5,451		3,164	32,169	8,950			131,665

1) Provisional data.
2) Former USSR until 1991.
3) Former GDR and GFR.

Table 10.1.3 Pelagic *S. mentella* landings (in tonnes) in 2002 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		100 %		
Faroes		100 %		
Germany			41 %	59 %
Greenland		100 %		
Iceland			14 %	86 %
Lithuania		100 %		
Norway		100 %		
Portugal		100 %		
Russia		100 %		
Spain			16 %	84 %
Total				

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	128,838	46 %	19 %	35 %
2002	131,665	50 %	10 %	40 %

Table 10.1.4 Results of dividing the Icelandic pelagic redfish catch (t) according to the Icelandic samples from the fishery.

	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%	2455	42507	45008
2001	34%	66%		4423	27999	42423
2002*	14%	86%		6229	38262	44491

*Preliminary

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 Subareas XII and XIV.

Year	Bulgaria	Germany[2]	Iceland	Norway	USSR-Russia (BMRT)
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
1996	-	1.45	1.74	1.20	1.30
1997	-	1.31	1.11	0.66	-[3]
1998	-	1.30	1.56	0.75	-
1999	-	0.97	1.55	0.97	-
2000	-	1.05	1.98	1.12	-
2001	-	0.91	1.40	0.88	-
2002[1]	-	1.14	1.90	1.23	0.89

1 Preliminary
2 1987-1990 reported as GDR (FVSIV)
3 1997-2001 Russian effort data are only available as fishing days

Table 10.2.4.a Results of the GLM model to calculate standardized CPUE for all pelagic redfish fishery, including single tow data from Germany (1995-2002), Iceland (1995-2002), Greenland (1999-2002), Faroe Island (1995-2001), Russia (1997-2001) and Norway (1995-2002). Note that the full output is not shown (afli=catch; ltogtimi=trawling time; ices = ices statistical squere; skip= vessel).

```
Analysis of Deviance Table
Quasi-likelihood model
Response: afli
Terms added sequentially (first to last)
              Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                  36012  181689865
    ltogtimi   1  1404554     36011  180285311 397.0146     0
  factor(yy)   7  7548837     36004  172736474 304.8246     0
  factor(mm)  11  6036235     35993  166700238 155.1106     0
factor(skip)  84 28456849     35909  138243390  95.7581     0
factor(ices) 230  9371695     35679  128871694  11.5175     0

Call: glm(formula = afli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip) +
factor(ices), family = quasi(link = log, variance = mu), data = testdata)
Deviance Residuals:
       Min        1Q    Median       3Q      Max
 -251.8473 -42.12827 -4.760622 32.18028 409.4896

Coefficients:
                        Value  Std. Error      t value
     (Intercept)  8.941645120 0.510787055  17.50562202
        ltogtimi  0.156644728 0.006553003  23.90426746
  factor(yy)1996  0.044604410 0.018704515   2.38468677
  factor(yy)1997 -0.241500209 0.017338001 -13.92895327
  factor(yy)1998 -0.122250482 0.017869202  -6.84140676
  factor(yy)1999 -0.193460622 0.017892690 -10.81227140
  factor(yy)2000 -0.019415520 0.018040945  -1.07619194
  factor(yy)2001 -0.058639607 0.017632108  -3.32572859
  factor(yy)2002  0.081719833 0.018402326   4.44073398
     factor(mm)2 -1.433731141 0.447433982  -3.20434120
     factor(mm)3 -0.216129982 0.270511180  -0.79896876
     factor(mm)4  0.168043623 0.267596974   0.62797281
     factor(mm)5  0.407939738 0.267589020   1.52450103
     factor(mm)6  0.307642616 0.267602810   1.14962401
     factor(mm)7  0.138641428 0.267760706   0.51778108
     factor(mm)8  0.265633370 0.267983037   0.99123203
     factor(mm)9  0.202804060 0.268085695   0.75648967
    factor(mm)10  0.100219041 0.268289993   0.37354744
    factor(mm)11  0.016326485 0.269664939   0.06054360
    factor(mm)12 -0.131193760 0.296476477  -0.44250985
 (Dispersion Parameter for Quasi-likelihood family taken to be 3537.789 )
    Null Deviance: 181689865 on 36012 degrees of freedom
Residual Deviance: 128871694 on 35679 degrees of freedom
Number of Fisher Scoring Iterations: 4
```

Table 10.2.4. b Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths shallower than 500 m (south-western area) including singlel tow data from Germany (1995-2002), Iceland (1995-2002), Greenland (1999-2002), Faroe Island (1995-2001), Russia (1997-2001) and Norway (1995-2002). Note that the full output is not shown.

```
Analysis of Deviance Table

Quasi-likelihood model

Response: afli
Terms added sequentially (first to last)
              Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                   9213   52614579
    ltogtimi   1   316778      9212   52297802  87.0662     0
  factor(yy)   7  4303329      9205   47994472 168.9670     0
  factor(mm)   9  3437250      9196   44557223 104.9697     0
factor(skip)  67  8856328      9129   35700895  36.3307     0
factor(ices) 131  2557084      8998   33143811   5.3650     0
Call: glm(formula = afli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip) +
factor(ices), family = quasi(link = log, variance = mu), data = testdata)
Deviance Residuals:
       Min        1Q   Median       3Q      Max
 -239.9342 -39.58192 -5.26949 31.50438 373.4299

Coefficients:
                       Value Std. Error     t value
     (Intercept)  8.04681561 0.52609392  15.2953974
        ltogtimi  0.18135630 0.01207254  15.0222096
  factor(yy)1996  0.07412931 0.05551622   1.3352730
  factor(yy)1997 -0.15569141 0.04114485  -3.7839825
  factor(yy)1998 -0.07993046 0.03846676  -2.0779101
  factor(yy)1999 -0.43158288 0.03580414 -12.0539925
  factor(yy)2000 -0.12360495 0.03800673  -3.2521858
  factor(yy)2001 -0.05944216 0.03598037  -1.6520722
  factor(yy)2002 -0.07248747 0.03899156  -1.8590554
     factor(mm)4  1.52691065 0.25476278   5.9934605
     factor(mm)5  1.73895938 0.24385059   7.1312493
     factor(mm)6  1.24732778 0.24404510   5.1110544
     factor(mm)7  1.16946407 0.24290056   4.8145796
     factor(mm)8  1.41474266 0.24220915   5.8409960
     factor(mm)9  1.32889393 0.24214161   5.4880858
    factor(mm)10  1.23371829 0.24256991   5.0860317
    factor(mm)11  0.90064532 0.24630319   3.6566531
    factor(mm)12  1.22066784 0.28604795   4.2673540
```

Table 10.2.4.c Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths deeper than 500 m (south-western area) including singlel tow data from Germany (1995-2002), Iceland (1995-2002), Greenland (1999-2002), Faroe Island (1995-2001), Russia (1997-2001) and Norway (1995-2002). Note that the full output is not shown.

```
Analysis of Deviance Table
Quasi-likelihood model
Response: afli
Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                 26784  128997336
    ltogtimi  1  1112446     26783  127884890 338.7725     0
  factor(yy)  7  8317519     26776  119567371 361.8469     0
  factor(mm) 11  3461155     26765  116106216  95.8203     0
factor(skip) 79 21486982     26686   94619234  82.8280     0
factor(ices) 98  4603244     26588   90015990  14.3043     0

Call: glm(formula = afli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip) +
factor(ices), family = quasi(link = log, variance = mu), data = testdata)
Deviance Residuals:
       Min        1Q    Median      3Q      Max
 -227.6338 -41.14726 -4.220292 32.0225 347.7267

Coefficients:
                        Value  Std. Error     t value
     (Intercept)  8.434173631 0.293986897  28.6889440
        ltogtimi  0.164426840 0.007864836  20.9065829
  factor(yy)1996  0.006160440 0.022212893   0.2773363
  factor(yy)1997 -0.308500874 0.021407430 -14.4109256
  factor(yy)1998 -0.178554522 0.022136918  -8.0659160
  factor(yy)1999 -0.142140342 0.022462434  -6.3279136
  factor(yy)2000 -0.048003716 0.022319939  -2.1507100
  factor(yy)2001 -0.131483338 0.022143955  -5.9376629
  factor(yy)2002  0.061631469 0.022672005   2.7183951
     factor(mm)2 -1.516024853 0.431386362  -3.5143087
     factor(mm)3 -0.246928657 0.260973190  -0.9461840
     factor(mm)4  0.117444720 0.257913521   0.4553647
     factor(mm)5  0.353140305 0.257910067   1.3692382
     factor(mm)6  0.278962868 0.257922184   1.0815776
     factor(mm)7  0.151546367 0.258098647   0.5871645
     factor(mm)8  0.078455882 0.259091372   0.3028116
     factor(mm)9 -0.029399779 0.260322807  -0.1129359
    factor(mm)10 -0.167667805 0.261546422  -0.6410633
    factor(mm)11  0.127224735 0.262556194   0.4845619
    factor(mm)12 -0.865802042 0.360270199  -2.4032019
```

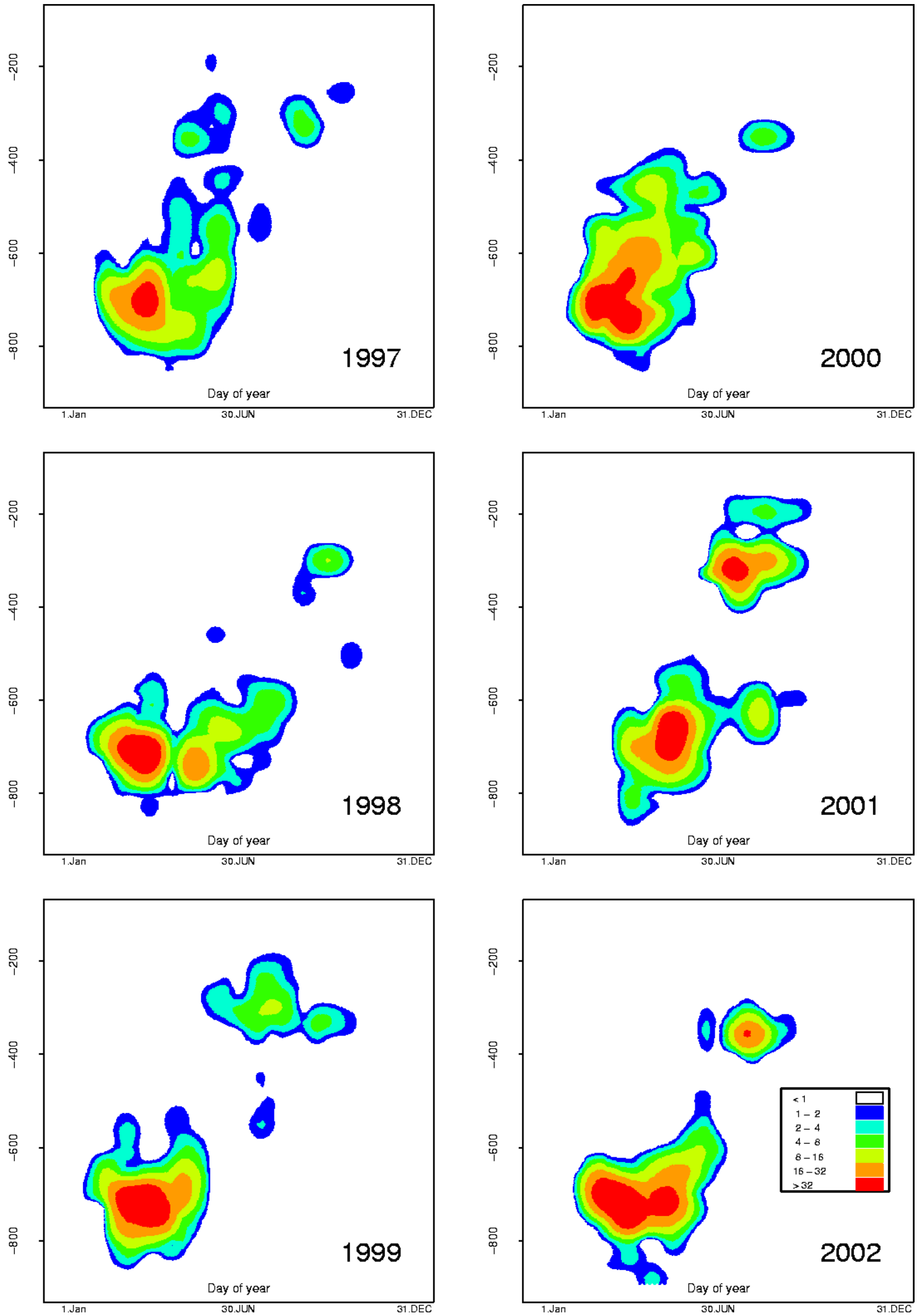


Figure 10.1.1 Depth distribution of Icelandic trawl hauls for oceanic redfish as reported in the log-books since Iceland began its oceanic redfish fishery in 1989. X-axis = day of year; Y axis = depth.

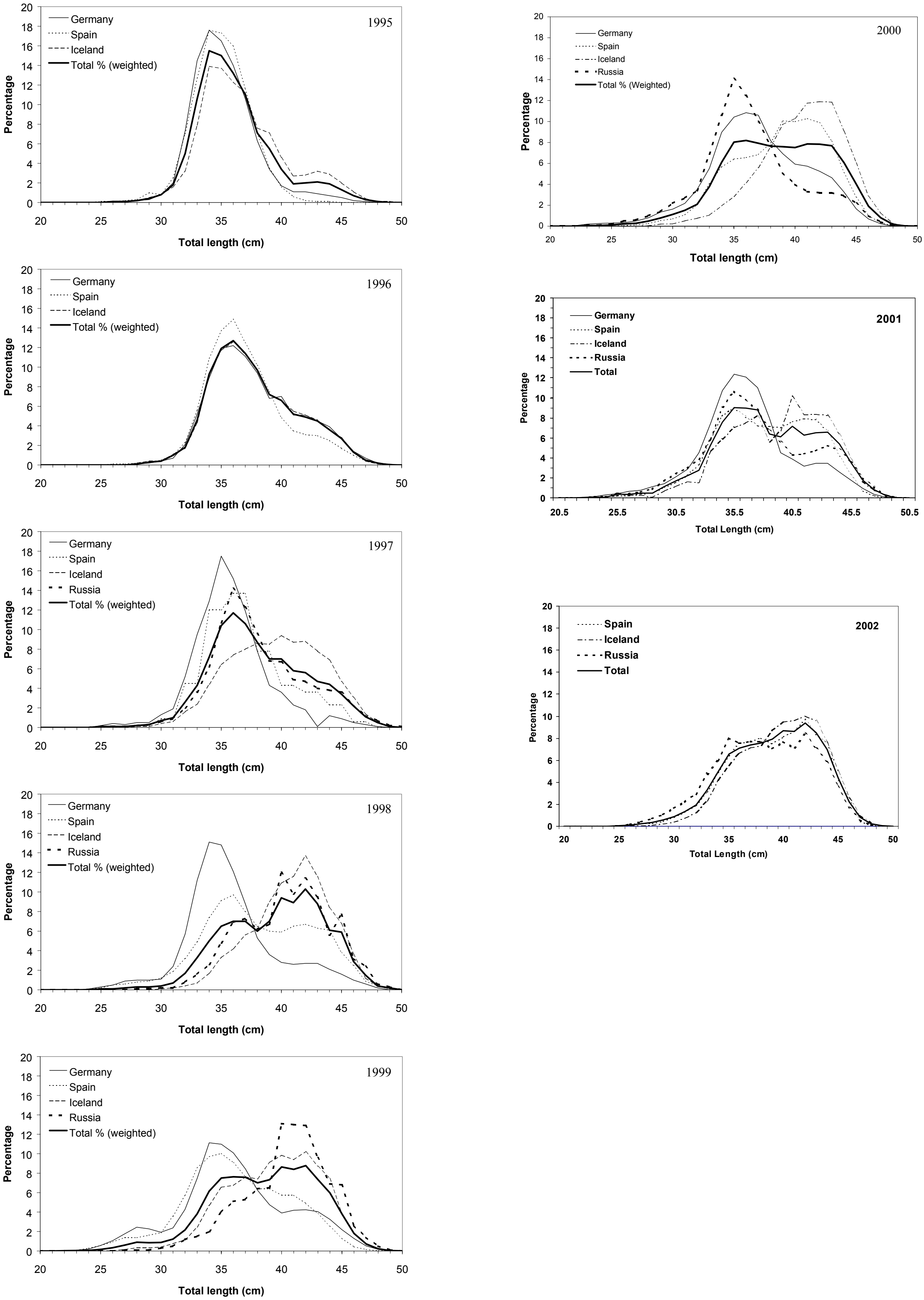


Figure 10.1.2 Length distributions from landings of pelagic *S. mentella* in 1995-2002.

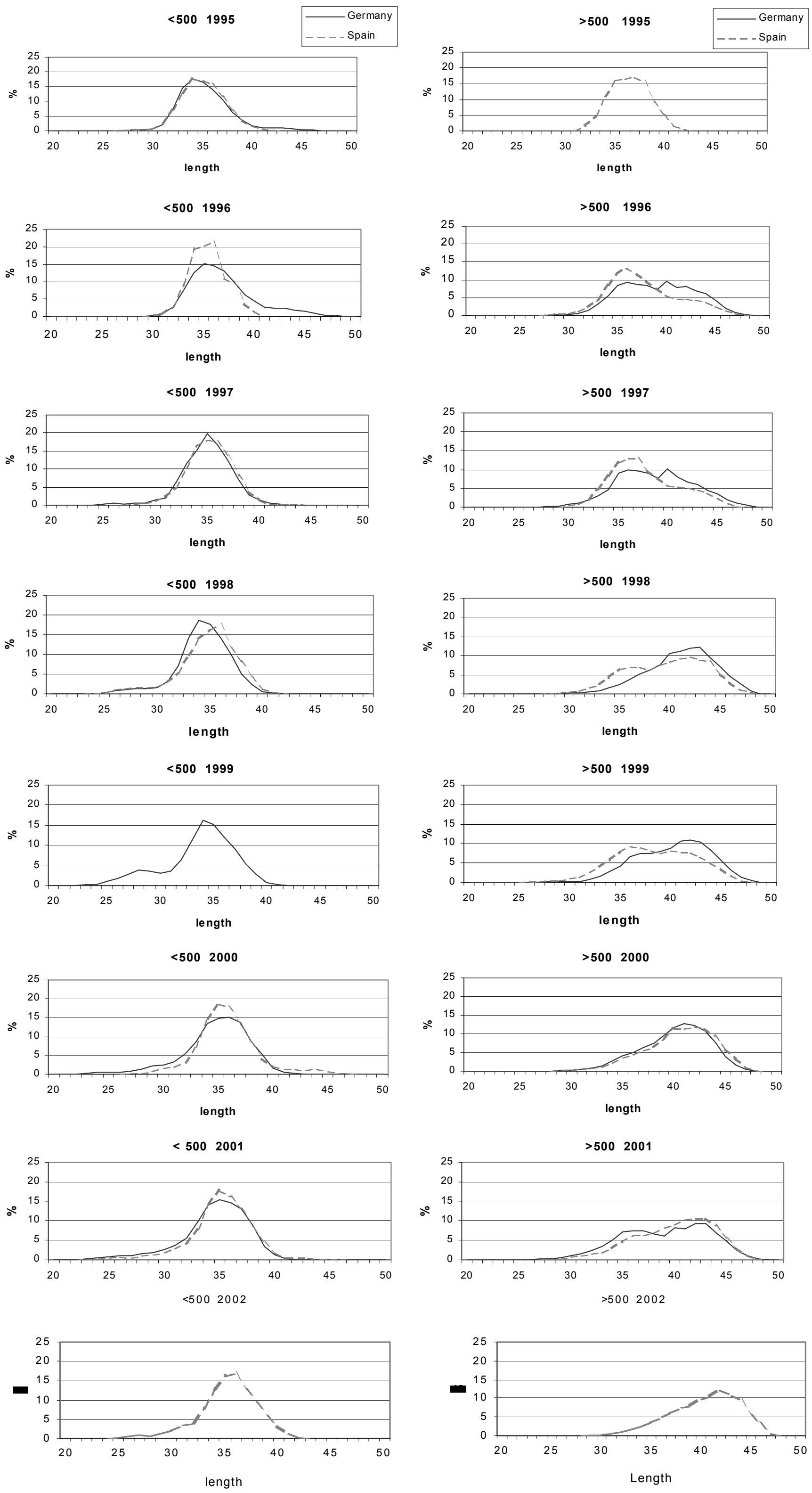


Figure 10.1.3 Length distributions from German and Spanish landings of pelagic *S. mentella* in 1995-2002, divided by depths shallower and deeper than 500 m.

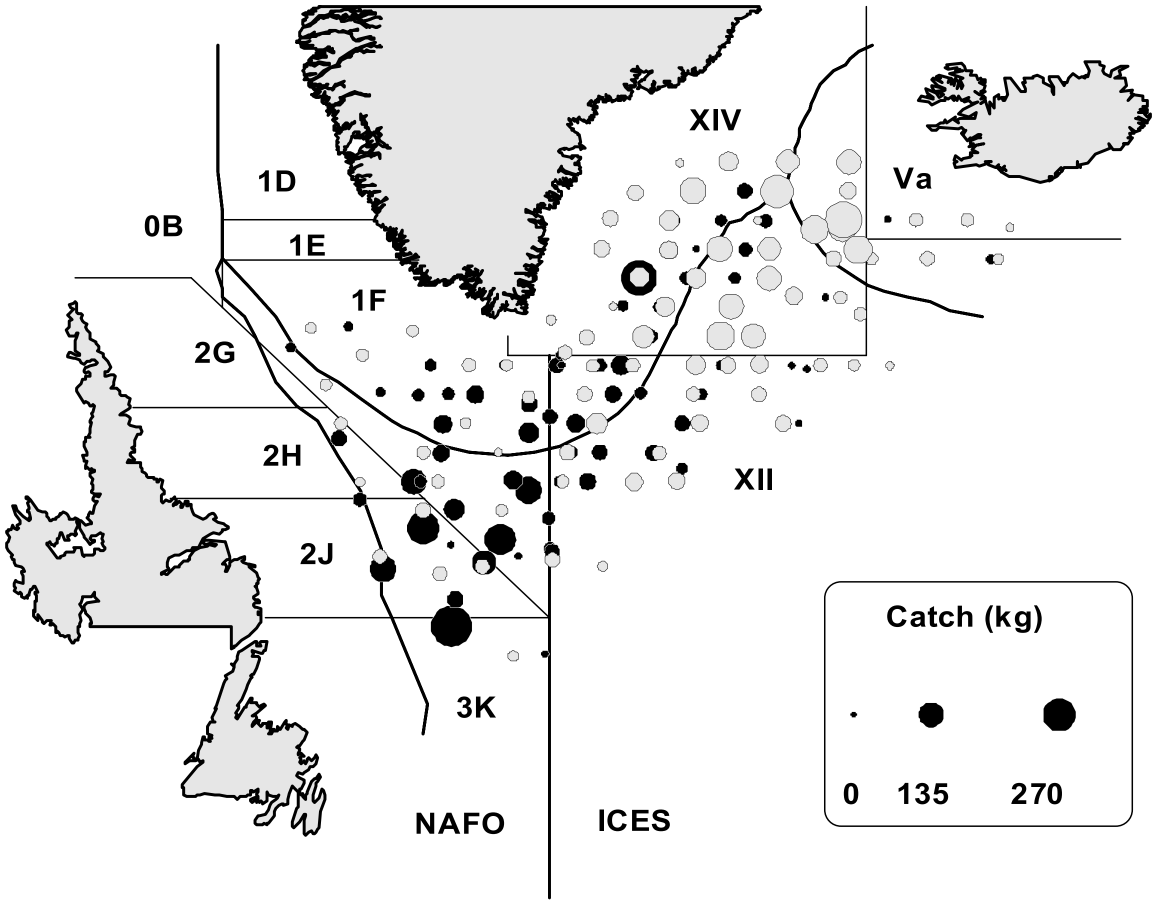


Figure 10.2.1 Pelagic redfish *S. mentella*. Survey catches in June/July 2001 shallower than 500 m depth (black) and deeper than 500 m depth (grey).

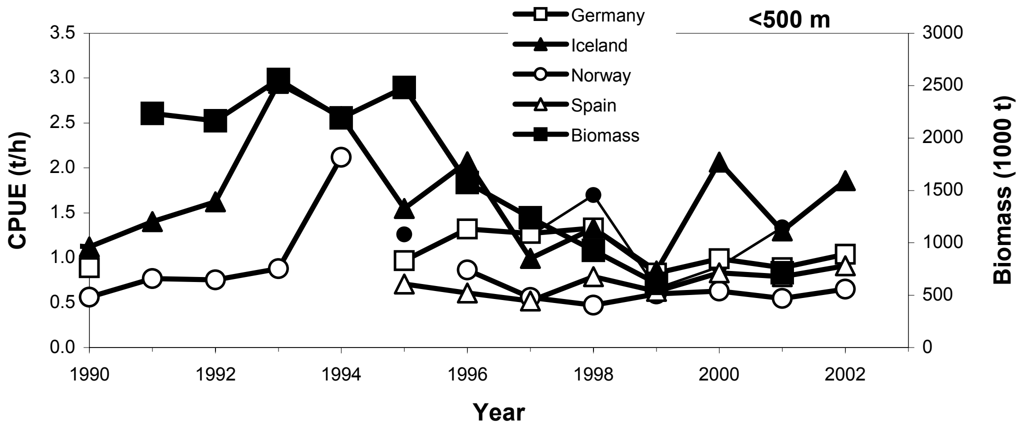


Figure 10.2.3.a Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, shallower than 500m, and estimated acoustic biomass from surveys.

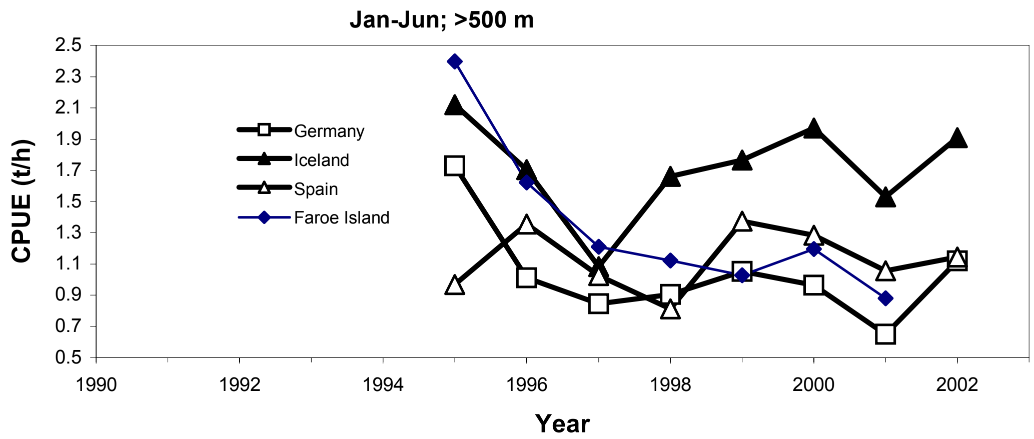


Figure 10.2.3.b Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, deeper than 500m, and estimated trawl biomass from surveys.

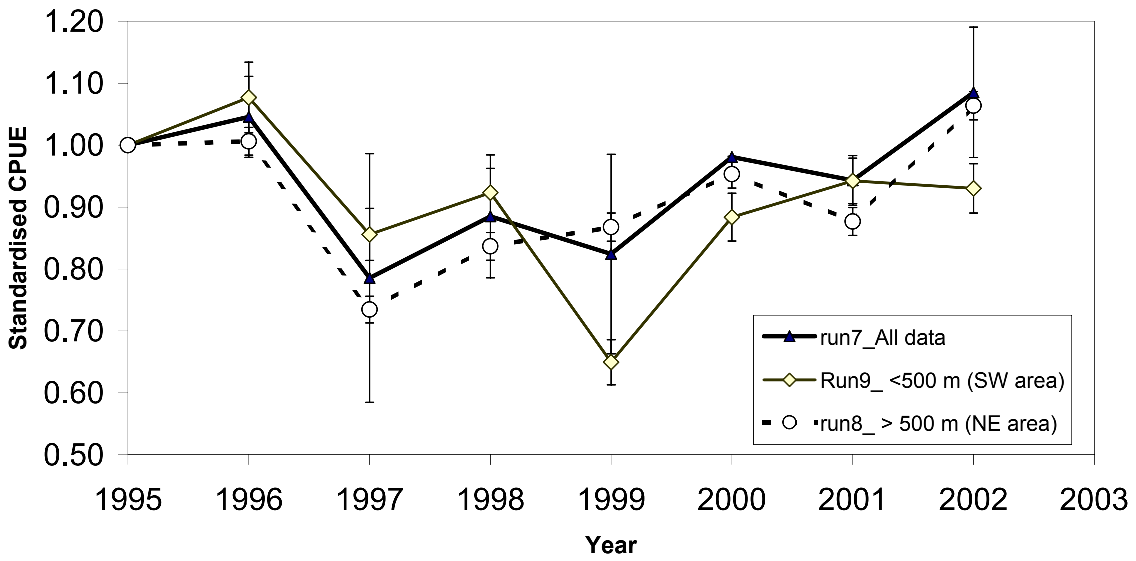


Figure 10.2.3.c Standardised CPUE, as calculated by using data from Germany (1995-2002), Iceland (1995-2002), Greenland (1999-2002), Faroe Island (1995-2001), Russia (1997-2001) and Norway (1995-2002) in the GLM model (see chapter 10.2.2.), divided by depths shallower (south-western area) and deeper than 500 m (northeastern area) and both depth layers (areas) combined (All data. 95% confidence limits are shown. Further details of the GLM models are given in Table 10.2.4

11 LIST OF WORKING DOCUMENTS

The following is a list of working documents that were made available both before and during the WG meeting.

WD 01: Hans-Joachim Rätz, Jens Ulleweit and Kai Panten. Data on German catches and effort for Greenland halibut (*Reinhardtius hippoglossoides*), demersal redfish (*Sebastes marinus* and deep sea S. *mentella*), and Atlantic cod (*Gadus morhua*) in ICES Div. Va, Vb, VIa and XIV, 1995-2002:

WD 02: Hans-Joachim Rätz, Thorsteinn Sigurðsson and Christoph Stransky. 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 1985-2002:

WD 03: Hans-Joachim Rätz. Groundfish Survey Results for Cod off Greenland (offshore component):

WD 04: Hans-Joachim Rätz, Jens Ulleweit and Kay Panten. On the German Fishery and Biological Characteristics of Oceanic Redfish (*Sebastes mentella* Travin):

WD 05: O.A. Jørgensen. Survey for Greenland halibut in ICES Division 14B, June-July 2002.:

WD 06: Fernando González. Report of the fishing activity of the Spanish fleet in *Sebastes mentella* fishery in 2002:

WD 07: S.P. Melnikov. Preliminar information about Russian fishery for the oceanic *S. mentella* in ICES subareas XII, XIV, in NAFO division 1F in 2002 and biological sampling from commercial catches.:

WD 08: Shibanov V. and S.Melnikov. Pelagic *Sebastes mentella* stock structure in ICES Subareas XII, XIV and NAFO Conventional Area by the results of Russian investigations:

WD 09: S. P. Melnikov, Yu. I. Bakay, I. V. Bakay, G. G. Novikov and A. N. Stroganov. Ecological and biological characteristics of redfish Sebastes mentella in Va and XIVb Divisions of ICES:

WD 10: Christoph Stransky. Shape analysis and microchemistry of redfish otoliths: investigation of geographical differences in the North Atlantic:

WD 11: Christoph Stransky, Sif Guðmundsdóttir, Þorsteinn Sigurðsson, Svend Lemvig and Kjell Nedreaas. Age readings of *Sebastes marinus* and *S. mentella* otoliths: bias and precision between readers:

WD 12: R. Alpoim, J. Vargas and E. Santos. NEAFC Portuguese research report for 2002:

WD 13: Fernando González. Report of NAFO scientific council in 2002:

WD 14: Petur Steingrund. Correction of maturity stages in the Faroese spring groundfish survey:

WD 15: J. Boje. The fishery for Greenland halibut in ICES Div. XIVb in 20The fishery for Greenland halibut in ICES Div. XIVb in 200202:

WD 16: Marie Storr-Paulsen. Cod stock off West Greenland:

WD 17: Thorsteinn Sigurðsson. *Sebastes marinus* in ICES division VA. Figures and tables:

WD 18: Thorsteinn Sigurdsson, Hajo Rätz, Kjell Nedreaas, Sergei P. Melnikov and Jákup Reinert . Fishery on pelagic redfish (S.mentella, Travin):Information based on log-book data from Faroe Island, Germany, Greenland, Iceland, Norway and Russia.

WD 19: Thorsteinn Sigurðsson. Information on the Icelandic Fishery of Oceanic Redfish (*S.Mentella* Travin); Information based on log-book data and sampling from the commercial fFishery:

WD 20: Jákup Reinert. Some information on the Faroese redfish fishery:

WD 21: Jákup Reinert. Preliminary assessment of Faroe Haddock:

WD 22: Agnes C. Gundersen and Åge Høines. Norwegian fishery for Greenland halibut and *S.marinus* and in ICES Subareas XII and XIV, and pelagic *Sebastes mentella* in the Irminger Sea, 2001-2002:

WD 23: Thorsteinn Sigurdsson and Kristjan Kristinsson. Information on the shelf deep-sea redfish (*Sebastes mentella*) fishery in Division Va 2003:

WD 24: Lise Helen Ofstad. Preliminary Assessment of Faroe Saithe 2002:

WD 25: Petur Steingrund. Preliminary assessments of Faroe Plateau cod:

WD 26: The Icelandic Haddock Council. Icelandic haddock:

WD 27: Björn Ævarr Steinarsson, Einar Hjörleifsson, Höskuldur Björnsson, Ólafur Karvel Pálsson and Sigfús Alexander Schopka. External experts: Árni Magnússon, Guðmundur Guðmundsson and Þorvaldur Gunnlaugsson. Icelandic cod in division Va:

WD 28: Einar Hjörleifsson. Excel Statistical Catch @ Age Model (EXCAM) analysis of Fareo haddock

WD 29: Einar Hjörleifsson. Excel Statistical Catch @ Age Model (EXCAM) analysis of Faroe cod:

WD 30: Kristján Kristinsson and Þorsteinn Sigurðsson. Request from Northeast Atlantic Fisheries Commission Regarding Redfish Stocks - Terms of Reference C.:

WD 31: Arni Magnusson. 2003 Coleraine assessment of the Icelandic cod stock:

WD 32: Einar Hjörleifsson. Excel Statistical Catch @ Age Model (EXCAM) analysis of Greenland cod

WD 33: Withdrawn

WD 34: Höskuldur Björnsson. Investigation of the relationship between hidden mortality of Icelandic haddock and fishing mortalility.