Advisory Committee on Fishery Management **ICES CM 2001/ACFM:20**

REPORT OF THE

NORTH-WESTERN WORKING GROUP

Tórshavn, Faroe Islands
24 April–3 May 2001

PARTS 1 AND 2

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

1.1 Participants

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1.2 Terms of Reference

The **North-Western Working Group** [NWWG] (Chair: J. Boje, Denmark) will meet in Tórshavn, Faeroe Islands from 24 April to 3 May 2001 to:

a) assess the status of and provide catch options for 2002 for the stocks of redfish in Sub-areas V, XII and XIV, Greenland halibut in Sub-areas V and XIV; cod in Sub-area XIV, NAFO Sub-area 1, and Divisions Va and Vb; saithe in Divisions Va; and Vb and haddock in Divisions Va and Vb;

b) for cod, haddock and saithe in Division Vb, where an effort control management system is in effect, estimate the probability profile of fishing mortalities which would be generated under the current effort control scheme and provide effort options which have a high probability (> 80%) that the realised fishing mortalities in 2002 which would correspond to the fishing mortality identified as being within safe biological limits;

c) update survey and fishery information on the stocks of redfish in Sub-areas 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 Sub-areas 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) identify major deficiencies in the assessments;

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

In addition a request on a biological justification for maintaining the Redfish-Box in East Greenland arrived after the ACFM Consultations in October 2000 (Appendix 1).

NWWG will report by 10 May 2001 for the attention of ACFM.

1.3 General comments

Terms of reference for the NWWG in 2001 were unchanged from 2000, apart from the special request on the redfish box and for the general request to evaluate the layout of a Quality Handbook.

Identification of deficiencies in the assessment the WG is dealt with in the sections 'Comments on assessment' and 'Management considerations' for each stock.

We were unable to provide information on TOR b) on estimation of probability profiles of fishing mortalities generated under the present management system in Faroese fisheries and corresponding effort options. This was owing to unreliability of information on recent effort, and the group further elaborates on this in section 2.1.4.

Since 1999 the group have updated progress in determining precautionary reference points and it is summarised below in Section 1.6; stock-specific arguments are found in the assessments.

The format of the report is similar to last year's, 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 basic input information regarded as necessary to assess stock status has been included, but further attempts to reduce the amount of documentation have not been made, as clients of the report as well as ACFM have requested that it should contain sufficient data and diagnostics from analyses.

The group are grateful to the Faroese Fisheries Laboratory in Tórshavn for hosting this meeting and for providing the group with excellent working facilities.

1.4 Stocks and Assessment Methods

The stocks dealt with by NWWG can be divided into two classes: those for which data are sufficient to allow an analytical assessment, and those for which either data amount is limited or for which the quality of the data is questionable, impeding analytical assessments. All gadoid stocks are in the first class except for Faroe Bank cod, where a short time series and incomplete biological sampling of the landings inhibit analytical assessment, and cod in Greenland, where a ceased fishery prevents a VPA. In the second class are all the stocks of redfishes, for which difficulties in age determination prevent calculations of catch at age and therefore age-based analytical assessment. The Greenland halibut stock in Greenland, Iceland and the Faroes have shifted to this category mainly due to unreliable determinations of age and maturity. For most of the stocks for which analytical assessments were carried out, terminal fishing mortalities have been estimated by tuning detailed catch data with selected fleet CPUE indices using the XSA module of the Lowestoft suite. Exceptionally, fishing mortalities for Iceland saithe have been modelled by a Time Series Analysis (TSA) as has been the done during the last 4-5 assessments. For Greenland halibut and deep-sea redfish on the continental shelves, a production model (ASPIC) was fitted to catch and effort data, to derive recent and historic F and B ratios in relation to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$.

1.5 Choices of stock size indices to be used in calibrations

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

The recent assessments of North Sea and Icelandic cod point to the importance of periodically examining critically what indices should be used in the assessment. The main result of the in-depth examination for these two stocks had led to the exclusion of all five commercial fleets in the Icelandic cod assessment, and four of the five commercial fleets in the North Sea cod assessment because of demonstrated or suspected increases in the commercial fleets catchability coefficients and/or data errors. The omission of commercial CPUE series has resulted in considerably lower stock sizes for both stocks, consistent with the increased catchability coefficients overestimating stock size. Increased catchability coefficients of the commercial fleets are expected to occur because of learning and technological improvements.

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

Although it is expected that fishing efficiency of commercial fleets will increase over time, the imposition of technical conservation measures has the contrary effect and it is not clear what the net outcome will be. The commercial CPUEs used in the Faroe cod, haddock and saithe assessments have been carefully selected from a subset of pair trawlers and longliners whose vessel configurations have remained relatively unchanged over the years and that have consistently provided reliable logbook information. The CPUE used for Greenland halibut has been modelled to take into account year, area, seasonal and vessel and even though the area fished has increased over the years, substantial changes in catchability are not expected. For the redfish stocks included in the mandate of the NWWG the commercial fleets' CPUE is a main source of information on changes in stock size.

1.6 Review of the layout of a Quality Handbook

The group discussed the new approach to quality assurance suggested by ICES. This included the Handbook (which was assumed to be the same as the 'Manual') and the two formats for stock assessment procedures.

The group generally considered the entire approach of having both a WG report and the stock annexes for the handbook to be excessive. If the stated requirements on data documentation in the annexes were satisfied, these would end up being the same size as the present reports. In addition, the information asked for in the handbook is also necessary for the WG report. Therefore, the format of the annexes could be used as a future format for the report in order to standardize it.

The suggested approach on quality control prompted the comments from the group that more effort should be put on quality control and compilation of input data. This issue is pointed out in the handbook as a responsibility of the national laboratories. However, guidelines for such compilations (i.e. age readings, catch at age compilation) would probably enhance the quality of the assessment substantially, compared with the proposed quality control at the analysis level. It is difficult to see how ICES will be able to ensure its clients that it is giving them quality advice if ICES itself does not have a mechanism to assess the quality of the data provided by national laboratories that is the basis for the advice.

In Section 3.3, on Assessment Models, we thought it important to distinguish between models, fitting methods, and implementation software. The group queried the basis on which the listed 'methods'—for which we thought 'software' a more appropriate term—had been approved. The experience of the WG with the newly "approved" prognosis tools is not building unreserved confidence. Furthermore, methods such as time-series analysis, which have been used by the group for several years, and accepted by ACFM, do not seem to appear on the approved list. Some development of assessment methods now takes place in Working Groups, and the NWWG was concerned that such a Handbook system would prevent this and so petrify assessment methods to an undesirable degree.

One of the basic principles of quality management is that processes and procedures should be such that errors cannot occur or have a low probability of occurring. In a stock assessment context, errors occur most often at the data preparation and compilation stages, not during the actual running of the assessment. Although it is a legitimate objective to encourage the use of standard software and outputs, it is equally important to build human capacity such that there is confidence in the product they are providing whether standard software has been used or not.

Section 4 in the draft, on the formulation of advice, needs further elaboration or rewording in order to give appropriate guidance.

1.7 Progress in determining precautionary reference points

The methods used for determining precautionary reference points generally remained stable since 1999, with a few minor changes (Table 1.7.1). They varied from stock to stock in response to the differences between stocks in the availability of data, the state of the stock, and the understanding of stock dynamic processes.

Biomass reference points were based either on a Minimum Biologically Acceptable Limit—more or less subjectively picked off the historic plot of recruitment against SSB—or on the lowest estimate of spawning stock biomass $\mathbf{B}_{loss}$. MBAL was usually referred to for setting $\mathbf{B}_{pa}$, but was once used for $\mathbf{B}_{lim}$. $\mathbf{B}_{loss}$ was referred to only for setting $\mathbf{B}_{lim}$. Reference points for fishing mortality appealed almost all the time to $\mathbf{F}_{med}$, either to set the value of $\mathbf{F}_{pa}$ or to justify a subjectively set value. The other standard Fs were not used in the precautionary context. If ACFM had set reference points in the past, the working group usually retained them.

In most cases where both 'pa' and 'lim' values were set, the smaller value was usually established first and the larger value derived by adding a multiple of an assumed standard error. The multiple chosen was either 1.645 or 2, but it is not easy to know how the choice between them was made. In one case (B for Faroe haddock), the multiple 2 was initially used, but the result was then adjusted downwards (in the past, by ACFM) and the final multiple was about 1.3. Error CVs were usually assumed to be 30% for reasonable assessments, or 40% if there was less confidence. Exceptionally, for Faroe saithe, $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ were independently set (by ACFM 99), at $\mathbf{B}_{loss}$ and at MBAL.

For several stocks in 2001, we did not carry out analytical assessments based on reconstruction of population age structure because of various dissatisfactions with the data available. We then usually resorted to simpler age-aggregated stock-production models. We did not developed a complete framework for setting PA reference points on the basis of such assessments. In two such cases we set $\mathbf{F}_{pa}$ (buffer reference point) equal to 2/3 of $\mathbf{F}_{MSY}$. We regarded that as equivalent to a 75% probability of avoiding an $\mathbf{F}_{lim}$ that by reference to SGPAFM 1998 would be taken as equal to $\mathbf{F}_{MSY}$.

We were still unable to specify reference points for most stocks of cod, as they were depleted, deficient in data, or unpredictable in dynamics. Cod off Iceland is managed by a harvest control rule that appears to be acceptable under the precautionary approach.

Owing to the state of knowledge of redfish stocks and their dynamics, a single reference parameter has been adopted, a survey catch:effort ratio designated as 'U'. Reference values were defined relative to the historic maximum value observed for this parameter. The 'lim' value was taken as 20% of the maximum, and the 'pa' value at 50% or 60%.

1.8 Recommendations

- The working group recommends that NEAFC asks all nations participating in the pelagic redfish fishery to provide ICES with information on the trawling depth (headline depth for each haul as a log-book data), so ICES can have more detailed description of the fishery by season and areas as a basis for giving its advice on the resource.

- The working group proposes that the ICES saithe study group that had its last meeting in Aberdeen in 1984 be called to a meeting in the near future.

Table 1.7.1: Precautionary-approach reference points included in the assessments.

Stock	Limit (lim) reference points	Buffer (pa) reference points	Other values given in the assessment	Notes
2.2 Faroe Plateau Cod	B=lowest SSB (ACFM1998); $\mathbf{F}_{lim}$=$\mathbf{F}_{pa}$.exp(1.645σ)	$\mathbf{B}_{lim}$.exp(1.645σ); F≈$\mathbf{F}_{max}$ and $\mathbf{F}_{med}$	$\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$, $\mathbf{F}_{med}$	σ is taken as 40% to account for the relatively large uncertainties in the assessment.
2.3. Faroe Bank Cod			$\mathbf{F}_{MSY}$; $\mathbf{B}_{MSY}$	poor sampling of commercial catches prevented analytical assessment. No analytical basis for reference points. Stock-production model results were not believed.
2.4. Faroe Haddock	B=MBAL; F=$\mathbf{F}_{pa}$ + 2σ (ACFM)	(B= $\mathbf{B}_{lim}$;+ 2σ); F=$\mathbf{F}_{med}$ (ACFM)	$\mathbf{F}_{max}$, $\mathbf{F}_{0.1}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$.	ACFM98 proposed a lower $\mathbf{B}_{pa}$ directly from the SSB-R plot. $\mathbf{F}_{lim}$ & $\mathbf{F}_{pa}$ also proposed by ACFM98. These reference points make sense now, but could be too low if recruitment returned to past high levels.
2.5 Faroe Saithe	B=$\mathbf{B}_{loss}$ (ACFM99); F = (ACFM98)	B= former MBAL (ACFM99); F = (ACFM98)	$\mathbf{F}_{max}$, $\mathbf{F}_{0.1}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$.	the assessment cites the PA reference points suggested by ACFM in 1998 and 1999.
3.2 Iceland Saithe	B=90kt (ACFM);	B = 150kt (ACFM); F = 0.3/yr;	$\mathbf{F}_{low}$, $\mathbf{F}_{0.1}$, $\mathbf{F}_{med}$, $F_{35\%SPR}$, $\mathbf{F}_{high}$.	the assessment cites the reference points suggested by ACFM
3.3. Iceland Cod	None	None	$\mathbf{F}_{max}$, $\mathbf{F}_{0.1}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$, $\mathbf{F}_{low}$	simulations indicate that the stock will not crash under the new catch rule; but some important factors were not taken into account in this exercise.
3.4. Iceland Haddock	None	no B; $\mathbf{F}_{pa}$=$\mathbf{F}_{med}$	$\mathbf{F}_{max}$, $\mathbf{F}_{0.1}$, $\mathbf{F}_{high}$.	$\mathbf{F}_{crash}$>1.3/yr and is too high to be a suitable candidate for $\mathbf{F}_{lim}$

Table 1.7.1 (Continued)

Stock	Limit (lim) reference points	Buffer (pa) reference points	Other values given in the assessment	Notes
5.1. Greenland Cod—Offshore	none	B 'could be' MBAL; no F	$\mathbf{F}_{0.1}$, $\mathbf{F}_{max}$, $\mathbf{F}_{med}$, $\mathbf{F}_{high}$.	given the depleted stock status, no reference points were proposed.
5.2. Greenland Cod—Inshore	None	None		no reference points due to the depleted state of the stocks
6. Greenland halibut		F=2/3 $\mathbf{F}_{MSY}$	$\mathbf{F}_{MSY}$	an analytical assessment was rejected owing to poor diagnostics and a new perception of the stock size. Maturity data and age readings have recently been unreliable. A logistic stock-production model was fitted by ASPIC.
8. S. marinus	$U_{lim}=0.2 \times U_{max}$	$U_{pa}=0.6 \times U_{max}$		U is a catch/effort ratio, the Icelandic groundfish survey index, i.e. an index of fishable biomass. Stock was below U_{pa} from 1993–96.
9. Deep-sea *S. mentella* on the shelf	$U_{lim}=0.2 \times U_{max}$	$U_{pa}=0.5 \times U_{max;}$ F = 2/3 $\mathbf{F}_{MSY}$		U is a survey and CPUE index. Currrently close to or below U_{pa}. A stock-production model was used in this assessment.
10. Pelagic *S. mentella*	none	none		'Based on the status of knowledge. No new information on reference points.'

Table 1.7.2: 'Technical basis for PA reference points' in ACFM summary sheets provided by NWWG, 2001

Stock	$\mathbf{F}_{lim}$	$\mathbf{B}_{lim}$	$\mathbf{F}_{pa}$	$\mathbf{B}_{pa}$	
2.2 Faroe Plateau Cod	$\mathbf{F}_{pa}$.exp(1.645σ); σ=0.4	$\mathbf{B}_{loss}$	close to $\mathbf{F}_{med}$ and $\mathbf{F}_{max}$	$\mathbf{B}_{lim}$.exp(1.645σ); σ=0.4	
2.3. Faroe Bank Cod					none
2.4. Faroe Haddock	2SD above $\mathbf{F}_{pa}$	former MBAL	$\mathbf{F}_{med}$ 1998	2SD above $\mathbf{B}_{lim}$, subsequently reduced after inspecting the SSB-R scatter plot	
2.5 Faroe Saithe	consistent with $\mathbf{B}_{lim}$	$\mathbf{B}_{loss}$	consistent with $\mathbf{F}_{lim}$ and $\mathbf{F}_{med}$	former MBAL	
3.2 Iceland Saithe		$\mathbf{B}_{loss}$	30-year-sustained F	low SSBs observed in 1978–1993	
3.3. Iceland Cod			simulation		
3.4. Iceland Haddock			$\mathbf{F}_{med}$ (provisional)		
5.1. Greenland Cod—Offshore					recommended no fishing
5.2. Greenland Cod—Inshore					none
6. Greenland halibut			2/3 $\mathbf{F}_{MSY}$		
8. S. marinus	U_{lim} is U_{max}/5		U_{pa} is 3 U_{lim}		
9. Deep-sea *S. mentella* on the shelf	U_{lim} is U_{max}/5		2/3 $\mathbf{F}_{MSY}$	U_{pa} is 2.5 U_{lim}	
10. Pelagic *S. mentella*					

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

2.1 General Trends in Demersal Fisheries in the Faroe Area

The fishery at the Faroes is a multi-fleet and multi-species fishery. Tables 2.1.1 - 2.1.3 show the yields of cod, haddock and saithe for Faroese fleet categories in Vb, and Figure 2.1 gives a summary of the 2000 assessments of the stocks of Faroe Plateau cod, Faroe haddock and Faroe saithe.

In 1977 an EEZ was introduced in the Faroe area. The demersal fishery by foreign nations have since decreased. The fishing mortalities on cod remained high in the first years, increased considerably during the 1980s and decreased substantially in the first half of the 1990s. In 1995 and especially in 1996-97 the fishing mortalities increased again substantially, and although they since have declined they still are higher than the proposed $\mathbf{F}_{pa}$. For saithe there has been a substantial increase in the fishing mortalities during most of the period but from 1991 it decreased generally steady to 1997-98 where they are estimated to be close to the proposed $\mathbf{F}_{pa}$. A substantial increase in fishing mortality was noted for 1999 and 2000, however. The fishing mortalities on haddock were very low from the late 1970s – middle of the 1990s, but have increased substantially to well above the proposed $\mathbf{F}_{pa}$. Landings decreased to a very low level due to poor recruitment but has in 1995 –1998 increased again because two very strong year classes entered the fishery and were in 2000 about average.

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

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

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

2.1.1 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 by-catch 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 by-catch 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 days 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 2.2 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-in in 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 2.1.4 and 2.1.5.

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.

2.1.2 Evaluation of the management system

In 1996, the Working Group estimated that the new management system proposed by the Faroese government could reduce the fishing mortality on cod in 1996 by a maximum of about 23 % if all the factors relating nominal fishing effort to fishing mortality were the same in 1996 as in 1995 except for the number of days fished. The Working Group expected that it was highly unlikely, however, that all factors would remain the same, and it speculated that the decrease in fishing mortality on cod would probably be less than 23 %, or that perhaps fishing mortality would not decrease at all. The current assessment suggests that the fishing mortality on cod doubled from $F = 0.32$ in 1995 to $F = 0.68$ in 1996, as did the catch.

There are many possible reasons to explain the discrepancy between the expected result of limiting the number of fishing days, and the estimated one. The fishing mortality is generally considered as being the product of the nominal fishing effort exerted multiplied by a factor, the catchability coefficient. Fishing day is an imprecise measure of the actual nominal fishing effort applied, and it leaves considerable scope for changes, for example in the number of hours fished, or the amount of gear utilized. The success of fishing is also related to atmospheric and hydrological conditions and to season. Therefore, by having the possibility to choose when to fish, one might predominantly fish during those days when the success is expected to be the greatest, and thus increase the efficiency of the fishing effort used. Thirdly, it is expected that the availability of fish varies from year to year, and therefore, a given amount of fishing effort will capture more fish when the availability is higher than normal. Evidence from the surveys suggests that cod may have been more available from 1995 to 1997, and this may have affected the commercial fishery as well, especially for longliners.

The current practise in allocating extra cod and haddock quotas to one of the fleets not included in the day regulations (see section 2.2) is not compatible with the intentions in the management law, unless the number of fishing days allocated to other fleets are reduced correspondingly.

The Faroese government commissioned a 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). The review states that no errors were found in calculations and lists minor concerns about the use of arithmetic means instead of geometric means in the calculations for the original allocation. “A potentially more serious effect is that the analysis assumes that catchabilities are in some sense typical over the adjustment period. It seems likely, that changes in regulations, technical efficiency and fishing practices might change catchability systematically over the averaging period. Hence, average historic levels of catchability might prove relatively poor predictors of future fleet performance (page 4, paragraph 4)”. The concerns of the review have been investigated in Section 2.2.8 and appear well founded.

That catchability would increase as a result of the implementation of the effort management system should not come as a surprise. The NWWG has noted this possibility from its first evaluation of the system. It is well known on the Faroes that those involved in the days at sea system are trying to use as few days as possible, and to make the most use of the days that are used by fishing more hours per day. For longliners, the introduction of automatic baiting machines, in order to reduce costs, would also be expected to increase efficiency. This means that it is not possible to use the catchabilities for 1985 to 1995 as a base period to estimate the probability profiles of the number of days allocated to the various fleets. In addition, the fleet definitions have changed as mentioned above. As indicated above, the number of days recorded in 1996-97 is believed to overestimate the real number of days because the number of days fished in trips landed at multiple landing sites were recorded at each landing site. Although the problem with the recording of the number of days from multiple landings trips is believed to have been resolved from 1998 onwards, there is no basis to make a quantitative estimate of catchabilities by fleet categories, and of the fishing mortality that will be generated in 2000/2001 from the number of days allocated.

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

Pope (2000) further states "Thus we cannot trust to catchability always being what it is now. We need to consider how it could change. The previous averaging over a number of years at least have the virtue that they include some variations that could repeat in the future. It would however be better to try to predict changes. Changes in vessel directivity to species might be more predictable than environment change, which might perhaps only be hindcast (page 6, last paragraph)." The NWWG could not implement this recommendation this year, given the problems with the 1996-97 data, and the change in the fleet categories.

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 text table in Section 2.2. 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.

2.1.3 Special request

For cod, haddock and saithe in Division Vb, where an effort control management system is in effect, estimate the probability profile of fishing mortalities which would be generated under the current effort control scheme and provide effort options which have a high probability (> 80%) that the realised fishing mortalities in 2002 would correspond to the fishing mortality identified as being within safe biological limits;

In recent reports, the fishing mortality on cod, haddock and saithe that could be generated in the upcoming fishing year, given the number of fishing days allocated to each fishing fleet, was estimated using partial fishing mortalities by age (3 to 7) and year for 1985 to 1995 to calculate catchability coefficients. Probability profiles for various combinations of effort allocations were then constructed from the effort allocated and the estimated catchabilities. Based on the 1999 assessment and the observed effort allocation, there was a high probability for all 3 stocks that fishing mortality was in excess of the proposed $\mathbf{F}_{pa}$'s. The number of fishing days reported for 1996 to 1997 are not believed to be reliable because the number of days fished in trips landed at multiple landing sites were recorded at each landing site. This problem is believed to have been resolved from 1998 onwards. With the implementation of the fishing days system, it is expected that the mortality exerted by a single fishing day for the various fleet category will have changed, and therefore the basis for the calculation of the expected fishing mortality is probably no longer valid. Another problem is that the fleet definitions have changed since the introduction of the day system and this makes comparisons back in time difficult.

However, as stated elsewhere in the report, the recent history and the present assessment indicate that fishing mortality on all three stocks is expected to be above the proposed $\mathbf{F}_{pa}$, unless the number of days are reduced substantially.

Moreover medium-term projections indicate that with present fishing mortalities there is a high probability that SSB for all three stocks will be below $\mathbf{B}_{pa}$, for haddock even below $\mathbf{B}_{lim}$.

Table 2.1.1 **Catches of COD in Vb by various faroese fleet categories. Tonnes gutted weight.**

Year	Open boats	Longliners < 100 GRT	Longliners > 100 GRT	Singletrawl < 400 HP	Singletrawl 400-1000HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000HP	Gill net	Jiggers	Others	Total
1985	5650	9659	3133	2506	3051	4352	5393	2223	291	1522	256	38037
1986	2946	4707	1700	1643	2049	2840	10132	4793	443	919	532	32704
1987	2151	3231	2586	1393	1546	1791	6361	3273	283	638	142	23407
1988	591	3049	3201	1114	1660	1501	6065	3455	568	1647	172	23022
1989	964	5986	3840	1102	1314	1157	2278	1729	692	1913	160	21135
1990	511	4225	2440	507	517	568	863	1259	201	988	106	12184
1991	342	2474	1394	439	413	371	663	1038	160	624	53	7969
1992	142	1359	708	325	161	192	634	1119	1	376	279	5295
1993	113	809	701	699	323	178	717	1141	0	452	63	5194
1994	244	1090	1259	914	332	448	651	1950	58	1507	57	8508
1995	732	3108	3328	1135	713	865	1164	2203	55	4348	9	17662
1996	1345	6849	7340	1562	1317	666	3313	7253	95	7388	97	37225
1997	956	8569	9571	1326	1659	983	1966	4585	191	3287	43	33135
1998	483	6549	6894	1257	1397	1419	1004	2694	316	1517	39	23561
1999	478	4271	4384	932	921	2075	1101	2508	412	1111	84	18277
2000	455	3855	3231	1790	1885	2592	1307	3273	177	2075	40	20680

Table 2.1.2 **Catches of HADDOCK in Vb by various faroese fleet categories. Tonnes gutted weight.**

Year	Open boats	Longliners < 100 GRT	Longliners > 100 GRT	Singletrawl < 400 HP	Singletrawl 400-1000HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000HP	Gill net	Jiggers	Others	Total
1985	903	5294	1816	196	780	1055	2546	832	18	86	43	13570
1986	951	5038	1535	250	354	664	2654	1313	4	62	143	12967
1987	1520	5414	1796	313	639	274	2340	1251	3	47	233	13829
1988	201	5219	2076	167	436	253	1205	914	2	50	174	10697
1989	476	7399	2257	122	425	213	862	749	2	173	185	12866
1990	278	6109	1815	63	308	192	534	800	1	132	86	10316
1991	213	4206	1321	86	125	126	495	799	0	41	57	7469
1992	76	1893	917	57	38	44	439	576	0	13	49	4103
1993	27	783	821	217	145	37	424	713	0	6	102	3275
1994	34	631	952	247	136	121	363	1046	0	4	96	3629
1995	46	1010	1630	296	207	91	370	695	0	15	11	4371
1996	124	2351	3068	487	572	163	562	1141	0	60	8	8535
1997	231	4860	6059	447	966	405	973	1850	0	72	27	15890
1998	298	5997	7871	383	1115	585	1022	2333	0	53	8	19670
1999	250	3759	6497	282	802	1162	967	2301	0	25	12	16057
2000	158	3301	4946	534	654	705	934	2607	1	34	7	13881

Table 2.1.3 **Catches of SAITHE in Vb by various faroese fleet categories. Tonnes gutted weight.**

Year	Open boats	Longliners < 100 GRT	Longliners > 100 GRT	Singletrawl < 400 HP	Singletrawl 400-1000HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000HP	Gill net	Jiggers	Others	Total
1985	89	38	28	23	2515	12923	10822	10805	13	982	139	38377
1986	107	67	21	31	1004	9872	9921	13173	54	1296	584	36130
1987	244	52	37	116	1468	7279	8134	15790	157	1985	409	35671
1988	173	101	31	40	2693	8224	7748	17266	113	2575	522	39486
1989	356	52	60	129	2148	7118	9440	16513	90	3717	509	40132
1990	309	131	101	84	2123	10742	13127	23442	122	4038	503	54722
1991	287	55	64	40	625	6791	12978	22584	281	4795	411	48911
1992	124	121	37	8	151	2248	7677	17486	0	3300	321	31473
1993	168	56	29	39	164	1879	6234	17639	0	2696	206	29110
1994	131	112	63	37	335	1995	5408	17243	2	3666	202	29194
1995	49	15	75	91	215	2406	4288	14776	5	2320	6	24246
1996	5	6	37	24	213	1178	4118	10173	5	1590	4	17353
1997	9	14	72	27	495	2098	3491	11529	3	1746	77	19561
1998	21	97	56	12	620	4531	3608	12610	0	1764	93	23412
1999	14	32	69	35	362	3715	5425	17752	2	1685	484	29575
2000	34	34	34	34	101	5061	5904	21019	0	1248	236	33705

Table 2.1.4 Number of fishing days used by various fleet groups in Vb1 1985-95 and 1998-00. 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	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
Average(98-00)	23277	2454	6837

Table 2.1.5 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	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	31
Group 3	Longliners > 110 GRT	3040	2660	2527	2527	2527	19
Group 4	Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	9320	9328	8861	8861	8861	106
Group 5	Longliners and jiggers < 15 GRT	22000	23625	22444	22444	22444	696

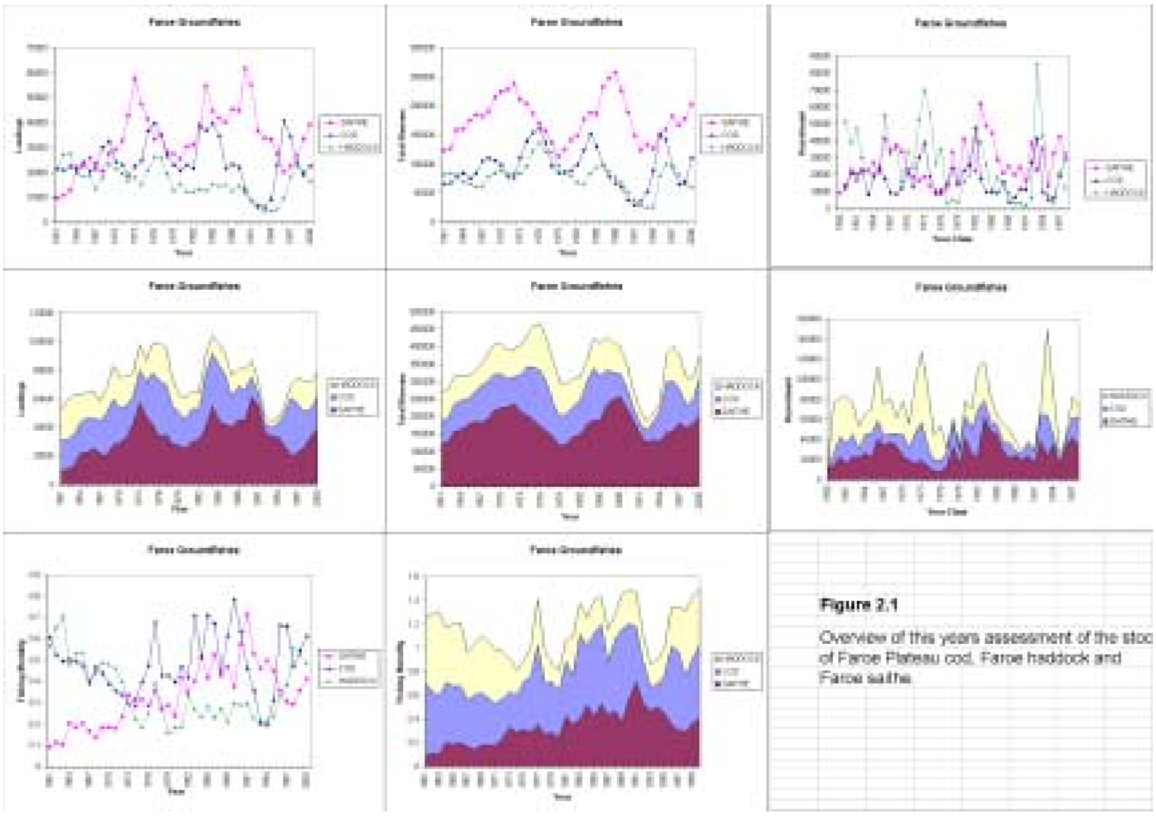
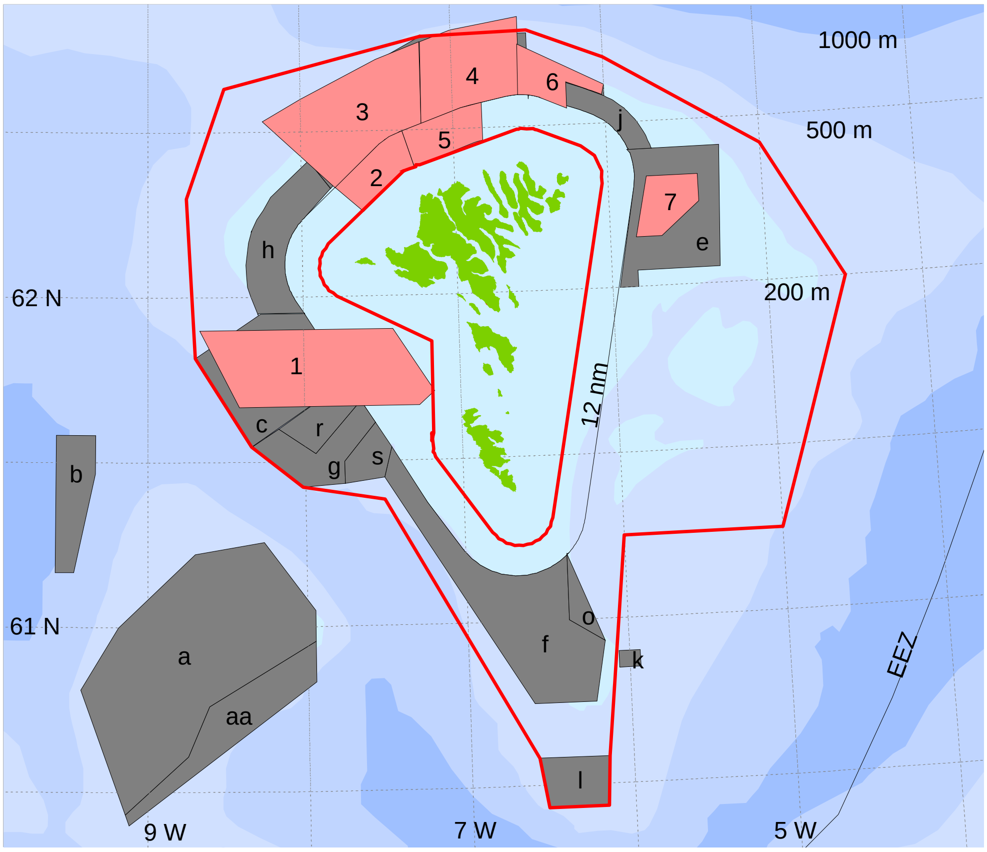


Figure 2.1

Overview of this years assessment of the stoc of Faroe Plateau cod, Faroe haddock and Faroe saithe.



Closed areas to trawlings

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

Spawning area closures

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 2.2 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 Trends in landings

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

In recent years, statistics for the Faroese fishery in that part of Sub-division 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 was 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 current assessment moved to the Faroe Plateau (Vb1), by advice from the Faroese Coastal Guard (Table 2.2.1.2).

During the last 15 years, the Faroe Plateau cod has almost entirely been exploited by the Faroese fishing fleets. Table 2.2.1.3 and Figure 2.2.1.1 show the landings for the most important fleet categories. In recent years, the longliners and the pair trawlers have usually taken most of the catches. Since autumn 1999, however, single trawlers > 400 HP have increased their share of the total catches considerably as a result of a special quota (in tonnes, not fishing days) allocated to them in shallow water (< 200 m) on a half year basis (September 1 and March 1).

2.2.2 Catch-at-age

Landings-at-age were updated to account for a change in the nominal landings for 1991-1999. Landings-at-age for 2000 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 2000 are shown in Table 2.2.2.2.

Samples from commercial fleets in 2000.

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

2.2.3 Mean weight-at-age

Mean weight-at-age data for 1961-2000 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 2000 showed a discrepancy of 4 %.

Figure 2.2.3.1 shows the mean weight-at-age for 1961 to 2000. From 1991 to 1995 weights at age appeared to have increased, they remained stable in 1996 and decreased during 1997-1998. Since 1998 they have increased again except for age 7.

2.2.4 Maturity-at-age

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) are given in Table 2.2.4.1 (1961 - 2000) and shown in Figure 2.2.4.1 (1983 - 2001). The average maturity at age for 1983 to 1996 were used in years prior to 1983.

Full maturity is generally reached at age 5 or 6, but considerable changes have been observed in the proportion mature for younger ages between years. The high proportion of mature 2-year-old cod some years (e.g. 1983 and 1994) were caused by either very small sample sizes or presumably incorrect classification as maturity status 2 (mature). The values were thus either recalculated (taking mature fish of maturity status 3 and higher) or replaced by an average for existing values 1983-2001 (Figure 2.2.4.2). The other observed values were used in the assessment as in previous years and the values prior to 1983 were not changed. These corrections reduced the spawning stock biomass in 1983, 1984 and 1994 (Figure 2.2.4.3).

2.2.5 Groundfish surveys

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

The overall mean catch (kg) of cod per unit effort (trawl hour) 1983-2001 is given in Figure 2.2.5.1. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased in 1999 and 2000, but increased again in 2001. Normally the stratified mean catch per trawl hour increases for the first 4-5 years of life of a year class, and decreases afterwards. From 1994 to 1995, however, there was an increase for all year classes, possibly because of increased availability. A more normal pattern was observed from 1996-2000. Due to serious uncertainties as to the integrity of the data in the database, only total kg/hour and information from aged fish were available in the current assessment. The database is being re-constructed and it is expected that the NWWG will be able to use the survey results in NWWG 2002.

2.2.6 Stock assessment

2.2.7 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 newly developed tuning series based on logbook data for five longliners > 100 GRT and eight pair trawlers > 1000 HP. In the new series, effort is measured in 1000 hooks for the longliners and trawl hours for the pair trawlers. Both tuning series are shown in Table 2.2.6.1.1 (age disaggregated) and Figure 2.2.6.1.1 (kg/1000 hooks and kg/hour). The two series show very similar trends for most of the years. Since last year's assessment, the database went through a thorough investigation and the results for the current assessment deviated somewhat from the previous values (Figure 2.2.6.1.2). Effort standardized catch curves are shown in Figure 2.2.6.1.3 (Cuba trawlers) and Figure 2.2.6.1.4 (longliners).

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

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

The residuals of log catchabilities are shown in Figure 2.2.6.1.5. For the longliners there are clear trends in the catchabilities with time. In the Cuba series the residuals are more random.

The results from the retrospective analysis of the XSA (Figure 2.2.6.1.6) show that the fishing mortality is being underestimated the last years.

The estimated fishing mortalities are shown in Tables 2.2.6.1.3 and 2.2.6.1.5 and Figures 2.2.6.1.7 and 2.2.6.1.8. The average F for age groups 3 to 7 in 2000 is estimated at 0.61 (F3-6 = 0.52), considerably higher than $\mathbf{F}_{max}$ = 0.32. Figure 2.2.6.1.7 shows, that the fishing mortality was underestimated in last years assessment.

2.2.7.1 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 2.2.6.1.8. A comparison between the survey CPUE and biomass of ages 3+ (Figure 2.2.6.2.1) suggests that the survey is a reasonable index of 3+ biomass. The stock-recruitment relationship is presented in Figure 2.2.6.2.2.

The assessment is consistent with last year's assessment (Figure 2.2.6.1.7). It confirms the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 20 200 t. It increased sharply to almost 90 000 t in 1996 and 1997 before declining to a level of about 45 000 t in 1999 and 2000. The 1997 year class seems to be slightly above average strength and the 1998 year class considerably higher.

2.2.8 Predictions of catch and biomass

2.2.8.1 Short-term prediction

The input data for the short-term prediction are given in Table 2.2.7.1.1. The year classes 1999-2001 were set at the geometric mean of the recruitment for 1961-2000. The 2000 year class and the rest of the numbers were taken from the VPA stock numbers. The exploitation pattern was the average fishing mortality for 1998-2000 rescaled to 2000 values. The rescaling was based on the ages 3-7. The weight at age for 2001-2003 was set to the average of the 1998-2000 values. The proportion mature in 2001 was set to the 2001 values from the groundfish survey, and for 2002-2003 to the average values for 1999-2001.

Table 2.2.7.1.2 shows that the landings in 2001 are expected to be 26 200 tonnes if the fishing mortality stays the same as in 2000. The spawning stock biomass is expected to remain relatively stable in 2001 and 2002 (about 60 000 t) and to decrease slightly afterwards (55 000 t in 2003). The VPA suggest that the 1998 year class is very strong, which also is supported by the age distribution (Figure 2.2.7.1.1) and the increase in survey CPUE (kg/hour) in 2001 (Figure 2.2.6.2.1). There is, however, the possibility, that longliners could have concentrated the effort on this strong year class, giving too optimistic prediction.

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$^{.645\,\sigma}$, assuming a σ of about 0.40 to account for the relatively large uncertainties in the assessment. ACFM further proposed that $\mathbf{F}_{pa}$ be set at 0.35, more than twice $\mathbf{F}_{0.1}$, about equal to $\mathbf{F}_{max}$ and $\mathbf{F}_{med}$ and at the low end of the range of previously estimated $\mathbf{F}_{MSY}$, from 0.33 (Stefansson and Bell, WD prepared for the SGPAFM) to 0.56 (NWWG, 1997). In previous years, MBAL was considered to be 52 000 t. Over the period covered by the assessment, fishing mortality has been equal to or less than this proposed $\mathbf{F}_{pa}$ in only 6 of 40 years of available data. This suggests that $\mathbf{F}_{pa}$ = 0.35 may be overly conservative. The updated assessment indicates an $\mathbf{F}_{med}$ = 0.42 and the medium-term predictions reported below suggest that a 25% decrease in $\mathbf{F}_{sq}$ results in approximate 5% probability or less that the SSB will be less than $\mathbf{B}_{pa}$. $\mathbf{F}_{pa}$ could therefore be set in the order of $\mathbf{F}_{med}$ = 0.42.

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

It is planned that the spring survey index and a summer survey index will be incorporated in the 2002 assessment and the WG suggests that the reference points not be changed until they are re-examined during the 2002 assessment.

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 predictions were done for Faroe Plateau cod using the results of the accepted XSA calibration and other required parameters (exploitation pattern, M, maturity at age, weights in the stock, weights in the catch, and proportion fishing mortality and natural mortality) identical to those used for the short-term predictions. Three recruitment options and two fishing mortality options were considered:

- recruitment drawn randomly from past observations for the 1959 to 1998 yearclasses;
- recruitment drawn randomly from past observation for the 1978 to 1998 yearclasses when recruitment was somewhat lower than in the previous period;
- Ricker stock and recruitment fitted to the 1961 to 1998 yearclasses, modified by a random number in the range of 50% to 200%;
- *status quo* fishing mortality;
- constant F at 75% *status quo* F.

Two hundred and fifty runs were made for each combination of recruitment and fishing mortality.

The median catches and SSB, as well as the probability that the SSB would be less than average have been tallied and graphed in Figures 2.2.7.3.1-4.

All combinations of fishing mortality and recruitment yield very similar median catches close to 25 000 t. The median SSBs are grouped according to fishing mortality. $\mathbf{F}_{sq}$ leads to median SSBs slightly lower than 50 000 t while at 0.75 $\mathbf{F}_{sq}$ median SSBs stabilize at about 65 000 t. The probabilities that SSB will be less than $\mathbf{B}_{pa}$ are similarly grouped by fishing mortality with $\mathbf{F}_{sq}$ generally resulting in a 20-30% probability that SSB will be smaller than $\mathbf{B}_{pa}$. At $\mathbf{F}_{sq}$, there are small but non-zero probabilities that SSB will be less than $\mathbf{B}_{lim}$. These suggest that fishing mortality should be reduced by 25% in order to decrease the risk that SSB will fall below $\mathbf{B}_{pa}$.

These medium-term predictions do not take account of changes in weights at age, maturity at age, or natural mortality that would result from changes in the size of the cod stocks, its preys or its predator. As such, they cannot be considered a forecast of future events. Their main use is in comparing the relative results of management actions taken today.

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 (rescaled to 2000 values) and weight at age were set to the average values for 1961-2000. The proportion mature was set to the average for 1983-2001.

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 0.15 and $\mathbf{F}_{max}$ as 0.32. The present average fishing mortality in 2000 of 0.61 is substantially above $\mathbf{F}_{max}$ and $\mathbf{F}_{med}$ = 0.42 (Figure 2.2.7.2.1).

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 0.31 in 1995 to 0.66 in 1996. The WG report for 2000 describes the scope for changes in catchability and how they could account for such increases in fishing mortality and it also reports on an external review of the scientific basis for the initial allocation of fishing days and of the method to calculate probability profiles for expected fishing mortalities given the possible utilisation of the allocated fishing days (Pope 2000).

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

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

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

Gear	Allocation	Optional change
LL<100	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.
PT400–1000	1270	
PT>1000	2149	
LL>100	1264	
OPEN	11222	
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 the current report suggest that fishing mortality should be decreased by 25%.

2.2.9.1 Comment on the assessment

New or changed things compared to last years report: Maturities for age 2 were revised. Age 3, and ages 7-8 were removed from the longliners and Cuba trawlers, respectively. The RCT3 program was not used to estimate recruitment, which was estimated as the geometric mean over the time period 1961-2000. The 1998 year class strength was estimated from the VPA (not RCT3) based on strong representation of the 1998 year class in the 2001 survey.

The average fishing mortality for ages 3-7 is 0.61 (Table 2.2.6.1.5) and for ages 3-6 0.52. The difference is caused by a high mortality of 7 year olds (0.98). The F3-6 column in Table 2.2.6.1.5 should not be taken as an alternative interpretation of the fishing mortality instead of the F3-7, but only as a way of clarifying the results.

The short-term prediction (Table 2.2.7.1.2) is very dependent on poorly estimated or assumed year classes. Calculations showed, that about 70% of the predicted biomass in 2003 would come from the 1998-2000 year classes, which are either poorly estimated (1998 year class) or assumed to be of average strength (1999 and 2000 year classes). This is a general problem with predictions where no, or very limited information of year class strength is available.

The results of the *Magnus Heinason* survey have not been used in recent assessments of Faroe Plateau cod because of serious uncertainties as to the integrity of the data. The database is being re-constructed and it is expected that the NWWG will be able to use the survey results in NWWG 2002.

2.2.9.2 References

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.

Table 2.2.1.1. Faroe Plateau (Sub-division VB1) COD. Nominal landings (tonnes) by countries, 1986-2000, 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 [1)]	4	17	17	-	-	- [2]	3 [3]	1 [3]	-	2 [3]	1 [3]	-	- [*]
Germany	8	12	5	7	24	16	12	+	2 [3]	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 [3]	27 [3]
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 [*]
Denmark	-	
Faroe Islands	19,156	21,793
France [1)]		3 [3]
Germany	39	2 [2]
Norway	557	429
Greenland		5 [3]
UK (Engl. and Wales)	51 [3]	
UK (Scotland)	-	
United Kingdom		264 [2]
Total	19,803	22,496

[*] Preliminary

[1)] Included in Vb2.

[2] Quantity unknown 1991.

[3] Reported as Vb.

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

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	19,803	22,496
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	210	-
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	20,013	22,496

*) Preliminary

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

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

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

Age\Fleet	Open boats	LL < 100 G	Jiggers	ST 0-399H	ST 400-10(	ST > 1000	PT < 1000	PT > 1000	LL > 100 G	Others	Total Far.	Foreign fle	Total
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	53	256	29	0	3	0	0	0	53	0	401	13	414
2	95	656	240	70	166	173	127	192	366	20	2166	70	2236
3	62	649	241	238	335	286	116	245	461	22	2732	88	2820
4	14	114	53	95	103	124	51	134	89	11	810	26	836
5	6	76	38	55	55	56	30	67	42	5	441	15	456
6	13	124	81	114	65	77	31	86	82	6	698	23	721
7	21	163	133	100	46	84	34	93	133	7	838	27	865
8	1	21	18	5	3	10	5	13	25	1	108	3	111
9	0	1	2	0	0	0	0	0	4	0	8	0	8
10	0	0	0	0	0	0	0	0	0	0	1	0	1
11	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0
13	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
15	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Numl	265	2060	835	677	776	810	394	830	1255	72	8203	265	8468
Catch, t	438	3676	2002	1734	1831	2423	1081	2642	2995	220	19633	634	20267

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

Table 2.2.2.2. Faroe Plateau COD. Catch in numbers at age 1961-2000.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND7

At 28/04/2001 11:10

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	3093,	4424,	4110,	2033,	852,	1337,	1609,	1529,	878,	402,
3,	2686,	2500,	3958,	3021,	3230,	970,	2690,	3322,	3106,	1163,
4,	1331,	1255,	1280,	2300,	2564,	2080,	860,	2663,	3300,	2172,
5,	1066,	855,	662,	630,	1416,	1339,	1706,	945,	1538,	1685,
6,	232,	481,	284,	350,	363,	606,	847,	1226,	477,	752,
7,	372,	93,	204,	158,	155,	197,	309,	452,	713,	244,
8,	78,	94,	48,	79,	48,	104,	64,	105,	203,	300,
9,	29,	22,	30,	41,	63,	33,	27,	11,	92,	44,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTALNUM,	8887,	9724,	10576,	8612,	8691,	6666,	8112,	10253,	10307,	6762,
TONSLAND,	21598,	20967,	22215,	21078,	24212,	20418,	23562,	29930,	32371,	24183,
SOPCOF %,	91,	94,	96,	98,	113,	109,	102,	106,	109,	99,

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	328,	875,	723,	2161,	2584,	1497,	425,	555,	575,	1129,
3,	757,	1176,	3124,	1266,	5689,	4158,	3282,	1219,	1732,	2263,
4,	821,	810,	1590,	1811,	2157,	3799,	6844,	2643,	1673,	1461,
5,	1287,	596,	707,	934,	2211,	1380,	3718,	3216,	1601,	895,
6,	1451,	1021,	384,	563,	813,	1427,	788,	1041,	1906,	807,
7,	510,	596,	312,	452,	295,	617,	1160,	268,	493,	832,
8,	114,	154,	227,	149,	190,	273,	239,	201,	134,	339,
9,	179,	25,	120,	141,	118,	120,	134,	66,	87,	42,
+gp,	0,	0,	97,	91,	150,	186,	9,	56,	38,	18,
0 TOTALNUM,	5447,	5253,	7284,	7568,	14207,	13457,	16599,	9265,	8239,	7786,
TONSLAND,	23010,	18727,	22228,	24581,	36775,	39799,	34927,	26585,	23112,	20513,
SOPCOF %,	123,	125,	101,	101,	97,	97,	70,	100,	98,	106,

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	646,	1139,	2149,	4396,	998,	210,	257,	509,	2237,	243,
3,	4137,	1965,	5771,	5234,	9484,	3586,	1362,	2122,	2151,	2849,
4,	1981,	3073,	2760,	3487,	3795,	8462,	2611,	1945,	2187,	1481,
5,	947,	1286,	2746,	1461,	1669,	2373,	3083,	1484,	1121,	852,
6,	582,	471,	1204,	912,	770,	907,	812,	2178,	1026,	404,
7,	487,	314,	510,	314,	872,	236,	224,	492,	997,	294,
8,	527,	169,	157,	82,	309,	147,	68,	168,	220,	291,
9,	123,	254,	104,	34,	65,	47,	69,	33,	61,	50,
+gp,	55,	122,	102,	66,	80,	38,	26,	25,	9,	26,
0 TOTALNUM,	9485,	8793,	15503,	15986,	18042,	16006,	8512,	8956,	10009,	6490,
TONSLAND,	22963,	21489,	38133,	36979,	39484,	34595,	21391,	23182,	22068,	13487,
SOPCOF %,	104,	100,	97,	97,	95,	96,	96,	101,	98,	99,

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	192,	205,	120,	573,	2615,	351,	200,	455,	1295,	2236,
3,	451,	455,	802,	788,	2716,	5164,	1278,	745,	1085,	2820,
4,	2152,	466,	603,	1062,	2008,	4608,	6710,	1558,	873,	836,
5,	622,	911,	222,	532,	1012,	1542,	3731,	5140,	1210,	456,
6,	303,	293,	329,	125,	465,	1526,	657,	1529,	2433,	721,
7,	142,	132,	96,	176,	118,	596,	639,	159,	480,	865,
8,	93,	53,	33,	39,	175,	147,	170,	118,	65,	111,
9,	53,	30,	22,	23,	44,	347,	51,	28,	19,	8,
+gp,	24,	34,	25,	16,	49,	47,	120,	25,	8,	1,
0 TOTALNUM,	4032,	2579,	2252,	3334,	9202,	14328,	13556,	9757,	7468,	8054,
TONSLAND,	8750,	6396,	6107,	9046,	23045,	40422,	34304,	24005,	20013,	22496,
SOPCOF %,	106,	102,	102,	101,	101,	99,	101,	103,	101,	104,

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Table 2.2.3.1. Faroe Plateau (sub-divisionVb1) COD. Catch weight at age 1961-2000.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND7

At 28/04/2001 11:10

Table 2 Catch weights at age (kg)

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	1.0800,	1.0000,	1.0400,	.9700,	.9200,	.9800,	.9600,	.8800,	1.0900,	.9600,
3,	2.2200,	2.2700,	1.9400,	1.8300,	1.4500,	1.7700,	1.9300,	1.7200,	1.8000,	2.2300,
4,	3.4500,	3.3500,	3.5100,	3.1500,	2.5700,	2.7500,	3.1300,	3.0700,	2.8500,	2.6900,
5,	4.6900,	4.5800,	4.6000,	4.3300,	3.7800,	3.5100,	4.0400,	4.1200,	3.6700,	3.9400,
6,	5.5200,	4.9300,	5.5000,	6.0800,	5.6900,	4.8000,	4.7800,	4.6500,	4.8900,	5.1400,
7,	7.0900,	9.0800,	6.7800,	7.0000,	7.3100,	6.3200,	6.2500,	5.5000,	5.0500,	6.4600,
8,	9.9100,	6.5900,	8.7100,	6.2500,	7.9300,	7.5100,	7.0000,	7.6700,	7.4100,	10.3100,
9,	8.0300,	6.6600,	11.7200,	6.1900,	8.0900,	10.3400,	11.0100,	10.9500,	8.6600,	7.3900,
+gp,	10.2700,	10.2700,	10.8200,	14.3900,	11.1100,	11.6500,	10.6900,	9.2800,	14.3900,	9.3400,
0 SOPCOFAC,	.9068,	.9444,	.9573,	.9824,	1.1262,	1.0905,	1.0224,	1.0598,	1.0851,	.9943,

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	.8100,	.6600,	1.1100,	1.0800,	.7900,	.9400,	.8700,	1.1120,	.8970,	.9270,
3,	1.8000,	1.6100,	2.0000,	2.2200,	1.7900,	1.7200,	1.7900,	1.3850,	1.6820,	1.4320,
4,	2.9800,	2.5800,	3.4100,	3.4400,	2.9800,	2.8400,	2.5300,	2.1400,	2.2110,	2.2200,
5,	3.5800,	3.2600,	3.8900,	4.8000,	4.2600,	3.7000,	3.6800,	3.1250,	3.0520,	3.1050,
6,	3.9400,	4.2900,	5.1000,	5.1800,	5.4600,	5.2600,	4.6500,	4.3630,	3.6420,	3.5390,
7,	4.8700,	4.9500,	5.1000,	5.8800,	6.2500,	6.4300,	5.3400,	5.9270,	4.7190,	4.3920,
8,	6.4800,	6.4800,	6.1200,	6.1400,	7.5100,	6.3900,	6.2300,	6.3480,	7.2720,	6.1000,
9,	6.3700,	6.9000,	8.6600,	8.6300,	7.3900,	8.5500,	8.3800,	8.7150,	8.3680,	7.6030,
+gp,	10.2200,	11.5500,	7.5700,	7.6200,	8.1700,	13.6200,	10.7200,	12.3000,	13.0420,	9.6680,
0 SOPCOFAC,	1.2264,	1.2481,	1.0134,	1.0134,	.9709,	.9653,	.7012,	.9964,	.9843,	1.0584,

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	1.0800,	1.2300,	1.3380,	1.1950,	.9050,	1.0990,	1.0930,	1.0610,	1.0100,	.9450,
3,	1.4700,	1.4130,	1.9500,	1.8880,	1.6580,	1.4590,	1.5170,	1.7490,	1.5970,	1.3000,
4,	2.1800,	2.1380,	2.4030,	2.9800,	2.6260,	2.0460,	2.1600,	2.3000,	2.2000,	1.9590,
5,	3.2100,	3.1070,	3.1070,	3.6790,	3.4000,	2.9360,	2.7660,	2.9140,	2.9340,	2.5310,
6,	3.7000,	4.0120,	4.1100,	4.4700,	3.7520,	3.7860,	3.9080,	3.1090,	3.4680,	3.2730,
7,	4.2400,	5.4420,	5.0200,	5.4880,	4.2200,	4.6990,	5.4610,	3.9760,	3.7500,	4.6520,
8,	4.4300,	5.5630,	5.6010,	6.4660,	4.7390,	5.8930,	6.3410,	4.8960,	4.6820,	4.7580,
9,	6.6900,	5.2160,	8.0130,	6.6280,	6.5110,	9.7000,	8.5090,	7.0870,	6.1400,	6.7040,
+gp,	10.0000,	6.7070,	8.0310,	10.9810,	10.9810,	8.8150,	9.8110,	8.2870,	9.1560,	8.6890,
0 SOPCOFAC,	1.0408,	1.0030,	.9695,	.9685,	.9491,	.9625,	.9642,	1.0061,	.9774,	.9897,

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	.7790,	.9890,	1.1550,	1.1940,	1.2180,	1.0160,	.9010,	1.0040,	1.0500,	1.4160,
3,	1.2710,	1.3640,	1.7040,	1.8430,	1.9860,	1.7370,	1.3410,	1.4170,	1.5860,	2.1700,
4,	1.5700,	1.7790,	2.4210,	2.6130,	2.6220,	2.7450,	1.9580,	1.8020,	2.3500,	3.1870,
5,	2.5240,	2.3120,	3.1320,	3.6540,	3.9250,	3.8000,	3.0120,	2.2800,	2.7740,	3.7950,
6,	3.1850,	3.4770,	3.7230,	4.5840,	5.1800,	4.4550,	4.1580,	3.4780,	3.2140,	4.0480,
7,	4.0860,	4.5450,	4.9710,	4.9760,	6.0790,	4.9780,	4.4910,	5.4330,	5.4960,	4.5770,
8,	5.6560,	6.2750,	6.1590,	7.1460,	6.2410,	5.2700,	5.3120,	5.8510,	8.2760,	8.1820,
9,	5.9730,	7.6190,	7.6140,	8.5640,	7.7820,	5.5930,	6.1720,	7.9700,	9.1290,	11.8950,
+gp,	8.1470,	9.7250,	9.5870,	8.7960,	8.6270,	7.4820,	7.0560,	7.3630,	10.6520,	13.0090,
0 SOPCOFAC,	1.0600,	1.0202,	1.0225,	1.0141,	1.0108,	.9940,	1.0108,	1.0294,	1.0137,	1.0427,

1

Table 2.2.4.1. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2000. From 1961-1982 the average from 1983-1996 is used.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND7

At 28/04/2001 11:10

Table 5 Proportion mature at age

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
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
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
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
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	.1700	.1700	.0300	.0700	.0000	.0000	.0000	.0600	.0500	.0000
3	.6400	.6400	.7100	.9600	.5000	.3800	.6700	.7200	.5400	.6800
4	.8700	.8700	.9300	.9800	.9600	.9300	.9100	.9000	.9800	.9000
5	.9500	.9500	.9400	.9700	.9600	1.0000	1.0000	.9700	1.0000	.9900
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9600
7	1.0000	1.0000	1.0000	1.0000	1.0000	.9600	1.0000	1.0000	1.0000	.9800
8	1.0000	1.0000	1.0000	1.0000	1.0000	.9400	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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
2	.0000	.0600	.0300	.0500	.0800	.0400	.0700	.0000	.0200	.0200
3	.7200	.5000	.7300	.8900	.5300	.4400	.7500	.7400	.4300	.3900
4	.8600	.8200	.7800	.9800	.5500	.7500	.9500	.9300	.8800	.7000
5	1.0000	.9800	.9100	.9900	.7400	.8700	.9800	.9900	.9800	.9200
6	1.0000	1.0000	.9900	1.0000	.9700	.9400	1.0000	1.0000	1.0000	.9900
7	1.0000	1.0000	1.0000	.9800	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

1

Table 2.2.6.1.1. Faroe Plateau (sub-division Vb1) COD. The two tuning series used in the assessment. For Cuba trawlers the effort is in number of trawling hours and for longliners in 1000 hooks. The catch in number at age for both fleets is in thousands.

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1)        C8L54.DAT
102
CUBA TRAWLERS
1985 2000
1 1 0.0 1.0
2 7
   3429    1.6    41.5    24.5    11       4.4    5.3
   3726    1.2    18.6    69.8    27.1    11.6    3.1
   6401    0.8    13.7    37.3    56.6    20.2    5.4
   6669    0.7    17.4    21.1    19.8    30.2    7.3
   5975    1.7    12.8    26.6    20.8    18.2   17.3
   6679    0.3    22.7    24.3    15       7.7    4.7
   5488    0.1     2.6    16.8    10.3     5.6    3.1
   4997    0.2     3.5     6.7    19.3     7.8    3.5
   6222    0.9    17.2    23.1    10.5    14      5.2
   7798    8.1    26.2    35.4    43.5    12.4   15.3
   9391   17.7    48.4    80.3    59.7    29.9    6.7
  10759    7.9   255.4   250.2    86.1    53.5   12.8
  14818    1.2    34.6   300.2   251.5    45.1   22.9
  12121    0.5    19.3    46.5   105      65.4    9.9
  13298    6.9    41.8    46.1    49      87.1   29.8
  11599   49.9    63.7    34.8    17.4    22.4   24.2
LONGLINERS
1986 2000
1 1 0.0 1.0
3 6
   9354   19.1    60.2    25.7    13.4
  18203    5.5    28.8    50.7    25.6
  15094   37.7    36.1    34.2    45.2
  21198   89.7    85.1    47.8    56.3
  24254  157.2    81.8    60.8    40.2
  18284   16.4   100.6    34.1    18.1
  19217   25.2    25.2    47.8    17.7
  24126   66.5    64.8    22.2    40.1
  18849   71.6    35.8    22.5     7
  25732  115.5    66.5    45.7    27.1
  27790  294.5   287.5   115.2   158.3
  47058  119.3   824.3   525.7   117.8
  49540  105     176.4   660.2   220.9
  42539   80.3    59.7    66.8   143.6
  44753  193      37.3    17.6    34.3
```

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

```
Lowestoft VPA Version 3.1

   28/04/2001  11:07

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_IND7

 CPUE data from file C8L54.dat

 Catch data for  40 years. 1961 to 2000. Ages  2 to  10.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 CUBA TRAWLERS       ,   1985, 2000,   2,     7,   .000,  1.000
 LONGLINERS          ,   1986, 2000,   3,     6,   .000,  1.000


 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years


 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  100 iterations


 Total absolute residual between iterations
 99 and 100 =     .00057

 Final year F values
 Age          ,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 99,  .0876,  .2371,  .3747,  .4807,  .9887,  .9815,  .1743,  .0400
 Iteration **,  .0876,  .2371,  .3747,  .4805,  .9884,  .9815,  .1742,  .0400

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

Table 2.2.6.1.2 (Continued)

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2,	.032,	.020,	.012,	.024,	.072,	.040,	.045,	.082,	.076,	.088
3,	.202,	.100,	.101,	.104,	.149,	.200,	.199,	.232,	.287,	.237
4,	.490,	.331,	.187,	.189,	.420,	.404,	.432,	.398,	.469,	.375
5,	.493,	.396,	.259,	.250,	.277,	.671,	.678,	.703,	.622,	.481
6,	.537,	.457,	.241,	.227,	.361,	.885,	.689,	.664,	.892,	.988
7,	.570,	.476,	.264,	.196,	.349,	1.142,	1.300,	.347,	.449,	.981
8,	.759,	.432,	.206,	.162,	.305,	1.007,	1.359,	.922,	.232,	.174
9,	.601,	.594,	.320,	.216,	.279,	1.999,	1.334,	.872,	.353,	.040

1

XSA population numbers (Thousands)

YEAR	AGE 2,	3,	4,	5,	6,	7,	8,	9,
1991 ,	6.67E+03,	2.73E+03,	6.14E+03,	1.76E+03,	8.06E+02,	3.61E+02,	1.93E+02,	1.30E+02,
1992 ,	1.15E+04,	5.28E+03,	1.83E+03,	3.08E+03,	8.82E+02,	3.85E+02,	1.67E+02,	7.40E+01,
1993 ,	1.09E+04,	9.22E+03,	3.91E+03,	1.07E+03,	1.70E+03,	4.57E+02,	1.96E+02,	8.89E+01,
1994 ,	2.72E+04,	8.78E+03,	6.82E+03,	2.66E+03,	6.79E+02,	1.09E+03,	2.87E+02,	1.31E+02,
1995 ,	4.14E+04,	2.17E+04,	6.48E+03,	4.63E+03,	1.70E+03,	4.43E+02,	7.35E+02,	2.00E+02,
1996 ,	9.94E+03,	3.15E+04,	1.53E+04,	3.49E+03,	2.87E+03,	9.68E+02,	2.56E+02,	4.44E+02,
1997 ,	5.07E+03,	7.82E+03,	2.12E+04,	8.38E+03,	1.46E+03,	9.71E+02,	2.53E+02,	7.65E+01,
1998 ,	6.38E+03,	3.97E+03,	5.25E+03,	1.12E+04,	3.48E+03,	6.00E+02,	2.17E+02,	5.32E+01,
1999 ,	1.95E+04,	4.81E+03,	2.58E+03,	2.89E+03,	4.56E+03,	1.47E+03,	3.47E+02,	7.05E+01,
2000 ,	2.95E+04,	1.48E+04,	2.96E+03,	1.32E+03,	1.27E+03,	1.53E+03,	7.67E+02,	2.25E+02,

Estimated population abundance at 1st Jan 2001

,	0.00E+00,	2.21E+04,	9.54E+03,	1.66E+03,	6.69E+02,	3.87E+02,	4.69E+02,	5.28E+02,

Taper weighted geometric mean of the VPA populations:

,	1.25E+04,	9.00E+03,	5.72E+03,	3.26E+03,	1.70E+03,	7.70E+02,	3.10E+02,	1.17E+02,

Standard error of the weighted Log(VPA populations) :

,	.7295,	.7022,	.7167,	.7054,	.6160,	.5321,	.4997,	.6072,

1

Log catchability residuals.

Fleet : CUBA TRAWLERS

Age ,	1985,	1986,	1987,	1988,	1989,	1990
2 ,	.00,	.40,	-.16,	-.12,	-.12,	.38
3 ,	.10,	.19,	-.17,	.01,	.00,	.02
4 ,	-.25,	.11,	-.15,	-.30,	.15,	.11
5 ,	-.47,	.13,	-.31,	-.54,	.21,	-.08
6 ,	-.45,	.19,	-.08,	-.40,	.19,	-.18
7 ,	-.17,	.20,	-.22,	-.27,	.25,	-.14

Table 2.2.6.1.2 (Continued)

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	-.70	-.85	-.14	-.06	-.17	.77	.33	-.23	-.07	.59
3	-.66	-.98	-.16	.09	-.37	.81	-.12	.19	.71	.12
4	-.57	-.26	-.07	-.42	.37	.50	.05	-.23	.41	.08
5	-.24	-.12	.04	.32	-.09	.60	.48	-.48	-.01	-.18
6	-.27	.02	-.36	.20	.04	.19	.29	-.02	.00	.10
7	-.05	.06	-.03	-.08	-.12	-.05	.27	-.29	-.13	-.01

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
Mean Log q	-14.7130	-13.6122	-13.1824	-12.9582	-12.9582
S.E(Log q)	.4785	.3274	.3408	.2161	.1704

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	.51	2.446	13.57	.71	16	.48	-17.63

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
3	.81	1.114	13.67	.79	16	.39	-14.71
4	.94	.449	13.31	.85	16	.32	-13.61
5	1.02	-.146	13.30	.81	16	.37	-13.18
6	1.03	-.224	13.10	.89	16	.23	-12.96
7	.95	.523	12.70	.92	16	.16	-13.01

1

Fleet : LONGLINERS

Age	1985	1986	1987	1988	1989	1990
2	No data for this fleet at this age					
3	99.99	-.67	-2.09	.00	.72	.70
4	99.99	-.45	-.94	-.07	.56	.55
5	99.99	-.22	-.84	-.19	.40	.66
6	99.99	-.12	-.43	-.35	.52	.65
7	No data for this fleet at this age					

Table 2.2.6.1.2 (Continued)

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	No data for this fleet at this age									
3	.01	-.31	-.13	.24	-.47	.04	.00	.51	.23	-.09
4	.53	.23	.12	-.78	-.31	.20	.42	.21	.02	-.68
5	.37	.06	.06	-.59	-.74	.57	.69	.58	-.24	-.90
6	.16	-.04	-.20	-.79	-.60	.79	.56	.26	-.20	-.36
7	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	3	4	5	6
Mean Log q	-14.7484	-14.1256	-13.8061	-13.4231
S.E(Log q)	.5396	.4764	.5822	.5019

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
3	1.19	-.652	15.84	.54	15	.66	-14.75
4	.95	.253	13.85	.72	15	.47	-14.13
5	.82	.864	12.78	.71	15	.48	-13.81
6	.88	.525	12.72	.67	15	.46	-13.42

1

Terminal year survivor and F summaries :

Age 2 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 TRAWLERS	39976.	.559	.000	.00	1	.563	.049
LONGLINERS	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	9002.	.70				.389	.203
F shrinkage mean	31012.	2.00				.048	.063

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
22102.	.43	.66	3	1.541	.088

Table 2.2.6.1.2 (Continued)

Age 3 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 TRAWLERS	,	9840.,	.355,	.092,	.26,	2,	.688,	.231
LONGLINERS	,	8740.,	.562,	.000,	.00,	1,	.284,	.256
F shrinkage mean	,	10677.,	2.00,,,,				.028,	.214

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
9537.,	.30,	.05,	4,	.185,	.237

1

Age 4 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 TRAWLERS	,	1955.,	.251,	.217,	.86,	3,	.676,	.327
LONGLINERS	,	1178.,	.376,	.441,	1.17,	2,	.307,	.496
F shrinkage mean	,	1419.,	2.00,,,,				.017,	.427

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1664.,	.21,	.19,	6,	.907,	.375

Age 5 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 TRAWLERS	,	739.,	.212,	.157,	.74,	4,	.703,	.443
LONGLINERS	,	529.,	.331,	.405,	1.23,	3,	.280,	.576
F shrinkage mean	,	507.,	2.00,,,,				.017,	.595

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
669.,	.18,	.15,	8,	.868,	.481

1

Table 2.2.6.1.2 (Continued)

Age 6 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
CUBA TRAWLERS	,	407.,	.188,	.103,	.55,	5,	.717,	.957
LONGLINERS	,	322.,	.305,	.128,	.42,	4,	.260,	1.106
F shrinkage mean	,	638.,	2.00,,,,				.023,	.705

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
387.,	.16,	.08,	10,	.499,	.988

Age 7 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
CUBA TRAWLERS	,	456.,	.192,	.082,	.43,	6,	.843,	1.000
LONGLINERS	,	513.,	.313,	.189,	.60,	4,	.128,	.927
F shrinkage mean	,	736.,	2.00,,,,				.029,	.724

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
469.,	.18,	.07,	11,	.399,	.981

1
Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1992

Fleet,		Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,		Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
CUBA TRAWLERS	,	527.,	.181,	.102,	.56,	6,	.836,	.175
LONGLINERS	,	670.,	.311,	.183,	.59,	4,	.145,	.140
F shrinkage mean	,	86.,	2.00,,,,				.018,	.773

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
528.,	.16,	.11,	11,	.695,	.174

Table 2.2.6.1.2 (Continued)

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

Year class = 1991

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
CUBA TRAWLERS ,	178.,	.182,	.148,	.81,	6,	.838,	.040
LONGLINERS ,	255.,	.313,	.194,	.62,	4,	.143,	.028
F shrinkage mean ,	9.,	2.00,,,,				.018,	.605

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
177.,	.16,	.17,	11,	1.055,	.040

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

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND7

At 28/04/2001 11:10

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	.3346,	.2701,	.2534,	.1086,	.1209,	.0829,	.0789,	.1010,	.1099,	.0530,
3,	.5141,	.4982,	.4138,	.2997,	.2518,	.1969,	.2389,	.2318,	.3063,	.2081,
4,	.4986,	.4838,	.5172,	.4523,	.4498,	.2552,	.2687,	.3949,	.3806,	.3654,
5,	.5737,	.7076,	.5124,	.5229,	.5622,	.4499,	.3442,	.5339,	.4180,	.3409,
6,	.4863,	.5569,	.5405,	.5659,	.6604,	.5016,	.5779,	.4472,	.5709,	.3709,
7,	.9566,	.3662,	.4879,	.6677,	.5305,	.9680,	.5203,	.7132,	.5118,	.6559,
8,	.8116,	.6826,	.3269,	.3531,	.4345,	.8520,	1.0438,	.3331,	.8457,	.4208,
9,	.6715,	.5641,	.4806,	.5164,	.5318,	.6106,	.5556,	.4882,	.5499,	.4339,
+gp,	.6715,	.5641,	.4806,	.5164,	.5318,	.6106,	.5556,	.4882,	.5499,	.4339,
0 FBAR 3- 7,	.6059,	.5226,	.4944,	.5017,	.4909,	.4743,	.3900,	.4642,	.4375,	.3882,
FBAR 3- 6,	.5182,	.5616,	.4960,	.4602,	.4811,	.3509,	.3574,	.4020,	.4189,	.3213,

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	.0309,	.0464,	.0657,	.0816,	.0775,	.0933,	.0481,	.0588,	.0433,	.0545,
3,	.1337,	.1476,	.2322,	.1568,	.3193,	.1723,	.3036,	.1897,	.2623,	.2392,
4,	.2225,	.2070,	.3048,	.2046,	.4359,	.3665,	.4749,	.4291,	.4309,	.3697,
5,	.3845,	.2497,	.2813,	.2953,	.4134,	.5568,	.7533,	.4290,	.5050,	.4338,
6,	.5572,	.6058,	.2526,	.3797,	.4544,	.5167,	.7334,	.4851,	.4908,	.5183,
7,	.4651,	.4686,	.3722,	.5330,	.3504,	.7619,	1.1138,	.5969,	.4481,	.4122,
8,	.7528,	.2464,	.3259,	.3052,	.4485,	.6430,	.7777,	.5674,	.6904,	.6439,
9,	.4801,	.3578,	.3091,	.3457,	.4235,	.5738,	.7783,	.5055,	.5171,	.4792,
+gp,	.4801,	.3578,	.3091,	.3457,	.4235,	.5738,	.7783,	.5055,	.5171,	.4792,
0 FBAR 3- 7,	.3526,	.3358,	.2886,	.3139,	.3947,	.4749,	.6758,	.4260,	.4274,	.3946,
FBAR 3- 6,	.3245,	.3025,	.2677,	.2591,	.4058,	.4031,	.5663,	.3832,	.4223,	.3903,

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	.0523,	.0587,	.0994,	.1073,	.0659,	.0247,	.0281,	.0636,	.1740,	.0774,
3,	.2887,	.2225,	.4685,	.3722,	.3543,	.3554,	.2208,	.3383,	.4142,	.3505,
4,	.3410,	.3618,	.5576,	.5818,	.5097,	.6225,	.4773,	.5640,	.7069,	.5649,
5,	.4371,	.3889,	.6459,	.6591,	.6187,	.7087,	.4850,	.5529,	.7622,	.6713,
6,	.5646,	.4051,	.7843,	.4592,	.9178,	.8406,	.5640,	.7735,	.9765,	.6993,
7,	.6944,	.6931,	1.0802,	.4770,	1.1414,	.8277,	.5066,	.8227,	1.0575,	.8659,
8,	.5019,	.5532,	.9434,	.4813,	1.3268,	.5777,	.6039,	.9270,	1.1947,	1.1085,
9,	.5118,	.4841,	.8105,	.5360,	.9127,	.7223,	.5948,	.6763,	1.1308,	1.0193,
+gp,	.5118,	.4841,	.8105,	.5360,	.9127,	.7223,	.5948,	.6763,	1.1308,	1.0193,
0 FBAR 3- 7,	.4652,	.4143,	.7073,	.5098,	.7084,	.6710,	.4508,	.6103,	.7835,	.6304,
FBAR 3- 6,	.4079,	.3446,	.6141,	.5181,	.6001,	.6318,	.4368,	.5572,	.7150,	.5715,

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	FBAR 98-**
AGE											
2,	.0324,	.0199,	.0123,	.0236,	.0723,	.0398,	.0446,	.0821,	.0764,	.0876,	.0820,
3,	.2015,	.1000,	.1011,	.1044,	.1487,	.1996,	.1991,	.2323,	.2867,	.2371,	.2520,
4,	.4898,	.3309,	.1866,	.1887,	.4195,	.4040,	.4317,	.3976,	.4688,	.3747,	.4137,
5,	.4935,	.3957,	.2591,	.2499,	.2767,	.6712,	.6778,	.7035,	.6220,	.4805,	.6020,
6,	.5372,	.4574,	.2410,	.2274,	.3611,	.8848,	.6887,	.6641,	.8919,	.9884,	.8482,
7,	.5703,	.4755,	.2641,	.1961,	.3487,	1.1419,	1.3001,	.3467,	.4486,	.9815,	.5923,
8,	.7595,	.4315,	.2057,	.1625,	.3052,	1.0074,	1.3589,	.9217,	.2318,	.1742,	.4426,
9,	.6007,	.5943,	.3196,	.2162,	.2785,	1.9988,	1.3343,	.8718,	.3534,	.0400,	.4217,
+gp,	.6007,	.5943,	.3196,	.2162,	.2785,	1.9988,	1.3343,	.8718,	.3534,	.0400,	
0 FBAR 3- 7,	.4585,	.3519,	.2104,	.1933,	.3110,	.6603,	.6595,	.4688,	.5436,	.6124,	
FBAR 3- 6,	.4305,	.3210,	.1969,	.1926,	.3015,	.5399,	.4993,	.4994,	.5674,	.5202,	

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

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)   COD_IND7

At 28/04/2001 11:10

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	12019,	20654,	20290,	21834,	8269,	18566,	23451,	17582,	9325,	8608,
3,	7385,	7042,	12907,	12893,	16037,	5999,	13990,	17744,	13012,	6840,
4,	3747,	3616,	3503,	6986,	7823,	10207,	4034,	9020,	11522,	7843,
5,	2699,	1863,	1825,	1710,	3639,	4085,	6475,	2525,	4976,	6447,
6,	666,	1245,	752,	895,	830,	1698,	2133,	3757,	1212,	2682,
7,	668,	335,	584,	358,	416,	351,	842,	980,	1967,	561,
8,	155,	210,	190,	294,	151,	200,	109,	410,	393,	965,
9,	66,	56,	87,	112,	169,	80,	70,	31,	240,	138,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTAL,	27403,	35021,	40138,	45083,	37332,	41186,	51104,	52049,	42647,	34085,

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	11928,	21320,	12573,	30480,	38316,	18574,	9994,	10745,	14994,	23520,
3,	6684,	9469,	16664,	9639,	22999,	29032,	13852,	7798,	8295,	11756,
4,	4548,	4788,	6688,	10816,	6747,	13683,	20007,	8372,	5281,	5224,
5,	4456,	2981,	3187,	4037,	7217,	3572,	7765,	10188,	4463,	2810,
6,	3754,	2483,	1901,	1969,	2460,	3908,	1676,	2993,	5431,	2205,
7,	1516,	1760,	1109,	1209,	1103,	1279,	1909,	659,	1509,	2722,
8,	238,	779,	902,	626,	581,	636,	489,	513,	297,	789,
9,	519,	92,	499,	533,	378,	304,	274,	184,	238,	122,
+gp,	0,	0,	400,	342,	476,	466,	18,	154,	103,	52,
0 TOTAL,	33642,	43673,	43923,	59652,	80277,	71453,	55983,	41606,	40611,	49201,

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	14012,	22083,	25109,	47766,	17285,	9510,	10263,	9124,	15480,	3604,
3,	18235,	10888,	17049,	18613,	35130,	13249,	7596,	8170,	7009,	10649,
4,	7577,	11186,	7136,	8737,	10503,	20181,	7602,	4987,	4769,	3792,
5,	2955,	4411,	6378,	3345,	3998,	5165,	8866,	3862,	2323,	1926,
6,	1491,	1563,	2448,	2737,	1417,	1763,	2082,	4469,	1819,	887,
7,	1075,	694,	853,	915,	1416,	463,	623,	970,	1688,	561,
8,	1476,	440,	284,	237,	465,	370,	166,	307,	349,	480,
9,	339,	731,	207,	91,	120,	101,	170,	74,	100,	86,
+gp,	150,	348,	200,	174,	145,	81,	63,	56,	14,	44,
0 TOTAL,	47312,	52344,	59665,	82615,	70479,	50883,	37431,	32018,	33551,	22031,

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	GMST 61-98	AMST 61-98
AGE													
2,	6666,	11490,	10859,	27160,	41415,	9943,	5073,	6378,	19465,	29465,	0,	14515,	17007,
3,	2731,	5284,	9222,	8782,	21718,	31541,	7823,	3972,	4811,	14765,	22102,	11050,	12834,
4,	6141,	1828,	3914,	6824,	6477,	15324,	21151,	5249,	2578,	2957,	9537,	7025,	8101,
5,	1765,	3081,	1075,	2659,	4626,	3486,	8377,	11246,	2887,	1321,	1664,	3803,	4381,
6,	806,	882,	1698,	679,	1696,	2872,	1459,	3482,	4556,	1269,	669,	1799,	2076,
7,	361,	385,	457,	1093,	443,	968,	971,	600,	1467,	1529,	387,	823,	957,
8,	193,	167,	196,	287,	735,	256,	253,	217,	347,	767,	469,	344,	416,
9,	130,	74,	89,	131,	200,	444,	77,	53,	71,	225,	528,	146,	195,
+gp,	58,	83,	100,	90,	221,	58,	176,	47,	29,	28,	199,		
0 TOTAL,	18850,	23274,	27610,	47705,	77531,	64891,	45358,	31243,	36212,	52327,	35555,		

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

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_IND7 ,

At 28/04/2001 11:10

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,	FBAR 3- 6,
1961,	12019,	65428,	46439,	21598,	.4651,	.6059,	.5182,
1962,	20654,	68225,	43326,	20967,	.4839,	.5226,	.5616,
1963,	20290,	77602,	49054,	22215,	.4529,	.4944,	.4960,
1964,	21834,	84666,	55362,	21078,	.3807,	.5017,	.4602,
1965,	8269,	75043,	57057,	24212,	.4244,	.4909,	.4811,
1966,	18566,	83919,	60629,	20418,	.3368,	.4743,	.3509,
1967,	23451,	105289,	73934,	23562,	.3187,	.3900,	.3574,
1968,	17582,	110433,	82484,	29930,	.3629,	.4642,	.4020,
1969,	9325,	105537,	83487,	32371,	.3877,	.4375,	.4189,
1970,	8608,	98398,	82034,	24183,	.2948,	.3882,	.3213,
1971,	11928,	78217,	63307,	23010,	.3635,	.3526,	.3245,
1972,	21320,	76438,	57179,	18727,	.3275,	.3358,	.3025,
1973,	12573,	110712,	83547,	22228,	.2661,	.2886,	.2677,
1974,	30480,	139264,	98432,	24581,	.2497,	.3139,	.2591,
1975,	38316,	153659,	109563,	36775,	.3357,	.3947,	.4058,
1976,	18574,	161252,	123072,	39799,	.3234,	.4749,	.4031,
1977,	9994,	136201,	112049,	34927,	.3117,	.6758,	.5663,
1978,	10745,	96224,	78498,	26585,	.3387,	.4260,	.3832,
1979,	14994,	85094,	66709,	23112,	.3465,	.4274,	.4223,
1980,	23520,	84961,	58860,	20513,	.3485,	.3946,	.3903,
1981,	14012,	88329,	63497,	22963,	.3616,	.4652,	.4079,
1982,	22083,	98810,	66933,	21489,	.3211,	.4143,	.3446,
1983,	25109,	123007,	78389,	38133,	.4865,	.7073,	.6141,
1984,	47766,	151865,	96484,	36979,	.3833,	.5098,	.5181,
1985,	17285,	130933,	84521,	39484,	.4672,	.7084,	.6001,
1986,	9510,	98959,	73415,	34595,	.4712,	.6710,	.6318,
1987,	10263,	78341,	61843,	21391,	.3459,	.4508,	.4368,
1988,	9124,	66932,	52347,	23182,	.4429,	.6103,	.5572,
1989,	15480,	59150,	38938,	22068,	.5667,	.7835,	.7150,
1990,	3604,	38315,	29518,	13487,	.4569,	.6304,	.5715,
1991,	6666,	29142,	21627,	8750,	.4046,	.4585,	.4305,
1992,	11490,	36183,	21170,	6396,	.3021,	.3519,	.3210,
1993,	10859,	52539,	33680,	6107,	.1813,	.2104,	.1969,
1994,	27160,	88681,	55531,	9046,	.1629,	.1933,	.1926,
1995,	41415,	148247,	68941,	23045,	.3343,	.3110,	.3015,
1996,	9943,	142076,	88691,	40422,	.4558,	.6603,	.5399,
1997,	5073,	95187,	85738,	34304,	.4001,	.6595,	.4993,
1998,	6378,	64536,	55750,	24005,	.4306,	.4688,	.4994,
1999,	19465,	68677,	43411,	20013,	.4610,	.5436,	.5674,
2000,	29465,	109658,	45946,	22496,	.4896,	.6124,	.5202,
Arith. Mean ,	17380,	94153,	66285,	24479,	.3761,	.4819,	.4389,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

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

	Stock size 2001	Recruitment 2002	Recruitment 2003
Age 2	14883	14883	14883
Age 3	22101		
Age 4	9537		
Age 5	1664		
Age 6	669		
Age 7	387		
Age 8	469		
Age 9	528		
Age 10+	199		

	Exploitation pattern			Weight-at-age			Proportion Mature		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
	Fbar98-00 resc.to 00	Fbar98-00 resc.to 00	Fbar98-00 resc.to 00	av98-00	av98-00	av98-00	2001	av99-01	av99-01
Age 2	0.093	0.093	0.093	1.157	1.157	1.157	0.07	0.04	0.04
Age 3	0.285	0.285	0.285	1.724	1.724	1.724	0.47	0.43	0.43
Age 4	0.468	0.468	0.468	2.447	2.447	2.447	0.86	0.81	0.81
Age 5	0.681	0.681	0.681	2.950	2.950	2.950	0.94	0.95	0.95
Age 6	0.959	0.959	0.959	3.581	3.581	3.581	1.00	1.00	1.00
Age 7	0.670	0.670	0.670	5.170	5.170	5.170	1.00	1.00	1.00
Age 8	0.501	0.501	0.501	7.438	7.438	7.438	1.00	1.00	1.00
Age 9	0.477	0.477	0.477	9.665	9.665	9.665	1.00	1.00	1.00
Age 10+	0.477	0.477	0.477	10.821	10.821	10.821	1.00	1.00	1.00

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

MFDP version 1
Run: Finalshortp
Index file 30/4-2001
Time and date: 22:24 01/05/01
Fbar age range: 3-7

2001				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
98711	58940	1.0000	0.6124	26196

2002					2003	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
95107	60614	0.0000	0.0000	0	118505	84129
.	60614	0.1000	0.0612	3460	114579	80507
.	60614	0.2000	0.1225	6753	110848	77073
.	60614	0.3000	0.1837	9888	107301	73814
.	60614	0.4000	0.2450	12875	103926	70722
.	60614	0.5000	0.3062	15720	100715	67786
.	60614	0.6000	0.3675	18433	97659	64997
.	60614	0.7000	0.4287	21019	94748	62348
.	60614	0.8000	0.4900	23486	91976	59830
.	60614	0.9000	0.5512	25840	89333	57437
.	60614	1.0000	0.6124	28087	86814	55160
.	60614	1.1000	0.6737	30233	84412	52995
.	60614	1.2000	0.7349	32283	82120	50935
.	60614	1.3000	0.7962	34242	79933	48973
.	60614	1.4000	0.8574	36115	77844	47106
.	60614	1.5000	0.9187	37905	75850	45327
.	60614	1.6000	0.9799	39618	73944	43632
.	60614	1.7000	1.0411	41258	72123	42017
.	60614	1.8000	1.1024	42827	70381	40477
.	60614	1.9000	1.1636	44330	68715	39008
.	60614	2.0000	1.2249	45770	67122	37607

Input units are thousands and kg - output in tonnes

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

Input to Yield per recruit

	Exploitatior pattern Average 1961-2000 Resc. to 2000	**Weightatage** Average 1961-2000	**PropMature** Average 1983-2001
Age 2	0.1066	1.02	0.03
Age 3	0.3340	1.725	0.62
Age 4	0.5240	2.597	0.87
Age 5	0.6364	3.488	0.95
Age 6	0.7372	4.362	0.99
Age 7	0.8306	5.437	1.00
Age 8	0.8034	6.553	1.00
Age 9	0.7683	7.952	1.00
Age 10+	0.7683	9.999	1.00

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

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

MFYPR version 1
Run: Yldfinal
Time and date: 22:39 01/05/01
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	25.1190	4.1165	23.2513	4.1165	23.2513
0.1000	0.0612	0.1985	0.9860	4.5287	17.0269	3.1388	15.1864	3.1388	15.1864
0.2000	0.1225	0.3133	1.3632	3.9583	12.8101	2.5781	10.9950	2.5781	10.9950
0.3000	0.1837	0.3893	1.5145	3.5821	10.3010	2.2111	8.5097	2.2111	8.5097
0.4000	0.2450	0.4440	1.5714	3.3122	8.6702	1.9500	6.9014	1.9500	6.9014
0.5000	0.3062	0.4856	1.5864	3.1072	7.5393	1.7533	5.7916	1.7533	5.7916
0.6000	0.3675	0.5187	1.5824	2.9447	6.7147	1.5988	4.9870	1.5988	4.9870
0.7000	0.4287	0.5459	1.5697	2.8118	6.0888	1.4736	4.3799	1.4736	4.3799
0.8000	0.4900	0.5687	1.5533	2.7005	5.5978	1.3696	3.9069	1.3696	3.9069
0.9000	0.5512	0.5882	1.5357	2.6054	5.2023	1.2815	3.5282	1.2815	3.5282
1.0000	0.6124	0.6052	1.5180	2.5228	4.8763	1.2057	3.2184	1.2057	3.2184
1.1000	0.6737	0.6202	1.5008	2.4503	4.6025	1.1397	2.9600	1.1397	2.9600
1.2000	0.7349	0.6335	1.4843	2.3858	4.3691	1.0814	2.7411	1.0814	2.7411
1.3000	0.7962	0.6455	1.4685	2.3280	4.1672	1.0296	2.5532	1.0296	2.5532
1.4000	0.8574	0.6564	1.4536	2.2758	3.9907	0.9832	2.3900	0.9832	2.3900
1.5000	0.9187	0.6663	1.4395	2.2282	3.8348	0.9412	2.2468	0.9412	2.2468
1.6000	0.9799	0.6754	1.4261	2.1847	3.6959	0.9031	2.1202	0.9031	2.1202
1.7000	1.0411	0.6838	1.4134	2.1447	3.5713	0.8683	2.0073	0.8683	2.0073
1.8000	1.1024	0.6915	1.4013	2.1077	3.4588	0.8363	1.9061	0.8363	1.9061
1.9000	1.1636	0.6988	1.3899	2.0733	3.3565	0.8069	1.8146	0.8069	1.8146
2.0000	1.2249	0.7055	1.3790	2.0413	3.2631	0.7796	1.7317	0.7796	1.7317

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6124
FMax	0.5180	0.3173
F0.1	0.2415	0.1479
F35%SPR	0.3198	0.1958
Flow	0.1964	0.1203
Fmed	0.6834	0.4185
Fhigh	1.8168	1.1127

Weights in kilograms

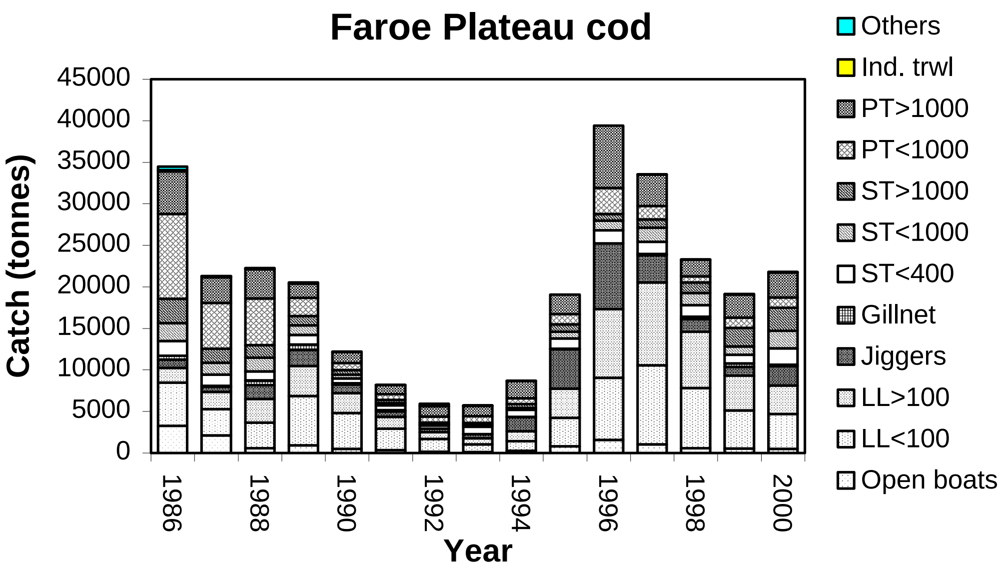


Figure 2.2.1.1. Faroe Plateau (sub-division VB1) COD. Catch landed by faroese fleets 1986-2000.

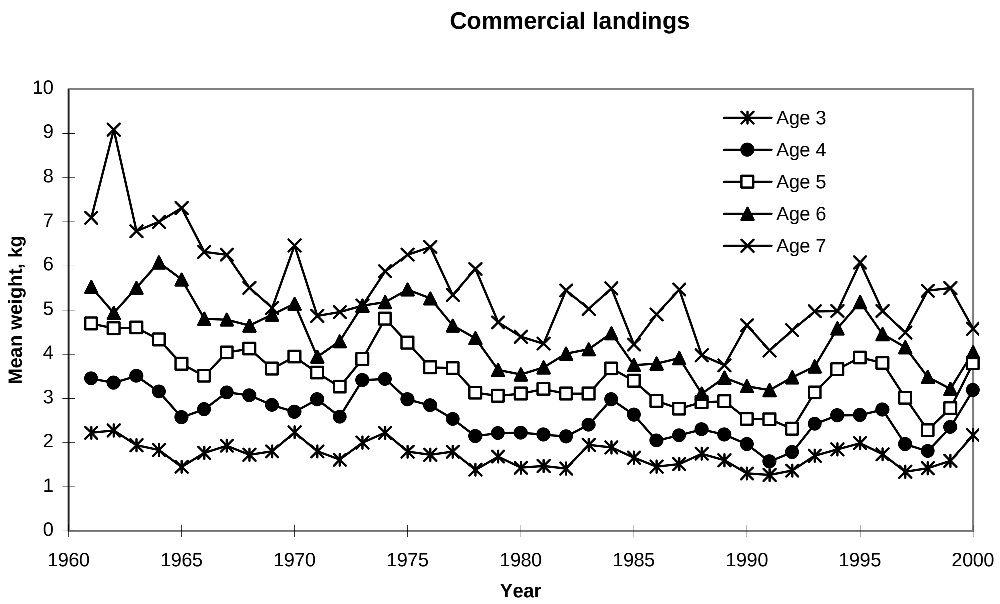


Figure 2.2.3.1. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2000.

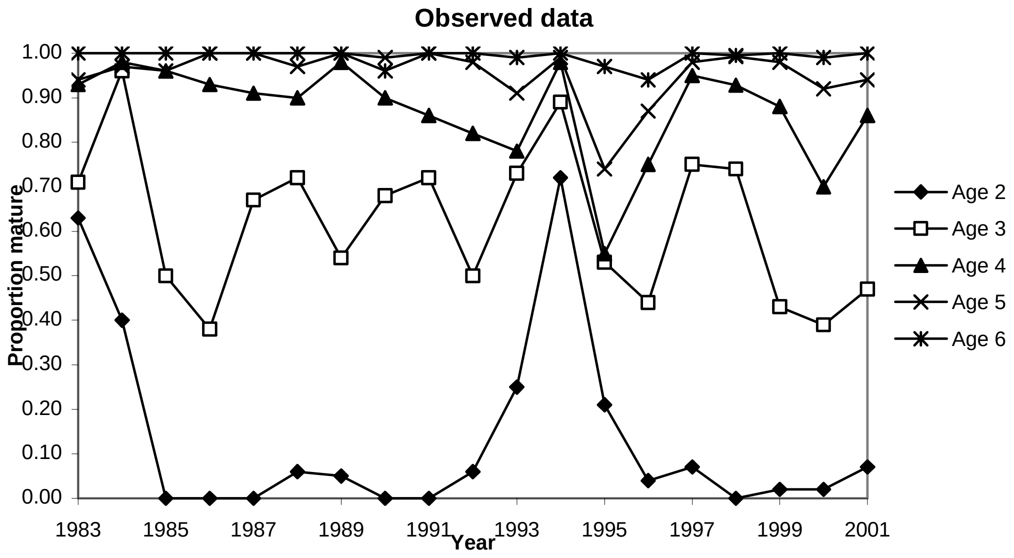


Figure 2.2.4.1. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey.

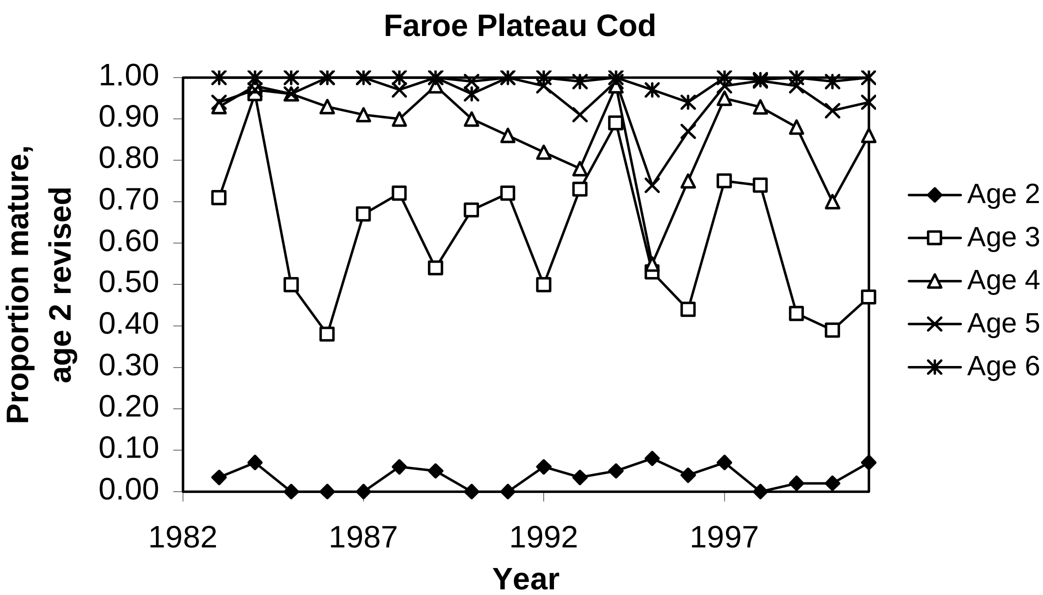


Figure 2.2.4.2. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey. Age 2 is revised.

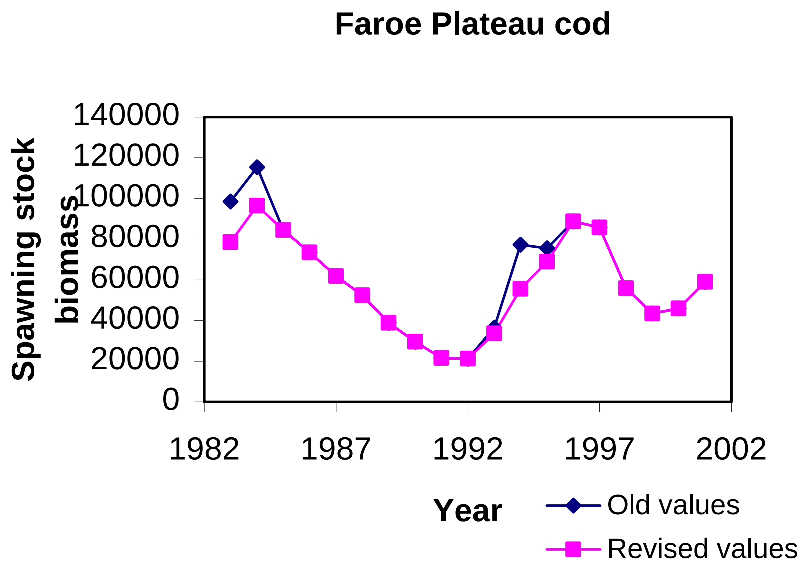


Figure 2.2.4.3. Faroe Plateau (sub-division VB1) COD. Effect of revised proportion mature of age 2 on spawning stock biomass.

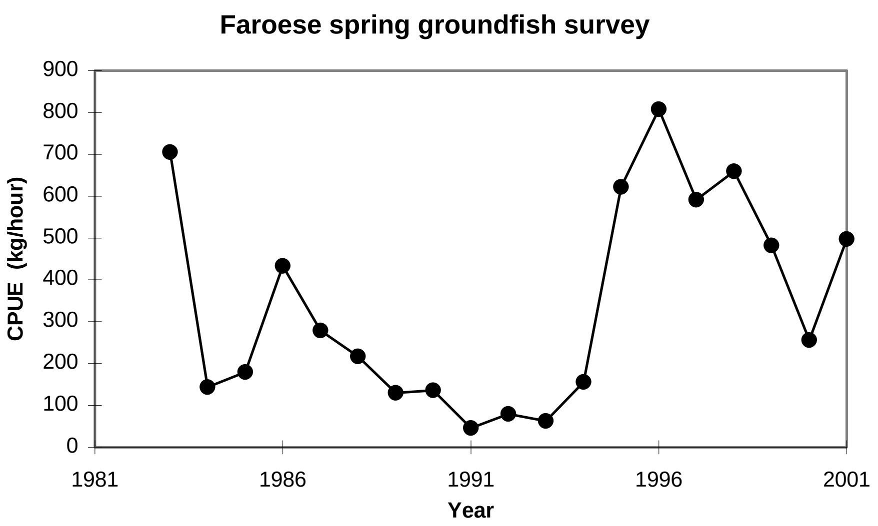


Figure 2.2.5.1. Faroe Plateau (sub-division VB1) COD. Catch per unit effort in the spring groundfish survey.

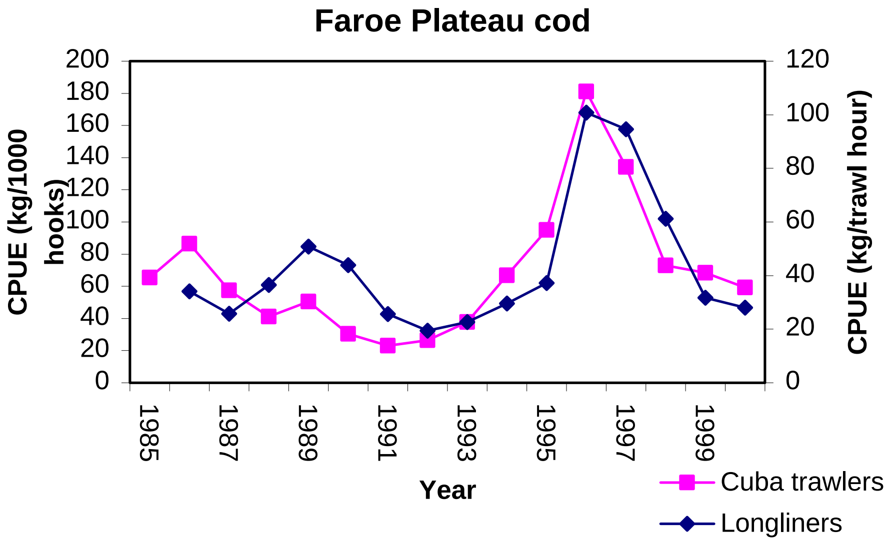
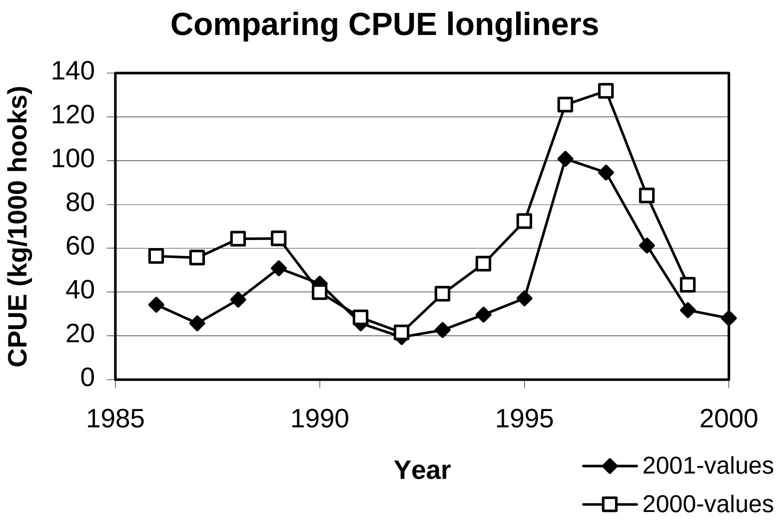


Figure 2.2.6.1.1. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for Cuba trawlers and longliners.



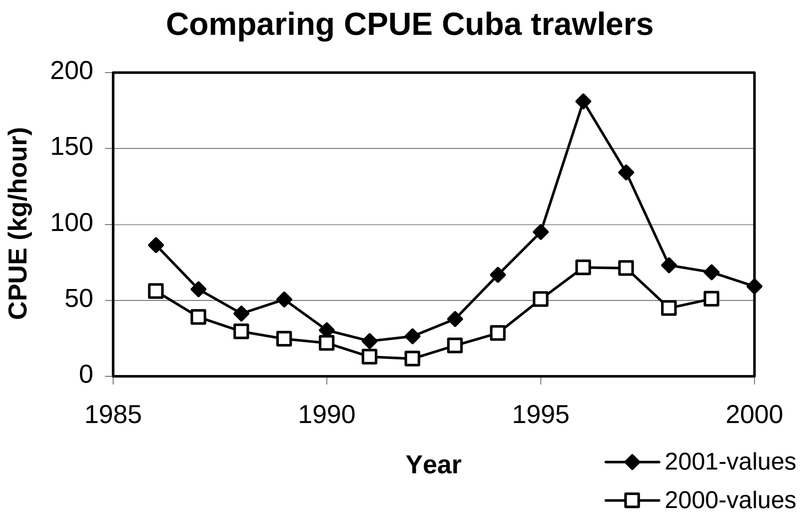


Figure 2.2.6.1.2. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for Cuba trawlers and longliners. Values for the assessments in 2000 and 2001 are compared.

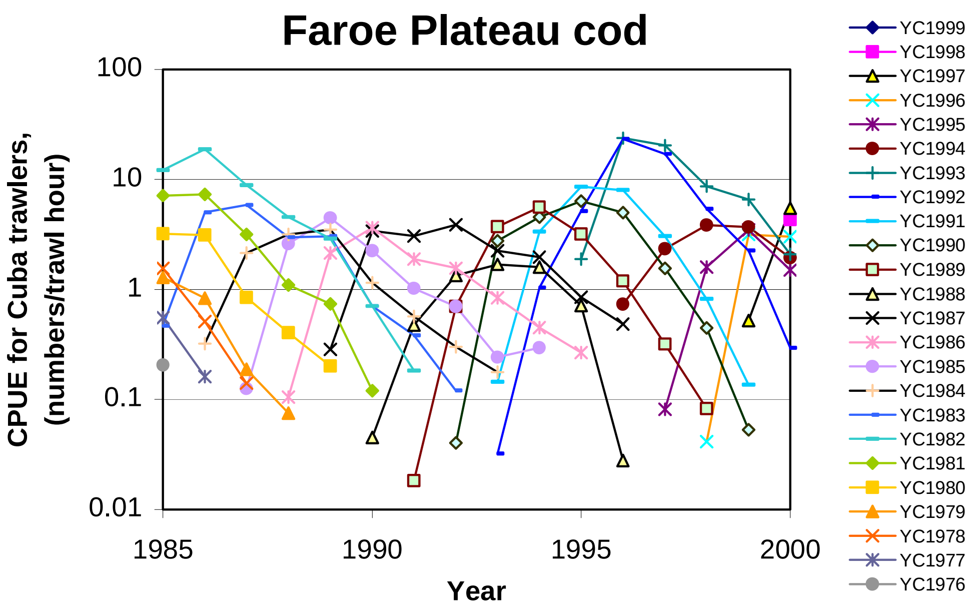


Figure 2.2.6.1.3. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for Cuba trawlers segregated to age classes.

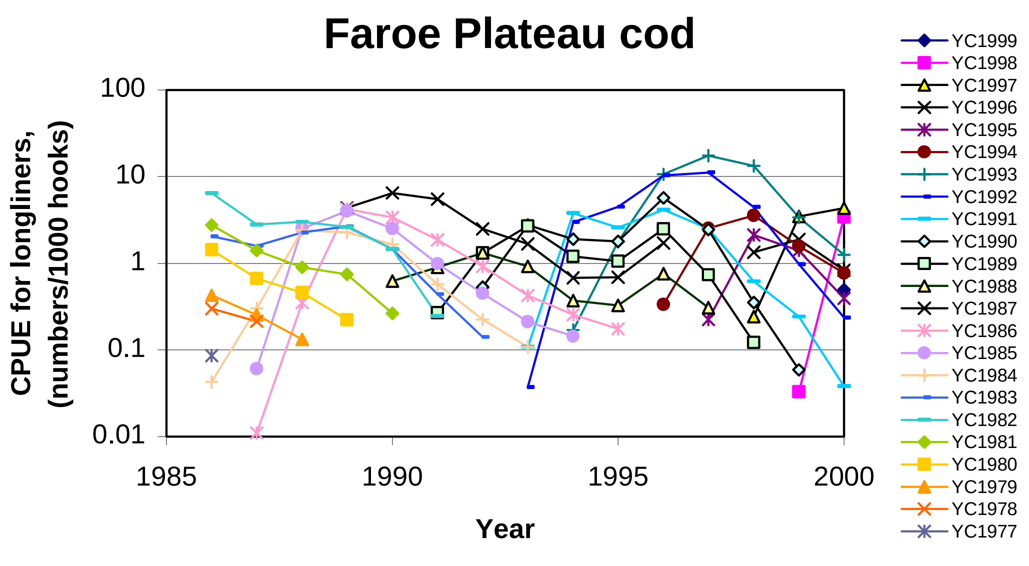


Figure 2.2.6.1.4. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for longliners segregated to age classes.

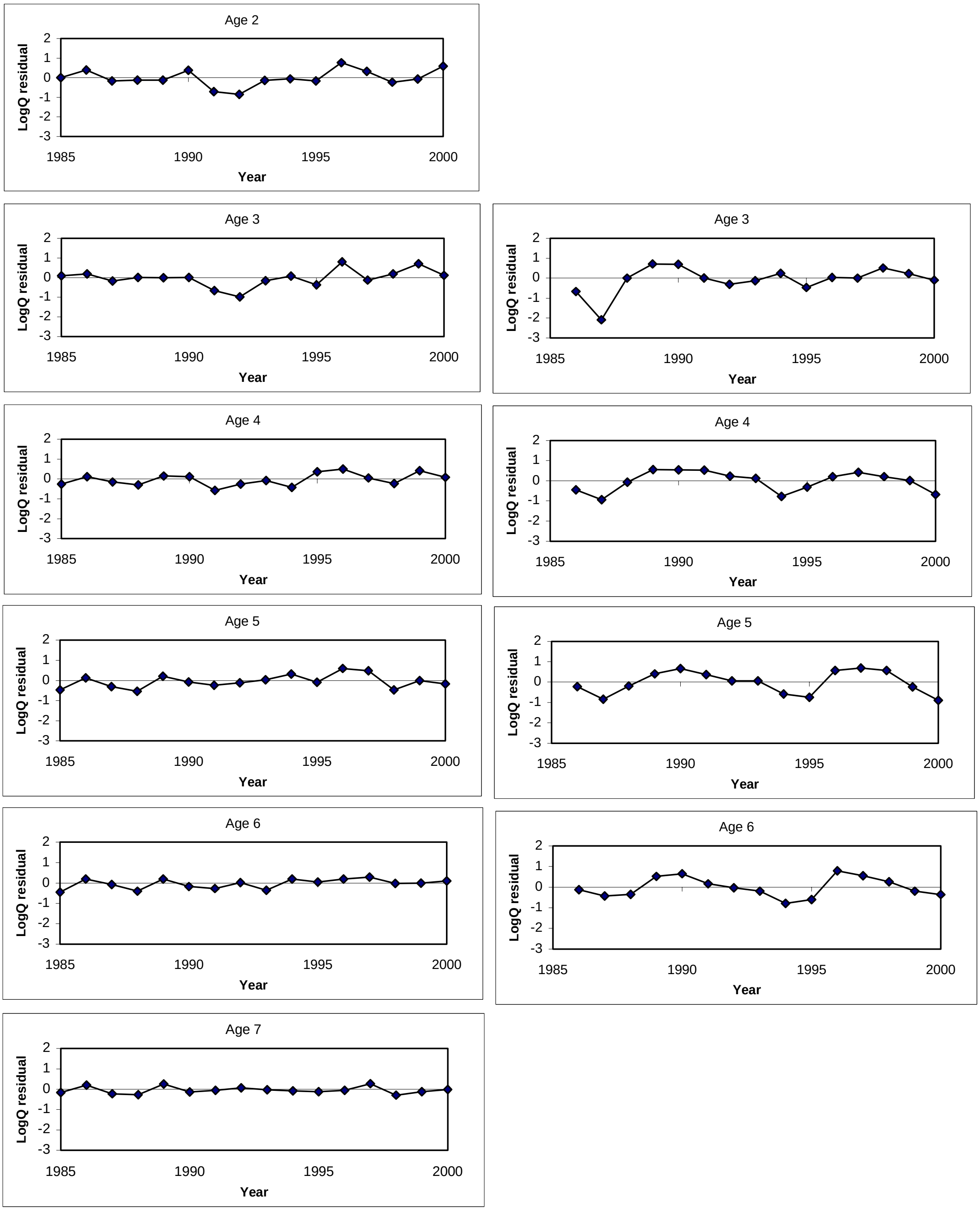


Figure 2.2.6.1.5. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for Cuba trawlers (left) and longliners (right).

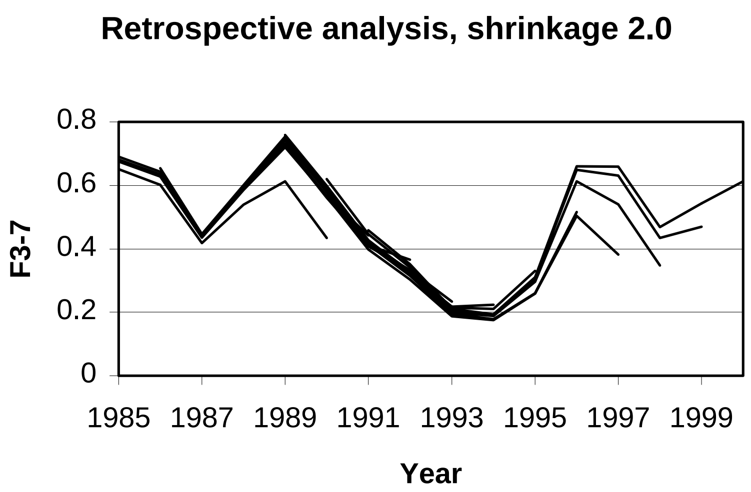
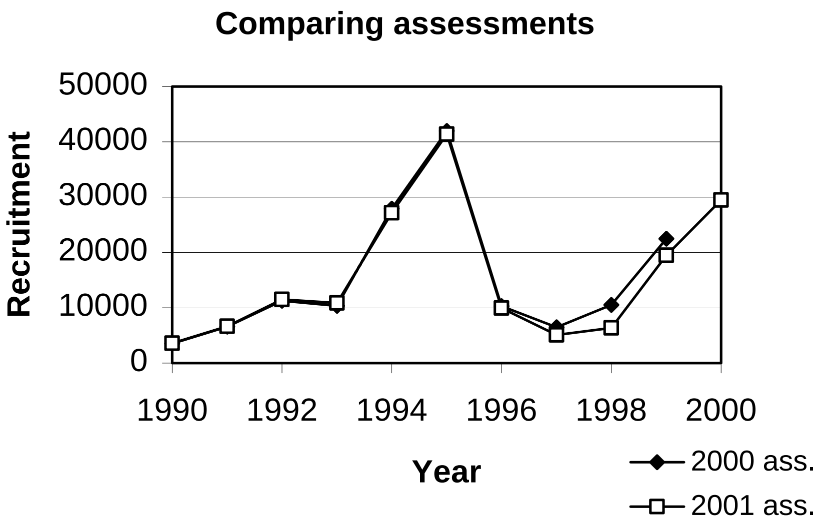


Figure 2.2.6.1.6. Faroe Plateau (sub-division VB1) COD. Results from retrospective analysis.



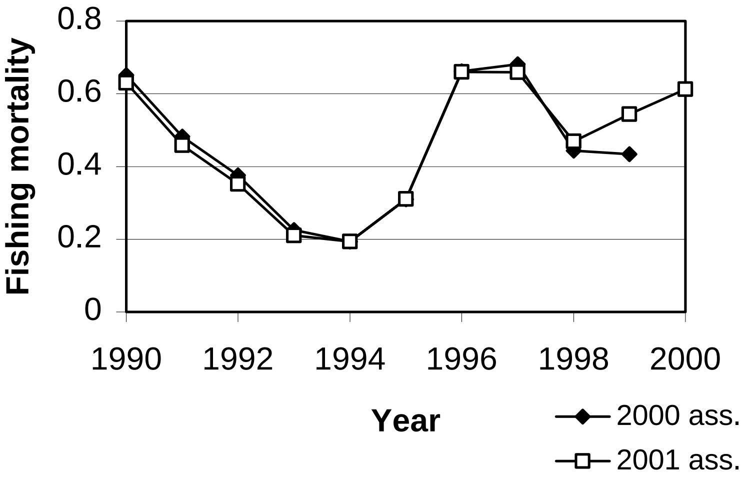
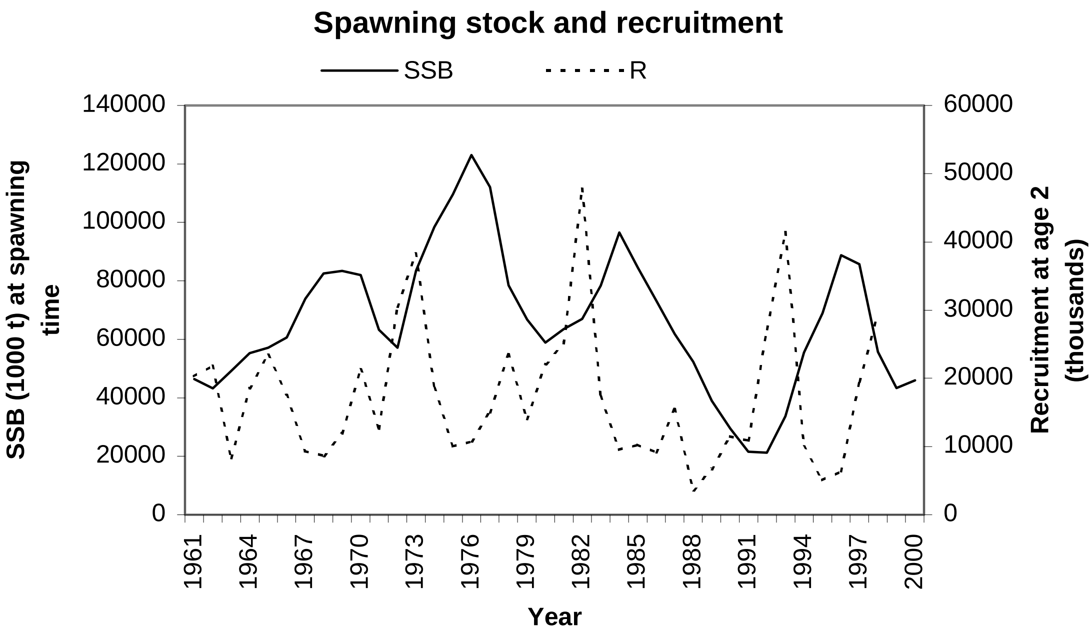


Figure 2.2.6.1.7. Faroe Plateau (sub-division VB1) COD. Current assessment compared with the assessment from last year.



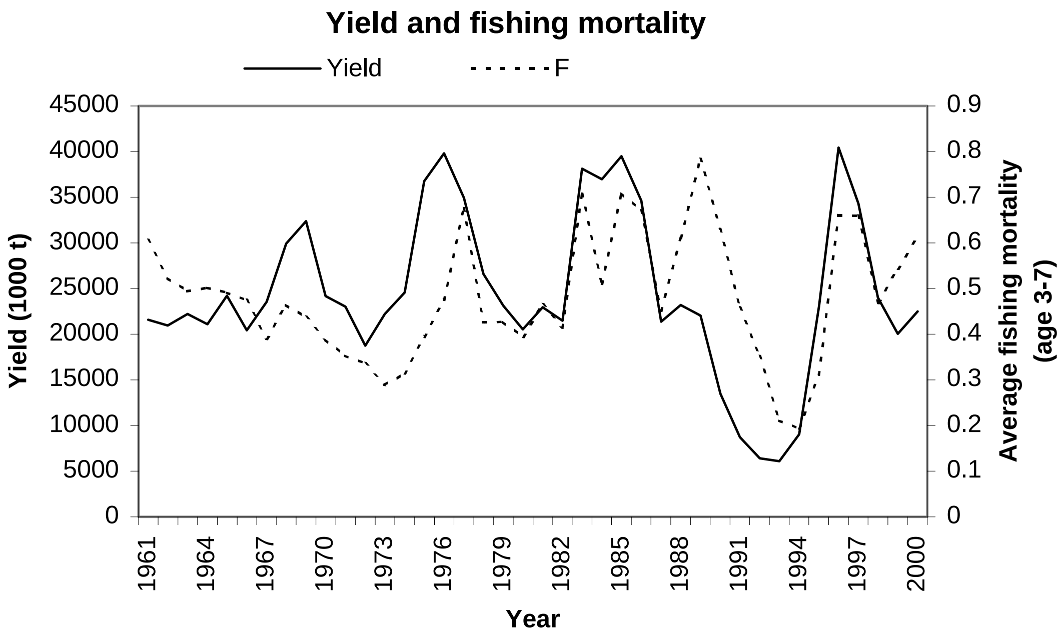


Figure 2.2.6.1.8. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment versus year.

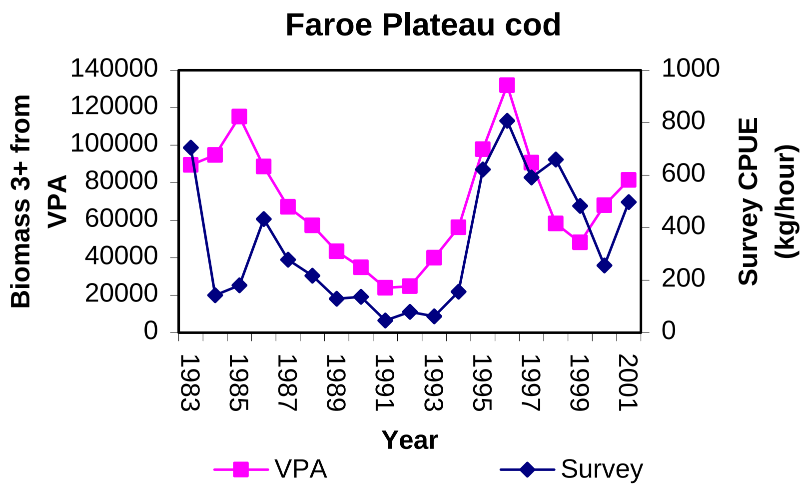


Figure 2.2.6.2.1. Faroe Plateau (sub-division VB1) COD. Biomass age 3 years and older from VPA compared with survey catch per unit effort.

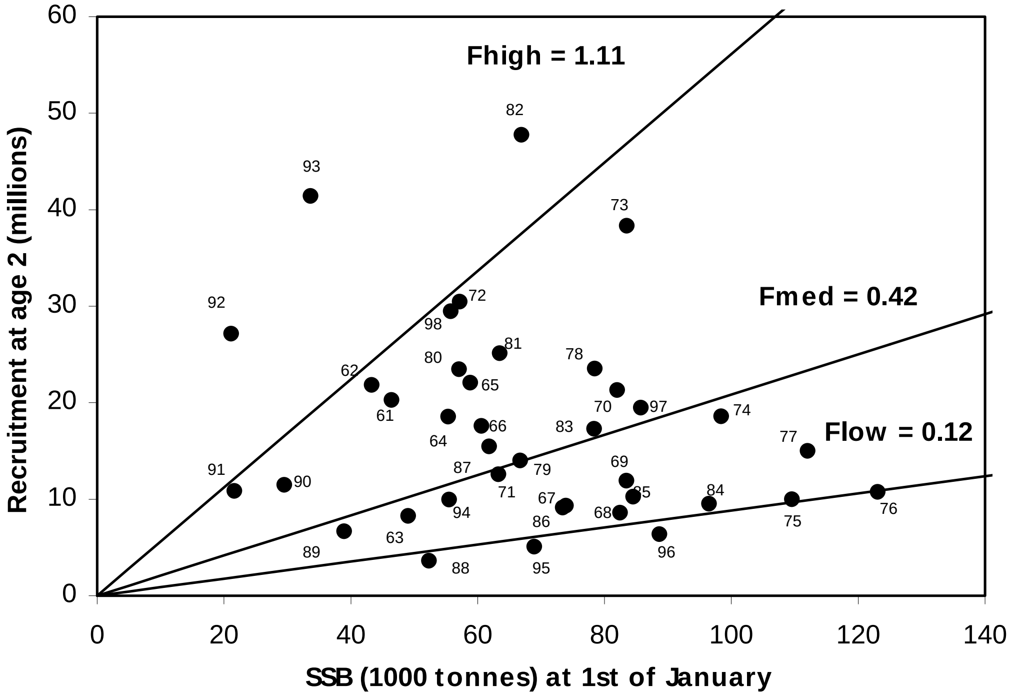


Figure 2.2.6.2.2. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-1998. Years are shown at each data point.

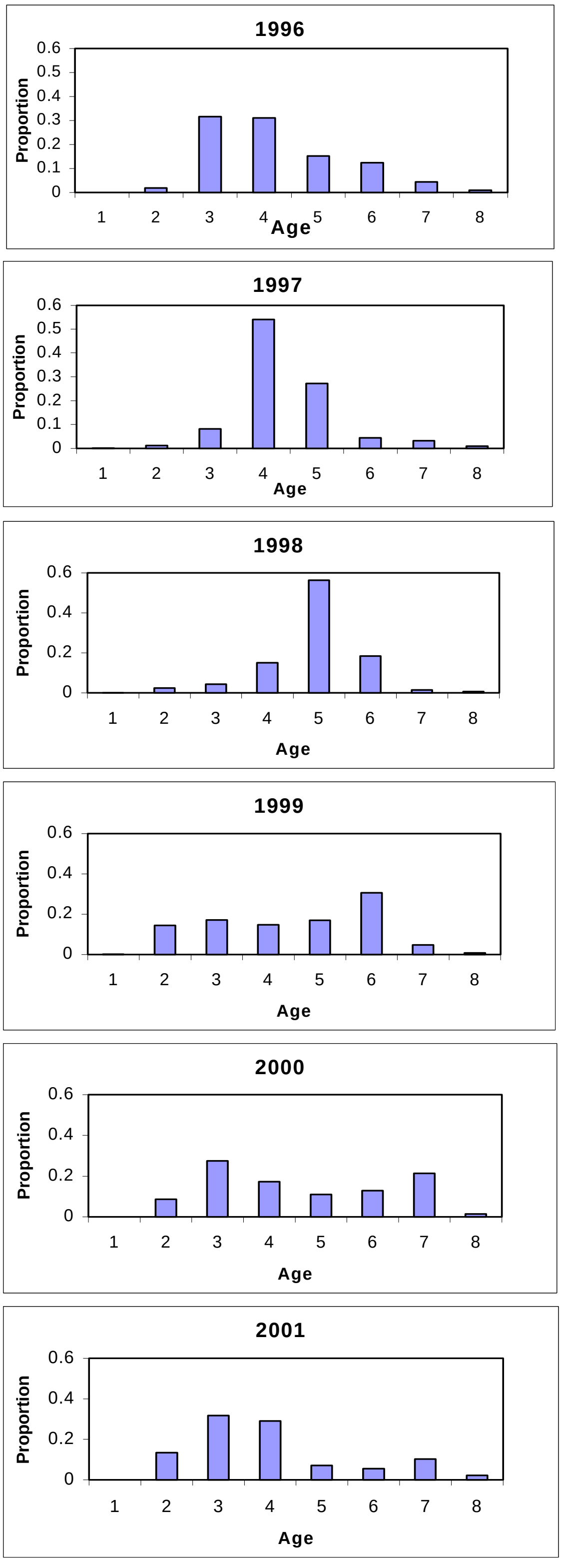
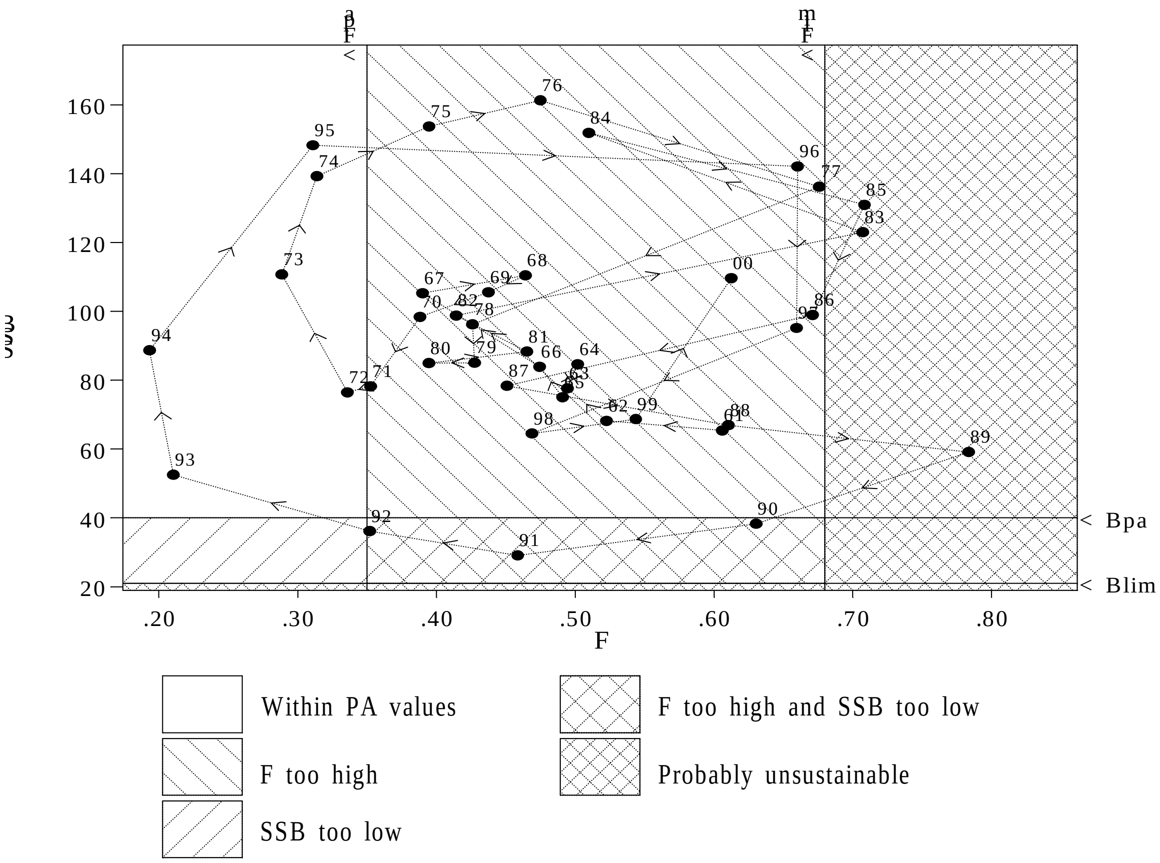


Figure 2.2.7.1.1. Faroe Plateau (sub-division VB1) COD. Frequency of age groups in otolith samples from the groundfish spring survey.

Cod,VB1



Data file(s):C:\VPAetc\Paplot\Exec\CodVb1.pa;C:\VPAetc\Paplot\Exec\CodVb1.sum
Plotted on 28/04/2001 at 17:15:28

Figure 2.2.7.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2000. Output from the PA software.

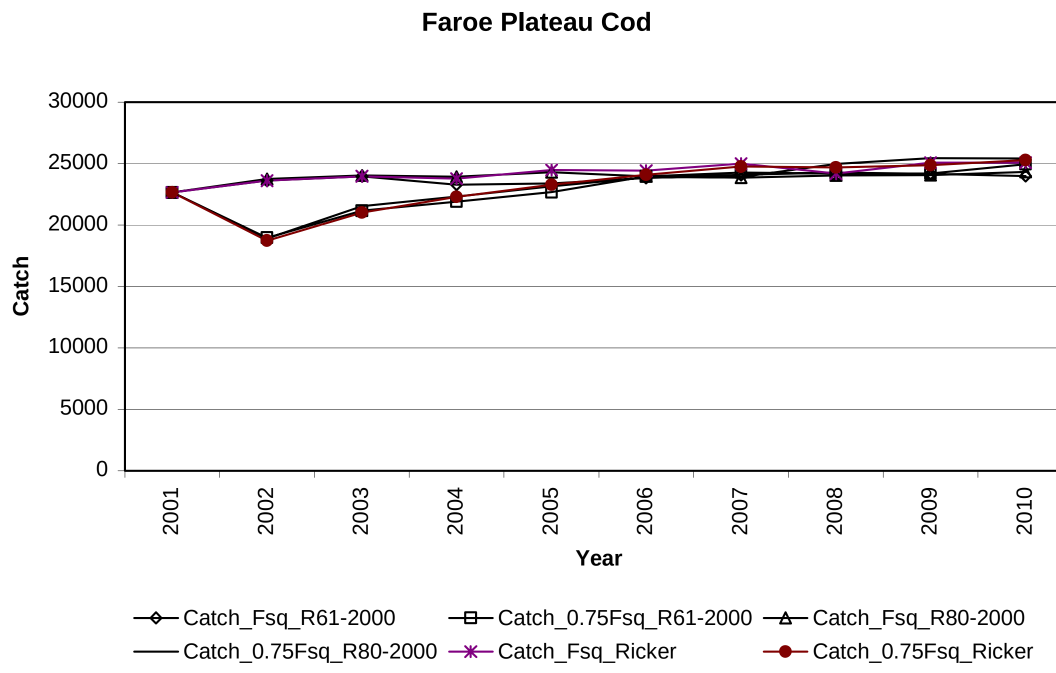


Figure 2.2.7.3.1. Faroe Plateau (sub-division VB1) COD. Medium term predictions of catch using varying options of $\mathbf{F}_{sq}$ (fishing mortality at status quo, in 2000) and recruitment (averages 1961-2000, 1980-2000, or Ricker SSB – R relationship).

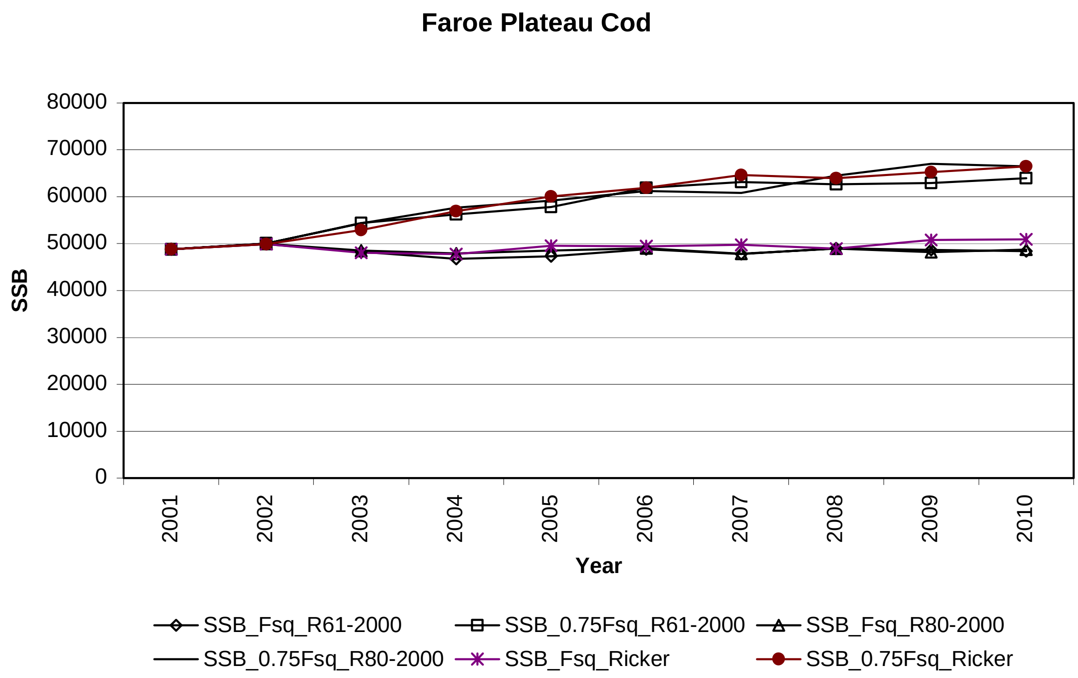


Figure 2.2.7.3.2. Faroe Plateau (sub-division VB1) COD. Medium term predictions of spawning stock biomass (SSB) using varying options of $\mathbf{F}_{sq}$ (fishing mortality at status quo, in 2000) and recruitment (averages 1961-2000, 1980-2000, or Ricker SSB – R relationship).

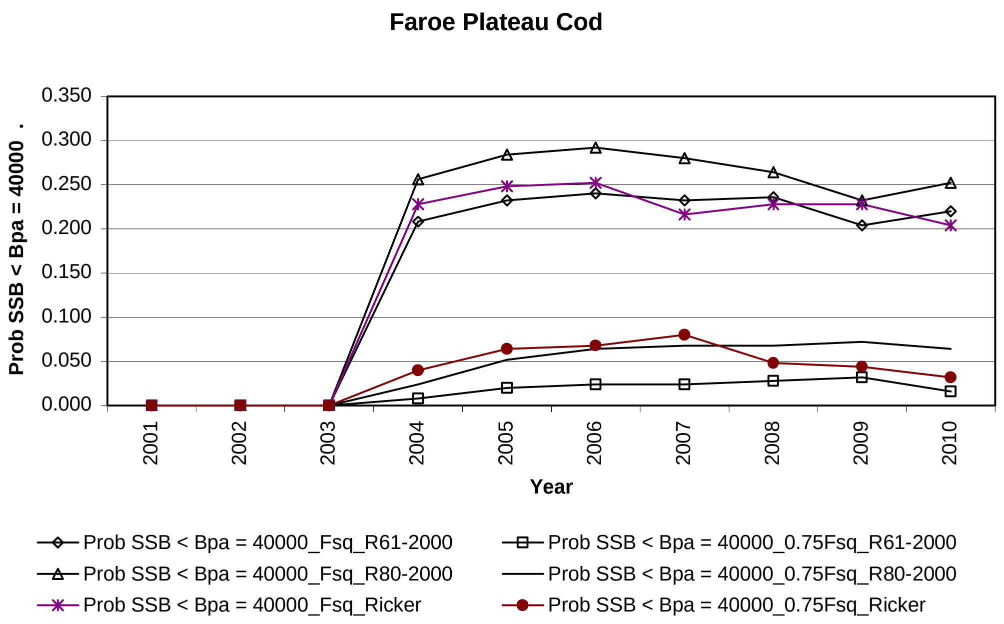


Figure 2.2.7.3.3. Faroe Plateau (sub-division VB1) COD. Medium term predictions of the probability that spawning stock biomass (SSB) will be below $\mathbf{B}_{pa}$ (40000 t). Various options of $\mathbf{F}_{sq}$ (fishing mortality at status quo, in 2000) and recruitment (averages 1961-2000, 1980-2000, or Ricker SSB – R relationship) are presented.

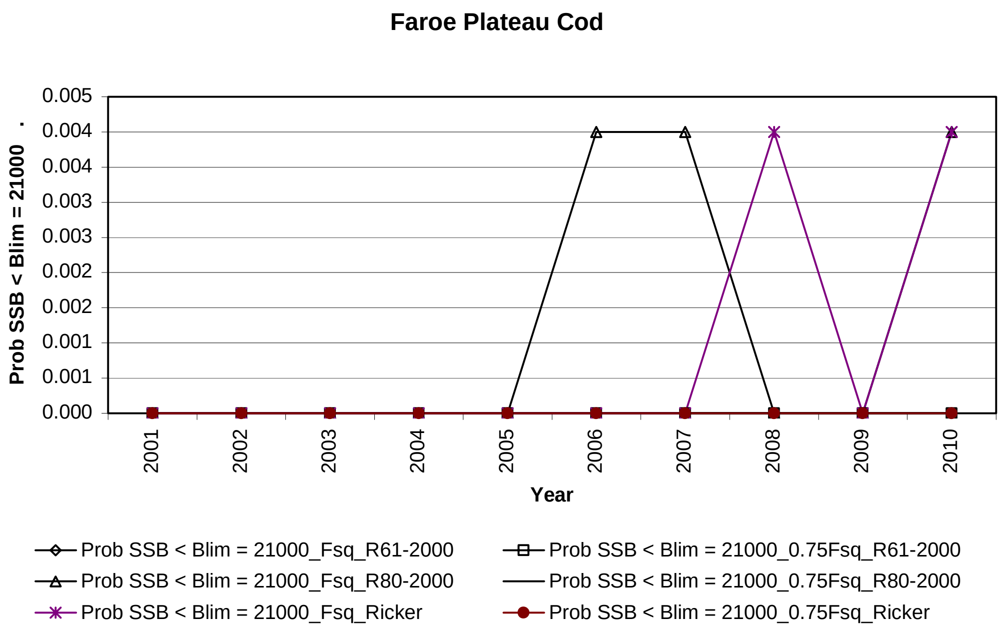
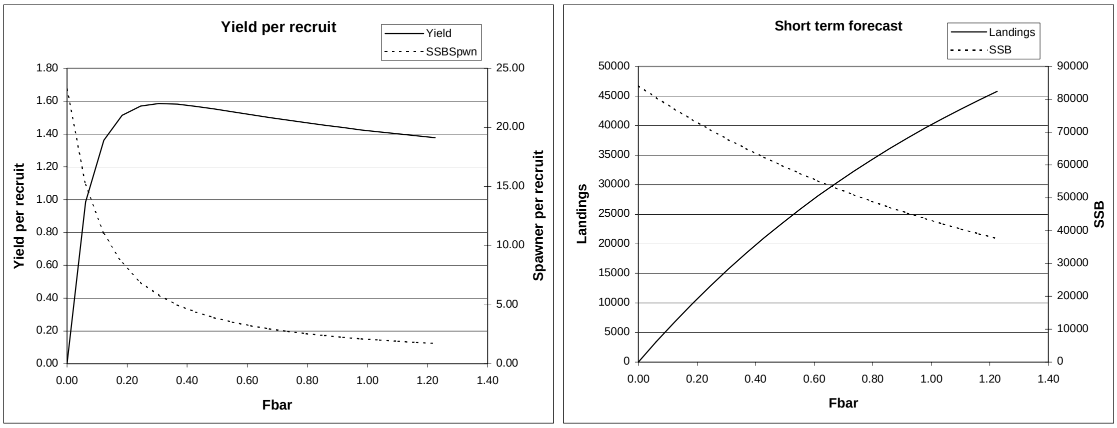


Figure 2.2.7.3.4. Faroe Plateau (sub-division VB1) COD. Faroe Plateau (sub-division VB1) COD. Medium term predictions of the probability that spawning stock biomass (SSB) will be below $\mathbf{B}_{lim}$ (21000 t). Various options of $\mathbf{F}_{sq}$ (fishing mortality at status quo, in 2000) and recruitment (averages 1961-2000, 1980-2000, or Ricker SSB – R relationship) are presented.



MFYPR version 1
Run: Yldfinal
Time and date: 22:39 01/05/01

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6124
FMax	0.5180	0.3173

MFDP version 1
Run: Finalshortp
Index file 30/4-2001
Time and date: 22:24 01/05/01
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

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

2.3 Faroe Bank Cod

2.3.1 Trends in landings and effort

Total nominal landings of the Faroe Bank cod from 1986 to 2000 as officially reported to ICES are given in Table 2.3.1.1 and since 1965 in Figure 2.3.1.1. Landings have been highly irregular from 1965 to the mid 1980s, reflecting the opportunistic nature of the fishery on the Bank, with peak landings exceeding slightly 5 000 t in 1973. The evolution of landings has been smoother since 1987, declining from about 3 500 t in 1987 to only 330 t in 1992 before increasing to 3 600 t in 1997. In 2000, 1 250t were reported from the Faroe Bank. Most of the Faroese catch has been taken by pair trawlers and longliners (Table 2.3.1.2).

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

2.3.2 Stock assessment

Biological samples have been taken from commercial landings since 1974 (the 2000 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 this year given the poor sampling for age composition particularly for trawl landings.

Sampling from commercial fleets in 2000.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	<100 GRT	1	169	60	0
Longliners	>100 GRT	9	1,705	240	180
Jiggers		1	137	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	0	0	0	0
Pair trawlers	>1000 HP	0	0	0	0
Total		11	2,011	360	240

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

A new production model was calculated with ASPIC using updated landing estimates (WG best estimate) and the survey estimate (Table 2.3.2.1). The model has difficulties fitting the large changes in CPUE in the second half of the 1990s, and therefore, the statistics are not particularly good. Parameter estimates are provided in the text table below:

Carrying Capacity	Intrinsic Growth rate	MSY	$\mathbf{F}_{MSY}$	$\mathbf{B}_{MSY}$
47320t	.6578	7780	0.329	23660t

The intrinsic growth rate and $\mathbf{F}_{MSY}$ appear reasonable, but not the other parameter estimates.

2.3.2.1 Comment on the assessment

An XSA was attempted in the 2000 assessment but not in the current one. The NWWG concludes that the poor sampling for age composition, particularly for the trawler landings whose catch is not separated into Faroe Bank or Faroe Plateau during the same trips. Therefore, XSA is not considered useful until reliable coverage of the total catch at age can be obtained. Statistical catch at age models do not require that the entire catch be aged, nor that age information be available for every year. They could therefore be of some use here, particularly given the availability of an aged survey stock size index, but there was insufficient time to pursue that avenue at the current meeting.

2.3.3 Reference points

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

2.3.4 Management considerations

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

Table 2.3.1.1. Faroe Bank (sub-division Vb2) COD. Nominal catches (tonnes) by countries 1986-2000 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 *	148 *
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	3,505
Used in assessment					361	335	154	266	725	601	2,106	3,594	3,240

	1999	2000 *
Faroe Islands	1,001	1,194
Norway	88 *	49
UK (E/W/NI)	-	
UK (Scotland)	210	
United Kingdom		- [2]
Total	1,299	1,243
Used in assessment	1,089	1,243

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

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

Table 2.3.2.1. Faroe Bank (sub-division 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
                                                                                   29 Apr 2001 at 13:44.09
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:	18	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	5.304E+00	18	3.315E-01	1.000E+00	1.000E+00	0.385
TOTAL OBJECTIVE FUNCTION:	5.30383827E+00					

Number of restarts required for convergence:	11	
Est. B-ratio coverage index (0 worst, 2 best):	0.5381	< These two measures are defined in Prager
Est. B-ratio nearness index (0 worst, 1 best):	0.5651	< 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 1983	1.687E-01	1.000E+00	1	1
MSY	Maximum sustainable yield	7.781E+03	3.000E+03	1	1
r	Intrinsic rate of increase	6.578E-01	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	Survey CPUE	3.418E-02	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	7.781E+03	Kr/4	
K	Maximum stock biomass	4.732E+04		
$\mathbf{B}_{MSY}$	Stock biomass at MSY	2.366E+04	K/2	
$\mathbf{F}_{MSY}$	Fishing mortality at MSY	3.289E-01	r/2	
F(0.1)	Management benchmark	2.960E-01	0.9*$\mathbf{F}_{MSY}$	
Y(0.1)	Equilibrium yield at F(0.1)	7.703E+03	0.99*MSY	
B-ratio	Ratio of B(2001) to $\mathbf{B}_{MSY}$	8.068E-01		
F-ratio	Ratio of F(2000) to $\mathbf{F}_{MSY}$	2.338E-01		
F01-mult	Ratio of F(0.1) to F(2000)	3.850E+00		
Y-ratio	Proportion of MSY avail in 2001	9.627E-01	2*Br-Br^2	Ye(2001) = 7.491E+03
....	Fishing effort at MSY in units of each fishery:			
$\mathbf{F}_{MSY}$(1)	Survey CPUE	9.622E+00	r/2q(1)	f(0.1) = 8.659E+00

Table 2.3.2.1 Faroe Bank Cod RV (Continued)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to F_{MSY}	Ratio of biomass to B_{MSY}
1	1983	0.589	3.990E+03	4.016E+03	2.367E+03	2.367E+03	2.417E+03	1.792E+00	1.687E-01
2	1984	0.529	4.041E+03	4.188E+03	2.216E+03	2.216E+03	2.511E+03	1.609E+00	1.708E-01
3	1985	0.727	4.335E+03	4.071E+03	2.961E+03	2.961E+03	2.447E+03	2.212E+00	1.832E-01
4	1986	0.465	3.821E+03	4.095E+03	1.905E+03	1.905E+03	2.460E+03	1.414E+00	1.615E-01
5	1987	0.934	4.376E+03	3.727E+03	3.479E+03	3.479E+03	2.257E+03	2.838E+00	1.850E-01
6	1988	1.425	3.154E+03	2.169E+03	3.091E+03	3.091E+03	1.358E+03	4.333E+00	1.333E-01
7	1989	1.446	1.421E+03	9.762E+02	1.412E+03	1.412E+03	6.282E+02	4.398E+00	6.005E-02
8	1990	0.535	6.370E+02	6.745E+02	3.610E+02	3.610E+02	4.373E+02	1.627E+00	2.692E-02
9	1991	0.418	7.133E+02	8.016E+02	3.350E+02	3.350E+02	5.183E+02	1.271E+00	3.015E-02
10	1992	0.132	8.966E+02	1.170E+03	1.540E+02	1.540E+02	7.503E+02	4.001E-01	3.789E-02
11	1993	0.138	1.493E+03	1.932E+03	2.660E+02	2.660E+02	1.218E+03	4.186E-01	6.310E-02
12	1994	0.244	2.445E+03	2.965E+03	7.250E+02	7.250E+02	1.827E+03	7.434E-01	1.033E-01
13	1995	0.133	3.547E+03	4.519E+03	6.010E+02	6.010E+02	2.683E+03	4.044E-01	1.499E-01
14	1996	0.331	5.629E+03	6.368E+03	2.106E+03	2.106E+03	3.622E+03	1.006E+00	2.379E-01
15	1997	0.485	7.146E+03	7.404E+03	3.594E+03	3.594E+03	4.108E+03	1.476E+00	3.020E-01
16	1998	0.391	7.659E+03	8.282E+03	3.240E+03	3.240E+03	4.492E+03	1.190E+00	3.237E-01
17	1999	0.099	8.911E+03	1.105E+04	1.089E+03	1.089E+03	5.547E+03	2.997E-01	3.767E-01
18	2000	0.077	1.337E+04	1.617E+04	1.243E+03	1.243E+03	6.963E+03	2.338E-01	5.651E-01
19	2001		1.909E+04						8.068E-01

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

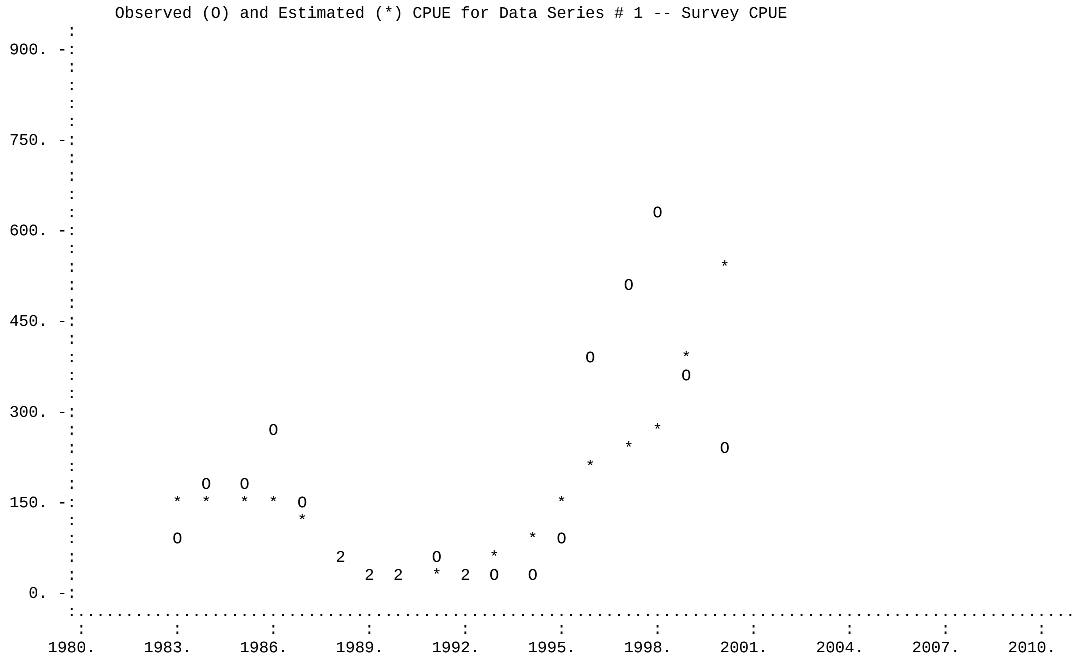
Data type CC: CPUE-catch series Series weight: 1.000

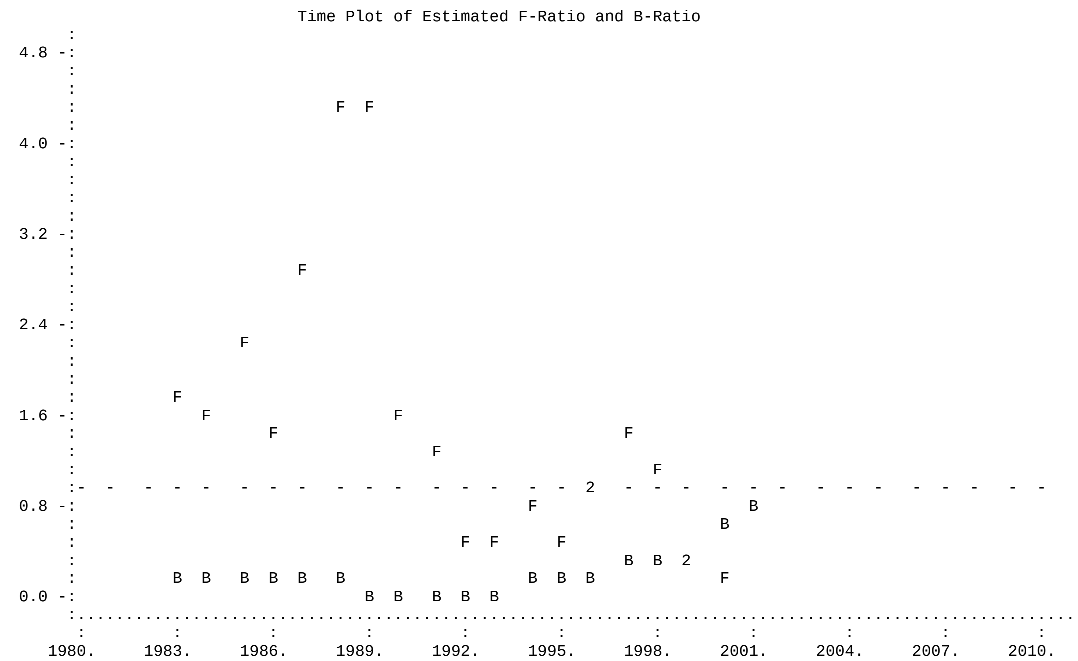
Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1983	7.899E+01	1.373E+02	0.5894	2.367E+03	2.367E+03	0.55254	0.000E+00
2	1984	1.752E+02	1.431E+02	0.5292	2.216E+03	2.216E+03	-0.20215	0.000E+00
3	1985	1.735E+02	1.391E+02	0.7274	2.961E+03	2.961E+03	-0.22051	0.000E+00
4	1986	2.661E+02	1.400E+02	0.4652	1.905E+03	1.905E+03	-0.64234	0.000E+00
5	1987	1.640E+02	1.274E+02	0.9335	3.479E+03	3.479E+03	-0.25290	0.000E+00
6	1988	7.311E+01	7.414E+01	1.4251	3.091E+03	3.091E+03	0.01393	0.000E+00
7	1989	3.655E+01	3.337E+01	1.4464	1.412E+03	1.412E+03	-0.09122	0.000E+00
8	1990	2.324E+01	2.305E+01	0.5352	3.610E+02	3.610E+02	-0.00815	0.000E+00
9	1991	5.097E+01	2.740E+01	0.4179	3.350E+02	3.350E+02	-0.62079	0.000E+00
10	1992	2.843E+01	4.000E+01	0.1316	1.540E+02	1.540E+02	0.34139	0.000E+00
11	1993	2.576E+01	6.604E+01	0.1377	2.660E+02	2.660E+02	0.94153	0.000E+00
12	1994	4.468E+01	1.014E+02	0.2445	7.250E+02	7.250E+02	0.81920	0.000E+00
13	1995	9.532E+01	1.545E+02	0.1330	6.010E+02	6.010E+02	0.48269	0.000E+00
14	1996	3.803E+02	2.177E+02	0.3307	2.106E+03	2.106E+03	-0.55782	0.000E+00
15	1997	5.164E+02	2.531E+02	0.4854	3.594E+03	3.594E+03	-0.71311	0.000E+00
16	1998	6.377E+02	2.831E+02	0.3912	3.240E+03	3.240E+03	-0.81217	0.000E+00
17	1999	3.685E+02	3.776E+02	0.0986	1.089E+03	1.089E+03	0.02428	0.000E+00
18	2000	2.465E+02	5.526E+02	0.0769	1.243E+03	1.243E+03	0.80717	0.000E+00

UNWEIGHTED LOG RESIDUAL PLOT FOR DATA SERIES # 1

```
                   -1       -0.75     -0.5      -0.25       0        0.25      0.5       0.75       1
                    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |    .    |
Year   Residual    -------------------------------------------------------------------------------------
1983     0.5525                                             |======================
1984    -0.2022                                     ========|
1985    -0.2205                                    =========|
1986    -0.6423                   ==========================|
1987    -0.2529                                   ==========|
1988     0.0139                                             |=
1989    -0.0912                                         ====|
1990    -0.0082                                             |
1991    -0.6208                    =========================|
1992     0.3414                                             |==============
1993     0.9415                                             |======================================
1994     0.8192                                             |=================================
1995     0.4827                                             |===================
1996    -0.5578                       ======================|
1997    -0.7131                =============================|
1998    -0.8122             ================================|
1999     0.0243                                             |=
2000     0.8072                                             |================================
                   -------------------------------------------------------------------------------------
```

Table 2.3.2.1 Faroe Bank Cod RV (Continued)





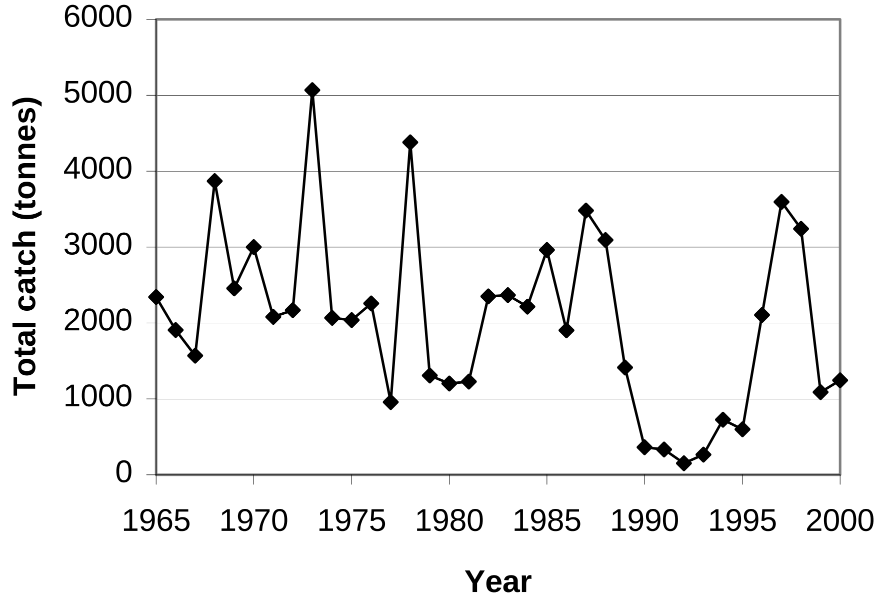


Figure 2.3.1.1. Faroe Bank (sub-division Vb2) COD. Reported landings 1965-2000. From 1992 only catches from Faroese and Norwegian vessels is considered to be taken on Faroe Bank.

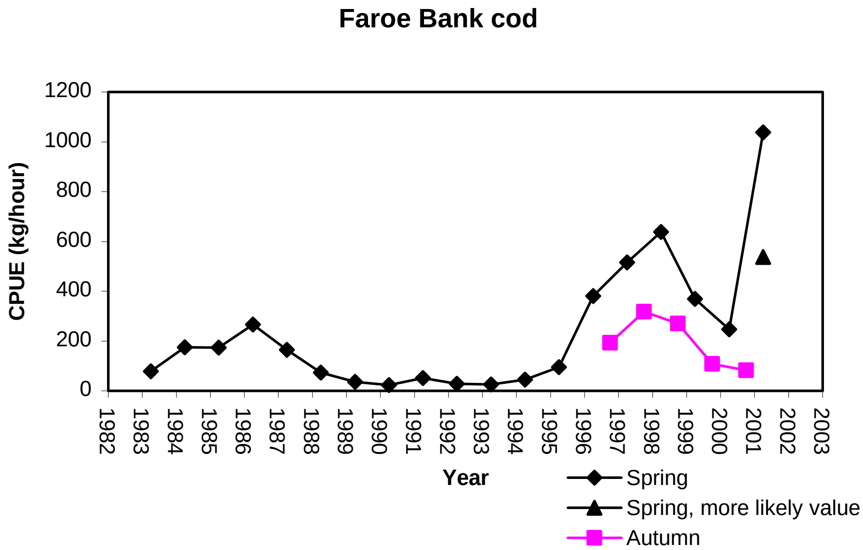


Figure 2.3.2.1. Faroe Bank (sub-division Vb2) COD. Catch per unit of effort in the spring groundfish survey and autumn groundfish survey. If one large haul (14 tonnes) is replaced by 4 tonnes (more typical for that particular station) the CPUE drops from about 1000 kg/hour to about 500 kg/hour.

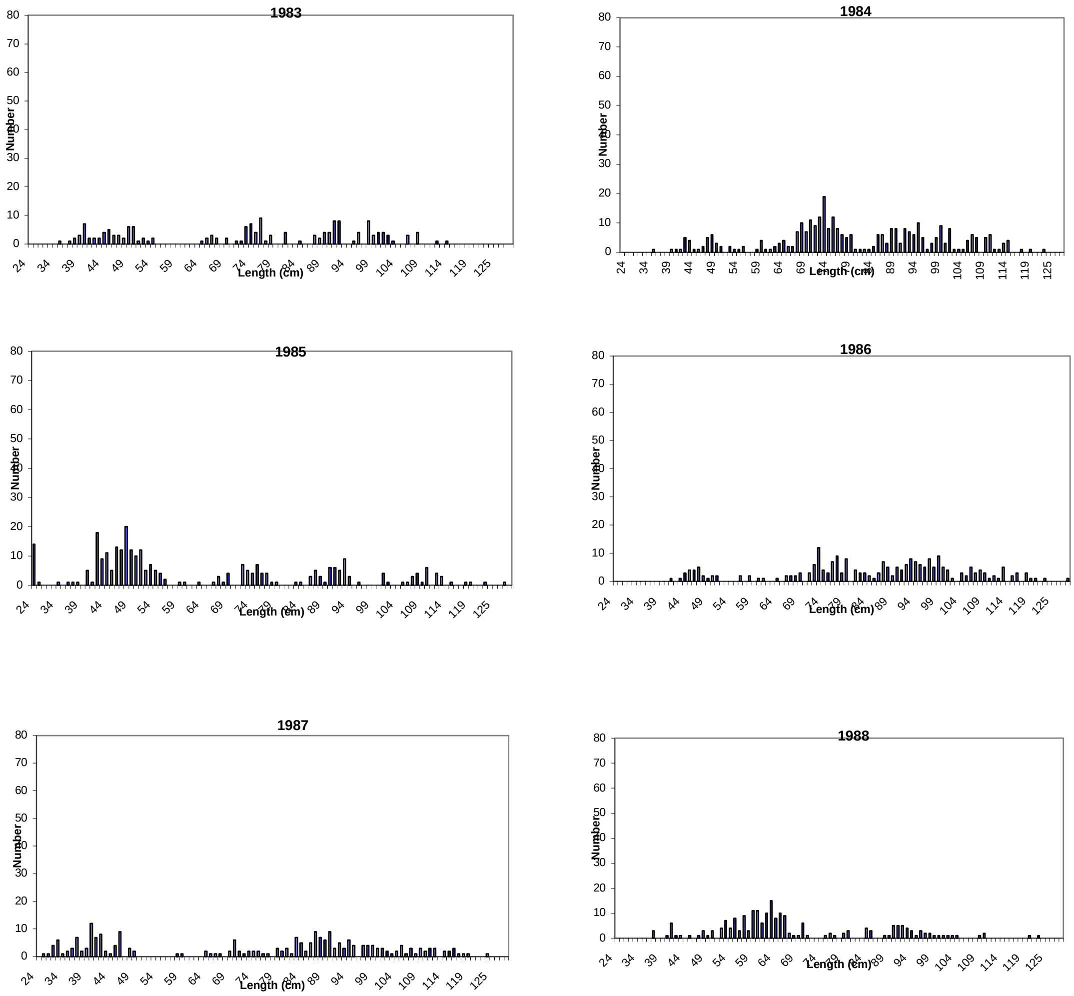


Figure 2.3.2.2. Faroe Bank (sub-division Vb2) COD. Length distributions in the spring survey 1983-1999 and 2001.

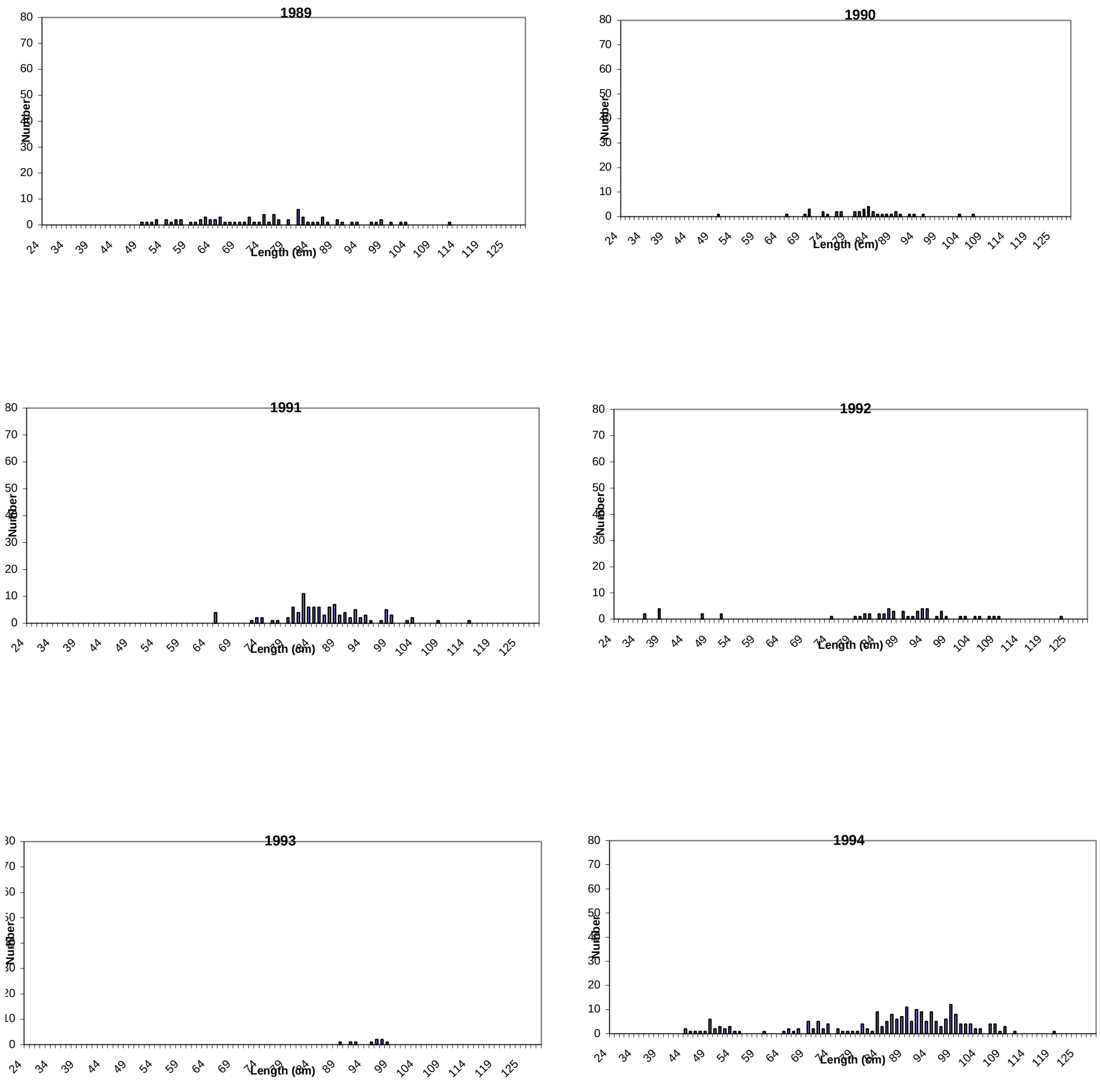


Figure 2.3.2.2 (Continued)

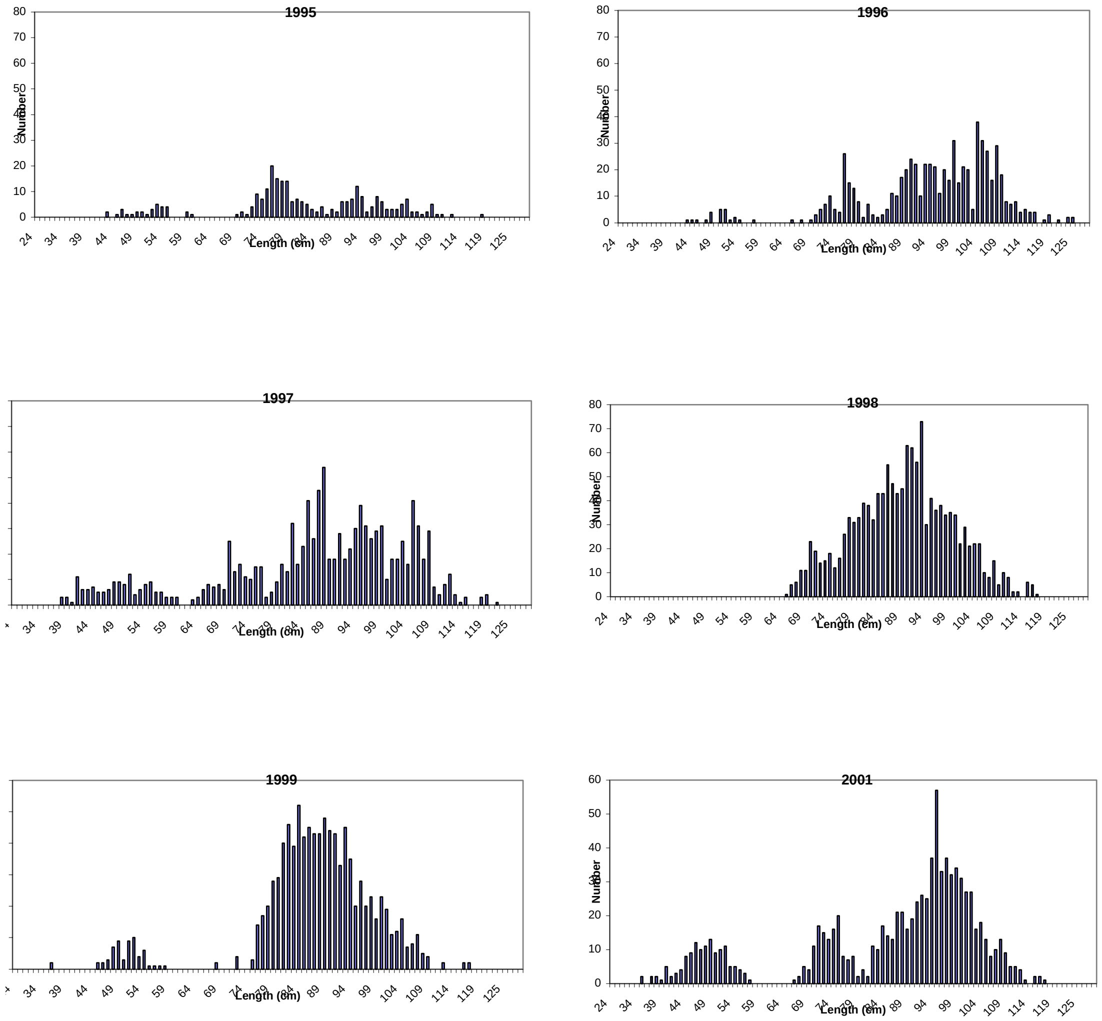


Figure 2.3.2.2 (Continued)

2.4 Faroe Haddock

2.4.1.1 Landings and trends in the fishery

Nominal landings of haddock from the Faroe Plateau increased from a low of 10,000 t in 1982 to 14,000 t in 1987, but later decreased drastically to the lowest recorded at about 4,000 t; a slight increase to about 4,600 t was noted for 1995 but in 1996 and 1997 catches almost doubled each year to about 9,200 t and 16,700 t, respectively. In 1998 landings increased further to more than 19,000 t but decreased again in 1999 and 2000 to 17,200 t and 14,600 t (Table 2.4.1). Nominal landings for 1982–1992 from the Faroe Bank have varied between 500 and 1,600 t (on average 1,000 t), but dropped in 1993–1996 to 300-500 t. The closure of the fishery on the shallower parts of the Bank in 1990 and the introduction of a controlled fishery there since 1993, as described in Section 2.1, reduced the Faroese landings (Table 2.4.2) whereas Scottish landings remained relatively high in 1990-92. However, in the assessment only the fraction of the Scottish catches, which have been reported to the Faroese authorities are included. In 1997 and 1998, landings on the bank increased abruptly to 1,300 and 3,000 t, but declined again in 1999 and 2000 to 1,100 t and 1,600 t. In some years, minor Faroese catches of haddock are taken in ICES Division IIa close to the boundary with Sub-Division Vb1 (labelled IIa4 in Figure 2.1.15 in ICES C.M., 1997). These catches are believed to be from the Faroe haddock stock and are consequently used in the assessment (Table 2.4.1).

Faroese vessels have taken almost the entire catch in recent years (Figure 2.4.1). Table 2.4.3 shows the Faroese landings since 1985 and the proportion taken by each fleet category. Pair trawlers and longliners took most of the catches in these years and within these two groups the relative importance of the larger vessels has increased. Due to poor catches and poor economic conditions, the effort of most fleets decreased in the early 1990s but from 1995 it has increased again (Tables 2.1.4 and 2.4.8). In addition, the fishing ban on the cod spawning grounds before and during the spawning period of cod since 1992 (Section 2.1) has had a restrictive impact on the haddock fishery as well. The catch rates for most fleets have declined drastically since the late 1980s. However, from 1995 the CPUE for most fleets has increased considerably (ICES C.M., 1999).

The 2000 monthly Faroese landings of haddock by fleet category from Sub-Divisions Vb1 and Vb2, are shown on Figure 2.4.2. The landings from the Plateau are high from late summer to the end of the spawning time in late April and stay low during the summer time. On the Faroe Bank the monthly landings show a similar pattern although the landings in mid winter are small. In 2000, pairtrawlers took the majority of the catch on the Faroe Bank followed by the longliners larger than 100 GRT on second place. On the Faroe Plateau the longliner landings are substantial except during the summer months when most of the longliners fish in deeper waters and/or outside the Faroese EEZ. The longline fishery mostly targets both cod and haddock, although haddock since the late 1980s must be characterized as a by-catch only. Haddock has also been by-catch in the trawler catches since the late 1980s except for the 2-3 most recent years.

2.4.2 Catch at age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. Data from the two areas are combined, as the fish are believed to belong to the same stock. The sampling intensity in 2000 is shown in the text table below. Compared to 1999, number of samples and of length measurements was higher in 2000 whereas the number of age readings and individual weightings was somewhat lower.

No. of samples:	312
No. of length measurements:	64215
No. of individual weight measurements:	3358
No. of aged fish:	7604

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

2.4.3 Weight at age

Mean weight-at-age data are provided for the Faroese fishery (Table 2.4.6). The sum-of-products check for 2000 was 1.04. Figure 2.4.4 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. After a decrease from a high level in the middle of the 1990s for all age groups in the most recent years, the weights have increased again for all ages except for the age 7.

2.4.4 Maturity at age

Maturity-at-age data were available from the Faroese Groundfish Surveys 1982–2001. The surveys are carried out in February-March, so the maturity at age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages should be relatively easy. In order to reduce eventual year-to-year effects due to possible inadequate sampling and at the same time allow for trends in the series, a 3-year running average was used in the assessment. For the years prior to 1982, average maturity at age from the surveys 1982–1995 was adopted (Table 2.4.7).

2.4.5 Assessment

2.4.5.1 Tuning and estimates of fishing mortality

Although several commercial catch per unit effort series are available, only two commercial series (see below) have been used for tuning as in last years assessment. Two annual groundfish survey series are available, one carried out in February-March since 1982, and the other in August-September since 1996. Due to problems with the database, it has not been possible to update the survey indices since 1999 and a major revision of the data in the base prior to 1999 is necessary before the existing data can be relied upon. This work is ongoing and is given a very high priority. It is expected that both survey series will be evaluated in next year's assessment. The lack of reliable survey indices has a major impact on the estimation of recent and future recruiting year classes, which again deteriorates the current estimate of stock status and the short-term predictions.

The two commercial series used for tuning of this years VPA consist of a longliner series consisting of the logbook data from 5 selected longliners larger than 100 GRT (directed effort measured as number of hooks) and a trawler series consisting of logbook data (catch at age in numbers and corresponding effort in number of trawlhours) from a homogenous group of pairtawlers larger than 1 000 HP which have been engaged in a mixed saithe, cod and haddock fishery since the middle of the 1980s (Table 2.4.8). Basically the series are the same as used last year, but in addition to updating the series by another year, the series now are based on a considerably larger amount of data since more logbooks have been made available and existing data have been quality checked and corrected. Last year the two series were analysed in details and plots of log Q residuals from Laurec-Shepherd runs were presented. The plots are not be repeated this year since the revised series are expected to behave almost identically to last years series because the age disaggregations are based on the same keys, and the overall trend is almost the same (Figure 2.4.5). The trawl and longline series seem however to behave somewhat different (Figure 2.4.6), but when used separately in tuning of the XSA, they result in almost identical results (WD 21).

Last year, based on the diagnostics from the L-S tunings, some ages were removed from the tuning series before tuning due to noise and apparent trends in the residuals, and the XSA was run with a shrinkage of 0.3 as there were no clear differences in the retrospective patterns of the fishing mortalities when using shrinkages of 0.3, 0.5 and 0.7 and because the VPA have been very unstable from year to year making it sensible to use a heavy shrinkage. This year a default XSA was run with the same settings as last year, and the retrospective plots of reference fishing mortalities, SSB's and R's are shown in Figure 2.4.7 A+B together with two additional shrinkages. The best retrospective patterns were obtained with no shrinkage (shrinkage = 2.0) but the estimated fishing mortalities are far too low to explain the recent development in the catches. The other two shrinkages indicate pronounced increases in fishing mortalities in recent years and consequently drastic declines in the stock size, which completely changes the perception of the state of the stock. Following analysis of the diagnostics from the XSA, it was decided to shorten the CPUE time series to only use data from 1990 onwards. Moreover the age range in the longliner series was increased from 4-8 to 3-8 and in the pair trawler series 5-8 to 4-7 in order to include more information on the younger ages. The retrospective plots of reference fishing mortalities, SSB's and R's using this revised tuning series and shrinkages 0.3, 0.5 and 2.0 are shown in Figure 2.4.7. The group decided to use the XSA shrunk 0.5 in the tuning of this years VPA.

The fishing mortalities from the final XSA run are given in Table 2.4.10 and in Figure 2.4.8A. According to this the fishing mortality has shown an overall decline since the early 1960s and it has been estimated to be below or at the natural mortality of 0.2 in several years from the late 1970s. Since 1993 it has been increasing again and in 1998 and 1999 it was estimated above 0.5, but decreased somewhat in 2000 to just below 0.5. Based on among others the retrospective pattern it was felt that the fishing mortality in 2000 is poorly estimated so it was decided to replace them with the average 1998-2000.

As seen in the retrospective plot on Figure 2.4.7, the tendency to overestimate terminal fishing mortalities in the terminal years has reversed in most recent years. This could be owing to abrupt increase in the stock size followed by a decrease. According to the overall CPUE values from the survey (Figure 2.4.9), the stock seems to have declined again from the recent historical highs. Last year based on different sources of information it was noted that the assessment of the fishing mortalities very probable were underestimates. The current assessment support that view.

2.4.5.2 Stock estimates and recruitment

Compared to recent assessments, this year's assessment has changed the perception of stock size considerably. The stock size in numbers is given in Table 2.4.11 and a summary of the "VPA" with the biomass estimates is given in Table 2.4.12 and Figure 2.4.8B. According to this assessment, the spawning stock biomass decreased from 66 000 t in 1987 to 21 000 t in 1994, increased to 77 000 t in 1997 but have since decreased considerably to about 40 000t in 2000. The decline in the spawning stock began in the late 1970s due to very poor recruitment in those years. The stabilization at relatively high SSB's in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since then was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights at age in the stock.. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the outstandingly large 1993 yearclass and the well above average 1994 yearclass. Due to the lack of reliable recruitment indices, the estimate of the most recent yearclasses, especially the 1998 yearclass, is poor. Therefore it was decided not to use the very high estimate from the XSA directly but to replace it with the geometric mean of the 1980-2000 recruitments at age 2. However, there are indications from survey samples that this geometric mean might be too conservative (Figure 2.4.10). The total biomass and the SSB were recalculated correspondingly.

2.4.6 Prediction of catch and biomass

2.4.6.1 Input data

2.4.6.1.1 Short-term prediction

The input data for the short-term predictions are given in Table 2.4.13. The year classes up to 1997 inclusive are from the final VPA while the 1998-2001 year classes at age 2 were estimated as the geometric mean of the 2 year olds in 1980-2000.

The exploitation pattern used in the prediction was derived from averaging the 1998–2000 fishing mortality matrices from the final VPA and then rescaling the averages to 2000. The same pattern was used for all three years.

The mean weight at age for ages 2-10 in 2001 was calculated as the average weight at age in 1998-2000. The 2001 mean weights at age were also applied for 2002 and 2003.

The maturity ogives for 2001-2003 are based on samples from the Faroese Groundfish Spring Surveys and estimated as the average of the smoothed 1999-2001 values.

2.4.6.1.2 Long-term prediction

The input data for the long-term yield and spawning stock biomass (yield per recruit calculations) are listed in Table 2.4.14. Mean weights-at-age are averages for the 1977–2000 period. The maturity ogives are averages for the years 1982-2000. The exploitation pattern was derived from the fishing mortality matrix from the final VPA as average F-values for the long time period, rescaled to the 2000 F_{bar}(age3-7).

2.4.6.2 Biological reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 2.4.16 and Figure 2.4.8C. $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are indicated here as 0.42 and 0.17, respectively. From Figure 2.4.11, showing the recruit/spawning stock relationship, and from Table 2.4.18, $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ were calculated to be 0.27 and 0.78, respectively.

In previous assessments of this stock the Minimum Biological Acceptable Limit (MBAL) was set at 40 000 t because the occurrence of good recruitment is considerably higher when the spawning stock biomass is above this value (Figure 2.4.11). Therefore, this is an appropriate value for a limit reference point and thus, $\mathbf{B}_{lim}$ is set by ACFM at 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. By inspecting the VPA results for the whole series, the NWWG felt this proposal to make sense as the recruitment in the last two decades has been very low with occasional big year classes. However, if recruitment returns to the levels seen in the 1960s and 1970s, when the stock apparently could withstand high fishing mortalities, this proposal might be too conservative.

The history of the haddock fishery in relation to the four reference points can be seen in Figure 2.4.12. In the period 1961-69 the fishing mortality was above $\mathbf{F}_{lim}$ and the spawning stock biomass was below $\mathbf{B}_{pa}$. Except for 1977–1978 the stock/fishery was in a precautionary zone in the period 1974–1981. In 1989 the biomass went below $\mathbf{B}_{pa}$ and continued to decrease and went 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 yearclass and the well above long-term average 1994 year class. According to this assessment, the stock was above or close to $\mathbf{B}_{pa}$ in 1996-1999, but is now close to $\mathbf{B}_{lim}$. The fishing mortality has however been above $\mathbf{F}_{pa}$ since 1996, and from 1998 even above $\mathbf{F}_{lim}$.

2.4.6.3 Projections of catch and biomass

2.4.6.3.1 Short-term prediction

In the light of the performance of the new management system (Section 2.4.8), it is not unrealistic to assume the same fishing mortalities in 2001 as the average of the ones in 1998-2000. The catch in 2001 is then predicted to be about 20 000 t and continuing with this fishing mortality will result in a 2002 catch of 12 000 t. The SSB will in this case decrease from 39 000 t in 2001 to 27 000 t in 2002, and 22 000 t in 2003. The results of the short-term prediction are shown in Table 2.4.15 and in Figure 2.4.8D. This prediction should be interpreted cautiously given the apparent poor estimation of recruitment and the changes in estimations of recent terminal fishing mortalities. If stock size and landings in 1999 (and 2000) are compared, the predicted 2001 landings seem too high.

In order to evaluate the influence of these poorly estimated yearclasses on the SSB composition in 2003, an exercise was made in Excel with two different estimates of the 1998 yearclass in 2201, i.e. based on the geometric mean 1980-2000 (as in the present prediction) and the high estimate from this years assessment. The 1999 and 2000 yearclasses were in both cases the geometric mean 1980-2000. The result showed that in the present prediction the 1998 accounts for 19% of the SSB in 2003, and the poorly estimated 1998-200 yearclasses all together 45% of the 2003 SSB. With the high estimate of the 1998 yearclass, the same accounts were 42% and 60%, respectively.

The overall CPUE from the survey supports the development of the SSB in recent years (Figure 2.4.9). However, this series seem to flat out in 1999-2001.

2.4.7 Medium term projections

In the management of demersal fish stocks in Vb several technical measures have been introduced. Based on among others a certain number of fishing days allocated to the fleets in the system and an arrangement with temporarily and static area closures the goal is on average to keep the fishing mortality on each of the stocks of cod, haddock and saithe at F=0.45 corresponding to yearly average catches of 33% of the exploitable stock in numbers.

In order to examine the development of catches and SSBs in coming years, medium term predictions were done (20 years) for Faroe haddock using the results of the accepted XSA calibration and using the same parameters as those used for the short term predictions (Table 2.4.17 and Figure 2.4.13). Recruitment for the projection years was randomly drawn from past observations and four fishing mortality options were considered: $\mathbf{F}_{sq}$, 0.75$\mathbf{F}_{sq}$, F=0.45 and $\mathbf{F}_{pa}$=0.25. Two hundred and fifty runs were made for each combination of fishing mortality randomly drawing recruitment from past observations.

The median catches for all fishing mortality options are expected to decrease in the near future and increase afterwards, to stabilise slightly in excess of 15 000t. Because in these calculations, recruitment is assumed to not depend on SSB, catches do not decrease in the future even at the current relatively high fishing mortality. The lines are the median of 250 different projections, which individually show considerably more variability than the medians do.

The median SSB under the different fishing mortality options show trends similar to those of the catches. At $\mathbf{F}_{sq}$ and F=0.45, the median SSBs remain close to $\mathbf{B}_{lim}$=40 000t, they remain less than $\mathbf{B}_{pa}$ at 0.75$\mathbf{F}_{sq}$, but at $\mathbf{F}_{pa}$ the median SSB is larger than $\mathbf{B}_{pa}$.

The probabilities that SSB will be less than $\mathbf{B}_{pa}$ or less than $\mathbf{B}_{lim}$ have been calculated. At $\mathbf{F}_{sq}$ and F=0.45 the probabilities are high that the SSB will be less than both $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$. The current assessment shows considerably smaller stock size than the previous one, and the medium term projections indicate non-negligible probabilities that the SSB will be less than $\mathbf{B}_{lim}$ even at $\mathbf{F}_{pa}$. This suggest that fishing mortality should be decreased to at least to $\mathbf{F}_{pa}$ at the earliest possible time in order to minimise the risk of serious stock declines.

2.4.8 Managements considerations

The medium term predictions presented here assume that the future will repeat itself, at least with respect to the ability of the Faroese waters to produce haddock. There are indications that the recruitment of haddock has been somewhat smaller during the 1980s and 1990s than during the 1960s and 1970s. The projections have used the whole time series of recruitment estimates available, and they therefore present an optimistic hypothesis. If recruitment had been selected randomly from the most recent 20 years only in the medium term predictions, the median catches and SSB would be lower while the probabilities of SSB being less than $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$ would all be higher at the fishing mortality tested.

These medium-term predictions do not take account of changes in weights at age, maturity at age, or natural mortality that would result from changes in the size of the haddock stock, its preys or its predators. As such, they cannot be considered forecast of future events. Their main use is in comparing the relative results of management actions taken today.

It should be noted that these medium-term predictions assume that the productive capacity of the environment has not changed. The medium-term simulations assumed that the current assessment is correct, although recent assessment have consistently overestimated stock size. The medium-term projections would therefore be likely to overestimate future stock size if the fishing mortality is underestimated in the 2001 as in the previous ones.

2.4.9 Comments on the assessment

Although the assessment basically is an updated version of the 2000 assessment there are some minor changes. The two tuning fleets have been revised and more logbooks have been included. The age range in the tuning fleets has been expanded to include younger ages. The XSA was shrunk 0.5 compared to a shrinkage of 0.3 last year.

The assessment of Faroe haddock has been problematic in recent years as indicated by the large differences from year to year seen in retrospective analyses. The reasons for the unstable assessment results are among others:

Recruitment has been low since the middle of the 1980s except for the exceptionally large 1993 and the large 1994 yearclasses.

- Due to the low recruitment, the stock has been very low and most of the haddock was taken as by-catch.

All recent assessments have shown that the fishing mortalities was less than 0.25 in the 1980s and 1990s. Therefore, it took many years for the VPA to converge and large changes could be observed from one assessment to the next. This year, however, the perception of the stock has changed a lot, since it shows that fishing mortalities in most recent years have increased considerably and from 1997 have been above $\mathbf{F}_{lim}$.

When large yearclasses enter the fishery, the VPA tends to overestimate the F’s and underestimates their size, while when weak yearclasses enter the fishery, the F’s tend to be underestimated. This is possibly linked to shrinkage.

Given the instability of the Faroe haddock assessment over the last few years, The WG investigated the potential use of estimating fishing mortality in the terminal year without CPUE information. The process is started by assuming an arbitrary fishing mortality for the most recent year. Population numbers in the terminal year are calculated from N = C x (F+M) / F x (1-exp(-F+M)) and in other years from $N_{t-1} = N_t$ x exp(M) + C_t x exp(M/0.2). Fishing mortalities are then calculated from LN(N_t/N_{t+1}) – M. After the very first calculation started for all terminal year classes with an arbitrary F = 0.40, F on age 9 was assumed equal to the average of the fishing mortalities on ages 5 to 7 in the same year while F on ages 2 to 8 in the terminal year were assumed to be equal to the average F on the same age in the previous three years. F in the terminal year was iteratively replaced with a new average until the maximum of the absolute difference between successive runs was less than 0.0001. Between 5 and 7 iterations were necessary to reach this criterion. The retrospective analysis of this method is shown in Figure 2.4.14.

Contrary to VPA tuned with CPUE, the evolution of the retrospective pattern is relatively easy to interpret; it reflects the sign of the error in assuming that F has been constant. Therefore, when F is decreasing, F is being overestimated and conversely when F is increasing. This exercise suggests that there is indeed reasonably good information in the catch at age alone. It is hoped that using the two survey indices in next year's assessment will be sufficient to stabilize the assessment. In the event that this were not the case, this iterative method could provide information on fishing mortality in the terminal year, particularly if there is information on fishing effort as well.

The Aspic software has proven useful in several assessments done by the NWWG this year. Using the yearly kg/tow from both surveys as indices of stock size in Aspic may provide a more stable alternative to providing management advice.

Table 2.4.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries 1982-2000, as officially reported to ICES, and the total Working Group estimate in Vb.

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

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000 [2]
Faroe Islands	4,655	3,622	3,675	4,549	9,152	16,585	19,135	16,643	14,038
France[1]	164	-					2 [2,7]	0	1 [6]
Germany	-	-		5	-	-		33	1 [7]
Greenland								30 [6]	22 [6]
Norway	71	28	22	28	45	45 [2]	71 [2]	415 [2]	372
UK (Engl. and Wales)	54	81	31	23	5	22 [1]	30 [1]	59 [7]	
UK (Scotland)[3]	-	-	-	-	…	…	…		
United Kingdom									204 [7]
Total	4,944	3,731	3,728	4,605	9,202	16,652	19,238	17,180	14,638
Working Group estimate[4,5]	5,476	4,026	4,252	4,948	9,642	17,924	22,210	18,486	16,286

1) Including catches from Sub-division Vb2. Quantity unknown 1989-1991, 1993 and 1995-2000.

2) Provisional data

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

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

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

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

7) Reported as Division Vb.

Table 2.4.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries, 1982-2000, as officially reported to ICES.

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

Country	1992	1993	1994	1995	1996	1997	1998	1999	2000 [2]
Faroe Islands	338	185	353	303	338	1,133	2,810	1,110	1,600
France[1]	-	-	-	-	-	-			
Norway	23	8	1	1 [2]	40 [2]	4 [2]	60 [2]	3 [2]	48
UK (Engl. and Wales)	+	+	+	... [1]	… [1]	… [1]	… [1]	[1]	[1]
UK (Scotland)[3]	869	102	170	39	62	135 [1]	102	193	[1]
Total	1,230	295	524	343	440	1,272	2,972	1,306	1,648

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)

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

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

Table 2.4.4 Haddock in ICES Division Vb 2000

Catch at age in numbers by fleet category

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 400HP	Vb1 OB. trawl. 400-999HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb1 Others	Vb1 Faroe Fleets	Vb2 Faroe LLiners	Vb2 Faroe Pairtrawl.	Vb2 Faroe Others	Vb2 Faroe Fleets	Vb Foreign Trawlers	Vb1 Foreign LLiners	Vb2 Foreign LLiners	Vb Total
1	4	44	21	0	0	0	0	0	4	71	0	0	0	0	0	2	0	73
2	36	660	450	71	60	24	13	41	55	1400	16	33	2	52	7	35	2	1504
3	63	979	736	102	142	64	74	186	60	2306	124	515	28	670	19	67	13	3151
4	3	43	61	4	4	4	6	22	3	150	16	38	3	69	1	6	2	216
5	6	123	192	25	26	30	39	109	10	564	40	61	7	110	9	15	4	702
6	20	442	876	112	136	167	197	539	43	2537	43	54	9	106	46	66	4	2784
7	25	527	1080	122	131	148	163	474	46	2736	28	32	5	64	44	84	3	2930
8	1	30	20	1	2	2	2	9	2	69	3	8	1	10	1	2	0	81
9	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
10	0	6	2	0	0	0	0	0	0	9	0	0	0	0	0	0	0	9
11	0	5	12	0	0	0	1	0	0	20	0	0	0	0	0	1	0	21
12	0	8	3	1	1	1	1	3	0	19	0	0	0	0	0	0	0	20
13	0	2	3	0	0	0	0	2	0	8	0	0	0	0	0	0	0	9
14	0	0	3	0	0	0	0	3	0	8	0	0	0	0	0	0	0	8
15	0	4	1	0	0	0	0	0	0	6	0	0	0	0	0	0	0	6
Total no.	149	2075	3461	440	526	431	497	1387	234	9990	269	740	56	1081	127	269	28	11496
Catch, t.	198	3263	4673	632	645	632	668	1948	291	12700	418	906	60	1431	186	366	43	14672

Notes: Numbers in '000'

Catch, gutted weight in tonnes

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

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

Table 2.4.5

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 30/04/2001 19:55

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	7932,	9631,	13552,	2284,	1368,	1081,	1425,	5881,	2384,	1728,
3,	7330,	13977,	8907,	7457,	4286,	3304,	2405,	4097,	7539,	4855,
4,	5134,	5233,	7403,	3899,	5133,	4804,	2599,	2812,	4567,	6581,
5,	1937,	2361,	2242,	2360,	1443,	2710,	1785,	1524,	1565,	1624,
6,	1305,	1407,	1539,	1120,	1209,	1112,	1426,	1526,	1485,	1383,
7,	838,	868,	860,	728,	673,	740,	631,	923,	1224,	1099,
8,	236,	270,	257,	198,	1345,	180,	197,	230,	378,	326,
9,	59,	72,	75,	49,	43,	54,	52,	68,	114,	68,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
TOTALNUM,	24771,	33819,	34835,	18095,	15500,	13985,	10520,	17061,	19256,	17664,
TONSLAND,	20831,	27151,	27571,	19490,	18479,	18766,	13381,	17852,	23272,	21361,
SOPCOF %,	89,	90,	90,	101,	94,	109,	102,	103,	108,	103,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	717,	750,	3300,	5633,	7337,	4396,	255,	32,	1,	143,
3,	4393,	3744,	8388,	2899,	7952,	7858,	4039,	1022,	1161,	58,
4,	4727,	4179,	1236,	3970,	2097,	6798,	5168,	4248,	1754,	3724,
5,	3267,	2706,	2786,	451,	1371,	1251,	4918,	4054,	3341,	2583,
6,	1292,	1171,	916,	976,	247,	1189,	2128,	1841,	1850,	2496,
7,	864,	696,	1051,	466,	352,	298,	946,	717,	772,	1568,
8,	222,	180,	150,	535,	237,	720,	443,	635,	212,	660,
9,	147,	113,	68,	68,	419,	258,	731,	243,	155,	99,
+gp,	0,	0,	11,	147,	187,	318,	855,	312,	74,	86,
TOTALNUM,	15629,	13539,	17906,	15145,	20199,	23086,	19483,	13104,	9320,	11417,
TONSLAND,	19393,	16485,	17976,	14773,	20715,	26211,	25555,	19200,	12418,	15016,
SOPCOF %,	99,	98,	98,	97,	117,	107,	98,	99,	104,	100,

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	74,	539,	441,	1195,	985,	230,	283,	655,	63,	105,
3,	455,	934,	1969,	1561,	4553,	2549,	1718,	444,	1518,	1275,
4,	202,	784,	383,	2462,	2196,	4452,	3565,	2463,	658,	1921,
5,	2586,	298,	422,	147,	1242,	1522,	2972,	3036,	2787,	768,
6,	1354,	2182,	93,	234,	169,	738,	1114,	2140,	2554,	1737,
7,	1559,	973,	1444,	42,	91,	39,	529,	475,	1976,	1909,
8,	608,	1166,	740,	861,	61,	130,	83,	151,	541,	885,
9,	177,	1283,	947,	388,	503,	71,	48,	18,	133,	270,
+gp,	36,	214,	795,	968,	973,	712,	334,	128,	81,	108,
TOTALNUM,	7051,	8373,	7234,	7858,	10773,	10443,	10646,	9510,	10311,	8978,
TONSLAND,	12233,	11937,	12894,	12378,	15143,	14477,	14882,	12178,	14325,	11726,
SOPCOF %,	109,	92,	106,	106,	106,	101,	102,	97,	100,	102,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	77,	40,	113,	277,	804,	326,	77,	106,	174,	1504,
3,	1044,	154,	298,	191,	452,	5234,	2913,	1055,	1142,	3151,
4,	1774,	776,	274,	307,	235,	1019,	10517,	5269,	942,	216,
5,	1248,	1120,	554,	153,	226,	179,	710,	9856,	4678,	702,
6,	651,	959,	538,	423,	132,	163,	116,	446,	6620,	2764,
7,	1101,	335,	474,	427,	295,	161,	123,	99,	226,	2930,
8,	698,	373,	131,	383,	290,	270,	93,	87,	26,	81,
9,	317,	401,	201,	125,	262,	234,	220,	95,	20,	1,
+gp,	32,	162,	185,	301,	295,	394,	516,	502,	192,	73,
TOTALNUM,	6942,	4320,	2768,	2587,	2991,	7980,	15285,	17515,	14020,	11422,
TONSLAND,	8429,	5476,	4026,	4252,	4948,	9642,	17924,	22210,	18486,	16286,
SOPCOF %,	106,	106,	104,	100,	103,	100,	103,	101,	100,	104,

Table 2.4.6

Run title : FAROE HADDOCK (ICES DIVISION Vb)   HAD_IND

At 30/04/2001 19:55

Table 2   Catch weights at age (kg)

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,
SOPCOFAC,	.8938,	.9011,	.8964,	1.0131,	.9401,	1.0920,	1.0166,	1.0278,	1.0835,	1.0274,

Table 2   Catch weights at age (kg)

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.3110,	.3570,	.3570,	.6430,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.6330,	.7900,	.6720,	.7130,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,	.9410,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,
SOPCOFAC,	.9874,	.9795,	.9776,	.9718,	1.1712,	1.0746,	.9784,	.9947,	1.0380,	1.0017,

Table 2   Catch weights at age (kg)

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	.4520,	.7000,	.4700,	.6810,	.5280,	.6080,	.6050,	.5010,	.5800,	.4380,
3,	.7250,	.8960,	.7400,	1.0110,	.8590,	.8870,	.8310,	.7810,	.7790,	.6990,
4,	.9570,	1.1500,	1.0100,	1.2550,	1.3910,	1.1750,	1.1260,	.9740,	.9230,	.9390,
5,	1.2370,	1.4440,	1.3200,	1.8120,	1.7770,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,
6,	1.6510,	1.4980,	1.6600,	2.0610,	2.3260,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,
7,	2.0530,	1.8290,	2.0500,	2.0590,	2.4400,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,
8,	2.4060,	1.8870,	2.2600,	2.1370,	2.4010,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,
9,	2.7250,	1.9610,	2.5400,	2.3680,	2.5320,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,
+gp,	3.2500,	2.8560,	3.0400,	2.6860,	2.6860,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,
SOPCOFAC,	1.0870,	.9238,	1.0554,	1.0602,	1.0559,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,

Table 2   Catch weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	.5470,	.5250,	.7550,	.7540,	.6660,	.5340,	.5190,	.6220,	.5040,	.6610,
3,	.6930,	.7240,	.9820,	1.1030,	1.0540,	.8580,	.7710,	.8460,	.6240,	.9360,
4,	.8840,	.8170,	1.0270,	1.2540,	1.4890,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,
5,	1.0860,	1.0380,	1.1920,	1.4650,	1.7790,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,
6,	1.2760,	1.2490,	1.3780,	1.5930,	1.9400,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,
7,	1.4770,	1.4300,	1.6430,	1.8040,	2.1820,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,
8,	1.5740,	1.5640,	1.7960,	2.0490,	2.3570,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,
9,	1.9300,	1.6330,	1.9710,	2.2250,	2.4900,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,
+gp,	2.1530,	2.1260,	2.2400,	2.4230,	2.6780,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,
SOPCOFAC,	1.0635,	1.0554,	1.0361,	.9969,	1.0331,	1.0043,	1.0250,	1.0106,	.9975,	1.0363,

Table 2.4.7

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 30/04/2001 19:55

Table 5 Proportion mature at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	.0600,	.0700,	.0800,	.0800,	.0300,	.0300,	.0500,	.0500,	.0200,	.0800,
3,	.4800,	.5200,	.6200,	.7600,	.6200,	.4300,	.3200,	.2400,	.2200,	.3700,
4,	.9100,	.8800,	.8900,	.9800,	.9600,	.9500,	.9100,	.8900,	.8700,	.9000,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9800,	.9800,	.9900,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	.1600,	.1800,	.1500,	.1200,	.1000,	.0600,	.0200,	.0100,	.0100,	.0200,
3,	.5800,	.6500,	.5300,	.5000,	.5500,	.5700,	.5500,	.4500,	.4100,	.3800,
4,	.9300,	.9100,	.9000,	.9200,	.9700,	.9500,	.9300,	.8900,	.8600,	.8700,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.9900,	.9900,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.4.8

```
Haddock in the Faroe Ground (Fishing Area Vb)
102
5LL_01: 5lline>100GRT cod-had rev 2001 (Catch: Numbers*1000) (Effort: 1000
hooks)
1990 2000
1 1 0.0 1.0
3 8
 21123   50.426  126.710   58.614  125.417 152.570 74.992
 17376   44.691  129.226  110.919   62.998 110.919 66.228
 17305   13.986   46.103  107.745   93.759  47.139 35.224
 23784   37.374   33.698   75.974   82.101  76.587 12.254
 17787   21.864   37.480   17.569   39.823  41.385 35.528
 23031   43.703   18.490   22.972   15.408  28.855 30.256
 27128  489.712  121.333   22.515   20.639  14.072 34.711
 45863  429.808 1661.236  142.178   26.191  30.400 19.175
 48750   86.229  838.633 1953.830  107.787  21.032 26.815
 41049  136.341  127.022  784.727 1119.309  41.403  5.279
 43755  379.811   31.447   99.119  452.137 557.579 10.093
CUBA_01: Pair trawlers > 1000 HP (Catch: Thousands) (Effort: Trawl-hours)
1990 2000
1 1 0.0 1.0
4 7
   6532  21.733   15.603  42.909  50.432
   6892  23.709   49.092  28.172  35.424
   6560  13.119   36.655  51.317  17.749
   8299  11.296   28.069  37.996  41.762
  13871  34.405   18.049  75.014  72.194
  16215  39.185   30.072  16.403  45.564
  15087 107.807   15.613  13.383  13.383
  24406 879.389   77.593   4.619  10.161
  27274 462.582 1074.649  38.843   8.239
  28131  66.978  428.992 506.231  17.914
  21068  15.356   77.486 383.376 337.453
```

Table 2.4.9

Lowestoft VPA Version 3.1

30/04/2001 19:54

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb)   HAD_IND

CPUE data from file C:\Documents and Settings\jakupr\VPA\tunc_01.dat

Catch data for 40 years. 1961 to 2000. Ages 2 to 10.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
5LL_01: 5lline>100GR,	1990,	2000,	3,	8,	.000,	1.000
CUBA_01: Pair trawle,	1990,	2000,	4,	7,	.000,	1.000

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

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 = .500

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

Prior weighting not applied

Tuning converged after 35 iterations

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

Fishing mortalities

Age,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000
2,	.030,	.017,	.071,	.048,	.010,	.009,	.012,	.038,	.009,	.022
3,	.171,	.077,	.165,	.165,	.104,	.088,	.099,	.217,	.724,	.232
4,	.273,	.186,	.190,	.256,	.313,	.357,	.254,	.260,	.306,	.282
5,	.232,	.277,	.196,	.154,	.305,	.419,	.455,	.402,	.388,	.395
6,	.348,	.282,	.208,	.226,	.193,	.377,	.531,	.584,	.522,	.419
7,	.435,	.303,	.219,	.253,	.243,	.380,	.548,	1.313,	.674,	.462
8,	.287,	.255,	.185,	.276,	.274,	.368,	.395,	.994,	2.051,	.547
9,	.313,	.266,	.213,	.271,	.308,	.371,	.585,	.928,	.649,	.383

Table 2.4.9 (continued**)**

XSA population numbers (Thousands)

YEAR	AGE 2	3	4	5	6	7	8	9
1991	2.91E+03	7.33E+03	8.20E+03	6.65E+03	2.45E+03	3.45E+03	3.09E+03	1.30E+03
1992	2.69E+03	2.31E+03	5.05E+03	5.11E+03	4.32E+03	1.42E+03	1.83E+03	1.90E+03
1993	1.82E+03	2.16E+03	1.75E+03	3.43E+03	3.17E+03	2.67E+03	8.56E+02	1.16E+03
1994	6.51E+03	1.39E+03	1.50E+03	1.19E+03	2.31E+03	2.11E+03	1.76E+03	5.82E+02
1995	8.52E+04	5.08E+03	9.65E+02	9.51E+02	8.33E+02	1.51E+03	1.34E+03	1.09E+03
1996	4.22E+04	6.90E+04	3.75E+03	5.78E+02	5.74E+02	5.62E+02	9.69E+02	8.34E+02
1997	7.40E+03	3.43E+04	5.18E+04	2.15E+03	3.11E+02	3.22E+02	3.15E+02	5.49E+02
1998	3.11E+03	5.99E+03	2.54E+04	3.29E+04	1.11E+03	1.50E+02	1.53E+02	1.74E+02
1999	2.08E+04	2.45E+03	3.95E+03	1.61E+04	1.80E+04	5.09E+02	3.30E+01	4.63E+01
2000	7.59E+04	1.68E+04	9.73E+02	2.38E+03	8.92E+03	8.75E+03	2.12E+02	3.47E+00

Estimated population abundance at 1st Jan 2001

	0.00E+00	6.08E+04	1.09E+04	6.01E+02	1.31E+03	4.80E+03	4.51E+03	1.01E+02

Taper weighted geometric mean of the VPA populations:

	1.18E+04	8.10E+03	5.33E+03	4.01E+03	2.56E+03	1.33E+03	6.10E+02	3.39E+02

Standard error of the weighted Log(VPA populations) :

	1.2952	1.2048	1.2971	1.2310	1.2491	1.2459	1.3501	1.8159

Log catchability residuals.

Fleet : 5LL_01: 5lline>100GR

Age	1990
3	-.77
4	-.34
5	-.44
6	-.27
7	-.01
8	.13

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	-.24	-.29	.49	.68	-.21	-.57	-.52	-.39	1.36	.17
4	.12	-.46	-.03	.55	.05	.43	-.15	-.18	-.01	-.08
5	-.16	.10	-.21	-.34	-.04	.33	.35	.16	.13	-.09
6	.14	-.06	-.23	-.34	-.55	.04	.44	.54	.24	-.07
7	.40	.38	-.13	-.20	-.49	-.32	.56	1.21	.57	.17
8	-.07	-.19	-.84	-.16	-.31	.03	.05	1.30	1.77	-.08

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	-14.4450	-13.8043	-13.4886	-13.2996	-13.2996	-13.2996
S.E(Log q)	.6523	.2966	.2536	.3414	.5520	.7908

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
3	1.50	-2.376	17.21	.74	11	.79	-14.44
4	1.09	-1.204	14.31	.95	11	.32	-13.80
5	.99	.145	13.43	.96	11	.27	-13.49
6	1.05	-.483	13.56	.93	11	.37	-13.30
7	1.27	-1.818	14.73	.85	11	.58	-13.10
8	1.71	-3.423	17.93	.74	11	.89	-13.12

Table 2.4.9 (continued)

Fleet : CUBA_01: Pair trawle

Age	1990
3	No data for this fleet at this age
4	-.94
5	-.71
6	-.24
7	-.01
8	No data for this fleet at this age

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	-.67	-.77	-.09	.70	1.14	.89	-.17	-.21	-.29	-.08
5	-.18	-.14	-.28	-.19	.46	.42	.25	.01	-.23	.26
6	.19	.24	-.02	.47	-.20	.13	-.74	.03	-.25	.42
7	.11	.30	.25	.54	.25	.15	.02	.78	.04	.33
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	4	5	6	7
Mean Log q	-13.7895	-13.3610	-13.2311	-13.2311
S.E(Log q)	.6705	.3398	.3584	.3676

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
4	1.32	-1.588	15.53	.75	11	.82	-13.79
5	1.15	-1.542	14.14	.93	11	.36	-13.36
6	.91	1.118	12.71	.95	11	.32	-13.23
7	1.04	-.640	13.22	.96	11	.26	-12.97

Terminal year survivor and F summaries :

Age 2 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
5LL_01: 5lline>100GR	1.	.000	.000	.00	0	.000	.000
CUBA_01: Pair trawle	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	8102.	1.20				.147	.155
F shrinkage mean	86033.	.50				.853	.016

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60801.	.46	11.05	2	23.921	.022

Table 2.4.9 (continued)

Age 3 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
5LL_01: 5lline>100GR,	13027.,	.684,	.000,	.00,	1,	.298,	.198
CUBA_01: Pair trawle,	1.,	.000,	.000,	.00,	0,	.000,	.000
F shrinkage mean ,	10163.,	.50,,,,				.702,	.247

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
10942.,	.41,	.21,	2,	.513,	.232

Age 4 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
5LL_01: 5lline>100GR,	631.,	.290,	.415,	1.43,	2,	.608,	.270
CUBA_01: Pair trawle,	553.,	.703,	.000,	.00,	1,	.108,	.303
F shrinkage mean ,	559.,	.50,,,,				.284,	.300

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
601.,	.24,	.19,	4,	.800,	.282

Age 5 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
5LL_01: 5lline>100GR,	1210.,	.209,	.063,	.30,	3,	.566,	.422
CUBA_01: Pair trawle,	1565.,	.320,	.202,	.63,	2,	.265,	.341
F shrinkage mean ,	1305.,	.50,,,,				.168,	.397

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
1312.,	.17,	.07,	6,	.439,	.395

Age 6 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
5LL_01: 5lline>100GR,	4557.,	.185,	.092,	.50,	4,	.526,	.437
CUBA_01: Pair trawle,	5389.,	.249,	.228,	.92,	3,	.326,	.381
F shrinkage mean ,	4470.,	.50,,,,				.147,	.444

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4800.,	.15,	.09,	8,	.599,	.419

Table 2.4.9 (continued)

Age 7 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
5LL_01: 5lline>100GR,	4963.,	.186,	.096,	.52,	5,	.428,	.428
CUBA_01: Pair trawle,	4878.,	.223,	.145,	.65,	4,	.399,	.434
F shrinkage mean ,	2974.,	.50,,,,				.173,	.637

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
4512.,	.15,	.10,	10,	.659,	.462

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

Year class = 1992

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
5LL_01: 5lline>100GR,	144.,	.213,	.108,	.51,	6,	.382,	.411
CUBA_01: Pair trawle,	112.,	.228,	.098,	.43,	4,	.312,	.503
F shrinkage mean ,	57.,	.50,,,,				.305,	.825

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
101.,	.19,	.16,	11,	.835,	.547

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

Year class = 1991

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
5LL_01: 5lline>100GR,	4.,	.261,	.291,	1.12,	6,	.100,	.185
CUBA_01: Pair trawle,	3.,	.225,	.386,	1.71,	4,	.070,	.301
F shrinkage mean ,	2.,	.50,,,,				.830,	.424

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
2.,	.42,	.23,	11,	.552,	.383

Table 2.4.10

Run title : FAROE HADDOCK (ICES DIVISION Vb)   HAD_IND

At 30/04/2001 19:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	.1875,	.3232,	.3801,	.0876,	.0691,	.0609,	.0641,	.1262,	.0860,	.0552,
3,	.4162,	.5866,	.5639,	.3723,	.2354,	.2371,	.1873,	.2647,	.2364,	.2529,
4,	.4209,	.5980,	.7261,	.5193,	.4767,	.4515,	.2971,	.3483,	.5320,	.3345,
5,	.4387,	.3480,	.5591,	.5369,	.3678,	.5006,	.2997,	.2847,	.3330,	.3639,
6,	.5879,	.6706,	.4026,	.6107,	.5882,	.5421,	.5406,	.4540,	.4975,	.5559,
7,	.9483,	1.0499,	1.2493,	.3375,	.9618,	.9128,	.6906,	.8367,	.8277,	.8740,
8,	.8742,	.9736,	1.1139,	1.2027,	2.3618,	.7509,	.6634,	.5851,	1.0631,	.5430,
9,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,
+gp,	.6600,	.7351,	.8185,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,
FBAR 3- 7,	.5624,	.6506,	.7002,	.4753,	.5260,	.5288,	.4031,	.4377,	.4853,	.4763,

Table 8 Fishing mortality (F) at age

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	.0527,	.0253,	.1672,	.1267,	.1232,	.0909,	.0108,	.0010,	.0004,	.0326,
3,	.1938,	.4229,	.4309,	.2173,	.2651,	.1881,	.1130,	.0548,	.0458,	.0286,
4,	.4188,	.2856,	.2386,	.3731,	.2413,	.3812,	.1818,	.1668,	.1256,	.2029,
5,	.2756,	.4520,	.3135,	.1279,	.2117,	.2217,	.5277,	.2119,	.1916,	.2755,
6,	.5561,	.1496,	.2696,	.1714,	.0957,	.2873,	.7250,	.3824,	.1411,	.2140,
7,	.8379,	.6722,	.1946,	.2135,	.0860,	.1602,	.3907,	.5766,	.2726,	.1706,
8,	.4224,	.4060,	.2908,	.1434,	.1600,	.2540,	.3791,	.4974,	.3309,	.3963,
9,	.5061,	.3957,	.2628,	.2068,	.1596,	.2623,	.4441,	.3694,	.2133,	.2532,
+gp,	.5061,	.3957,	.2628,	.2068,	.1596,	.2623,	.4441,	.3694,	.2133,	.2532,
FBAR 3- 7,	.4564,	.3965,	.2894,	.2207,	.1800,	.2477,	.3876,	.2785,	.1553,	.1783,

Run title : FAROE HADDOCK (ICES DIVISION Vb)   HAD_IND

At 30/04/2001 19:55

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	.0238,	.0385,	.0254,	.0331,	.0285,	.0099,	.0354,	.0409,	.0050,	.0129,
3,	.1376,	.4630,	.1924,	.1178,	.1705,	.0957,	.0948,	.0715,	.1257,	.1316,
4,	.1320,	.3718,	.3495,	.3916,	.2418,	.2511,	.1882,	.1913,	.1442,	.2321,
5,	.2117,	.2933,	.3511,	.2183,	.3501,	.2634,	.2649,	.2425,	.3444,	.2498,
6,	.2270,	.2784,	.1392,	.3354,	.4194,	.3627,	.3139,	.3103,	.3313,	.3754,
7,	.2010,	.2532,	.3005,	.0860,	.2098,	.1588,	.4826,	.2133,	.5282,	.4440,
8,	.0922,	.2273,	.3115,	.2947,	.1734,	.5231,	.5932,	.2436,	.4015,	.4791,
9,	.1735,	.2864,	.2920,	.2666,	.2804,	.3137,	.3709,	.2414,	.3521,	.3583,
+gp,	.1735,	.2864,	.2920,	.2666,	.2804,	.3137,	.3709,	.2414,	.3521,	.3583,
FBAR 3- 7,	.1819,	.3320,	.2665,	.2298,	.2783,	.2263,	.2689,	.2058,	.2947,	.2866,

Table 8 Fishing mortality (F) at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
2,	.0297,	.0166,	.0710,	.0482,	.0105,	.0086,	.0116,	.0384,	.0093,	.0295,
3,	.1714,	.0765,	.1653,	.1647,	.1036,	.0875,	.0986,	.2166,	.7238,	.3097,
4,	.2733,	.1860,	.1898,	.2563,	.3134,	.3574,	.2542,	.2599,	.3063,	.3765,
5,	.2323,	.2775,	.1963,	.1538,	.3048,	.4192,	.4551,	.4024,	.3884,	.5279,
6,	.3479,	.2815,	.2078,	.2260,	.1926,	.3767,	.5313,	.5836,	.5216,	.5608,
7,	.4349,	.3032,	.2185,	.2535,	.2434,	.3803,	.5475,	1.3127,	.6744,	.6181,
8,	.2872,	.2555,	.1853,	.2758,	.2736,	.3682,	.3952,	.9936,	2.0506,	.7318,
9,	.3132,	.2658,	.2127,	.2708,	.3084,	.3712,	.5852,	.9282,	.6494,	.5120,
+gp,	.3132,	.2658,	.2127,	.2708,	.3084,	.3712,	.5852,	.9282,	.6494,	.5120,
FBAR 3- 7,	.2919,	.2249,	.1955,	.2109,	.2315,	.3242,	.3773,	.5551,	.5229,	.4785,

Table 2.4.11

Run title : FAROE HADDOCK (ICES DIVISION Vb)   HAD_IND

At 30/04/2001 19:55

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,	1969,	1970,
AGE										
2,	51279,	38537,	47362,	30110,	22644,	20205,	25355,	54838,	31966,	35576,
3,	23796,	34806,	22837,	26515,	22585,	17302,	15565,	19470,	39576,	24014,
4,	16517,	12850,	15850,	10638,	14961,	14613,	11176,	10567,	12233,	25581,
5,	6028,	8877,	5786,	6278,	5182,	7604,	7617,	6798,	6107,	5884,
6,	3245,	3182,	5132,	2708,	3005,	2937,	3774,	4622,	4187,	3584,
7,	1512,	1476,	1332,	2809,	1204,	1366,	1398,	1800,	2403,	2084,
8,	448,	480,	423,	313,	1641,	377,	449,	574,	638,	860,
9,	135,	153,	148,	114,	77,	127,	146,	189,	262,	180,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
TOTAL,	102958,	100361,	98871,	79485,	71299,	64531,	65480,	98857,	97373,	97764,

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

YEAR,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,	1979,	1980,
AGE										
2,	15447,	33170,	23686,	52320,	69980,	55904,	26154,	35032,	2773,	4935,
3,	27564,	11998,	26479,	16407,	37739,	50656,	41793,	21182,	28653,	2270,
4,	15268,	18592,	6435,	14089,	10810,	23703,	34363,	30562,	16418,	22409,
5,	14989,	8223,	11441,	4150,	7943,	6953,	13255,	23458,	21179,	11855,
6,	3348,	9316,	4284,	6846,	2990,	5263,	4560,	6403,	15538,	14317,
7,	1683,	1572,	6568,	2679,	4722,	2224,	3233,	1808,	3576,	11047,
8,	712,	596,	657,	4426,	1772,	3548,	1552,	1791,	832,	2229,
9,	409,	382,	325,	402,	3140,	1236,	2253,	870,	892,	489,
+gp,	0,	0,	52,	865,	1395,	1514,	2612,	1108,	423,	422,
TOTAL,	79419,	83849,	79928,	102185,	140490,	151001,	129775,	122214,	90284,	69972,

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

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
2,	3484,	15781,	19450,	40523,	38798,	25897,	8993,	18066,	14023,	9063,
3,	3911,	2785,	12432,	15525,	32096,	30874,	20995,	7107,	14198,	11424,
4,	1806,	2790,	1435,	8397,	11299,	22158,	22971,	15634,	5417,	10251,
5,	14977,	1296,	1575,	828,	4647,	7263,	14113,	15581,	10572,	3839,
6,	7369,	9922,	791,	908,	545,	2681,	4570,	8866,	10010,	6134,
7,	9463,	4808,	6149,	564,	531,	294,	1527,	2733,	5322,	5885,
8,	7626,	6337,	3056,	3728,	423,	353,	205,	772,	1808,	2570,
9,	1228,	5693,	4133,	1832,	2273,	291,	171,	93,	495,	991,
+gp,	249,	944,	3447,	4544,	4370,	2903,	1182,	656,	299,	393,
TOTAL,	50111,	50355,	52469,	76849,	94983,	92714,	74727,	69508,	62145,	50550,

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

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,
AGE											
2,	2906,	2685,	1823,	6507,	85204,	42245,	7396,	3110,	20769,	12100,	0,
3,	7325,	2310,	2162,	1390,	5077,	69032,	34293,	5986,	2450,	16847,	9690,
4,	8200,	5053,	1752,	1501,	965,	3748,	51783,	25441,	3946,	973,	10942,
5,	6655,	5108,	3435,	1186,	951,	578,	2146,	32880,	16061,	2379,	601,
6,	2449,	4319,	3169,	2311,	833,	574,	311,	1115,	18002,	8917,	1312,
7,	3450,	1416,	2669,	2108,	1509,	562,	322,	150,	509,	8749,	4800,
8,	3090,	1829,	856,	1756,	1339,	969,	315,	153,	33,	212,	4512,
9,	1303,	1899,	1160,	582,	1091,	834,	549,	174,	46,	3,	101,
+gp,	131,	762,	1062,	1393,	1220,	1393,	1273,	902,	439,	252,	142,
TOTAL,	35509,	25380,	18086,	18734,	98190,	119935,	98388,	69909,	62256,	114256,	32088,

Table 2.4.12

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD_IND

At 30/04/2001 19:55

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 3- 7,
1961,	51279,	81164,	47797,	20831,	.4358,	.5624,
1962,	38537,	83420,	51875,	27151,	.5234,	.6506,
1963,	47362,	80753,	49547,	27571,	.5565,	.7002,
1964,	30110,	68577,	44128,	19490,	.4417,	.4753,
1965,	22644,	65654,	45555,	18479,	.4056,	.5260,
1966,	20205,	60933,	43953,	18766,	.4270,	.5288,
1967,	25355,	60205,	41958,	13381,	.3189,	.4031,
1968,	54838,	78071,	45378,	17852,	.3934,	.4377,
1969,	31966,	83809,	53419,	23272,	.4356,	.4853,
1970,	35576,	87288,	59853,	21361,	.3569,	.4763,
1971,	15447,	81739,	62899,	19393,	.3083,	.4564,
1972,	33170,	83062,	61963,	16485,	.2660,	.3965,
1973,	23686,	82733,	61562,	17976,	.2920,	.2894,
1974,	52320,	95386,	64610,	14773,	.2286,	.2207,
1975,	69980,	121719,	75376,	20715,	.2748,	.1800,
1976,	55904,	135505,	89167,	26211,	.2940,	.2477,
1977,	26154,	120912,	96281,	25555,	.2654,	.3876,
1978,	35032,	120396,	97091,	19200,	.1978,	.2785,
1979,	2773,	97507,	85243,	12418,	.1457,	.1553,
1980,	4935,	87454,	81732,	15016,	.1837,	.1783,
1981,	3484,	78760,	75650,	12233,	.1617,	.1819,
1982,	15781,	68096,	56240,	11937,	.2123,	.3320,
1983,	19450,	63674,	51608,	12894,	.2498,	.2665,
1984,	40523,	82873,	53507,	12378,	.2313,	.2298,
1985,	38798,	93104,	62128,	15143,	.2437,	.2783,
1986,	25897,	97213,	64910,	14477,	.2230,	.2263,
1987,	8993,	86056,	66283,	14882,	.2245,	.2689,
1988,	18066,	75538,	60622,	12178,	.2009,	.2058,
1989,	14023,	67627,	50251,	14325,	.2851,	.2947,
1990,	9063,	51634,	41988,	11726,	.2793,	.2866,
1991,	2906,	37023,	33048,	8429,	.2551,	.2919,
1992,	2685,	27513,	25400,	5476,	.2156,	.2249,
1993,	1823,	24345,	21997,	4026,	.1830,	.1955,
1994,	6507,	25812,	20578,	4252,	.2066,	.2109,
1995,	85204,	79276,	25753,	4948,	.1921,	.2315,
1996,	42245,	99373,	52425,	9642,	.1839,	.3242,
1997,	7396,	96358,	76834,	17924,	.2333,	.3773,
1998,	3110,	81034,	73069,	22210,	.3040,	.5551,
1999,	20769,	65012,	53013,	18486,	.3487,	.5229,
2000,	12100,	60815,	39904,	16286,	.4081,	.4786,
Arith. Mean	26402,	79490,	56714,	15994,	.2889,	.3505,
Units	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

Table 2.4.13

Faroe Haddock Short Term Prediction Input

MFDP version 1
Run: jak1
Time and date: 11:51 02/05/2001
Fbar age range: 3-7

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12100	0.2	0.02	0	0	0.5957	0.0237	0.5957
3	9678	0.2	0.32	0	0	0.8020	0.3843	0.8020
4	10942	0.2	0.84	0	0	1.0520	0.2898	1.0520
5	601	0.2	0.99	0	0	1.3287	0.4054	1.3287
6	1312	0.2	1	0	0	1.7287	0.5122	1.7287
7	4800	0.2	1	0	0	2.3017	0.8010	2.3017
8	4512	0.2	1	0	0	2.6837	1.1609	2.6837
9	101	0.2	1	0	0	2.9330	0.6424	2.9330
10	142	0.2	1	0	0	2.9673	0.6424	2.9673

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12100	0.2	0.02	0	0	0.5957	0.0237	0.5957
3	.	0.2	0.32	0	0	0.8020	0.3843	0.8020
4	.	0.2	0.84	0	0	1.0520	0.2898	1.0520
5	.	0.2	0.99	0	0	1.3287	0.4054	1.3287
6	.	0.2	1	0	0	1.7287	0.5122	1.7287
7	.	0.2	1	0	0	2.3017	0.8010	2.3017
8	.	0.2	1	0	0	2.6837	1.1609	2.6837
9	.	0.2	1	0	0	2.9330	0.6424	2.9330
10	.	0.2	1	0	0	2.9673	0.6424	2.9673

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12100	0.2	0.02	0	0	0.5957	0.0237	0.5957
3	.	0.2	0.32	0	0	0.8020	0.3843	0.8020
4	.	0.2	0.84	0	0	1.0520	0.2898	1.0520
5	.	0.2	0.99	0	0	1.3287	0.4054	1.3287
6	.	0.2	1	0	0	1.7287	0.5122	1.7287
7	.	0.2	1	0	0	2.3017	0.8010	2.3017
8	.	0.2	1	0	0	2.6837	1.1609	2.6837
9	.	0.2	1	0	0	2.9330	0.6424	2.9330
10	.	0.2	1	0	0	2.9673	0.6424	2.9673

Input units are thousands and kg - output in tonnes

Table 2.4.14

Faroe Haddock Yield per Recruit Input

MFYPR version 1
Run: jak_yld1
Index file 30/4/2001
Time and date: 00:03 01/05/2001
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.069	0	0	0.5210	0.0887	0.5210
3	0.2	0.4875	0	0	0.7822	0.3083	0.7822
4	0.2	0.9135	0	0	1.1012	0.4297	1.1012
5	0.2	0.9955	0	0	1.4683	0.4434	1.4683
6	0.2	1	0	0	1.8317	0.5245	1.8317
7	0.2	1	0	0	2.1875	0.6871	2.1875
8	0.2	1	0	0	2.4547	0.7704	2.4547
9	0.2	1	0	0	2.7211	0.5834	2.7211
10	0.2	1	0	0	3.0859	0.5834	3.0859

Weights in kilograms

Table 2.4.15

MFDP version 1
Run: jak_man1
Index file 30/4/2001
Time and date: 22:49 30/04/2001
Fbar age range: 3-7

2001				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
53431	39233	1.0000	0.4784	19706

2002					0	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
40049	26711	0.0000	0.0000	0	48189	34331
.	26711	0.1000	0.0478	1558	46517	32723
.	26711	0.2000	0.0957	3019	44949	31218
.	26711	0.3000	0.1435	4390	43477	29807
.	26711	0.4000	0.1914	5678	42093	28483
.	26711	0.5000	0.2392	6890	40792	27238
.	26711	0.6000	0.2871	8032	39566	26068
.	26711	0.7000	0.3349	9108	38410	24966
.	26711	0.8000	0.3828	10123	37319	23928
.	26711	0.9000	0.4306	11083	36289	22948
.	26711	1.0000	0.4784	11990	35314	22023
.	26711	1.1000	0.5263	12850	34392	21149
.	26711	1.2000	0.5741	13664	33518	20322
.	26711	1.3000	0.6220	14436	32690	19538
.	26711	1.4000	0.6698	15169	31903	18796
.	26711	1.5000	0.7177	15866	31157	18092
.	26711	1.6000	0.7655	16528	30447	17424
.	26711	1.7000	0.8134	17158	29772	16790
.	26711	1.8000	0.8612	17759	29129	16186
.	26711	1.9000	0.9091	18331	28517	15613
.	26711	2.0000	0.9569	18877	27933	15067

Input units are thousands and kg - output in tonnes

Table 2.4.16

MFYPR version 1
Run: jak_yld1
Time and date: 00:03 01/05/2001
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	9.1805	4.1056	8.2998	4.1056	8.2998
0.1000	0.0479	0.1677	0.3116	4.6816	6.9308	3.2767	6.0558	3.2767	6.0558
0.2000	0.0957	0.2744	0.4693	4.1516	5.5815	2.7527	4.7120	2.7527	4.7120
0.3000	0.1436	0.3488	0.5544	3.7826	4.6952	2.3896	3.8311	2.3896	3.8311
0.4000	0.1914	0.4041	0.6018	3.5088	4.0742	2.1215	3.2154	2.1215	3.2154
0.5000	0.2393	0.4472	0.6285	3.2959	3.6175	1.9144	2.7638	1.9144	2.7638
0.6000	0.2872	0.4820	0.6432	3.1246	3.2685	1.7485	2.4197	1.7485	2.4197
0.7000	0.3350	0.5109	0.6508	2.9828	2.9934	1.6122	2.1495	1.6122	2.1495
0.8000	0.3829	0.5353	0.6540	2.8630	2.7710	1.4977	1.9319	1.4977	1.9319
0.9000	0.4307	0.5564	0.6546	2.7600	2.5874	1.3998	1.7530	1.3998	1.7530
1.0000	0.4786	0.5748	0.6535	2.6701	2.4332	1.3151	1.6034	1.3151	1.6034
1.1000	0.5265	0.5911	0.6513	2.5908	2.3018	1.2408	1.4764	1.2408	1.4764
1.2000	0.5743	0.6056	0.6485	2.5202	2.1883	1.1750	1.3672	1.1750	1.3672
1.3000	0.6222	0.6187	0.6454	2.4567	2.0893	1.1164	1.2725	1.1164	1.2725
1.4000	0.6700	0.6306	0.6421	2.3993	2.0021	1.0637	1.1895	1.0637	1.1895
1.5000	0.7179	0.6414	0.6387	2.3471	1.9247	1.0160	1.1161	1.0160	1.1161
1.6000	0.7658	0.6513	0.6352	2.2992	1.8555	0.9727	1.0509	0.9727	1.0509
1.7000	0.8136	0.6605	0.6318	2.2552	1.7932	0.9332	0.9925	0.9332	0.9925
1.8000	0.8615	0.6690	0.6285	2.2146	1.7369	0.8970	0.9400	0.8970	0.9400
1.9000	0.9093	0.6768	0.6253	2.1770	1.6857	0.8636	0.8926	0.8636	0.8926
2.0000	0.9572	0.6842	0.6221	2.1419	1.6389	0.8329	0.8495	0.8329	0.8495

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.4786
FMax	0.8767	0.4196
F0.1	0.3601	0.1724
F35%SPR	0.4656	0.2228
Flow	-99	
Fmed	0.5653	0.2705
Fhigh	1.6267	0.7785

Weights in kilograms

Table 2.4.17

Faroe haddock medium term simulation results

Simulation 1, Fsq, Random R 1961-2000											
Catch weight	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
25th Percentile	19708.4103	11935.5032	8816.60748	10197.6968	10926.4487	11306.5701	12404.3896	13162.5482	12856.9238	13255.3074	13130.7461
Median Catch	19708.4103	12108.5438	11430.9525	12815.6255	13234.3407	14584.1082	15682.8863	16697.9714	16132.6515	16588.1222	16772.0638
75th Percentile	19708.4103	12313.3125	14374.4652	16140.4987	16368.6695	17679.4866	20369.586	19890.5875	21007.9252	20276.8564	21192.6474
SSB											
25th Percentile	39095.87	26526.6147	21317.2123	22309.5371	24688.3069	26591.3871	27759.7279	29066.14	29460.2334	28243.0296	29380.8301
Median SSB	39095.87	26648.5864	24219.115	27931.6458	31016.1699	32836.8465	36016.285	37552.0627	38279.3138	38311.0058	37861.0411
75th Percentile	39095.87	26792.9224	27415.3647	34181.5644	38547.2537	40999.8546	45310.0588	46633.492	47730.3011	46676.8369	47219.7733
Prob SSB < Bpa = 55000	1	1	1	0.984	0.964	0.952	0.92	0.908	0.884	0.884	0.896
Prob SSB < Blim = 40000	1	1	1	0.884	0.772	0.728	0.636	0.556	0.552	0.54	0.568
Simulation 2, 0.75Fsq, Random R 1961-2000											
Catch weight											
25th Percentile	19708.4103	9580.58083	7944.83696	9216.31643	10537.5411	11458.6902	12548.7366	13608.7953	13828.6734	13870.7176	13936.6192
Median Catch	19708.4103	9715.03286	9774.78935	11572.5654	13148.2683	14251.538	15768.1572	16646.6199	16990.6087	17086.9687	16872.7324
75th Percentile	19708.4103	9864.08184	12219.8834	14125.6001	16345.0736	17106.4755	19302.1746	20519.6947	20585.6402	20098.6193	20551.1682
SSB											
25th Percentile	39095.87	26527.2402	24074.3124	26521.0129	29826.3272	33363.4756	36617.2239	38238.8092	38598.0445	39814.7024	38632.658
Median SSB	39095.87	26653.2415	26662.5511	32254.2637	38059.2269	42189.572	45325.6032	49023.4384	49349.764	48344.6125	47907.1545
75th Percentile	39095.87	26792.9224	30039.6383	40520.5406	48414.1889	52864.7428	56582.9004	57747.3813	59504.0378	59706.1786	60524.2066
Prob SSB < Bpa = 55000	1	1	1	0.968	0.86	0.8	0.712	0.68	0.64	0.66	0.656
Prob SSB < Blim = 40000	1	1	1	0.74	0.544	0.436	0.36	0.304	0.288	0.26	0.28
Simulation 3, 0.50Fsq, Random R 1961-2000											
Catch weight											
25th Percentile	19708.4103	6860.43766	6021.59393	7560.67241	9019.78242	9983.82497	11498.135	12982.8392	13206.4666	13330.5039	13876.2564
Median Catch	19708.4103	6933.70489	7228.4484	9137.85386	11010.4305	11908.0639	14270.339	15337.01	15830.1048	16103.649	16764.8713
75th Percentile	19708.4103	7026.42038	8793.64965	10885.5408	13157.4933	14573.6382	17150.4022	18890.8877	19563.1711	19003.0367	19772.545
SSB											
25th Percentile	39095.87	26526.6147	26535.3801	30846.2369	35493.5691	40616.1506	46850.1009	52769.2934	53000.3992	53357.5595	54327.8727
Median SSB	39095.87	26629.3136	28906.092	36276.0204	45212.5734	52012.8939	57558.5103	62688.1612	63195.8448	64015.5594	67467.9942
75th Percentile	39095.87	26759.2732	31988.4878	44947.6644	55217.8146	62798.7939	70343.9305	74618.5829	78150.1493	77848.8063	78513.3253
Prob SSB < Bpa = 55000	1	1	1	0.94	0.74	0.58	0.448	0.312	0.292	0.284	0.26
Prob SSB < Blim = 40000	1	1	0.988	0.64	0.368	0.244	0.136	0.108	0.056	0.06	0.04
Simulation 4, 0.25Fsq, Random R 1961-2000											
Catch weight											
25th Percentile	19708.4103	3709.67933	3758.07596	4884.8955	6272.87021	7034.01022	8507.40622	9557.13672	10495.2522	10549.462	10980.372
Median Catch	19708.4103	3749.37947	4409.74246	5692.63937	7423.72705	8577.60816	10334.8197	11948.8822	12594.8842	12892.3479	12998.8711
75th Percentile	19708.4103	3800.52891	5258.41616	6634.80138	8754.05667	10241.5248	12757.4057	14334.4657	14871.6566	15751.5589	16078.5325
SSB											
25th Percentile	39095.87	26554.3758	30442.952	37340.4976	46976.1541	55868.4562	63415.7254	71222.7837	75669.9914	77847.0166	81149.0223
Median SSB	39095.87	26665.3529	33011.0497	44441.4365	55483.2226	66785.0417	79606.831	87223.068	90637.4059	95571.0929	95792.0932
75th Percentile	39095.87	26808.3353	36169.8832	53664.2804	70125.7287	83661.0697	96192.528	105713.051	108147.715	112381.682	114983.96
Prob SSB < Bpa = 55000	1	1	1	0.788	0.48	0.236	0.144	0.088	0.056	0.036	0.02
Prob SSB < Blim = 40000	1	1	0.952	0.348	0.104	0.044	0.028	0.016	0.008	0.008	0.004
Simulation 5, F=0.45=0.94Fsq, Random R 1961-2000											
Catch weight											
25th Percentile	19708.4103	11400.6662	8571.65395	9616.59458	11097.6577	11751.1713	12827.4443	13787.1824	13913.6712	13719.9079	13855.5789
Median Catch	19708.4103	11575.0258	11119.9453	12155.6441	14288.9094	14819.4954	16739.4733	16874.7484	16916.7009	17067.861	17025.978
75th Percentile	19708.4103	11716.798	13386.2575	15039.0316	16606.2808	18619.8664	20010.6581	20853.2423	21260.5129	21046.4649	21710.2482
SSB											
25th Percentile	39095.87	26527.2402	21934.3799	22823.5558	25546.1654	28835.1218	30659.3358	31913.5195	32346.4127	32260.6583	32019.5803
Median SSB	39095.87	26657.8967	24829.1611	28835.8052	32868.2955	36961.8976	39168.8996	41423.0406	41014.9284	41241.1109	41128.9609
75th Percentile	39095.87	26764.1338	27344.7908	35022.0518	39383.1955	44643.6555	49595.6345	50795.6506	50144.6883	50753.3979	51672.411
Prob SSB < Bpa = 55000	1	1	1	1	0.952	0.932	0.856	0.828	0.824	0.824	0.804
Prob SSB < Blim = 40000	1	1	1	0.872	0.764	0.616	0.52	0.464	0.476	0.476	0.468
Simulation 6, Fpa=0.25=0.52Fsq, Random R 1961-2000											
Catch weight											
25th Percentile	19708.4103	7127.74966	6203.03887	7624.39523	9281.63205	10079.7897	11631.1942	12826.2524	12535.2837	13137.8223	12904.7003
Median Catch	19708.4103	7218.74524	7651.35567	9378.91604	11325.5672	12423.1422	14195.6035	15711.8914	16078.7875	16563.9983	16651.9156
75th Percentile	19708.4103	7324.68567	9306.46582	11418.23	13490.241	14983.5735	17288.0016	18902.8179	19623.3089	19717.5297	20019.0648
SSB											
25th Percentile	39095.87	26526.6147	26215.9813	30247.3125	34940.5391	40128.1845	45011.3406	47870.8802	48878.5965	49350.6283	49661.222
Median SSB	39095.87	26648.5864	29083.1209	36608.5142	44970.0685	49777.981	56842.6837	61119.2693	62273.5545	62311.4842	65247.569
75th Percentile	39095.87	26790.5904	32245.3397	44068.7359	54737.0259	63811.2366	70425.8596	73175.2208	76046.2112	77065.9551	77957.3131
Prob SSB < Bpa = 55000	1	1	1	0.936	0.756	0.596	0.44	0.348	0.372	0.372	0.332
Prob SSB < Blim = 40000	1	1	0.968	0.632	0.388	0.244	0.168	0.136	0.092	0.1	0.1

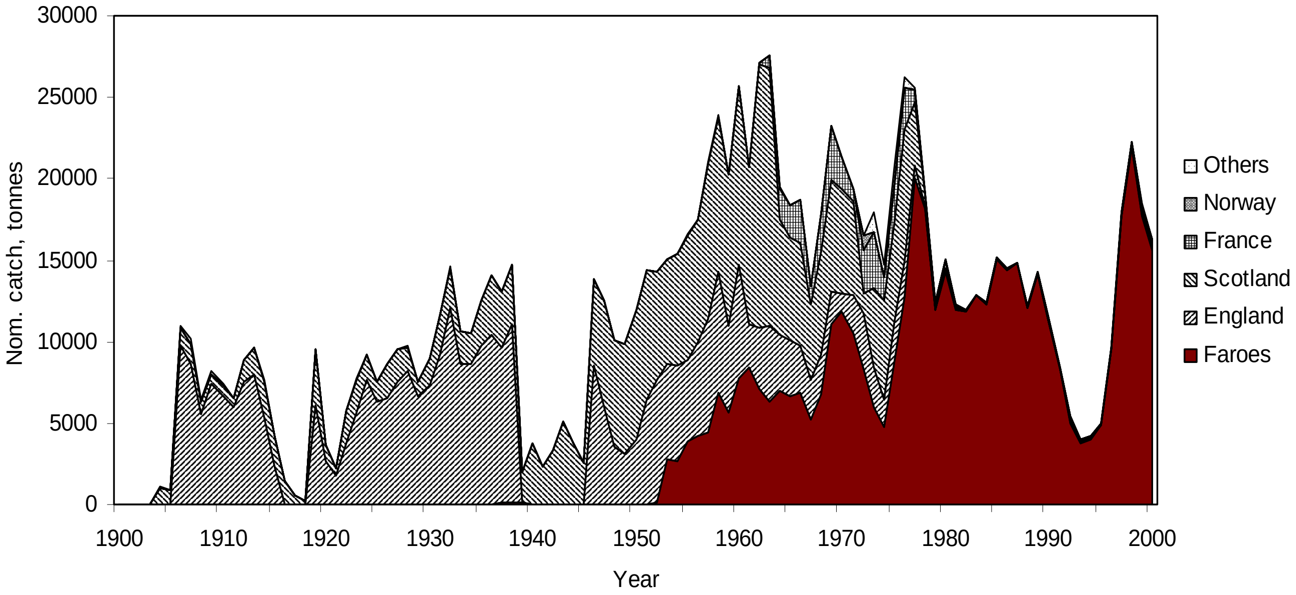


Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1903-2000.

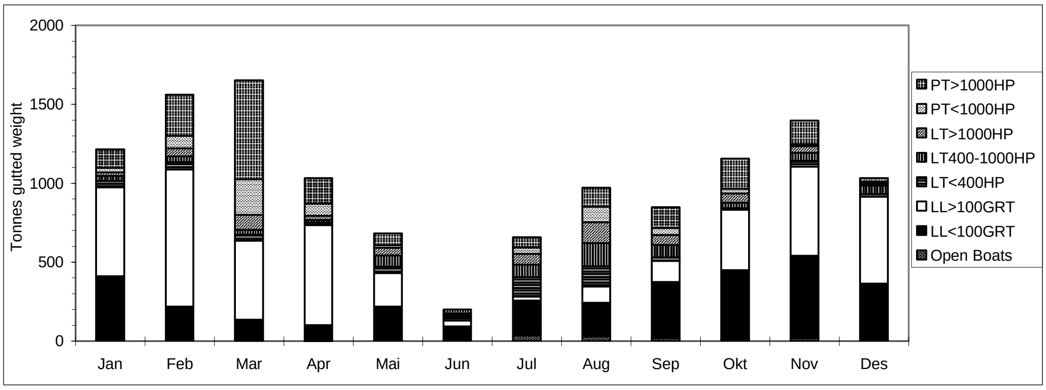


Figure 2.4.2.A. Faroese landings of haddock from Vb1 in 2000 by fleet. Tonnes gutted weight.

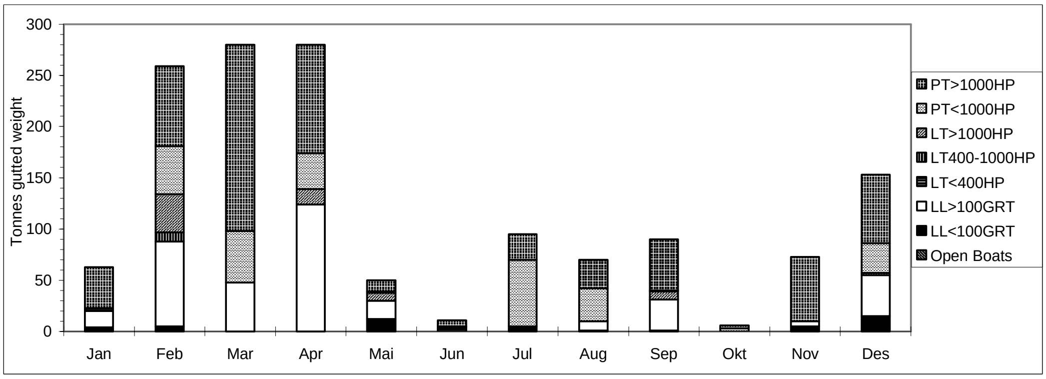


Figure 2.4.2.B. Faroese landings of haddock from Vb2 in 2000 by fleet. Tonnes gutted weight.

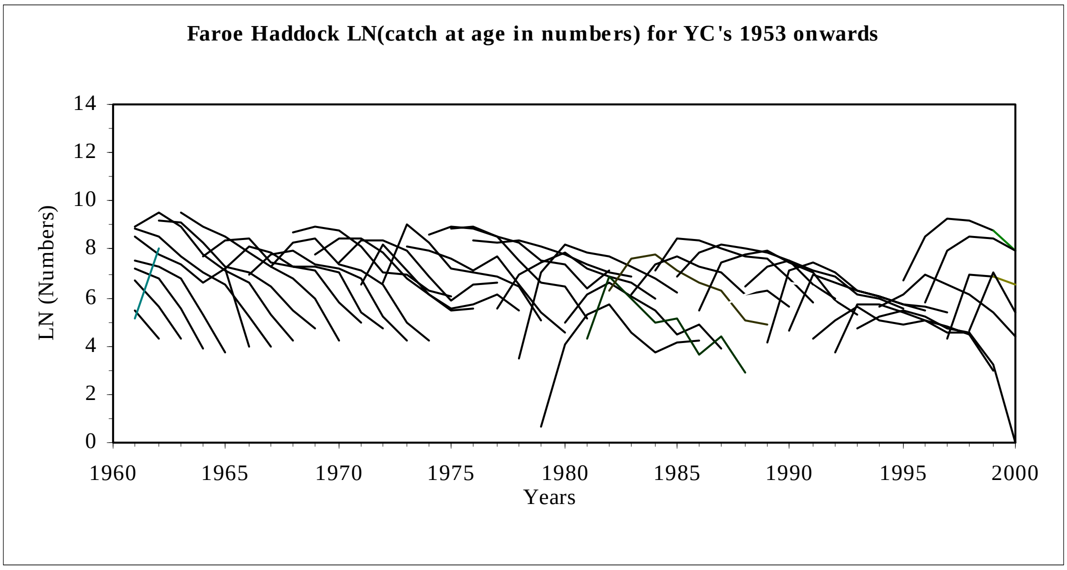


Figure 2.4.3

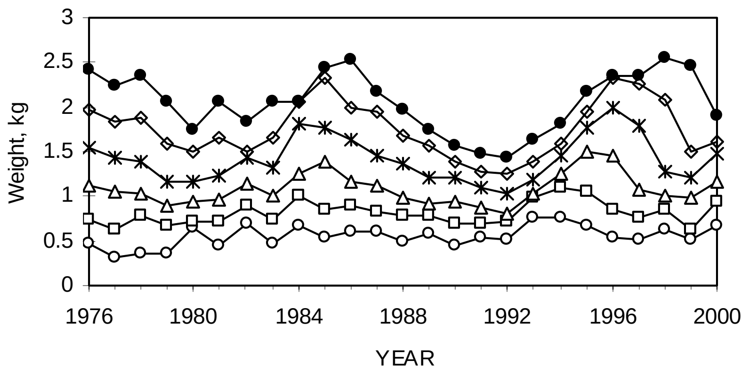


Figure 2.4.4. Faroe haddock 1976-2000. Mean weight at age for ages 2-7.

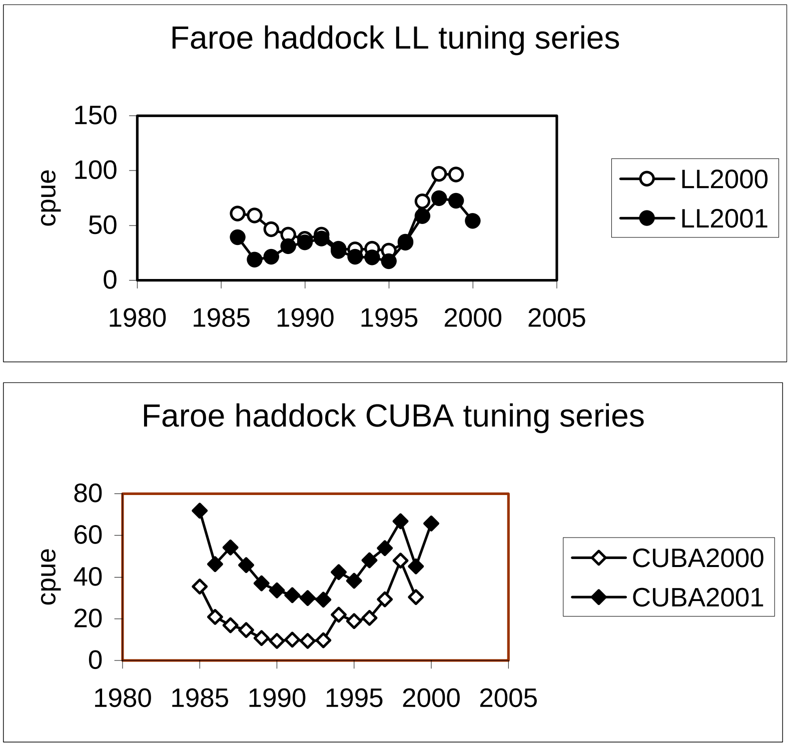


Figure 2.4.5. Comparison of this and last years tuning series.

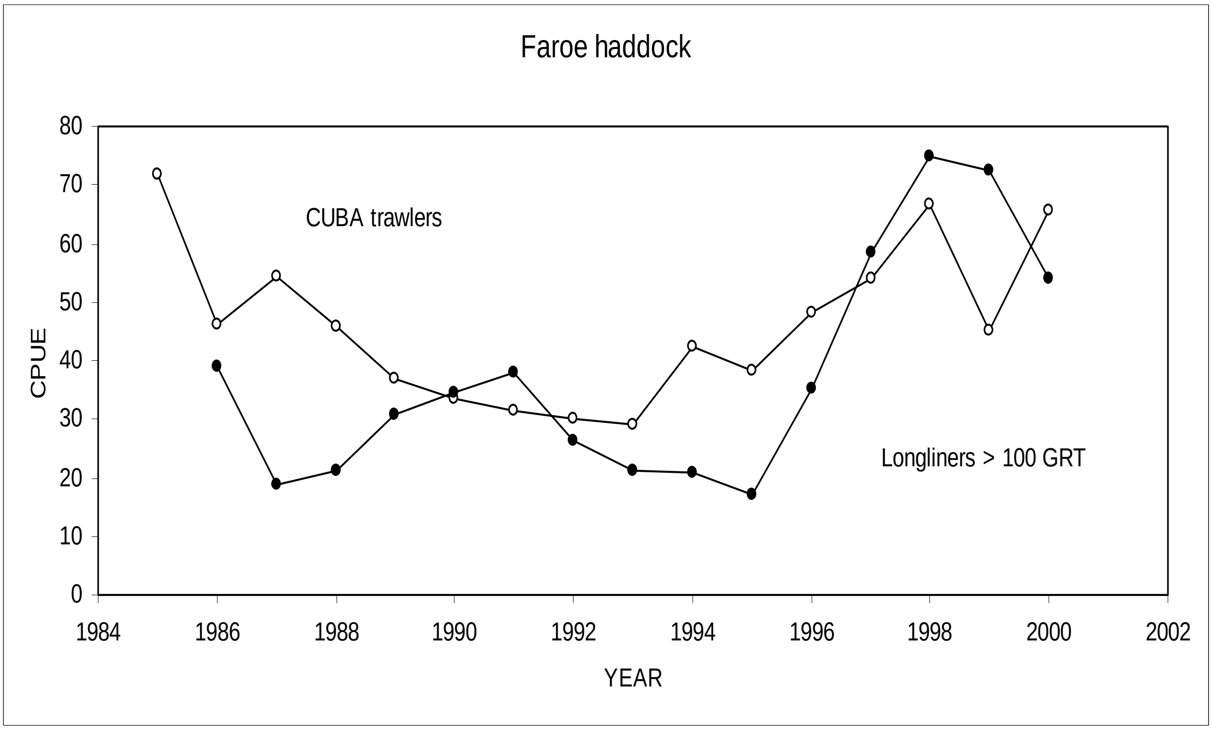


Figure 2.4.6. Comparison of the two tuning series used in this years assessment.

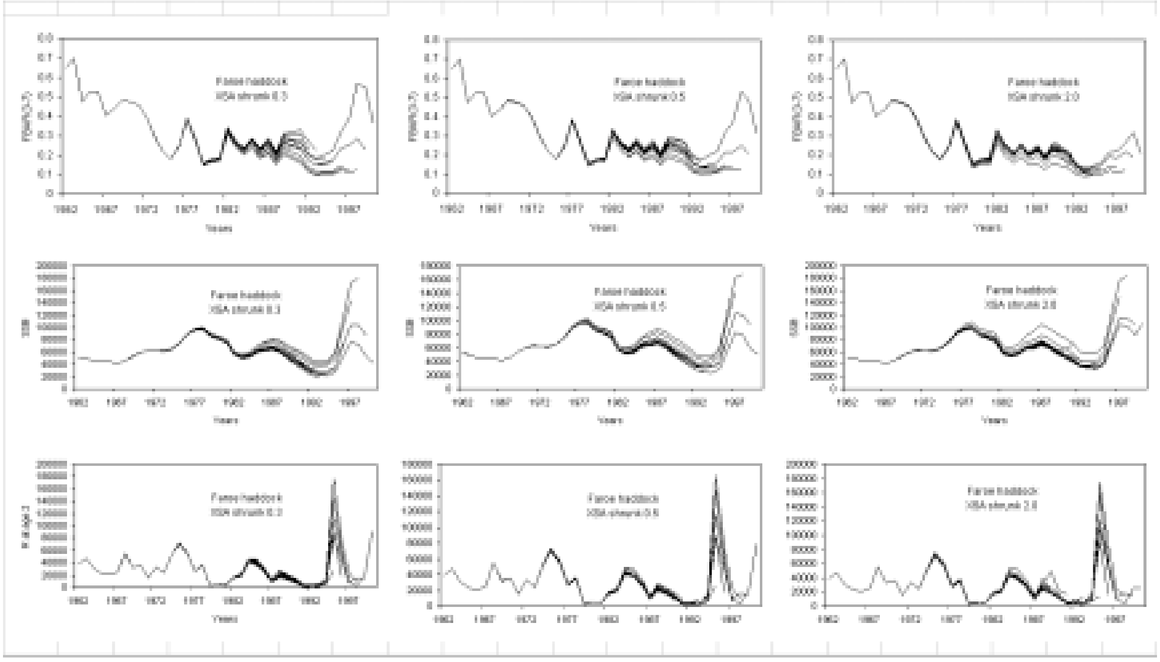


Figure 2.4.7A. Retrospective patterns of fishing mortality, spawning stock biomass and recruitment when the XSA is made with the same setting as last year.

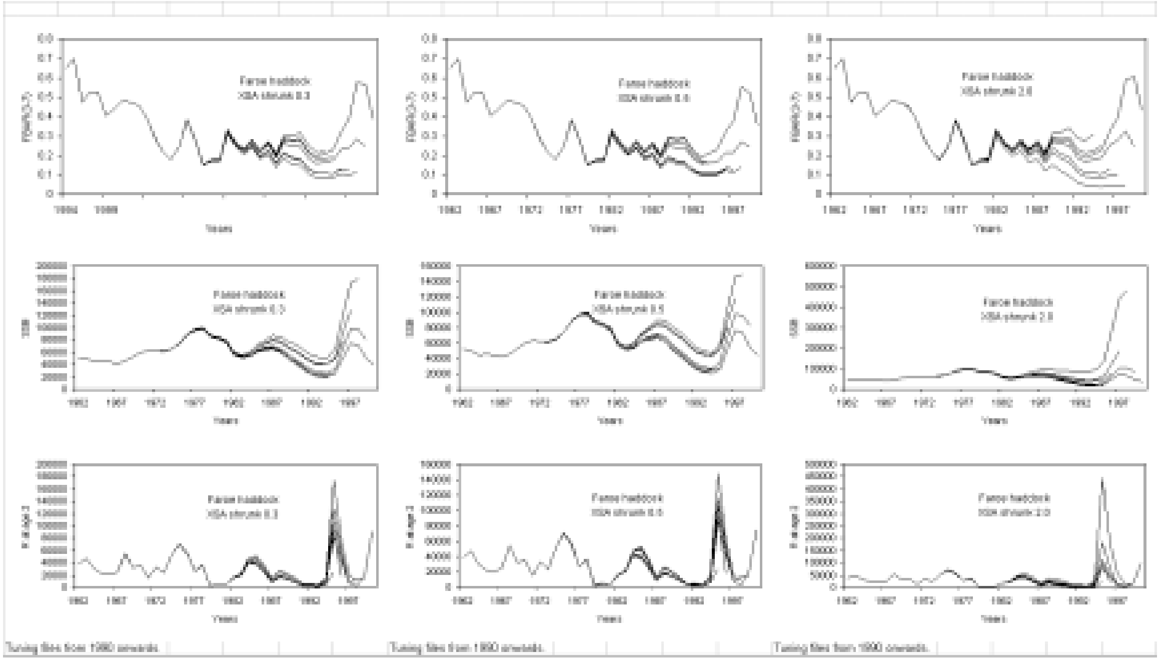


Figure 2.4.7B. Retrospective patterns of fishing mortality, spawning stock biomass and recruitment in this years XSA.

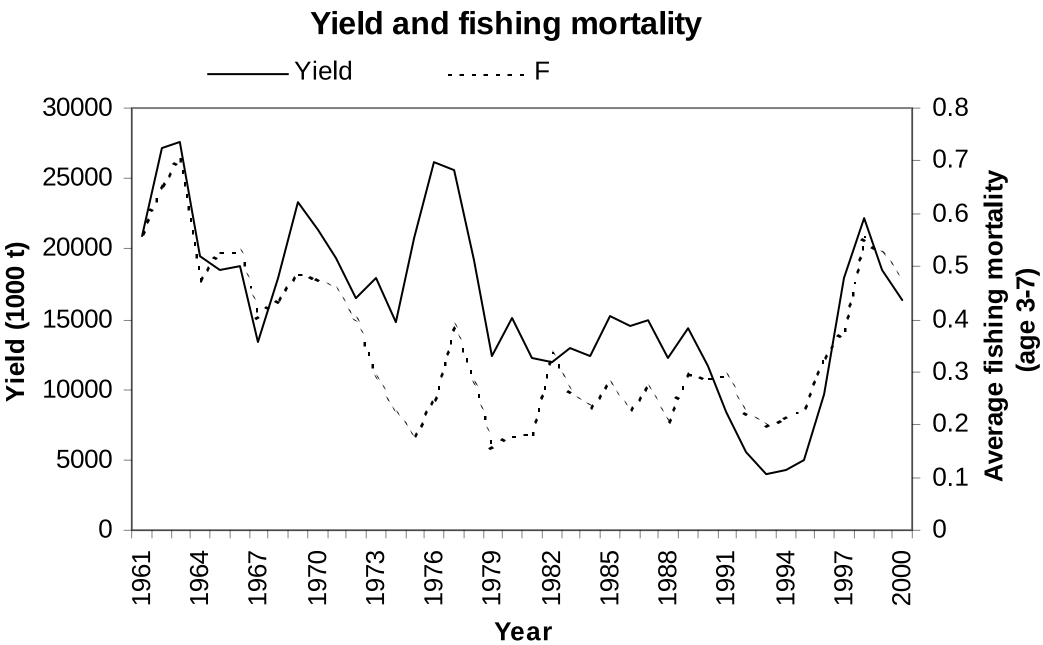


Figure 2.4.8 A

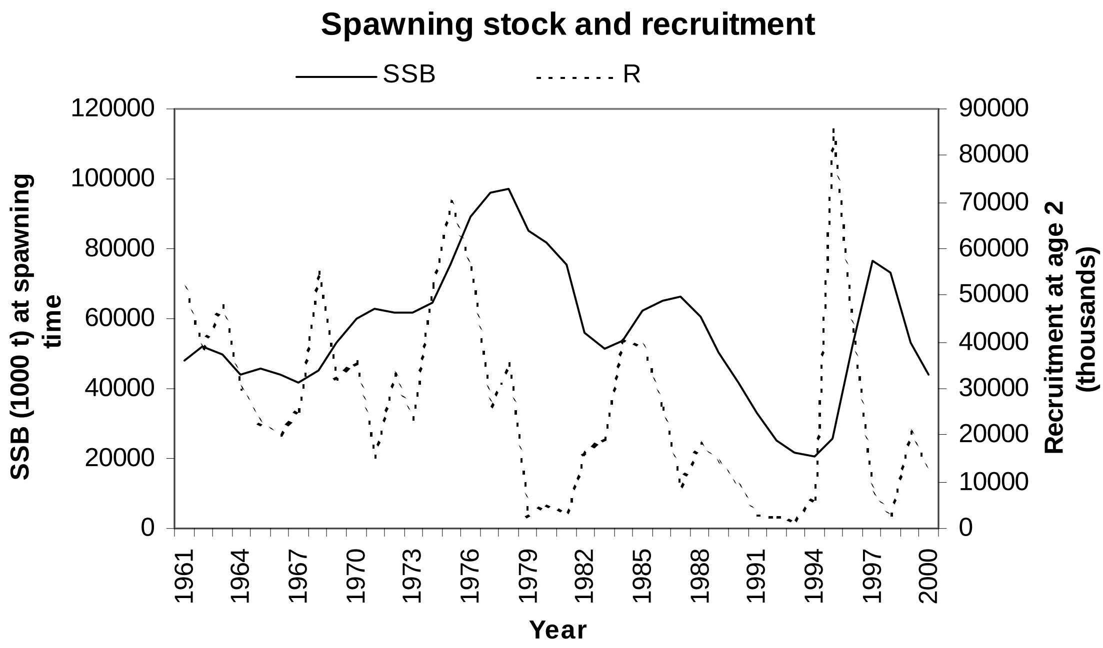
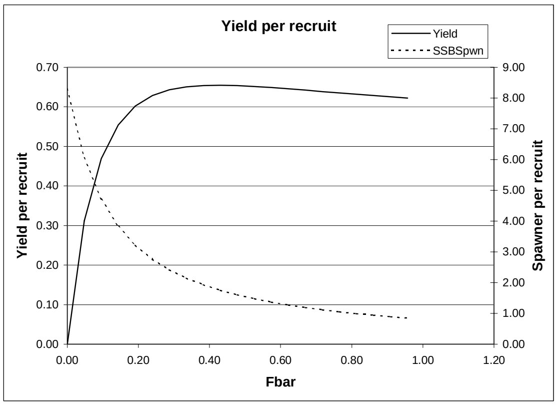
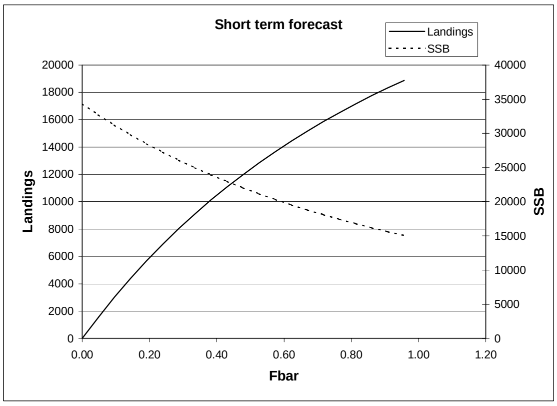

Spawning stock and recruitment
SSB
R
SSB (1000 t) at spawning time
Recruitment at age 2 (thousands)
Year
120000
100000
80000
60000
40000
20000
0
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000

Figure 2.4.8 B





MFYPR version 1
Run: jak_yld1
Time and date: 00:03 01/05/2001

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.4786
FMax	0.8767	0.4196
F0.1	0.3601	0.1724
F35%SPR	0.4656	0.2228
Flow	-99.0000	
Fmed	0.5653	0.2705
Fhigh	1.6267	0.7785

Weights in kilograms

MFDP version 1
Run: jak_man1
Index file 30/4/2001
Time and date: 22:49 30/04/2001
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.4.8 C and D

.

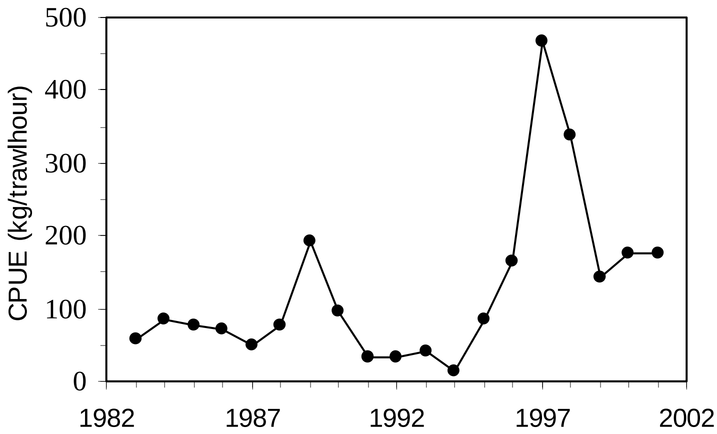


Figure 2.4.9. Faroe haddock. CPUE (kg/trawlhour) in the Faroese groundfish surveys in February-March 1983-2001.

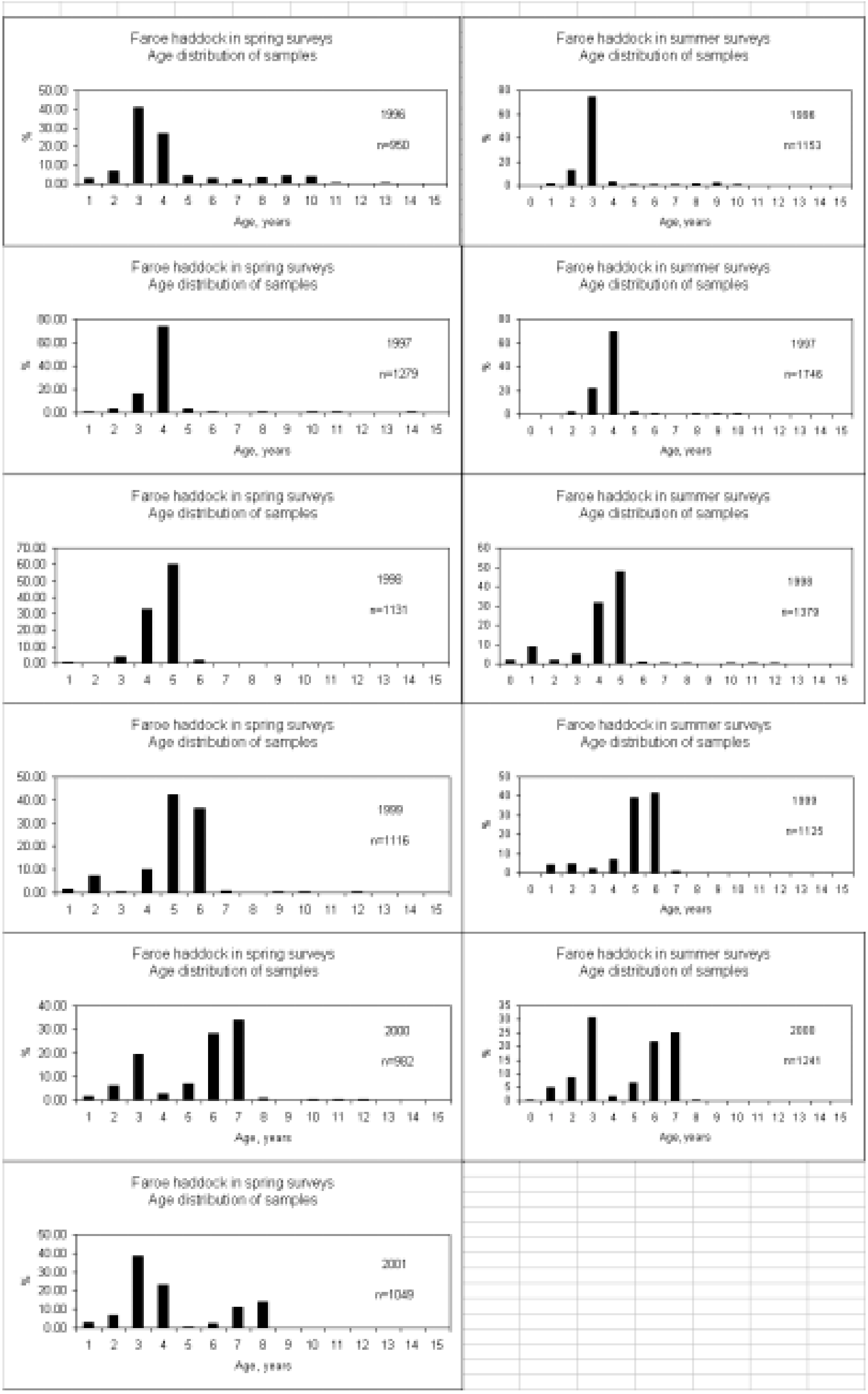


Figure 2.4.10. Age distributions in samples from the Faroese groundfish surveys since 1996. The distributions have not been weighted by the total catch so they are not directly comparable. Especially the youngest ages, i.e. 0-2, are underrepresentated in the figures.

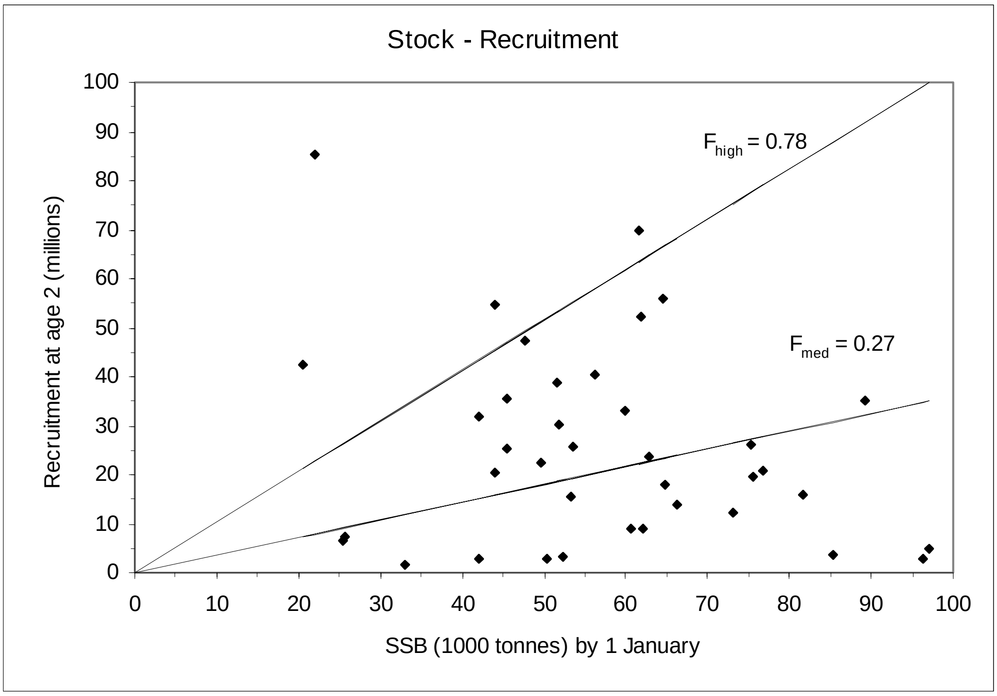
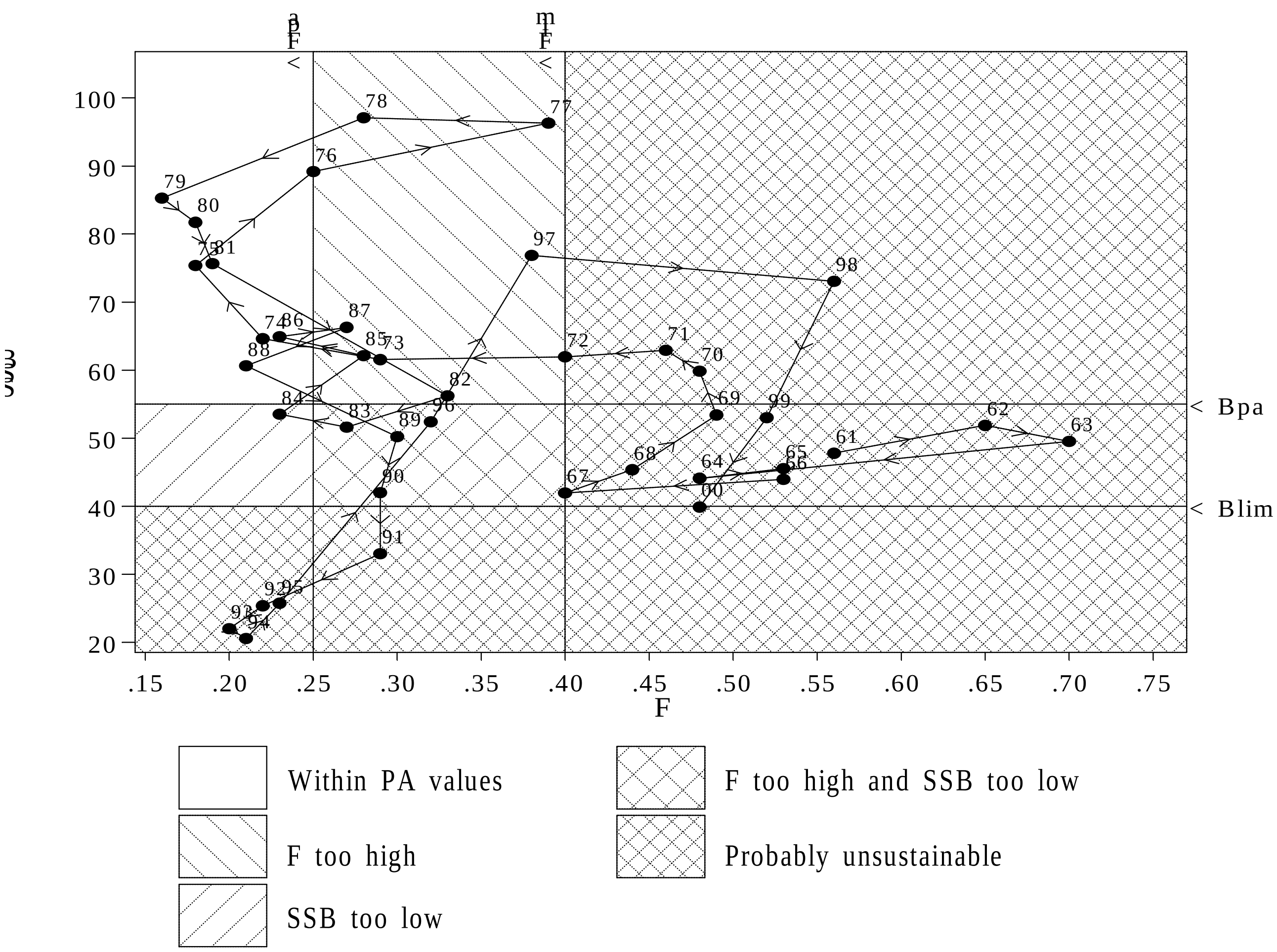


Figure 2.4.11. Faroe haddock.

Had_far



Data file(s):C:\Program Files\VPA\Had_far.pa;*.sum
Plotted on 30/04/2001 at 19:41:31

Figure 2.4.12.

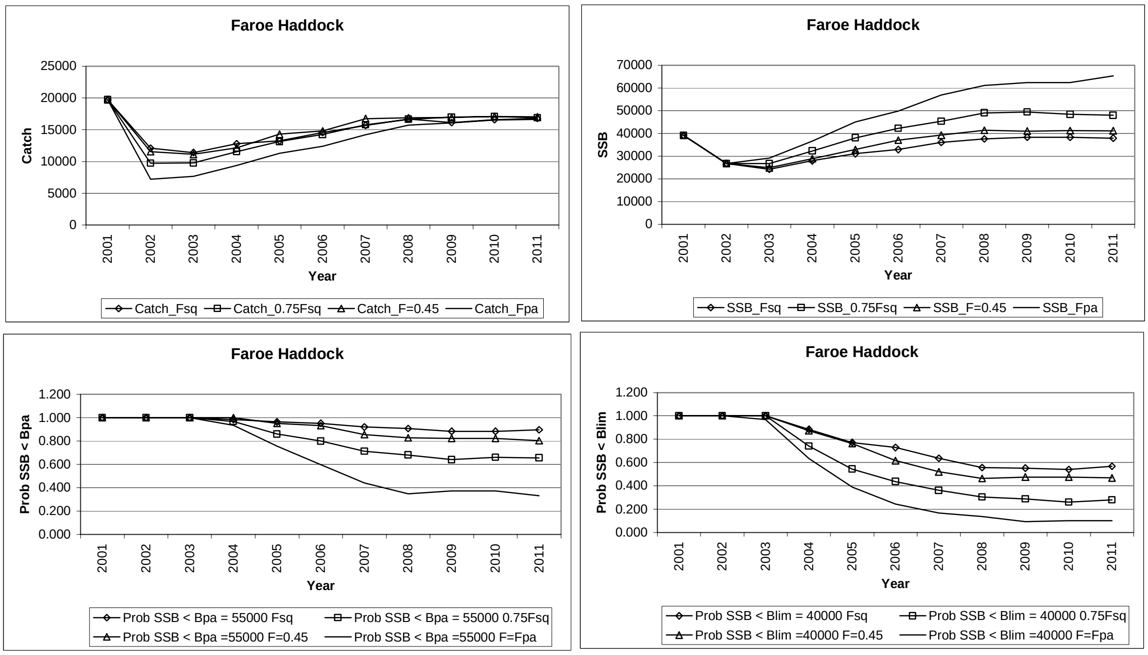


Figure 2.4.13. Faroe haddock medium term simulations under different assumptions (see text)

Figure 2.4.13.

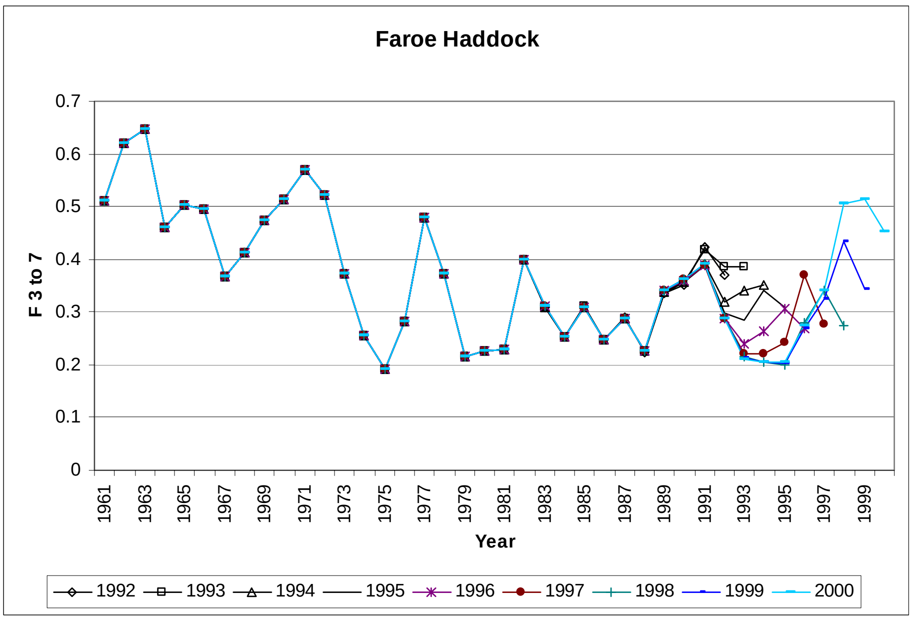


Figure 2.4.14.

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 steadily again to 39 000 t in 2000 (Table 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 1993-2000 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) have a more mixed fishery and they account for about 20% of the total landings of saithe in 1993-2000. During the last decade the proportion of saithe in the catches has generally increased for larger pair trawlers but decreased for the smaller pair trawlers, larger single trawlers (>1000 HP) and jiggers. Other vessels only have small catches of saithe as by-catch.

Prior to 1996, when a fishery management system based on days fished was introduced; practically all the fish from a given trip were landed at the same place. This practice changed in 1997-1998 for saithe, with a single trip being possibly landed in several sites. The landing slips are the main source of information on landings and number of fishing days, and for those trips that have been landed at several sites, a landing slip was completed at each landing site, each one recording the actual landings at that site, but the total number of fishing days.

The CPUE derived from the Cuba pair trawlers, with effort in hours fished, is not affected by the problem mentioned above because the effort comes from logbooks rather than from the landing slips and also because of direct contact with captains of the boats involved. The effort for Cuba Beta pair trawlers, witch is used as tuning fleet, decreased by about 20% in 2000.

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 Sub-division IIa, which lies immediately north of the Faroes, have also been included.

2.5.2 Catch at age

Catch at age is based on length and otolith samples from Faroese landings of jiggers, small and large single and pair trawlers, and landing statistic by fleet provided by the Faroese Authorities. Catch at age was calculated for each fleet by four-month periods, before the numbers were combined. Catch at age was thereafter raised by the foreign catches. The catch-at-age data for previous years were also revised according to the final catch statistics (Tables 2.5.2.1 and 2.5.2.2). The sampling intensity in 2000 was similar to that in 1999:

Fleet	Samples	Lengths	Otoliths	Weights
Jiggers	11	2143	300	300
Single trawlers 1000 – 1499	4	756	121	121
Single trawlers 1500 - 1999	2	461	120	60
Single trawlers > 2000 HP	5	911	60	60
Pair trawlers 400 – 699 HP	8	1572	300	240
Pair trawlers 700 – 999 HP	31	7316	720	660
Pair trawlers 1000 – 1499	121	25902	2816	2696
Total	182	39061	4437	4137

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2000. For example, the mean weights at age 5 varied between about 1.6 kg and 3.3 kg while at age 7 it varied between 2.6 kg and 5.3 kg (Table 2.5.3.1 and Figure 2.5.3.1). Mean weights at age were generally high during 1980-86 and dropped in the period 1987-1991. The mean weights increased again in the period 1992-96 but have shown a general decreased since. The SOP for 2000 was 102%.

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 this 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. Of those factors, age and mean weight at age where significant and no other independent variables were needed. This model was applied to predict the entire maturity at age for 1983-2000 (Table 2.5.4.1 and Figure 2.5.4.1).

2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

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

After the default XSA run in the 2001 assessment the diagnostics for age 4 turned out poorly, and this lead to the working group recommending excluding this age group from the CPUE series. The CPUE series was thus in the input file split to two fleets, one fleet containing age 3 and one fleet containing age 5-11 (Table 2.5.5.1). The final XSA run was made with the same parameters as last year, except that catchability dependency had to be set to age 3 and 4, due to the change in tuning. 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 reasonably low, however. The log catchability residuals from the XSA tuning for age groups 3 and 5-11 (Figure 2.5.5.1) show more negative values (36) in the first eight years than in the last eight years (26) of the 16 years time series.

Retrospective analysis of the average fishing mortality for age groups 4-8 years (Figure 2.5.5.2) shows a tendency to overestimate F in the four previous assessments with Fbar (4-8) for 1998 estimated at 0.45 in 1998, at 0.32 in 1999 and at 0.29 in 2000. The spawning stock biomass for 1998 increased from 60 000 t estimated in the 1999 assessment to 90 000 t in this year assessment. This is in part due to an underestimation of the 1992 yearclass in previous assessments. Last years assessment pointed out that the 1992 year-class is the only one amongst the 1953 to 1996 year classes where catch numbers increased from age 6 to 7 (Figure 2.5.5.3). This could be due to an immigration of seven-year-old saithe into Faroese fishing grounds in 1999 or to late recruitment of the 1992 year-class. This year's assessment also indicates that the number of eight year old is fairly high in the beginning of 2001.

The fishing mortalities for 1961-2000 are presented in Table 2.5.5.3. The average fishing mortality for age groups 4-8 was 0.41 in 2000.

2.5.5.2 Stock estimates and recruitment

Recruitment in the 1980s was above or close to average (26 millions). The strongest year class since 1961 was produced in the 1980s and the average for that decade is about 33 million. Even though recruitment had been above average, SSB declined from 100 000 t in 1989 to 60 000 t in 1992 as a result of high fishing mortality yielding the highest (1990) and third highest (1991) landings of the whole 1961-2000 period. The historically low SSB persisted in 1992-1995 (Table 2.5.5.5 and Figure 2.5.5.4). The SSB has increased since 1996 with the maturation of the 1992, 1994 and 1996 year-classes. SSB was estimated to be 88 000 t in 2000, which is a decrease of 10 000 t compared to SSB in 1999, but still high compared to the SSB level in the beginning of the 1990s and close to the average SSB level (94 000 t) in the 1980s.

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.

Population numbers for the short-term prediction up to the 1997 yearclass are from the final VPA run whereas values for the 1998-2000 year classes are the geometric mean of the 1995 to 1997 year classes. Mean weights for the stock and for the catches are the same for 2001-2003, the arithmetic mean for 1998-2000. In the long-term prediction (yield per recruit) mean weights for 1961-2000 were used.

In the short term prediction the fitted proportion mature values from the model for 2001 were used for that year and for 2002 and 2003 the average of fitted values for 1999-2001 was used. In the long term prediction the average of fitted values for 1983-2001 was used.

For all three years in the short-term prediction the average exploitation pattern in the final VPA for 1998-2000, rescaled to Fbar (ages 4-8) in 2000, was used. In the long-term prediction the exploitation pattern was set equal to the average of exploitation patterns for 1961-2000.

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 2000 average fishing mortality of 0.41 in age groups 4-8, $\mathbf{F}_{max}$ is 0.42, $\mathbf{F}_{0.1}$ is 0.16, $\mathbf{F}_{med}$ is 0.29 and $\mathbf{F}_{high}$ is 0.58 (Table 2.5.6.3, Figure 2.5.6.1 and Figure 2.5.6.2).

ACFM have set $\mathbf{F}_{lim}$ at 0.40 and $\mathbf{F}_{pa}$ = 0.28 (May 1998), and $\mathbf{B}_{lim}$ at 60 000 t and $\mathbf{B}_{pa}$ = 85 000 t (May 1999).

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 result in catches of 39 000 t in 2001 and 38 000 t in 2002. The spawning stock biomass would increase from 89 000 t in 2001 to 92 000 t, more than $\mathbf{B}_{pa}$, in 2002.

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 2001 and weight composition in SSB by year classes in 2002 is presented in Figure 2.5.6.4. The catch in 2001 is predicted to rely on the three most recent year classes that all may be poorly estimated. In 2002 the 1995 and 1996 year classes are expected to contribute almost half the SSB biomass. This may be a reminder that one has to be cautious regarding the reliability of the short-term prediction, because of the uncertain estimate of the 1996 and 1997 yearclasses.

2.5.6.4 Medium-term projections

Medium-term 10 years predictions were done for Faroese saithe using the results of the XSA. The exploitation pattern was taken as the average of the most recent three years in the assessment; other input values (M, maturity at age, weights in the stock, weights in the stock, and proportion fishing mortality and natural mortality) were as in the short-term predictions. Two recruitment options and three fishing mortality options were considered:

- recruitment drawn randomly from past observations for the 1958 to 1997 year classes;
- Ricker stock and recruitment fitted to the 1958 to 1997 year classes, modified by a random number in the range of 50% to 200%;
- status quo fishing mortality;
- constant F at 75% *status quo* F;
- constant F at 50% *status quo* F.

Two hundred and fifty runs were made for each combination of recruitment and fishing mortality.

The median catches and SSB, as well as the probability that the SSB would be less than $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$ have been accounted and are shown in Figure 2.5.6.5.

As expected, the results depend greatly on what assumption is made about future recruitment. If future recruitment is randomly drawn from past observations during the whole period, median catches stabilise in the range of 30 000 t regardless of the assumed fishing mortality. This is because if a stock and recruitment relationship is not used, medium term projections are similar to yield per recruit calculations where the average yield or SSB per recruit is multiplied by the average recruitment. Under this recruitment scenario, the median SSB are highly different: the highest median SSB, in the order of 130 000 t, is reached when F is reduced to 50% of $\mathbf{F}_{sq}$. The next highest median SSB is about 100 000 t when F is held at 75% $\mathbf{F}_{sq}$. If F is maintained at $\mathbf{F}_{sq}$, the median SSB stabilises slightly below 80 000t and therefore below $\mathbf{B}_{pa}$.

At a fishing mortality 50% of $\mathbf{F}_{sq}$, there is a zero probability that the SSB will be less than $\mathbf{B}_{pa}$. At a fishing mortality 75% of $\mathbf{F}_{sq}$ there is an approximate 20% probability that the SSB will be less than $\mathbf{B}_{pa}$ and at $\mathbf{F}_{sq}$, there is a 70% probability that SSB will be less than $\mathbf{B}_{pa}$.

If future recruitment is assumed to follow a Ricker relationship with the actual value varying between 50 and 200% of the predicted values, the median SSB at $0.50\mathbf{F}_{sq}$ increases above 140 000 t, at $\mathbf{F}_{sq}$ there remains a non-negligible nearly 30% probability that the SSB will be less than $\mathbf{B}_{pa}$ but there is low probability that the SSB will be less than $\mathbf{B}_{lim}$ under any of the fishing mortality scenarios.

These medium term predictions do not take account of changes in weights at age, maturity at age, or natural mortality that would result from changes in the size of the Faroese saithe stock, its prey or its predators. As such, they cannot be considered as forecasts of future events. Their main use is in comparing the relative results of management actions taken today.

It should be noted that these medium term predictions assume that the productive capacity of the environment has not changed. In medium term simulations it is assumed that the current assessment is correct, although recent assessment have consistently underestimated stock size. It would, however, not be prudent to assume that this will continue. The medium term projections suggest that $\mathbf{F}_{sq}$ will lead to a relatively high probability that the SSB will be less than $\mathbf{B}_{pa}$, particularly if environmental variation is more important than SSB in determining future recruitment.

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, but not in the medium term. A 30% increase in fishing mortality in 2002 would result in the SSB falling below $\mathbf{B}_{pa}$ in 2002. A 30% decrease in fishing mortality in 2001 would bring the SSB above 100 000 t in 2002.

The cumulative probability distribution of F in 1998 showed that there was an approximately 50% probability that the fishing mortality in 1999/2000 will be about 0.40 with the present number fishing days allocated in 1998. The fishing mortality was higher (0.44) in 1999. It has been estimated that a decrease to 60% of the allocated number of days would be required to have an 80% probability that F would be at the proposed $\mathbf{F}_{pa}$ = .28 or less. Although no probability distribution is available for 2000/2001 (see section 2.2), there is no doubt that fishing mortality will exceed the proposed $\mathbf{F}_{pa}$ at current fishing effort.

2.5.8 Comments on the assessment

The XSA settings are the same as last year, except for that the age for catchability dependency on stock size was set to age groups 3 and 4, because of the decision by the working group to exclude age 4 from the CPUE series.

Medium term predictions of catch and spawning stock biomass and different probability scenarios were included in this year's assessment, and were made available by using options in Fishlab.

There still is no independent recruitment index to predict recruits in the first year in the short-term prediction. A programme for echo sounding and biological sampling of age group 0-2 is in progress, but it may need five consecutive years of data before such recruitment index can be included in the assessment. 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. Due to database unreliability of the survey data, such an analysis has been postponed a year's time, when the database hopefully has passed a cross-checking.

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

Table 2.5.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1986-2000, as officially reported to ICES.

Country	1987	1988	1989	1990	1991	1992	1993
Denmark	255	94	-	2	-	-	-
Faroe Islands	39,301	44,402	43,624	59,821	53,321	35,979	32,719
France [3]	153	313	-	-	-	120	75
German Dem.Rep.	-	-	9	-	-	5	2
German Fed. Rep.	49	74	20	15	32		-
Netherlands	-	-	22	67	65	-	32
Norway	14	52	51	46	103	85	279
UK (Eng. & W.)	108	-	-	-	5	74	425
UK (Scotland)	140	92	9	33	79	98	
USSR/Russia [2]	-	-	-	30	-	12	-
Total	40,020	45,027	43,735	60,014	53,605	36,373	33,532
Working Group estimate [4,5]	40,020	45,285	44,477	61,628	54,858	36,487	33,543

Country	1994	1995	1996	1997	1998	1999	2000 [1]
Estonia	-	-	-	16	-	-	-
Faroe Islands	32,406	26,918	19,297	21,721	25,995	32,439	38,073
France	19	10	12	9	17	-	58
Germany	1	41	3	5	-	100	230
Greenland	-	-	-	-	-	-	1
Norway	156	10	16	67	54	189	113
UK (Eng. & W.)	151	21	53	-	19	67	...
UK (Scotland)	438	200	580	460	337	441	...
United Kingdom							565
Russia	-	-	18	28	-	-	8
Total	33,171	27,200	19,979	22,306	26,422	33,236	39,048
Working Group estimate [4,5]	33,182	27,209	20,029	22,306	26,422	33,236	39,048

[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.

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 1985-2000 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 catch tonnes gutted*
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	38377
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	36132
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	35700
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	39586
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	40132
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	54721
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	48910
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	31472
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	29111
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	29194
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	24248
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	17353
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	19561
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	23417
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	29781
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	33739
Average	0.3	0.2	0.2	0.1	7.6	2.6	15.2	21.8	51.0	0.2	0.7	0.1	33215

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

Age	*Jiggers*	*ST>1000 HP*	*PT<100 HP*	*PT>1000HP*	*Others*	*Tot. Faroe**	*Foreign*	*Total*
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	4	11	7	0	22	1	23
3	36	124	209	401	9	792	20	812
4	102	389	732	1461	31	2762	71	2832
5	56	202	271	875	20	1447	37	1485
6	173	605	714	2635	63	4263	109	4372
7	72	297	387	1347	31	2172	56	2227
8	107	402	405	1661	39	2659	68	2727
9	12	51	62	204	4	340	9	348
10	6	29	27	113	3	181	5	186
11	1	11	7	33	0	54	1	56
12	1	2	2	11	0	17	0	18
13	0	0	0	2	0	2	0	2
14	0	0	2	0	0	3	0	3
15	0	0	0	0	0	2	0	2
Total No.	565	2118	2830	8754	201	14716	377	15093
Catch, t.	1277	5046	5911	21019	468	34300	878	35178

Notes: Numbers in 1000'

Catch, gutted weight in tonnes

Others includes longliners, small single trawlers, industrial trawlers and catches not otherwise accounted for

*Revised catch numbers by total Faroese catch

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 27/04/2001  18:47
```

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

YEAR / AGE	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	183	562	614	684	996	488	595	614	1191	1445
4	379	542	340	1908	850	1540	796	1689	2086	6577
5	483	617	340	1506	1708	1201	1364	1116	2294	1558
6	403	495	415	617	965	1686	792	1095	1414	1478
7	216	286	406	572	510	806	1192	548	1118	899
8	129	131	202	424	407	377	473	655	589	730
9	116	129	174	179	306	294	217	254	580	316
10	82	113	158	150	201	205	190	128	239	241
11	45	71	94	100	156	156	97	89	115	86
+gp	82	105	274	174	285	225	140	187	190	132
TOTALNUM	2118	3051	3017	6314	6384	6978	5856	6375	9816	13462
TONSLAND	9592	10454	12693	21893	22181	25563	21319	20387	27437	29110
SOPCOF %	108	93	96	99	92	98	104	102	97	96

YEAR / AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	2857	2714	2515	3504	2062	3178	1609	611	287	996
4	3316	1774	6253	4126	3361	3217	2937	1743	933	877
5	5585	2588	7075	4011	3801	1720	2034	1736	1341	720
6	1005	2742	3478	2784	1939	1250	1288	548	1033	673
7	828	1529	1634	1401	1045	877	767	373	584	726
8	469	1305	693	640	714	641	708	479	414	284
9	326	1017	550	368	302	468	498	466	247	212
10	164	743	403	340	192	223	338	473	473	171
11	100	330	215	197	193	141	272	407	368	196
+gp	100	210	186	265	298	287	330	535	691	786
TOTALNUM	14750	14952	23002	17636	13907	12002	10781	7371	6371	5641
TONSLAND	32706	42663	57431	47188	41576	33065	34835	28138	27246	25230
SOPCOF %	109	100	120	113	116	107	104	100	102	99

YEAR / AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	411	387	2483	368	1224	1167	1581	866	451	294
4	1804	4076	1103	11067	3990	1997	5793	2950	5981	3833
5	769	994	5052	2359	5583	4473	3827	9555	5300	10120
6	932	1114	1343	4093	1182	3730	2785	2784	7136	9219
7	908	380	575	875	1898	953	990	1300	793	5070
8	734	417	339	273	273	1077	532	621	546	477
9	343	296	273	161	103	245	333	363	185	123
10	192	105	98	52	38	104	81	159	83	61
11	92	88	98	65	26	67	43	27	55	60
+gp	1021	902	540	253	275	158	97	60	39	79
TOTALNUM	7206	8759	11904	19566	14592	13971	16062	18685	20569	29336
TONSLAND	30103	30964	39176	54665	44605	41716	40020	45285	44477	61628
SOPCOF %	96	96	100	100	94	94	96	99	97	98

YEAR / AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	1030	521	1316	690	398	297	344	163	322	812
4	5125	4067	2611	3961	1019	1087	832	1689	656	2832
5	7452	3667	4689	2663	3468	1146	2440	1934	3099	1485
6	5544	2679	1665	2368	1836	1449	1767	3475	2553	4372
7	3487	1373	858	746	1177	1156	1335	1379	4117	2227
8	1630	894	492	500	345	521	624	683	916	2727
9	405	613	448	307	241	132	165	368	381	348
10	238	123	245	303	192	77	71	77	147	186
11	128	63	54	150	104	64	29	32	24	56
+gp	118	108	52	49	117	82	100	73	69	25
TOTALNUM	25157	14108	12430	11737	8897	6011	7707	9873	12284	15070
TONSLAND	54858	36487	33543	33182	27209	20029	22306	26422	33236	39048
SOPCOF %	99	105	102	102	102	103	100	102	102	102

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 27/04/2001 18:47

Table 2 Catch weights at age (kg)

YEAR / AGE	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	1.4300	1.2730	1.2800	1.1750	1.1810	1.3610	1.2730	1.3020	1.1880	1.2440
4	2.3020	2.0450	2.1970	2.0550	2.1250	2.0260	1.7800	1.7370	1.6670	1.4450
5	3.3480	3.2930	3.2120	3.2660	2.9410	3.0550	2.5340	2.0360	2.3020	2.2490
6	4.2870	4.1910	4.5680	4.2550	4.0960	3.6580	3.5720	3.1200	2.8530	2.8530
7	5.1280	5.1460	5.0560	5.0380	4.8780	4.5850	4.3680	4.0490	3.6730	3.5150
8	6.1550	5.6550	5.9320	5.6940	5.9320	5.5200	5.3130	5.1830	5.0020	4.4180
9	7.0600	6.4690	6.2590	6.6620	6.3210	6.8370	5.8120	6.2380	5.7140	5.4440
10	7.2650	6.7060	8.0000	6.8370	7.2880	7.2650	6.5540	7.5200	6.4050	5.7330
11	7.4970	7.1500	7.2650	7.6860	8.0740	7.6620	7.8060	8.0490	6.5540	6.6620
+gp	9.3399	9.0237	8.8589	8.5591	8.9035	9.2233	8.1494	9.0925	8.0870	8.5844
SOPCOFAC	1.0779	.9342	.9590	.9933	.9220	.9769	1.0357	1.0194	.9663	.9634

YEAR / AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	1.1010	1.0430	1.0880	1.4300	1.1140	1.0880	1.2230	1.4930	1.2200	1.2300
4	1.3160	1.4850	1.4610	1.5250	1.6580	1.6760	1.6410	2.3240	1.8800	2.1200
5	1.8180	2.0550	1.5820	2.2070	2.2600	2.8780	2.6600	3.0680	2.6200	3.3200
6	2.9780	2.8290	2.2490	2.5000	3.1200	3.0810	3.7900	3.7460	3.4000	4.2800
7	3.7020	3.7910	3.6870	3.1200	3.5570	4.2870	4.2390	4.9130	4.1800	5.1600
8	4.2710	4.1750	4.3850	4.6010	4.0960	4.3520	5.5970	4.3680	4.9500	6.4200
9	5.3880	4.8080	5.1280	5.5590	5.1280	4.7900	5.3500	5.2760	5.6900	6.8700
10	5.9720	5.2940	5.2760	5.7140	6.0940	5.9120	5.9120	5.8320	6.3800	7.0900
11	6.4900	6.9480	6.7270	6.2590	7.1960	6.6190	6.8370	6.0530	7.0200	7.9300
+gp	8.0047	7.5146	8.0307	8.0104	8.5982	7.8941	7.7085	7.5756	8.6262	9.2153
SOPCOFAC	1.0935	1.0043	1.2006	1.1296	1.1607	1.0680	1.0442	1.0049	1.0248	.9937

YEAR / AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	1.3100	1.3370	1.2080	1.4310	1.4010	1.7180	1.6090	1.5000	1.3090	1.2230
4	2.1300	1.8510	2.0290	1.9530	2.0320	1.9860	1.8350	1.9750	1.7350	1.6330
5	3.0000	2.9510	2.9650	2.4700	2.9650	2.6180	2.3950	1.9780	1.9070	1.8300
6	3.8100	3.5770	4.1430	3.8500	3.5960	3.2770	3.1820	2.9370	2.3730	2.0520
7	4.7500	4.9270	4.7240	5.1770	5.3360	4.1860	4.0670	3.7980	3.8100	2.8660
8	5.2500	6.2430	5.9010	6.3470	7.2020	5.5890	5.1490	4.4190	4.6670	4.4740
9	5.9500	7.2320	6.8110	7.8250	6.9660	6.0500	5.5010	5.1150	5.5090	5.4240
10	6.4300	7.2390	7.0510	6.7460	9.8620	6.1500	6.6260	6.7120	5.9720	6.4690
11	7.0000	8.3460	7.2480	8.6360	10.6700	9.5360	6.3430	9.0400	6.9390	6.3430
+gp	8.9618	10.0411	10.0547	10.0976	11.9501	10.2181	10.2439	9.3369	9.9364	8.2869
SOPCOFAC	.9564	.9632	.9997	.9991	.9415	.9419	.9620	.9928	.9698	.9811

YEAR / AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	1.2400	1.2640	1.4080	1.5030	1.4560	1.4320	1.4760	1.3880	1.3740	1.4770
4	1.5680	1.6020	1.8600	1.9510	2.1770	1.8750	1.7830	1.7110	1.7120	1.6060
5	1.8640	2.0690	2.3230	2.2670	2.4200	2.4960	2.0320	1.9540	1.9050	2.0770
6	2.2110	2.5540	3.1310	2.9360	2.8950	3.2290	2.7780	2.4050	2.3960	2.3600
7	2.6480	3.0570	3.7300	4.2140	3.6510	3.7440	3.5980	3.3000	2.8450	2.9770
8	3.3800	4.0780	4.3940	4.9710	5.0640	4.9640	4.7660	4.2200	4.1240	3.4800
9	4.8160	5.0120	5.2090	5.6570	5.4400	6.3750	5.9820	4.9990	5.2560	4.8510
10	5.5160	6.7680	6.5400	5.9500	6.1670	6.7450	7.6580	6.3910	5.5260	5.2680
11	6.4070	7.7540	8.4030	6.8910	7.0800	7.4660	7.8820	6.6650	6.9560	6.5230
+gp	7.7285	8.2297	8.0501	9.1086	7.5392	7.9806	9.2453	8.4847	8.5237	5.9024
SOPCOFAC	.9938	1.0506	1.0169	1.0240	1.0205	1.0319	.9994	1.0221	1.0181	1.0155

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 27/04/2001  18:47

       Table  5    Proportion mature at age
```

YEAR / AGE	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
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 / AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
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 / AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	.0400	.0400	.0800	.0900	.0900	.1200	.1100	.1000	.0900	.0800
4	.2600	.2600	.2900	.2800	.2900	.2800	.2600	.2800	.2400	.2300
5	.5700	.5700	.6600	.5600	.6600	.5900	.5500	.4600	.4500	.4300
6	.8200	.8200	.9000	.8800	.8600	.8200	.8100	.7800	.6900	.6300
7	.9100	.9100	.9500	.9700	.9700	.9300	.9200	.9000	.9000	.8100
8	.9800	.9800	.9900	.9900	1.0000	.9900	.9800	.9700	.9700	.9700
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.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 / AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	.0800	.0800	.0900	.1000	.1000	.0900	.1000	.0900	.0900	.0900
4	.2200	.2200	.2600	.2800	.3100	.2600	.2500	.2600	.2800	.2400
5	.4400	.4800	.5300	.5200	.5500	.5700	.4700	.5600	.5600	.4500
6	.6600	.7200	.8000	.7800	.7700	.8200	.7500	.7800	.8100	.6900
7	.7800	.8300	.9000	.9300	.8900	.9000	.8900	.9000	.9100	.8100
8	.9300	.9600	.9700	.9800	.9800	.9800	.9800	.9700	.9800	.9600
9	.9900	.9900	.9900	.9900	.9900	1.0000	1.0000	.9900	1.0000	.9900
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

```
Faroe Saithe (ICES Div. Vb) age3+5-11
102
Cuba Logbook age3
1985 2000
1 1 0 1
3 3
3864    31
4175    65
7126   120
7314    66
7167    52
8177    23
8082    34
8600    11
8622    83
9601    81
11326   74
11594   41
15185  102
12747   22
14271   59
12495  143
Cuba Logbook age5-11
1985 2000
1 1 0 1
5 11
3864    396  83   103   13   5   1   2
4175    342  245   68   72  18   6   3
7126    401  319  119   63  33   7   5
7314    876  308  125   52  35   8   1
7167    507  641   73   43  14   8   5
8177    741  717  394   36  10   4   4
8082    495  400  252  124  15  14  10
8600    277  234  117   68  59  11   6
8622    525  189  101   60  44  26   6
9601    372  349  112   78  51  47  22
11326   898  368  227   76  38  29  21
11594   217  224  274  210 101  26  14
15185   522  383  294  133  31  15   5
12747   349  606  257  128  72  14   5
14271   694  632 1026  249 109  36   6
12495   311  936  479  590  73  40  12
```

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

```
Lowestoft VPA Version 3.1

  27/04/2001  18:46

Extended Survivors Analysis

FAROE SAITHE (ICES Division Vb)                 SAI_IND

CPUE data from file D:\Ices2001\Xsanew\Saithtun.DAT

Catch data for  40 years. 1961 to 2000. Ages  3 to  12.

     Fleet             First  Last  First  Last  Alpha   Beta
                        year  year   age    age
Cuba Logbook age3       1985  2000    3      3    .000   1.000
Cuba Logbook age5-11    1985  2000    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   17 iterations



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

Table 2.5.5.2 (Continued)

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	.047	.030	.063	.047	.011	.015	.011	.014	.011	.021
4	.415	.263	.205	.272	.092	.039	.051	.067	.072	.126
5	.771	.597	.552	.332	.407	.142	.117	.162	.169	.232
6	.899	.714	.603	.605	.403	.296	.338	.242	.334	.383
7	.803	.581	.523	.604	.704	.481	.491	.483	.505	.549
8	.671	.488	.423	.672	.631	.803	.524	.505	.700	.757
9	.800	.579	.486	.513	.831	.530	.647	.685	.593	.636
10	.926	.607	.483	.727	.716	.704	.615	.732	.653	.658
11	.934	.678	.593	.624	.595	.556	.635	.630	.529	.560

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10	11
1991	2.49E+04	1.67E+04	1.53E+04	1.03E+04	6.98E+03	3.68E+03	8.13E+02	4.36E+02	2.33E+02
1992	1.96E+04	1.94E+04	9.01E+03	5.80E+03	3.44E+03	2.56E+03	1.54E+03	2.99E+02	1.41E+02
1993	2.39E+04	1.56E+04	1.22E+04	4.06E+03	2.33E+03	1.58E+03	1.29E+03	7.07E+02	1.33E+02
1994	1.64E+04	1.84E+04	1.04E+04	5.76E+03	1.82E+03	1.13E+03	8.46E+02	6.48E+02	3.57E+02
1995	3.85E+04	1.28E+04	1.15E+04	6.11E+03	2.57E+03	8.14E+02	4.72E+02	4.15E+02	2.56E+02
1996	2.28E+04	3.11E+04	9.59E+03	6.25E+03	3.34E+03	1.04E+03	3.55E+02	1.68E+02	1.66E+02
1997	3.54E+04	1.84E+04	2.45E+04	6.81E+03	3.80E+03	1.69E+03	3.83E+02	1.71E+02	6.82E+01
1998	1.29E+04	2.87E+04	1.43E+04	1.79E+04	3.98E+03	1.91E+03	8.20E+02	1.64E+02	7.57E+01
1999	3.26E+04	1.04E+04	2.20E+04	9.94E+03	1.15E+04	2.01E+03	9.42E+02	3.39E+02	6.46E+01
2000	4.25E+04	2.64E+04	7.94E+03	1.52E+04	5.83E+03	5.68E+03	8.18E+02	4.26E+02	1.44E+02

Estimated population abundance at 1st Jan 2001

0.00E+00	3.41E+04	1.91E+04	5.16E+03	8.48E+03	2.76E+03	2.18E+03	3.54E+02	1.81E+02

Taper weighted geometric mean of the VPA populations:

2.70E+04	2.09E+04	1.44E+04	8.58E+03	3.94E+03	1.74E+03	7.08E+02	3.13E+02	1.33E+02

Standard error of the weighted Log(VPA populations) :

.4093	.4096	.4486	.5164	.5569	.5400	.4398	.5035	.5579

Log catchability residuals.

Fleet : Cuba Logbook age3

Age	1985	1986	1987	1988	1989	1990
3	.57	.09	.40	-.05	.21	-.27
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	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	-.10	-.87	.65	.90	-.18	-.17	-.07	-.21	-.40	.20
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									

Table 2.5.5.2 (Continued)

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	.84	.442	14.54	.45	16	.48	-15.34

Fleet : Cuba Logbook age5-11

Age	1985	1986	1987	1988	1989	1990
3	No data for this fleet at this age					
4	No data for this fleet at this age					
5	.82	.71	.43	.08	-.30	.32
6	-.11	.64	.38	.43	-.04	.15
7	.02	-.03	.01	-.01	-.47	-.04
8	-.50	.36	-.07	-.20	-.37	-.81
9	-.72	.62	.01	.17	-.73	-1.32
10	-1.68	.06	.24	-.59	-.48	-1.60
11	-.19	.04	.19	-.64	-.21	-.65

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	.43	.24	.55	.16	.82	-.57	-.91	-.58	-.43	-.06
6	.22	.12	.21	.37	.11	-.48	-.28	-.66	-.10	.02
7	-.11	-.33	-.11	.16	.40	.21	-.12	-.12	.10	.17
8	-.34	-.72	-.39	.21	.33	1.14	-.19	-.18	.41	.39
9	-.85	-.27	-.43	.04	.30	1.41	-.06	.21	.33	.23
10	-.24	-.30	-.36	.32	.11	.88	.00	.20	.27	.28
11	.05	-.13	-.11	.11	.22	.21	-.17	-.10	.09	.12

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	-12.4089	-11.9667	-11.7467	-11.6460	-11.6856	-11.6856	-11.6856
S.E(Log q)	.5466	.3387	.2203	.5315	.6575	.5965	.2557

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	1.57	-.972	14.01	.23	16	.86	-12.41
6	1.28	-1.092	12.77	.61	16	.43	-11.97
7	1.01	-.060	11.77	.86	16	.23	-11.75
8	1.21	-.552	12.51	.42	16	.66	-11.65
9	2.47	-1.363	19.20	.08	16	1.56	-11.69
10	1.32	-.663	13.66	.30	16	.81	-11.73
11	.85	1.383	10.68	.89	16	.20	-11.73

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	41592.	.521	.000	.00	1	.265	.018
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	20893.	.41				.440	.035
F shrinkage mean	58941.	.50				.295	.012

Table 2.5.5.2 (Continued)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
34059.	.27	.35	3	1.290	.021

Age 4 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	12789.	.500	.000	.00	1	.280	.183
Cuba Logbook age5-11	1.	.000	.000	.00	0	.000	.000
P shrinkage mean	14372.	.45				.399	.164
F shrinkage mean	38434.	.50				.321	.065

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
19081.	.28	.44	3	1.596	.126

Age 5 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	4186.	.546	.000	.00	1	.274	.278
Cuba Logbook age5-11	4876.	.569	.000	.00	1	.276	.243
F shrinkage mean	6060.	.50				.450	.200

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5157.	.31	.14	3	.463	.232

Age 6 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	7882.	.503	.000	.00	1	.158	.407
Cuba Logbook age5-11	7767.	.301	.197	.65	2	.543	.412
F shrinkage mean	10317.	.50				.299	.325

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
8475.	.24	.12	4	.519	.383

Age 7 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	2327.	.510	.000	.00	1	.079	.624
Cuba Logbook age5-11	2784.	.216	.163	.75	3	.673	.545
F shrinkage mean	2835.	.50				.249	.537

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2757.	.20	.10	5	.500	.549

Table 2.5.5.2 (Continued)

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	1824.	.512	.000	.00	1	.061	.856
Cuba Logbook age5-11	1940.	.206	.261	1.26	4	.600	.821
F shrinkage mean	2763.	.50				.340	.638

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
2179.	.21	.18	6	.859	.757

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

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	874.	.528	.000	.00	1	.034	.308
Cuba Logbook age5-11	351.	.223	.141	.63	5	.537	.641
F shrinkage mean	335.	.50				.429	.663

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
354.	.25	.11	7	.449	.636

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

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	345.	.548	.000	.00	1	.015	.398
Cuba Logbook age5-11	188.	.241	.142	.59	6	.519	.639
F shrinkage mean	169.	.50				.467	.690

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
181.	.26	.10	8	.363	.658

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook age3	28.	.632	.000	.00	1	.004	1.030
Cuba Logbook age5-11	77.	.230	.031	.14	7	.681	.505
F shrinkage mean	51.	.50				.314	.690

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
67.	.22	.09	9	.392	.560

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

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Run title : FAROE SAITHE (ICES Division Vb)                SAI_IND
At 27/04/2001  18:47
               Terminal Fs derived using XSA (With F shrinkage)

   Table  8    Fishing mortality (F) at age
```

YEAR	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
AGE										
3	.0226	.0465	.0307	.0478	.0495	.0250	.0248	.0321	.0328	.0479
4	.0556	.0864	.0358	.1260	.0773	.1007	.0518	.0910	.1453	.2549
5	.0994	.1208	.0716	.2198	.1588	.1492	.1218	.0955	.1721	.1539
6	.1219	.1402	.1115	.1798	.2137	.2326	.1388	.1358	.1685	.1599
7	.0933	.1192	.1634	.2213	.2217	.2785	.2564	.1345	.2001	.1537
8	.0852	.0752	.1157	.2567	.2424	.2537	.2616	.2184	.2095	.1944
9	.0972	.1150	.1355	.1424	.2983	.2771	.2269	.2183	.3065	.1657
10	.0915	.1295	.2012	.1658	.2356	.3347	.2904	.2028	.3290	.2009
11	.0916	.1069	.1514	.1891	.2601	.2901	.2610	.2142	.2832	.1878
+gp	.0916	.1069	.1514	.1891	.2601	.2901	.2610	.2142	.2832	.1878
FBAR 4- 8	.0911	.1083	.0996	.2007	.1828	.2030	.1661	.1350	.1791	.1833

YEAR	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
AGE										
3	.0885	.0936	.1272	.2296	.1508	.2059	.1484	.0842	.0376	.0932
4	.1481	.0728	.3229	.3172	.3600	.3714	.2985	.2378	.1789	.1544
5	.3582	.1651	.4587	.3547	.5446	.3159	.4267	.2891	.2907	.2041
6	.1405	.2988	.3490	.3281	.2896	.3436	.4153	.1925	.2793	.2317
7	.1263	.3289	.2923	.2300	.1961	.2052	.3672	.2010	.3234	.3237
8	.1119	.2998	.2428	.1773	.1755	.1771	.2544	.4131	.3592	.2573
9	.1245	.3763	.1984	.1964	.1185	.1668	.2031	.2651	.3889	.3152
10	.1213	.4605	.2499	.1812	.1488	.1205	.1745	.3028	.4722	.5140
11	.1197	.3814	.2315	.1857	.1482	.1554	.2116	.3290	.4096	.3645
+gp	.1197	.3814	.2315	.1857	.1482	.1554	.2116	.3290	.4096	.3645
FBAR 4- 8	.1770	.2331	.3332	.2815	.3132	.2827	.3524	.2667	.2863	.2342

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
3	.0138	.0297	.0696	.0159	.0633	.0211	.0366	.0217	.0176	.0158
4	.2436	.1847	.1109	.4984	.2381	.1396	.1386	.0889	.2048	.2040
5	.1969	.2053	.3668	.3658	.5076	.4589	.4317	.3559	.2281	.6345
6	.4431	.4863	.4719	.5770	.3151	.7758	.5849	.6533	.4942	.7863
7	.5614	.3252	.5023	.6536	.5837	.4537	.4781	.6036	.3867	.8089
8	.6387	.5490	.5427	.4754	.4332	.7972	.4966	.6343	.5536	.4260
9	.5670	.5805	.8794	.5413	.3292	.9020	.6171	.7679	.3890	.2275
10	.5273	.3358	.3830	.3974	.2320	.6554	.8949	.6887	.3896	.2126
11	.5826	.4922	.6070	.4749	.3538	.8263	.6303	.8896	.5426	.5457
+gp	.5826	.4922	.6070	.4749	.3538	.8263	.6303	.8896	.5426	.5457
FBAR 4- 8	.4168	.3501	.3989	.5140	.4155	.5250	.4260	.4672	.3735	.5719

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-00
AGE											
3	.0469	.0298	.0628	.0475	.0115	.0145	.0108	.0141	.0110	.0213	.0155
4	.4150	.2632	.2045	.2721	.0918	.0393	.0514	.0672	.0721	.1260	.0885
5	.7710	.5971	.5518	.3323	.4071	.1417	.1165	.1621	.1695	.2316	.1877
6	.8988	.7137	.6033	.6055	.4034	.2963	.3377	.2420	.3338	.3831	.3196
7	.8033	.5810	.5233	.6037	.7035	.4814	.4911	.4827	.5046	.5486	.5120
8	.6714	.4879	.4228	.6722	.6314	.8029	.5237	.5046	.7000	.7571	.6539
9	.8002	.5791	.4859	.5126	.8307	.5299	.6473	.6847	.5926	.6357	.6377
10	.9256	.6066	.4828	.7275	.7163	.7039	.6145	.7316	.6534	.6583	.6811
11	.9343	.6783	.5929	.6237	.5952	.5555	.6347	.6297	.5286	.5604	.5729
+gp	.9343	.6783	.5929	.6237	.5952	.5555	.6347	.6297	.5286	.5604	
FBAR 4- 8	.7119	.5286	.4611	.4971	.4474	.3523	.3041	.2917	.3560	.4093	

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 27/04/2001 18:47

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR AGE	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
3	9046	13662	22427	16187	22797	21821	26865	21503	40779	34113
4	7738	7241	10677	17806	12634	17763	17424	21457	17050	32309
5	5643	5993	5438	8434	12852	9575	13150	13545	16039	12072
6	3880	4183	4348	4144	5542	8977	6752	9532	10080	11056
7	2680	2812	2977	3184	2835	3665	5824	4812	6813	6973
8	1746	1998	2044	2070	2090	1859	2271	3690	3444	4567
9	1384	1313	1518	1491	1311	1343	1181	1431	2428	2286
10	1036	1028	958	1085	1058	797	833	771	942	1463
11	568	774	740	641	753	685	467	510	515	555
+gp	1032	1141	2147	1111	1367	981	669	1066	846	848
TOTAL	34753	40144	53272	56154	63238	67464	75437	78318	98937	106243

YEAR AGE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
3	37260	33584	23272	18878	16276	18876	12896	8365	8594	12364
4	26622	27921	25041	16778	12285	11460	12579	9102	6296	6777
5	20502	18796	21255	14844	10003	7017	6472	7641	5875	4310
6	8474	11732	13047	11000	8524	4750	4189	3458	4685	3597
7	7715	6028	7124	7535	6487	5224	2758	2264	2336	2901
8	4896	5567	3552	4354	4902	4366	3484	1564	1516	1384
9	3078	3584	3377	2281	2986	3367	2994	2211	847	867
10	1586	2225	2014	2267	1535	2171	2333	2001	1389	470
11	980	1150	1150	1284	1549	1083	1576	1604	1210	709
+gp	976	726	989	1720	2381	2195	1902	2094	2253	2822
TOTAL	112089	111314	100820	80941	66927	60509	51183	40306	35002	36201

YEAR AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	33085	14613	40806	25832	22046	61717	48566	44544	28533	20690
4	9222	26716	11614	31162	20816	16942	49474	38332	35686	22953
5	4755	5918	18185	8511	15500	13433	12064	35264	28714	23805
6	2878	3197	3946	10317	4834	7638	6950	6414	20226	18713
7	2336	1513	1609	2015	4744	2888	2879	3170	2733	10103
8	1719	1091	895	797	858	2166	1502	1461	1419	1520
9	876	743	516	426	406	456	799	748	634	668
10	518	407	340	175	203	239	151	353	284	352
11	230	250	238	190	96	132	102	51	145	158
+gp	2527	2539	1296	733	1012	306	227	111	102	205
TOTAL	58144	56987	79445	80158	70515	105917	122713	130448	118477	99168

YEAR AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 61-98	AMST 61-98
3	24858	19630	23899	16444	38482	22754	35436	12910	32644	42497	0	22487	25116
4	16674	19420	15600	18376	12839	31146	18361	28701	10422	26436	34059	17257	19500
5	15324	9014	12220	10410	11461	9589	24517	14280	21970	7939	19081	11356	12958
6	10333	5803	4062	5762	6113	6245	6814	17865	9941	15183	5157	6684	7633
7	6980	3444	2327	1819	2575	3344	3802	3980	11482	5829	8475	3628	4084
8	3684	2559	1577	1129	814	1043	1692	1905	2011	5676	2757	2023	2347
9	813	1541	1286	846	472	355	383	820	942	818	2179	1138	1423
10	436	299	707	648	415	168	171	164	339	426	354	643	895
11	233	141	133	357	256	166	68	76	65	144	181	374	566
+gp	211	239	127	115	285	210	232	171	184	64	97		
TOTAL	79545	62091	61939	55906	73713	75021	91475	80871	90000	105012	72341		

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND
At 27/04/2001 18:47

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 3	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1961	9046	121961	83791	9592	.1145	.0911
1962	13662	126450	85627	10454	.1221	.1083
1963	22427	158219	100620	12693	.1261	.0996
1964	16187	160405	98370	21893	.2226	.2007
1965	22797	174741	107197	22181	.2069	.1828
1966	21821	184101	108753	25563	.2351	.2030
1967	26865	181585	104602	21319	.2038	.1661
1968	21503	189721	115916	20387	.1759	.1350
1969	40779	214925	123735	27437	.2217	.1791
1970	34113	224316	129066	29110	.2255	.1833
1971	37260	228269	139403	32706	.2346	.1770
1972	33584	236863	147448	42663	.2893	.2331
1973	23272	210336	136540	57431	.4206	.3332
1974	18878	203833	137431	47188	.3434	.2815
1975	16276	187135	137669	41576	.3020	.3132
1976	18876	169427	121784	33065	.2715	.2827
1977	12896	155944	113826	34835	.3060	.3524
1978	8365	136908	95715	28138	.2940	.2667
1979	8594	112527	83187	27246	.3275	.2863
1980	12364	124052	88372	25230	.2855	.2342
1981	33085	141126	75697	30103	.3977	.4168
1982	14613	148054	82329	30964	.3761	.3501
1983	40806	176680	94198	39176	.4159	.3989
1984	25832	187614	95777	54665	.5708	.5140
1985	22046	185970	109014	44605	.4092	.4155
1986	61717	232679	95256	41716	.4379	.5250
1987	48566	247742	92676	40020	.4318	.4260
1988	44544	257300	99411	45285	.4555	.4672
1989	28533	226266	98952	44477	.4495	.3735
1990	20690	189107	92184	61628	.6685	.5719
1991	24858	148755	71263	54858	.7698	.7119
1992	19630	123171	59945	36487	.6087	.5286
1993	23899	132851	63729	33543	.5263	.4611
1994	16444	126515	62712	33182	.5291	.4971
1995	38482	152028	64622	27209	.4211	.4474
1996	22754	159096	70952	20029	.2823	.3523
1997	35436	181815	77387	22306	.2882	.3041
1998	12910	166169	90198	26422	.2929	.2917
1999	32644	178166	98455	33236	.3376	.3560
2000	42497	202180	88490	39048	.4413	.4093
Arith. Mean	25739	176625	98558	33242	.3510	.3282
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

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

MFDP version 1
Run: man1
Time and date: 22:19 29/04/01
Fbar age range: 4-8

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26164	0.2	0.10	0	0	1.413	0.018	1.413
4	34059	0.2	0.22	0	0	1.676	0.103	1.676
5	19081	0.2	0.48	0	0	1.979	0.218	1.979
6	5157	0.2	0.69	0	0	2.387	0.371	2.387
7	8475	0.2	0.82	0	0	3.041	0.595	3.041
8	2757	0.2	0.93	0	0	3.941	0.760	3.941
9	2179	0.2	0.99	0	0	5.035	0.741	5.035
10	354	0.2	1.00	0	0	5.728	0.791	5.728
11	181	0.2	1.00	0	0	6.715	0.666	6.715
12	97	0.2	1.00	0	0	8.438	0.666	8.438

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26164	0.2	0.09	0	0	1.413	0.018	1.413
4	.	0.2	0.25	0	0	1.676	0.103	1.676
5	.	0.2	0.50	0	0	1.979	0.218	1.979
6	.	0.2	0.73	0	0	2.387	0.371	2.387
7	.	0.2	0.85	0	0	3.041	0.595	3.041
8	.	0.2	0.96	0	0	3.941	0.760	3.941
9	.	0.2	0.99	0	0	5.035	0.741	5.035
10	.	0.2	1.00	0	0	5.728	0.791	5.728
11	.	0.2	1.00	0	0	6.715	0.666	6.715
12	.	0.2	1.00	0	0	8.438	0.666	8.438

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	26164	0.2	0.09	0	0	1.413	0.018	1.413
4	.	0.2	0.25	0	0	1.676	0.103	1.676
5	.	0.2	0.50	0	0	1.979	0.218	1.979
6	.	0.2	0.73	0	0	2.387	0.371	2.387
7	.	0.2	0.85	0	0	3.041	0.595	3.041
8	.	0.2	0.96	0	0	3.941	0.760	3.941
9	.	0.2	0.99	0	0	5.035	0.741	5.035
10	.	0.2	1.00	0	0	5.728	0.791	5.728
11	.	0.2	1.00	0	0	6.715	0.666	6.715
12	.	0.2	1.00	0	0	8.438	0.666	8.438

Input units are thousands and kg - output in tonnes

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

MFYPR version 1
Run: yr6
Index file 28/4/2001
Time and date: 12:32 02/05/01
Fbar age range: 4-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.09	0	0	1.320	0.068	1.320
4	0.2	0.26	0	0	1.837	0.223	1.837
5	0.2	0.52	0	0	2.480	0.374	2.480
6	0.2	0.77	0	0	3.228	0.464	3.228
7	0.2	0.89	0	0	4.087	0.484	4.087
8	0.2	0.97	0	0	5.018	0.502	5.018
9	0.2	0.99	0	0	5.820	0.512	5.820
10	0.2	1.00	0	0	6.521	0.513	6.521
11	0.2	1.00	0	0	7.365	0.525	7.365
12	0.2	1.00	0	0	8.723	0.525	8.723

Weights in kilograms

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

MFYPR version 1
Run: yr6
Time and date: 12:32 02/05/01
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.7428	3.4893	18.9483	3.4893	18.9483
0.1000	0.0409	0.1466	0.6785	4.7866	17.5181	2.7882	13.8134	2.7882	13.8134
0.2000	0.0819	0.2448	1.0369	4.2985	14.2534	2.3273	10.6319	2.3273	10.6319
0.3000	0.1228	0.3157	1.2374	3.9467	12.0528	2.0012	8.5087	2.0012	8.5087
0.4000	0.1638	0.3696	1.3537	3.6795	10.4862	1.7582	7.0141	1.7582	7.0141
0.5000	0.2047	0.4123	1.4224	3.4686	9.3235	1.5702	5.9187	1.5702	5.9187
0.6000	0.2456	0.4471	1.4631	3.2971	8.4314	1.4204	5.0896	1.4204	5.0896
0.7000	0.2866	0.4761	1.4868	3.1543	7.7280	1.2982	4.4453	1.2982	4.4453
0.8000	0.3275	0.5007	1.4999	3.0333	7.1607	1.1968	3.9335	1.1968	3.9335
0.9000	0.3685	0.5220	1.5063	2.9290	6.6942	1.1111	3.5194	1.1111	3.5194
1.0000	0.4094	0.5406	1.5085	2.8379	6.3043	1.0379	3.1787	1.0379	3.1787
1.1000	0.4503	0.5570	1.5079	2.7576	5.9735	0.9746	2.8947	0.9746	2.8947
1.2000	0.4913	0.5717	1.5055	2.6860	5.6895	0.9193	2.6548	0.9193	2.6548
1.3000	0.5322	0.5849	1.5019	2.6218	5.4429	0.8706	2.4501	0.8706	2.4501
1.4000	0.5732	0.5969	1.4977	2.5636	5.2266	0.8274	2.2737	0.8274	2.2737
1.5000	0.6141	0.6078	1.4930	2.5106	5.0353	0.7888	2.1203	0.7888	2.1203
1.6000	0.6550	0.6179	1.4881	2.4621	4.8649	0.7541	1.9859	0.7541	1.9859
1.7000	0.6960	0.6271	1.4831	2.4175	4.7119	0.7228	1.8674	0.7228	1.8674
1.8000	0.7369	0.6357	1.4781	2.3762	4.5737	0.6943	1.7621	0.6943	1.7621
1.9000	0.7779	0.6437	1.4732	2.3378	4.4482	0.6683	1.6681	0.6683	1.6681
2.0000	0.8188	0.6511	1.4683	2.3021	4.3336	0.6445	1.5837	0.6445	1.5837

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.4094
FMax	1.0216	0.4182
F0.1	0.388	0.1589
F35%SPR	0.4317	0.1767
Flow	0.3493	0.143
Fmed	0.7068	0.2893
Fhigh	1.4202	0.5814

Weights in kilograms

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

MFDP version 1
Run: man1
Index file 28/4/2001
Time and date: 22:19 29/04/01
Fbar age range: 4-8

2001				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
195794	89036	1.0000	0.4094	38955

2002					2003	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
188000	92937	0.0000	0.0000	0	223920	127807
.	92937	0.1000	0.0409	4607	218790	123390
.	92937	0.2000	0.0819	9004	213903	119200
.	92937	0.3000	0.1228	13203	209245	115223
.	92937	0.4000	0.1638	17214	204802	111446
.	92937	0.5000	0.2047	21049	200563	107858
.	92937	0.6000	0.2456	24719	196515	104446
.	92937	0.7000	0.2866	28231	192647	101200
.	92937	0.8000	0.3275	31595	188949	98111
.	92937	0.9000	0.3685	34819	185411	95170
.	92937	1.0000	0.4094	37911	182025	92367
.	92937	1.1000	0.4503	40878	178782	89694
.	92937	1.2000	0.4913	43727	175675	87145
.	92937	1.3000	0.5322	46464	172695	84711
.	92937	1.4000	0.5732	49095	169835	82388
.	92937	1.5000	0.6141	51626	167090	80167
.	92937	1.6000	0.6550	54061	164454	78044
.	92937	1.7000	0.6960	56407	161919	76013
.	92937	1.8000	0.7369	58666	159482	74069
.	92937	1.9000	0.7779	60845	157137	72207
.	92937	2.0000	0.8188	62946	154880	70423

Input units are thousands and kg - output in tonnes

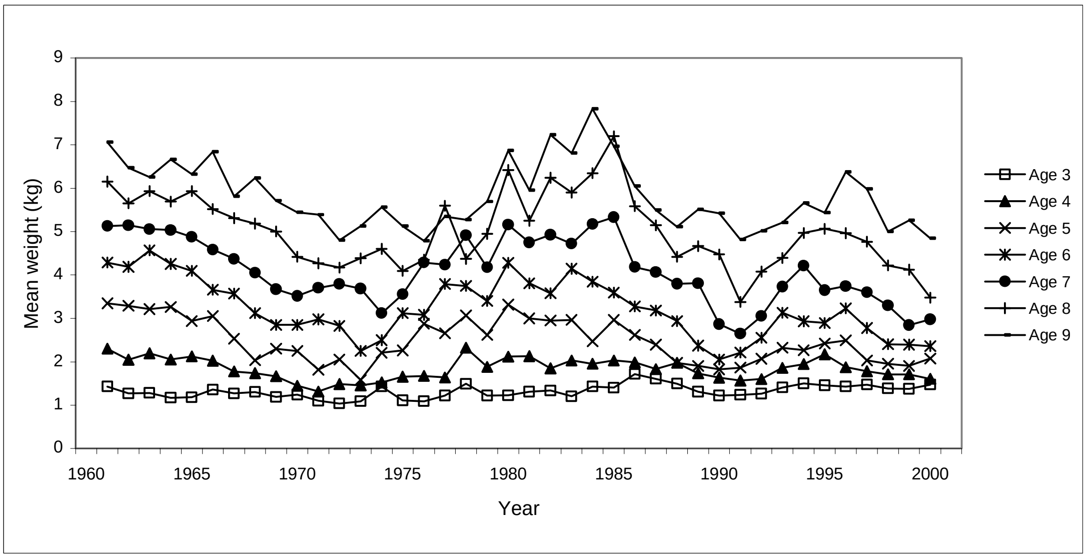
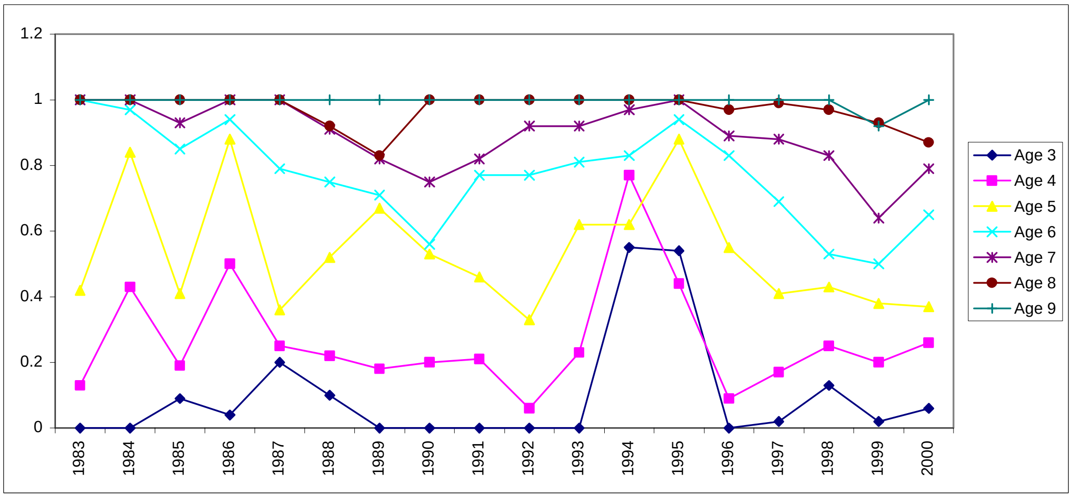


Figure 2.5.3.1. Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2000.



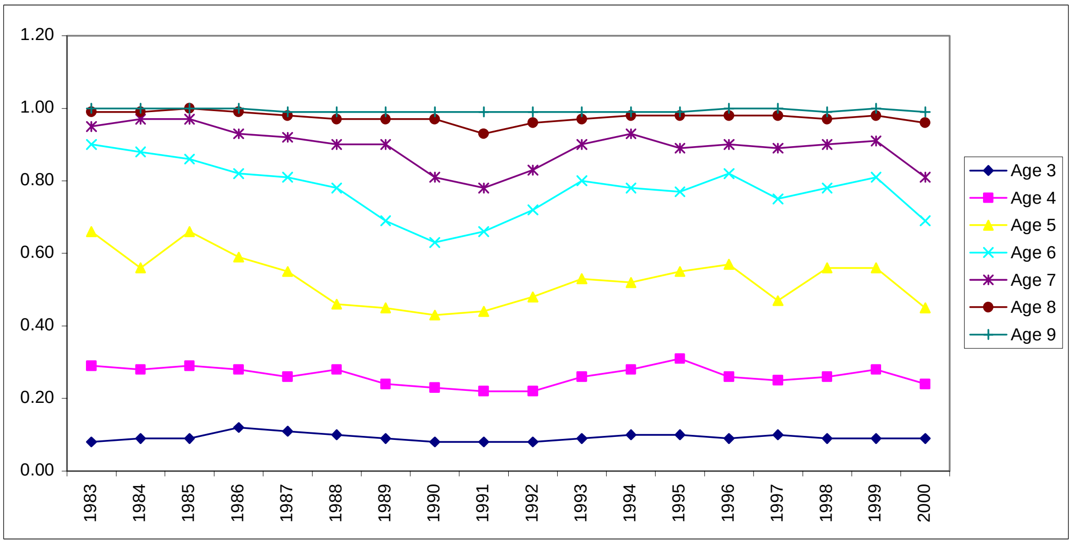


Figure 2.5.4.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and fitted values (lower figure) proportion mature at age for the period 1983-2000.

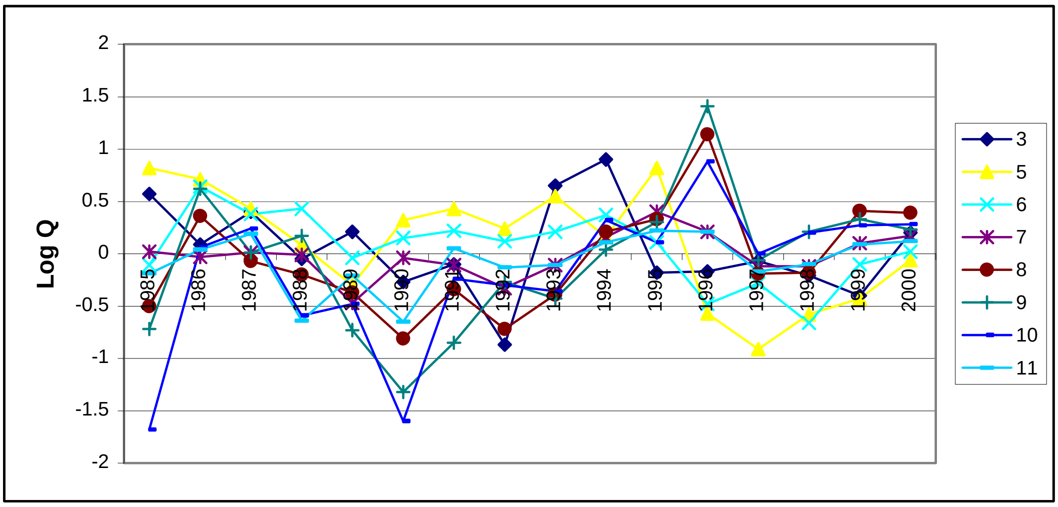


Figure 2.5.5.1. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 and 5-11 from XSA.

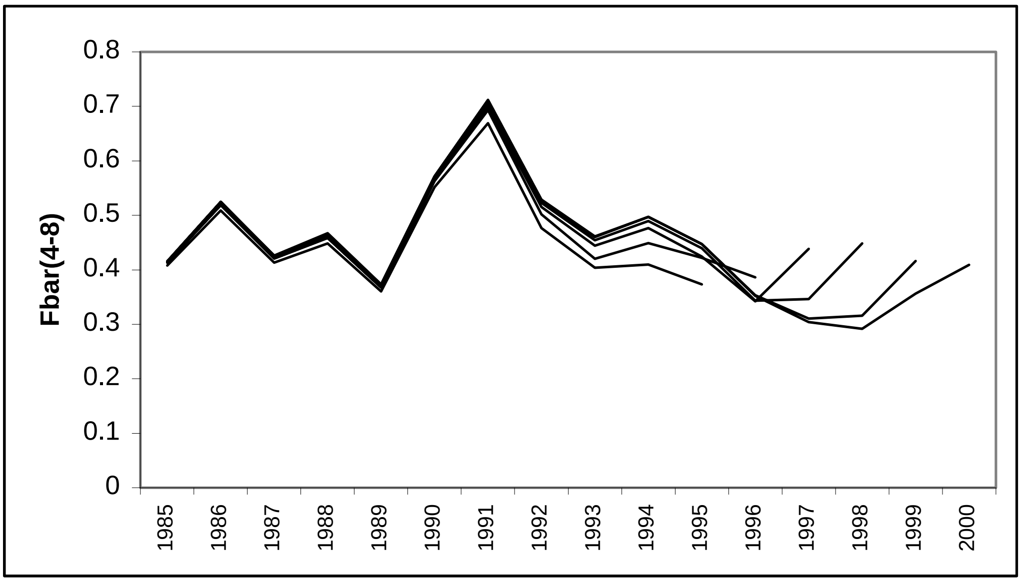


Figure 2.5.5.2. Saithe in the Faroes (Division Vb). Retrospective analysis of average fishingmortality of age groups 4-8 from XSA for the years 1995-2000.

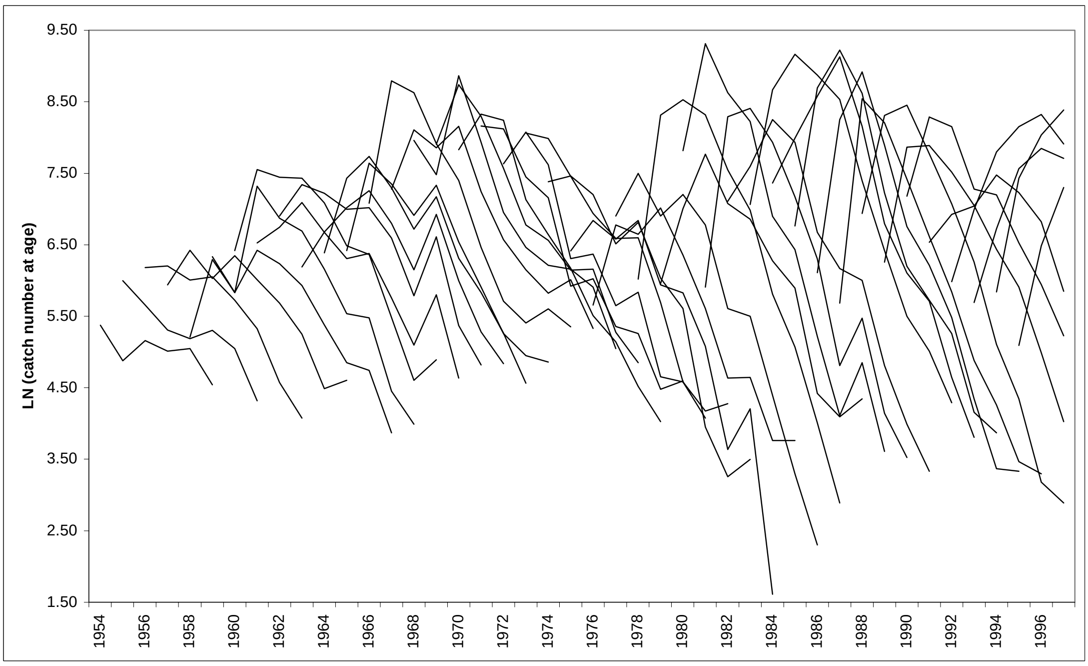


Figure 2.5.5.3. Saithe in the Faroes (Division Vb). Catch curve (LN numbers) for year-classes 1954-94.

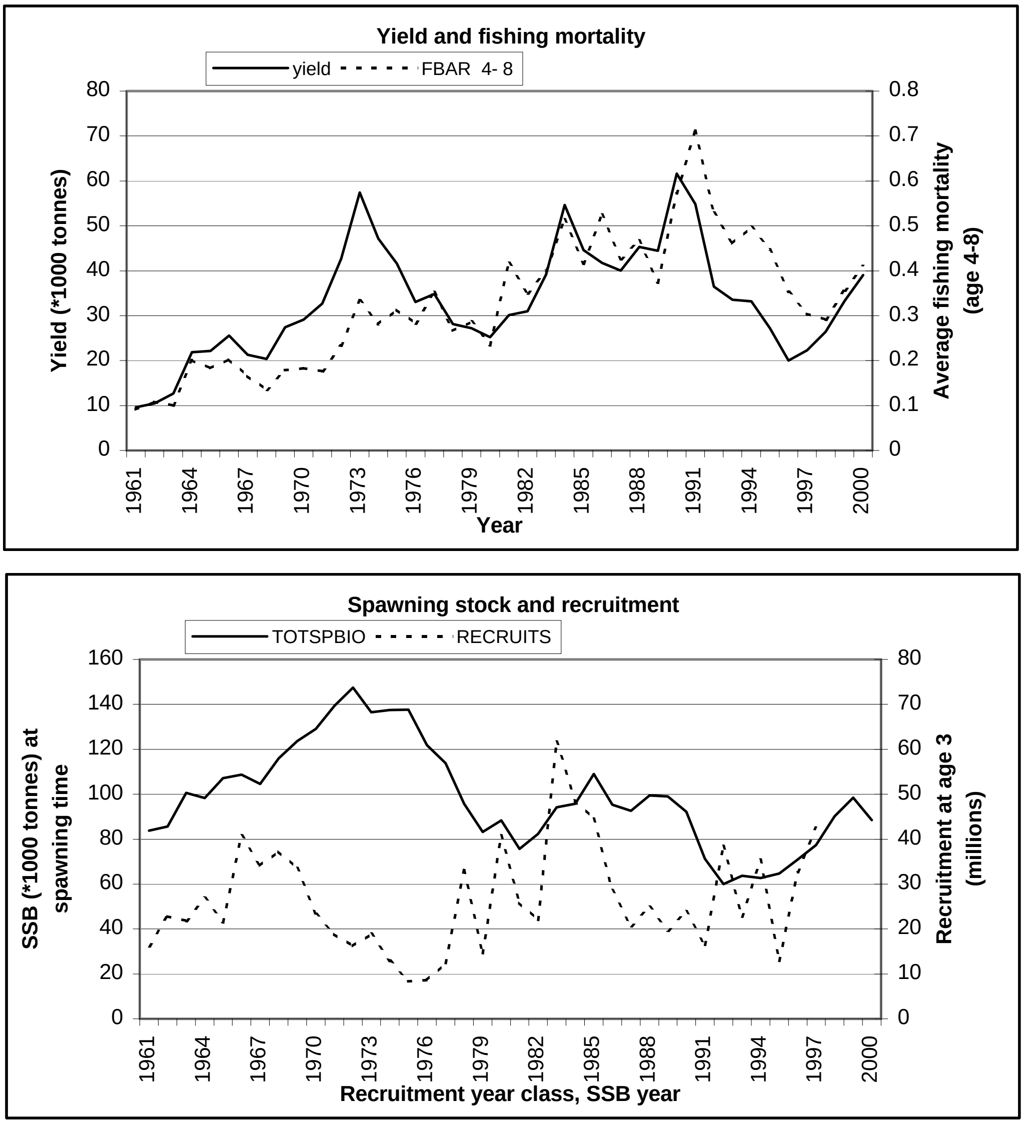
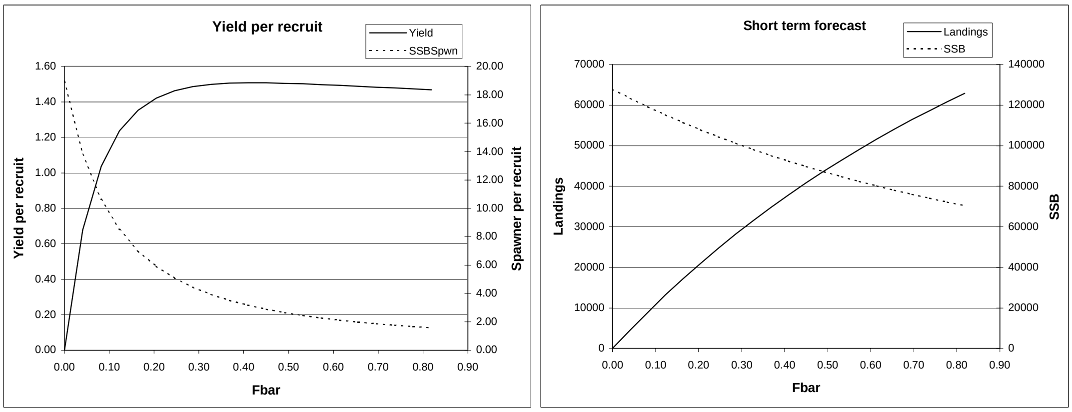


Figure 2.5.5.4. Saithe in the Faroes (Division Vb). Fish stock summary.



MFYPR version 1
Run: yr6
Time and date: 12:32 02/05/01

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.4094
FMax	1.0216	0.4182
F0.1	0.3880	0.1589
F35%SPR	0.4317	0.1767
Flow	0.3493	0.1430
Fmed	0.7068	0.2893
Fhigh	1.4202	0.5814

Weights in kilograms

MFDP version 1
Run: man1
Index file 28/4/2001
Time and date: 22:19 29/04/01
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.

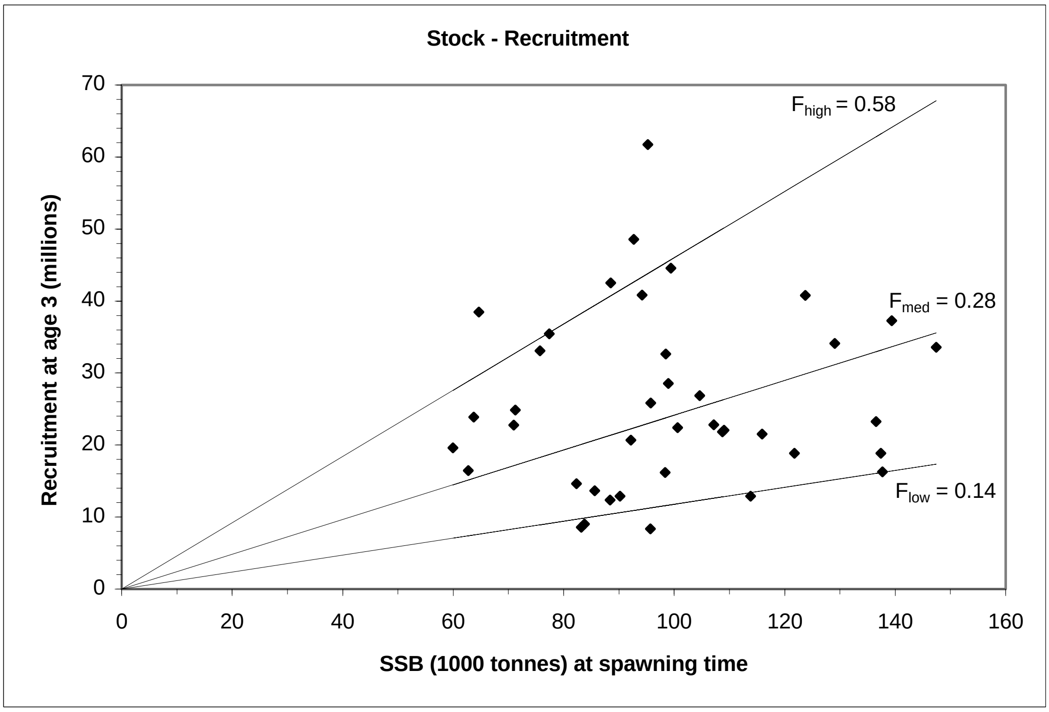
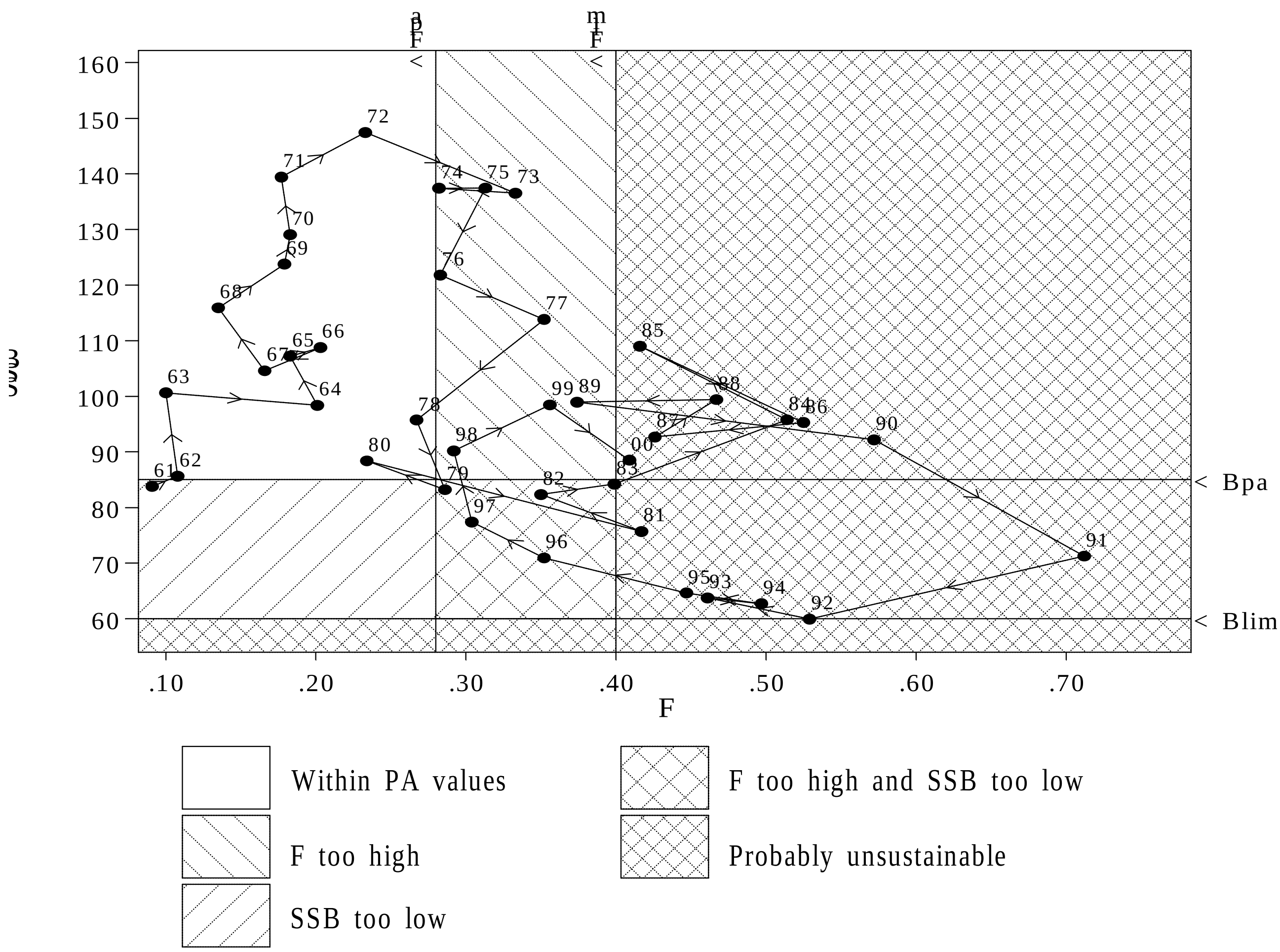


Figure 2.5.6.2. Saithe in the Faroes (Division Vb). Stock- recruitment.

Faroe saithe (Division Vb)



Data file(s):D:\VPA\Pa-plot\Farsai.pa;*.sum
Plotted on 01/05/2001 at 00:42:41

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

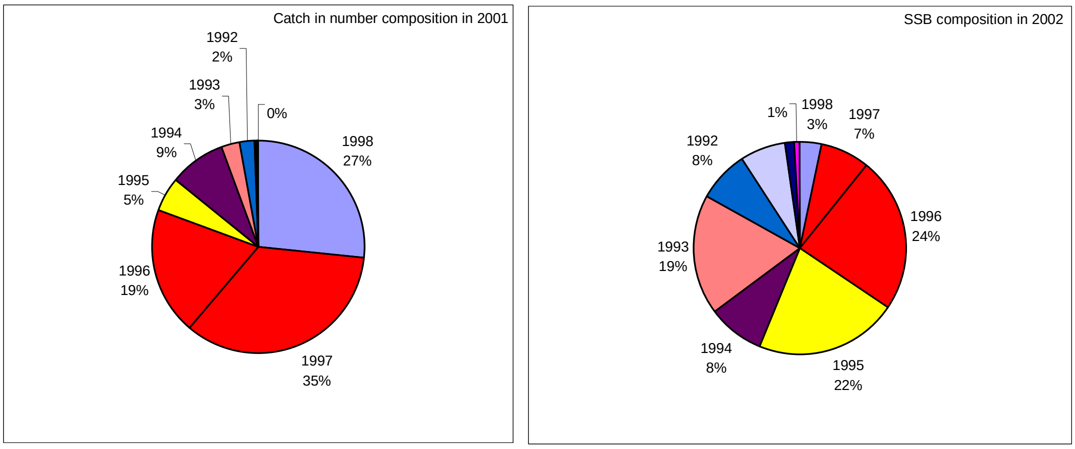


Figure 2.5.6.4. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2001 (left figure) and the composition in SSB in 2002 by year classes (right figure).

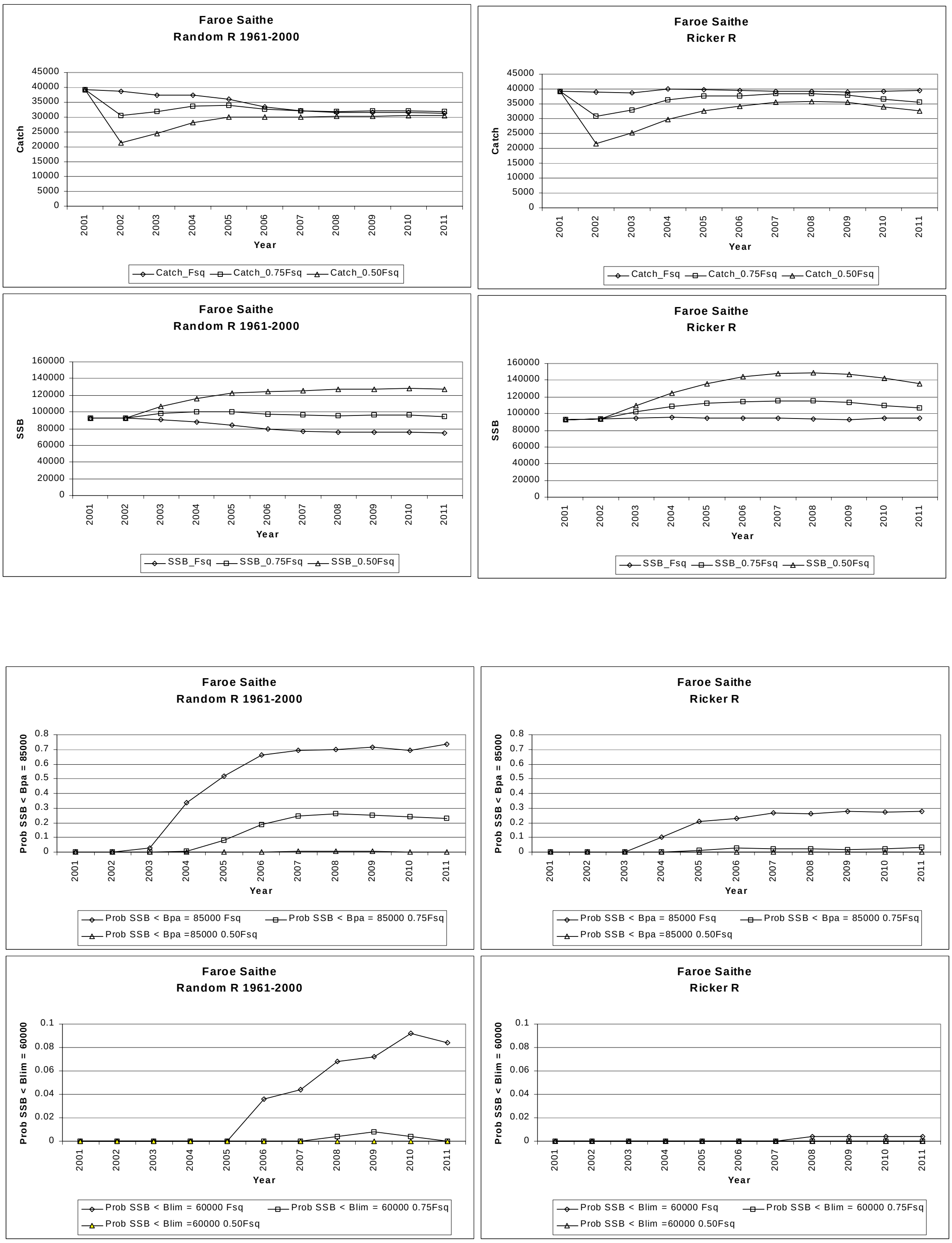


Figure 2.5.6.5. Saithe in the Faroes (Division Vb). Medium term 10 years predictions. The median catches and SSB, with recruitment options random estimate (left) and fitted to Ricker (right), as well as the probability that the SSB would be less than $\mathbf{B}_{pa}$ and $\mathbf{B}_{lim}$.

3 DEMERSAL STOCKS AT ICELAND (DIVISION VA)

3.1 Regulation of Demersal Fisheries

3.2 Saithe in Icelandic waters

3.2.1 Trends in landings

Saithe landings from Icelandic grounds (Division Va) have declined from a peak of 103 Kt in 1991 to around 30 Kt in the last 3-4 years (Table 3.2.1). The Icelandic landings in the quota year September 1999/August 2000 amounted to 29 650 t, or a little less than the national TAC for the same period.

Landings of saithe in the fishing years 1999/2000 and 2000/2001 and in calendar years 2000 and 2001 show that the fishery commenced at a slightly more rapid rate in autumn and winter 2000 than in the year before, but in 2001 the fishery has slowed down to previous years rate. A fishermens' strike on most fleets has almost put a halt to the fishery at the moment (Figure 3.2.1).

3.2.2 Fleets and fishing grounds

More than three quarters of the catches were taken by bottom trawl, 13% in gillnets, 6% on hooks and 3% in Danish seine in 2000. The proportion of the catch taken in gillnets has declined from almost a third of the total in 1994 and 1995, while the bottom trawl share has increased. Landings of hook and Danish seine catches have been fairly stable in the period 1993-2000.

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast but the gillnet fishery is concentrated on spawning grounds south and southwest of Iceland (Fig 3.2.6).

3.2.3 Catch at age

Data from samples from most gear types were used to calculate the catch in numbers at age for the total landings in 2000, with the sampling level indicated in the text table below, and used as input for the assessment (Table 3.2.2).

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	4 296	25	921	30	2 861
Jiggers	1 314	-	-	-	-
Danish seine	980	5	233	5	536
Bottom trawl	25 703	88	4 319	146	21 369
Other gear	605	-	-	-	-
Faroese jiggers	228	-	-	-	-
Total	33 126	118	5 473	181	24 766

Gillnet catches were split according to a gear-specific age-length key, the rest of the catches were split according to a key based on all samples from commercial gear except those from gill nets. The length weight relationship used was $W = 0.02498 \cdot L^{2.75674}$ for all fleets. A revision of catch at age for 1996 was made since it was discovered that an age-length-key for jiggers in that year was based on very few otoliths. Minor revisions were made to the catch at age matrix to account for slightly adjusted landings in 1999 (Table 3.2.2).

Compared to last years prognosis considerably lower proportions of age group 5 and higher proportions of age groups 3,4 and 8 were observed in the 2000 landings. Note that 8 year olds in 2000 belong to the 1992 yearclass for which migration was estimated in the 2000 assessment. The difference between last year's prognosis and the present estimate was as large as 15% for age group 5 (Figure 3.2.2).

3.2.4 Mean weight at age

Mean weights at age in the landings are computed on the basis of samples of otoliths and lengths along with length distributions and length-weight relationships. The mean weights at age are computed for the same categories as the catch numbers at age and are then weighted together across the fleets. In recent years a slight increasing trend in mean weight at age is apparent, with the exception of the 1992 year class which has had lower than average mean weight as age groups 4-8 (Figure 3.2.3 and Table 3.2.3). These weights at age where also used as weight at age in the stock.

3.2.5 Maturity at age

As has been pointed out in earlier reports of this working group, the maturity at age data for saithe can be misleading due to the nature of the fishery and of the species, and inadequate sampling. A GLM model, described in the 1993 Working Group report (ICES. C.M.1993/Assess:18), has been used to explain maturity at age as a function of age and year class strength. This model was used to predict maturity at age for 1980-2000 (Table 3.2.4). The maturity at age prior to 1980 is derived from ICES C.M. 1979/G:6.

3.2.6 Migration of saithe

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

Other evidence of saithe migrations exists, albeit of a more circumstantial nature. Sudden changes in average length or weight at age and reciprocal fluctuation in catch numbers at age in different areas of the NE-Atlantic have been interpreted as signs of migrations between saithe stocks (Reinsch 1976, Jakobsen and Olsen 1987, S.T. Jonsson 1996). Since mean weight at age decrease along an approximately NW-SE-NE gradient, migration of e.g. northeast arctic saithe to Icelandic waters will, theoretically, be detectable as a reduction in size at age (Figure 3.2.3). Catch curves from some year classes, from different areas show some reciprocal variations (Figure 3.2.4). Inspection of the data based on the above indicate that the most likely years and ages for immigration are as follows: Age 10 in 1986, age 7 in 1991, age 9 in 1993 and the 1992 year class as age 7 saithe in 1999 and 8 in 2000.

A tagging program was started in Icelandic waters in 2000. More than 1 700 mostly juvenile saithe, caught with hooks at the nearshore nursery areas have been tagged. Recapture rates to date are approaching 5% (Fig. 3.2.5), mostly from saithe of approx. 50 cm or more at tagging. The fish tagged in 2000 were mostly from age groups 2 and 3 and therefore less than 50 cm so they are not expected to enter the fishery until autumn 2001. It is planned to continue these taggings for monitoring saithe migrations.

3.2.7 Stock Assessment

3.2.7.1 Tuning input

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

With reduced stock size in the nineties a continuous shift, from effort directed at saithe towards mixed fisheries, has been observed. Traditional analyses using CPUE data from commercial fleets have been based on the criteria of using tows where more than certain percent (50-70) of the catch was saithe. For saithe, big schools of fish are occasionally encountered but the number of schools might decrease with reduced stock size.

To bypass this problem CPUE from all tows and gillnet settings from the most important fishing areas for saithe was calculated. The areas selected are shown in Figure 3.2.6. In last year tuning of time series analysis (TSA), CPUE from the trawler fleet in the period January – May was used. The CPUE was disaggregated on ages 4 to 11.

As fishermen have complained about using fleets based on logbook information to tune the assessment, when they claim to be avoiding saithe, a fleet was set up using the year effect, from a GLM model of CPUE in hauls where saithe was more than 50% of the catch, as an index of abundance.

In the followup to the Icelandic cod workshop in autumn 2000 and discussions there about the use of median based indices, some experimenting with age-disaggregated median based indices for saithe based on data from the Icelandic Ground Fish Survey (IGFS, March 1985-2001) was done. Traditional indices for saithe (stratified averages) cannot be used in tuning without some doctoring, i.e. the most extreme outlier has been set at the second highest observation. By using medians of age group numbers and multiplying them with the proportion of positive stations, that nuisance is avoided. Extreme hauls of saithe on the IGFS are rare and it is disappointing to let that prevent us from using information that could be of help in assessment. Although saithe is among the species with the highest CV in IGFS, it should be kept in mind that it is possibly 'better to be vaguely right than definitely wrong' (quote attributed to M. Pennington). That is, instead of tuning XSA with an commercial fleet index age-disaggregated in a way that makes it auto-correlated with catch at age, leading to 'false' estimates of se(log(q)), we might in the future be able to tune with a survey fleet, that is independent of the catch at age, although somewhat noisy.

The following text table gives an overview of various tuning fleets used in preliminary XSAs and TSAs on saithe in Va:

ut1	Mean CPUE in all hauls in areas given in Figure 3.2.6 in Jan-May, age disaggegated using samples from trawlers in the same period. Used for tuning TSA in 2000 assessment.
ut2	As above except ut2 is based on Jun-Dec
GLIM	GLM-model in which log(catch) is modelled by log(effort) and a year, month, ship and square effect. Period Jan-Dec, hauls giving more than 50% saithe are used.
SMBCochran	Stratified mean numbers per standard haul in IGFS by age
SMBMED	Median number of saithe per standard haul in IGFS by age

3.2.7.2 Estimates of fishing mortality

As has usually been done prior NWWG-meetings, time series analysis (TSA) (Gudmundsson 1994, WD19) and XSA were used in a few preliminary runs. TSA run with the same settings as last year gave estimates of F4-9 in 2000 of 0.356 and spawning stock biomass (SSB) of 84°Kt at the start of 2000 as compared to 95°Kt estimated in spring 2000.

An overview of the results of a preliminary runs tuned with different fleets is given in the text table below. XSAs were all run with the same settings, but different tuning fleets, only one at a time. TSAs were either without tuning fleets or one fleet, in addition catchability and recruitment variations were treated differently as described in the table below:

	Year range variants in TSA	TSA settings	TSA		XSA	
Tuning fleet *ut1* *used last year*		*linear trend in recrruitment*	F4-9,2000 *0.357*	B4-11,2000 *120*	F4-9,2000 *0.319*	SSB2000 *86*
none - chosen this year		linear trend in recrruitment	0.358	122		
none		no trend in recruitment	0.383	115		
ut2		linear trend in recruitment	0.306	138	0.237	100
SMB Cochran	1985-2000	no trend in recruitment	0.339	136	0.401	65
SMB Cochran	1985-2000	linear trend in recrruitment	0.346	138		
SMB Cochran	1991-2000	linear trend in recrruitment	0.410	112		
SMBMED					0.263	93
GLIM		random walk in catchability	0.380	112	0.204	120
GLIM		linear trend in catchability	0.423	102		
GLIM		no permanent variations in q	0.198	190		
		Average	0.349	128	0.285	93

Retrospective plots of three TSAs and five XSAs are shown in Figures 3.2.7 and 3.2.8.

No useful indices of recruitment are available for saithe. Therefore first estimates of a year class have to be based on mean recruitment or stock-recruitment relationships. In the last decade recruitment has been showing a more or less continuous decrease, so using mean recruitment or a stock-recruitment relationship as the first estimate of a year class will be an overestimate. Currently this problem of declining recruitment is solved in TSA by allowing the mean recruitment to follow a linear trend. This solution seems to work at the moment but will be unacceptable if recruitment starts to improve.

Continuing the precedence from last year's assessment, saithe migration was estimated. The same migration events as in the 2000 assessment were included and estimated again. A continued migration of the 1992 year class was allowed The years and ages were selected by studying anomalies in length at age data as well as comparison with Norwegian catch at age data (see also section 3.2.6). The years and age groups chosen were the ones for which the largest discrepancies in catch at age data had been detected in TSA runs. The strength of the migrations was estimated in TSA.

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

As it is difficult to find good tuning fleets for the stock the group chose a TSA based on catch at age only, with linear trend in recruitment estimated. The problem with tuning fleets is twofold. Survey indices are highly variable and have to be studied in more detail before they can be used in assessment. Fleets based on commercial CPUE age-disaggregated for tuning XSA or TSA have the serious drawback of being auto-correlated with catch in numbers, since it is not possible to age disaggregate them independently. Further, under a restrictive quota, as for the saithe in recent years, it is probable that some avoidance effect may make a tuning fleet such as the one used in the 2000 assessment of saithe in Va biased downwards. In addition the use of a biomass index from commercial fleets is a much more attractive alternative, but for that different packages than XSA have to be used, or the TSA modified. The commercial tuning fleets for saithe in Va must also be studied further before they are used in assessment.

In the TSA chosen by the group, the measurement errors of log C_{at} in the best observed ages and transitory variations of individual $\log F_{at}$, $\sigma = \sigma_5 = 0.098$. The matrices $\mathbf{\Omega_t}$ are chosen so that relative measurement errors are bigger in the older ages and $\mathbf{\Omega_5}$ to make the transitory variations in F bigger for the 4 year old fish. The standard deviation of joint transitory variations of logF, σ_6, are negligible and the joint persistent variations produced by random walk $\sigma_1 = 0.070$. Persistent variations in selectivity were not significant. The estimated trend in recruitment (at 4 years age) was large, from 45500 thousand in 1985-1987 to 6500 thousand in 1998-2000. (These values are only used to produce initial values for the Kalman filter, so don’t read too much into them).

Table 3.2.5 shows the estimated stock size and fishing mortalities from the selected TSA run along with estimated standard errors. The estimated standard errors are underestimates of the real standard errors. This applies in particular to results using commercial fleet data as these data are strongly correlated with the catch-at-age data.

The terminal F values obtained from the TSA were used as input into the VPA program at MRI that has been used for back calculation of stock size of Icelandic cod (see section 3.3.5.2) which includes estimated migration (Tables 3.2.6 and 3.2.7). The estimates were (in units of millions): $N_{10,86} = 2.6$, $N_{7,91}=7.9$, $N_{9,93}=3.8$, $N_{7,99}=1.7$, $N_{8,00}=1.9$

3.2.7.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.9 and given in Table 3.2.8. After a decline from 1970-1977, the spawning stock biomass averaged between 160-180 Kt in 1978-1989 and increased to about 190 Kt in 1990. Since 1992 the spawning stock biomass has declined to a minimum in 2000 of 83 Kt, which is the lowest SSB recorded. Spawning stock biomass at the beginning of 2001 is estimated at only 86 Kt.

Estimates of recruitment at age 3 are plotted in Figure 3.2.9. The 1983-1985 year classes are all well above the 1962-1998 long-term average of 41 million 3-year-old recruits. The 1984 year class is among highest on record at 80 million recruits. All year classes after 1985 are well below the long-term average. The average size of the 1986-1995 year classes is estimated at only 20 million recruits, which is below the lower quartile of the historic series of recruitment. Since no information is available for the more recent year classes, the 1996-1998 year classes were set at the rounded average for the 1987-1995 year classes, *i.e.* at 20 million recruits.

The scatter of SSB and recruitment is shown in figure 3.2.10 with lines drawn for the reference points $\mathbf{F}_{high}$, $\mathbf{F}_{med}$ and $\mathbf{F}_{low}$.

3.2.8 Prediction of catch and biomass

3.2.8.1 Input data

Predicted catch in 2001 is based on a 'similar' overshoot of the quota as in recent year. The 2000/2001 quota is 30Kt, the catch in 2001 was set at 31Kt. The input data for the catch projections is shown in Table 3.2.9.

For catch predictions and stock biomass calculations, the mean weight at ages 4-9 were predicted using a multiple regression analysis where the mean weight at age was predicted by the mean weight of the year class in the previous year and the year class strength. Since the regression analysis showed significant relationships only for the above age groups, the mean weights at age for other age groups were averaged over the 1998-2000 period, excluding the strong 1984 year class as 14 year olds, as it had weight at age much lower than average.

For the short-term predictions, maturity at age was predicted as described in Section 3.2.5. The selection pattern was based on average fishing mortality for 1998-2000, with F8+ set at the average for age groups 8-14. This average was scaled to the reference F of 2000. The rounded average of the 1986-1995 year classes was used as recruitment. Short-term prediction based on these inputs is given in Table 3.2.10.

For long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the average of the fishing mortalities during 1981-2000 from the standard VPA run. Averages over 1981-2000 for maturity and mean weight at age for all age groups were used, along with a natural mortality of 0.2 (Table 3.2.11).

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

3.2.8.2 Biological reference points

The ACFM has set $\mathbf{B}_{pa}$ at 150 Kt, $\mathbf{B}_{lim}$ tentatively at 90 Kt, and $\mathbf{F}_{pa}$ at 0.3. $\mathbf{F}_{lim}$ has not been set for this stock. The stock is well below $\mathbf{B}_{pa}$ and close to $\mathbf{B}_{lim}$ to according to this assessment. A plot similar to the standard PA-plot is shown in Figure 3.2.12.

3.2.8.3 Medium term projections

Medium term projections were done for the stock this year. Input data on selectivity, weight and maturity at age were the same as for short-term prediction. Recruitment values were drawn from three periods, the whole range of values from the years 1962-1998, from 1980-1998, and the recent period of lower than long-term average recruitment in 1990-1998. Yield and SSB under constant fishing mortalities of *status quo* F ($\mathbf{F}_{sq}$), 0.75$\mathbf{F}_{sq,}$ and 0.6 $\mathbf{F}_{sq}$. were brought forward in 6 simulations for 20 years with 250 simulations for relevant combination of F and R.

The results of the medium term simulations indicate that if recruitment will on average be the same as in 1962-98, fishing at *status quo* F will lead to catches rising to 70Kt and SSB to 200Kt by 2010. If recruitment is drawn from 1980-98 values, $\mathbf{F}_{sq}$ will lead to annual yield approaching 60Kt and SSB getting above $\mathbf{B}_{pa}$ of 150Kt by 2010. Reducing F by 25% in this recruitment scenario will basically give the same yield but indicates SSB will reach $\mathbf{B}_{pa}$ already in 2005 and eventually reach 200Kt. In the most pessimistic scenario, with recruitment drawn from the recent low values in 1990-98 none of the simulated fishing strategies showed SSB rising above $\mathbf{B}_{pa}$. The simulations indicate that the probability of SSB reaching $\mathbf{B}_{pa}$ by 2010 is close to 50% when fishing at $\mathbf{F}_{sq}$ on a stock composed of recruitments as in the period 1980-98, but close to 90% when a 25% reduction in fishing mortality is imposed. On the other hand, if long term average recruitment is used as input to the simulations, even fishing at $\mathbf{F}_{sq}$ appears to give 10% probability of SSB in 2010 less than $\mathbf{B}_{pa}$. The medium term projections for yield and SSB are shown in Figure 3.2.13 and the probability that SSB will be less than $\mathbf{B}_{pa}$ in a given year is shown in Figure 3.2.14.

3.2.9 Management considerations

The stock was overestimated until in the 1997 assessment but has been more stable in more recent assessments. It is at the lowest observed level at present. The reference F values have been at or above $\mathbf{F}_{med}$ for the whole time series in the assessment, and were higher than $\mathbf{F}_{max}$ in 1993-1995. Recruitment in recent years (the 1986 and more recent year classes) has been well below the long-term average.

At the start of 2000 stakeholders in the saithe fishery in became increasingly vociferous about the saithe, and in October 2000 the MRI was asked to revise it assessment of the saithe. Claims from fishermen about high catches of saithe, continued migration, and problems associated with saithe qouta status were the main reasons for the request for an extra assessment. After doing a full fledged assessment similar to the one done in April—May, where the use of survey indices from the Icelandic GroundFish Survey (IGFS) was also studied, MRI did not change its recommendations. It was stated, that given the uncertainty in the assessment and dire straits the stock appears to be in, it would be imprudent to raise the saithe quota from the TAC of 30 Kt. That quota was set 5 Kt in excess of last years ACFM advice of 25 Kt.

A further reduction in fishing mortality, of at least 25% is advisable.

3.2.10 Comments on the assessment

In this year's assessment TSA was run on catch at age only, with linear trend in recruitment estimated. This only changed the results of the assessment slightly. Reasons for throwing out last years tuning fleet (trawlers on main areas in January-May, all hauls included in straight average CPUE) are: a) claims from fishermen that under a restrictive quota they have to avoid saithe, b) the drawback of using fleet indices correlated with catch at age.

Time series analysis has been used to assess this stock in recent years. Preliminary XSAs gave terminal reference F-values ranging from 0.204 to 0.401 and SSBs from 65 to 120Kt and TSAs gave Fs ranging from 0.198 to 0.410 and stock biomass for ages 4-11 (age range included in TSA) of 102 to 190. These ranges are indicative of the precision in this stock assessment.

Tag returns and stock assessment data indicate migration between saithe stock units in NE-Atlantic, and indications from catch at age have been described (Reinch 1977, Jakobsen & Olsen 1987). Little is known about their magnitude and frequency. Better understanding of saithe biology, e.g. behaviour, recruitment and migrations, is needed. A few new studies on saithe have recently been initiated. The tagging program mention in section 3.2.6 will continue at least in 2001 and 2002, with the addition of electronic tags planned later in 2001. A nordic project setting out to test a hypothesis of migration of the 1984 and 1992 year classes of saithe from east to west in the NA-Atlantic by analysis of otolith chemistry from four saithe stocks managed by Iceland, Faroe Islands and Norway (and EU and Russia) is underway.

Table 3.2.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1982-2000, as officially reported to ICES

Country	1982	1983	1984	1985	1986	1987	1988	1989
Belgium	201	224	269	158	218	217	268	369
Faroe Islands	3,582	2,138	2,044	1,778	783	2,139	2,596	2,246
France	23	-	-	-	-	-	-	-
Iceland	65,124	55,904	60,406	55,135	63,867	78,175	74,383	79,810
Norway	1	+	-	1	-	-	-	-
UK (Engl. and Wales)	-	-	-	29	-	-	-	-
Total	70,913	60,249	64,703	59,086	66,854	82,518	79,235	82,425
WG estimate	-	-	-	-	66,376[2]	-	-	

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Belgium	190	236	195	104	30	-	-	-	-
Faroe Islands	2,905	2,690	1,570	1,562	975	1,161	803	716	997
France	-	-	-	-	-	-	-	-	-
Germany	-	-	-	-	1	1	1	-	3
Iceland	95,032	99,390	77,832	69,982	63,333	47,466	39,297	36,548	30,531
Norway	-	-	-	-	-	1	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
Total	98,127	102,316	79,597	71,648	64,339	48,629	40,101	37,264	31,531
WG estimate		102,737[3]	-	-	-	-	-		

Country	1999[1]	2000[1]
Belgium	-	
Faroe Islands	706	228
France	-	
Germany	2	
Iceland	30560	32898
Norway	6	
UK (Engl. and Wales)	-	
Total		
WG estimate	31274	33126

1) Provisional
2) Additional catch of 1,508 t by Faroe Islands included
3) Additional catch of 451 t by Iceland included

Table 3.2.2. Saithe in division Va. Catch in numbers (millions) 1981--2000.

Marine Research Institute Fri May 18 10:17:26 2001
Virtual Population Analysis : Catch in numbers, millions
Ufsi 2001 - TSAnofleet

Age	1981	1982	1983	1984	1985	1986	1987
3	0.203	0.508	0.107	0.053	0.376	3.108	0.956
4	1.325	1.092	1.750	0.657	4.014	1.400	5.135
5	3.503	2.804	1.065	0.800	3.366	4.170	4.428
6	5.404	4.845	2.455	1.825	1.958	2.665	5.409
7	1.457	4.293	4.454	2.184	1.536	1.550	2.915
8	1.415	1.215	2.311	3.610	1.172	1.116	1.348
9	0.578	0.975	0.501	0.844	0.747	0.628	0.661
10	0.242	0.306	0.251	0.376	0.479	1.549	0.496
11	0.061	0.059	0.038	0.291	0.074	0.216	0.498
12	0.154	0.035	0.012	0.135	0.023	0.051	0.058
13	0.135	0.048	0.002	0.185	0.072	0.030	0.027
14	0.128	0.046	0.004	0.226	0.071	0.014	0.048
Juvenile	6.478	6.361	4.361	2.564	6.729	8.333	11.670
Adult	8.127	9.865	8.589	8.622	7.159	8.164	10.309
Sum 3- 3	0.203	0.508	0.107	0.053	0.376	3.108	0.956
Sum 4-14	14.402	15.718	12.843	11.133	13.512	13.389	21.023
Total	14.605	16.226	12.950	11.186	13.888	16.497	21.979

Age	1988	1989	1990	1991	1992	1993	1994
3	1.318	0.315	0.143	0.198	0.242	0.657	0.702
4	5.067	4.313	1.692	0.874	2.928	1.083	2.955
5	6.619	8.471	5.471	3.613	3.844	2.841	1.770
6	3.678	7.309	10.112	6.844	4.355	2.252	2.603
7	2.859	1.794	6.174	10.772	3.884	2.247	1.377
8	1.775	1.928	1.816	3.223	4.046	2.314	1.243
9	0.845	0.848	1.087	0.858	1.290	3.671	1.263
10	0.226	0.270	0.380	0.838	0.350	0.830	2.009
11	0.270	0.191	0.151	0.228	0.196	0.223	0.454
12	0.107	0.135	0.055	0.040	0.056	0.188	0.158
13	0.024	0.076	0.076	0.006	0.054	0.081	0.188
14	0.001	0.010	0.037	0.005	0.015	0.012	0.082
Juvenile	13.735	16.329	15.031	12.436	8.604	5.009	4.977
Adult	9.054	9.331	12.163	15.063	12.656	11.390	9.827
Sum 3- 3	1.318	0.315	0.143	0.198	0.242	0.657	0.702
Sum 4-14	21.471	25.345	27.051	27.301	21.018	15.742	14.102
Total	22.789	25.660	27.194	27.499	21.260	16.399	14.804

Age	1995	1996	1997	1998	1999	2000
3	1.573	1.102	0.603	0.183	0.989	0.850
4	1.853	2.608	2.960	1.289	0.732	2.383
5	2.661	1.868	2.766	1.767	1.564	0.896
6	1.807	1.649	1.651	1.545	2.176	1.511
7	2.370	0.835	1.178	1.114	1.934	1.612
8	0.905	1.233	0.599	0.658	0.669	1.806
9	0.574	0.385	0.454	0.351	0.324	0.335
10	0.482	0.267	0.125	0.265	0.140	0.173
11	0.521	0.210	0.095	0.120	0.072	0.057
12	0.106	0.232	0.114	0.081	0.025	0.033
13	0.035	0.141	0.077	0.085	0.028	0.017
14	0.013	0.074	0.043	0.810	0.022	0.007
Juvenile	5.133	4.551	4.870	2.711	3.208	3.713
Adult	7.767	6.053	5.795	5.557	5.467	5.967
Sum 3- 3	1.573	1.102	0.603	0.183	0.989	0.850
Sum 4-14	11.327	9.502	10.062	8.085	7.686	8.830
Total	12.900	10.604	10.665	8.268	8.675	9.680

Table 3.2.3. Saithe in Division Va. Mean weight at age in the catches and in the stock.

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Marine Research Institute Fri May 18 10:17:26 2001
Virtual Population Analysis : Weight at age in the catches, in grams
Ufsi 2001 - TSAnofleet
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Age	1981	1982	1983	1984	1985	1986	1987
3	1585	1547	1530	1653	1609	1450	1516
4	2037	2194	2221	2432	2172	2190	1715
5	2696	3015	3171	3330	3169	2959	2670
6	3525	3183	4270	4681	3922	4402	3839
7	4541	5114	4107	5466	4697	5488	5081
8	6247	6202	5984	4973	6411	6406	6185
9	6991	7256	7565	7407	6492	7570	7330
10	8202	7922	8673	8179	8346	6487	8025
11	9537	8924	8801	8770	9401	9616	7974
12	9089	10134	9039	8831	10335	10462	9615
13	9351	9447	11138	11010	11027	11747	12246
14	10225	10535	9818	11127	10644	11902	11656

Age	1988	1989	1990	1991	1992	1993	1994
3	1261	1403	1647	1224	1269	1381	1444
4	2017	2021	1983	1939	1909	2143	1836
5	2513	2194	2566	2432	2578	2742	2649
6	3476	3047	3021	3160	3288	3636	3512
7	4719	4505	4077	3634	4150	4398	4906
8	5932	5889	5744	4967	4865	5421	5539
9	7523	7172	7038	6629	6168	5319	6818
10	8439	8852	7564	7704	7926	7006	6374
11	8748	10170	8854	9061	8349	8070	8341
12	9559	10392	10645	9117	9029	10048	9770
13	10824	12522	11674	10922	11574	9106	10528
14	14099	11923	11431	11342	9466	11591	11257

Age	1995	1996	1997	1998	1999	2000	2001
3	1370	1229	1325	1347	1279	1367	1331
4	1977	1755	1936	1972	2106	1929	2022
5	2769	2670	2409	2943	2752	2751	2718
6	3722	3802	3906	3419	3497	3274	3682
7	4621	4902	5032	4850	3831	4171	4355
8	5854	5681	6171	5962	5819	4447	5386
9	6416	7182	7202	6933	7072	6790	6995
10	7356	7734	7883	7781	8078	8216	8025
11	6815	9256	8856	8695	8865	9369	8976
12	8312	8322	9649	9564	10550	9817	9977
13	9119	10501	9621	10164	10823	10932	10640
14	11910	11894	10877	10379	11300	12204	11629

Table 3.2.4. Saithe in Division Va. Sexual maturity at age from model, used as input to VPA.

Marine Research Institute Fri May 18 10:17:26 2001
Virtual Population Analysis : Sexual maturity at age in the stock
Ufsi 2001 - TSAnofleet

Age	1981	1982	1983	1984	1985	1986	1987
3	0.150	0.150	0.120	0.080	0.110	0.050	0.040
4	0.250	0.290	0.280	0.230	0.170	0.210	0.100
5	0.350	0.440	0.480	0.470	0.410	0.320	0.380
6	0.520	0.550	0.640	0.680	0.670	0.610	0.520
7	0.820	0.710	0.730	0.800	0.830	0.820	0.780
8	0.890	0.910	0.850	0.860	0.900	0.920	0.910
9	0.960	0.950	0.960	0.930	0.930	0.950	0.960
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1988	1989	1990	1991	1992	1993	1994
3	0.070	0.120	0.150	0.130	0.170	0.150	0.160
4	0.090	0.150	0.240	0.290	0.260	0.320	0.290
5	0.200	0.180	0.280	0.420	0.480	0.440	0.510
6	0.580	0.360	0.340	0.470	0.620	0.680	0.640
7	0.710	0.760	0.560	0.530	0.670	0.790	0.830
8	0.890	0.850	0.880	0.750	0.720	0.820	0.890
9	0.960	0.950	0.930	0.940	0.870	0.860	0.910
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Age	1995	1996	1997	1998	1999	2000	2001
3	0.140	0.140	0.170	0.200	0.150	0.150	0.150
4	0.300	0.280	0.280	0.320	0.360	0.290	0.290
5	0.480	0.500	0.470	0.470	0.510	0.560	0.480
6	0.710	0.680	0.690	0.670	0.670	0.710	0.680
7	0.800	0.850	0.830	0.840	0.820	0.820	0.830
8	0.920	0.900	0.930	0.920	0.920	0.910	0.920
9	0.950	0.960	0.960	0.970	0.960	0.960	0.970
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.2.5. Saithe in Division Va. Output from TSA run with linear trend in recruitment and no tuning fleet.

Saithe
Estimated with catch-at-age
linear trend in recruitment

STOCK

	4	5	6	7	8	9	10	11	BIOM
1985	37445.	20683.	9956.	5585.	3884.	4926.	1515.	313.	268.6
1986	28246.	26980.	14036.	6390.	3272.	2171.	3946.	877.	307.4
1987	58282.	21229.	18373.	8913.	3728.	1759.	1175.	2078.	334.4
1988	58117.	42798.	13626.	10411.	4639.	1858.	855.	583.	373.2
1989	46417.	42924.	28675.	8007.	5640.	2245.	862.	427.	369.7
1990	26025.	33948.	28225.	17196.	4580.	2917.	1114.	433.	356.9
1991	18065.	19342.	22407.	18081.	8429.	2141.	1396.	533.	290.2
1992	22907.	13611.	12459.	12075.	5831.	3761.	957.	586.	234.1
1993	12169.	15805.	7789.	6481.	5998.	9503.	1799.	454.	225.5
1994	16330.	8959.	10270.	4263.	3181.	2846.	4458.	836.	183.2
1995	13944.	10440.	5732.	6023.	2191.	1471.	1260.	1983.	150.7
1996	13470.	9704.	6248.	3091.	2907.	1006.	699.	606.	123.3
1997	19134.	8294.	6198.	3651.	1688.	1384.	479.	339.	126.9
1998	11677.	12387.	4758.	3535.	1926.	861.	717.	251.	118.0
1999	6511.	8510.	8196.	6356.	1870.	953.	409.	344.	114.1
2000	18613.	4655.	5541.	4824.	5159.	953.	491.	211.	122.4

STANDARD DEVIATION OF STOCK ESTIMATES

1999	1040.	967.	977.	748.	242.	153.	71.	74.	11.6
2000	2860.	837.	773.	760.	587.	182.	112.	51.	13.3

Estimated immigration

year	age	number	standard dev.
1986	10	2600	600
1991	7	7900	2900
1993	9	3800	1100
1999	7	1700	1000
2000	8	1900	800

FISHING MORTALITY RATES

	4	5	6	7	8	9	10	11	Average 4-9 geom.	Average 4-9 arithm.
1985	0.127	0.188	0.242	0.335	0.382	0.041	0.351	0.300	0.177	0.219
1986	0.083	0.184	0.254	0.335	0.421	0.414	0.441	0.423	0.247	0.282
1987	0.108	0.235	0.363	0.453	0.495	0.521	0.502	0.478	0.320	0.362
1988	0.099	0.199	0.326	0.411	0.522	0.563	0.493	0.501	0.303	0.353
1989	0.110	0.218	0.308	0.356	0.459	0.499	0.488	0.496	0.291	0.325
1990	0.096	0.215	0.397	0.513	0.560	0.537	0.537	0.548	0.329	0.386
1991	0.082	0.237	0.418	0.803	0.607	0.605	0.665	0.650	0.365	0.459
1992	0.163	0.321	0.443	0.500	0.805	0.533	0.542	0.580	0.413	0.461
1993	0.103	0.228	0.370	0.493	0.541	0.554	0.562	0.561	0.330	0.382
1994	0.222	0.246	0.334	0.448	0.546	0.592	0.592	0.565	0.372	0.398
1995	0.157	0.285	0.408	0.523	0.562	0.534	0.524	0.514	0.377	0.411
1996	0.254	0.249	0.333	0.405	0.533	0.529	0.515	0.503	0.366	0.384
1997	0.235	0.320	0.362	0.439	0.470	0.456	0.444	0.462	0.370	0.380
1998	0.114	0.211	0.367	0.436	0.493	0.531	0.517	0.505	0.317	0.359
1999	0.135	0.229	0.330	0.417	0.472	0.462	0.459	0.450	0.312	0.341
2000	0.152	0.241	0.346	0.446	0.485	0.481	0.476	0.472	0.331	0.358

STANDARD DEVIATIONS OF LOG(F)

1999	0.18	0.15	0.15	0.15	0.14	0.15	0.16	0.16	0.121
2000	0.37	0.19	0.17	0.17	0.16	0.19	0.20	0.19	0.158

Table 3.2.5. continued.
Standardized residuals

Estimation with catch-at-age values and linear trend in recruitment

STANDARDIZED CATCH PREDICTION ERRORS

1986	-1.71	-0.51	-0.69	0.08	0.95	-0.16	1.36	-0.52
1987	0.76	0.18	1.12	1.12	1.82	1.41	1.37	-0.79
1988	0.92	0.55	-0.90	-1.63	0.48	2.17	-1.16	0.73
1989	0.28	1.78	1.15	-2.22	-0.42	-0.11	-0.94	0.48
1990	-1.31	0.33	2.43	1.64	1.52	0.51	-0.35	-0.17
1991	-1.49	-0.08	1.32	1.26	0.13	0.51	2.03	0.27
1992	0.68	1.06	0.44	-1.21	-1.49	-0.90	-0.44	-0.73
1993	-0.90	-1.09	-2.35	-1.58	-0.10	-0.02	1.05	0.79
1994	0.91	-0.31	-0.71	-2.19	-1.15	0.45	0.60	0.65
1995	-0.08	-0.73	0.74	1.04	-0.60	-1.05	-0.81	-1.53
1996	1.06	-0.63	-1.87	-1.93	0.04	-0.85	-0.53	-0.47
1997	1.24	-0.16	0.23	-0.60	0.14	-1.10	-1.64	-0.91
1998	0.32	-1.79	-1.61	0.03	-0.11	1.29	0.37	0.87
1999	-0.13	0.63	1.20	0.36	0.19	-0.75	-0.68	-1.65
2000	1.23	0.31	0.79	0.59	0.30	-0.05	-0.14	-0.75

First order correlation within cohorts 0.06; between years 0.05

Table 3.2.6. Saithe in Division Va. Fishing mortality.

Marine Research Institute Fri May 18 10:17:27 2001
Virtual Population Analysis : Fishing mortality
Ufsi 2001 - TSAnofleet

Age	1981	1982	1983	1984	1985	1986	1987
3	0.012	0.026	0.004	0.001	0.012	0.047	0.012
4	0.066	0.079	0.116	0.027	0.120	0.054	0.102
5	0.153	0.195	0.104	0.071	0.190	0.176	0.242
6	0.366	0.326	0.262	0.258	0.248	0.225	0.362
7	0.366	0.558	0.565	0.392	0.361	0.317	0.410
8	0.454	0.594	0.674	1.358	0.378	0.485	0.503
9	0.493	0.659	0.526	0.562	1.313	0.357	0.599
10	0.278	0.531	0.349	0.994	0.737	0.897	0.533
11	0.076	0.101	0.113	0.883	0.531	0.913	0.846
12	0.871	0.057	0.027	0.724	0.149	0.884	0.676
13	0.546	0.755	0.004	0.700	1.164	0.296	2.300
14	0.443	0.361	0.123	0.825	0.645	0.748	1.089
W.Av 4- 9	0.216	0.296	0.286	0.239	0.199	0.169	0.219
Ave 4- 9	0.317	0.402	0.374	0.445	0.435	0.269	0.370

Age	1988	1989	1990	1991	1992	1993	1994
3	0.026	0.011	0.007	0.008	0.018	0.036	0.045
4	0.078	0.112	0.077	0.057	0.158	0.106	0.226
5	0.185	0.182	0.203	0.233	0.378	0.226	0.252
6	0.326	0.320	0.342	0.420	0.486	0.399	0.332
7	0.331	0.261	0.491	0.495	0.450	0.501	0.456
8	0.473	0.390	0.458	0.517	0.349	0.532	0.578
9	0.691	0.436	0.398	0.408	0.403	0.389	0.630
10	0.421	0.494	0.356	0.615	0.290	0.493	0.382
11	0.630	0.772	0.571	0.376	0.280	0.304	0.554
12	0.433	0.765	0.530	0.288	0.148	0.473	0.366
13	0.671	0.633	1.517	0.098	0.791	0.329	1.308
14	0.539	0.666	0.744	0.344	0.377	0.400	0.653
W.Av 4- 9	0.173	0.206	0.278	0.352	0.340	0.318	0.326
Ave 4- 9	0.347	0.283	0.328	0.355	0.371	0.359	0.412

Age	1995	1996	1997	1998	1999	2000	1998-2000
3	0.079	0.053	0.044	0.025	0.047	0.038	0.037
4	0.161	0.182	0.198	0.126	0.134	0.152	0.137
5	0.326	0.242	0.299	0.174	0.222	0.241	0.212
6	0.440	0.344	0.349	0.272	0.335	0.346	0.318
7	0.574	0.374	0.443	0.421	0.423	0.446	0.430
8	0.620	0.676	0.506	0.478	0.484	0.479	0.480
9	0.582	0.592	0.572	0.636	0.460	0.479	0.525
10	0.527	0.595	0.387	0.795	0.568	0.479	0.614
11	0.160	0.462	0.437	0.801	0.518	0.479	0.600
12	0.239	0.099	0.493	0.837	0.378	0.479	0.565
13	0.128	0.572	0.043	0.860	0.806	0.479	0.715
14	0.264	0.432	0.340	0.823	0.568	0.479	0.623
W.Av 4- 9	0.347	0.280	0.291	0.226	0.294	0.286	0.248
Ave 4- 9	0.450	0.402	0.394	0.351	0.343	0.357	0.350

Table 3.2.7. Saithe in Division Va. Stock in numbers.

Marine Research Institute Fri May 18 10:17:26 2001
Virtual Population Analysis : Stock in numbers, millions
Ufsi 2001 - TSAnofleet

Age	1981	1982	1983	1984	1985	1986	1987
3	19.484	22.081	32.982	47.872	36.016	74.590	91.580
4	22.704	15.769	17.620	26.907	39.147	29.148	58.263
5	27.170	17.393	11.925	12.848	21.436	28.432	22.601
6	19.329	19.088	11.715	8.803	9.797	14.520	19.522
7	5.217	10.973	11.275	7.384	5.566	6.260	9.489
8	4.243	2.964	5.142	5.245	4.085	3.178	3.732
9	1.624	2.205	1.339	2.145	1.104	2.293	1.602
10	1.095	0.812	0.934	0.648	1.001	2.843	1.313
11	0.915	0.679	0.391	0.539	0.196	0.392	0.949
12	0.288	0.694	0.503	0.286	0.183	0.095	0.129
13	0.351	0.099	0.537	0.401	0.113	0.129	0.032
14	0.392	0.166	0.038	0.438	0.163	0.029	0.078
Juvenile	61.998	51.854	55.999	76.749	81.859	120.379	166.225
Adult	40.814	41.070	38.403	36.768	36.949	41.528	43.066
Sum 3- 3	19.484	22.081	32.982	47.872	36.016	74.590	91.580
Sum 4-14	83.329	70.842	61.420	65.644	82.792	87.317	117.711
Total	102.813	92.924	94.402	113.517	118.808	161.907	209.291

Age	1988	1989	1990	1991	1992	1993	1994
3	56.034	31.120	21.289	27.221	14.756	20.369	17.532
4	74.116	44.686	25.194	17.300	22.108	11.862	16.084
5	43.071	56.110	32.697	19.101	13.376	15.462	8.735
6	14.520	29.303	38.310	21.845	12.387	7.500	10.103
7	11.126	8.584	17.424	30.183	11.746	6.239	4.120
8	5.154	6.541	5.414	8.733	15.060	6.134	3.095
9	1.848	2.629	3.625	2.805	4.264	12.496	2.950
10	0.720	0.759	1.392	1.992	1.526	2.333	6.936
11	0.631	0.387	0.379	0.798	0.882	0.935	1.167
12	0.333	0.275	0.146	0.175	0.449	0.546	0.565
13	0.054	0.177	0.105	0.071	0.108	0.317	0.278
14	0.003	0.022	0.077	0.019	0.052	0.040	0.187
Juvenile	163.980	133.305	94.639	75.159	48.916	40.603	35.370
Adult	43.630	47.287	51.412	55.084	47.796	43.632	36.382
Sum 3- 3	56.034	31.120	21.289	27.221	14.756	20.369	17.532
Sum 4-14	151.576	149.472	124.763	103.022	81.957	63.865	54.220
Total	207.610	180.592	146.052	130.242	96.712	84.235	71.753

Age	1995	1996	1997	1998	1999	2000	2001
3	22.746	23.361	15.289	8.045	20.000	20.000	20.000
4	13.721	17.204	18.132	11.974	6.421	15.625	15.764
5	10.509	9.564	11.737	12.180	8.641	4.598	10.989
6	5.560	6.213	6.150	7.123	8.380	5.667	2.958
7	5.933	2.931	3.606	3.552	6.142	4.907	3.283
8	2.139	2.737	1.650	1.896	1.909	5.194	2.572
9	1.422	0.942	1.139	0.815	0.962	0.963	2.634
10	1.286	0.651	0.427	0.526	0.353	0.498	0.489
11	3.876	0.621	0.294	0.237	0.195	0.164	0.252
12	0.549	2.704	0.321	0.155	0.087	0.095	0.083
13	0.321	0.354	2.004	0.160	0.055	0.049	0.048
14	0.062	0.231	0.164	1.572	0.056	0.020	0.025
Juvenile	37.672	39.999	34.646	24.128	29.406	33.149	35.696
Adult	30.450	27.514	26.266	24.107	23.796	24.630	23.400
Sum 3- 3	22.746	23.361	15.289	8.045	20.000	20.000	20.000
Sum 4-14	45.376	44.152	45.623	40.190	33.203	37.779	39.096
Total	68.122	67.513	60.912	48.235	53.203	57.779	59.096

Table 3.2.8. Saithe in Division Va. Summary table

Year	R (as 3 year olds)	TSB (Kt)	SSB (Kt)	FSB (Kt)	Yield (Kt)	Y/SSB	Fbar 4-9
1962	30.999	266.315	131.495	231.597	50.514	0.384	0.287
1963	84.106	324.473	132.811	230.274	48.011	0.361	0.304
1964	55.196	373.053	134.478	311.233	60.257	0.448	0.250
1965	94.063	461.038	161.200	355.688	60.177	0.373	0.231
1966	70.223	544.090	207.827	465.440	52.003	0.250	0.178
1967	68.329	641.351	272.626	564.822	75.712	0.278	0.237
1968	59.671	692.224	340.913	625.392	77.549	0.227	0.210
1969	88.749	760.460	393.200	661.061	115.853	0.295	0.294
1970	66.329	752.663	396.236	678.375	116.601	0.294	0.322
1971	50.637	713.769	378.082	657.055	136.764	0.362	0.443
1972	26.455	601.953	332.879	572.323	111.301	0.334	0.361
1973	26.104	515.978	313.070	486.742	110.888	0.354	0.345
1974	25.125	433.277	287.185	405.137	97.568	0.340	0.287
1975	25.928	385.521	262.239	356.482	87.954	0.335	0.278
1976	31.236	346.503	226.587	311.518	82.003	0.362	0.326
1977	21.672	297.705	184.129	273.432	62.026	0.337	0.282
1978	49.437	305.486	163.137	250.117	49.672	0.304	0.237
1979	44.467	329.976	159.536	280.351	63.504	0.398	0.245
1980	28.027	328.461	159.665	288.438	58.347	0.365	0.312
1981	19.461	307.605	158.774	276.759	58.986	0.372	0.316
1982	22.058	294.543	165.587	260.419	68.615	0.414	0.402
1983	32.695	286.503	159.180	236.480	58.266	0.366	0.375
1984	47.715	331.742	160.587	252.868	62.719	0.391	0.446
1985	35.620	322.231	140.946	264.918	57.101	0.405	0.437
1986	74.353	414.948	172.341	307.136	66.376	0.385	0.270
1987	78.576	455.853	166.072	336.731	80.559	0.485	0.373
1988	56.034	467.524	159.184	396.866	77.247	0.485	0.354
1989	31.120	436.994	163.924	393.333	82.425	0.503	0.295
1990	21.289	406.074	179.266	371.012	98.130	0.547	0.349
1991	27.221	355.897	186.155	322.579	102.737	0.552	0.387
1992	14.756	284.689	171.007	265.965	79.597	0.465	0.407
1993	20.369	260.846	169.009	232.716	71.648	0.424	0.398
1994	17.532	213.726	140.250	188.409	64.338	0.459	0.412
1995	22.746	182.727	108.865	151.564	48.650	0.447	0.450
1996	23.361	166.169	95.430	137.458	40.101	0.420	0.402
1997	15.289	157.502	88.856	137.244	37.246	0.419	0.394
1998	8.045	139.812	84.221	128.975	31.531	0.374	0.351
1999	set at 20	140.360	83.241	114.780	31.274	0.376	0.343
2000	set at 20	146.124	84.516	118.784	33.126	0.392	0.357
2001	set at 20	153.643	85.277	127.023	NA	NA	NA
Arith. Mean	40.946	374.995	189.000	325.687	70.958	0.387	0.332

Table 3.2.9. Saithe in Division Va. Prediction with management option - Input data.

MFDP version 1
Run: siggi2
Time and date: 13:01 30.4.2001
Fbar age range: 4-9

2001

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	20.00	0.2	0.16	0	0	1331	0.035	1331
4	15.76	0.2	0.29	0	0	2022	0.130	2022
5	10.99	0.2	0.49	0	0	2718	0.201	2718
6	2.96	0.2	0.74	0	0	3743	0.300	3743
7	3.28	0.2	0.84	0	0	4384	0.406	4384
8	2.57	0.2	0.91	0	0	5366	0.533	5366
9	2.63	0.2	0.96	0	0	6978	0.533	6978
10	0.49	0.2	1	0	0	8025	0.533	8025
11	0.25	0.2	1	0	0	8976	0.533	8976
12	0.08	0.2	1	0	0	9977	0.533	9977
13	0.05	0.2	1	0	0	10640	0.533	10640
14	0.02	0.2	1	0	0	11705	0.533	11705

2002

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	20	0.2	0.16	0	0	1331	0.035	1331
4	.	0.2	0.29	0	0	1992	0.130	1992
5	.	0.2	0.49	0	0	2795	0.201	2795
6	.	0.2	0.68	0	0	3667	0.300	3667
7	.	0.2	0.86	0	0	4803	0.406	4803
8	.	0.2	0.92	0	0	5576	0.533	5576
9	.	0.2	0.96	0	0	7742	0.533	7742
10	.	0.2	1	0	0	8025	0.533	8025
11	.	0.2	1	0	0	8976	0.533	8976
12	.	0.2	1	0	0	9977	0.533	9977
13	.	0.2	1	0	0	10640	0.533	10640
14	.	0.2	1	0	0	11705	0.533	11705

2003

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	20	0.2	0.16	0	0	1331	0.035	1331
4	.	0.2	0.29	0	0	1992	0.130	1992
5	.	0.2	0.49	0	0	2770	0.201	2770
6	.	0.2	0.68	0	0	3731	0.300	3731
7	.	0.2	0.83	0	0	4690	0.406	4690
8	.	0.2	0.93	0	0	5952	0.533	5952
9	.	0.2	0.96	0	0	6566	0.533	6566
10	.	0.2	1	0	0	8025	0.533	8025
11	.	0.2	1	0	0	8976	0.533	8976
12	.	0.2	1	0	0	9977	0.533	9977
13	.	0.2	1	0	0	10640	0.533	10640
14	.	0.2	1	0	0	11705	0.533	11705

Input units are millions and grams - output in tonnes

Table 3.2.10. Saithe in Division Va. Prediction with management option.

MFDP version 1
Run: siggi2
SaiVa index-file for deterministic projection
Time and date: 13:01 30.4.2001
Fbar age range: 4-9

2001				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
153824	86441	0.9842	0.3450	31000

2002					2003	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
159588	87600	0.0000	0.0000	0	197577	116838
.	87600	0.1000	0.0351	3664	193532	113517
.	87600	0.2000	0.0701	7199	189628	110325
.	87600	0.3000	0.1052	10611	185859	107254
.	87600	0.4000	0.1402	13904	182221	104299
.	87600	0.5000	0.1753	17084	178706	101456
.	87600	0.6000	0.2103	20155	175311	98720
.	87600	0.7000	0.2454	23123	172030	96085
.	87600	0.8000	0.2804	25990	168859	93548
.	87600	0.9000	0.3155	28762	165793	91105
.	87600	1.0000	0.3505	31442	162828	88751
.	87600	1.1000	0.3856	34033	159959	86482
.	87600	1.2000	0.4206	36541	157184	84296
.	87600	1.3000	0.4557	38967	154498	82188
.	87600	1.4000	0.4907	41315	151897	80155
.	87600	1.5000	0.5258	43589	149379	78195
.	87600	1.6000	0.5608	45791	146939	76303
.	87600	1.7000	0.5959	47924	144576	74478
.	87600	1.8000	0.6309	49991	142286	72716
.	87600	1.9000	0.6660	51995	140065	71015
.	87600	2.0000	0.7010	53937	137913	69373

Input units are millions and grams - output in tonnes

Table 3.2.11. Saithe in Division Va. Long term prediction. Input data.
MFYPR version 1
Run: siggi2
SaiVa index-file for deterministic projection
Time and date: 11:12 30.4.2001
Fbar age range: 3-14

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.119	0	0	1421.8	2.54E-02	1421.8
4	0.2	0.238	0	0	2024.2	0.107728	2024.2
5	0.2	0.4085	0	0	2748.9	0.198376	2748.9
6	0.2	0.6015	0	0	3629.1	0.313608	3629.1
7	0.2	0.7735	0	0	4614.5	0.402231	4614.5
8	0.2	0.885	0	0	5734.95	0.510005	5734.95
9	0.2	0.9465	0	0	6943.65	0.517923	6943.65
10	0.2	1	0	0	7837.35	0.50379	7837.35
11	0.2	1	0	0	8823.6	0.45522	8823.6
12	0.2	1	0	0	9613.95	0.408538	9613.95
13	0.2	1	0	0	10713.8	0.632971	10713.8
14	0.2	1	0	0	11330.65	0.500245	11330.65

Weights in grams

Table 3.2.12. Saithe in Division Va. Long term prediction.
MFYPR version 1
Run: siggi2
Time and date: 11:12 30.4.2001
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJa	SSBJan	SpwnNosS	SSBSpwn
0	0.000	0.00	0	5.02	21197	2.74	15974	2.74	15974
0.1	0.038	0.11	605	4.67	18437	2.41	13327	2.41	13327
0.2	0.076	0.19	1003	4.39	16284	2.16	11279	2.16	11279
0.3	0.114	0.25	1266	4.15	14585	1.95	9679	1.95	9679
0.4	0.153	0.30	1439	3.96	13227	1.78	8413	1.78	8413
0.5	0.191	0.34	1554	3.80	12128	1.64	7401	1.64	7401
0.6	0.229	0.37	1629	3.66	11228	1.52	6583	1.52	6583
0.7	0.267	0.39	1679	3.54	10482	1.42	5914	1.42	5914
0.8	0.305	0.42	1710	3.44	9857	1.34	5360	1.34	5360
0.9	0.343	0.44	1730	3.35	9326	1.27	4898	1.27	4898
1	0.381	0.45	1742	3.27	8871	1.20	4508	1.20	4508
1.1	0.420	0.47	1749	3.20	8477	1.15	4176	1.15	4176
1.2	0.458	0.48	1752	3.13	8133	1.10	3890	1.10	3890
1.3	0.496	0.49	1752	3.07	7829	1.05	3642	1.05	3642
1.4	0.534	0.50	1750	3.02	7559	1.01	3425	1.01	3425
1.5	0.572	0.52	1747	2.97	7317	0.98	3234	0.98	3234
1.6	0.610	0.52	1744	2.92	7100	0.94	3065	0.94	3065
1.7	0.648	0.53	1740	2.88	6902	0.91	2913	0.91	2913
1.8	0.686	0.54	1735	2.84	6722	0.89	2778	0.89	2778
1.9	0.725	0.55	1731	2.80	6557	0.86	2655	0.86	2655
2	0.763	0.56	1726	2.76	6405	0.84	2544	0.84	2544

Reference	F multiplier	Absolute F
Fbar(3-14)	1	0.3813
$\mathbf{F}_{max}$	-1	
$\mathbf{F}_{0.1}$	0.5525	0.2107
F35%SPR	0.7561	0.2883

Weights in grams

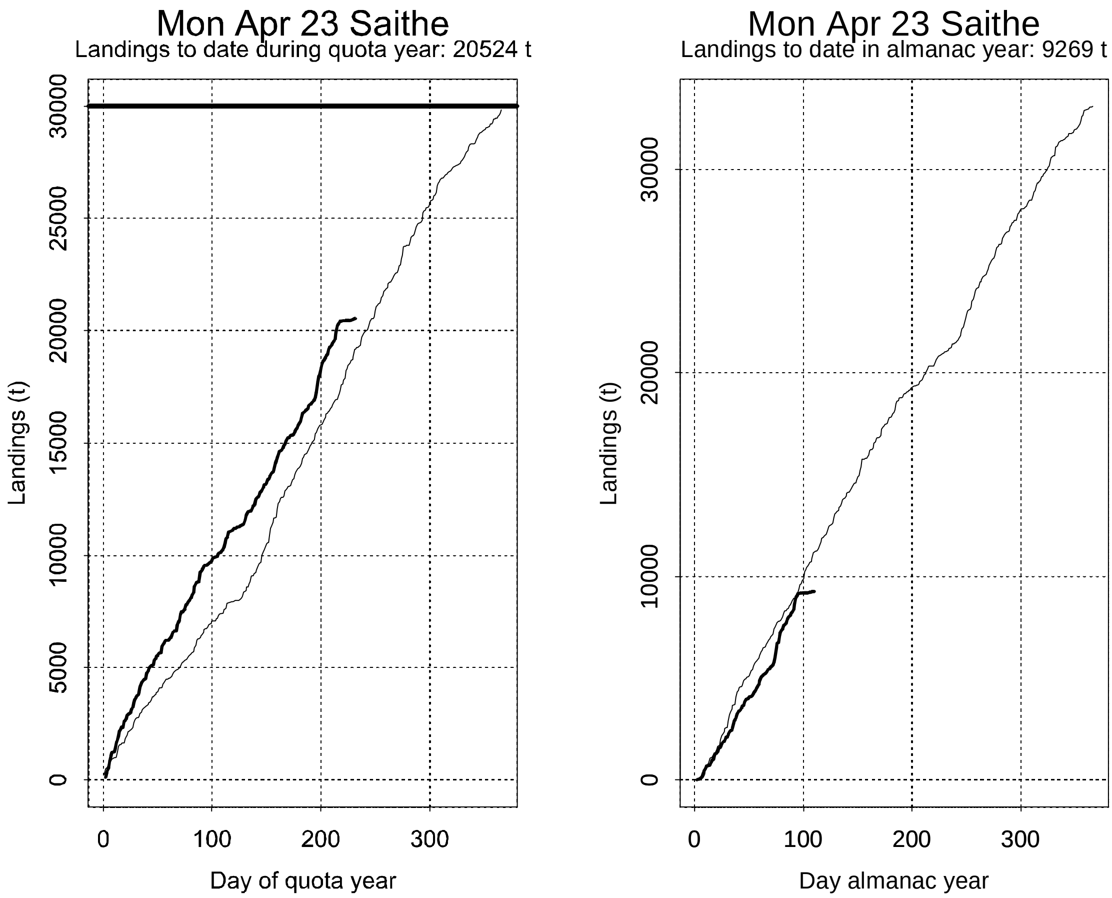


Figure 3.2.1. Saithe in Va. Cumulative landings (tonnes) of saithe in Icelandic waters by qouta year on left and calendar year on right. Broad line shows current year (qouta year 2000/2001 and calendar year 2000), thin line previous year (1999/2000 and 2000, respectively).

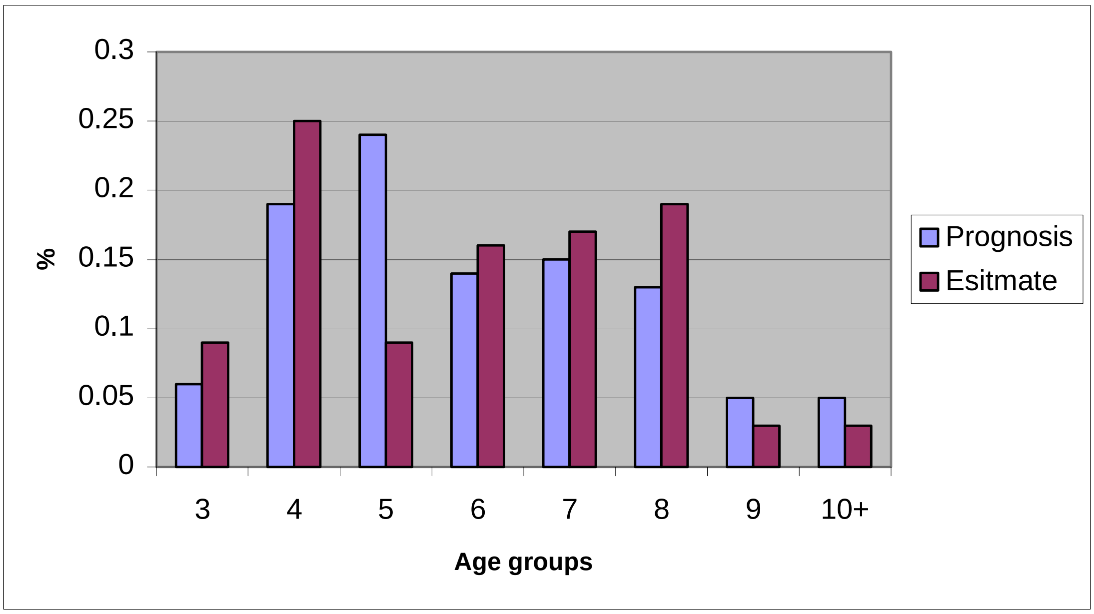


Figure 3.2.2. Saithe in division Va. Prognosis in May 2000 and estimate in April 2001 for percent (by number) age distribution in 2000 landings.

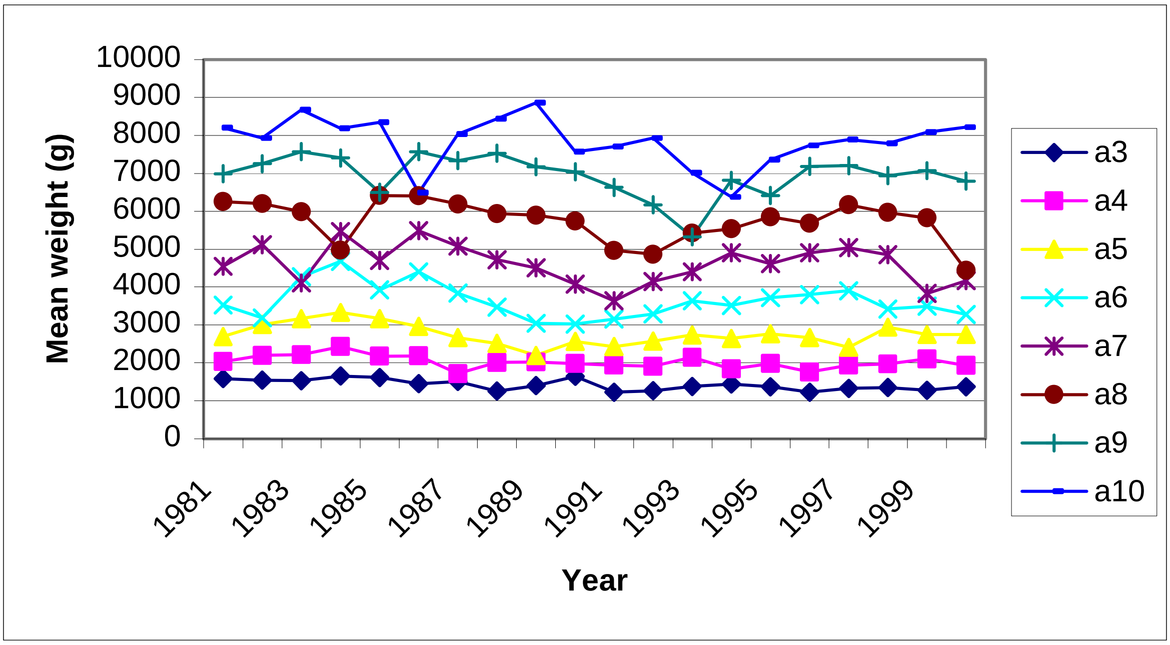


Figure 3.2.3. Saithe in div. Va (a). Mean weight at age in the catches 1981-2000 for age groups 3-10.

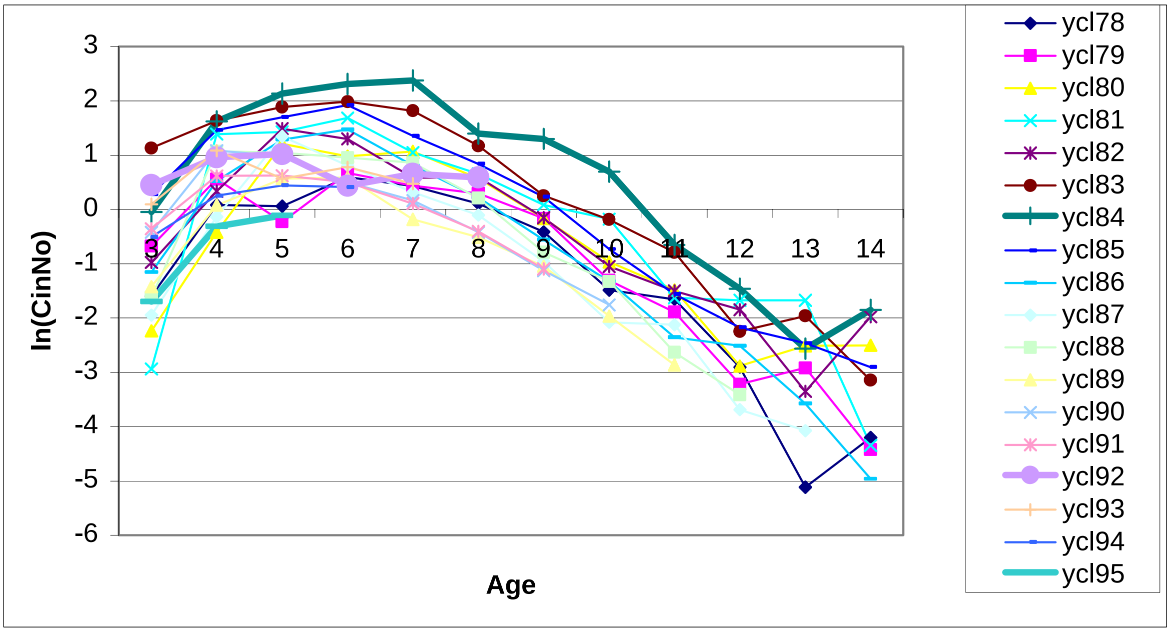


Figure 3.2.4. Saithe in Va. Catch curve for some yearclasses.

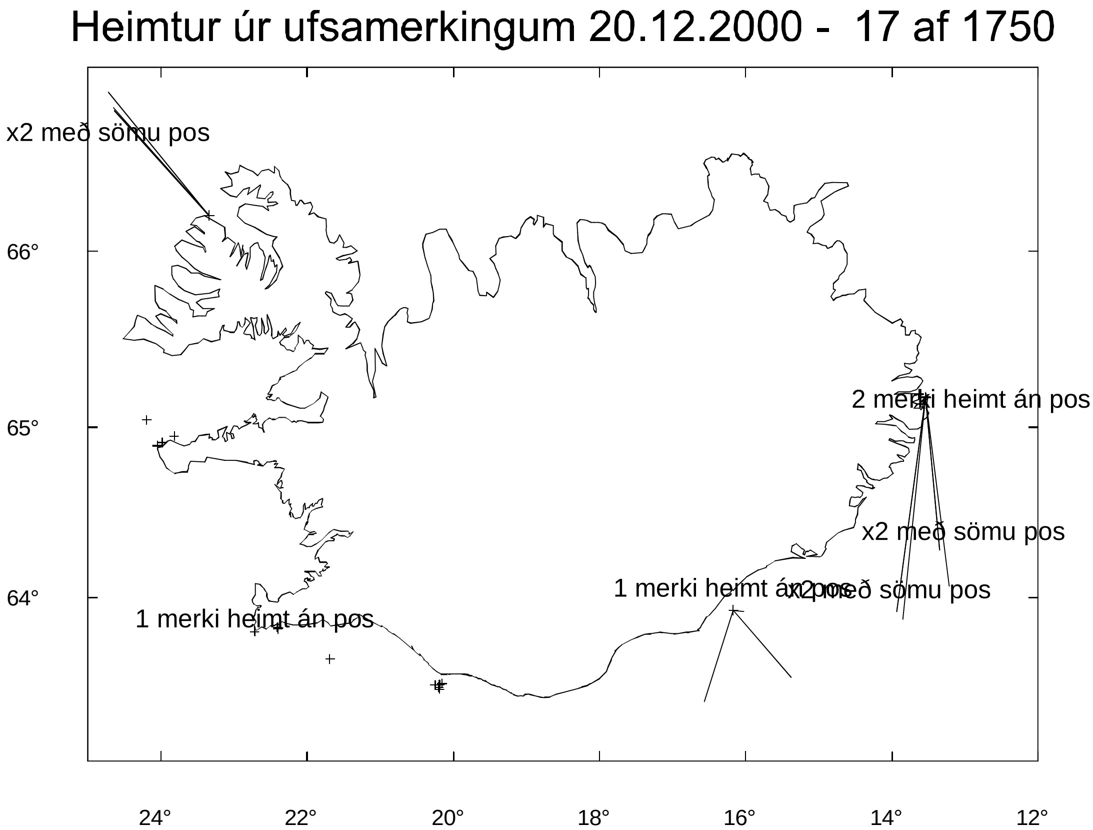


Figure 3.2.5. Saithe in Va. Preliminary results from nearshore taggings of saithe in June-July 2000. Straight lines connect tagging site and position of recovery.

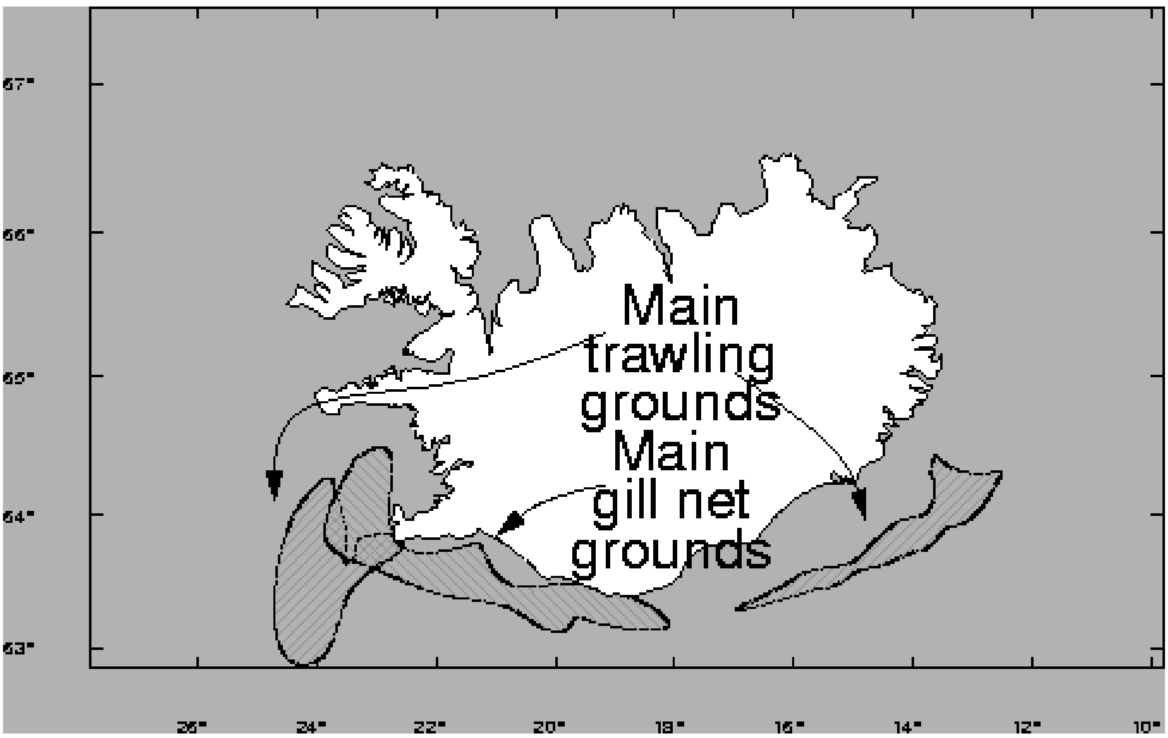
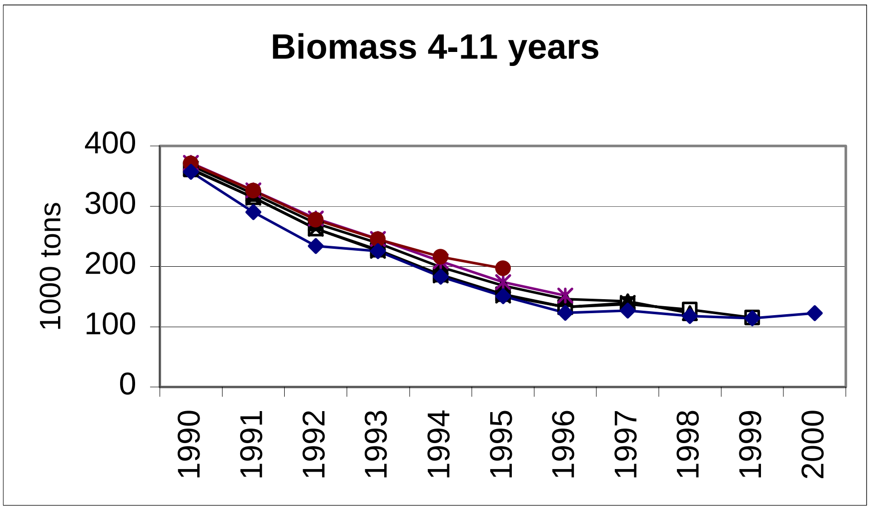
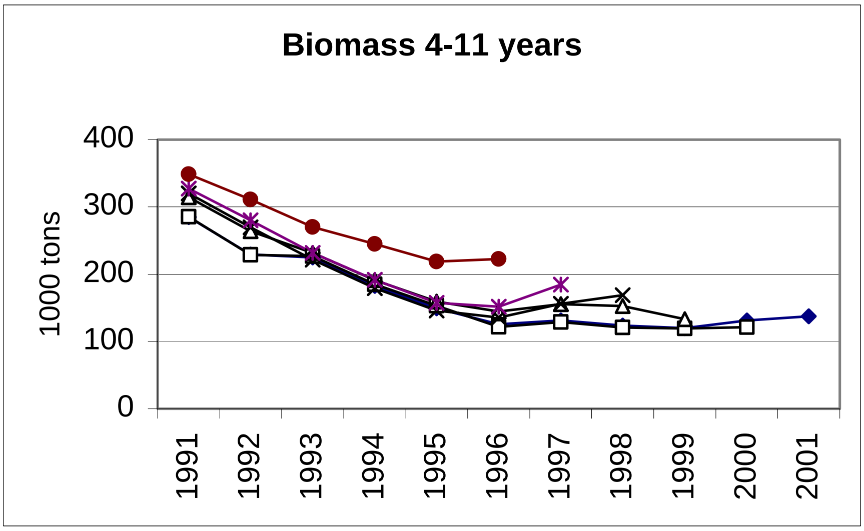


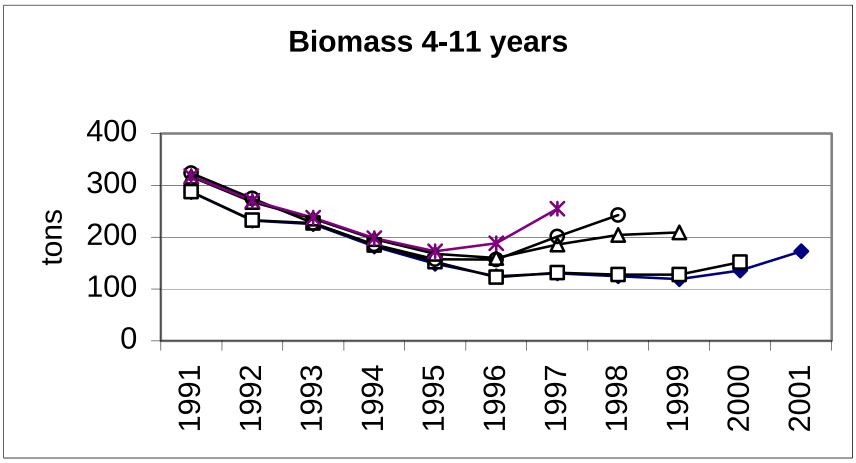
Figure 3.2.6. Areas selected for the setting up tuning fleets based CPUE in all hauls.



a



b



c

Figure 3.2.7. Saithe in Va. Retrospective analysis of TSA. a) Catch at age 1985-2000 only, ages 4-11, linear trend in recruitment estimated. b) catch at age 1985-2000, ages 4-11, tuned with trawl survey, ages 4-8, linear trend in recruitment estimated. c) Catch-at-age 1985-2000, ages 4-11, and trawl survey, ages 4-8, no trend in recruitment estimated

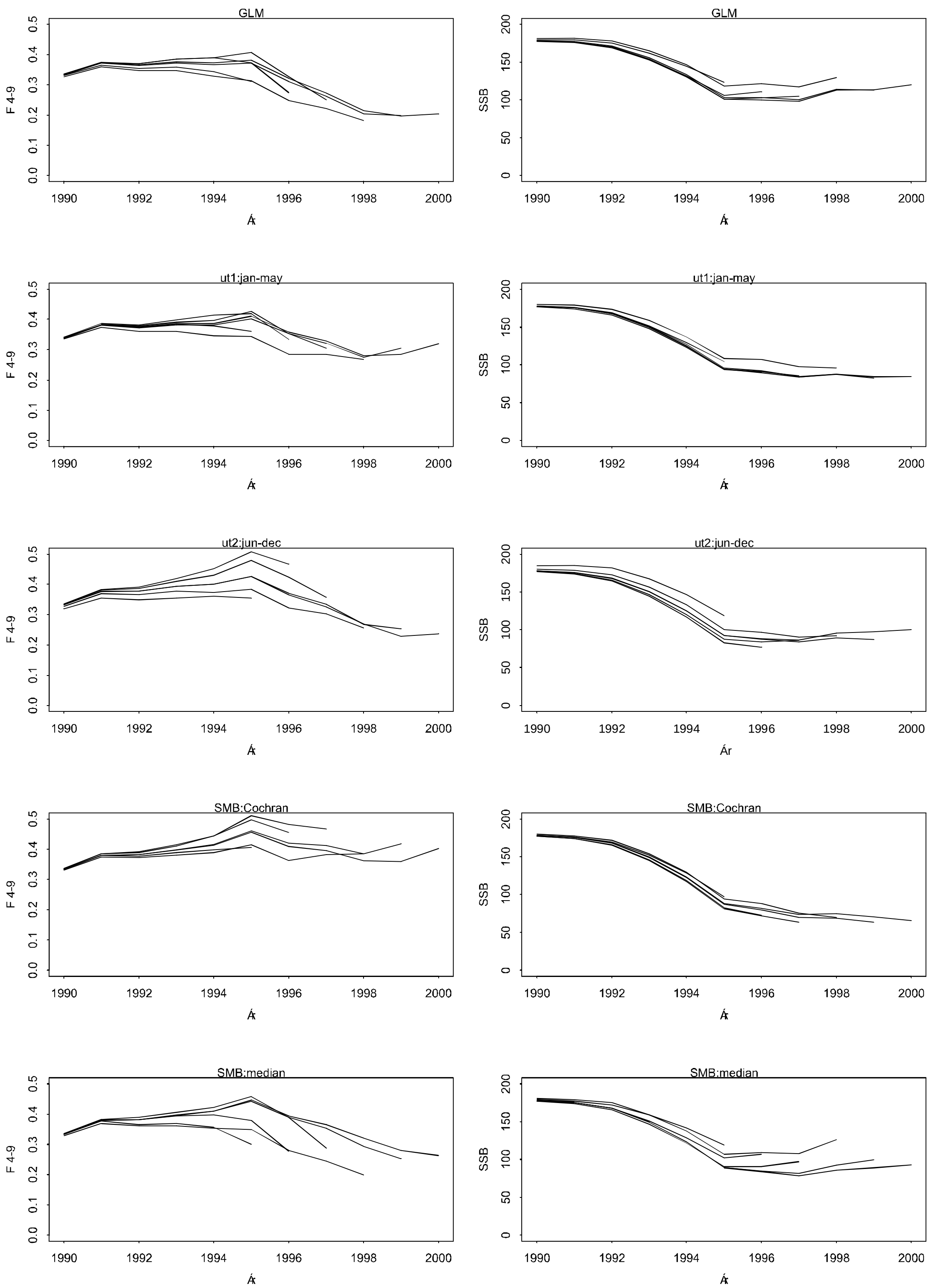


Figure 3.2.8. Saithe in Va. Retrospective analysis of XSA. Tuning fleets as in text table in section 3.2.7.1.

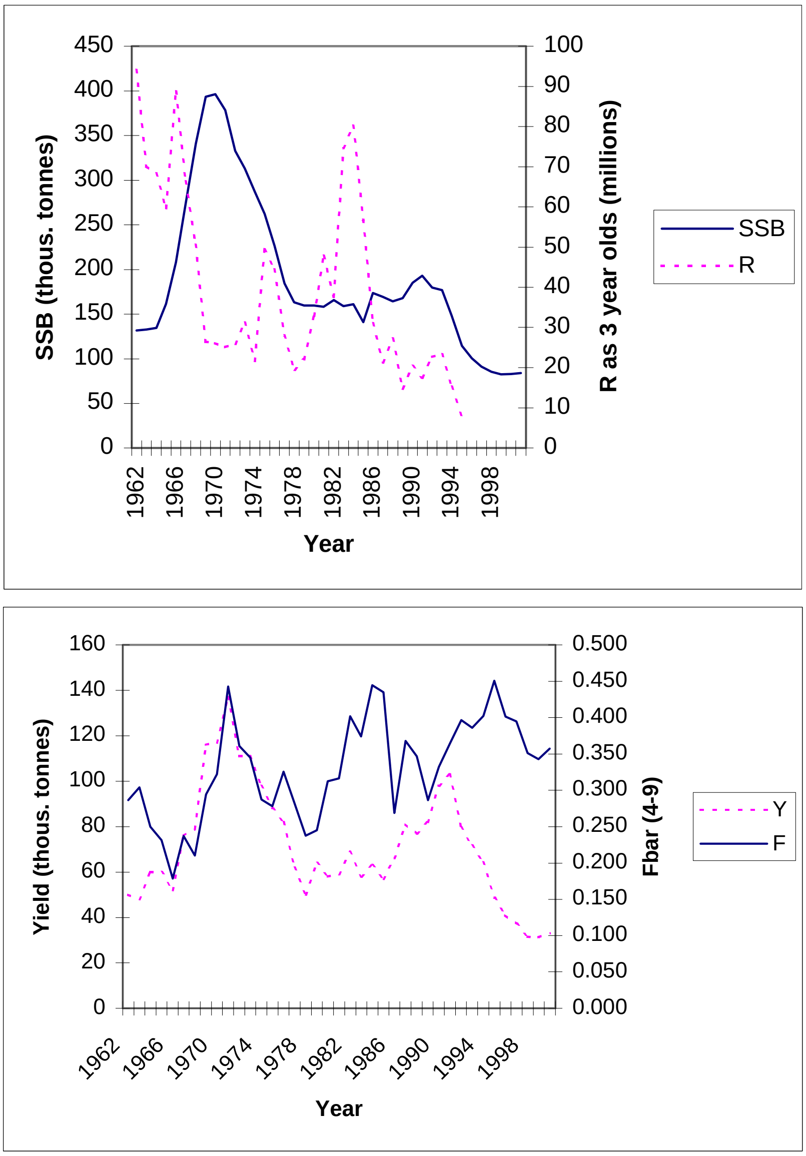


Figure 3.2.9. Saithe in Va. Fish stock summary.

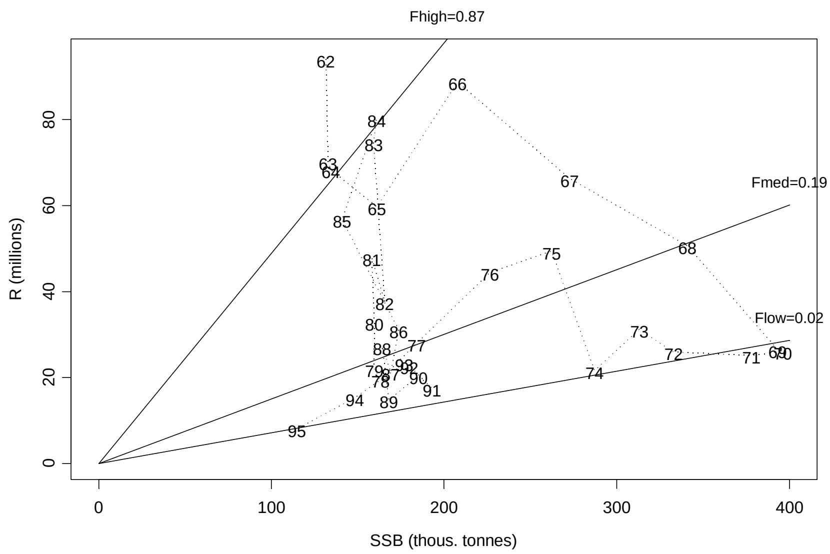


Figure 3.2.10. Saithe in Va. Stock and recruitment.

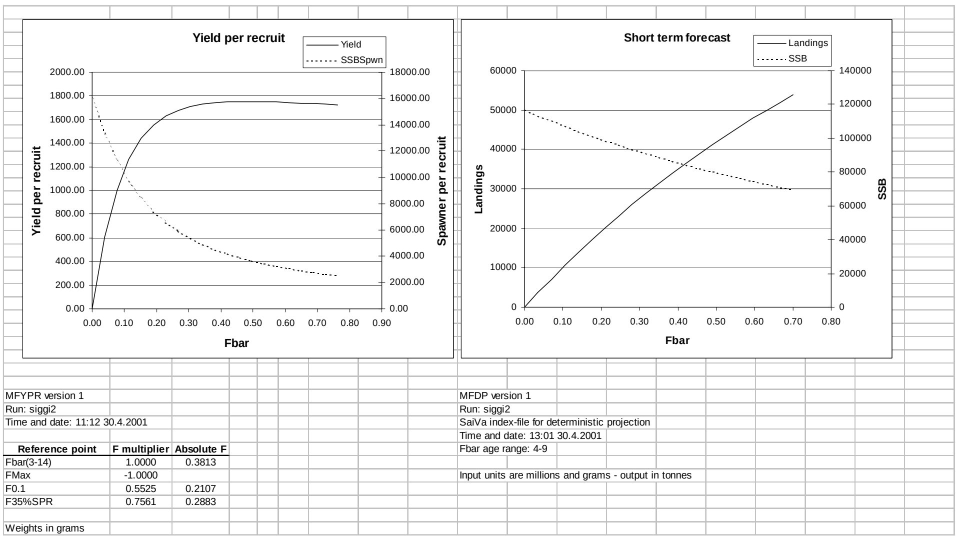
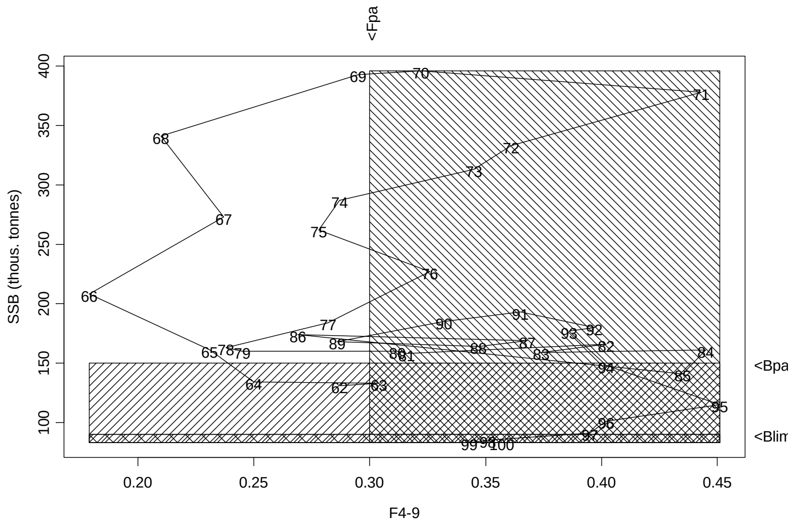


Figure 3.2.11. Saithe in Va. Yield per recruit and deterministic projection.



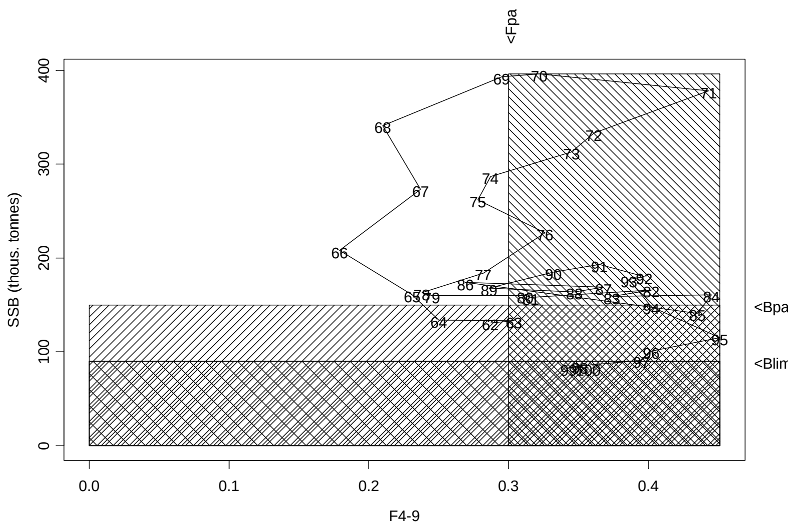


Figure 3.2.12. Saithe in Va. Two versions of pa-plot.

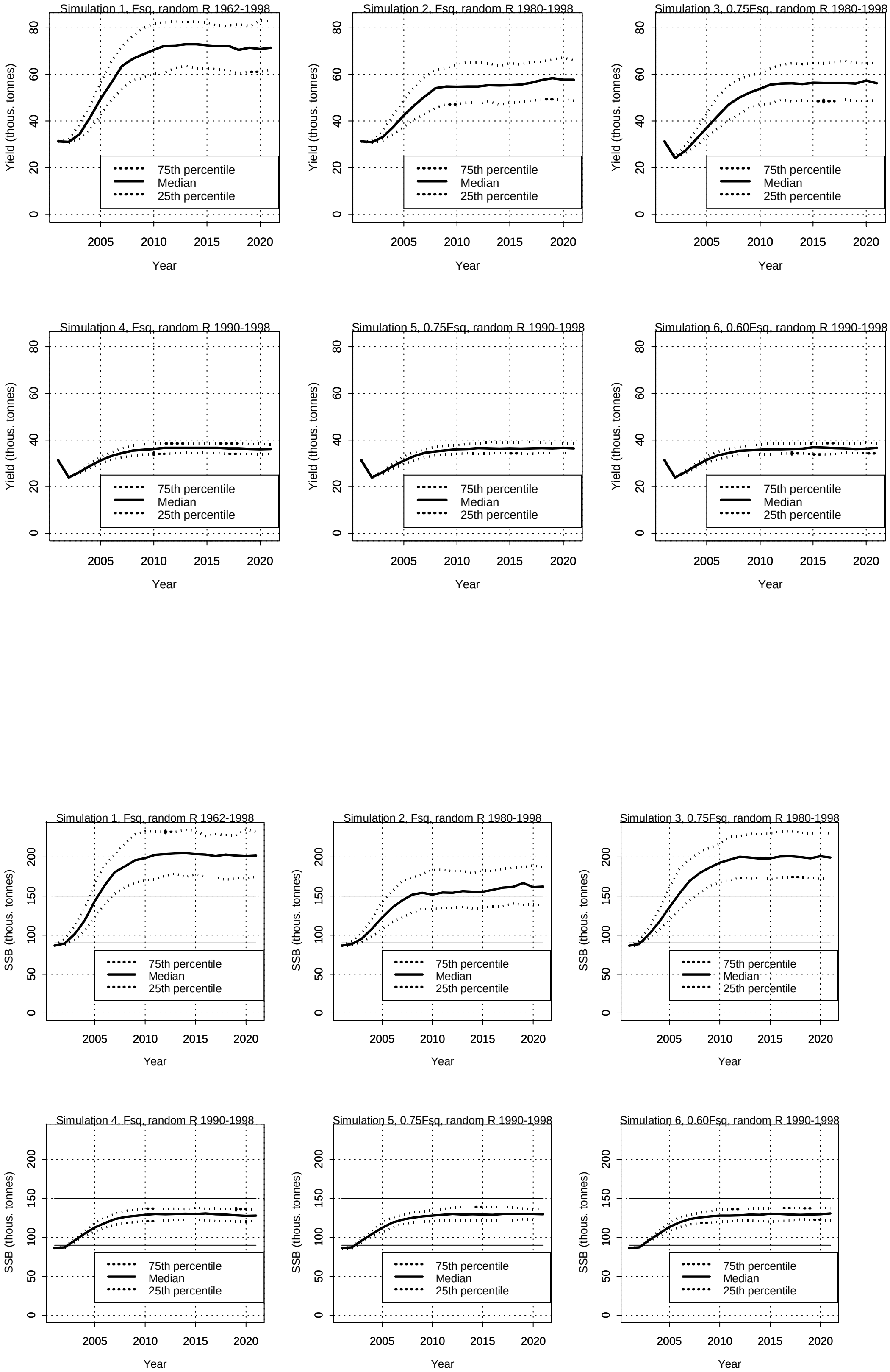


Figure 3.2.13. Saithe in Va. Medium term projections of yield and SSB for $\mathbf{F}_{sq}$, 0.75$\mathbf{F}_{sq}$ and 0.6$\mathbf{F}_{sq}$ and R randomly drawn from the periods 1962-1998, 1980-19998 and 1990-1998.

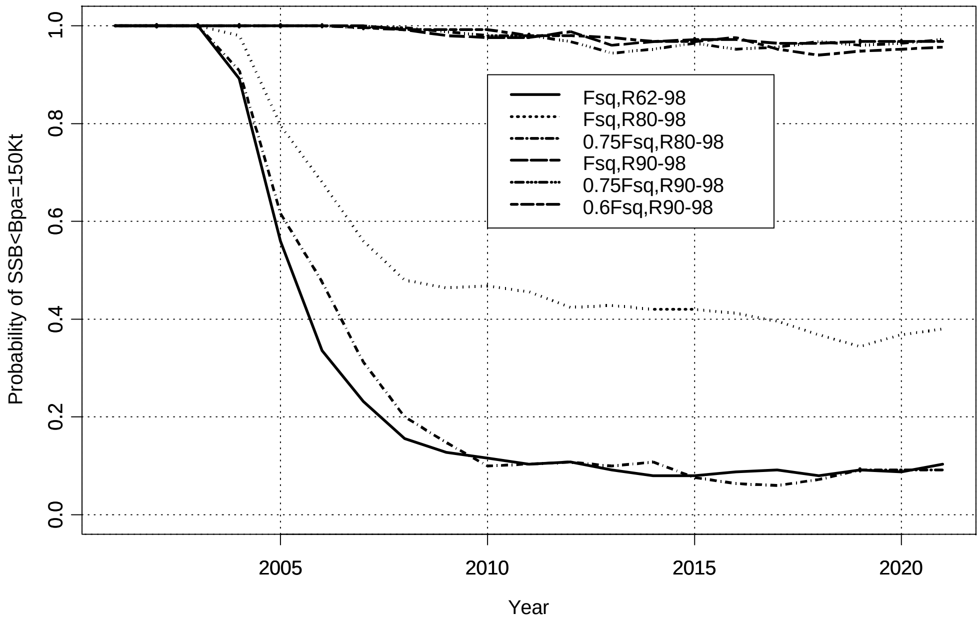


Figure 3.2.14. Saithe in Va. Plot of medium term probability of SSB being less than $\mathbf{B}_{pa}$ for $\mathbf{F}_{sq}$, 0.75$\mathbf{F}_{sq}$ and 0.6$\mathbf{F}_{sq}$ and R randomly drawn from the periods 1962-1998, 1980-19998 and 1990-1998

3.3 Icelandic cod (Division Va)

3.3.1 Trends in landing

In the period 1978–1981 landings of cod increased from 320 000 t to 469 000 t due to immigration of the strong 1973 year class from Greenland waters combined with an increase in fishing effort. Catches then declined rapidly to only 280 000 t in 1983. Although cod catches have been regulated by quotas since 1984, catches increased to 392 000 t in 1987 due to the recruitment of the 1983 and 1984 year classes to the fishable stock in those years (Table 3.3.1 and Fig. 3.3.1).

During the period 1988-1996 all year classes entering the fishable stock have been well below average, or even poor, resulting in a continuous decline in the landings. The 1995 catch of only 170 000 t is the lowest catch level since 1942. In the years 1993 - 1995 a marked reduction in effort against cod was observed (Table 3.3.2 and Figure 3.3.2) with the adoption of the HCR. The largest drop was taken by the trawlers who diverted their effort to other species and other areas.

From 1995 catches increased continuously to 1999 when the estimated landings were 260 000 tonnes but decreased to 235 000 tonnes in the year 2000.

3.3.1.1 Catch in number at age and sampling intensity

The fleet fishing for cod at Iceland operates throughout the year. The fishing vessels are of different sizes but can however be grouped into three main categories: 1) Multi-gear boats; < 300 GRT, 2) Small boats; < 20 GRT, 3) Trawlers; > 300 GRT.

The trawlers operate throughout the year outside the 12-mile limits. They follow the spawning and feeding migration patterns of cod and fish on spawning grounds off the southwest and south coasts during the spawning season but move to 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 southwest coasts but in recent years this fleet has also used gillnet in late autumn. In the years 1995 to 1998 this fleet increased the mesh size in their nets from 7 to 9 inches but reduced the mesh size back to 8 inches in 1999 and 2000 (Figure 3.3.3). Part of this fleet uses longlines during autumn and early winter. During summer some of these boats trawl along the coast out to the 3-mile limit. Others fish with Danish seines close to the shore. Most of the smaller boats operate with handlines mainly in shallow waters during the summer and autumn period.

The data samples comprising the age-length keys for 2000 are given in the following table: The number of samples in gillnets in January-May can be explained by inclusion of gillnet surveys in the numbers.

Gear	Period	Area	Landings	Nos. aged	samples	Nos fish measured	Nos. fish aged
Longline	Jan-May	S	21062		15	2967	749
Gillnet	Jan-May	S	37368		2795	11812	4213
Danish seine	Jan-May	S	6500		7	1407	349
Bottom trawl	Jan-May	S	19147		32	21790	1436
Longline	Jan-May	N	9877		9	4609	448
Gillnet	Jan-May	N	505		755	701	150
Handlines	Jan-May	N	1214		2	569	200
Bottom trawl	Jan-May	N	24695		51	33334	2487
Danish Saine	Jan-May	N	679		0	305	0
Longline	Jun-Dec	S	7419		8	2455	369
Handlines	Jun-Dec	S	3901		4	569	200
Gillnet	Jun-Dec	S	6428		4	728	195
Danish Seine	Jun-Dec	S	2823		7	798	332
Bottom trawl	Jun-Dec	S	6376		16	4889	749
Longline	Jun-Dec	N	14371		9	23833	443
Gillnet	Jun-Dec	N	1566		0	0	155
Handlines	Jun-Dec	N	10771		6	1053	300
Danish seine	Jun-Dec	N	4846		5	2004	250
Bottom trawl	Jun-Dec	N	53127		75	142105	3669
Total			235082		3565	255878	17739

Catch in number at age is calculated by splitting the landings by 5 fleets ("metiers"), 2 areas and 2 gears. The gears are long lines, bottom trawl, gillnets, hand lines and Danish seine, seasons January-May (spawning season) and June-December (and regions North and South. Historically, there have been some changes in fleet definitions and thus there does not currently exist a fully consistent set of catch-at-age data on a per-fleet basis.

The sampling effort in each cell (Gear-Season-Area) in the year 2000 is shown in the table above.

In some cases samples are not available for a cell or are to few to give reliable keys. In those cases otolith samples from "related" cells are used. Notably hand lines are included with long lines in the same area and season.

In recent years emphasis has been put on relating the sampling scheme to the landings database automatically, calling for samples when certain amount has been landed in each cell.

The total catch-at-age data is given in Table 3.3.3. 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.

3.3.2 Mean weight at age

3.3.2.1 Mean weight at age in the landings

Mean weight at age in the landings is calculated with the catch in numbers. Before 1993 weighting of cod was relatively uncommon so length-weight relationships were based on little data. Since 1994 weighting has been much more extensive but currently all fishes sampled for otolith are weighted and length-weight relationships can be calculated from current data. The weights are shown in Table 3.3.5.

Mean weight at age have been shown to correlate well with the size of the capelin stock and capelin stock size has for some time been used as a predictor of weights in the landings. In 1981-1982 weights were low following collapse of the capelin stock and were also relatively low in 1990-1991 when the capelin 9stock was small. The weights were very high in 1994 to 1998 but have been low in 1999 and 2000, lower than the predicted from the capelin stock size. Weights at age for this stock are all the same relatively stable compared to most other cod stocks.

Mean weights at age are not available on an annual basis for catches taken before 1973, and hence the average for the years 1973 - 1991 is used as the constant (in time) mean weight at age for earlier years.

3.3.2.2 Mean weight at age in the stock

Weights at age in the landings have been used without modification to compute stock biomasses, with the exception of the spawning stock biomass (see below).

The Icelandic groundfish survey (IGFS) provides 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".

Weights at age in the IGFS were high in 1994–1997 but have dropped since, though not as much as in the catches. Survey weights for ages 3 to 5 are always considerably lower than weights from the catches from the same period.

A problem with using survey weights for calculation of stock biomass is that they are only available back to 1985.

3.3.2.3 Mean weight at age in the spawning stock

For years up to 2001, weight at age data from the commercial catch period January-May have been used for estimation of mean weights at age in the spawning stock. It is assumed that catches in different gears and areas appropriately reflect stock composition with regard to mean weight at age. Weights in the SSB have decreased in recent years after being very high in 1996 to 1998. The peak in 1996 to 1998 could be related to selection of the commercial fleets that 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.

3.3.3 Maturity at age

Maturity at age is based on samples from the commercial fleets in January-May (ICES 1992/Assess:14) (Table 3.3.7). 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 has been increasing to relatively high values in last decade.

Maturity at age data are not available on an annual basis for catches taken prior to 1973 and, hence, the average for the years 1973–1991 is used as a constant (in time) maturity at age for the years prior to 1973.

3.3.4 Stock Assessment

Intersessional review of last year's assessment

The 2000 ICES assessment showed that the stock had been seriously overestimated in recent years. In May-June 2000 the MRI asked a group of external experts to review and reanalyse the assessment. The group was chaired by Prof. John Pope. Various alternative assessment models were used: XSA (John Pope), Coleraine (Árni Magnússon/Ray Hilborn), Cagean like model (Pat Sullivan), TSA (Guðmundur Guðmundsson) as well as some unconventional methods such as Bormicon (Höskuldur Björnsson). The group met twice, first in May/June 2000 and again in late autumn.

At the spring meeting, several different tuning sets and assumptions were explored. The outcome of the final runs of the various assessment models are shown in Figure 3.3.4. The main conclusion was that the MRI 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 MRI 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.

3.3.4.1 Tuning data

CPUE from commercial fleets

Commercial trawler CPUE data were analysed as described in Stefansson (1988) to create GLM indices of abundance (numbers) at age. The analysis takes into account catchability changes in the fleet due to vessel renewal and vessels shifting between regions, but not changes in the spatial distribution of the resource or changes within vessels in the fleet. For this reason the analysis of the logbook data was restricted to the years 1995–2000. These indices are based on logbooks from demersal trawl fisheries for two parts of the year (January-May and June-December) and two areas i.e. southwestern areas, and northern areas (Table 3.3.8).

The same method was applied for the gillnet fleet. Logbooks for this fleet have been analysed for the years 1995–2000. The gillnet fleet operates mainly during the spawning season on the spawning grounds off the south and west coasts of the Iceland. This fishery has often been referred to as "the spawning fishery" in earlier reports of this Working Group. The GLM indices presented here (Table 3.3.9) are based on the gillnet fishery in the south and west areas during January-May.

For retrospective analysis the commercial series were analysed using the same GLM model back to 1985 for the trawlers and 1988 for the gillnet fleet.

Survey indices

In recent years a method based on gam smoothers (Björnsson, 1994) has been used to calculate indices from the Icelandic groundfish survey (IGFS). The same method of calculating indices was used this year in order to repeat the default run from last year (Table 3.3.10). Due to software updates (Splus versions) it was difficult to run the standard program of last year. Based on this the working group decided to adopt a more conventional Cochran type method for calculating survey indices. The Cochran type indices also give estimates of CV, which the gam smoother method did not supply. The stratas used follow depth contours. The Cochran indices were calculated separately for two areas: Northern area and Southern area and then combined. For the XSA tuning the indices were combined by simple summation (Table 3.3.12) but for the TSA tuning the two area indices a weighted geometric mean was calculated (Table3.3.11). In order to compare the "gam smooth" indices used in former assessments and the survey indices a comparison plot was made, see Figure 3.3.5. The plot shows the indices are very similar implying that the use of either index should not affect the result of the XSA tuning.

Figure 3.3.6 shows plots of survey index for cod vs. the index of the same yearclass 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. In the age 3 vs 4 plot the most striking outlier is the 1997 yearclass, which is far below expectation in the survey 2001. It is estimated that 11 million fishes of this yearclass were landed in 2000. Although this is more than has been landed of age 3 cod for some years it is not enough to explain the difference in the indices. The 1990 yearclass, which is the other outlier, sustained a fishing mortality of 0.16 at age 3, which is much higher than any other yearclass in the last 20 years. The 1982 yearclass also stands out but it could be a problem related to insufficient otolith sampling in the 1985 survey. Yearclass 1993 as age 4 is above prediction compared with age 3 indices. This deviation coincides with low fishing effort in 1996 when this year class was 3 years old.

To use the latest information available for tuning, the 2001 survey indices were moved three months back in time i.e. to December 2000 for the age groups 4-9. The same applies to abundance indices for the other survey years. No shift in time needs to be applied to age groups 3 and 2.

3.3.4.2 Estimates of fishing mortality

On the basis of the conclusions of the reviewing process several XSA runs were explored using only one fleet at a time and single arial combined survey indices. The same procedures were followed in the TSA runs using the same data sets.

XSA tunings

Firstly the default run from last years assessment was run on the updated data sets (Tables 3.3.8-10). The resulting tuning diagnostic and terminal F's are presented in Table 3.3.13 and resulting retrospective analysis in Figure 3.3.7 and Figure 3.3.8. The estimated terminal reference F (average of age groups 5-10) is 0.67.

Two runs were made on survey indices combined in different way. The results are given in Tables 3.3.16 and 3.3.17. The resulting terminal F´s were very similar as were the retrospective analysis, indicating no major differences in these two indices (the weighted indices were otherwise only used as inputs in the TSA). The resulting diagnostics of the run using the unweighted survey indices are presented in Table 3.3.15. The results of the corresponding retrospective analysis are presented in Figures 3.3.7 and 3.3.8. The resulting reference F in the terminal year is 0.77.

Four XSA runs were performed using the four Trawlers series in the default run one at a time. The resulting retrospective analyses were of relatively poor quality. All the four runs gave very similar estimate of the reference F in the terminal year of about 0.6. Run using the gillnet fleet from the default run gave on the other hand similar results to runs using survey only.

In all the XSA runs the estimated F's in the final year were shrunk to the mean of the three latest years instead of using a default setting of five years, as there has been an increase in fishing mortality of this stock during the most recent period.

All XSA runs showed retrospective patterns, reiterating the overestimation in biomass and underestimation in fishing mortality in recent years. The retrospective pattern in the default run of last year showed greater overestimation of biomass and underestimation of fishing mortality than the run using the survey only. The former was thus rejected from further considerations by the working group.

TSA runs

Several TSA runs were made with the same fleets tried in XSA. The run giving the most consistent retrospective results and diagnostic was a run using catch at age data and survey indices. The results of this run and some diagnostics area presented in Table 3.3.14, the results from corresponding retrospective analysis are presented in Figures 3.3.7-8. The terminal reference fishing mortality based on this run is 0.85.

The selection of a final run

Comparison of the two runs using the survey only show that the retrospective results from TSA is more consistent overall, especially in the retrospective pattern of the fishable biomass. The difference in the terminal reference F of these two runs (XSA $F_{5\text{-}10,2000}$=0.77, TSA $F_{5\text{-}10,2000}$=0.85) can mostly be explained by higher fishing mortality of age group 8-10 in the TSA compared with XSA (Figure 3.3.9). The difference in the estimate of the fishable biomass in year 2000 is about 10% with most of that difference attributed to the 1996 yearclass. Considering that the difference was relatively small, the group decided to adopt the XSA run as a basis of forward projections, since that method has been the more traditional method used by ICES.

The resulting fishing mortalities from the final XSA run are given in Table 3.3.16 and in Figure 3.3.10. The fishing mortality increased to a peak in 1988, decreased in 1989 but then rose to another peak in 1993. Due to restriction of the cod quota effort dropped markedly in 1994 and 1995. In recent years fishing mortality has again shown an increasing trend.

3.3.4.3 Stock and recruitment estimates

The resulting stock size in numbers and stock in weight from the final VPA are given in Tables 3.3.17 & 3.3.19. In the stock in numbers table, the recruitment in the most recent years (year classes 1997–2000 as 3-year-olds in 2000-2003) was estimated using RCT3 as described in Section 3.3.6.1.

3.3.5 Biological and technical interactions

Several important biological interactions in the ecosystem around Iceland are connected to the cod stock. The single most important interaction is the cod-capelin connection (Pálsson, 1981) and this has been studied in some detail (Magnússon and Pálsson, 1989 and 1991a and Steinarsson and Stefánsson, 1991). Another important interaction is between cod and shrimp. This has been studied by Magnússon and Pálsson (1991b) and Stefánsson *et al.* (1994). The cod-capelin interaction is used in the short-term prediction in Section 3.3.7.1 based on the results in Steinarsson and Stefánsson (1996).

Various factors affect the natural mortality of cod and several of these factors could change in magnitude in the future. The cod is a cannibal and the mortality through cannibalism has been estimated in Björnsson (WD 26,1998). Cannibalism occurs mainly on prerecruits and immature fish. Further, the minke whale, the harbour seal and the grey seal are apex predators, all of which consume cod to varying degrees. Most of these M values will affect cod at an early age, before recruitment to the fishery.

It has been illustrated that not only may cetaceans have a considerable impact on future yields from cod in Division Va (Stefánsson *et al.*, 1995), but seals may have an even greater impact (Stefánsson *et al.*, 1997). These results imply that predictions, which do not take into account the possible effects of marine mammals may be too optimistic in terms of long-term yields. It is therefore desirable to include marine mammals as a part of future natural mortality for the cod stock.

A number of fleets operate in Division Va. The primary gears are described in Section 3.3.1.1. 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 2001. For the year 2001 onwards, the average over the years 1998–2000 is used (Table 3.3.21). In the most recent period maturity at age has been high compared to the years prior to 1993. For the short-term predictions the average for the years 1998–2000 has been used for the years 2001-2003. The exploitation pattern used for the short-term predictions was taken as the average of the years 1998–2000 from the VPA. The combined Cochran survey indices, age groups 1-4 and recruitment estimates from the VPA were used for recruitment prediction. The input for the RCT3 is given in Table 3.3.22. The size of the year classes 1997–2000 has been estimated using RCT3, with the output as given in Table 3.3.23.

3.3.6.2 Short term prediction results

Input data to the short term prediction and results from projections up to the year 2003 with different management options are presented in Table 3.3.24 and Figure 3.3.12.

Based on the amended harvest control rule the expected catch in 2001 will be 205,000 t corresponding to F=0.74. The amended catch control, with an upper limit of between year changes in TACs of 30 thousand tonnes, will result in a TAC of 190,000 tonnes in the 2001/2002 fishing year resulting in slight increase of the SSB in 2002 and a reference F about 0.6.

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 1981–2000 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 $\mathbf{F}_{max}$- level is 1.75 kg (Figure 3.3.13, Table 3.3.26).

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.14. When using the period 1955–1996, the reference points $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ are about 0.52 and 0.87, respectively.

The inclusion of the stock recruitment relationship has a major effect on long-term predictions. From Figure 3.3.14 it is seen that below-median recruitment occurs more frequently when the SSB is below-median than when the SSB is above the median. The increased probability of poor recruitment at low SSB levels is of major concern.

3.3.7 Medium term simulation

The model used is a statistical catch at age model with simulation options. The model is written in AD-model builder and the skeleton of the model is the catch at age example shown in the AD-model builder manual but ideas from the TSA model on evolution of fishing mortalities as time series have been incorportated. Some of the characteristics of the model are: a) Beverton Holt stock – recruitment relationship with lognormal non-autocorrelated errors (year class 2001 onwards; survey estimates for older year classes were used), b) fishing mortalities evolve as random walk, c) fishing mortalities nonparametric, d) nonlinear relationship between number in stock and survey indices for ages 1 to 4, linear after that, e) ratio of process and measurement noise fixed but standard deviation of catch at age and survey indices estimated, f) 30 Ktons limit of changes in catch rule implemented, g) CV in stock assessment 15% (not autocorrelated) same as in the simulation of the catch rule.

Figure 3.3.15 shows the retrospective using the model for assessment with the last assessment simulated til 2007 with future catches following the catch rule with 30 Ktons limits on interannual changes and Figures 3.3.16 to 3.3.18 show likelihood profiles of the esimates from the model with estimates from the XSA run selected as the final run at this working group meeting and the TSA run using the groundfish survey shown for comparison.

One of the main goals of running this model was to see explore the effects of the new catch rule on stock trends in medium term timeframe. Figure 3.3.17 indicates that the models estimate of current stock size is more pessimistic than the XSA assessment selected as the final run in this working group meeting but similar or little more pessimistic than the TSA estimate. In spite of that the model indicates that the stock will get out of the current low, mostly due to signs that yearclasses 1997 – 2000 are good compared to recent yearclasses.

Figure 3.3.17 shows how narrow the error margins are on the catchable biomass in the year 2000 compared to 2001 and 2002. According to the catch rule the TAC for the fishery year 2001-2002 will be based on the mean of the catchable biomass in 2001 and 2002.The retro in Figure 3.3.15 shows the catchable biomass in the beginning of the year before the assessment is done (as most retros shown do). This illustrates that conventional retrospective plots, if used as an indicator of accuracy of an assessment, give overoptimistic results about the errors in assessment. For that the mean of the catchable biomass in the beginning of the assessment year and the beginning of next year need to be put on the retrospective plot.

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 last year 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.

Recent assessments have overestimated fishable biomass and underestimated fishing mortality. The current assessment confirms these results and gives much more pessimistic view on the stock than last years assessment. Retrospective patterns indicate that the overestimation of the stock may not yet be fully accounted for in the current assessment.

Last year the Icelandic government, after some limited studies by the MRI, changed the adopted 25% catch rule by limiting the allowed changes in TAC between years to 30 thousand tonnes. Since detailed results of that study were not available to the working group an ad hoc exercise was done during the working group meeting to test if the new catch rule could lead to serious decline in SSB in the short to medium term. The results shown in Figure 3.3.18 show that the probability that the spawning stock will be above present is high if the catch rule with the amendments is followed. as recruitment in coming years seems to be good (yearclasses 1997-2000). However, high fishing effort in 2001 and 2002 might severely affect the incoming yearclasses through discard and other hidden mortality related to fishing effort (disturbance).

It should though be emphasized that the medium term projections presented here are preliminary ad-hoc exercises and more in depth studies are needed to evaluate the medium term effects of the ammendment to the Harvest Control rule.

Previous and current evaluations of the catch rules do not take into account the consistent overestimation of stock size which results in the effective exploitation rate being consistently above the intended 25% nor the fact that poor yearclasses have a tendency to occur in strings, particularly since the late 1980s. These and other potentially autocorrelated factors have to be taken into account when adopting a catch rule, specifically one with an interannual constraint on variation in TAC.

At present fishing mortality is high and age 4 and younger fish account for most of the stock biomass. This situation makes discard (and possibly hidden mortality due to mesh penetration) a major concern today as much fishing effort will be directed towards the small fish. This concern is supported by the data in Figure 3.3.6 which show that the survey index of the 1997 yearclass at age 4 is well below what would have been predicted by the index of the same yearclass at age 3, more than be explained by landed catch.

3.3.9 Comments on the assessment

In this years assessment indices from commercial fleets were not included in the final assessment. This decision was based on retrospective patterns and on the results from the working group on Icelandic cod last autumn that using multiple indices in XSA runs letting XSA selecting the weights was a questionable procedure. It must though be born in mind that indices from commercial fleets are still used even if they are not used directly in tuning and they are as such an important source of information on the state of the stock. They usually give the same main message as the survey and a situation where they would show opposite trends would demand thorough investigation of the survey and the

CPUE indices. Sometimes in the future a new survey series might have to be started as the trawlers used in the survey become obsolete and in that situation reliable series of CPUE indices would be very valuable.

Stock assessments in recent years showed that fishing mortality decreased considerably since 1993, which was in accordance with the measures taken by Iceland to reduce fishing effort against cod. In last years and especially this years assessment is appears that the stock has been overestimated in recent years. The fishing mortality in 1998 was estimated to be 0.49 in the assessment 1999 but is now estimated to be 0.7 or higher.

The main reason for the discrepancy seems to be high availability of cod in the years 1997 and 1998. This availability showed up in CPUE indices from the commercial fleets and in the groundfish survey. The availability also shows up in catch in numbers with much higher than expected number of old fish. The MRI was aware of this change in selection which was for example seen by the gillnet fleet changing from 7 to 9 inch mesh size (Figure 3.3.3) but underestimated its magnitude.

The question arises what caused the changes in availability seen in recent years. Relating it to environmental variables has turned out to be difficult, which does not mean it has nothing to do with the environment, we just do not understand the effects.

Other possible factors affecting the availability of cod are capelin availability and fishing effort (perturbance).

Capelin is the most important food of Icelandic cod. Large part of the adult capelin is outside the reach of the cod stock during the summer but returns back in the autumn and is the main food of cod deep of the north coast in the autumn and all around Iceland in the spawning period in late winter. In the late nineties the acoustic measurements of the capelin in the autumn did not succeed in many cases indicating changes in its summer migration.

Fishing effort must though be considered a likely cause of increased availability. When fishing effort was reduced in 1994 – 1995 the reduction was most prominent by the trawler fleet. Soon after the effort was reduced the CPUE of the trawlers started to increase. The same phenomenon was seen in the survey although it started later. When the effort increases again survey indices and CPUE drop rapidly, possibly due to a combination of decreased availability and stock size.

Increased availability with reduced effort (disturbance) seems logical, as the most available fishes have better chances to survive. It can though not be excluded that hidden mortality increases with increasing fishing effort making the stock rebuild faster when effort is reduced and collapse faster when effort increases.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1987- 2000 as officially reported to ICES.

Country	1987	1988	1989	1990	1991	1992	1993
Belgium	597	365	309	260	548	222	145
Faroe Islands	1,848	1,966	2,012	1,782	1,323	883	664
Germany	-	-	-	-	-	-	-
Greenland	-	-	-	-	-	-	-
Iceland	389,808	375,741	353,985	333,348	306,697	266,662	251,170
Norway	4	4	3	-	-	-	-
UK	-	-	-	-	-	-	-
Total	392,257	378,076	356,309	335,390	308,568	267,767	251,979
WG estimate	-	-	-	-	-	-	-

Country	1994	1995	1996	1997	1998	1999	2000 [1]
Belgium	136	-	-	-	-	-	-
Faroe Islands		739	599	408	1,078	1,247	1,176
Germany	-	-	-	-	9	21	15
Greenland	-	-	-	-	-	25	-
Iceland	177,919	168,685	181,052	202,745	241,545	258,658	232,272
Norway	-	-	7	-	-	85	101
UK	-	-	-	-	-	16	
Total	178,809	169,424	181,658	203,153	242,632	260,052	
WG estimate	-	-	-	-	-	-	235,199 [2]

1) Provisional.
2) Additional landings by Iceland of 1602 t, and Faroes of 33 t are included.

Table 3.3.2. Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-2000 (with 1991 as 100%). Data are based on logbooks which have been mandatory in the fisheries since 1991.

Bottom trawl

Year	Catch	effort	effort % changes	cpue	cpue % changes
1991	175142	234946	100	745	100
1992	131504	228196	97	576	77
1993	114587	182882	78	627	84
1994	66186	83975	36	788	106
1995	60580	71202	30	851	114
1996	66867	66867	28	1000	134
1997	81202	74841	32	1085	146
1998	109947	86098	37	1277	171
1999	124381	120408	51	1033	138
2000	103347	126341	54	818	110

Gillnet

Year	Catch	effort	effort % changes	cpue	cpue % changes
1991	58948	1060	100	56	100
1992	59712	984	93	61	109
1993	56701	1008	95	56	101
1994	39192	718	68	55	98
1995	32309	437	41	74	133
1996	41764	492	46	85	153
1997	46742	483	46	97	174
1998	51554	721	68	71	127
1999	47648	781	74	61	104
2000	48265	847	80	57	102

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	173
1999	53380	1570	78	34	155
2000	49847	1662	83	30	136

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**
1981	2.1	13.3	39.2	23.2	12.7	26.5	4.8	1.7	0.58	0.23
1982	3.3	20.8	24.5	28.4	14	7.7	11.5	1.9	0.33	0.09
1983	3.6	10.9	24.3	18.9	17.4	8.4	2.1	2.7	0.51	0.22
1984	6.8	31.6	19.4	15.3	8.1	7.3	2.7	0.5	0.54	0.2
1985	6.5	24.6	35.4	18.3	8.7	4.2	2.3	1.1	0.22	0.23
1986	20.6	20.3	26.6	30.8	11.4	4.4	1.8	0.8	0.39	0.1
1987	11	62.1	27.2	15.1	15.7	4.2	1.5	0.6	0.25	0.14
1988	6.7	39.3	55.9	18.7	6.4	5.9	1.3	0.5	0.3	0.16
1989	2.6	28	50.1	31.5	6	1.9	0.9	0.2	0.11	0.09
1990	5.8	12.3	27.2	44.5	17	2.6	0.6	0.3	0.12	0.05
1991	8.6	25.1	15.5	21.5	25	6.4	0.9	0.2	0.12	0.06
1992	12.2	21.7	26.5	11.4	10.1	8.3	2	0.3	0.05	0.03
1993	20.5	33.1	15.2	13.3	3.6	2.8	2.7	1.2	0.18	0.03
1994	6.2	24.1	19.7	7	4.4	1.3	0.6	0.5	0.28	0.05
1995	10.8	9.1	16.8	13.1	4.1	1.6	0.3	0.2	0.16	0.14
1996	5.4	14.9	7.4	12.3	9.4	2.2	0.8	0.2	0.08	0.06
1997	1.7	16.4	17.3	6.7	7.4	6	1.1	0.5	0.13	0.03
1998	3.5	7.7	25.4	20.2	5.9	3.9	3	0.5	0.2	0.06
1999	2.5	19.6	15.2	24.6	13	2.8	1.5	0.7	0.14	0.05
2000	10.5	6.6	29	11.2	11.4	5.7	1.1	0.6	0.31	0.07

Table 3.3.4. Cod at Iceland. Division Va. Proportion of fishing and natural mortality before spawning

Age	**F**	**M**
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	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
1981	1180	1651	2260	3293	4483	5821	7739	9422	11374	12784	12514	19069
1982	1006	1550	2246	3104	4258	5386	6682	9141	11963	14226	17287	16590
1983	1095	1599	2275	3021	4096	5481	7049	8128	11009	13972	15882	18498
1984	1288	1725	2596	3581	4371	5798	7456	9851	11052	14338	15273	16660
1985	1407	1971	2576	3650	4976	6372	8207	10320	12197	14683	16175	19050
1986	1459	1961	2844	3593	4635	6155	7503	9084	10356	15283	14540	15017
1987	1316	1956	2686	3894	4716	6257	7368	9243	10697	10622	15894	12592
1988	1438	1805	2576	3519	4930	6001	7144	8822	9977	11732	14156	13042
1989	1186	1813	2590	3915	5210	6892	8035	9831	11986	10003	12611	16045
1990	1290	1704	2383	3034	4624	6521	8888	10592	10993	14570	15732	17290
1991	1309	1899	2475	3159	3792	5680	7242	9804	9754	14344	14172	20200
1992	1289	1768	2469	3292	4394	5582	6830	8127	12679	13410	15715	11267
1993	1392	1887	2772	3762	4930	6054	7450	8641	10901	12517	14742	16874
1994	1443	2063	2562	3659	5117	6262	7719	8896	10847	12874	14742	17470
1995	1348	1959	2920	3625	5176	6416	7916	10273	11022	11407	13098	15182
1996	1457	1930	3132	4141	4922	6009	7406	9772	10539	13503	13689	16194
1997	1484	1877	2878	4028	5402	6386	7344	8537	10797	11533	10428	12788
1998	1230	1788	2477	3588	5013	7293	7843	9283	10976	15352	17718	16068
1999	1241	1716	2426	3443	4720	6352	8730	9946	11088	12535	14995	15151
2000	1308	1782	2330	3252	4690	5894	7809	9203	10240	11172	13172	17442

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
1981	967	1513	2101	3225	4520	5851	7661	9084	10833	12401	11724	14326
1982	996	1626	2095	3006	4339	5571	6801	9259	11550	13445	17138	16554
1983	891	1472	2139	2918	4130	5553	7007	7770	10817	13176	14175	18543
1984	1002	1479	2257	3476	4480	5887	7660	9920	11035	14531	15378	16394
1985	1131	1597	2285	3524	5010	6195	7800	9225	11336	13277	15325	18932
1986	1182	1762	2681	3562	4824	6457	7843	9419	10674	13660	13812	18479
1987	1289	1811	2735	4202	5110	6497	7802	10220	11197	10620	15893	16514
1988	1218	1604	2499	3566	5161	6238	7302	8647	10184	11504	14159	10952
1989	1012	1542	2423	3743	5298	6910	7725	9397	11953	9529	12195	14270
1990	813	1330	2132	3187	4691	6627	8915	10362	12093	15453	15337	17257
1991	1122	1776	2233	3044	3891	5897	7657	10573	11230	14340	14172	20200
1992	876	1389	2174	3185	4481	5587	6775	8225	11702	13474	15436	11267
1993	1037	1570	2518	3611	4872	6150	7538	8840	11088	12002	14402	18383
1994	1193	1748	2382	3684	5175	6210	7676	8814	10842	12595	14402	17470
1995	1066	1826	2735	3497	4741	6126	7582	9887	10829	11307	13098	15182
1996	1264	1627	2600	3829	4605	5792	7550	9433	11293	12984	13821	16194
1997	1221	1613	2595	3807	5434	6440	7629	8606	10486	11774	10943	15225
1998	1260	2018	2335	3529	5321	7731	8173	9397	10995	15274	17387	15069
1999	1068	1459	2231	3181	4743	6577	8561	10081	11200	12567	14995	15151
2000	1025	1498	2159	3236	4655	5957	7881	9458	10231	11736	13172	17442

Table 3.3.7 Cod at Iceland. Division Va. Maturity at age in the stock at spawning time.

Year /age	3	4	5	6	7	8	9	10	11	12	13	14
1981	0.00	0.03	0.09	0.29	0.66	0.89	0.95	0.96	0.99	1.00	1.00	1.00
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	0.04	0.24	0.49	0.67	0.82	0.93	0.98	0.96	1.00	1.00	1.00	1.00

Table 3.3.8. Cod at Iceland. Division Va. Bottom trawl CPUE(GLM) indices

June-Dec. northern area:

Year/age	4	5	6	7
1995	471	1101	831	143
1996	878	545	650	358
1997	1352	849	286	217
1998	384	1266	989	243
1999	844	558	743	381
2000	336	828	287	195

Jan.--May. northern area:

Year/age	4	5	6	7	8	9
1995	248	1488	1211	286	57	10
1996	1217	655	1200	562	102	26
1997	1048	1331	493	483	413	26
1998	347	2235	1629	515	202	126
1999	630	797	2195	712	100	39
2000	214	1840	819	605	234	39

Jan.-May. southern area:

Year/age	5	6	7	8
1995	409	449	278	143
1996	208	593	500	137
1997	509	361	408	237
1998	717	919	493	275
1999	333	1247	680	165
2000	629	405	709	328

June-Dec. southern area:

Year/age	5	6	7	8
1995	594	366	106	64
1996	355	446	226	51
1997	772	380	251	149
1998	1043	670	212	80
1999	368	541	468	129
2000	572	253	267	94

Table 3.3.9 Cod at Iceland. Division Va. Gillnet CPUE(GLM)

Year/age	8	9
1995	122	55
1996	176	57
1997	363	126
1998	234	108
1999	102	24
2000	295	42

Table 3.3.10 Cod at Iceland. Division Va. Groundfish Survey indices as used in the XSA tuning from last year (Default run)

Northern area:

year/age	4	5	6	7	8
1984	55261	48059	13027	6211	1990
1985	22540	18404	17203	4864	1388
1986	77227	15257	7551	7364	1453
1987	92490	49378	5573	2906	2306
1988	60113	46566	18693	1665	545
1989	8272	15722	18464	6501	456
1990	22262	8102	8772	9355	1242
1991	13601	9542	2499	2303	1347
1992	31684	9441	5124	1100	672
1993	18211	13369	2675	1550	263
1994	4301	11353	7088	1330	417
1995	19228	6083	6923	6599	1160
1996	48173	23365	5898	5422	3004
1997	13959	48786	20710	5656	2806
1998	35495	7683	12466	5233	811
1999	4451	20382	4670	3675	1447
2000	27378	2346	7292	1763	907

Northern area:
age 3 on age 3:

Year/age	3
1985	31297
1986	84656
1987	99294
1988	68604
1989	17511
1990	19408
1991	15633
1992	30540
1993	26030
1994	5556
1995	17477
1996	37466
1997	11969
1998	28949
1999	5985
2000	54472

Table 3.3.10 (Continued)

Northern area:
age 2 on age 3:

Year/age	3
1986	39301
1987	52943
1988	25874
1989	5820
1990	14921
1991	11786
1992	14473
1993	16407
1994	2237
1995	10539
1996	28480
1997	3869
1998	18566
1999	3570
2000	31265

South-eastern area:

Year/age	4	5	6	7
1984	561	470	524	373
1985	686	1171	608	294
1986	404	391	842	286
1987	3153	519	333	385
1988	4474	3858	619	274
1989	419	1673	1762	265
1990	114	324	1104	396
1991	511	309	763	1087
1992	391	361	146	163
1993	1189	356	321	79
1994	1943	2084	619	300
1995	460	1056	1654	502
1996	860	358	582	561
1997	3397	1605	624	615
1998	637	1591	915	214
1999	2437	632	889	525
2000	137	638	274	223

Table 3.3.10 (Continued)

South western area:

Year/age	3	4	5	6	7	8
1984	1723	4444	2588	1911	813	417
1985	1413	2203	2968	1310	535	232
1986	4003	1266	1190	1656	410	104
1987	3929	5935	1144	860	873	102
1988	5857	9371	5845	812	296	224
1989	1702	6149	8867	4150	409	113
1990	3044	2560	4625	7491	1556	193
1991	1088	2019	1016	1702	2172	387
1992	4112	1935	1664	420	359	255
1993	4366	3533	851	573	114	66
1994	1298	4397	3538	866	355	22
1995	3829	1958	3133	3764	804	181
1996	3785	3024	1181	1655	1554	126
1997	911	5132	3131	1182	895	537
1998	3820	1874	5897	3780	851	317
1999	619	4485	1550	2267	1375	121
2000	4005	439	1802	549	310	140

Table 3.3.11 CPUE from bottom trawl survey 1985-2001 as used in the TSA runs. Weighted geometric mean of North and South (stratified mean) areas.

Year/age	3	4	5	6	7	8	9
1985	138513	138145	136149	54912	24321	10332	6708
1986	349824	71165	58520	61797	16258	4299	1930
1987	386888	235396	47503	30323	22357	6274	1759
1988	249235	296276	168768	21151	11036	9150	1417
1989	72154	228764	182019	93292	11345	3356	2047
1990	110380	30088	81137	94280	33517	4043	1384
1991	66237	87470	41690	51565	60362	10753	1975
1992	153667	71264	43309	16565	16944	17231	3845
1993	228120	160917	44700	25978	5204	5373	2792
1994	65772	120188	63839	15109	8057	1669	1526
1995	136617	43636	74159	45030	8945	3667	847
1996	209250	108567	36564	40339	32208	6111	2238
1997	79306	152925	69680	24090	18568	9952	926
1998	118115	41655	125619	63296	13091	10053	7271
1999	31469	108613	34094	64787	27859	6800	2578
2000	197057	27621	82516	22163	19242	12574	1217
2001	191420	131144	14930	38548	7285	4036	2067

Table 3.3.12. CPUE from bottom trawl survey 1985-2001 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
1985	16.63	112.37	35.39	48.19	64.82	22.97	15.30	5.05	3.40
1986	15.10	61.06	95.74	22.49	21.54	27.49	7.19	2.80	0.94
1987	3.80	29.07	104.05	83.46	21.73	13.00	13.15	2.82	1.00
1988	3.50	7.57	72.79	104.98	71.00	8.56	6.51	7.04	0.68
1989	4.15	17.32	22.36	80.13	74.62	39.41	4.88	1.73	1.43
1990	5.59	12.10	26.71	14.29	27.93	35.30	16.78	1.77	0.59
1991	3.97	16.81	18.42	30.16	15.92	19.42	22.78	4.81	0.95
1992	0.81	19.04	32.44	19.05	16.71	6.95	6.36	5.73	1.48
1993	3.60	4.95	35.55	39.28	13.48	10.58	2.45	2.17	1.41
1994	14.39	16.12	8.47	27.03	23.45	6.15	4.23	0.85	0.62
1995	1.19	29.25	26.16	9.36	24.98	18.35	3.96	1.89	0.37
1996	3.72	5.47	41.59	27.82	12.66	15.16	14.01	3.32	1.03
1997	1.23	22.64	13.68	56.47	29.29	9.79	8.98	6.29	0.46
1998	8.17	5.77	30.16	16.01	61.45	28.16	6.49	5.45	3.39
1999	7.41	34.49	7.44	43.75	13.37	24.63	11.52	2.43	1.38
2000	18.54	28.78	55.92	7.27	31.13	8.58	8.51	4.41	0.49
2001	11.97	24.14	37.06	38.32	5.14	15.89	3.43	2.04	0.81

Table 3.3.13. Cod at Iceland. Division Va. Default XSA run using same tuning fleets as last year. Diagnostic and resulting estimates.

ICELANDIC COD. DEFAULT-2000

12/04/2001 12:08

Extended Survivors Analysis

" ""ICELANDIC COD (Div. Va); data from 1971-2000(4/2001)"" "

CPUE data from file codvarnt.dat

Catch data for 29 years. 1972 to 2000. Ages 3 to 14.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SMB. N.	1984	2000	3	7	0.99	1
SMB. a3 on a3. N	1985	2000	3	3	0.17	0.25
SMB. a2 on a3. N.	1986	2000	3	3	0.17	0.25
SMB. SE	1984	2000	4	7	0.99	1
SMB. SW.	1984	2000	3	8	0.99	1
TRAWL-JUN-DEC-N	1995	2000	4	7	0.42	1
TRAWL-JAN-MAY-N	1995	2000	4	9	0	0.42
TRAWL-JAN-MAY-S	1995	2000	5	8	0	0.42
GILLNET-JAN-MAY-S	1995	2000	8	9	0	0.42
TRAWL-JUN-DEC-S	1995	2000	5	8	0.42	1

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 >= 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 had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00040

1

Regression weights

0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	0.097	0.08	0.166	0.094	0.075	0.035	0.023	0.025	0.049	0.06
4	0.311	0.378	0.323	0.3	0.196	0.142	0.142	0.139	0.191	0.173
5	0.505	0.635	0.498	0.324	0.354	0.241	0.244	0.339	0.445	0.479
6	0.773	0.894	0.782	0.449	0.372	0.477	0.361	0.499	0.649	0.699
7	0.948	1.1	0.807	0.652	0.526	0.506	0.594	0.628	0.709	0.723
8	0.786	1.023	1.129	0.758	0.524	0.585	0.709	0.73	0.705	0.808
9	0.779	0.617	1.236	0.798	0.423	0.582	0.726	0.979	0.707	0.679
10	0.881	0.528	0.95	0.821	0.612	0.558	0.841	0.839	0.723	0.649
11	0.964	0.396	0.903	0.624	0.649	0.555	0.804	1.022	0.597	0.782
12	0.844	0.709	0.576	0.67	0.749	0.626	0.406	1.074	0.713	0.748
13	0.356	0.263	0.567	0.701	1.169	0.758	0.927	1.279	0.559	0.935
14	0.769	0.478	0.757	0.71	0.802	0.63	0.752	1.066	0.654	0.796

1

Table 3.3.13 (Continued)

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10	11	12
1991	1.03E+05	1.04E+05	4.32E+04	4.42E+04	4.52E+04	1.29E+04	1.84E+03	4.59E+02	2.23E+02	1.22E+02
1992	1.75E+05	7.63E+04	6.24E+04	2.13E+04	1.67E+04	1.43E+04	4.82E+03	6.93E+02	1.56E+02	6.97E+01
1993	1.48E+05	1.32E+05	4.28E+04	2.71E+04	7.15E+03	4.55E+03	4.22E+03	2.13E+03	3.34E+02	8.58E+01
1994	7.59E+04	1.03E+05	7.85E+04	2.13E+04	1.01E+04	2.61E+03	1.20E+03	1.00E+03	6.74E+02	1.11E+02
1995	1.64E+05	5.65E+04	6.24E+04	4.65E+04	1.11E+04	4.32E+03	1.00E+03	4.44E+02	3.61E+02	2.96E+02
1996	1.74E+05	1.24E+05	3.80E+04	3.58E+04	2.63E+04	5.38E+03	2.10E+03	5.38E+02	1.97E+02	1.54E+02
1997	8.22E+04	1.38E+05	8.84E+04	2.45E+04	1.82E+04	1.30E+04	2.46E+03	9.58E+02	2.52E+02	9.27E+01
1998	1.56E+05	6.58E+04	9.77E+04	5.67E+04	1.40E+04	8.23E+03	5.22E+03	9.73E+02	3.38E+02	9.23E+01
1999	5.86E+04	1.24E+05	4.69E+04	5.70E+04	2.82E+04	6.10E+03	3.25E+03	1.61E+03	3.44E+02	9.97E+01
2000	1.98E+05	4.57E+04	8.42E+04	2.46E+04	2.44E+04	1.14E+04	2.47E+03	1.31E+03	6.38E+02	1.55E+02

Estimated population abundance at 1st Jan 2001

0.00E+00 1.52E+05 3.14E+04 4.27E+04 1.00E+04 9.70E+03 4.15E+03 1.02E+03 5.60E+02 2.39E+02

Taper weighted geometric mean of the VPA populations:

1.31E+05 9.88E+04 6.96E+04 3.83E+04 1.81E+04 6.95E+03 2.43E+03 9.12E+02 3.47E+02 1.36E+02

Standard error of the weighted Log(VPA populations) :

0.4502 0.4545 0.4094 0.4804 0.5188 0.5353 0.5436 0.5194 0.4978 0.5208

YEAR	AGE 13	14
1991	4.06E+01	2.47E+01
1992	4.30E+01	2.33E+01
1993	2.81E+01	2.71E+01
1994	3.95E+01	1.30E+01
1995	4.65E+01	1.60E+01
1996	1.14E+02	1.18E+01
1997	6.77E+01	4.39E+01
1998	5.05E+01	2.19E+01
1999	2.58E+01	1.15E+01
2000	4.00E+01	1.21E+01

Estimated population abundance at 1st Jan 2001

6.02E+01 1.29E+01

Taper weighted geometric mean of the VPA populations:

5.55E+01 2.26E+01

Standard error of the weighted Log(VPA populations) :

0.5988 0.6935

1

Log catchability residuals.

Fleet : SMB. N.

Age	1984	1985	1986	1987	1988	1989	1990
3	0.5	-0.03	-0.18	0.09	0.35	-0.05	0.05
4	0.12	0.14	-0.05	-0.15	-0.08	-0.17	0.13
5	0.37	0.27	0.24	-0.23	0.23	-0.09	0.03
6	0.5	0.15	0.31	0.26	-0.41	-0.03	0.06
7	0.44	0.18	0.33	0.62	0.04	-0.47	-0.4
8	No data for this fleet at this age						
9	No data for this fleet at this age						

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	0.06	-0.01	-0.11	-0.28	-0.23	0.2	0.25	0.14	-0.03	-0.23
4	-0.18	0.16	-0.22	-0.08	0.11	0.06	0.38	0.06	0.01	-0.24
5	-0.5	-0.02	-0.43	-0.24	0	0.22	0.64	0.12	-0.02	-0.12
6	-0.34	-0.23	-0.24	-0.48	0.26	0.43	0.74	-0.04	-0.25	-0.1
7	-0.43	0.03	-0.36	-0.4	0.41	0.48	0.87	-0.08	-0.12	-0.43
8	No data for this fleet at this age									
9	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	5	6	7
Mean Log q	-1.6477	-1.6436	-1.9449

S.E(Log q) 0.2986 0.3601 0.4439

Table 3.3.13 (Continued)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.56	3.226	6.12	0.84	17	0.2	-1.64
4	0.57	3.416	5.83	0.86	17	0.19	-1.6

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.8	1.162	3.55	0.77	17	0.24	-1.65
6	0.96	0.178	2	0.66	17	0.36	-1.64
7	0.98	0.091	2.13	0.59	17	0.45	-1.94

1

Fleet : SMB. a3 on a3. N

Age		1984	1985	1986	1987	1988	1989	1990	
3	99.99		0.11	-0.14		0.13	0.42	0.31	-0.09
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								

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000				
3	0.05	-0.09		-0.01		-0.27		-0.36		0.04	0.1	-0.01		0.03	0.13
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														

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.6	3.026	5.77	0.85	16	0.2	-1.74

1

Fleet : SMB. a2 on a3. N.

Age		1984	1985	1986	1987	1988	1989	1990		
3	99.99		99.99		-0.31		0.03	0.16	0.06	0.11
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									

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000			
3	0.25	-0.18		0.06	-0.34		-0.28		0.19	-0.14		0.06	0.16	0.11
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													

Table 3.3.13 (Continued)

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.54	3.392	6.73	0.85	15	0.2	-2.36

1

Fleet : SMB. SE

Age	1984	1985	1986	1987	1988	1989	1990
3	No data for this fleet at this age						
4	-0.81	-0.14	-0.49	-0.19	0.1	-0.61	-0.61
5	-0.68	-0.15	-0.45	-0.34	0.92	-0.22	-1
6	-0.3	-0.25	-0.19	-0.23	0.28	0.34	-0.4
7	-0.12	-0.25	-0.18	-0.05	0.48	0.1	-0.43
8	No data for this fleet at this age						
9	No data for this fleet at this age						

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	-0.23	-0.03	-0.03	0.47	0.26	-0.23	0.39	0.25	0.34	-0.17
5	-0.32	-0.4	-0.18	0.81	0.39	-0.31	0.35	0.33	0.25	-0.29
6	0.23	-0.58	-0.14	0.42	0.55	-0.13	0.21	-0.12	0	-0.29
7	0.48	-0.27	-0.44	0.39	0.69	-0.08	0.47	-0.29	-0.02	-0.71
8	No data for this fleet at this age									
9	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	5	6	7
Mean Log q	-3.9162	-3.3169	-3.0636
S.E(Log q)	0.4981	0.3306	0.4341

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.52	1.948	7.78	0.63	17	0.37	-4.41

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.75	0.89	5.71	0.56	17	0.38	-3.92
6	0.98	0.097	3.47	0.69	17	0.34	-3.32
7	1.12	-0.42	2.23	0.53	17	0.51	-3.06

1

Fleet : SMB. SW.

Age	1984	1985	1986	1987	1988	1989	1990
3	-0.31	-0.49	-0.59	-0.44	0.35	0.18	0.14
4	-0.29	-0.21	-0.69	-0.36	0.06	0.3	0.35
5	-0.1	-0.34	-0.46	-0.67	0.21	0.33	0.54
6	0.11	-0.36	-0.39	-0.16	-0.33	0.31	0.64
7	0	-0.32	-0.48	0.1	-0.11	-0.13	0.28
8	0.38	0.05	-0.45	-0.3	0.72	0.38	0.52
9	No data for this fleet at this age						

Table 3.3.13 (Continued)

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000			
3	-0.29		0.1	0.36	0.14	0.11	0.01	-0.24		0.12	-0.15		-0.06	
4	-0.21		0.12	-0.04		0.35	0.3	-0.22		0.06	0.08	0.1	-0.56	
5	-0.25		0	-0.43		0.22	0.36	-0.24		-0.1	0.52	0.03	-0.37	
6	0.15	-0.4	-0.44		-0.12		0.49	0.04	-0.03		0.43	0.06	-0.47	
7	0.51	-0.15		-0.74		-0.1	0.5	0.28	0.18	0.43	0.28	-1.05		
8	0.25	-0.03		-0.13		-1.05		0.32	-0.2	0.5	0.45	-0.24		-0.62
9	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	5	6	7	8
Mean Log q	-2.7948	-2.4387	-2.4003	-2.7773
S.E(Log q)	0.3546	0.3609	0.4819	0.4971

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
3	0.7	1.788	6.16	0.78	17	0.25	-3.74
4	0.71	1.417	5.59	0.7	17	0.31	-3.16

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.72	1.569	5.11	0.76	17	0.24	-2.79
6	0.64	3.457	5.33	0.9	17	0.16	-2.44
7	0.8	0.896	3.9	0.66	17	0.39	-2.4
8	0.77	1.071	4.18	0.68	17	0.38	-2.78

1

Fleet : TRAWL-JUN-DEC-N

Age		1991	1992	1993	1994	1995	1996	1997	1998	1999	2000						
3	No data for this fleet at this age																
4	99.99		99.99		99.99		99.99		0.16	-0.09		0.21	-0.22		-0.09		0.04
5	99.99		99.99		99.99		99.99		0.36	0.07	-0.33		0.04	0.02	-0.14		
6	99.99		99.99		99.99		99.99		0.1	0.19	-0.33		0.17	-0.02		-0.1	
7	99.99		99.99		99.99		99.99		-0.04		0.01	-0.07		0.34	0.14	-0.38	
8	No data for this fleet at this age																
9	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	5	6	7
Mean Log q	-4.004	-3.7255	-3.8084
S.E(Log q)	0.2279	0.1969	0.2383

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.93	0.415	5.13	0.89	6	0.19	-4.65

Table 3.3.13 (Continued)

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	1.34	-0.923	1.6	0.66	6	0.31	-4
6	0.75	1.781	5.45	0.93	6	0.12	-3.73
7	1.21	-0.555	2.55	0.65	6	0.31	-3.81

1

Fleet : TRAWL-JAN-MAY-N

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	99.99	99.99	99.99	99.99	-0.06	0.22	0.02	0	-0.22	0.05
5	99.99	99.99	99.99	99.99	0.21	-0.14	-0.27	0.17	-0.11	0.15
6	99.99	99.99	99.99	99.99	-0.15	0.12	-0.41	-0.03	0.3	0.16
7	99.99	99.99	99.99	99.99	-0.04	-0.23	0	0.34	-0.03	-0.04
8	99.99	99.99	99.99	99.99	-0.45	-0.08	0.46	0.21	-0.2	0.05
9	99.99	99.99	99.99	99.99	-0.36	-0.11	-0.24	0.64	-0.11	0.15

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
Mean Log q	-3.8323	-3.3802	-3.468	-3.7257	-4.1238
S.E(Log q)	0.1996	0.2536	0.1857	0.3198	0.3575

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
4	0.68	2.118	7.08	0.92	6	0.16	-5.06

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
5	0.85	0.687	4.9	0.85	6	0.18	-3.83
6	0.8	0.798	4.78	0.81	6	0.21	-3.38
7	1.34	-1.177	1.29	0.75	6	0.24	-3.47
8	0.61	3.639	5.77	0.96	6	0.1	-3.73
9	0.65	2.73	5.41	0.94	6	0.15	-4.12

1

Fleet : TRAWL-JAN-MAY-S

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	0	-0.21	-0.15	0.11	0.1	0.15
6	99.99	99.99	99.99	99.99	-0.5	0.06	-0.08	0.04	0.37	0.1
7	99.99	99.99	99.99	99.99	-0.03	-0.31	-0.13	0.33	-0.03	0.16
8	99.99	99.99	99.99	99.99	0.17	-0.08	-0.39	0.22	0	0.09
9	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

Table 3.3.13 (Continued)

Age	5	6	7	8
Mean Log q	-4.911	-4.0196	-3.5084	-3.428
S.E(Log q)	0.1494	0.2848	0.2238	0.2202

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	0.86	0.874	5.76	0.91	6	0.13	-4.91
6	0.93	0.218	4.5	0.69	6	0.29	-4.02
7	1.28	-0.779	1.72	0.66	6	0.3	-3.51
8	1.31	-1.03	1.74	0.74	6	0.29	-3.43
1							

Fleet : GILLNET-JAN-MAY-S

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
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	99.99	99.99	99.99	99.99	0.05	0.21	0.08	0.1	-0.44	0.02
9	99.99	99.99	99.99	99.99	0.78	0.11	0.77	-0.09	-1.17	-0.34

Mean log catchability and standard error of ages with catchability

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

Age	8	9
Mean Log q	-3.4674	-3.5509
S.E(Log q)	0.227	0.7367

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
8	0.94	0.237	3.79	0.81	6	0.24	-3.47
9	3.99	-1.301	-9.18	0.05	6	2.75	-3.55
1							

Fleet : TRAWL-JUN-DEC-S

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	No data for this fleet at this age									
4	No data for this fleet at this age									
5	99.99	99.99	99.99	99.99	0.09	-0.01	-0.07	0.19	-0.04	-0.16
6	99.99	99.99	99.99	99.99	-0.43	0.1	0.24	0.06	-0.05	0.06
7	99.99	99.99	99.99	99.99	-0.3	-0.42	0.11	0.23	0.38	-0.03
8	99.99	99.99	99.99	99.99	0.12	-0.29	-0.01	-0.16	0.6	-0.27
9	No data for this fleet at this age									

Table 3.3.13 (Continued)

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	-4.3557	-4.0128	-3.8433	-3.8252
S.E(Log q)	0.126	0.2278	0.3087	0.3345

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	0.96	0.245	4.62	0.91	6	0.13	-4.36
6	1.41	-1.134	1.33	0.66	6	0.31	-4.01
7	0.89	0.311	4.53	0.66	6	0.3	-3.84
8	1.32	-0.657	2.18	0.51	6	0.47	-3.83

1

Terminal year survivor and F summaries :

Age 3 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	121601	0.3	0	0	1	0.206	0.075
SMB. a3 on a3. N	174291	0.3	0	0	1	0.206	0.053
SMB. a2 on a3. N.	170112	0.3	0	0	1	0.206	0.054
SMB. SE	1	0	0	0	0	0	
SMB. SW.	143908	0.3	0	0	1	0.206	0.064
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
P shrinkage mean	98781	0.45				0.095	0.092
F shrinkage mean	287323	0.5				0.079	0.032

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
152491	0.14	0.12	6	0.846	0.06

1

Age 4 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	27405	0.212	0.105	0.49	2	0.218	0.196
SMB. a3 on a3. N	32312	0.3	0	0	1	0.106	0.169
SMB. a2 on a3. N.	37009	0.3	0	0	1	0.106	0.149
SMB. SE	26470	0.425	0	0	1	0.056	0.202
SMB. SW.	23143	0.239	0.198	0.83	2	0.17	0.228
TRAWL-JUN-DEC-N	32815	0.3	0	0	1	0.112	0.166
TRAWL-JAN-MAY-N	32944	0.3	0	0	1	0.112	0.166
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0
P shrinkage mean	69627	0.41				0.071	0.082
F shrinkage mean	34775	0.5				0.048	0.158

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
31443	0.1	0.09	11	0.917	0.173

Table 3.3.13 (Continued)

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

Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	42710	0.176	0.076	0.43	3	0.192	0.479
SMB. a3 on a3. N	42230	0.3	0	0	1	0.06	0.483
SMB. a2 on a3. N.	45542	0.3	0	0	1	0.06	0.455
SMB. SE	46148	0.318	0.313	0.98	2	0.06	0.45
SMB. SW.	41087	0.191	0.158	0.83	3	0.161	0.494
TRAWL-JUN-DEC-N	37842	0.213	0.024	0.11	2	0.137	0.527
TRAWL-JAN-MAY-N	41884	0.213	0.184	0.86	2	0.137	0.486
TRAWL-JAN-MAY-S	49768	0.3	0	0	1	0.075	0.424
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	36364	0.3	0	0	1	0.075	0.543
F shrinkage mean	63831	0.5				0.044	0.344

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
42678	0.08	0.05	17	0.588	0.479

1

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

Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	10430	0.164	0.075	0.46	4	0.154	0.679
SMB. a3 on a3. N	11060	0.302	0	0	1	0.036	0.65
SMB. a2 on a3. N.	8736	0.302	0	0	1	0.036	0.77
SMB. SE	9428	0.238	0.187	0.79	3	0.087	0.73
SMB. SW.	8325	0.176	0.13	0.74	4	0.136	0.796
TRAWL-JUN-DEC-N	9119	0.179	0.064	0.36	3	0.145	0.747
TRAWL-JAN-MAY-N	10444	0.179	0.082	0.46	3	0.145	0.678
TRAWL-JAN-MAY-S	11020	0.22	0	0	2	0.105	0.652
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	10242	0.217	0.05	0.23	2	0.108	0.688
F shrinkage mean	15353	0.5				0.048	0.507

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10014	0.07	0.04	24	0.574	0.699

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	9479	0.167	0.153	0.92	5	0.126	0.735
SMB. a3 on a3. N	10046	0.304	0	0	1	0.022	0.705
SMB. a2 on a3. N.	11674	0.304	0	0	1	0.022	0.632
SMB. SE	8093	0.229	0.259	1.13	4	0.083	0.82
SMB. SW.	8448	0.179	0.268	1.5	5	0.11	0.796
TRAWL-JUN-DEC-N	8436	0.167	0.131	0.79	4	0.161	0.797
TRAWL-JAN-MAY-N	10519	0.167	0.081	0.48	4	0.161	0.682
TRAWL-JAN-MAY-S	11891	0.19	0.072	0.38	3	0.136	0.623
GILLNET-JAN-MAY-S	1	0	0	0	0	0	0
TRAWL-JUN-DEC-S	9822	0.195	0.068	0.35	3	0.124	0.716
F shrinkage mean	11238	0.5				0.054	0.65

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9696	0.07	0.06	31	0.802	0.723

1

Table 3.3.13 (Continued)

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	4473	0.161	0.155	0.96	5	0.084	0.767
SMB. a3 on a3. N	2903	0.307	0	0	1	0.015	1.021
SMB. a2 on a3. N.	3125	0.307	0	0	1	0.015	0.975
SMB. SE	3960	0.218	0.095	0.44	4	0.054	0.834
SMB. SW.	3786	0.19	0.172	0.9	6	0.102	0.859
TRAWL-JUN-DEC-N	4227	0.16	0.109	0.68	4	0.103	0.797
TRAWL-JAN-MAY-N	4137	0.165	0.06	0.37	5	0.167	0.809
TRAWL-JAN-MAY-S	4246	0.176	0.046	0.26	4	0.17	0.795
GILLNET-JAN-MAY-S	4234	0.3	0	0	1	0.085	0.797
TRAWL-JUN-DEC-S	4066	0.188	0.149	0.79	4	0.137	0.819
F shrinkage mean	4874	0.5				0.068	0.722

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4149	0.07	0.04	36	0.515	0.808

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

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	1200	0.161	0.169	1.05	5	0.077	0.604
SMB. a3 on a3. N	782	0.313	0	0	1	0.013	0.822
SMB. a2 on a3. N.	729	0.313	0	0	1	0.013	0.862
SMB. SE	1018	0.216	0.15	0.69	4	0.049	0.682
SMB. SW.	1050	0.183	0.113	0.62	6	0.089	0.667
TRAWL-JUN-DEC-N	1109	0.159	0.152	0.96	4	0.094	0.641
TRAWL-JAN-MAY-N	1028	0.172	0.105	0.61	6	0.224	0.678
TRAWL-JAN-MAY-S	1069	0.169	0.104	0.61	4	0.143	0.659
GILLNET-JAN-MAY-S	674	0.293	0.04	0.14	2	0.085	0.907
TRAWL-JUN-DEC-S	1437	0.181	0.13	0.72	4	0.117	0.527
F shrinkage mean	795	0.5				0.095	0.812

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1025	0.08	0.05	38	0.619	0.679

1

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

Year class = 1990

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	739	0.172	0.192	1.11	5	0.063	0.526
SMB. a3 on a3. N	556	0.32	0	0	1	0.009	0.653
SMB. a2 on a3. N.	597	0.32	0	0	1	0.009	0.619
SMB. SE	706	0.228	0.164	0.72	4	0.044	0.546
SMB. SW.	751	0.199	0.067	0.34	6	0.076	0.52
TRAWL-JUN-DEC-N	618	0.186	0.122	0.66	3	0.073	0.603
TRAWL-JAN-MAY-N	579	0.188	0.07	0.37	5	0.204	0.633
TRAWL-JAN-MAY-S	607	0.174	0.084	0.48	4	0.137	0.612
GILLNET-JAN-MAY-S	462	0.295	0.532	1.81	2	0.085	0.746
TRAWL-JUN-DEC-S	559	0.186	0.075	0.4	4	0.111	0.651
F shrinkage mean	411	0.5				0.19	0.809

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
560	0.11	0.05	36	0.452	0.649

Table 3.3.13 (Continued)

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

Year class = 1989

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	256	0.172	0.144	0.84	5	0.053	0.744
SMB. a3 on a3. N	218	0.331	0	0	1	0.008	0.831
SMB. a2 on a3. N.	199	0.331	0	0	1	0.008	0.884
SMB. SE	317	0.226	0.2	0.88	4	0.037	0.639
SMB. SW.	324	0.191	0.087	0.46	6	0.062	0.629
TRAWL-JUN-DEC-N	250	0.22	0.046	0.21	2	0.047	0.757
TRAWL-JAN-MAY-N	327	0.197	0.214	1.09	4	0.14	0.624
TRAWL-JAN-MAY-S	162	0.188	0.047	0.25	3	0.093	1.01
GILLNET-JAN-MAY-S	248	0.295	0.07	0.24	2	0.061	0.761
TRAWL-JUN-DEC-S	188	0.206	0.146	0.71	3	0.074	0.92
F shrinkage mean	225	0.5				0.418	0.816

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
239	0.21	0.05	32	0.237	0.782

1

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

Year class = 1988

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	56	0.187	0.188	1.01	5	0.041	0.787
SMB. a3 on a3. N	63	0.346	0	0	1	0.005	0.723
SMB. a2 on a3. N.	77	0.346	0	0	1	0.005	0.625
SMB. SE	91	0.239	0.17	0.71	4	0.031	0.553
SMB. SW.	57	0.21	0.132	0.63	6	0.051	0.78
TRAWL-JUN-DEC-N	58	0.307	0	0	1	0.026	0.768
TRAWL-JAN-MAY-N	52	0.219	0.061	0.28	3	0.11	0.826
TRAWL-JAN-MAY-S	56	0.223	0.024	0.11	2	0.072	0.783
GILLNET-JAN-MAY-S	83	0.292	0.227	0.78	2	0.057	0.591
TRAWL-JUN-DEC-S	45	0.258	0.008	0.03	2	0.052	0.913
F shrinkage mean	61	0.5				0.55	0.738

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
60	0.28	0.04	28	0.132	0.748

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

Year class = 1987

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	10	0.215	0.081	0.38	5	0.013	1.075
SMB. a3 on a3. N	12	0.367	0	0	1	0.001	0.992
SMB. a2 on a3. N.	14	0.367	0	0	1	0.001	0.872
SMB. SE	14	0.265	0.174	0.65	4	0.01	0.886
SMB. SW.	13	0.251	0.126	0.5	6	0.019	0.917
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0
TRAWL-JAN-MAY-N	10	0.271	0.172	0.63	2	0.04	1.096
TRAWL-JAN-MAY-S	15	0.307	0	0	1	0.022	0.837
GILLNET-JAN-MAY-S	14	0.293	0.023	0.08	2	0.028	0.899
TRAWL-JUN-DEC-S	14	0.37	0	0	1	0.015	0.864
F shrinkage mean	13	0.5				0.85	0.932

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13	0.43	0.02	24	0.047	0.935

Table 3.3.13 (Continued)

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

Year class = 1986

Fleet		Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. N.	3	0.222	0.098	0.44	5	0.008	0.946	
SMB. a3 on a3. N	6	0.394	0	0	1	0.001	0.639	
SMB. a2 on a3. N.	5	0.394	0	0	1	0.001	0.762	
SMB. SE	3	0.282	0.05	0.18	4	0.006	1.095	
SMB. SW.	2	0.273	0.207	0.76	6	0.013	1.201	
TRAWL-JUN-DEC-N	1	0	0	0	0	0	0	
TRAWL-JAN-MAY-N	3	0.396	0	0	1	0.022	1.007	
TRAWL-JAN-MAY-S	1	0	0	0	0	0	0	
GILLNET-JAN-MAY-S	10	0.816	0	0	1	0.005	0.445	
TRAWL-JUN-DEC-S	1	0	0	0	0	0	0	
F shrinkage mean	5	0.5		0.944	0.786			

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
4	0.47	0.07	20	0.159	0.796

1
Summary   (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 3	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 5-10,
1972,	136518,	1124760,	400870,	398528,	.9942,	.8375,	.7061,
1973,	303382,	1363776,	455186,	383446,	.8424,	1.0386,	.7059,
1974,	170676,	1250091,	337449,	374770,	1.1106,	1.0180,	.7456,
1975,	265502,	1281893,	347985,	370991,	1.0661,	1.0171,	.7971,
1976,	432345,	1475659,	293374,	347849,	1.1857,	1.0046,	.7587,
1977,	144740,	1456137,	328968,	340050,	1.0337,	.9999,	.6319,
1978,	223765,	1626974,	415771,	330390,	.7946,	1.0024,	.4568,
1979,	248027,	1769684,	572399,	368064,	.6430,	1.0044,	.3877,
1980,	145475,	1804011,	651167,	434344,	.6670,	1.0049,	.4387,
1981,	144763,	1388613,	399103,	468659,	1.1743,	1.0078,	.6785,
1982,	135055,	1148193,	276778,	388387,	1.4032,	1.0219,	.7757,
1983,	229014,	987718,	218814,	300056,	1.3713,	1.0067,	.7808,
1984,	140579,	988375,	224347,	283822,	1.2651,	1.0064,	.6225,
1985,	145627,	1015169,	273893,	325267,	1.1876,	1.0057,	.6558,
1986,	339191,	1252831,	275547,	368633,	1.3378,	1.0105,	.7763,
1987,	283147,	1412966,	258908,	392257,	1.5150,	1.0060,	.8247,
1988,	170468,	1231540,	195549,	378076,	1.9334,	1.0014,	.9666,
1989,	83941,	1350606,	358357,	355954,	.9933,	1.2851,	.6177,
1990,	133349,	928713,	347900,	335390,	.9640,	1.0002,	.7178,
1991,	102597,	808919,	234804,	308560,	1.3141,	1.0026,	.7788,
1992,	175317,	667097,	250053,	267718,	1.0706,	1.0109,	.7994,
1993,	148282,	689772,	223365,	251979,	1.1281,	1.0051,	.9004,
1994,	75850,	634418,	262740,	178808,	.6806,	1.0038,	.6337,
1995,	163916,	713898,	340660,	169404,	.4973,	1.0048,	.4685,
1996,	173866,	841784,	285536,	181656,	.6362,	1.0053,	.4915,
1997,	82246,	860465,	372465,	203366,	.5460,	1.0013,	.5791,
1998,	155803,	948027,	309535,	242566,	.7836,	.9942,	.6690,
1999,	58558,	753366,	342781,	260053,	.7587,	.9996,	.6564,
2000,	197821,	757159,	261281,	235083,	.8997,	1.0025,	.6729,
Arith. Mean	179649,	1121814,	328124,	318763,	1.0275		.6791,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 3.3.14. Cod at Iceland. Division Va. TSA-results

Estimated stock in numbers and total biomass

Year/age	4	5	6	7	8	9	10	11	BIOM(4-11)
1985	108393.	123064.	44426.	19315.	7620.	4860.	1854.	369.	901.0
1986	107761.	65805.	67021.	20486.	7811.	2883.	1752.	663.	826.7
1987	257722.	68984.	31153.	26715.	6938.	2448.	892.	557.	1012.3
1988	247570.	153929.	32858.	11666.	8295.	1996.	698.	255.	1089.3
1989	133290.	163005.	76384.	11920.	3405.	1823.	448.	161.	1069.4
1990	64128.	82954.	102624.	33697.	4508.	1137.	610.	148.	821.7
1991	103432.	41325.	43294.	44153.	12274.	1550.	383.	204.	689.6
1992	76515.	60645.	19654.	16060.	14192.	3989.	475.	112.	532.0
1993	134097.	41912.	26235.	6731.	4621.	4400.	1397.	160.	575.7
1994	100398.	80429.	20186.	10008.	2258.	1298.	1176.	372.	576.9
1995	55208.	61649.	46418.	10146.	4367.	905.	530.	488.	554.9
1996	120323.	36873.	35422.	25231.	5044.	2116.	441.	254.	671.6
1997	131121.	85142.	22981.	18176.	12219.	2269.	953.	196.	786.9
1998	61346.	92467.	53460.	12437.	8114.	4919.	866.	365.	702.7
1999	125299.	43107.	52990.	25667.	5063.	2793.	1479.	270.	697.4
2000	29486.	81322.	22278.	21393.	9537.	1741.	946.	503.	498.5
2001	146367.	18424.	40518.	8735.	7226.	2900.	505.	279.	549.2

STANDARD DEVIATION OF STOCK ESTIMATES

2000	3676.	6028.	1602.	1788.	814.	180.	147.	99.	28.4
2001	18293.	2775.	4386.	1073.	1142.	535.	117.	82.	45.8

Estimated fishing mortality rates:

Year/age	4	5	6	7	8	9	10	11	FGBAR	FBAR
1984	0.203	0.344	0.531	0.656	0.863	0.825	0.811	0.814	0.641	0.672
1985	0.295	0.408	0.574	0.705	0.772	0.817	0.827	0.821	0.664	0.684
1986	0.246	0.534	0.719	0.882	0.958	0.968	0.945	0.963	0.817	0.835
1987	0.314	0.540	0.779	0.969	1.046	1.055	1.053	1.057	0.883	0.907
1988	0.218	0.501	0.813	1.031	1.308	1.295	1.263	1.266	0.982	1.035
1989	0.260	0.426	0.618	0.762	0.887	0.876	0.883	0.900	0.719	0.742
1990	0.238	0.443	0.641	0.806	0.867	0.886	0.891	0.901	0.734	0.756
1991	0.334	0.542	0.765	0.909	0.908	0.961	0.994	0.978	0.830	0.846
1992	0.402	0.638	0.868	1.008	0.954	0.849	0.890	0.922	0.859	0.868
1993	0.310	0.530	0.764	0.893	1.040	1.093	1.111	1.095	0.877	0.905
1994	0.268	0.349	0.485	0.629	0.715	0.697	0.680	0.681	0.575	0.592
1995	0.204	0.344	0.407	0.496	0.521	0.514	0.530	0.535	0.463	0.469
1996	0.145	0.273	0.452	0.525	0.596	0.596	0.606	0.604	0.491	0.508
1997	0.147	0.265	0.413	0.602	0.710	0.763	0.760	0.752	0.548	0.585
1998	0.153	0.347	0.533	0.698	0.833	0.962	0.931	0.901	0.677	0.717
1999	0.230	0.459	0.680	0.782	0.854	0.849	0.845	0.866	0.728	0.745
2000	0.269	0.496	0.729	0.865	0.973	1.017	0.993	0.995	0.821	0.845

STANDARD DEVIATIONS OF LOG(F)

2000	0.10	0.09	0.08	0.08	0.09	0.11	0.11	0.12	0.070

Table 3.3.15 XSA Tuning diagnostic. Total stratified mean survey indices.

```
Catch data for  30 years. 1971 to 2000. Ages  3 to  14.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SMB. N.             ,   1984, 2000,   3,     8,  0.990,  1.000
 SMB. N. a3 on a3    ,   1985, 2000,   3,     3,  0.170,  0.250


 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 >=   12


 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 =   0.500

      Minimum standard error for population
      estimates derived from each fleet =   0.300

      Prior weighting not applied

 Lowestoft VPA Version 3.1

21/04/2001  17:56

 Retrospective XSA run

 "ICELANDIC COD (Div. Va); data from 1971-99(4/2000)"

 CPUE data from file codvarnt.dat.hb.02

 Terminal year for this assessment : 2000


 Tuning converged after   16 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,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000

      3, 0.097, 0.080, 0.166, 0.096, 0.077, 0.036, 0.023, 0.024, 0.045, 0.060
      4, 0.311, 0.378, 0.323, 0.302, 0.200, 0.145, 0.148, 0.139, 0.185, 0.159
      5, 0.505, 0.635, 0.498, 0.324, 0.357, 0.248, 0.250, 0.357, 0.445, 0.458
      6, 0.773, 0.894, 0.782, 0.449, 0.372, 0.482, 0.375, 0.517, 0.709, 0.700
      7, 0.948, 1.100, 0.807, 0.652, 0.526, 0.506, 0.605, 0.669, 0.759, 0.873
      8, 0.786, 1.023, 1.129, 0.759, 0.524, 0.585, 0.710, 0.756, 0.803, 0.942
      9, 0.779, 0.617, 1.237, 0.798, 0.423, 0.582, 0.727, 0.984, 0.760, 0.899
     10, 0.881, 0.528, 0.950, 0.821, 0.612, 0.559, 0.841, 0.841, 0.731, 0.754
     11, 0.964, 0.396, 0.904, 0.624, 0.649, 0.555, 0.806, 1.022, 0.599, 0.799
     12, 0.845, 0.708, 0.576, 0.670, 0.750, 0.626, 0.407, 1.082, 0.713, 0.755
     13, 0.356, 0.263, 0.566, 0.701, 1.170, 0.759, 0.928, 1.282, 0.568, 0.935
     14, 0.769, 0.477, 0.758, 0.709, 0.802, 0.631, 0.754, 1.069, 0.658, 0.821
```

Table 3.3.15 (Continued)

1

XSA population numbers (Thousands)

YEAR	AGE 3	4	5	6	7	8	9	10	11	12
1991	1.03E+05	1.04E+05	4.32E+04	4.42E+04	4.52E+04	1.29E+04	1.84E+03	4.59E+02	2.23E+02	1.22E+02
1992	1.75E+05	7.63E+04	6.24E+04	2.13E+04	1.67E+04	1.43E+04	4.82E+03	6.92E+02	1.56E+02	6.97E+01
1993	1.48E+05	1.32E+05	4.28E+04	2.71E+04	7.15E+03	4.55E+03	4.22E+03	2.13E+03	3.34E+02	8.58E+01
1994	7.45E+04	1.02E+05	7.85E+04	2.13E+04	1.01E+04	2.61E+03	1.20E+03	1.00E+03	6.74E+02	1.11E+02
1995	1.61E+05	5.54E+04	6.20E+04	4.65E+04	1.11E+04	4.32E+03	1.00E+03	4.44E+02	3.61E+02	2.95E+02
1996	1.68E+05	1.22E+05	3.71E+04	3.55E+04	2.62E+04	5.38E+03	2.10E+03	5.37E+02	1.97E+02	1.54E+02
1997	8.22E+04	1.32E+05	8.65E+04	2.37E+04	1.80E+04	1.29E+04	2.45E+03	9.58E+02	2.52E+02	9.26E+01
1998	1.60E+05	6.58E+04	9.35E+04	5.52E+04	1.33E+04	8.03E+03	5.21E+03	9.72E+02	3.38E+02	9.19E+01
1999	6.30E+04	1.28E+05	4.69E+04	5.36E+04	2.69E+04	5.60E+03	3.09E+03	1.59E+03	3.43E+02	9.97E+01
2000	1.99E+05	4.93E+04	8.72E+04	2.46E+04	2.16E+04	1.03E+04	2.05E+03	1.18E+03	6.29E+02	1.54E+02

Estimated population abundance at 1st Jan 2001

,	0.00E+00	1.54E+05	3.44E+04	4.51E+04	1.00E+04	7.38E+03	3.29E+03	6.84E+02	4.55E+02	2.31E+02

Taper weighted geometric mean of the VPA populations:

,	1.63E+05	1.26E+05	8.48E+04	4.64E+04	2.26E+04	9.67E+03	3.72E+03	1.49E+03	5.44E+02	2.01E+02

Standard error of the weighted Log(VPA populations) :

,	0.4434	0.4383	0.4117	0.4570	0.5312	0.6566	0.7729	0.8289	0.7441	0.6883

YEAR	AGE 13	14
1991	4.06E+01	2.47E+01
1992	4.30E+01	2.33E+01
1993	2.81E+01	2.70E+01
1994	3.95E+01	1.31E+01
1995	4.65E+01	1.60E+01
1996	1.14E+02	1.18E+01
1997	6.76E+01	4.38E+01
1998	5.05E+01	2.19E+01
1999	2.55E+01	1.15E+01
2000	4.00E+01	1.18E+01

Estimated population abundance at 1st Jan 2001

,	5.94E+01	1.29E+01

Taper weighted geometric mean of the VPA populations:

,	7.50E+01	2.55E+01

Standard error of the weighted Log(VPA populations) :

,	0.6773	1.1136

1

Log catchability residuals.

Fleet : SMB. N.

Age	1984	1985	1986	1987	1988	1989	1990
3	0.29	-0.24	-0.22	0.09	0.42	0.00	0.03
4	0.12	-0.05	-0.13	-0.09	0.03	-0.10	0.20
5	0.24	0.03	0.08	-0.50	0.27	-0.14	0.12
6	0.57	-0.28	0.06	0.25	-0.15	0.09	0.13
7	0.24	-0.25	-0.14	0.60	0.07	-0.25	-0.18
8	0.64	-0.40	-0.03	-0.25	0.73	0.19	0.26

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
3	0.03	-0.05	-0.06	-0.11	-0.19	0.20	0.09	0.08	-0.14	-0.20
4	-0.16	0.05	-0.17	0.12	0.20	-0.05	0.37	0.03	-0.03	-0.32
5	-0.18	0.00	-0.30	0.01	0.09	0.06	0.27	0.17	-0.11	-0.10
6	-0.15	-0.26	-0.06	-0.22	0.19	0.12	0.10	-0.03	-0.11	-0.25
7	-0.11	0.07	-0.31	-0.02	0.33	0.09	0.42	-0.03	-0.04	-0.48
8	-0.25	-0.17	0.26	-0.07	0.22	-0.75	0.50	0.12	-0.51	-0.48

Table 3.3.15 (Continued)

```
 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,   -7.8526,   -7.7278,   -7.7209,   -7.8386,
 S.E(Log q),    0.2067,    0.2236,    0.2786,    0.4167,




 Regression statistics :

 Ages with q dependent on year class strength

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Log q

  3,    0.65,    3.280,      9.46,    0.85,     17,    0.19,   -8.17,
  4,    0.68,    3.403,      9.13,    0.88,     17,    0.17,   -7.96,

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

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

  5,    0.86,    1.389,      8.34,    0.86,     17,    0.17,   -7.85,
  6,    0.88,    1.196,      8.09,    0.86,     17,    0.19,   -7.73,
  7,    0.96,    0.278,      7.80,    0.76,     17,    0.28,   -7.72,
  8,    0.94,    0.321,      7.91,    0.63,     17,    0.40,   -7.84,
1



 Fleet : SMB. N. a3 on a3

  Age  ,  1984,  1985,  1986,  1987,  1988,  1989,  1990
     3 , 99.99,  0.06, -0.13,  0.10,  0.37,  0.31, -0.03
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age



  Age  ,  1991,  1992,  1993,  1994,  1995,  1996,  1997,  1998,  1999,  2000
     3 ,  0.00, -0.17,  0.07, -0.19, -0.23,  0.03,  0.02, -0.14, -0.11,  0.05
     4 , No data for this fleet at this age
     5 , No data for this fleet at this age
     6 , No data for this fleet at this age
     7 , No data for this fleet at this age
     8 , No data for this fleet at this age


 Regression statistics :

 Ages with q dependent on year class strength

 Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e, Mean Log q

  3,    0.65,    3.626,      9.61,    0.88,     16,    0.17,   -8.39,
1

 Fleet disaggregated estimates of survivors :


 Age  3   Catchability dependent on age and year class strength

 Year class = 1997

 SMB. N.
        Age,         3,
   Survivors,   125176.,
 Raw Weights,    10.466,
```

Table 3.3.15 (Continued)

```
 SMB. N. a3 on a3
        Age,         3,
  Survivors,   161238.,
Raw Weights,    10.466,




 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. N.              ,    125176.,  0.300,      0.000,   0.00,   1, 0.347,    0.073
 SMB. N. a3 on a3     ,    161238.,  0.300,      0.000,   0.00,   1, 0.347,    0.057

   P shrinkage mean   ,    125639.,   0.44,,,,                       0.173,    0.073

   F shrinkage mean   ,    300630.,   0.50,,,,                       0.133,    0.031

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    153632.,      0.18,     0.17,    4,   0.961,  0.060


1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1996

 SMB. N.
        Age,         4,          3,
  Survivors,    24945.,     29816.,
Raw Weights,     9.477,      9.057,




 SMB. N. a3 on a3
        Age,         4,          3,
  Survivors,        0.,     30836.,
Raw Weights,     0.000,      9.057,




 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. N.              ,     27217.,  0.212,      0.089,   0.42,   2, 0.494,    0.197
 SMB. N. a3 on a3     ,     30836.,  0.300,      0.000,   0.00,   1, 0.242,    0.176

   P shrinkage mean   ,     84830.,   0.41,,,,                       0.157,    0.068

   F shrinkage mean   ,     34772.,   0.50,,,,                       0.107,    0.158

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     34434.,      0.15,     0.22,    5,   1.465,  0.159


1
 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 1995

 SMB. N.
        Age,         5,          4,          3,
  Survivors,    40742.,     43626.,     48678.,
Raw Weights,     7.025,      5.840,      5.700,
```

Table 3.3.15 (Continued)

SMB. N. a3 on a3

Age,	5,	4,	3,
Survivors,	0.,	0.,	39258.,
Raw Weights,	0.000,	0.000,	5.700,

Fleet,		Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,		Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. N.	,	43966.,	0.174,	0.052,	0.30,	3,	0.657,	0.468
SMB. N. a3 on a3	,	39258.,	0.300,	0.000,	0.00,	1,	0.202,	0.512
F shrinkage mean	,	62056.,	0.50,,,,				0.142,	0.353

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
45121.,	0.15,	0.08,	5,	0.537,	0.458

1

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

Year class = 1994

SMB. N.

Age,	6,	5,	4,	3,
Survivors,	7753.,	8949.,	10272.,	10936.,
Raw Weights,	5.520,	3.538,	3.080,	3.009,

SMB. N. a3 on a3

Age,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	10160.,
Raw Weights,	0.000,	0.000,	0.000,	3.009,

Fleet,		Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,		Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. N.	,	9090.,	0.155,	0.080,	0.51,	4,	0.684,	0.749
SMB. N. a3 on a3	,	10160.,	0.300,	0.000,	0.00,	1,	0.136,	0.692
F shrinkage mean	,	14210.,	0.50,,,,				0.181,	0.538

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
10003.,	0.15,	0.10,	6,	0.672,	0.700

1

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

Year class = 1993

SMB. N.

Age,	7,	6,	5,	4,	3,
Survivors,	4575.,	6581.,	8706.,	10696.,	9057.,
Raw Weights,	4.643,	2.284,	1.598,	1.379,	1.330,

Table 3.3.15 (Continued)

SMB. N. a3 on a3

Age,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	7575.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	1.330,

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. N. ,	6496.,	0.153,	0.163,	1.06,	5,	0.678,	0.949
SMB. N. a3 on a3 ,	7575.,	0.300,	0.000,	0.00,	1,	0.080,	0.857
F shrinkage mean ,	10466.,	0.50,,,,				0.241,	0.684

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
7379.,	0.16,	0.14,	7,	0.896,	0.873

1

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

Year class = 1992

SMB. N.

Age,	8,	7,	6,	5,	4,	3,
Survivors,	2043.,	3158.,	3187.,	4313.,	3118.,	2725.,
Raw Weights,	2.120,	2.027,	1.208,	0.941,	0.815,	0.754,

SMB. N. a3 on a3

Age,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	2619.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.754,

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. N. ,	2874.,	0.157,	0.106,	0.68,	6,	0.623,	1.028
SMB. N. a3 on a3 ,	2619.,	0.300,	0.000,	0.00,	1,	0.060,	1.088
F shrinkage mean ,	4495.,	0.50,,,,				0.317,	0.764

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
3294.,	0.19,	0.12,	8,	0.643,	0.942

1

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

Year class = 1991

SMB. N.

Age,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	412.,	667.,	753.,	725.,	838.,	610.,
Raw Weights,	0.000,	0.992,	1.038,	0.713,	0.557,	0.456,	0.414,

Table 3.3.15 (Continued)

SMB. N. a3 on a3

Age,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	568.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.414,

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. N.	,	624.,	0.149,	0.110,	0.74,	6,	0.486,	0.954
SMB. N. a3 on a3	,	568.,	0.300,	0.000,	0.00,	1,	0.048,	1.013
F shrinkage mean	,	767.,	0.50,,,,				0.466,	0.832

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
684.,	0.24,	0.09,	8,	0.351,	0.899

1

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

Year class = 1990

SMB. N.

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	513.,	693.,	515.,	498.,	512.,	427.,
Raw Weights,	0.000,	0.000,	0.561,	0.626,	0.387,	0.271,	0.200,	0.169,

SMB. N. a3 on a3

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	487.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.169,

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. N.	,	549.,	0.156,	0.069,	0.44,	6,	0.347,	0.659
SMB. N. a3 on a3	,	487.,	0.300,	0.000,	0.00,	1,	0.027,	0.719
F shrinkage mean	,	409.,	0.50,,,,				0.627,	0.812

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
455.,	0.32,	0.09,	8,	0.291,	0.754

1

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

Year class = 1989

SMB. N.

Age,	11,
Survivors,	0.,
Raw Weights,	0.000,

Table 3.3.15 (Continued)

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	380.,	253.,	280.,	234.,	196.,	221.,
Raw Weights,	0.000,	0.000,	0.216,	0.266,	0.184,	0.133,	0.096,	0.089,

SMB. N. a3 on a3

Age,	11,
Survivors,	0.,
Raw Weights,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	194.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.089,

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. N. ,	269.,	0.148,	0.093,	0.63,	6,	0.194,	0.720
SMB. N. a3 on a3 ,	194.,	0.300,	0.000,	0.00,	1,	0.017,	0.899
F shrinkage mean ,	224.,	0.50,,,,				0.789,	0.818

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
231.,	0.40,	0.06,	8,	0.164,	0.799

1
Age 12 Catchability constant w.r.t. time and dependent on age

Year class = 1988

SMB. N.

Age,	12,	11,
Survivors,	0.,	0.,
Raw Weights,	0.000,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	28.,	82.,	48.,	44.,	62.,	61.,
Raw Weights,	0.000,	0.000,	0.163,	0.197,	0.126,	0.076,	0.052,	0.048,

SMB. N. a3 on a3

Age,	12,	11,
Survivors,	0.,	0.,
Raw Weights,	0.000,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	59.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.048,

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. N. ,	51.,	0.157,	0.181,	1.16,	6,	0.141,	0.841
SMB. N. a3 on a3 ,	59.,	0.300,	0.000,	0.00,	1,	0.010,	0.756
F shrinkage mean ,	61.,	0.50,,,,				0.849,	0.741

Table 3.3.15 (Continued)

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
59.,	0.43,	0.08,	8,	0.196,	0.755

1

Age 13 Catchability constant w.r.t. time and age (fixed at the value for age) 12

Year class = 1987

SMB. N.

Age,	13,	12,	11,
Survivors,	0.,	0.,	0.,
Raw Weights,	0.000,	0.000,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	16.,	13.,	12.,	13.,	11.,	13.,
Raw Weights,	0.000,	0.000,	0.054,	0.057,	0.026,	0.014,	0.010,	0.010,

SMB. N. a3 on a3

Age,	13,	12,	11,
Survivors,	0.,	0.,	0.,
Raw Weights,	0.000,	0.000,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	12.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.010,

Fleet,		Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SMB. N.	,	13.,	0.178,	0.055,	0.31,	6,	0.041,	0.908
SMB. N. a3 on a3	,	12.,	0.300,	0.000,	0.00,	1,	0.002,	0.954
F shrinkage mean	,	13.,	0.50,,,,				0.957,	0.936

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
13.,	0.48,	0.02,	8,	0.039,	0.935

1

Age 14 Catchability constant w.r.t. time and age (fixed at the value for age) 12

Year class = 1986

SMB. N.

Age,	14,	13,	12,	11,
Survivors,	0.,	0.,	0.,	0.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	4.,	3.,	3.,	4.,	5.,	4.,
Raw Weights,	0.000,	0.000,	0.036,	0.033,	0.013,	0.008,	0.006,	0.006,

SMB. N. a3 on a3

Age,	14,	13,	12,	11,
Survivors,	0.,	0.,	0.,	0.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,

Table 3.3.15 (Continued)

Age,	10,	9,	8,	7,	6,	5,	4,	3,
Survivors,	0.,	0.,	0.,	0.,	0.,	0.,	0.,	6.,
Raw Weights,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.006,

Fleet,		Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,		Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SMB. N.	,	4.,	0.185,	0.065,	0.35,	6,	0.025,	0.914
SMB. N. a3 on a3	,	6.,	0.300,	0.000,	0.00,	1,	0.002,	0.657
F shrinkage mean	,	4.,	0.50,,,,				0.973,	0.819

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
4.,	0.49,	0.05,	8,	0.107,	0.821

Table 3.3.16 Cod at Iceland. Division Va. Resulting fishing mortality using final F from the XSA tuning with survey fleet only.

Marine Research Institute Sun Apr 22 22:47:25 2001
Virtual Population Analysis : Fishing mortality
XSA total Cochran

Age	1981	1982	1983	1984	1985	1986	1987
3	0.016	0.027	0.017	0.055	0.051	0.070	0.045
4	0.137	0.221	0.120	0.211	0.288	0.222	0.309
5	0.388	0.400	0.433	0.323	0.388	0.580	0.519
6	0.470	0.541	0.622	0.539	0.572	0.697	0.785
7	0.635	0.581	0.767	0.598	0.683	0.883	0.976
8	0.839	1.046	0.852	0.900	0.731	0.936	0.994
9	0.802	1.187	0.930	0.746	0.802	0.806	0.975
10	0.950	0.910	1.082	0.634	0.770	0.764	0.707
11	0.982	0.479	0.671	0.639	0.613	0.740	0.582
12	0.904	0.404	0.678	0.587	0.641	0.672	0.665
13	1.076	0.417	0.533	0.685	0.711	0.445	0.739
14	0.943	0.679	0.779	0.658	0.707	0.685	0.734
W.Av 5-10	0.529	0.582	0.609	0.479	0.486	0.689	0.697
Ave 5-10	0.681	0.777	0.781	0.623	0.658	0.778	0.826

Age	1988	1989	1990	1991	1992	1993	1994
3	0.045	0.035	0.050	0.097	0.081	0.168	0.096
4	0.222	0.265	0.231	0.312	0.379	0.324	0.304
5	0.506	0.485	0.445	0.507	0.635	0.499	0.326
6	0.838	0.601	0.640	0.776	0.892	0.780	0.451
7	0.953	0.727	0.785	0.949	1.099	0.806	0.651
8	1.393	0.875	0.816	0.786	1.024	1.125	0.758
9	1.112	0.819	0.785	0.779	0.618	1.231	0.798
10	0.986	0.546	0.836	0.870	0.530	0.947	0.820
11	1.032	0.664	0.624	0.963	0.390	0.901	0.624
12	0.905	0.975	0.771	0.829	0.709	0.561	0.670
13	2.334	0.575	0.438	0.377	0.360	0.570	0.665
14	1.274	0.716	0.691	0.763	0.522	0.842	0.715
W.Av 5-10	0.629	0.544	0.596	0.751	0.790	0.689	0.397
Ave 5-10	0.965	0.676	0.718	0.778	0.800	0.898	0.634

Age	1995	1996	1997	1998	1999	2000	1997-2000
3	0.076	0.036	0.024	0.025	0.045	0.060	0.038
4	0.201	0.144	0.149	0.140	0.185	0.159	0.158
5	0.359	0.248	0.247	0.359	0.446	0.458	0.378
6	0.374	0.487	0.374	0.506	0.711	0.700	0.573
7	0.529	0.509	0.613	0.662	0.725	0.873	0.718
8	0.525	0.590	0.715	0.774	0.782	0.844	0.779
9	0.426	0.582	0.736	0.992	0.801	0.844	0.843
10	0.615	0.561	0.835	0.862	0.750	0.844	0.823
11	0.649	0.560	0.810	0.999	0.634	0.844	0.822
12	0.747	0.626	0.414	1.085	0.682	0.844	0.756
13	1.153	0.754	0.923	1.299	0.577	0.844	0.911
14	0.718	0.617	0.743	1.048	0.689	0.844	0.831
W.Av 5-10	0.387	0.416	0.366	0.468	0.629	0.596	0.548
Ave 5-10	0.471	0.496	0.587	0.693	0.703	0.761	0.686

Table 3.3.17. Cod at Iceland. Division Va. Resulting Stock in numbers using final F from the XSA tuning survey fleet only.

Virtual Population Analysis : Stock in numbers, millions
XSA total Cochran

Age	1981	1982	1983	1984	1985	1986	1987
3	143.274	133.575	226.325	139.007	144.031	335.808	277.527
4	113.999	115.390	106.396	182.090	107.718	112.095	256.312
5	133.569	81.350	75.742	77.274	120.679	66.119	73.479
6	67.877	74.178	44.653	40.214	45.818	67.038	30.295
7	29.534	34.736	35.350	19.620	19.203	21.166	27.346
8	50.702	12.818	15.903	13.437	8.835	7.941	7.168
9	9.481	17.940	3.687	5.554	4.471	3.484	2.551
10	2.970	3.480	4.482	1.191	2.156	1.642	1.274
11	1.011	0.940	1.147	1.244	0.517	0.817	0.627
12	0.417	0.310	0.476	0.480	0.537	0.230	0.319
13	0.087	0.138	0.170	0.198	0.219	0.232	0.096
14	0.121	0.024	0.075	0.081	0.082	0.088	0.122
Juvenile	450.105	383.310	444.545	405.969	361.273	531.451	607.936
Adult	102.936	91.570	69.860	74.423	92.994	85.210	69.178
Sum 3- 3	143.274	133.575	226.325	139.008	144.031	335.808	277.526
Sum 4-14	409.767	341.305	288.080	341.384	310.236	280.853	399.587
Total	553.041	474.880	514.405	480.392	454.267	616.661	677.114

Age	1988	1989	1990	1991	1992	1993	1994
3	168.495	82.990	131.929	101.594	173.622	146.125	74.072
4	217.288	131.893	65.594	102.793	75.463	131.128	101.170
5	154.014	142.510	82.818	42.624	61.576	42.298	77.639
6	35.806	76.025	102.819	43.434	21.021	26.704	21.017
7	11.314	12.686	34.110	44.375	16.373	7.050	10.019
8	8.435	3.572	5.022	12.734	14.061	4.467	2.578
9	2.172	1.715	1.219	1.818	4.751	4.135	1.187
10	0.788	0.585	0.619	0.455	0.683	2.096	0.988
11	0.514	0.241	0.278	0.220	0.156	0.329	0.666
12	0.287	0.150	0.101	0.122	0.069	0.087	0.110
13	0.134	0.095	0.046	0.038	0.044	0.028	0.040
14	0.038	0.011	0.044	0.024	0.022	0.025	0.013
Juvenile	516.076	345.213	311.668	247.138	259.685	213.022	140.190
Adult	83.209	107.258	112.932	103.095	108.156	151.449	149.309
Sum 3- 3	168.495	82.990	131.929	101.594	173.622	146.125	74.072
Sum 4-14	430.790	369.481	292.671	248.638	194.219	218.347	215.427
Total	599.285	452.471	424.600	350.232	367.840	364.471	289.499

Age	1995	1996	1997	1998	1999	2000	2001
3	161.476	165.710	81.345	159.127	62.798	185.000	170.000
4	55.090	122.489	130.837	65.045	127.079	49.136	142.645
5	61.133	36.908	86.871	92.304	46.308	86.434	34.315
6	45.896	34.939	23.586	55.562	52.769	24.261	44.763
7	10.960	25.847	17.578	13.285	27.425	21.221	9.864
8	4.277	5.288	12.715	7.793	5.612	10.880	7.257
9	0.989	2.072	2.400	5.091	2.941	2.102	3.830
10	0.438	0.529	0.948	0.941	1.545	1.081	0.740
11	0.357	0.194	0.247	0.337	0.325	0.598	0.380
12	0.292	0.152	0.091	0.090	0.101	0.141	0.210
13	0.046	0.113	0.067	0.049	0.025	0.042	0.050
14	0.017	0.012	0.044	0.022	0.011	0.011	0.015
Juvenile	196.826	312.968	192.339	303.543	233.632	298.641	340.761
Adult	144.143	81.286	164.388	96.103	93.308	82.265	73.308
Sum 3- 3	161.476	165.710	81.345	159.127	62.798	185.000	170.000
Sum 4-14	179.493	228.544	275.381	240.519	264.142	195.906	244.069
Total	340.969	394.254	356.727	399.646	326.940	380.906	414.069

Table 3.3.18 Cod at Iceland. Division Va. Resulting SSB using final F from the XSA tuning survey fleet only.

```
        Marine Research Institute Sun Apr 22 22:47:25 2001
  Virtual Population Analysis : SSB in 1000 x tons
 XSA total cochran
```

Age	1981	1982	1983	1984	1985	1986	1987
3	0.000	2.917	0.000	0.000	4.166	1.877	6.780
4	4.674	8.747	12.670	10.555	9.011	9.747	19.211
5	20.608	18.924	23.102	28.990	48.126	35.627	40.003
6	52.345	40.895	34.834	47.189	71.051	100.356	56.152
7	65.636	62.440	53.319	43.624	54.566	52.824	73.973
8	174.044	36.502	41.484	39.718	34.163	28.874	27.027
9	44.874	62.993	13.516	24.330	21.231	17.356	11.320
10	15.691	19.197	19.366	7.881	13.102	9.835	8.836
11	6.445	8.215	8.439	9.326	4.166	5.759	4.950
12	3.193	3.271	4.322	4.755	5.000	2.165	2.348
13	0.582	1.845	1.773	2.089	2.271	2.463	1.020
14	1.052	0.277	0.906	0.928	1.051	1.115	1.347
Total	389.143	266.223	213.731	219.385	267.905	267.998	252.965

Age	1988	1989	1990	1991	1992	1993	1994
3	7.584	0.000	0.000	0.000	10.345	11.084	8.004
4	6.371	8.853	5.970	10.342	20.955	45.444	44.755
5	66.525	65.815	45.569	17.086	61.129	42.069	92.492
6	45.213	124.596	163.242	54.282	34.524	51.984	51.298
7	26.631	39.719	92.351	89.259	41.552	22.550	34.419
8	22.627	13.743	20.214	44.942	45.909	15.723	10.051
9	8.247	7.561	6.774	8.634	22.274	16.037	5.923
10	3.829	3.994	4.036	2.545	4.154	10.860	4.776
11	2.965	1.992	2.370	1.483	1.443	2.261	5.021
12	1.672	0.771	1.031	1.118	0.628	0.756	0.953
13	0.595	0.719	0.549	0.432	0.538	0.289	0.403
14	0.213	0.103	0.516	0.327	0.180	0.291	0.151
Total	192.473	267.867	342.623	230.450	243.630	219.349	258.246

Age	1995	1996	1997	1998	1999	2000
3	6.995	15.493	6.883	4.948	3.051	7.178
4	36.364	17.919	59.609	31.413	50.661	12.043
5	106.055	43.950	101.252	90.023	48.738	69.718
6	116.027	81.750	56.581	103.727	92.630	38.608
7	34.450	80.336	63.254	43.345	77.398	53.922
8	18.905	20.510	52.534	38.486	23.174	39.222
9	5.825	9.481	11.906	24.283	15.819	10.324
10	3.069	3.633	4.856	5.159	10.235	6.369
11	2.695	1.593	1.676	2.182	2.562	3.888
12	2.199	1.377	0.760	0.780	0.876	1.054
13	0.330	1.009	0.447	0.436	0.226	0.352
14	0.175	0.136	0.443	0.189	0.114	0.127
Total	333.089	277.189	360.202	344.971	325.484	242.807

Table 3.3.19 Cod at Iceland. Division Va. Resulting stock weight using final F from the XSA tuning using survey fleet only.

Marine Research Institute Sun Apr 22 22:47:25 2001
Virtual Population Analysis : Stock weight 1. Jan. in 1000 x tons
XSA Total Cochran

Age	1981	1982	1983	1984	1985	1986	1987
3	169.064	134.377	247.826	179.042	202.652	489.944	365.225
4	188.212	178.855	170.127	314.104	212.312	219.818	501.345
5	301.866	182.712	172.314	200.603	310.870	188.043	197.364
6	223.519	230.249	134.895	144.007	167.234	240.869	117.969
7	132.400	147.906	144.793	85.761	95.554	98.106	128.965
8	295.134	69.040	87.164	77.908	56.296	48.878	44.849
9	73.375	119.873	25.988	41.413	36.696	26.139	18.795
10	27.981	31.809	36.431	11.733	22.251	14.920	11.771
11	11.495	11.244	12.631	13.747	6.311	8.462	6.703
12	5.325	4.411	6.657	6.884	7.892	3.509	3.390
13	1.091	2.388	2.692	3.024	3.537	3.370	1.525
14	2.308	0.404	1.378	1.358	1.557	1.321	1.532
Juvenile	914.624	715.808	746.864	768.932	756.214	1002.756	1123.698
Adult	517.146	397.460	296.032	310.653	366.949	340.622	275.735
Sum 3- 3	169.064	134.377	247.826	179.042	202.652	489.944	365.225
Sum 4-14	1262.706	978.891	795.070	900.543	920.511	853.435	1034.208
Total	1431.770	1113.268	1042.896	1079.585	1123.163	1343.379	1399.433

Age	1988	1989	1990	1991	1992	1993	1994
3	242.296	98.426	170.189	132.986	223.799	203.406	106.886
4	392.206	239.121	111.773	195.204	133.419	247.439	208.714
5	396.739	369.100	197.355	105.494	152.031	117.249	198.911
6	126.000	297.638	311.953	137.209	69.201	100.460	76.902
7	55.777	66.096	157.727	168.269	71.942	34.758	51.267
8	50.621	24.617	32.750	72.331	78.490	27.041	16.144
9	15.516	13.778	10.835	13.169	32.449	30.808	9.160
10	6.950	5.751	6.554	4.461	5.555	18.112	8.794
11	5.129	2.883	3.051	2.143	1.980	3.592	7.221
12	3.363	1.500	1.476	1.746	0.921	1.084	1.410
13	1.903	1.197	0.729	0.544	0.684	0.408	0.596
14	0.489	0.171	0.756	0.495	0.243	0.419	0.224
Juvenile	1028.457	755.026	621.813	498.900	432.410	383.023	281.390
Adult	268.534	365.253	383.334	335.152	338.303	401.751	404.838
Sum 3- 3	242.296	98.426	170.189	132.986	223.799	203.406	106.886
Sum 4-14	1054.695	1021.854	834.958	701.065	546.914	581.369	579.342
Total	1296.991	1120.279	1005.147	834.052	770.713	784.774	686.228

Age	1995	1996	1997	1998	1999	2000	2001
3	217.670	241.440	120.716	195.726	77.933	241.980	225.080
4	107.920	236.404	245.581	116.300	218.067	87.560	264.035
5	178.507	115.595	250.014	228.638	112.344	201.391	84.003
6	166.373	144.684	95.003	199.356	181.685	78.898	141.003
7	56.728	127.217	94.955	66.600	129.444	99.526	44.457
8	27.440	31.777	81.195	56.834	35.645	64.124	45.481
9	7.832	15.347	17.626	39.927	25.676	16.413	29.652
10	4.495	5.172	8.091	8.739	15.367	9.944	7.012
11	3.930	2.041	2.669	3.696	3.608	6.119	4.103
12	3.331	2.059	1.045	1.383	1.272	1.578	2.739
13	0.601	1.550	0.696	0.869	0.374	0.553	0.761
14	0.259	0.192	0.558	0.349	0.166	0.200	0.240
Juvenile	334.990	621.710	407.419	551.323	445.919	506.279	590.605
Adult	440.096	301.770	510.729	367.093	355.662	302.006	257.960
Sum 3- 3	217.670	241.440	120.716	195.726	77.933	241.980	225.080
Sum 4-14	557.416	682.040	797.433	722.689	723.648	566.306	623.486
Total	775.086	923.480	918.149	918.416	801.581	808.286	848.566

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	3405
1994	3350
1995	3921
1996	4705
1997	4229
1998	3344
1999	3565
2000	3719
2001	3565
Average	3184

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) and total biomass ('000 tonnes).

Year	Landings	F5-10	Recruitment	SSB	Tot. Bio
1955	538	0.31	260	1261	
1956	481	0.26	307	1199	
1957	452	0.32	153	1145	
1958	509	0.32	191	1034	
1959	453	0.33	143	928	
1960	465	0.38	163	825	
1961	374	0.33	292	760	
1962	387	0.40	255	729	
1963	410	0.45	273	683	
1964	434	0.54	328	569	
1965	394	0.61	174	454	
1966	357	0.54	255	412	
1967	345	0.49	186	476	
1968	381	0.67	178	594	
1969	406	0.53	136	693	
1970	471	0.56	303	684	
1971	453	0.62	170	615	
1972	399	0.71	265	477	
1973	383	0.71	432	436	
1974	375	0.76	143	329	
1975	371	0.81	222	339	
1976	348	0.76	246	283	
1977	340	0.63	144	319	
1978	330	0.48	143	375	
1979	368	0.43	134	447	
1980	434	0.45	226	602	
1981	469	0.68	139	389	1432
1982	388	0.78	144	266	1113
1983	300	0.78	336	214	1043
1984	284	0.62	278	219	1080
1985	325	0.66	168	268	1123
1986	369	0.78	83	268	1343
1987	392	0.83	132	253	1399
1988	378	0.96	102	192	1297
1989	356	0.68	174	268	1120
1990	335	0.72	146	343	1005
1991	309	0.78	74	231	834
1992	268	0.80	161	244	771
1993	252	0.90	166	219	785
1994	179	0.63	81	258	686
1995	169	0.47	159	333	775
1996	182	0.50	63	277	923
1997	203	0.59	185	360	918
1998	243	0.69	170	345	918
1999	260	0.70	180	326	802
2000	235	0.76	175	243	808

Table 3.3.22. Cod at Iceland. Division Va. Input file used for RCTR3

```
Iceland Cod: VPA and groundfish survey data
4 26 2
'Yearcl'  'VPAage3'  'Surv4'  'Surv3'  'Surv2'  'Surv1'
1975     222      -11      -11      -11      -11
1976     245      -11      -11      -11      -11
1977     144      -11      -11      -11      -11
1978     143      -11      -11      -11      -11
1979     134      -11      -11      -11      -11
1980     226      -11      -11      -11      -11
1981     139     4819      -11      -11      -11
1982     144     2249     3539      -11      -11
1983     336     8346     9574    11237      -11
1984     278    10498    10405     6106     1663
1985     169     8013     7279     2907     1510
1986      83     1429     2236      757      380
1987     132     3016     2671     1732      350
1988     102     1905     1842     1210      415
1989     174     3928     3244     1681      559
1990     146     2703     3555     1904      397
1991      74      936      847      495       81
1992     161     2782     2616     1612      360
1993     165     5647     4159     2925     1439
1994      81     1601     1368      547      119
1995     159     4375     3016     2264      372
1996      63      727      744      577      123
1997     -11     3832     5592     3439      817
1998     -11      -11     3706     2878      741
1999     -11      -11      -11     2414     1854
2000     -11      -11      -11      -11     1197
```

Table 3.3.23. Cod at Iceland. Division Va. Output from RCT3

Analysis by RCT3 ver3.1 of data from file :

qqq.dat

Iceland Cod: VPA and groundfish survey data

Data for 4 surveys over 26 years : 1975 - 2000
Regression type = C
Tapered time weighting applied
power = 3 over 20 years
Survey weighting not applied

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

Forecast/Hindcast variance correction used.

Yearclass = 1997

	I------	------Regression	------	------I		I------	------Prediction	------	------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4	.61	.07	.17	.878	16	8.25	5.07	.198	.291
Surv3	.64	-.15	.18	.872	15	8.63	5.36	.213	.257
Surv2	.57	.67	.14	.920	14	8.14	5.34	.167	.291
Surv1	.53	1.72	.29	.699	13	6.71	5.24	.341	.100
					VPA Mean =		4.86	.438	.061

Yearclass = 1998

	I------	------Regression	------	------I		I------	------Prediction	------	------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3	.64	-.14	.17	.874	15	8.22	5.10	.205	.379
Surv2	.58	.63	.14	.915	14	7.97	5.24	.170	.400
Surv1	.52	1.73	.29	.699	13	6.61	5.20	.343	.136
					VPA Mean =		4.84	.435	.085

Yearclass = 1999

	I------	------Regression	------	------I		I------	------Prediction	------	------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2	.59	.58	.14	.910	14	7.79	5.14	.175	.676
Surv1	.52	1.75	.29	.700	13	7.53	5.68	.390	.178
					VPA Mean =		4.82	.430	.146

Yearclass = 2000

	I------	------Regression	------	------I		I------	------Prediction	------	------I
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.52	1.76	.29	.702	13	7.09	5.46	.379	.557
					VPA Mean =		4.80	.425	.443

Table 3.3.23 (Continued)

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	186	5.23	.11	.08	.50		
1998	172	5.15	.13	.06	.26		
1999	179	5.19	.16	.18	1.20		
2000	175	5.17	.28	.33	1.35		

Table 3.3.24. Short term prediction (Management option table)

Calculation were done with a spreadsheet: codpr2001.xls

Input data:

Sexual maturity at spawning time:

age\year	2000	2001	2002	2003	2004	76-00	98-00	85-00
3	0.040	0.038	0.038	0.038	0.038	0.033	0.038	0.040
4	0.177	0.244	0.244	0.244	0.244	0.122	0.244	0.165
5	0.440	0.491	0.491	0.491	0.491	0.322	0.491	0.403
6	0.636	0.666	0.666	0.666	0.666	0.570	0.666	0.652
7	0.801	0.819	0.819	0.819	0.819	0.784	0.819	0.828
8	0.920	0.930	0.930	0.930	0.930	0.904	0.930	0.917
9	0.980	0.978	0.978	0.978	0.978	0.953	0.978	0.955
10	0.980	0.964	0.964	0.964	0.964	0.965	0.964	0.961
11	1.000	0.999	0.999	0.999	0.999	0.995	0.999	0.995
12	1.000	1.000	1.000	1.000	1.000	0.978	1.000	0.971
13	1.000	0.946	0.946	0.946	0.946	0.987	0.946	0.979
14	1.000	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	2000	2001	2002	2003	2004	98-00
3	1.025	1.070	1.118	1.118	1.118	1.118
4	1.498	1.619	1.658	1.658	1.658	1.658
5	2.159	2.221	2.242	2.242	2.242	2.242
6	3.236	3.107	3.315	3.315	3.315	3.315
7	4.655	4.535	4.906	4.906	4.906	4.906
8	5.957	6.322	6.755	6.755	6.755	6.755
9	7.881	7.837	8.205	8.205	8.205	8.205
10	9.458	9.645	9.645	9.645	9.645	9.645
11	10.231	10.809	10.809	10.809	10.809	10.809
12	11.736	13.192	13.192	13.192	13.192	13.192
13	13.172	15.185	15.185	15.185	15.185	15.185
14	17.442	15.887	15.887	15.887	15.887	15.887

Table 3.3.24 (Continued)

Mean weights in the catch

age\year	2000	2001	2002	2003	2004	98-00
3	1.308	1.324	1.260	1.260	1.260	1.260
4	1.782	1.851	1.762	1.762	1.762	1.762
5	2.330	2.448	2.411	2.411	2.411	2.411
6	3.252	3.150	3.428	3.428	3.428	3.428
7	4.690	4.507	4.808	4.808	4.808	4.808
8	5.894	6.266	6.513	6.513	6.513	6.513
9	7.809	7.742	8.127	8.127	8.127	8.127
10	9.203	9.477	9.477	9.477	9.477	9.477
11	10.240	10.768	10.768	10.768	10.768	10.768
12	11.172	13.020	13.020	13.020	13.020	13.020
13	13.172	15.295	15.295	15.295	15.295	15.295
14	17.442	16.220	16.220	16.220	16.220	16.220

Selection pattern from a VPA:

age\year	1995	1996	1997	1998	1999	2000	98-00	Used
3	0.161	0.073	0.041	0.036	0.064	0.079	0.060	0.060
4	0.426	0.290	0.254	0.202	0.263	0.209	0.225	0.225
5	0.762	0.500	0.421	0.518	0.635	0.602	0.586	0.586
6	0.793	0.982	0.638	0.731	1.012	0.920	0.889	0.889
7	1.122	1.026	1.045	0.956	1.032	1.148	1.048	1.048
8	1.114	1.189	1.219	1.118	1.113	1.110	1.113	1.113
9	0.904	1.173	1.255	1.432	1.140	1.110	1.223	1.223
10	1.305	1.131	1.423	1.245	1.068	1.110	1.139	1.139
11	1.377	1.129	1.381	1.443	0.902	1.110	1.149	1.205
12	1.585	1.262	0.706	1.567	0.971	1.110	1.211	1.205
13	2.446	1.520	1.573	1.876	0.821	1.110	1.262	1.205
14	1.523	1.244	1.266	1.513	0.981	1.110	1.197	1.205
Ave(5-10)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Natural Mortality

age\year	2000	2001	2002	2003	2004
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

age\year	2001	2002	2003	2004
3	170.000	180.000	175.000	200.000
4	142.645			
5	34.315			
6	44.763			
7	9.864			
8	7.257			
9	3.830			
10	0.740			
11	0.380			
12	0.210			
13	0.050			
14	0.015			

Mortality proportions before spawning

age	F	M
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 3.3.24 (Continued)

Icelandic COD. Division Va.

Prognosis – Summary and plots

Catch, '000 tonnes

	1997	1998	1999	2000	2001	2002	2003	2004
Opt1	179	169	182	204	205	150	150	150
Opt2	179	169	182	204	205	164	190	224
Opt3	179	169	182	204	205	175	175	175
Opt4	179	169	182	204	205	190	190	215
Opt5	179	169	182	204	205	220	220	220

Average fishing mortality of 5-10 years old

	1997	1998	1999	2000	2001	2002	2003	2004
Opt1	0.636	0.464	0.447	0.482	0.742	0.451	0.333	0.247
Opt2	0.636	0.464	0.447	0.482	0.742	0.501	0.453	0.432
Opt3	0.636	0.464	0.447	0.482	0.742	0.542	0.421	0.323
Opt4	0.636	0.464	0.447	0.482	0.742	0.599	0.480	0.437
Opt5	0.636	0.464	0.447	0.482	0.742	0.722	0.620	0.517

Fishable stock, 4+ in '000 tonnes at the beginnig of the year

	1997	1998	1999	2000	2001	2002	2003	2004
Opt1	624	619	760	950	623	689	850	1024
Opt2	624	619	760	950	623	689	833	956
Opt3	624	619	760	950	623	689	820	960
Opt4	624	619	760	950	623	689	802	922
Opt5	624	619	760	950	623	689	765	845

Spawning stock in '000 at the time of spawning

	1997	1998	1999	2000	2001	2002	2003	2004
Opt1	273	373	328	447	245	295	390	519
Opt2	273	373	328	447	245	291	368	450
Opt3	273	373	328	447	245	288	364	466
Opt4	273	373	328	447	245	284	348	427
Opt5	273	373	328	447	245	276	316	373

Table 3.3.24 (Continued)

Prognosis - Summary table (nwwg2001)

2001				2002				2003				2004			
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)*
205	623	245	0.742	150	689	295	0.451	150	850	390	0.333	150	1024	519	0.247
				164	689	291	0.501	190	833	368	0.453	224	956	450	0.432
				175	689	288	0.542	175	820	364	0.421	175	960	466	0.323
				190	689	284	0.599	190	802	348	0.480	215	922	427	0.437
				220	689	276	0.722	220	765	316	0.620	220	845	373	0.517

The shaded option corresponds to the harvest control rule without the +- 30 thous. tonnes buffer introduced in 2000.

Table 3.3.25 Cod at Iceland. Division Va. Yield perr ecruit input data

MFYPR version 1
Run: Run1
"ICELANDIC COD (Div. Va);
Time and date: 09:58 01/05/01
Fbar age range: 5-10

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.0334	0.085	0.25	1.08165	6.02E-02	1.3083
4	0.2	0.1427	0.18	0.25	1.613	0.243746	1.8183
5	0.2	0.3511	0.248	0.25	2.36545	0.442939	2.5727
6	0.2	0.58465	0.296	0.25	3.4516	0.668573	3.5262
7	0.2	0.78135	0.382	0.25	4.77405	0.813633	4.73275
8	0.2	0.8952	0.437	0.25	6.21265	0.942937	6.1528
9	0.2	0.94515	0.477	0.25	7.6769	0.908739	7.6177
10	0.2	0.96145	0.477	0.25	9.33085	0.849379	9.34685
11	0.2	0.9933	0.477	0.25	11.0764	0.774328	11.0115
12	0.2	0.97855	0.477	0.25	12.78245	0.770358	13.02055
13	0.2	0.9915	0.477	0.25	14.39255	0.825857	14.5734
14	0.2	1	0.477	0.25	16.24015	0.812945	16.25435

Weights in kilograms

Table 3.3.26. Cod at Iceland. Division Va. Yield per recruit: Summary table

MFYPR version 1
Run: Run1
Time and date: 09:58 01/05/01
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJ	SSBJan	SpwnNosS	SSBSpwn
0	0	0	0	5.0162	23.0225	2.5159	18.0281	2.3932	17.1489
0.1	0.0771	0.1833	1.0439	4.382	17.0417	1.9464	12.349	1.7978	11.3408
0.2	0.1542	0.296	1.4948	3.9461	13.2937	1.5668	8.8459	1.4109	7.8635
0.3	0.2313	0.3703	1.6785	3.6334	10.8549	1.3039	6.6109	1.1489	5.7065
0.4	0.3084	0.4225	1.7426	3.3998	9.2047	1.115	5.1339	0.9645	4.3179
0.5	0.3855	0.4616	1.754	3.2187	8.0436	0.9745	4.1223	0.8298	3.3897
0.6	0.4626	0.4921	1.743	3.0738	7.1953	0.8665	3.4052	0.7281	2.746
0.7	0.5397	0.5169	1.7235	2.9547	6.5538	0.7814	2.88	0.649	2.2839
0.8	0.6168	0.5376	1.7014	2.8543	6.0533	0.7125	2.4835	0.5859	1.9414
0.9	0.6939	0.5554	1.6795	2.7683	5.652	0.6557	2.1762	0.5344	1.6801
1	0.771	0.5709	1.6587	2.6933	5.3226	0.608	1.9324	0.4916	1.4758
1.1	0.8481	0.5846	1.6394	2.6271	5.0468	0.5673	1.7348	0.4554	1.3123
1.2	0.9252	0.5968	1.6217	2.5679	4.812	0.5322	1.5719	0.4245	1.1791
1.3	1.0023	0.6078	1.6054	2.5146	4.6092	0.5016	1.4356	0.3977	1.0687
1.4	1.0794	0.6179	1.5905	2.4662	4.4318	0.4747	1.3199	0.3742	0.976
1.5	1.1566	0.6271	1.5768	2.4219	4.2752	0.4507	1.2207	0.3535	0.897
1.6	1.2337	0.6356	1.5642	2.3812	4.1355	0.4293	1.1347	0.3351	0.8291
1.7	1.3108	0.6434	1.5526	2.3435	4.01	0.41	1.0595	0.3186	0.7701
1.8	1.3879	0.6507	1.5418	2.3085	3.8965	0.3926	0.9932	0.3038	0.7185
1.9	1.465	0.6576	1.5317	2.2759	3.7932	0.3767	0.9345	0.2903	0.6729
2	1.5421	0.664	1.5224	2.2453	3.6987	0.3622	0.8821	0.2781	0.6325

Reference	F multiplier	Absolute F
Fbar(5-10)	1	0.771
FMax	0.4865	0.3751
F0.1	0.2656	0.2048
F35%SPR	0.2833	0.2184
Flow	0.3456	0.2665
Fmed	0.6581	0.5074
Fhigh	1.0881	0.839

s Weights in kilograms

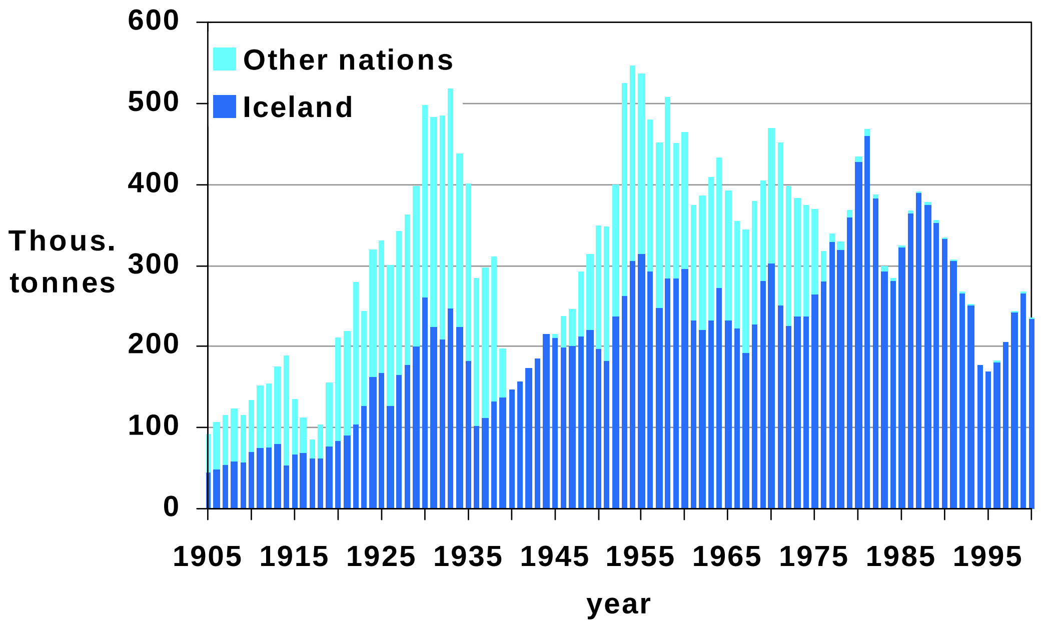


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.

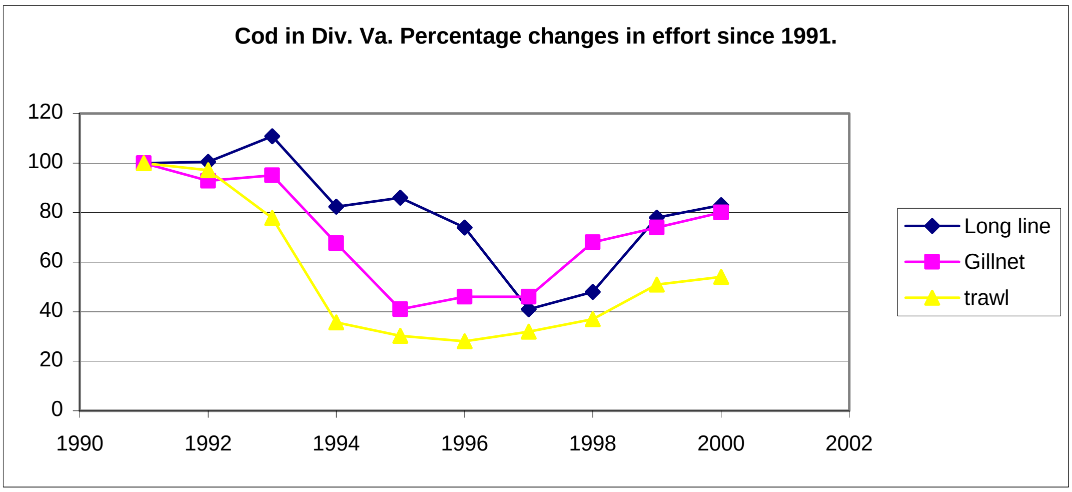


Figure 3.3.2.A Cod at Iceland Division Va. Percentage changes in effort for the main gears since 1991.

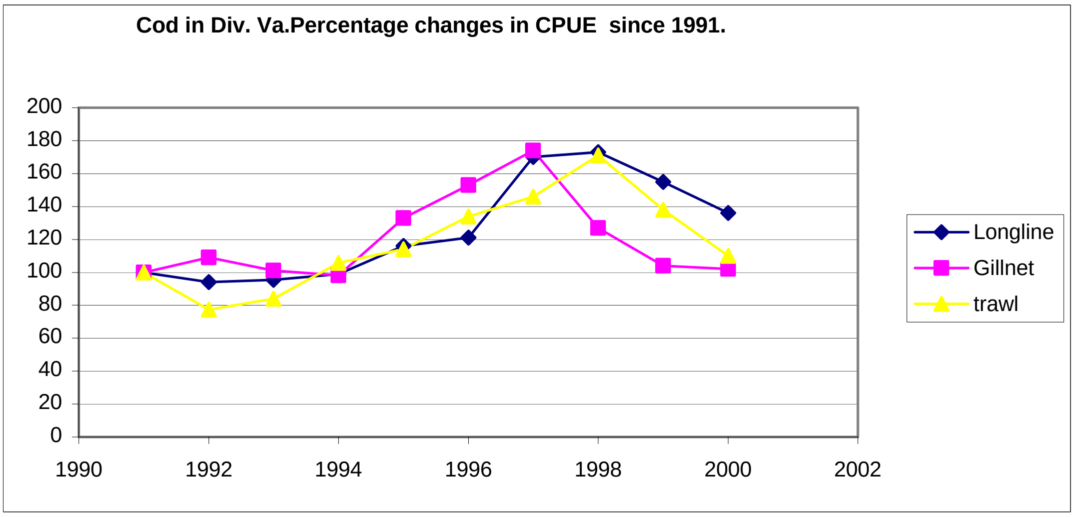


Figure 3.3.2.B Cod at Iceland Division Va. Percentage changes in CPUE for the main gears since 1991.

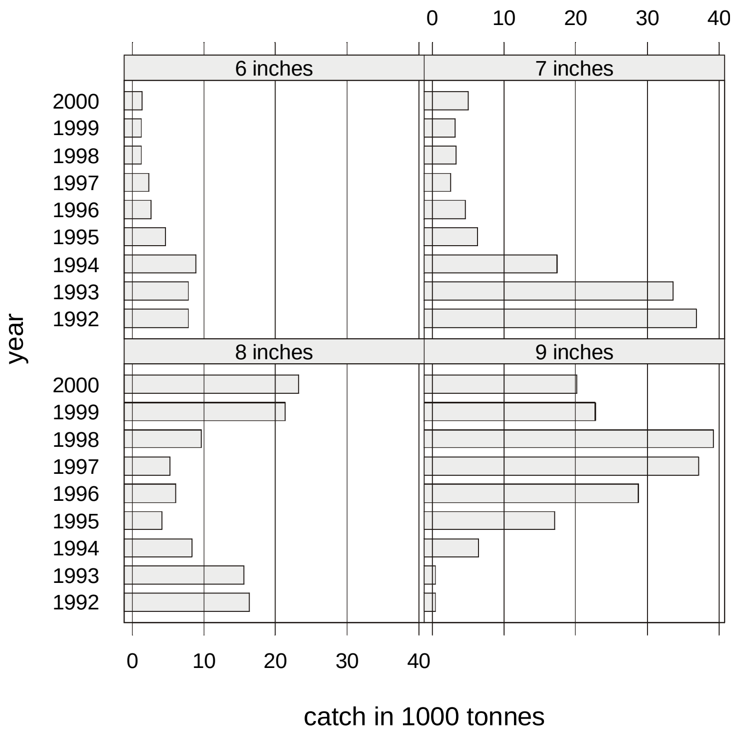


Figure 3.3.3 Cod at Iceland Division Va. Landings in gillnets split by mesh size.

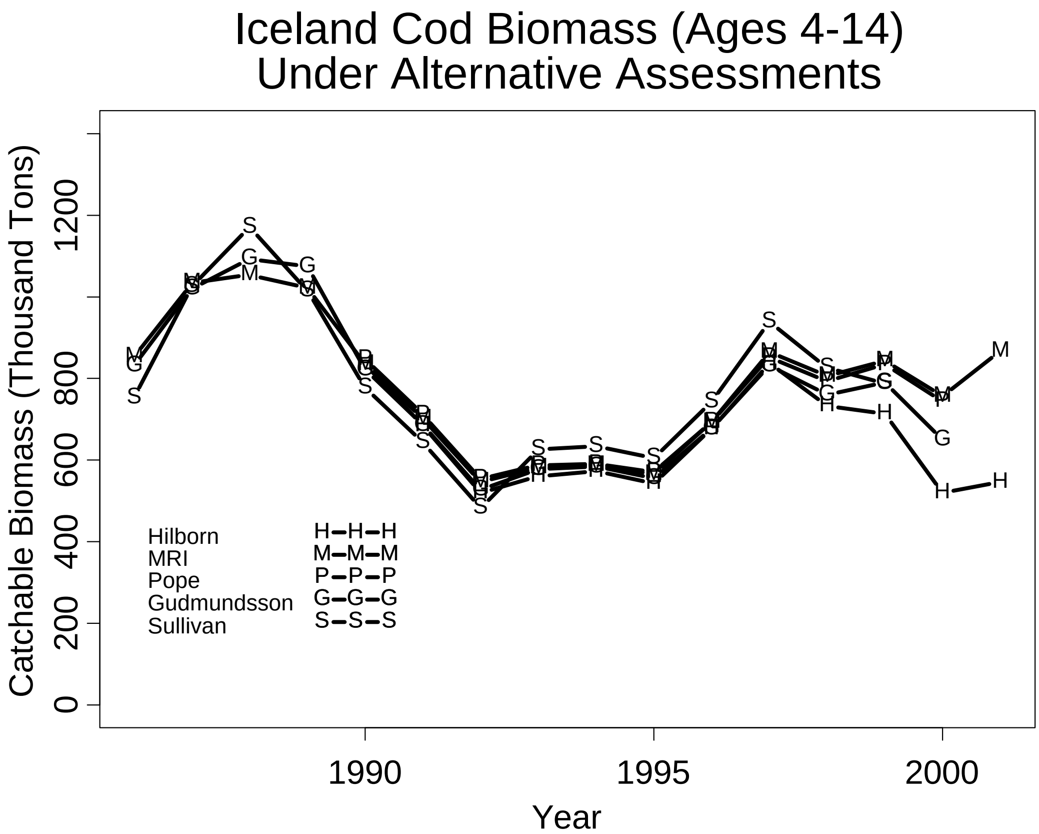


Figure 3.3.4. Results from the various assessments models run at the review workshop last year.

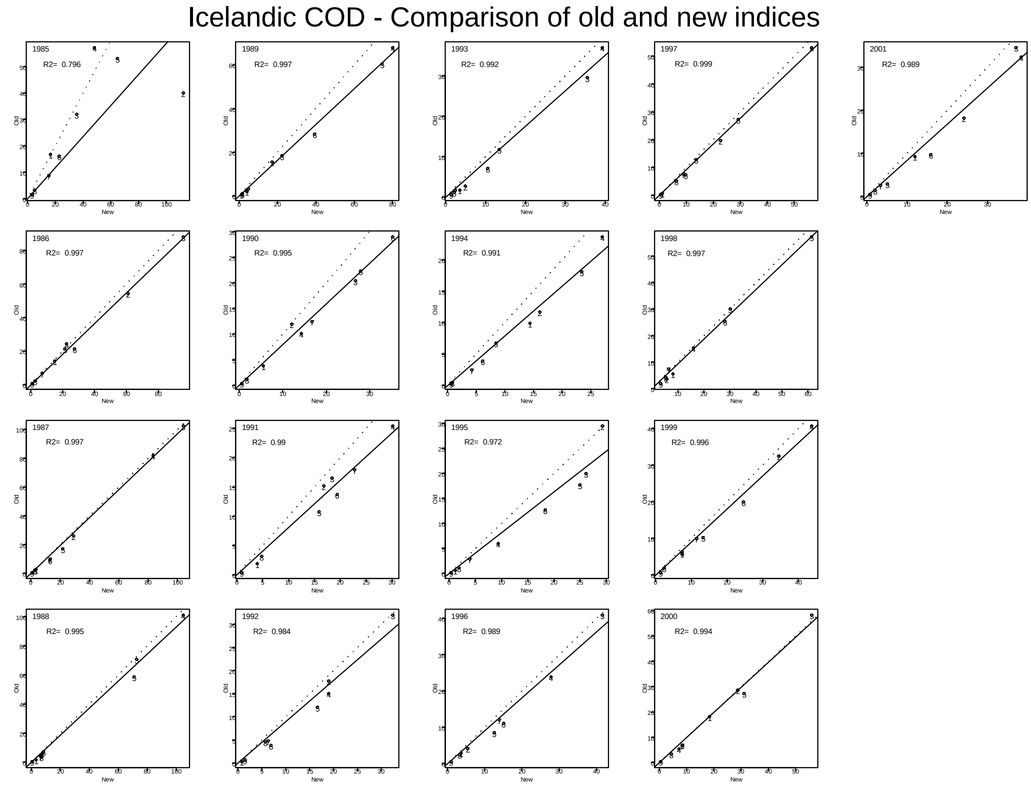


Figure 3.3.5 Cod at Iceland Division Va. Comparison of Cohran indices and the indices that have been used in recent years.

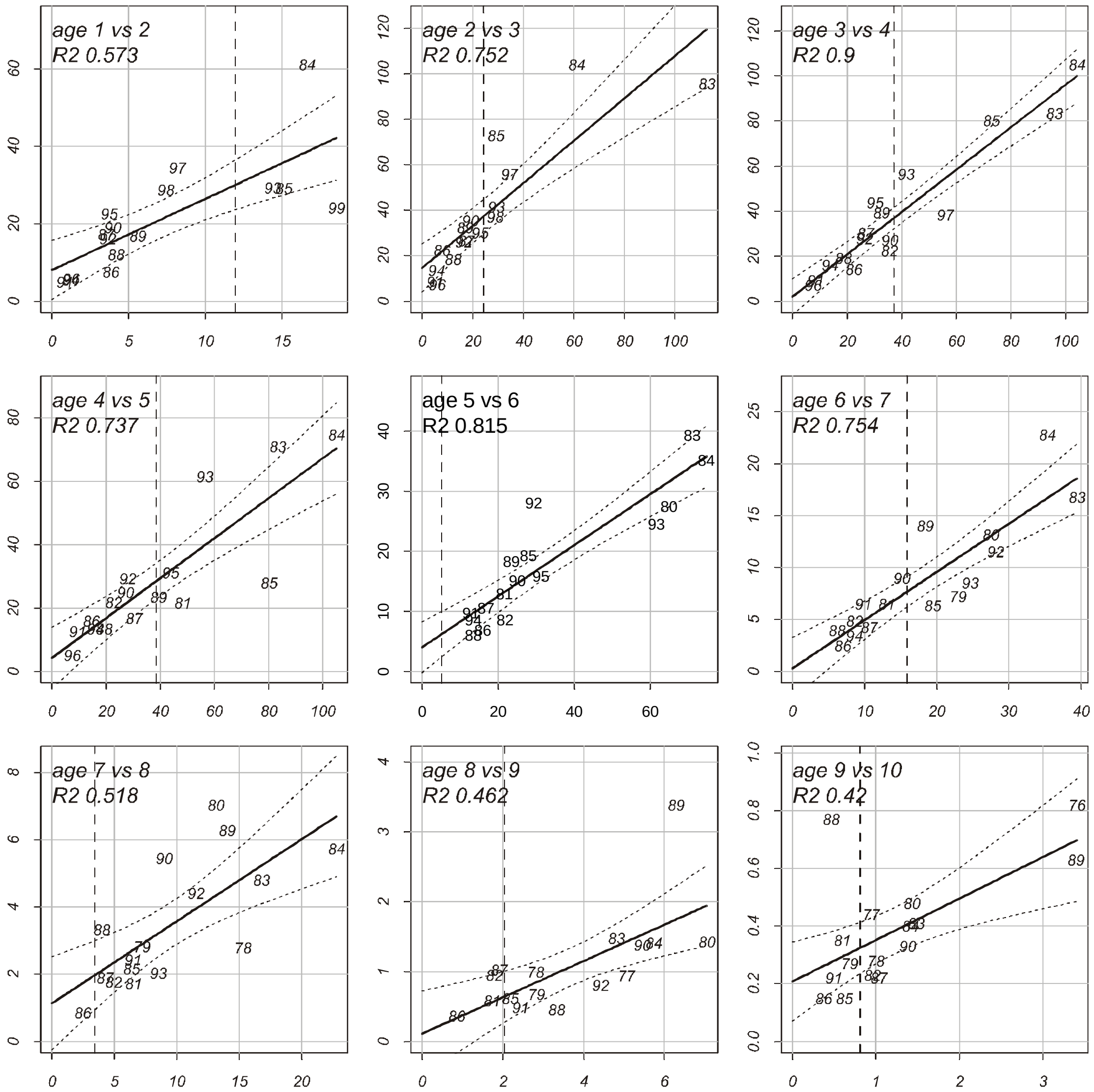
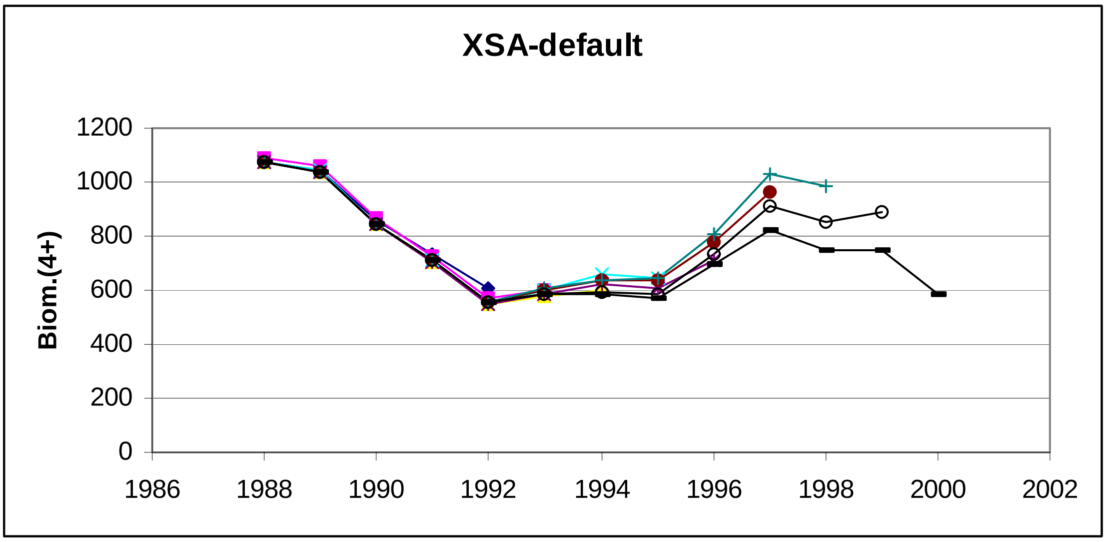
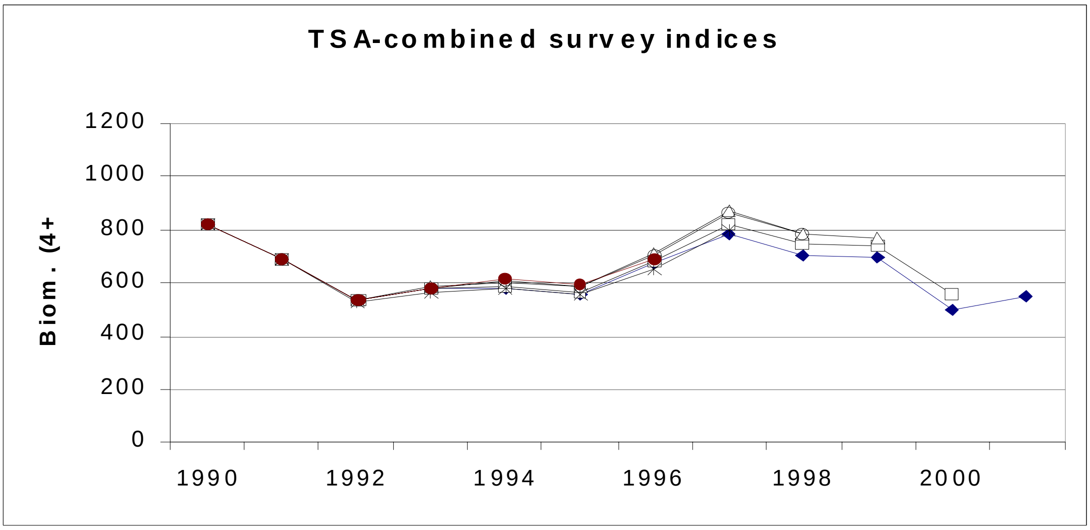


Figure 3.3.6 Cod at Iceland Division Va. Index from the groundfish survey vs. index of the same yearclass in the survey a year later.





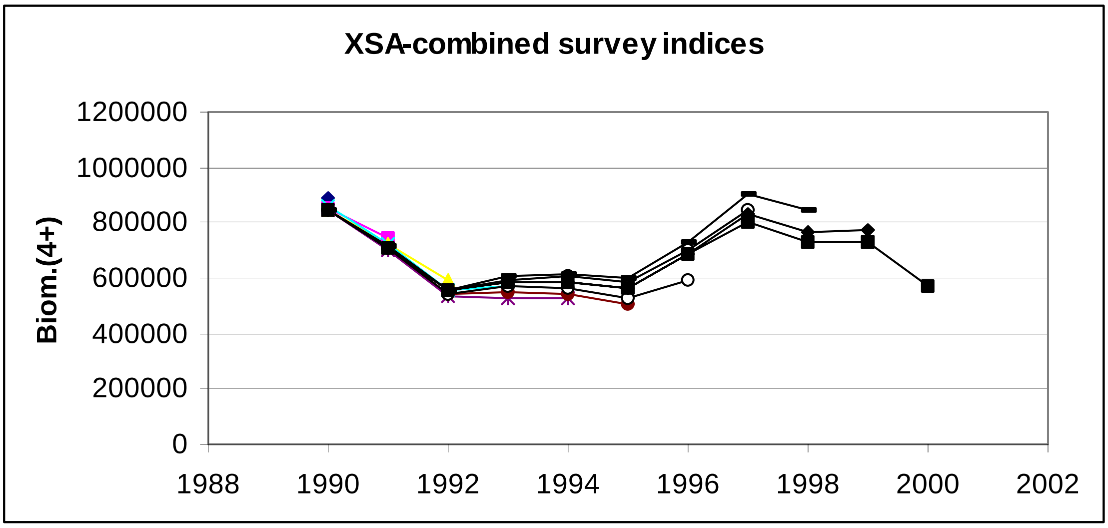
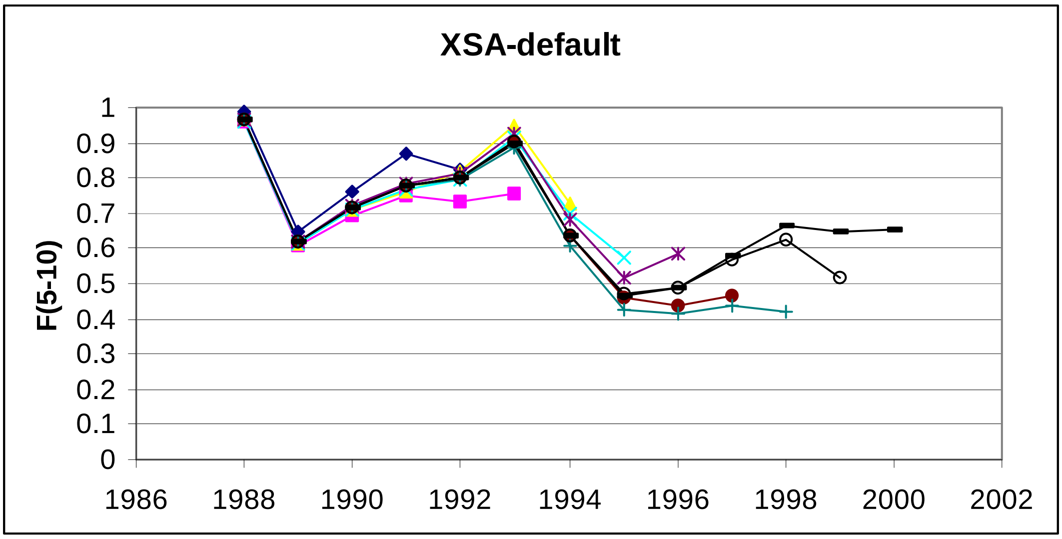
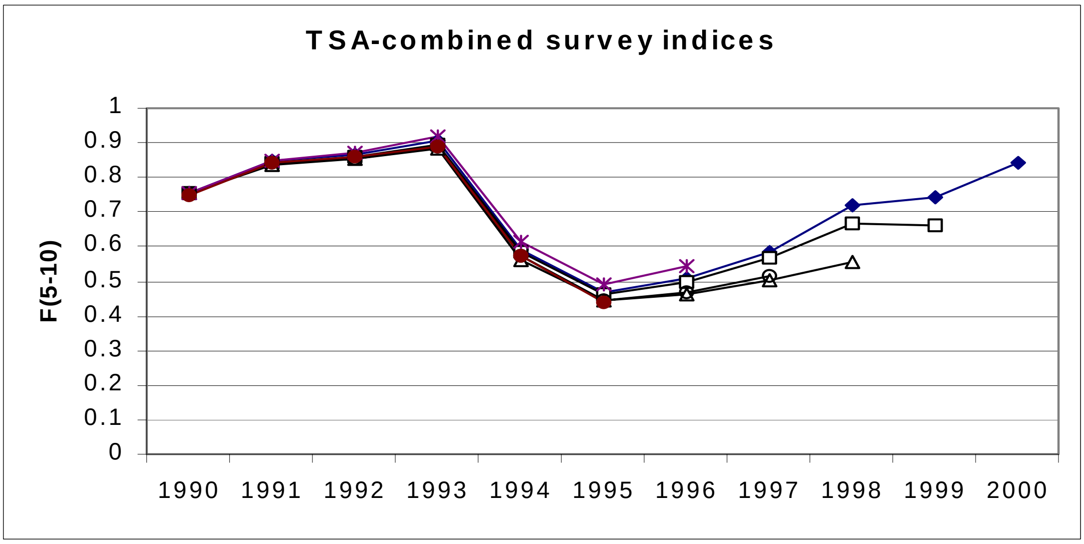


Figure 3.3.7 Retrospective pattern from assessment runs. The figure shows number of age 4 and older multiplied by the weight at age in the catches.





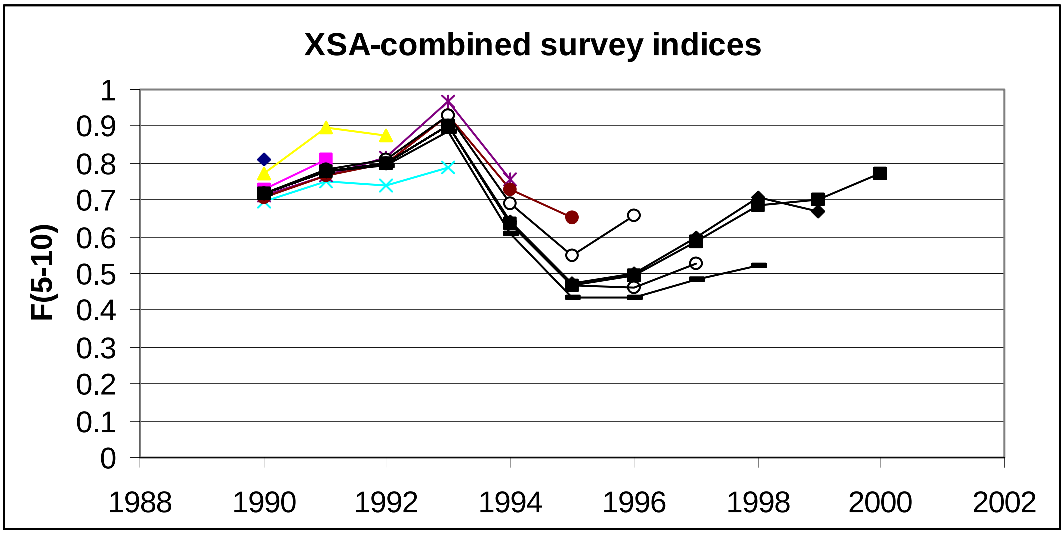


Figure 3.3.8 Retrospective pattern from assessment runs The figure shows mean fishing mortality of ages 5 to 10.

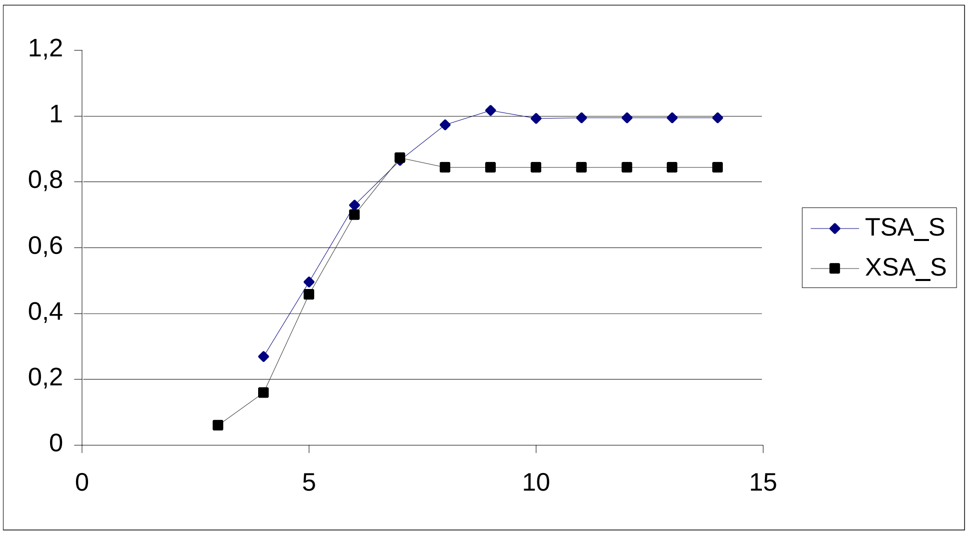


Figure 3.3.9 Comparison of fishing mortalities according to XSA and TSA runs using the groundfish survey for tuning.

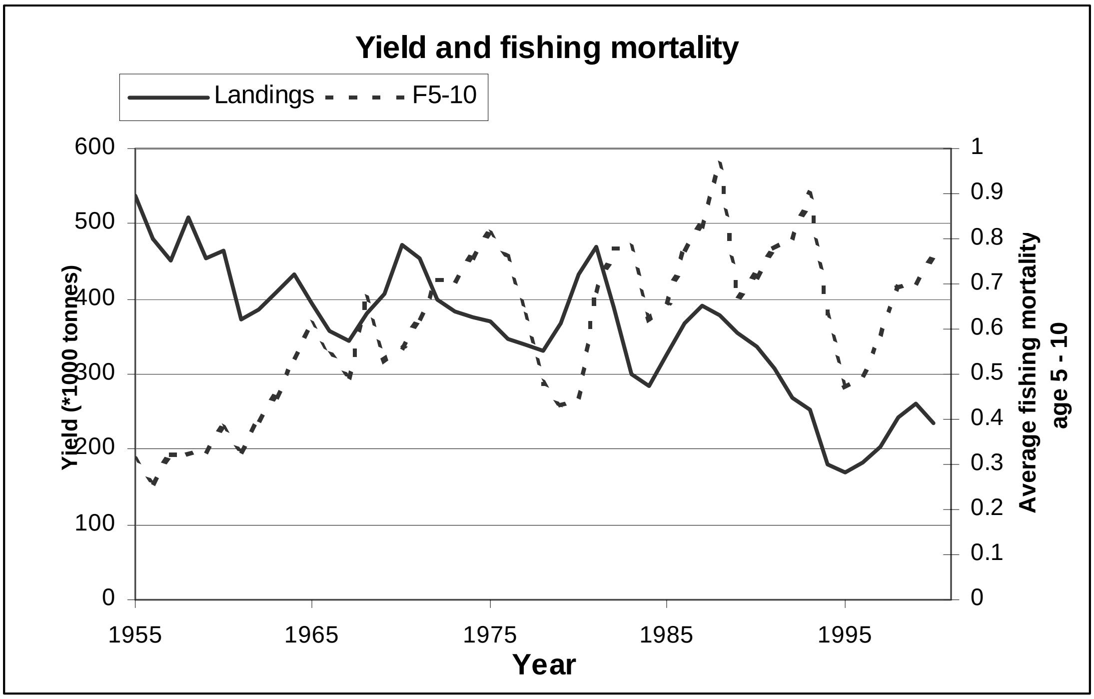


Figure 3.3.10 Yield and fishing mortality

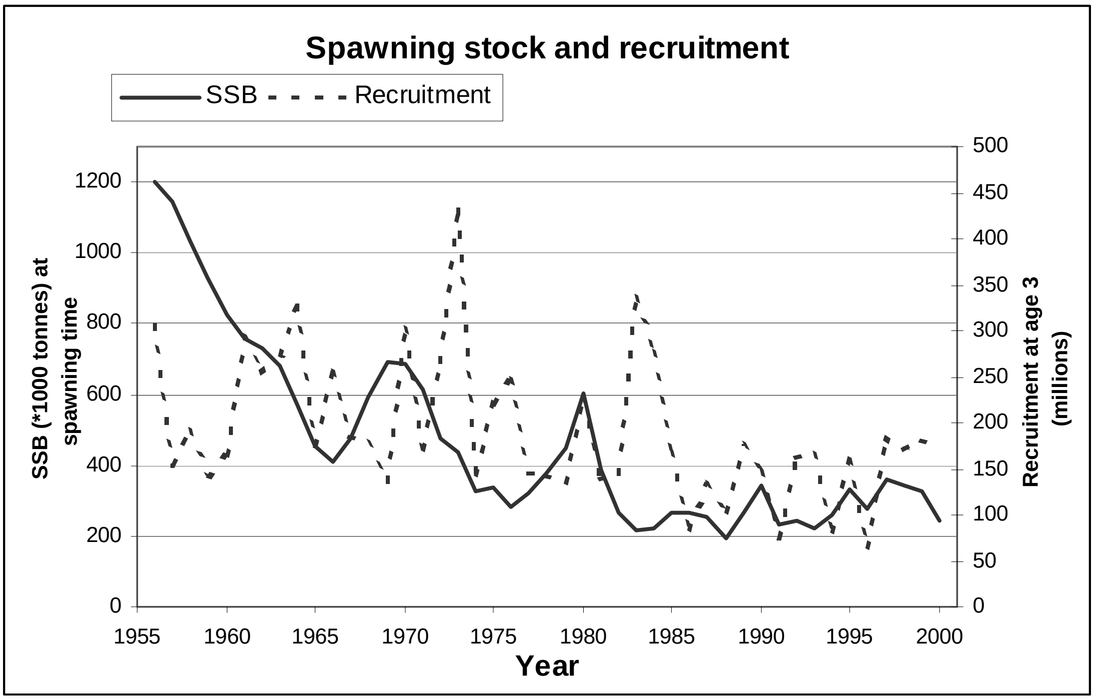


Figure 3.11. Spawning stock and recruitment

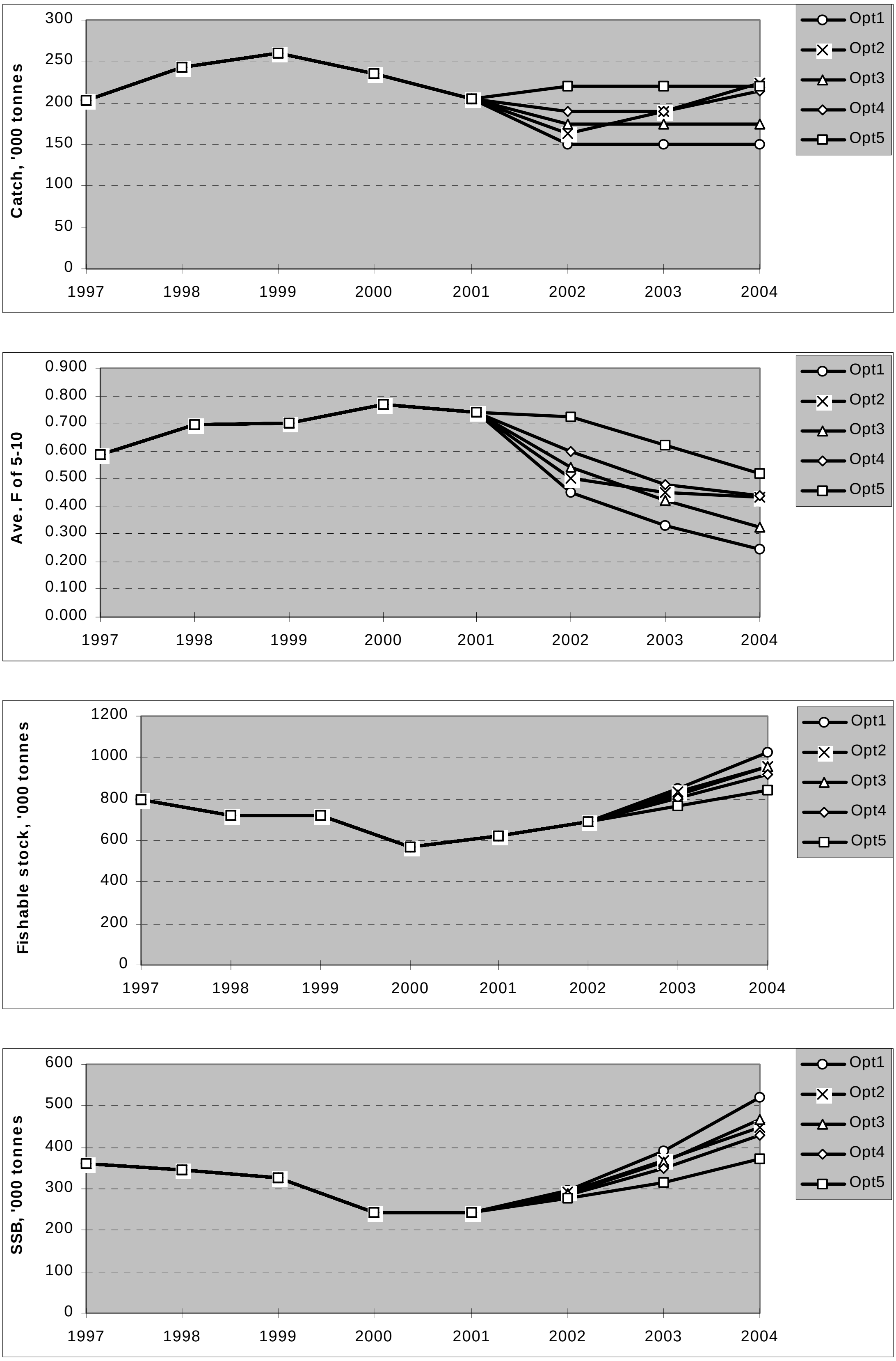
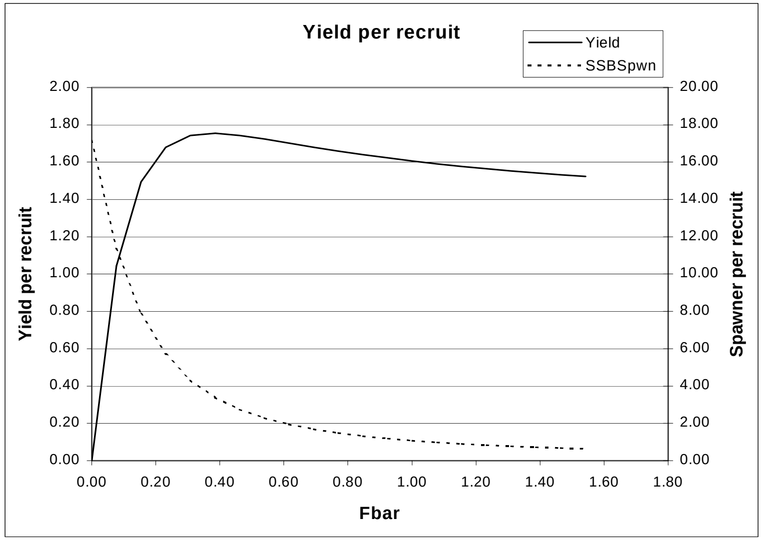
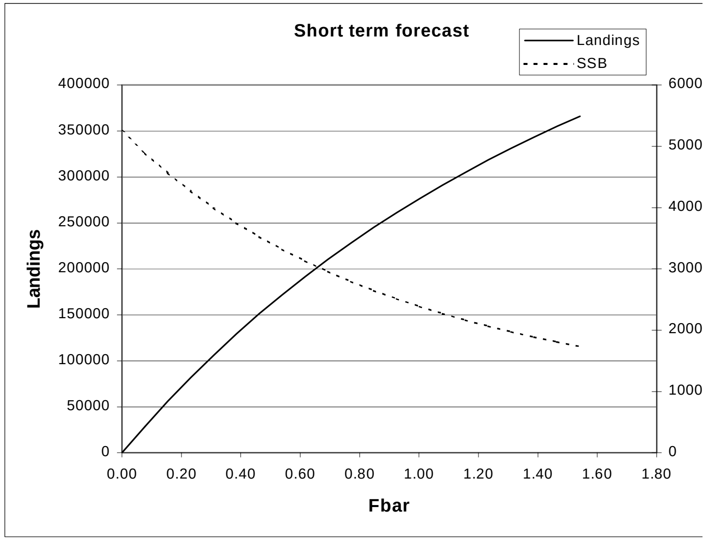


Figure 3.3.12 Results of different management options





MFYPR version 1
Run: Run1
Time and date: 09:58 01/05/01

Reference point	F multiplier	Absolute F
Fbar(5-10)	1.0000	0.7710
FMax	0.4865	0.3751
F0.1	0.2656	0.2048
F35%SPR	0.2833	0.2184
Flow	0.3456	0.2665
Fmed	0.6581	0.5074
Fhigh	1.0881	0.8390

Weights in kilograms

MFDP version 1
Run: Run1
"ICELANDIC COD (Div. Va);
Time and date: 21:10 30/04/01
Fbar age range: 5-10

Input units are thousands and kg - output in tonnes

Figure 3.3.13 Yield per recruit and short term forecast

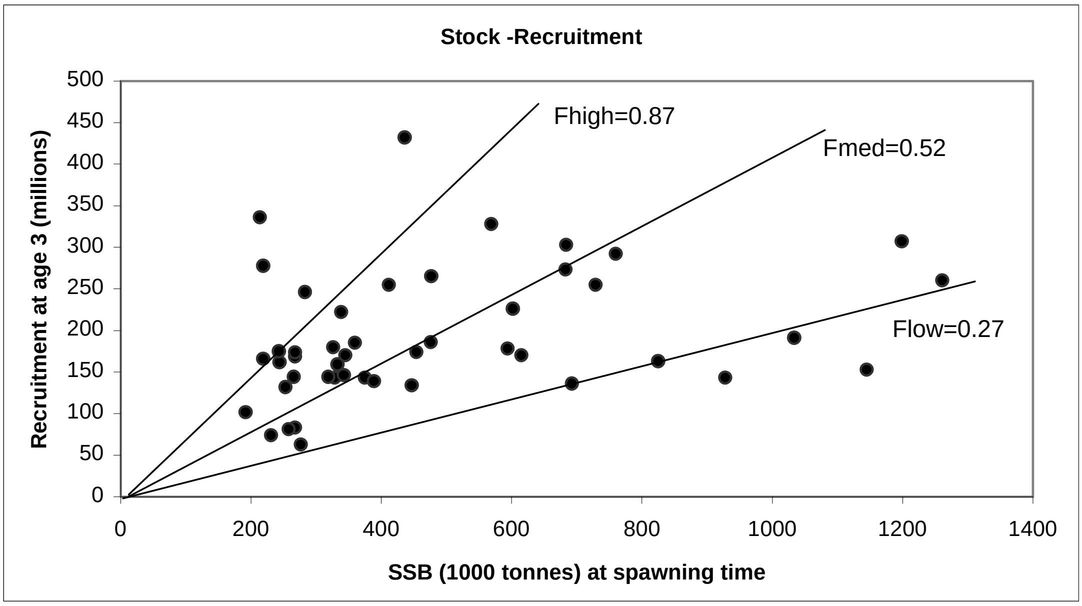


Figure 3.3.14 Spawning stock biomass and recruitment at age 3

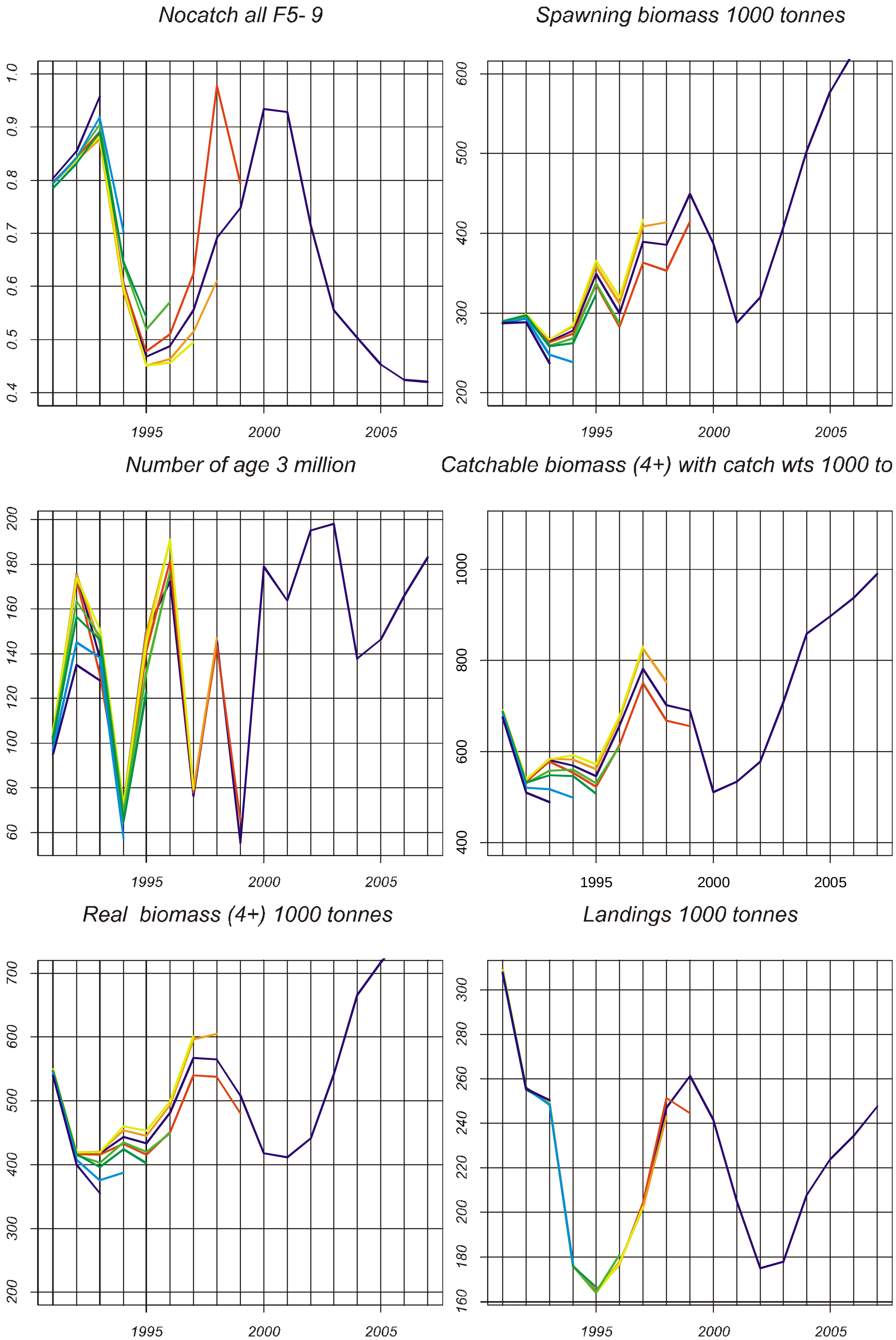


Figure 3.3.15 Cod division Va Retrospective pattern in estimation Stock estimate for 2001 is projected till 2006 using the new catch rule with limit on changes.

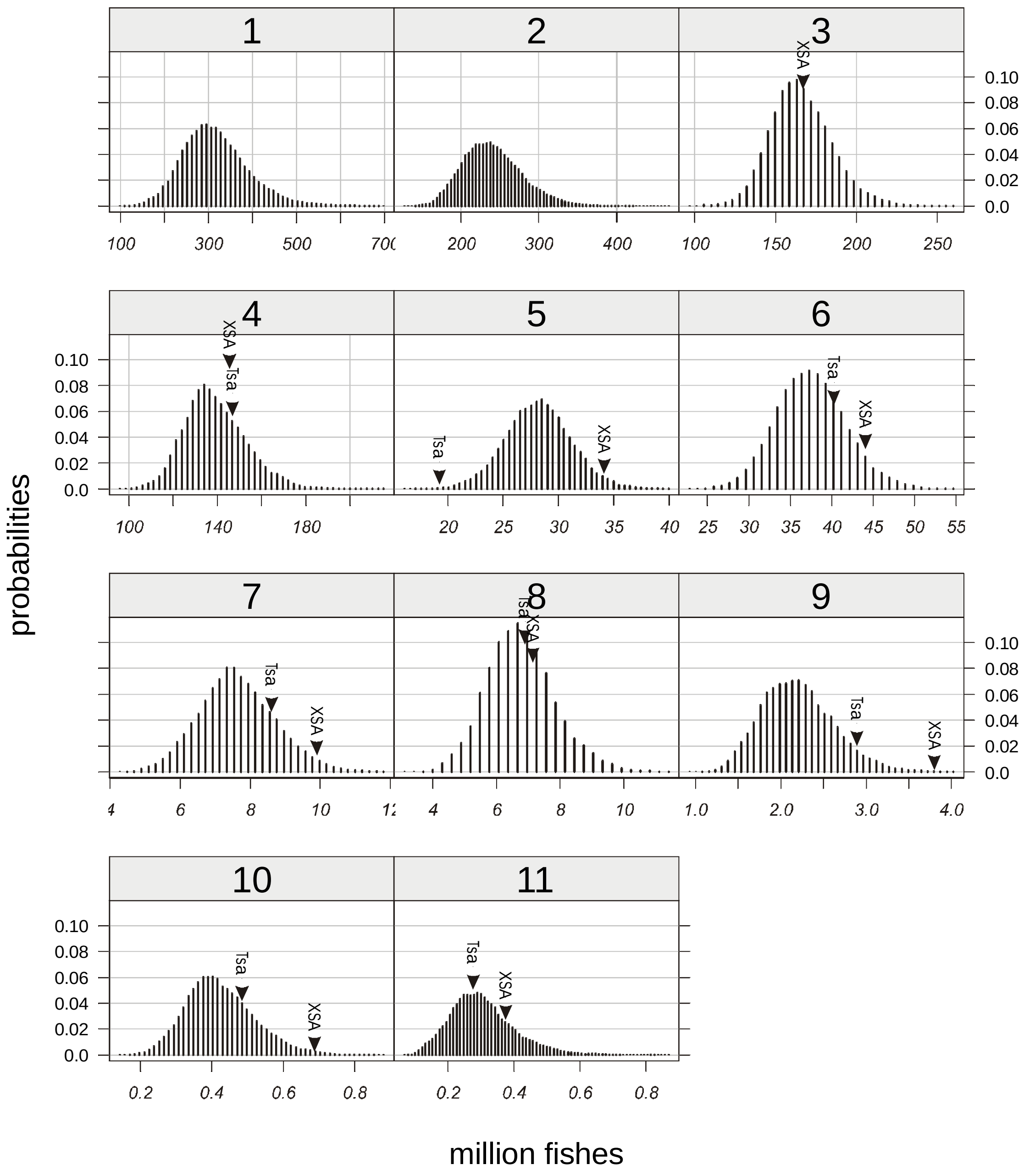


Figure 3.3.16. Cod division Va. Number in stock in the beginning of the year 2001.

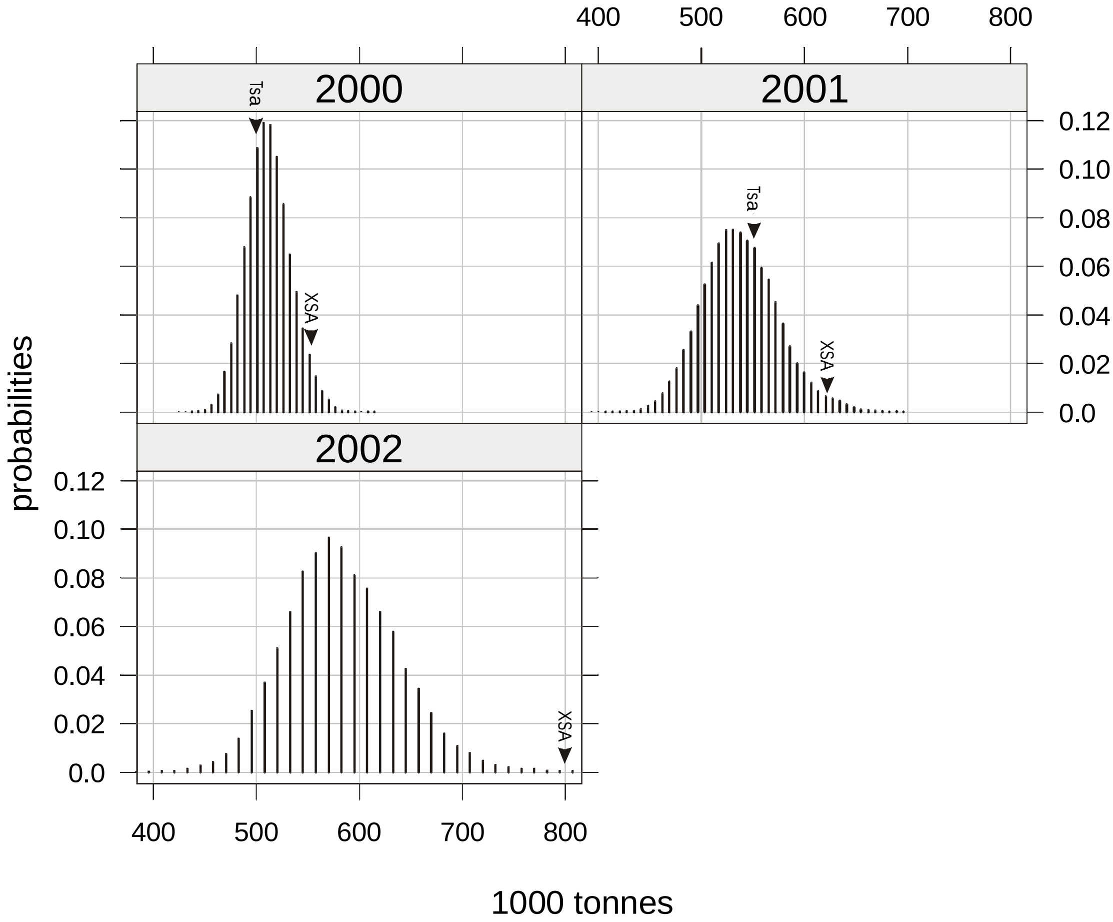


Figure 3.3.17. Cod division Va Likelihood profiles of catchable biomass. Results from XSA and TSA shown for comparison.

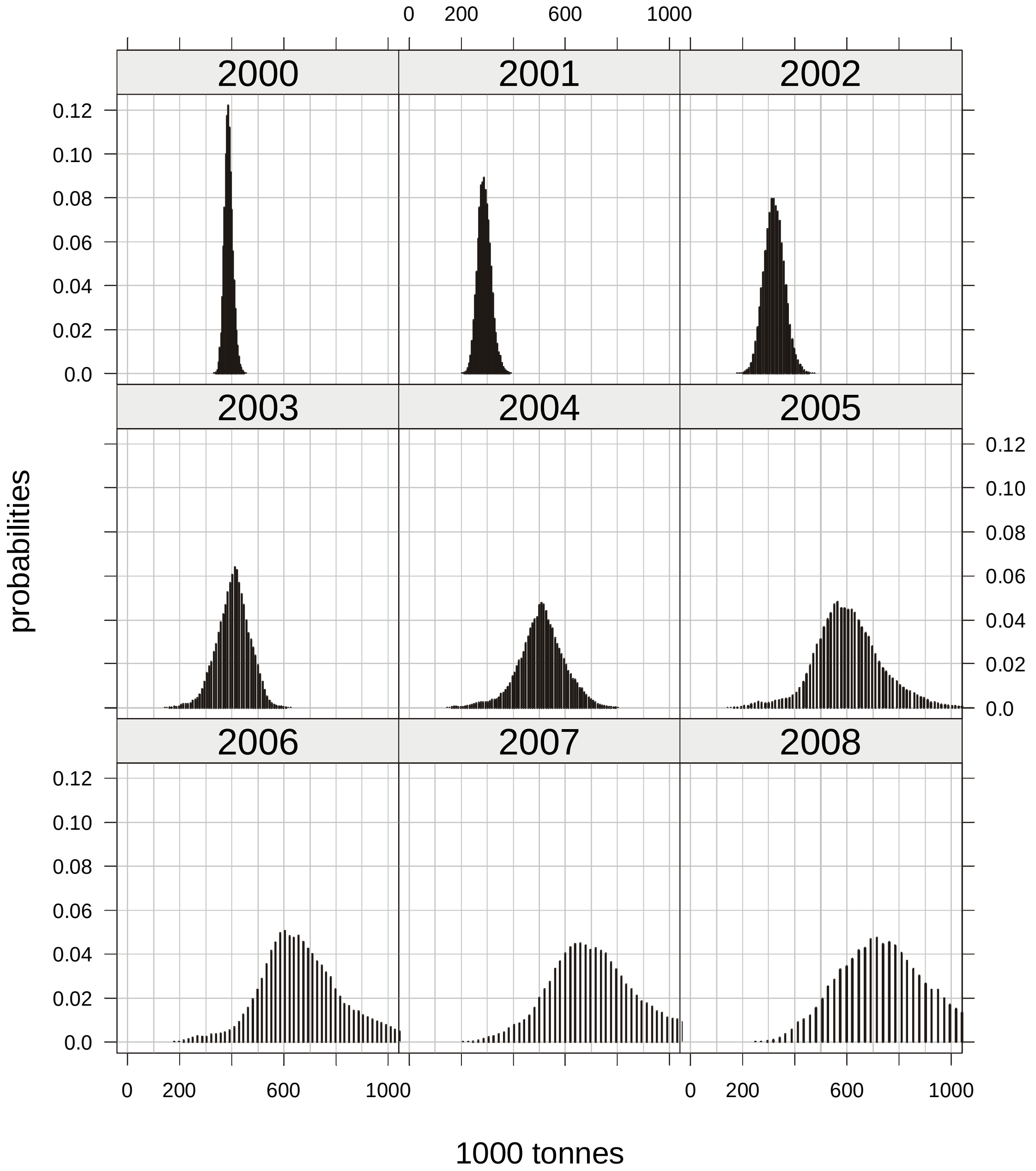


Figure 3.3.18 Cod division Va Likelihood profiles of spawning stock biomass.

3.4 Icelandic haddock

3.4.1 Introductory comment

Haddock (*Melanogrammus aeglefinus*) in Icelandic waters is only connected with other haddock stocks in that 0-group and occasionally young fish found in E-Greenland waters originate from the Icelandic stock. The species is distributed all around the Icelandic coast, principally in the relatively warm waters off the west and south coast, on fairly shallow grounds. It is also found off the North coast and in warm periods a large part of the immature haddock can be found in that area.

Icelandic haddock was assessed at the North-Western Working Group in 1970 and 1976 but otherwise assessments were conducted by the Marine Research Institute in Iceland until in 1999 when it was again assessed by the North-Western Working Group.

3.4.2 Trends in landings and fisheries

During the sixties haddock landings rose to a record level of around 100 000 tonnes for several years (Figure 3.4.2.1) After that, landings have been between 40 000 and 65 000 tonnes. Historically landings by foreign fleets accounted for up to half of the total landed catch. Since 1976 fisheries by foreign nations have been negligible except a small catch by the Faroese. Haddock landings are subject to fluctuations, reflecting variability in stock biomass and recruitment which is very variable.

The landings in 2000 are estimated as 42200 tonnes decreasing from 45500 tonnes in 1999. In last year the forecasted landings for the year 2000 were 39000 tonnes, 3000 tonnes less than what was caught.

In 2000, 56% of landings were by demersal trawl, 7% by Danish seine, 32% by long line and 4% by gillnets, similar to 1999. The share of longline in the fishery increased between 1998 and 1999 but the share of gillnets decreased. This increase was due to increased longline effort where cod is probably the main target species.

3.4.3 Catch at age

Catch at age for 2000 for the Icelandic fishery is provided in Table 3.4.3.1. Catch at age is calculated by 3 fleets and two time intervals. The time intervals are January-May and June-December and the fleets are gill nets, long line and bottom trawl. Hand lines are included with the long line fleet. Danish seine (as well as minor units such as pelagic trawl and other gears which are dragged or hauled) are included in the trawl feet. The Faroese catch that is caught by long line is included in that category. Numbers sampled in 2000 are given below.

Gear	Total landings	Number length measured	Number aged
Longline	13000	12654	2142
Gillnets	1600	1353	397
Danish Seine	3100	796	3114
Trawl	22990	62112	5617
Total	42000	80007	9151

Figure 3.4.3.1 show the catch in number plotted on log scale. The curves indicate that total mortality is high or close to 1 for the oldest haddock. The 1976 yearclass is shown for comparison but the fishing mortality was low in the early eighties. Figure 3.4.3.1 indicates that CV in these data is low. Shephard Nicholson model gives a CV of 20% for age groups 2-8.

3.4.4 Weight and maturity at age

Mean weight at age in the catch is shown in Table 3.4.4.1

Mean weight at age in the stock for 1981–2001 is given in Table 3.4.4.2. Those data are calculated from the Icelandic groundfish survey. Weights for 1985–1992 were calculated using a length-weight relationship, which is the mean from the years 1993–2000. Weights from 1993 onwards are based on weighting of fish in the groundfish survey each year. Stock weights prior to 1985 have been taken to be the mean of 1985-1999 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 yearclasses (1990 and 1995) grow slower.

Maturity at age data are given in Table 3.4.4.3. They show high maturity at age in recent years compared to earlier years. Maturity at age data from 1985 onwards are taken from the groundfish survey but maturity at age in catches January - May is used 1980 to 1984.

3.4.5 Survey and CPUE data

Haddock is one of the most abundant fishes in the Icelandic groundfish survey, being caught in large number at age 1 and becoming fully recruited at age 2 or 3. The survey indices seem to be good indices of stock size and the relationship between number in stock and survey index is close to linear for all age groups. Figure 3.4.5.1 shows abundance indices from the survey plotted on log scale. Compared to catch curves from the commercial catch (Figure 3.4.3.1) the survey indices indicate higher mortality. Age disaggregated indices from the survey are given in Table 3.4.5.1.

Running the Shephard Nicholson model on the survey gives CV of 25% for ages 1 to 7 but 34% if ages 8 and 9 are included. The consistency of the survey indices can also be seen in figure 3.4.5.3 where the abundance indices of a yearclass are plotted against the abundance indices of the same yearclass one year later.

The total and catchable biomass in the survey is shown in Figure 3.4.5.2. The total biomass was at record low in 2000 but has increased since then due to good recruitment.

CPUE from the commercial fleet are shown in Figure 3.4.5.4. The figure is calculated from records where more than 50% of the catch is haddock. The commercial catch does not indicate the same drop as seen in the survey. Figure 3.4.5.5 compares catchable biomass from the survey, VPA and bottom trawl. The figure is based on data from 1991 but in that year logbooks were made mandatory. The figure seems to indicate that the catch per unit effort by trawlers is more stable than the VPA and the survey.

3.4.6 Stock Assessment

3.4.6.1 Tuning input

Last years assessment was based on 3 tuning fleets, the groundfish survey 1985 – 2000, age 3 – 9, CPUE from trawlers 1993-1999, age 4-9 and CPUE data from gillnets 1992 – 1999 age 5-8. The GLIM indices, based on settings where more than 50% of the catch was haddock (Stefansson 1988), were used for the gillnets, while raw CPUE from tows where more than 70% of the catch was haddock was used for trawlers. Indices were age disaggregated according to catch in number for the gear.

In this years assessment it was decided not to use multiple indices, letting XSA select the weights on different fleets. This decision was based on recommendations of the meeting about the assessment of the Icelandic cod in November 2000 (Pope 2000). Instead XSA runs were made using one fleet at a time, though the survey was always used for the youngest age groups. The 2 runs that were most thoroughly investigated were run using survey only and run using survey for ages 2-4 and bottom trawl indices for ages 5 –9. The run using survey only gave higher fishing mortality than and lower biomass than the default run from last year (F = 0.82 vs 0.66, SSB=51000 vs. 55000 tonnes)

Analysis of CPUE of trawlers, survey indices and VPA estimates indicates increased efficiency of the trawler fleet (Figure 3.4.5.5). Therefore CPUE indices from the survey were the only tuning data used in the final run. Tuning input is shown in Table 3.4.6.1.1.

3.4.6.2 Tuning and estimation of fishing mortality

The XSA run used for the assessment uses survey indices from age 1985-2001, ages 2-9 for tuning. Shrinkage was set to 2 years and 2 ages with SE = 0.5. Varying the shrinkage did not affect the results much. Catchability of all age groups was independent of stock size.

Result from the XSA run are given in Tables 3.4.6.2.1 and 3.4.6.2.2. The resulting mean F in 2000 for age groups 4–7 from the final run was 0.81. The plot of yield and fishing mortality (Figure 3.4.6.2.1) indicates that fishing mortality increased substantially in 1986 before falling slightly the following year and has been stable since but increasing in the recent years.

Retrospective pattern from the final run is shown in Figure 3.4.6.2.2. The retrospective patterns show good consistency with a tendency to underestimate the stock in recent years.

Looking at the composition of the stock in the beginning of 2001 the most important yearclasses are the 1995 yearclass and the recruiting yearclasses (1998 and younger).

3.4.6.3 Stock and recruitment estimates

The resulting stock size in numbers and summary table from the final XSA are given in Tables 3.4.6.2.1 and 3.4.6.2.2 and summary plots in Figure 3.4.6.2.1. The spawning stock and recruitment plot (Figure 3.4.6.3.1) shows that although SSB is highly variable - ranging from a low of 42 000 tonnes in 1987 to a maximum of 110 000 tonnes in 1982 - there are no trends. The spawning stock in 2000 is estimated to be 51,000 tonnes, decreasing to 45,000 tonnes in 2001, which is the second lowest since 1980.

3.4.7 Prediction of catch and biomass

3.4.7.1 Input data

The input data for the prediction are shown in Table 3.4.7.1.1.

For the short-term catch prediction and stock biomass calculations, the mean weight at age 3–8 in the catches in 2001 were predicted using regression analysis, where the mean weight at age was predicted by the mean weight of the same year class in the previous year. For the years 2002 to 2004 the mean for the years 1998 – 2000 was used. For age groups 2, the mean of the years 1998–2000 was used.

For the stock weights survey weights for the year 2001 were used for that year but for the year 2002 mean weight at age was predicted by mean weight of the same year class in the survey in 2001. For 2003 and 2004 the mean of the weights in 1999-2001 was used.

The exploitation pattern was taken as the mean exploitation pattern from 1996–2000.

Recruitment for yearclasses 1999 – 2000 was estimated using the RCT3 prediction program with input from VPA runs and the survey indices (age 1-4) (Tables 3.4.7.1.2 and 3.4.7.1.3). Recruitment for yearclasses 2001 and 2002 was taken to be the geometric mean of recruitment from 1980–1999. A TAC constraint of 42 000 tonnes was applied to the prediction for the year 2001 but it is the predicted catch in the year 2001.

For the long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the mean relative fishing mortality from 1981-2000. Mean weight at age in the stock and the maturity ogive are means from 1985-2000. Mean weight at age in the catch is the mean from 1980-2000. Input data for long term yield per recruit are given in Table 3.4.7.1.4.

3.4.7.2 Biological reference points

The yield per recruit is shown in Figure 3.4.7.2.1.

Compared to the estimated fishing mortality of $F_{4–7}$ = 0.81 for 2000, $\mathbf{F}_{max}$ = 0.57 and $\mathbf{F}_{0.1}$ = 0.30.
Yield per recruit at $\mathbf{F}_{max}$ corresponds to 0.86 kg (Table 3.4.7.2.1).

A plot of spawning stock biomass and recruitment from 1981-2000 is shown in Figure 3.4.7.2.2. The SSB-recruit reference points $\mathbf{F}_{med}$ and $\mathbf{F}_{high}$ are 0.43 and 1.15 respectively, where $\mathbf{F}_{high}$ is the fishing mortality rate with SSB/R equal to the inverse of the 90th percentile of the observed R/SSB.

Work has been done in constructing a longer time series of data than used in the present assessment (Taylor NWWG:1999). Preliminary results are available back to 1960. It is not always easy to select which samples to use for calculating catch in numbers from the old data. Therefore 5 different sets of catch in number have been presented.

According to preliminary runs the fishing mortality was high (0.7) during the sixties and early seventies but dropping to 0.4 in the late seventies with the introduction of the very good 1976 yearclass to the fishery at the same time as reduction of foreign catch. The fishing mortality in 1980 was 0.4, which is the lowest in the timeperiod, and there are only 3 years since 1962 where the fishing mortality was below the proposed $\mathbf{F}_{pa}$ of 0.47. $\mathbf{F}_{crash}$ was larger than 1.3 irrespective of which data set was chosen. Therefore $\mathbf{F}_{crash}$ is an unsuitable candidate for $\mathbf{F}_{lim}$.

The data were used to calculate reference points. $\mathbf{F}_{MSY}$ varied from 0.53 to 0.61 and $\mathbf{F}_{med}$ from 0.51 to 0.62, depending on which data set was selected. This is to be contrasted with $\mathbf{F}_{med}$ = 0.44 obtained using data since 1981 to 2000. The dataset having the best internal consistency according to the Shephard-Nicholson model gives $\mathbf{F}_{med}$ = 0.525 and $\mathbf{F}_{MSY}$ = 0.51, both above the proposed $\mathbf{F}_{pa}$ of 0.47, but close to it.

Last year the working group proposed provisional $\mathbf{F}_{pa}$ set to the $\mathbf{F}_{med}$ value of 0.47 obtained using the data from 1980 to 1999. Since 1986 $F_{4–7}$ has exceeded $\mathbf{F}_{max}$ and for only 4 years since 1960 has $F_{4–7}$ been lower than $\mathbf{F}_{med}$.

3.4.7.3 Projection of catch and biomass

At the beginning of 2001, the biomass of age 3+ is predicted to be 82 000 tonnes with a spawning stock of 45 000 t (Table 3.4.7.3.1). The forecast from last year for the year 2001 were 63 000 tonnes for the spawning stock biomass. Of this discrepancy 3000 tonnes can be explained by more than anticipated catch, 1-2 thousand tonnes by less than anticipated weight in stock but the rest by change in stock estimate. If the same tuning fleets had been used last year the discrepancy would have been less. The projections are also shown in Figure 3.4.7.3.1 for 5 different effort options.

With a catch of 42 000 t in 2001, fishing mortality is estimated to be 0.85, the biomass of age 3+ is predicted to be 104 000 tonnes in the beginning of the year 2002 and the spawning stock biomass 62 000 tonnes.

The short-term predictions indicate that in for wide range of fishing mortalities the biomass of the stock is going to increase in coming years due to good recruitment. In those predictions the catch in the year 2001 is estimated to be 42,000 tonnes. This catch will lead to very high fishing mortality in the year 2001. Discard and hidden mortality due to mesh penetration has been a point of concern in this stock. Some preliminary information on discard is available indicating substantial discard in some years but no direct information on the harm caused by mesh penetration are available. Situation as encountered in 2001, high fishing mortality with age 2 and 3 being a large part of the stock is therefore not desirable.

The short-term predictions do not take any of these factors nor do they include possible effect of much fishing effort on weight at age in the catches and in the stock. The predictions are therefore not valid for predictions where fishing effort differs considerably from recent years, they will most likely underestimate the stock if effort is reduced but overestimate if effort is increased. For similar effort the predictions should be reasonably accurate.

3.4.8 Medium-term simulation

Medium-term 10 years predictions were done for Icelandic haddock using the results of the XSA calibration with the survey only. The exploitation pattern was taken as the average of the most recent 5 years in the assessment; other input values (M, maturity at age, weights in the stock, selection pattern and natural mortality were as in the short term predictions. Recruitment was drawn randomly from past observations 1981 to 2000. Three fishing mortality options were considered:

- *status quo* fishing mortality;
- 75% of status quo fishing mortality;
- Proposed $\mathbf{F}_{pa}$ of 0.47.

Two hundred and fifty runs were made for each fishing mortality.

The median catches and SSB, as well as the probability that the SSB would be less than 60 000 tonnes have been tallied and graphed in Figures 3.4.8.1 – 3.4.8.3

The medium term projections indicate that with current level of exploitation the spawning stock will most likely be at similar level as today. Fishing mortality does not seem to affect the expected yield much but the limitation of these predictions with regard to hidden mortality are the same as in the short term simulations. Fluctuations in the yield increase with increased fishing mortality.

It should be noted that these medium term predictions assume that mean weight at age remains as it has been in recent years where it has been low.

3.4.9 Management considerations

For more than a decade fishing mortality on haddock has been high with F_{4-7} between 0.6 and 0.8 since 1986. The advice in 2000 was based on F_{med} and if followed would have meant substantial reduction in fishing mortality while the real outcome was that the fishing mortality was at the same level as it has been.

The assessment results show that the 1996 and 1997 yearclasses are small, specially the 1996 yearclass. The 1998 to 2000 yearclasses are on the other hand above average. In the fishery year 2001-2002 the composition of the stock will be such that a large portion of it will be below landing size. To protect incoming recruitment fishing effort should be limited.

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 3.4.6.2.2.) 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 last 2 years.

The assessment presented here gives $F_{4-7} = 0.81$ in 2000. As mentioned earlier assessments including commercial CPUE give lower mortality (F_{4-7} = 0.65-0.71) in 2000. In spite of this high fishing mortality the stock size is going to increase in coming years due to good recruitment.

As many important factors are not included in the prognosis (mesh penetration, discard, reduced weight at age in catch and stock) reducing fishing mortalities would be more profitable than Table 3.4.7.3.1 indicates. Reducing fishing mortality substantially is therefore important.

Table 3.4.2.1 Haddock in Division Va Landings by nation**.**

HADDOCK Va

Country	1978	1979	1980	1981	1982	1983	1984	1985
Belgium	807	1010	1144	673	377	268	359	391
Faroe Islands	2116	2161	2029	1839	1982	1783	707	987
Iceland	40552	52152	47916	61033	67038	63889	47216	49553
Norway	13	11	23	15	28	3	3	+
UK								
Total	43488	55334	51112	63560	69425	65943	48285	50933

HADDOCK Va

Country	1986	1987	1988	1989	1990	1991	1992	1993
Belgium	257	238	352	483	595	485	361	458
Faroe Islands	1289	1043	797	606	603	773	757	754
Iceland	47317	39479	53085	61792	66004	53516	46098	46932
Norway		1	+					
UK								
Total	48863	40761	54234	62881	67202	53774	47216	48144

HADDOCK Va

Country	1994	1995	1996	1997	1998	1999	2000
Belgium	248						
Faroe Islands	911	758	664	340	639	624	968
Iceland	58408	60061	56223	43245	40795	44557	41199
Norway	1	+	4				
UK							
Total	59567	60819	56891	43585	41434	45481	42167

Table 3.4.3.1 Haddock in division Va.

Marine Research Institute Wed Apr 18 11:21:35 2001
Virtual Population Analysis : Catch in numbers, millions

Age	1981	1982	1983	1984	1985	1986	1987
2	0.001	0.050	0.001	0.060	0.427	0.196	2.237
3	0.516	0.286	0.705	0.755	1.773	3.681	7.559
4	4.929	2.698	1.498	4.970	4.981	3.822	7.500
5	16.961	10.703	4.645	1.176	6.058	4.933	2.696
6	6.021	14.115	10.301	4.875	0.837	5.761	2.249
7	2.835	2.288	8.808	3.772	1.564	0.493	1.194
8	1.810	1.167	0.874	4.446	2.475	0.852	0.151
9	0.169	0.816	0.241	0.171	2.212	0.898	0.208
Juvenile	15.455	12.851	8.736	7.097	9.652	8.124	15.382
Adult	17.787	19.272	18.337	13.128	10.675	12.512	8.412
Sum 2- 2	0.001	0.050	0.001	0.060	0.427	0.196	2.237
Sum 3- 9	33.241	32.073	27.072	20.165	19.900	20.440	21.557
Total	33.242	32.123	27.073	20.225	20.327	20.636	23.794

Age	1988	1989	1990	1991	1992	1993	1994
2	0.133	0.078	0.446	2.461	2.726	0.218	0.280
3	10.068	2.603	2.603	1.282	7.343	11.617	3.030
4	15.927	23.077	7.994	3.942	4.181	12.642	27.025
5	5.598	9.703	23.803	6.711	4.158	3.167	10.722
6	1.260	3.118	6.654	13.650	3.989	1.786	1.550
7	1.009	0.541	0.857	2.956	5.936	1.504	0.756
8	0.577	0.507	0.167	0.398	1.314	2.263	0.404
9	0.058	0.144	0.071	0.052	0.132	0.379	0.700
Juvenile	19.540	16.344	11.221	9.468	14.024	16.227	16.507
Adult	15.090	23.427	31.374	21.984	15.755	17.349	27.960
Sum 2- 2	0.133	0.078	0.446	2.461	2.726	0.218	0.280
Sum 3- 9	34.497	39.693	42.149	28.991	27.053	33.358	44.187
Total	34.630	39.771	42.595	31.452	29.779	33.576	44.467

Age	1995	1996	1997	1998	1999	2000
2	2.357	1.467	1.375	0.207	1.077	2.351
3	6.327	8.982	3.690	8.109	1.455	6.496
4	5.667	7.076	11.127	5.984	16.897	2.335
5	23.357	4.751	4.885	8.390	4.844	13.817
6	5.605	13.963	2.540	2.420	4.982	2.052
7	0.610	2.446	4.981	1.502	0.942	1.789
8	0.263	0.228	0.692	1.884	0.588	0.364
9	0.210	0.087	0.052	0.207	0.514	0.197
Juvenile	14.717	15.344	9.926	9.154	10.140	11.138
Adult	29.679	23.656	19.416	19.549	21.159	18.263
Sum 2- 2	2.357	1.467	1.375	0.207	1.077	2.351
Sum 3- 9	42.039	37.533	27.967	28.496	30.222	27.050
Total	44.396	39.000	29.342	28.703	31.299	29.401

Table 3.4.4.1 Haddock in division Va

Marine Research Institute Wed Apr 18 11:21:35 2001
Virtual Population Analysis : Weight at age in the catches, in grams

Age	1981	1982	1983	1984	1985	1986	1987
2	584	330	655	980	599	867	446
3	693	819	958	1041	1002	1187	1048
4	1081	1365	1436	1476	1783	1755	1629
5	1656	1649	1827	2105	2201	2377	2373
6	2283	2329	2355	2460	2727	2710	2984
7	3214	3012	2834	3028	3431	3591	3550
8	3409	3384	3569	3014	3783	3760	4483
9	4046	3965	4308	3807	4070	4135	4667

Age	1988	1989	1990	1991	1992	1993	1994
2	468	745	357	409	320	420	568
3	808	856	716	868	856	756	720
4	1474	1170	1039	1111	1253	1372	1058
5	2230	2010	1542	1546	1597	1870	1742
6	2934	2879	2403	2035	2088	2360	2380
7	3545	4109	3458	2849	2529	2888	2785
8	3769	4035	4186	3464	3133	2975	3447
9	4574	4706	4969	4642	4022	3442	3156

Age	1995	1996	1997	1998	1999	2000	2001
2	457	387	450	689	616	518	0
3	874	841	829	777	866	951	0
4	1145	1189	1192	1166	1096	1314	0
5	1366	1528	1663	1692	1638	1461	0
6	2079	1816	1934	2312	2205	2096	0
7	2853	2641	2360	2379	2681	2679	0
8	3251	3499	3059	2882	2863	3181	0
9	3899	3526	3010	3417	3229	3438	0

Table 3.4.4.2 Haddock in division Va

Marine Research Institute Wed Apr 18 11:21:35 2001
Virtual Population Analysis : Weight at age in the stock, in grams

Age	1981	1982	1983	1984	1985	1986	1987
2	185	185	185	185	245	234	157
3	475	475	475	475	555	677	564
4	901	901	901	901	1158	1128	1211
5	1411	1411	1411	1411	1629	1929	1825
6	2004	2004	2004	2004	2349	2371	2596
7	2526	2526	2526	2526	2736	3149	3020
8	3201	3201	3201	3201	3213	3241	3626
9	3266	3266	3266	3266	3302	3688	3818

Age	1988	1989	1990	1991	1992	1993	1994
2	176	181	183	174	157	171	180
3	453	439	447	495	496	385	402
4	969	885	829	998	902	874	700
5	1826	1502	1238	1397	1379	1492	1243
6	2679	2380	1962	1879	1926	1807	1689
7	3089	2987	2688	2490	2373	2617	1646
8	3464	3503	3080	3732	2932	2620	2697
9	3294	3194	3317	3642	3672	3346	1997

Age	1995	1996	1997	1998	1999	2000	2001
2	165	180	172	202	203	179	188
3	443	456	424	404	481	552	487
4	738	855	808	741	721	893	1053
5	1053	1040	1195	1223	1200	1165	1436
6	1868	1437	1425	1725	1965	1776	1506
7	2624	2171	1919	2001	2378	2620	2180
8	5285	3172	2331	2320	2797	2911	2780
9	1313	4780	3686	3030	2907	3137	3025

Table 3.4.4.3 Haddock in division Va

Marine Research Institute Wed Apr 18 11:21:35 2001
Virtual Population Analysis : Sexual maturity at age in the stock and ssb

Age	1981	1982	1983	1984	1985	1986	1987
2	0.000	0.000	0.000	0.000	0.010	0.020	0.020
3	0.130	0.130	0.130	0.130	0.100	0.190	0.110
4	0.300	0.300	0.300	0.300	0.400	0.430	0.410
5	0.460	0.460	0.460	0.460	0.430	0.660	0.520
6	0.680	0.680	0.680	0.680	0.720	0.830	0.790
7	0.860	0.860	0.860	0.860	0.670	0.870	0.780
8	0.960	0.960	0.960	0.960	0.920	0.950	1.000
9	1.000	1.000	1.000	1.000	0.890	0.990	0.960

Age	1988	1989	1990	1991	1992	1993	1994
2	0.010	0.040	0.110	0.040	0.040	0.120	0.250
3	0.220	0.200	0.280	0.200	0.140	0.330	0.320
4	0.380	0.530	0.590	0.580	0.420	0.470	0.570
5	0.770	0.720	0.810	0.750	0.770	0.660	0.780
6	0.790	0.800	0.840	0.820	0.860	0.880	0.860
7	0.930	1.000	0.920	0.910	0.870	0.970	1.000
8	0.900	1.000	0.900	0.940	0.710	0.930	0.900
9	1.000	1.000	1.000	1.000	1.000	0.850	1.000

Age	1995	1996	1997	1998	1999	2000	2001
2	0.160	0.170	0.090	0.030	0.050	0.100	0.100
3	0.490	0.360	0.440	0.480	0.390	0.250	0.380
4	0.430	0.580	0.660	0.680	0.680	0.620	0.520
5	0.780	0.650	0.710	0.780	0.720	0.800	0.750
6	0.830	0.780	0.750	0.760	0.760	0.870	0.900
7	0.690	0.730	0.860	0.850	0.900	0.870	0.920
8	1.000	0.960	0.890	0.910	0.770	1.000	0.920
9	1.000	0.980	1.000	1.000	0.920	1.000	1.000

Table 3.4.5.1 Icelandic haddock. Age disaggregated survey indices.

Year/ age	1	2	3	4	5	6	7	8	9
1985	28.16	32.74	18.35	23.66	26.55	3.73	10.98	4.88	5.64
1986	124	108.54	59.1	12.81	16.39	13.21	0.98	2.77	1.26
1987	22.26	296.28	163.65	57.09	13.17	11.17	8.09	0.58	1.28
1988	15.77	40.74	184.8	88.88	22.87	1.36	2.25	1.87	0.18
1989	10.59	23.36	41.55	146.7	44.92	12.74	0.85	0.84	0.41
1990	70.52	31.9	27.29	39.12	91.83	30.88	3.44	0.9	0.23
1991	89.73	145.9	41.56	17.84	20.26	32.54	7.66	0.3	0.1
1992	18.54	212.29	138.68	35.63	16.57	13.15	15.94	2.21	0.18
1993	29.94	37.23	252.91	88.81	11.32	3.87	1.66	4.47	0.88
1994	58.66	61.2	40.64	162.82	46.09	7.25	2.93	1.42	4.09
1995	35.81	83.19	48.8	20.66	68.43	8.1	1.41	0.11	0.37
1996	94.63	71.25	118.35	34.28	18.73	40.45	6.19	0.63	0.14
1997	8.64	120.39	49.55	54.55	10.36	6.98	11.2	1.41	0.07
1998	23.14	18.19	110.36	28.44	23.36	4.65	3.47	4.58	0.33
1999	81.21	86.51	25.84	98.24	12.9	9.6	1.43	1.7	1.03
2000	61.08	91.02	45.38	8.59	24.74	2.94	1.62	0.41	0.15
2001	81.91	148.16	115.22	22.23	4.1	10.6	0.93	0.57	0

Table 3.4.6.1.1 Haddock in division Va. Input data for tuning.

```
ICE HADDOCK Catch at age
102
SUR CPU
1984 2000
1 1 0.99 1
2 8
0.1 18.4 23.7 26.6 3.7 11.0 4.9 5.6
0.1 59.1 12.8 16.4 13.2 1.0 2.8 1.3
0.1 163.6 57.1 13.2 11.2 8.1 0.6 1.3
0.1 184.8 88.9 22.9 1.4 2.2 1.9 0.2
0.1 41.6 146.8 44.9 12.7 0.8 0.8 0.4
0.1 27.3 39.1 91.8 30.9 3.4 0.9 0.2
0.1 41.6 17.8 20.3 32.5 7.7 0.3 0.1
0.1 138.7 35.6 16.6 13.2 15.9 2.2 0.2
0.1 252.9 88.8 11.3 3.9 1.7 4.5 0.9
0.1 40.6 162.8 46.1 7.2 2.9 1.4 4.1
0.1 48.8 20.7 68.4 8.1 1.4 0.1 0.4
0.1 118.4 34.3 18.7 40.4 6.2 0.6 0.1
0.1 49.6 54.6 10.4 7.0 11.2 1.4 0.1
0.1 110.4 28.4 23.4 4.6 3.5 4.6 0.3
0.1 25.8 98.2 12.9 9.6 1.4 1.7 1.0
0.1 45.5 8.6 24.7 2.9 1.6 0.4 0.2
0.1 115.2 22.2 4.1 10.6 0.9 0.6 0.0
2are CPU
1985 2000
1 1 0.17 0.25
2 2
0.1 32.7
0.1 108.5
0.1 296.3
0.1 40.7
0.1 23.4
0.1 31.9
0.1 146.0
0.1 212.3
0.1 37.2
0.1 61.2
0.1 83.2
0.1 71.3
0.1 120.4
0.1 18.2
0.1 86.5
0.1 91.0
```

Table 3.4.6.2.1 Haddock Va. Output from XSA.

```
Lowestoft VPA Version 3.1

   Mon Apr 30 20:53:03

 Extended Survivors Analysis

 Icelandic Haddock. Run 3.

 CPUE data from file hadvaef.1.fleet.rall.2

 Catch data for  21 years. 1980 to 2000. Ages  2 to   9.

      Fleet            First Last First Last Alpha  Beta
                        year year  age   age
 SUR CPU                1984 2000   2     8  0.990  1.000
 2are CPU               1985 2000   2     2  0.170  0.250

 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   18 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  1991  1992  1993  1994  1995  1996  1997  1998  1999  2000

      2 0.034 0.018 0.006 0.008 0.038 0.048 0.017 0.018 0.028 0.031
      3 0.082 0.137 0.098 0.116 0.235 0.196 0.164 0.133 0.169 0.233
      4 0.331 0.419 0.369 0.348 0.331 0.448 0.398 0.437 0.448 0.446
      5 0.577 0.704 0.657 0.619 0.579 0.515 0.648 0.598 0.780 0.832
      6 0.710 0.837 0.768 0.810 0.793 0.849 0.579 0.801 0.900 0.945
      7 0.763 0.798 0.923 0.911 0.916 1.037 0.875 0.835 0.877 1.021
      8 0.916 0.971 0.840 0.689 0.998 1.152 0.992 1.038 0.978 1.085
      9 0.859 0.935 0.863 0.689 0.993 1.179 0.924 0.968 0.936 1.136



1
 XSA population numbers (Thousands)

                                AGE
 YEAR            2        3        4        5        6        7        8        9

 1991     8.02E+04 1.79E+04 1.55E+04 1.69E+04 2.97E+04 6.12E+03 7.33E+02 9.97E+01
 1992     1.70E+05 6.35E+04 1.35E+04 9.09E+03 7.78E+03 1.19E+04 2.34E+03 2.40E+02
 1993     3.75E+04 1.37E+05 4.53E+04 7.27E+03 3.68E+03 2.76E+03 4.40E+03 7.25E+02
 1994     4.12E+04 3.05E+04 1.02E+05 2.57E+04 3.09E+03 1.40E+03 8.97E+02 1.55E+03
 1995     7.06E+04 3.34E+04 2.22E+04 5.87E+04 1.13E+04 1.12E+03 4.60E+02 3.69E+02
 1996     3.45E+04 5.57E+04 2.17E+04 1.31E+04 2.70E+04 4.19E+03 3.68E+02 1.39E+02
 1997     8.96E+04 2.69E+04 3.75E+04 1.13E+04 6.39E+03 9.44E+03 1.22E+03 9.53E+01
 1998     1.29E+04 7.21E+04 1.87E+04 2.06E+04 4.85E+03 2.93E+03 3.22E+03 3.69E+02
 1999     4.33E+04 1.04E+04 5.17E+04 9.88E+03 9.28E+03 1.78E+03 1.04E+03 9.34E+02
 2000     8.41E+04 3.45E+04 7.17E+03 2.70E+04 3.71E+03 3.09E+03 6.08E+02 3.21E+02
```

Table 3.4.6.2.1 (Continued)

Estimated population abundance at 1st Jan 2001

0.00E+00 6.67E+04 2.24E+04 3.76E+03 9.63E+03 1.18E+03 9.12E+02 1.68E+02

Taper weighted geometric mean of the VPA populations:

4.42E+04 3.56E+04 2.80E+04 1.76E+04 8.34E+03 3.50E+03 1.26E+03 3.93E+02

Standard error of the weighted Log(VPA populations) :

0.7425 0.7399 0.7967 0.7714 0.8336 0.8787 0.9607 1.0384

1

Log catchability residuals.

Fleet : SUR CPU

Age	1984	1985	1986	1987	1988	1989	1990
2	-0.38	0.06	0.31	-0.19	-0.43	-0.27	0.34
3	-0.19	-0.30	0.47	0.13	-0.02	-0.10	-0.24
4	0.06	0.03	0.44	0.23	0.12	0.06	-0.14
5	0.35	0.10	0.57	-0.86	0.55	0.49	-0.16
6	0.92	-0.11	0.99	-0.11	-0.40	0.41	0.03
7	-0.06	0.50	0.59	0.61	-0.02	0.97	-1.00
8	0.09	-0.31	0.90	0.52	0.43	0.24	-0.11

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.28	0.11	-0.21	-0.12	0.25	0.11	-0.08	0.41	-0.22	0.04
3	0.58	0.29	0.09	-0.46	0.07	-0.01	0.03	0.26	-0.20	-0.39
4	0.28	0.12	0.26	-0.17	0.04	-0.41	-0.20	-0.06	-0.42	-0.24
5	0.28	-0.19	0.60	-0.58	0.16	-0.16	-0.30	-0.21	-0.49	-0.15
6	0.08	-0.69	0.53	0.02	0.19	-0.03	-0.03	-0.45	-0.86	-0.48
7	-0.17	-0.09	0.33	-1.64	0.38	0.03	0.24	0.38	-0.53	-0.53
8	-0.29	0.11	0.86	-0.03	-0.44	-0.06	-0.32	-0.04	-0.58	99.99

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	-4.1048	-4.2211	-4.2835	-4.3619	-4.4058	-4.4999	-4.4999
S.E(Log q)	0.2637	0.2894	0.2398	0.4353	0.5086	0.6452	0.4402

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	0.074	4.15	0.88	17	0.27	-4.10
3	0.91	1.012	4.81	0.89	17	0.26	-4.22
4	1.06	-0.708	3.91	0.89	17	0.26	-4.28
5	1.01	-0.056	4.32	0.74	17	0.45	-4.36
6	0.90	0.674	4.86	0.74	17	0.46	-4.41
7	1.03	-0.120	4.41	0.59	17	0.68	-4.50
8	0.94	0.581	4.60	0.87	16	0.42	-4.44

1

Fleet : 2are CPU

Age	1984	1985	1986	1987	1988	1989	1990
2	99.99	-0.50	-0.06	0.31	-0.42	-0.39	0.10
3	No data for this fleet at this age						
4	No data for this fleet at this age						
5	No data for this fleet at this age						
6	No data for this fleet at this age						
7	No data for this fleet at this age						
8	No data for this fleet at this age						

Table 3.4.6.2.1 (Continued)

Age	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	0.35	-0.04	-0.27	0.14	-0.09	0.48	0.04	0.09	0.44	-0.17
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	-4.3032
S.E(Log q)	0.3017

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	0.96	0.384	4.58	0.86	16	0.30	-4.30

1

Terminal year survivor and F summaries :

Age 2 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
SUR CPU	69767.	0.300	0.000	0.00	1	0.434	0.030
2are CPU	56044.	0.311	0.000	0.00	1	0.404	0.037
F shrinkage mean	91715.	0.50				0.161	0.023

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
66737.	0.20	0.13	3	0.650	0.031

Age 3 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
SUR CPU	16398.	0.212	0.085	0.40	2	0.592	0.306
2are CPU	34635.	0.311	0.000	0.00	1	0.272	0.157
F shrinkage mean	36000.	0.50				0.136	0.151

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
22366.	0.17	0.22	4	1.346	0.233

1

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

Table 3.4.6.2.1 (Continued)

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUR CPU	3661.	0.174	0.207	1.19	3	0.667	0.456
2are CPU	4107.	0.311	0.000	0.00	1	0.193	0.415
F shrinkage mean	3761.	0.50				0.140	0.446

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3757.	0.15	0.12	5	0.821	0.446

Age 5 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
SUR CPU	8667.	0.166	0.144	0.87	4	0.621	0.893
2are CPU	10018.	0.311	0.000	0.00	1	0.145	0.810
F shrinkage mean	12445.	0.50				0.234	0.695

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
9632.	0.16	0.12	6	0.714	0.832

1

Age 6 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
SUR CPU	983.	0.180	0.127	0.70	5	0.535	1.061
2are CPU	1900.	0.311	0.000	0.00	1	0.090	0.682
F shrinkage mean	1364.	0.50				0.375	0.859

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1180.	0.21	0.12	7	0.569	0.945

Age 7 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
SUR CPU	678.	0.208	0.157	0.75	6	0.428	1.220
2are CPU	835.	0.311	0.000	0.00	1	0.057	1.078
F shrinkage mean	1177.	0.50				0.515	0.865

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
912.	0.27	0.17	8	0.616	1.021

1

Table 3.4.6.2.1 (Continued)

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUR CPU	122.	0.209	0.092	0.44	6	0.240	1.310
2are CPU	193.	0.311	0.000	0.00	1	0.031	0.996
F shrinkage mean	186.	0.50				0.729	1.020

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
168.	0.37	0.13	8	0.350	1.085

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 7

Year class = 1991

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUR CPU	62.	0.228	0.130	0.57	7	0.239	1.352
2are CPU	65.	0.311	0.000	0.00	1	0.021	1.323
F shrinkage mean	94.	0.50				0.740	1.065

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
84.	0.37	0.14	9	0.362	1.136

Table 3.4.6.2.2 Haddock Va. Output from XSA.

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1980
AGE	
2	0.0180
3	0.0226
4	0.1357
5	0.2816
6	0.4909
7	0.6469
8	0.9095
9	0.7861
0 FBAR 4- 7	0.3888

Table 8 Fishing mortality (F) at age

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	0.0001	0.0013	0.0000	0.0033	0.0114	0.0024	0.0148	0.0031	0.0032	0.0223
3	0.0194	0.0404	0.0228	0.0344	0.1284	0.1282	0.1218	0.0856	0.0768	0.1418
4	0.1046	0.1337	0.3062	0.2217	0.3310	0.4473	0.4163	0.4053	0.2881	0.3560
5	0.3042	0.3459	0.3579	0.4208	0.4613	0.6437	0.6656	0.6362	0.4650	0.5459
6	0.8136	0.4485	0.6651	0.8020	0.6066	1.1419	0.6994	0.7760	0.9287	0.6849
7	0.8631	0.8747	0.5644	0.5490	0.6577	0.9167	0.7762	0.8093	0.9547	0.7216
8	0.7746	1.1682	1.0564	0.6304	0.8825	0.9650	0.8245	1.1791	1.4475	0.9224
9	0.8273	1.0332	0.8188	0.5948	0.7630	0.9887	0.6626	0.9185	1.1594	0.8127
0 FBAR 4- 7	0.5214	0.4507	0.4734	0.4984	0.5142	0.7874	0.6393	0.6567	0.6591	0.5771

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	FBAR 98-**
AGE											
2	0.0345	0.0178	0.0065	0.0075	0.0376	0.0482	0.0171	0.0179	0.0279	0.0314	0.0257
3	0.0824	0.1368	0.0984	0.1164	0.2346	0.1963	0.1644	0.1327	0.1686	0.2333	0.1782
4	0.3310	0.4190	0.3686	0.3480	0.3313	0.4481	0.3978	0.4369	0.4482	0.4462	0.4438
5	0.5771	0.7041	0.6568	0.6194	0.5787	0.5146	0.6476	0.5977	0.7802	0.8320	0.7366
6	0.7105	0.8368	0.7684	0.8099	0.7935	0.8493	0.5788	0.8011	0.8995	0.9454	0.8820
7	0.7629	0.7979	0.9233	0.9108	0.9157	1.0372	0.8747	0.8350	0.8767	1.0208	0.9108
8	0.9162	0.9712	0.8405	0.6890	0.9984	1.1523	0.9924	1.0383	0.9779	1.0851	1.0337
9	0.8586	0.9353	0.8631	0.6886	0.9933	1.1794	0.9243	0.9683	0.9363	1.1357	1.0134
0 FBAR 4- 7	0.5954	0.6895	0.6793	0.6720	0.6548	0.7123	0.6247	0.6677	0.7512	0.8111	

1

un title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR	1980
AGE	
2	0.0463
3	0.0581
4	0.3490
5	0.7243
6	1.2627
7	1.6640
8	2.3396
9	2.0219
0 REFMEAN	0.3888

Table 3.4.6.2.2 (Continued)

Table 9 Relative F at age

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	0.0002	0.0029	0.0001	0.0067	0.0221	0.0031	0.0232	0.0047	0.0049	0.0386
3	0.0372	0.0896	0.0482	0.0690	0.2497	0.1629	0.1904	0.1304	0.1166	0.2457
4	0.2006	0.2967	0.6468	0.4449	0.6438	0.5681	0.6511	0.6172	0.4371	0.6169
5	0.5834	0.7674	0.7560	0.8444	0.8972	0.8175	1.0410	0.9687	0.7055	0.9459
6	1.5605	0.9951	1.4049	1.6092	1.1799	1.4502	1.0939	1.1817	1.4090	1.1868
7	1.6554	1.9408	1.1923	1.1016	1.2792	1.1643	1.2140	1.2323	1.4484	1.2504
8	1.4857	2.5921	2.2316	1.2649	1.7164	1.2256	1.2896	1.7956	2.1962	1.5983
9	1.5868	2.2925	1.7296	1.1934	1.4839	1.2556	1.0364	1.3987	1.7590	1.4082
0 REFMEAN	0.5214	0.4507	0.4734	0.4984	0.5142	0.7874	0.6393	0.6567	0.6591	0.5771

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 9 Relative F at age

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	MEAN 98-**
AGE											
2	0.0579	0.0259	0.0095	0.0112	0.0574	0.0676	0.0274	0.0268	0.0371	0.0387	0.0342
3	0.1385	0.1984	0.1449	0.1732	0.3583	0.2756	0.2632	0.1988	0.2244	0.2877	0.2370
4	0.5559	0.6077	0.5427	0.5178	0.5060	0.6291	0.6368	0.6543	0.5967	0.5501	0.6004
5	0.9693	1.0213	0.9669	0.9217	0.8838	0.7224	1.0366	0.8952	1.0386	1.0258	0.9865
6	1.1934	1.2137	1.1312	1.2052	1.2118	1.1924	0.9264	1.1998	1.1976	1.1656	1.1877
7	1.2814	1.1573	1.3593	1.3553	1.3984	1.4561	1.4002	1.2506	1.1671	1.2585	1.2254
8	1.5389	1.4086	1.2373	1.0253	1.5248	1.6177	1.5886	1.5551	1.3018	1.3378	1.3982
9	1.4422	1.3566	1.2705	1.0247	1.5169	1.6558	1.4796	1.4503	1.2464	1.4002	1.3656
0 REFMEAN	0.5954	0.6895	0.6793	0.6720	0.6548	0.7123	0.6247	0.6677	0.7512	0.8111	

1

Run title : Icelandic Haddock. Run 3.

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Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1980
AGE	
2	36896
3	68533
4	99973
5	19346
6	10814
7	8654
8	1007
9	185
0 TOTAL	245407

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

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	9752	42215	30162	19932	41757	89225	168056	47662	26664	22362
3	29669	7983	34517	24693	16264	33801	72874	135569	38902	21760
4	54858	23824	6277	27622	19534	11712	24343	52824	101884	29495
5	71467	40454	17064	3784	18118	11486	6131	13144	28838	62535
6	11952	43165	23436	9768	2034	9352	4940	2580	5696	14831
7	5419	4337	22569	9867	3586	908	2444	2010	972	1843
8	3710	1872	1481	10508	4666	1521	297	921	733	306
9	332	1400	476	422	4580	1580	474	107	232	141
0 TOTAL	187159	165250	135983	106596	110540	159586	279560	254816	203921	153273

1

Table 3.4.6.2.2 (Continued)

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

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

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	GMST 80-98	AMST 80-98
2	80236	170295	37459	41153	70625	34477	89586	12889	43325	84111	0	42727	56390
3	17905	63464	136959	30472	33440	55690	26900	72102	10365	34497	66737	38099	48500
4	15461	13499	45316	101621	22207	21653	37468	18685	51695	7170	22366	29092	38329
5	16915	9091	7269	25663	58747	13054	11326	20608	9883	27035	3757	17780	23949
6	29661	7776	3681	3086	11309	26964	6388	4852	9281	3709	9632	8659	12226
7	6121	11934	2757	1398	1124	4188	9442	2932	1783	3091	1180	3647	5395
8	733	2337	4399	897	460	368	1215	3223	1042	608	912	1326	2140
9	100	240	725	1554	369	139	95	369	934	321	168	379	712
0 TOTAL	167132	278638	238567	205844	198281	156533	182420	135661	128309	160541	104752		

1

Run title : Icelandic Haddock. Run 3.

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Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

AGE	1980
2	0
3	8909
4	29992
5	8899
6	7354
7	7443
8	966
9	185

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	0	0	0	0	418	1784	3361	477	1067	2460
3	3857	1038	4487	3210	1626	6422	8016	29825	7780	6093
4	16457	7147	1883	8287	7814	5036	9981	20073	53999	17402
5	32875	18609	7850	1741	7791	7581	3188	10121	20763	50653
6	8127	29352	15937	6642	1464	7763	3903	2038	4557	12458
7	4661	3730	19409	8486	2403	790	1907	1869	972	1695
8	3562	1797	1422	10088	4292	1445	297	829	733	276
9	332	1400	476	422	4076	1565	455	107	232	141

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 11 Spawning stock number at age (spawning time) Numbers*10**-3

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
2	3209	6812	4495	10288	11300	5861	8063	387	2166	8411
3	3581	8885	45197	9751	16386	20049	11836	34609	4042	8624
4	8967	5670	21299	57924	9549	12559	24729	12332	35153	4445
5	12686	7000	4798	20017	45823	8485	8041	16074	7116	21628
6	24322	6688	3239	2654	9387	21032	4791	3688	7054	3227
7	5571	10382	2675	1398	776	3057	8120	2492	1605	2689
8	689	1659	4091	807	460	354	1082	2740	802	608
9	100	240	616	1554	369	136	95	369	860	321

1

Table 3.4.6.2.2 (Continued)

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1980
AGE	
2	6826
3	32553
4	90075
5	27297
6	21672
7	21860
8	3222
9	603
0 TOTALBIO	204109

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	1804	7810	5580	3687	10230	20879	26385	8388	4826	4092
3	14093	3792	16396	11729	9027	22883	41101	61413	17078	9727
4	49427	21466	5656	24888	22620	13211	29480	51187	90168	24451
5	100840	57081	24078	5339	29515	22157	11188	24002	43314	77418
6	23951	86503	46967	19575	4777	22175	12825	6911	13558	29098
7	13689	10956	57009	24925	9812	2859	7382	6209	2904	4953
8	11877	5991	4740	33636	14991	4930	1078	3190	2566	944
9	1084	4573	1556	1377	15124	5829	1812	351	741	468
0 TOTALBIO	216765	198171	161981	125157	116097	114922	131250	161651	175154	151150

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 12 Stock biomass at age (start of year) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
2	13961	26736	6406	7408	11653	6206	15409	2604	8795	15056
3	8863	31478	52729	12250	14814	25395	11405	29129	4986	19042
4	15430	12176	39606	71135	16389	18514	30274	13845	37272	6403
5	23630	12537	10846	31899	61861	13576	13534	25204	11860	31496
6	55734	14977	6651	5212	21126	38747	9104	8370	18237	6587
7	15242	28319	7216	2301	2950	9091	18119	5867	4240	8098
8	2736	6852	11526	2418	2432	1168	2833	7478	2913	1769
9	363	882	2424	3104	484	664	351	1118	2716	1006
0 TOTALBIO	135959	133958	137405	135726	131708	113361	101029	93616	91020	89456

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1980
AGE	
2	0
3	4232
4	27023
5	12557
6	14737
7	18800
8	3093
9	603
0 TOTSPBIO	81044

Table 3.4.6.2.2 (Continued)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	0	0	0	0	102	418	528	84	193	450
3	1832	493	2131	1525	903	4348	4521	13511	3416	2724
4	14828	6440	1697	7466	9048	5681	12087	19451	47789	14426
5	46386	26257	11076	2456	12691	14623	5818	18481	31186	62709
6	16287	58822	31937	13311	3440	18405	10132	5460	10846	24442
7	11773	9422	49028	21436	6574	2487	5758	5774	2904	4557
8	11402	5752	4550	32291	13792	4683	1078	2871	2566	849
9	1084	4573	1556	1377	13461	5771	1739	351	741	468
0 TOTSPBIO	103592	111758	101976	79861	60011	56416	41660	65983	99640	110624

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 13 Spawning stock biomass at age (spawning time) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
2	558	1069	769	1852	1865	1055	1387	78	440	1506
3	1773	4407	17401	3920	7259	9142	5018	13982	1944	4761
4	8949	5114	18615	40547	7047	10738	19981	9138	25345	3970
5	17723	9653	7158	24881	48252	8824	9609	19659	8539	25197
6	45702	12881	5853	4482	17534	30223	6828	6362	13860	5730
7	13871	24637	7000	2301	2035	6637	15583	4987	3816	7045
8	2572	4865	10719	2177	2432	1122	2521	6357	2243	1769
9	363	882	2061	3104	484	650	351	1118	2499	1006
0 TOTSPBIO	91510	63509	69575	83263	86908	68391	61278	61680	58687	50983

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1980
AGE	
2	6854
3	32687
4	90446
5	27409
6	21761
7	21950
8	3235
9	606
0 TOTALBIO	204950

Table 14 Stock biomass at age with SOP (start of year) Tonnes

YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE										
2	1807	7900	5688	3700	10367	21581	26825	8445	4847	4102
3	14114	3836	16713	11769	9147	23654	41786	61829	17150	9750
4	49501	21714	5765	24972	22923	13656	29971	51534	90551	24510
5	100990	57741	24543	5357	29909	22902	11375	24164	43498	77605
6	23987	87503	47875	19642	4841	22921	13039	6958	13615	29168
7	13709	11083	58111	25010	9943	2955	7505	6251	2916	4965
8	11895	6060	4832	33751	15191	5096	1096	3212	2577	946
9	1086	4625	1586	1381	15326	6025	1842	354	744	469
0 TOTALBIO	217087	200462	165113	125582	117648	118790	133438	162747	175898	151516

1

Table 3.4.6.2.2 (Continued)

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 14 Stock biomass at age with SOP (start of year) Tonnes

	YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	AGE										
	2	13971	26842	6420	7450	11851	6232	15425	2513	8844	15274
	3	8869	31603	52846	12320	15065	25503	11418	28120	5013	19318
	4	15441	12225	39694	71542	16667	18593	30307	13366	37478	6495
	5	23647	12586	10870	32081	62911	13634	13549	24330	11925	31952
	6	55773	15037	6666	5242	21484	38913	9113	8080	18338	6682
	7	15253	28431	7232	2314	3000	9130	18139	5664	4264	8215
	8	2738	6880	11552	2432	2474	1173	2836	7219	2929	1794
	9	363	885	2430	3122	492	666	352	1079	2731	1021
0	TOTALBIO	136055	134488	137708	136503	133944	113845	101138	90371	91523	90752

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

	YEAR	1980
	AGE	
	2	0
	3	4249
	4	27134
	5	12608
	6	14798
	7	18877
	8	3106
	9	606
0	TOTSPBIO	81378

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

	YEAR	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
	AGE										
	2	0	0	0	0	104	432	536	84	194	451
	3	1835	499	2173	1530	915	4494	4596	13602	3430	2730
	4	14850	6514	1730	7492	9169	5872	12288	19583	47992	14461
	5	46455	26561	11290	2464	12861	15116	5915	18607	31319	62860
	6	16311	59502	32555	13357	3486	19024	10301	5497	10892	24501
	7	11790	9531	49976	21509	6662	2571	5854	5813	2916	4568
	8	11419	5818	4638	32401	13976	4841	1096	2890	2577	851
	9	1086	4625	1586	1381	13640	5965	1768	354	744	469
0	TOTSPBIO	103746	113050	103948	80133	60813	58314	42355	66431	100064	110892

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Terminal Fs derived using XSA (With F shrinkage)

Table 3.4.6.2.2 (Continued)

Table 15 Spawning stock biomass with SOP (spawning time) Tonnes

YEAR	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
AGE										
2	559	1074	770	1862	1896	1059	1388	75	442	1527
3	1774	4424	17439	3942	7382	9181	5024	13497	1955	4830
4	8956	5134	18656	40779	7167	10784	20003	8821	25485	4027
5	17735	9692	7174	25024	49071	8862	9619	18978	8586	25562
6	45734	12932	5866	4508	17832	30352	6835	6141	13937	5813
7	13880	24735	7015	2314	2070	6665	15599	4814	3837	7147
8	2574	4884	10743	2189	2474	1126	2524	6136	2256	1794
9	363	885	2065	3122	492	653	352	1079	2513	1021
0 TOTSPBIO	91575	63760	69729	83740	88383	68683	61344	59542	59012	51721

1

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 7
1980	36896	204109	81044	51112	0.6307	0.3888
1981	9752	216765	103592	63580	0.6138	0.5214
1982	42215	198171	111758	69325	0.6203	0.4507
1983	30162	161981	101975	65943	0.6467	0.4734
1984	19932	125157	79861	48285	0.6046	0.4984
1985	41757	116097	60011	50933	0.8487	0.5142
1986	89225	114922	56416	48863	0.8661	0.7874
1987	168056	131250	41660	40801	0.9794	0.6393
1988	47662	161651	65983	54236	0.8220	0.6567
1989	26664	175154	99640	62979	0.6321	0.6591
1990	22362	151150	110624	67200	0.6075	0.5771
1991	80236	135959	91510	54732	0.5981	0.5954
1992	170295	133958	63509	47212	0.7434	0.6895
1993	37460	137405	69575	48844	0.7020	0.6793
1994	41153	135726	83263	59345	0.7127	0.6720
1995	70625	131708	86908	61131	0.7034	0.6548
1996	34477	113360	68391	56958	0.8328	0.7123
1997	89586	101029	61278	44053	0.7189	0.6247
1998	12889	93616	61680	41434	0.6718	0.6677
1999	43325	91020	58687	45481	0.7750	0.7512
2000	84111	89456	50983	42167	0.8271	0.8111
Arith. Mean	57087	139031	76588	53553	0.7218	0.6202
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Run title : Icelandic Haddock. Run 3.

At Mon Apr 30 20:54:21

Table 3.4.6.2.2 (Continued)

Table 17 Summary (with SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 4- 7
1980	36896	204950	81378	51112	0.6281	1.0041	0.3888
1981	9752	217087	103746	63580	0.6128	1.0015	0.5214
1982	42215	200462	113050	69325	0.6132	1.0116	0.4507
1983	30162	165114	103948	65943	0.6344	1.0193	0.4734
1984	19932	125582	80133	48285	0.6026	1.0034	0.4984
1985	41757	117648	60813	50933	0.8375	1.0134	0.5142
1986	89225	118790	58314	48863	0.8379	1.0337	0.7874
1987	168056	133438	42355	40801	0.9633	1.0167	0.6393
1988	47662	162747	66431	54236	0.8164	1.0068	0.6567
1989	26664	175898	100064	62979	0.6294	1.0042	0.6591
1990	22362	151516	110892	67200	0.6060	1.0024	0.5771
1991	80236	136055	91575	54732	0.5977	1.0007	0.5954
1992	170295	134488	63760	47212	0.7405	1.0040	0.6895
1993	37460	137708	69729	48844	0.7005	1.0022	0.6793
1994	41153	136503	83740	59345	0.7087	1.0057	0.6720
1995	70625	133944	88383	61131	0.6917	1.0170	0.6548
1996	34477	113845	68683	56958	0.8293	1.0043	0.7123
1997	89586	101138	61344	44053	0.7181	1.0011	0.6247
1998	12889	90371	59542	41434	0.6959	0.9653	0.6677
1999	43325	91523	59012	45481	0.7707	1.0055	0.7512
2000	84111	90752	51721	42167	0.8153	1.0145	0.8111
Arith. Mean	57087	139979	77077	53553	0.7167		0.620
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 3.4.7.1.1 Haddock Va. Input data for short term prediction.

Sexual maturity at spawning time:

age\year	2000	2001	2002	2003	2004	99-2001
2	0,100	0,100	0,080	0,080	0,080	0,080
3	0,250	0,320	0,340	0,340	0,340	0,340
4	0,620	0,510	0,610	0,610	0,610	0,610
5	0,800	0,760	0,760	0,760	0,760	0,760
6	0,870	0,820	0,840	0,840	0,840	0,840
7	0,870	0,870	0,890	0,890	0,890	0,900
8	1,000	0,920	0,890	0,890	0,890	0,900
9	1,000	1,000	1,000	1,000	1,000	1,000

Mean weights in the fishable stock

age\year	2000	2001	2002	2003	2004
2	0,179	0,188	0,190	0,190	0,190
3	0,552	0,487	0,457	0,506	0,506
4	0,893	1,053	1,027	0,888	0,888
5	1,165	1,436	1,369	1,367	1,265
6	1,776	1,506	1,644	1,984	1,748
7	2,620	2,180	2,290	2,382	2,391
8	2,911	2,780	3,151	2,727	2,892
9	3,137	3,025	3,035	3,025	3,025

Mean weights in the spawning stock

age\year	2000	2001	2002	2003	2004
2	0,179	0,188	0,190	0,190	0,190
3	0,552	0,487	0,457	0,506	0,506
4	0,893	1,053	1,027	0,888	0,888
5	1,165	1,436	1,369	1,367	1,265
6	1,776	1,506	1,644	1,984	1,748
7	2,620	2,180	2,290	2,382	2,391
8	2,911	2,780	3,151	2,727	2,892
9	3,137	3,025	3,035	3,025	3,025

Mean weights in the catch

age\year	2000	2001	2002	2003	2004
2	0,518	0,606	0,606	0,606	0,606
3	0,951	0,862	0,864	0,864	0,864
4	1,314	1,381	1,192	1,192	1,192
5	1,461	1,799	1,597	1,597	1,597
6	2,096	1,956	2,204	2,204	2,204
7	2,679	2,613	2,580	2,580	2,580
8	3,181	3,156	2,975	2,975	2,975
9	3,438	3,361	3,361	3,361	3,361

Selection pattern

Fishing mortality from a VPA;

age\year	1995	1996	1997	1998	1999	2000	96-200
2	0,038	0,048	0,017	0,018	0,033	0,029	0,029
3	0,236	0,197	0,167	0,134	0,172	0,278	0,190
4	0,332	0,446	0,399	0,443	0,450	0,455	0,439
5	0,580	0,510	0,649	0,598	0,793	0,831	0,676
6	0,791	0,848	0,576	0,801	0,895	0,979	0,820
7	0,899	1,022	0,871	0,823	0,874	1,003	0,919
8	0,937	1,089	0,956	1,023	0,941	1,070	1,016
9	0,876	0,986	0,801	0,882	0,903	1,017	0,918
Ave(4-7)	0,651	0,707	0,624	0,666	0,753	0,817	0,713

Selection pattern from a VPA;

age\year	1995	1996	1997	1998	1999	2000	96-200
2	0,058	0,068	0,027	0,027	0,044	0,035	0,041
3	0,363	0,279	0,268	0,201	0,228	0,340	0,266
4	0,510	0,631	0,640	0,665	0,598	0,557	0,615
5	0,892	0,722	1,040	0,898	1,053	1,017	0,948
6	1,216	1,200	0,923	1,202	1,189	1,198	1,149
7	1,382	1,447	1,396	1,235	1,161	1,228	1,288
8	1,440	1,541	1,533	1,535	1,250	1,310	1,424
9	1,347	1,396	1,284	1,324	1,199	1,245	1,287
Ave(4-7)	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Given stock numbers

age\year	2001	2002	2003	2004
2	92,000	94,00	62,00	62,00
3	66,700			
4	22,400			
5	3,760			
6	9,630			
7	1,180			
8	0,912			
9	0,168			

Table 3.4.7.1.2 Haddock in division Va. Input file for RCT3.

Iceland Haddock: VPA and groundfish survey data

4 24 2

'Yearcl'	'VPAage2'	'Surv4'	'Surv3'	'Surv2'	'Surv1'
1977	88	-11	-11	-11	-11
1978	37	-11	-11	-11	-11
1979	10	-11	-11	-11	-11
1980	42	-11	-11	-11	-11
1981	30	237	-11	-11	-11
1982	20	128	184	-11	-11
1983	42	571	591	327	-11
1984	89	889	1636	1085	282
1985	166	1468	1848	2963	1240
1986	47	391	416	407	223
1987	26	178	273	234	158
1988	22	356	416	319	106
1989	79	888	1387	1460	705
1990	169	1628	2529	2123	897
1991	37	207	406	372	185
1992	41	343	488	612	299
1993	71	546	1184	832	587
1994	35	284	496	712	358
1995	92	982	1104	1204	946
1996	13	86	258	182	86
1997	-11	222	454	865	231
1998	-11	-11	1152	910	812
1999	-11	-11	-11	1482	611
2000	-11	-11	-11	-11	819

Table 3.4.7.1.3 Haddock in division Va. Output file from RCT3.

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

 Recrun5.dat

 Iceland Haddock: VPA and groundfish survey data

 Data for    4 surveys over   24 years :  1977 - 2000

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

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

 Forecast/Hindcast variance correction used.
 Yearclass =   1995

          I-----------Regression----------I  I-----------Prediction---------I

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

 Surv4      .94  -1.82    .28   .860     14   6.89    4.69     .341     .228
 Surv3      .91  -1.96    .24   .901     13   7.01    4.39     .277     .345
 Surv2      .89  -1.82    .28   .858     12   7.09    4.50     .336     .234
 Surv1      .98  -1.69    .35   .811     11   6.85    5.01     .439     .137

                                        VPA Mean =    3.93     .684     .057
 Yearclass =   1996

          I-----------Regression----------I  I-----------Prediction---------I

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

 Surv4      .93  -1.75    .27   .866     15   4.47    2.41     .373     .210
 Surv3      .92  -2.06    .23   .900     14   5.56    3.07     .287     .355
 Surv2      .90  -1.90    .27   .862     13   5.21    2.80     .357     .230
 Surv1      .93  -1.46    .34   .807     12   4.47    2.69     .457     .140

                                        VPA Mean =    3.99     .668     .065
 Yearclass =   1997

          I-----------Regression----------I  I-----------Prediction---------I

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

 Surv4      .89  -1.47    .25   .905     16   5.41    3.33     .295     .279
 Surv3     1.02  -2.73    .27   .895     15   6.12    3.51     .310     .252
 Surv2      .94  -2.18    .27   .893     14   6.76    4.20     .312     .250
 Surv1      .94  -1.52    .32   .860     13   5.45    3.59     .373     .174

                                        VPA Mean =    3.90     .743     .044
 Yearclass =   1998

          I-----------Regression----------I  I-----------Prediction---------I

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

Table 3.4.7.1.3 (Continued)

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3	1.03	-2.79	.27	.897	15	7.05	4.46	.316	.350
Surv2	.95	-2.24	.27	.895	14	6.81	4.24	.316	.352
Surv1	.93	-1.51	.32	.865	13	6.70	4.75	.386	.235
					VPA Mean =		3.90	.746	.063

Yearclass = 1999

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2	.96	-2.31	.27	.897	14	7.30	4.71	.333	.504
Surv1	.93	-1.49	.31	.870	13	6.42	4.47	.376	.396
					VPA Mean =		3.90	.750	.100

Yearclass = 2000

Survey/ Series	Slope (Regression)	Inter- cept	Std Error	Rsquare	No. Pts	Index Value (Prediction)	Predicted Value	Std Error	WAP Weights
Surv4									
Surv3									
Surv2									
Surv1	.92	-1.48	.31	.877	13	6.71	4.72	.387	.793
					VPA Mean =		3.89	.757	.207

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	93	4.54	.16	.13	.61	92	4.53
1996	17	2.88	.17	.19	1.25	14	2.64
1997	39	3.66	.16	.17	1.14		
1998	82	4.42	.19	.13	.51		
1999	92	4.53	.24	.17	.50		
2000	94	4.55	.34	.33	.94		

Table 3.4.7.1.4 Haddock in division Va. Input to yield per recruit.

MFYPR version 1
Run: run1
Icelandic Haddock.
Time and date: 18:57 01/05/01
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.063	0	0	0.18495	1.98E-02	0.54385
3	0.2	0.251	0	0	0.47865	0.151717	0.8733
4	0.2	0.4805	0	0	0.9007	0.448399	1.3052
5	0.2	0.6575	0	0	1.399	0.728878	1.80365
6	0.2	0.783	0	0	1.9925	0.998818	2.36845
7	0.2	0.863	0	0	2.5306	1.068305	3.0208
8	0.2	0.923	0	0	3.1864	1.252504	3.4573
9	0.2	0.9795	0	0	3.25935	1.159425	3.9514

Weights in kilograms

Table 3.4.7.2.1 Haddock in division Va. Output from yield per recruit.

MFYPR version 1
Run: run1
Time and date: 18:57 01/05/01
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJ	SSBJan	SpwnNosS	SSBSpwn
0	0	0	0	4.4029	5.5381	2.1403	4.0825	2.1403	4.0825
0.1	0.0811	0.171	0.4052	4.044	4.5956	1.8313	3.2404	1.8313	3.2404
0.2	0.1622	0.2815	0.6284	3.7702	3.9033	1.6002	2.6304	1.6002	2.6304
0.3	0.2433	0.3557	0.7493	3.5568	3.3857	1.4239	2.1811	1.4239	2.1811
0.4	0.3244	0.4076	0.8127	3.3872	2.9916	1.2867	1.8445	1.2867	1.8445
0.5	0.4056	0.4453	0.8439	3.2496	2.686	1.178	1.588	1.178	1.588
0.6	0.4867	0.4741	0.8573	3.1359	2.4448	1.0902	1.389	1.0902	1.389
0.7	0.5678	0.4967	0.8609	3.0404	2.2511	1.018	1.2321	1.018	1.2321
0.8	0.6489	0.5152	0.8591	2.9589	2.0929	0.9578	1.1064	0.9578	1.1064
0.9	0.73	0.5307	0.8546	2.8884	1.9617	0.9068	1.0039	0.9068	1.0039
1	0.8111	0.5441	0.8488	2.8266	1.8513	0.863	0.9193	0.863	0.9193
1.1	0.8922	0.5557	0.8424	2.7719	1.7572	0.825	0.8484	0.825	0.8484
1.2	0.9733	0.5661	0.8359	2.7229	1.676	0.7916	0.7883	0.7916	0.7883
1.3	1.0544	0.5754	0.8295	2.6788	1.6052	0.762	0.7368	0.762	0.7368
1.4	1.1355	0.5839	0.8234	2.6386	1.5428	0.7355	0.6921	0.7355	0.6921
1.5	1.2167	0.5916	0.8175	2.6019	1.4875	0.7117	0.6531	0.7117	0.6531
1.6	1.2978	0.5987	0.8119	2.5681	1.438	0.6901	0.6186	0.6901	0.6186
1.7	1.3789	0.6053	0.8066	2.5369	1.3934	0.6704	0.5881	0.6704	0.5881
1.8	1.46	0.6114	0.8016	2.5079	1.3529	0.6524	0.5607	0.6524	0.5607
1.9	1.5411	0.6171	0.7969	2.4808	1.316	0.6358	0.5361	0.6358	0.5361
2	1.6222	0.6225	0.7924	2.4555	1.2822	0.6205	0.5138	0.6205	0.5138

Reference	F multiplier	Absolute F
Fbar(4-7)	1	0.8111
FMax	0.7068	0.5733
F0.1	0.3723	0.302
F35%SPR	0.5779	0.4688
Flow	-99	
Fmed	0.5462	0.443
Fhigh	1.4297	1.1596

Weights in kilograms

Table 3.4.7.3.1 Output from short term prediction.

MFDP version 1
Run: hadrun3
Icelandic Haddock.
Time and date: 14:53 2.5.2001
Fbar age range: 4-7

2001 Biomass	SSB	FMult	FBar	Landings
98873	45222	1,1846	0,8452	42000

2002 Biomass	SSB	FMult	FBar	Landings	2003 Biomass	SSB
121782	61120	0,0000	0,0000	0	180981	108228
.	61120	0,1000	0,0714	5268	175685	104171
.	61120	0,2000	0,1427	10284	170655	100331
.	61120	0,3000	0,2141	15064	165874	96694
.	61120	0,4000	0,2854	19621	161328	93247
.	61120	0,5000	0,3568	23968	157001	89979
.	61120	0,6000	0,4281	28118	152882	86879
.	61120	0,7000	0,4995	32082	148958	83935
.	61120	0,8000	0,5708	35871	145217	81140
.	61120	0,9000	0,6422	39496	141649	78483
.	61120	1,0000	0,7135	42964	138243	75956
.	61120	1,1000	0,7849	46285	134992	73553
.	61120	1,2000	0,8562	49468	131885	71265
.	61120	1,3000	0,9276	52519	128916	69086
.	61120	1,4000	0,9989	55446	126075	67009
.	61120	1,5000	1,0703	58255	123357	65029
.	61120	1,6000	1,1416	60953	120754	63140
.	61120	1,7000	1,2130	63546	118260	61337
.	61120	1,8000	1,2843	66039	115870	59615
.	61120	1,9000	1,3557	68438	113577	57970
.	61120	2,0000	1,4270	70746	111377	56397

Input units are thousands and kg - output in tonnes

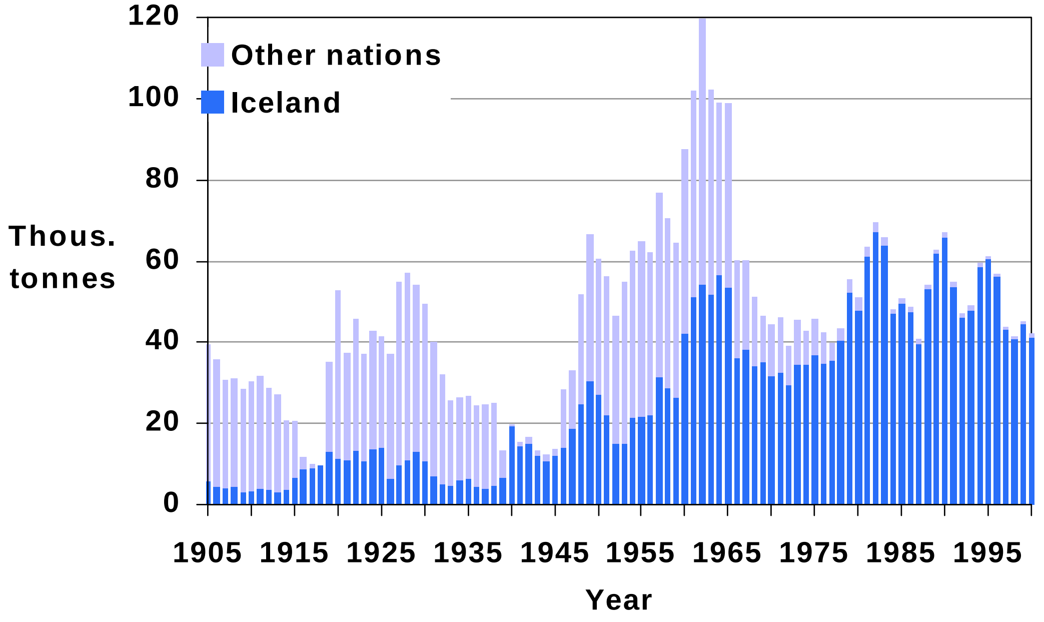


Figure 3.4.2.1 Haddock Division VA. Nominal landings (tonnes) 1905 – 2000.

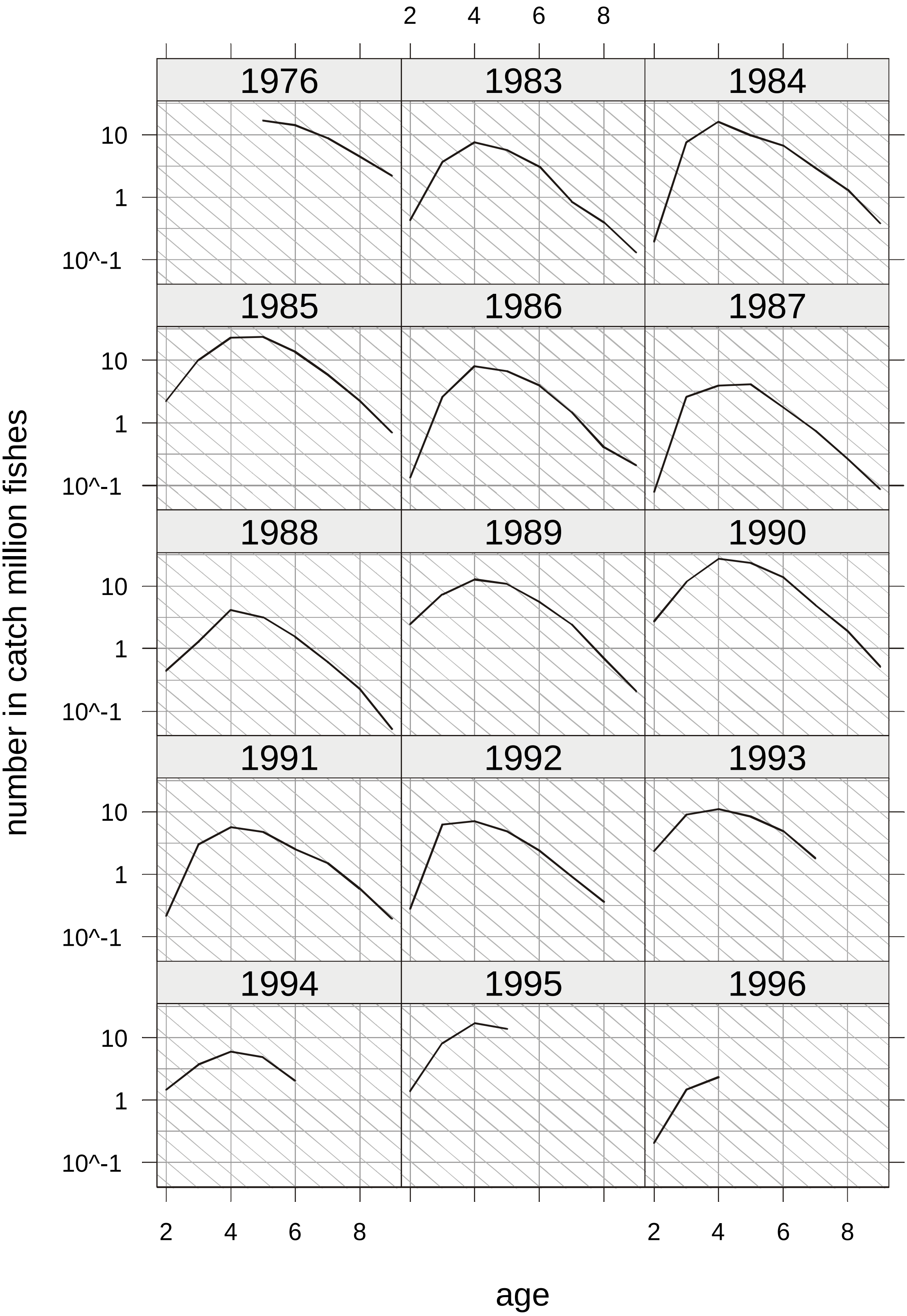


Figure 3.4.3.1. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

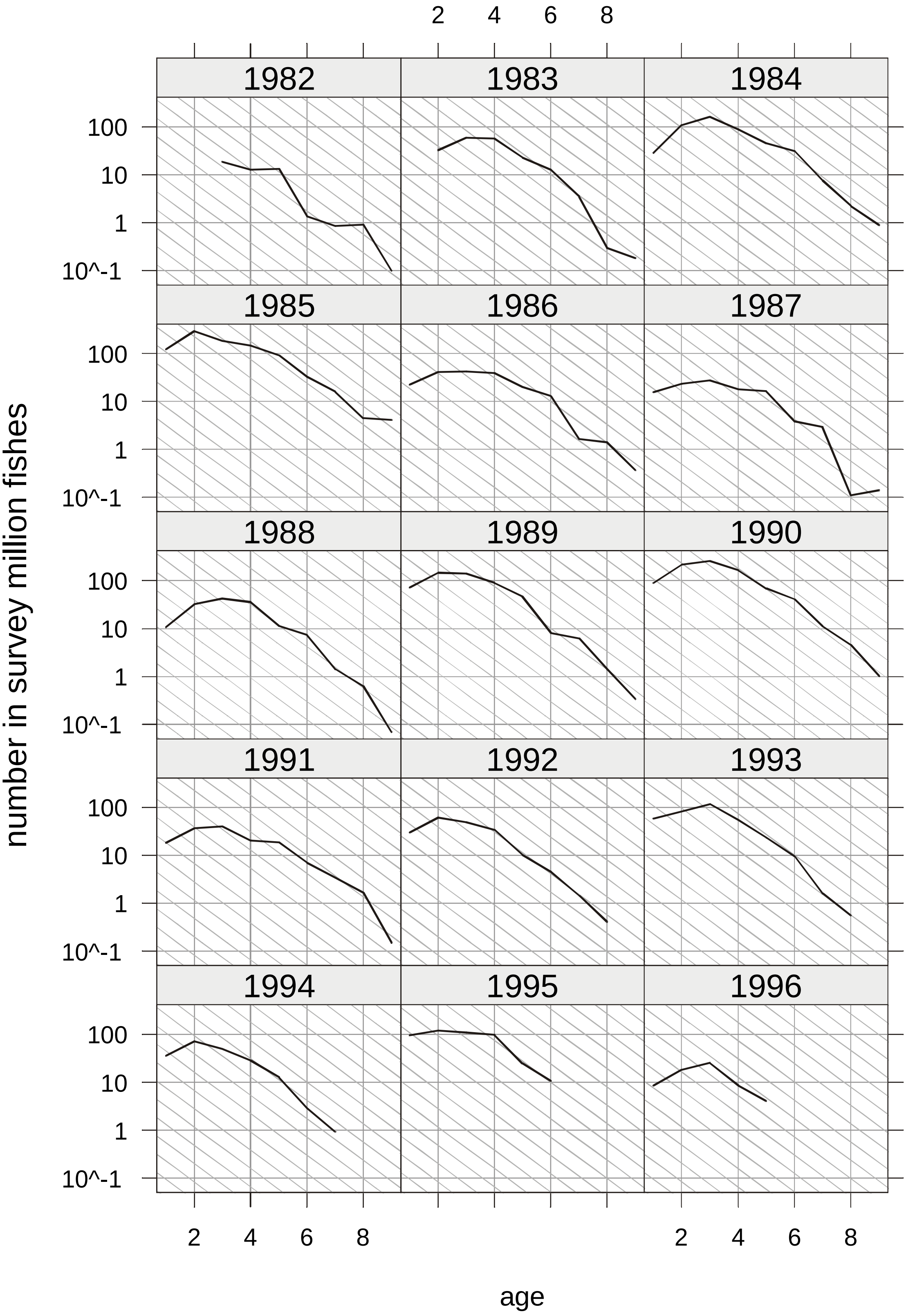


Figure 3.4.5.1 Haddock in division Va. Age disaggregated survey indices plotted on log scale. The grey lines show Z=1.

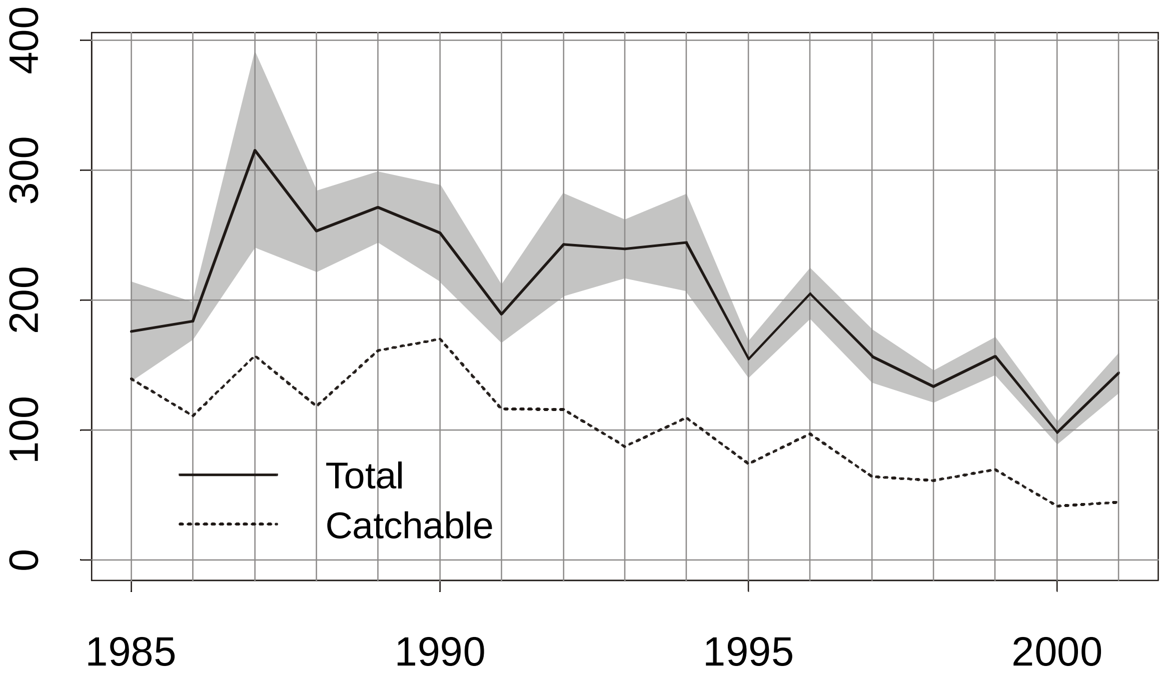


Figure 3.4.5.2. Haddock in division va. Biomass indices from the groundfish survey. The upper figure shows the total biomass and the lower figure the catchable biomass. Shaded areas show 2 times the standard error in the survey biomass.

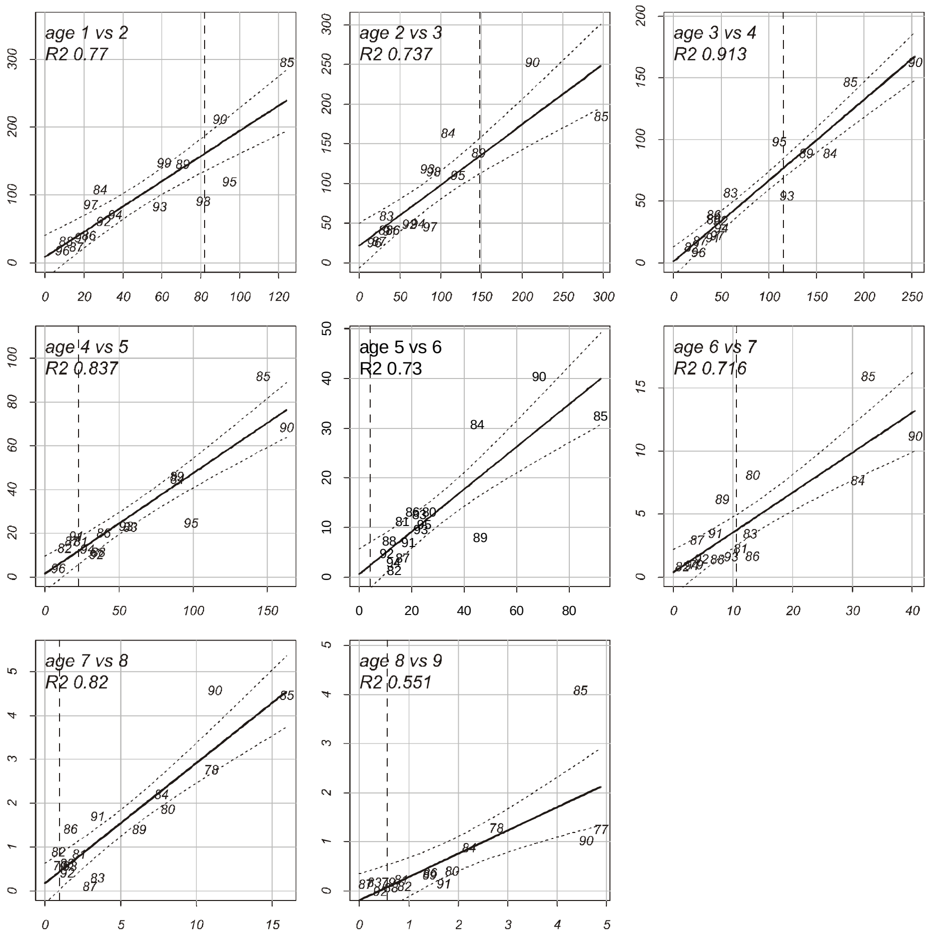


Figure 3.4.5.3 Haddock in division Va. Survey indices plotted against survey indices of the same yearclass one year earlier.

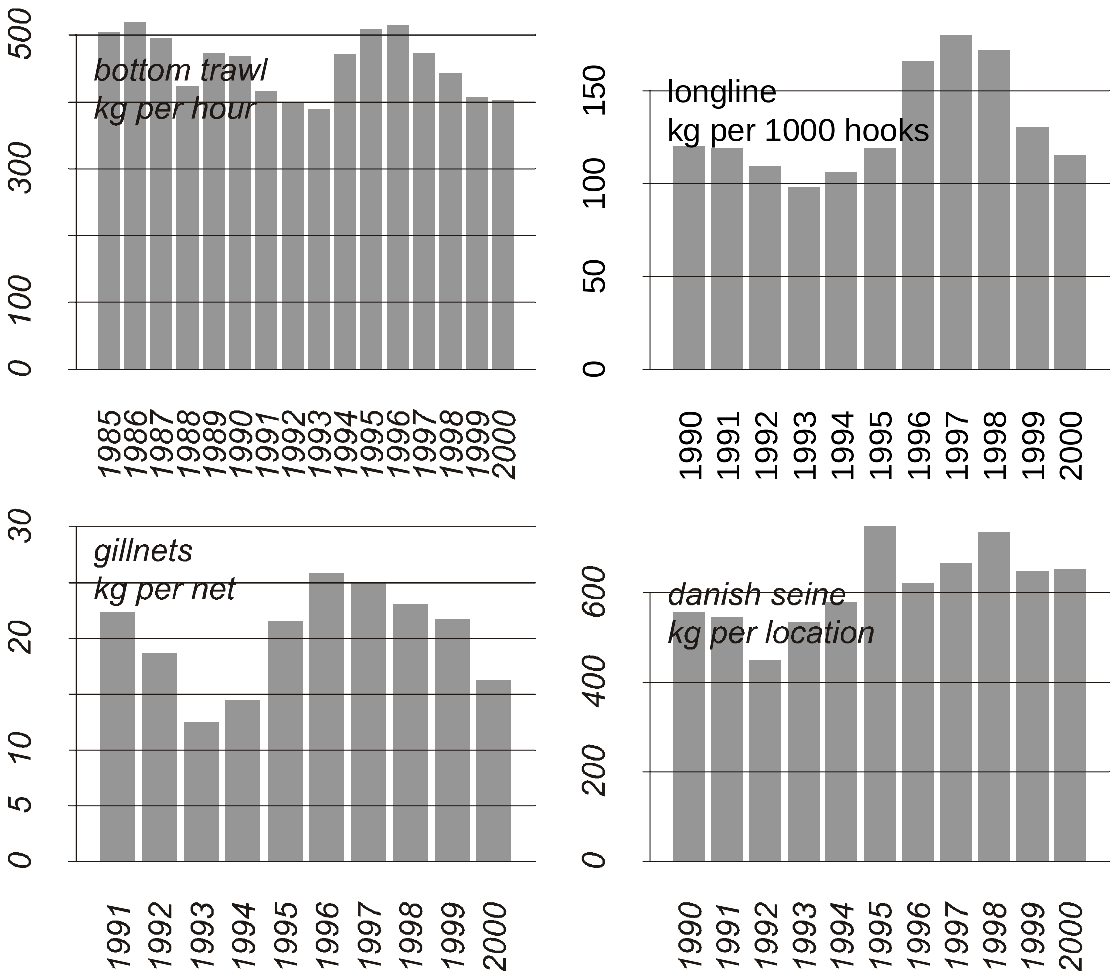


Figure 3.4.5.4. Haddock in division Va. Catch per unit effort in the most important gear types. The figure is based on records where more than 50% of the catch is haddock.

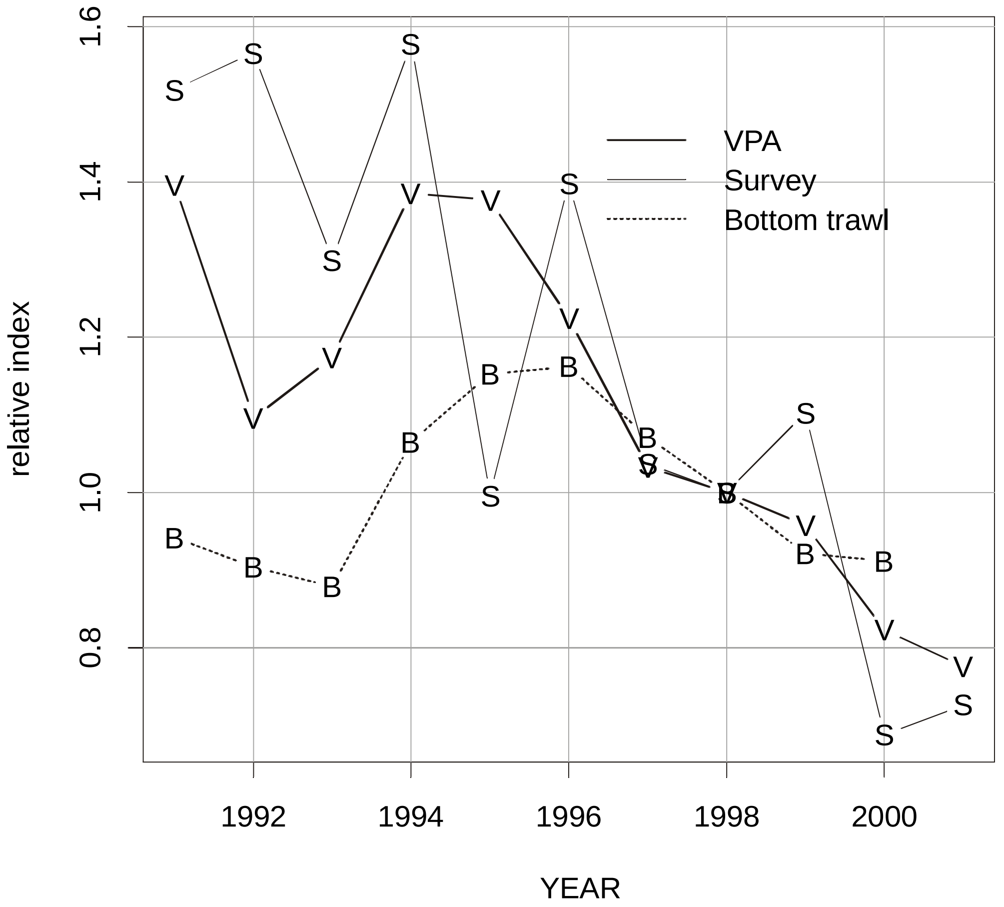


Figure 3.4.5.5 Haddock in division Va. Comparison of evolution of catchable biomass from VPA, survey catchable biomass and catch per unit effort from bottom trawl using tows where more than 50% of the catch was haddock. The VPA run used is based on survey and bottom trawl.

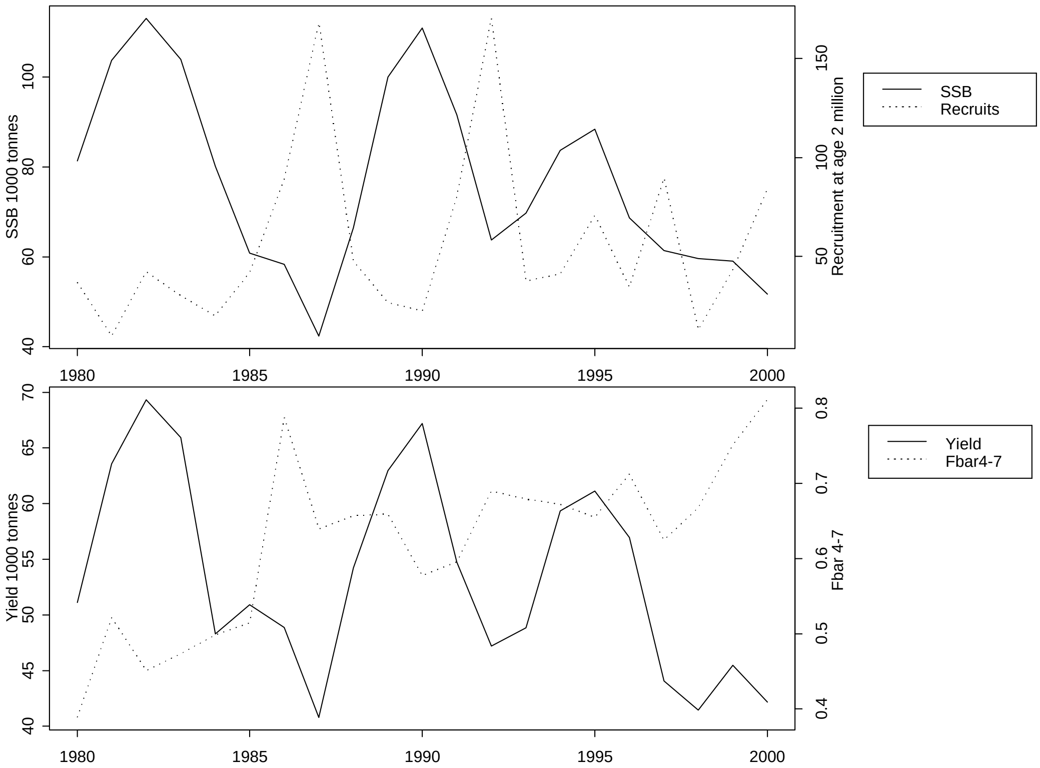


Figure 3.4.6.2.1 Haddock in division Va. Summary plots

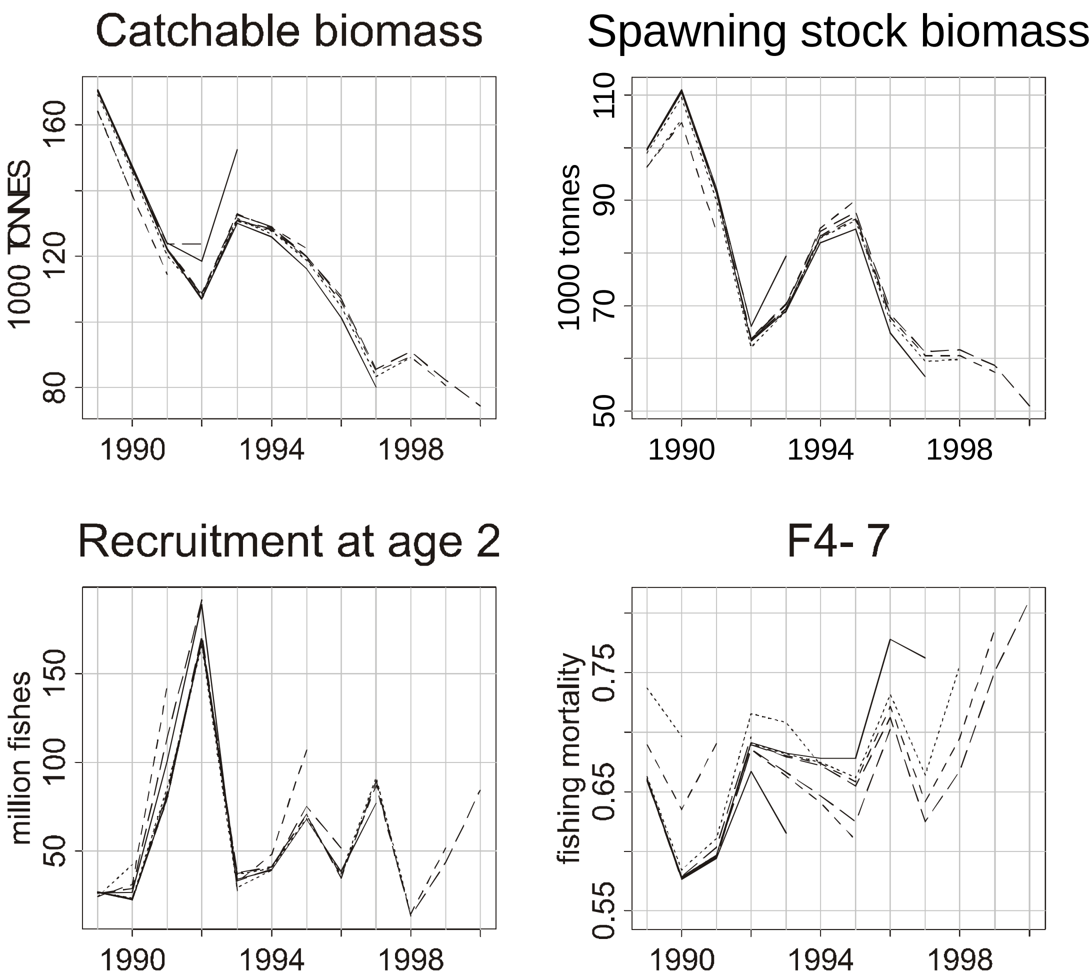


Figure 3.4.6.2.2 Haddock in division Va. Retrospective pattern from the run using survey indices from age 2 to 9.

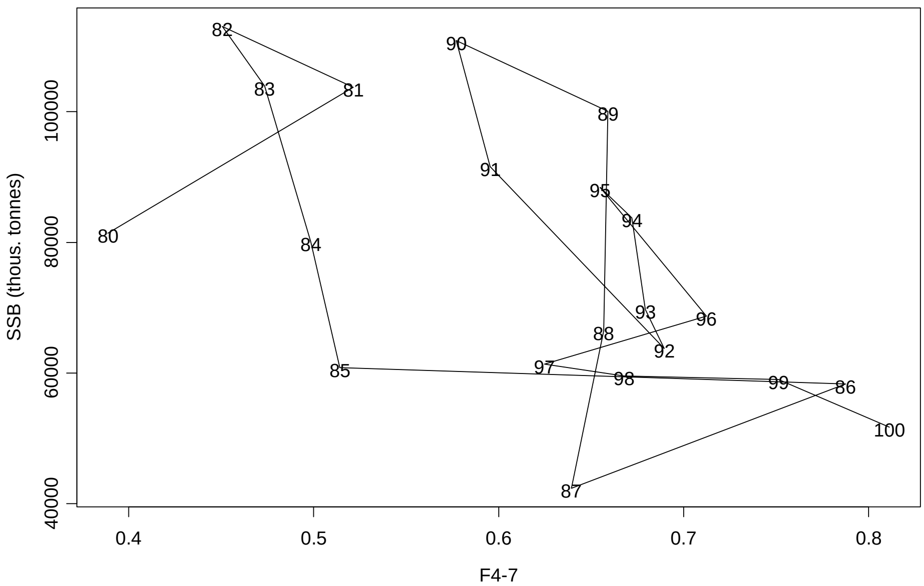
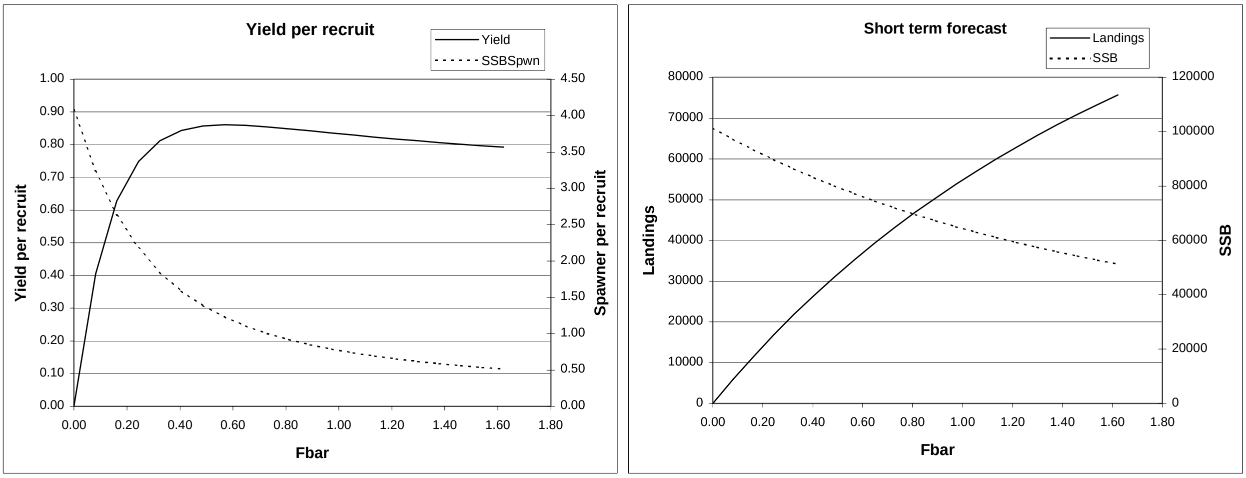


Figure 3.4.6.3.1 Haddock in division Va. Spawning stock vs. fishing mortality.



MFYPR version 1
Run: run1
Time and date: 18:57 01/05/01

Reference point	F multiplier	Absolute F
Fbar(4-7)	1.0000	0.8111
FMax	0.7068	0.5733
F0.1	0.3723	0.3020
F35%SPR	0.5779	0.4688
Flow	-99.0000	
Fmed	0.5462	0.4430
Fhigh	1.4297	1.1596

Weights in kilograms

MFDP version 1
Run: run1
Icelandic Haddock.
Time and date: 16:24 01/05/01
Fbar age range: 4-7

Input units are thousands and kg - output in tonnes

Figure 3.4.7.2.1 Haddock in division Va. Yield per recruit.

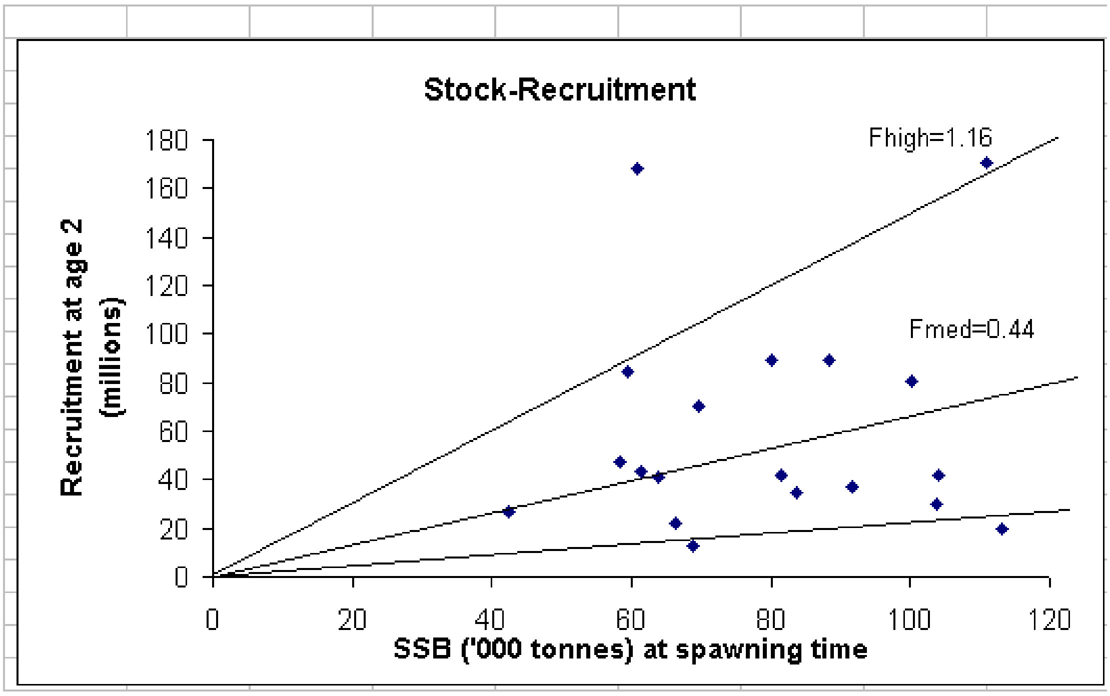


Figure 3.4.7.2.2 Haddock in division Va. Spawning stock vs. recruit.

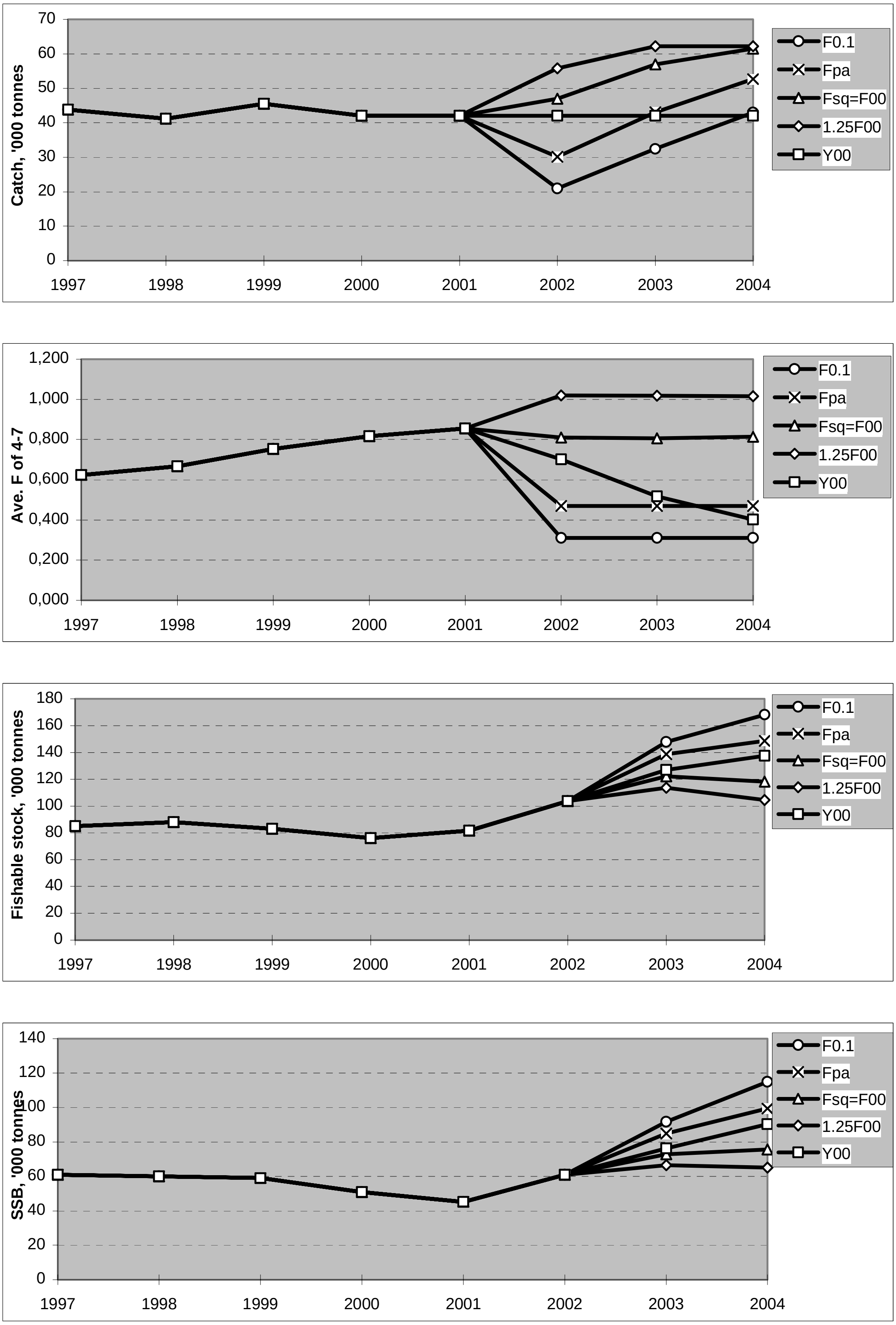


Figure 3.4.7.3.1 Haddock in division Va. Short term prediction. Summary of results for 5 different fishing mortalities.

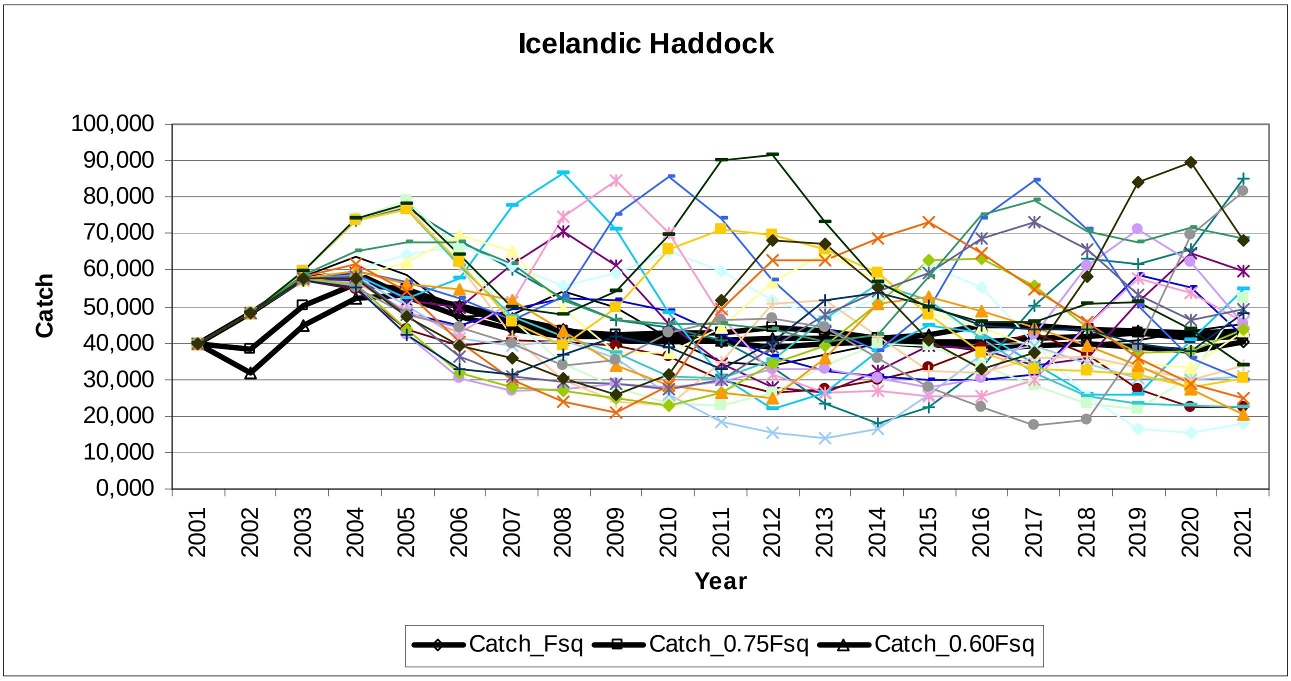


Figure 3.4.8.1. Haddock in division Va. Catches for different fishing mortality options. The figure shows individual trajectories but the bold lines the median.

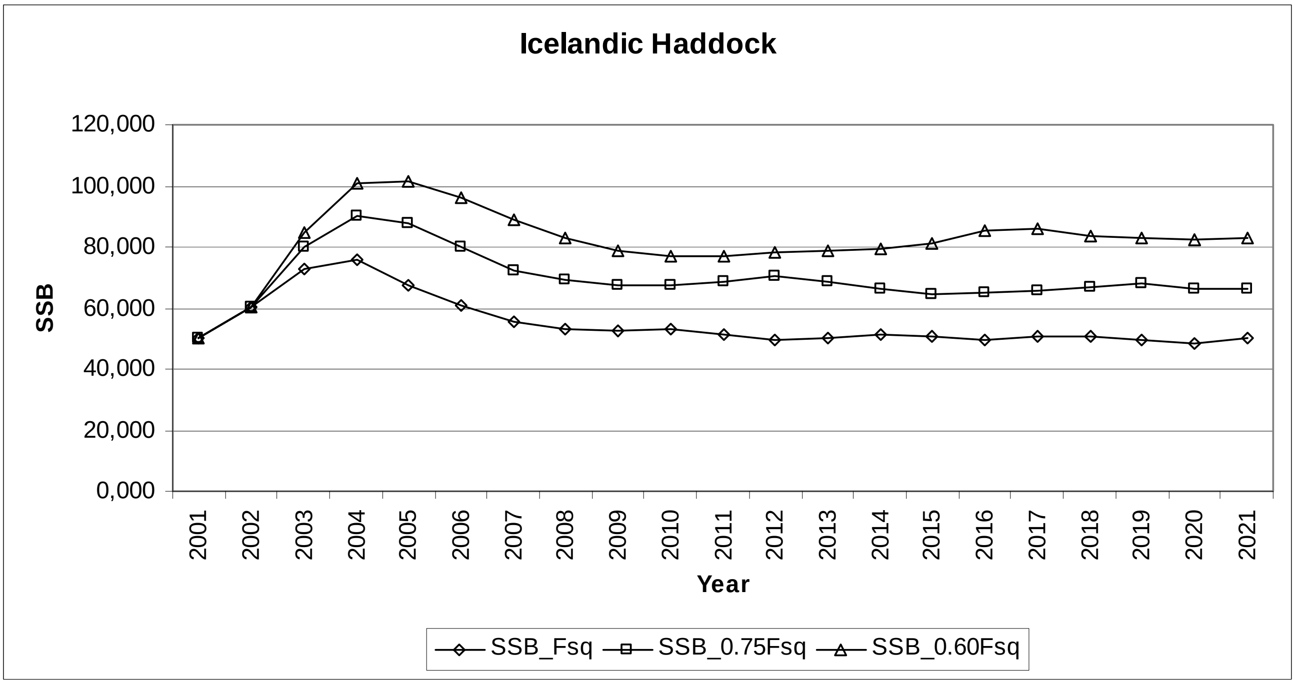


Figure 3.4.8.2. Haddock in division Va. Median spawning stock size for different fishing mortality options.

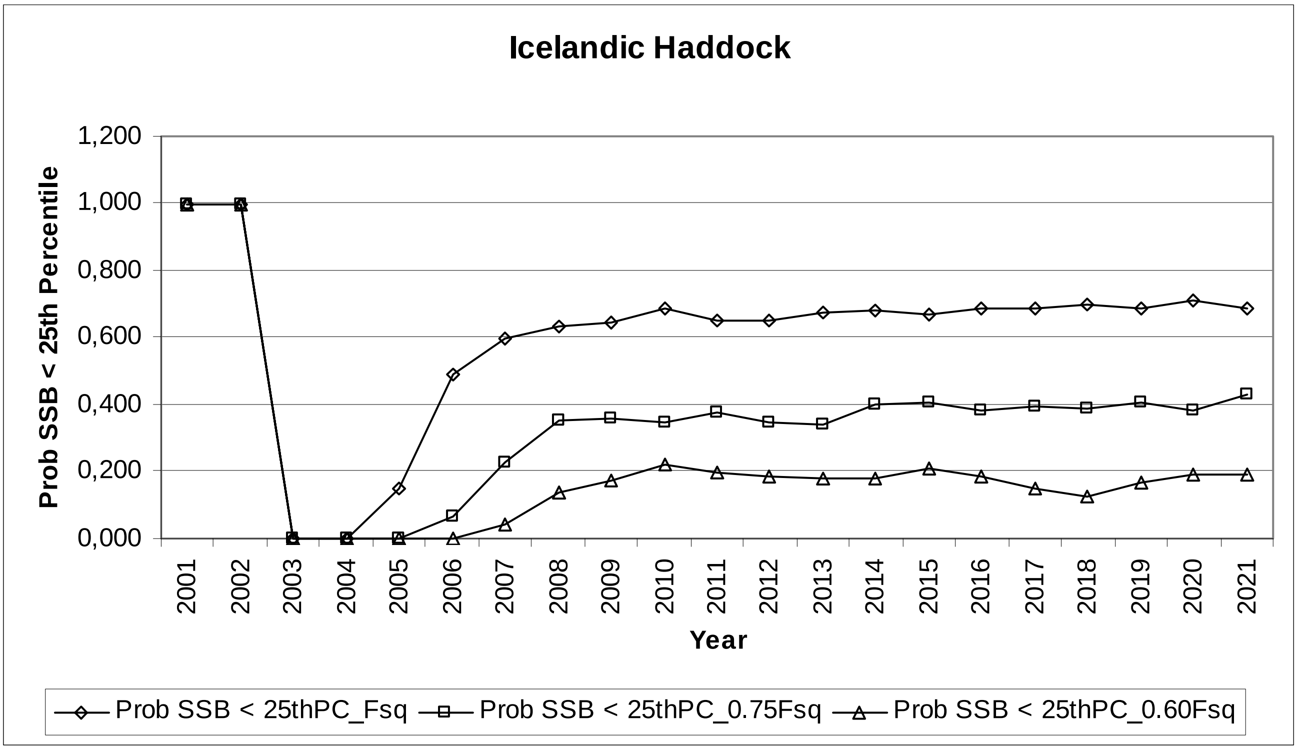


Figure 3.4.8.3. Haddock in division Va. Propability of spawning stock being below 60 000 tonnes for different fishing mortality options.

4 THE COD STOCK COMPLEX IN GREENLAND (NAFO SUB-AREA 1 AND ICES SUB-AREA XIV) AND ICELANDIC WATERS (DIVISION Va)

4.1 Inter-relationship Between the Cod Stocks in the Greenland-Iceland Area

Tagging experiments carried out at Greenland and Iceland show that mature cod at West Greenland migrate to East Greenland. Tagging experiments at East Greenland also show that mature cod from that area migrate to Iceland (Tåning, 1937; Hansen, 1949; and Anon. 1971). On the other hand, immature cod seem not to emigrate from East Greenland to Iceland, but in some years immature cod migrate from East Greenland to the West Greenland stock (Anon. 1971). Tagging experiments at Iceland show that migration of cod from Iceland to Greenland waters occurs very seldom and can be ignored in stock assessments (Jonsson 1965, 1986). Migrations from Greenland waters to Iceland can, therefore, be regarded as a one-way migration.

In egg and larval surveys cod eggs have been found in an almost 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 2000 are exceptionally high. More than 60% of the 0-group cod were distributed in northern areas off Iceland (Table 4.1.1). However, none of these year classes seem to have drifted in significant numbers to the Greenland shelf.

The 1973 and 1984 year classes have been very important to the fisheries off both West and East Greenland. Tagging results have shown that when these two year classes became mature, they had migrated in large numbers from West to East Greenland and, to some extent, to the spawning area off the southwest coast of Iceland. This migration of mature cod from Greenland to Iceland influences the assessment of these stocks (Schopka, 1993) and it cannot therefore be ignored in the assessments.

Table 4.1.1 Abundance indices of O-group cod from international and Icelandic O-group surveys (Sveinbjörnsson and Hjörleifsson, 2000) in the East Greenland/Iceland area, 1971-2000 (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

[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 SUB-DIVISION XIVB)

5.1 Cod off Greenland (offshore component)

Prior to 1996, the cod stocks off Greenland have been divided into West and East Greenland or treated as one stock unit for assessment purposes to avoid migration effects. Fjord populations (inshore) have always been included. In 1996, the offshore component off West and East Greenland, the so called Bank Cod, was assessed separately as one stock unit and distinguished from the inshore populations for the first time. The completion of a re-evaluation of available German sampling data for the offshore catches back to 1955 enabled such an analysis given in the 1996 North-Western Working Group report (ICES 1996/Assess:15). Due to the severely depleted status of the offshore stock component, the directed cod fishery was given up in 1992, the final year in the VPA. Since then, no adequate data were available to update the assessment. Therefore, the present report includes the summary table and figures of the 1996 assessment only appended by long term management considerations and updated survey results and catch information.

5.1.1 Trends in landings and fisheries

Officially reported catches are given in Tables 5.1.1 and 5.1.2 for West and East Greenland including inshore catches, respectively. Landings as used by the working group are listed in Table 5.1.3 by inshore and offshore areas and gear for both West and East Greenland combined, their trends being illustrated in Fig. 5.1.1. Until 1975, offshore landings have dominated the total figures by more than 90%. Thereafter, the proportions taken offshore declined to 40–50% and inshore landings have dominated the most recent yields since 1993. Otter trawl board catches (OTB) were most important throughout the time series for offshore fisheries. Miscellaneous gears, mainly long lines and gill nets, contributed 30–40% until 1977 but have disappeared since then.

Annual landings taken offshore averaged about 300 000 t during the period 1955–60. Until 1968, figures increased to a higher level between 330 000 t and of 440 000 t in 1962. Landings decreased sharply by 90% to 46 000 t in 1973. Subsequently, the landings dropped below 40 000 t in 1977 and were very variable. The level of 40 000 t was only exceeded during the periods 1980–83 and 1988–1990. Since 1970, there have been large changes in effort, which increased during exploitation of the strong year classes born in 1973 and 1984. The offshore fishery was closed in 1986 and for the first 10 months in 1987. During 1990–92, the landings decreased from 100 000 t by 90% to 11 000 t. Since then, almost no directed cod fishery has taken place offshore and the reported landings varied from 116 t to 736 t. A total offshore catch amounting to 156 t was reported for 2000.

It is important to note that catch figures, especially since 1992, are believed to be incomplete due to unreported by-catches in the shrimp fishery which has recently expanded to all traditional areas of the groundfish fisheries. Discards of finfish by-catches were difficult to record due to the processing of the shrimp catch on board. A first assessment of the catch taken by the shrimp fishery amounted to 32 t or 110 000 individuals of cod in 1994. This estimate was added to the catch figures used by the Working Group for the 1992–95 period.

5.1.2 Results of the German groundfish survey

Annual abundance and biomass indices have been derived using stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in the report of the 1993 North-Western Working Group (ICES 1993/Assess:18) and Working Doc. 15. Figure 5.1.2 indicates names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3-mile line offshore except for some inshore regions in Strata 6.1 and 6.2 off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, and 1994 the survey coverage was incomplete off East Greenland partly due to technical problems.

5.1.2.1 Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–99. Trends of the abundance and biomass estimates for West and East Greenland were shown in Figures 5.1.3 and 5.1.4, respectively. These Figures illustrate the pronounced increase in stock abundance and biomass indices from 23 million individuals and 45 000 tons in 1984 to 828 million individuals and 690 000 tons in 1987. This trend was the result of the recruitment of the predominating year classes 1984 and 1985, which were mainly distributed in the northern and the shallow strata 1.1, 2.1 and 3.1 off West Greenland during 1987–89. Such high indices were never observed in strata off East Greenland, although their abundance and biomass estimates increased during the period 1989–91 suggesting an eastward migration. During the period 1987–89, which were years with high abundance, the precision of survey indices was extremely low due to enormous variation in catch per tow data. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000 tons in 1993. The 2000 survey results confirmed the severely depleted status of the stock.

5.1.2.2 Age composition

Age disaggregated abundance indices for West, East Greenland and the total are listed in Tables 5.1.5–7, respectively. In 2000, the stock structure off West Greenland was found to be composed mainly of the pre-recruiting age groups 2 and 3 (60%). The age composition off East Greenland was found to be more diverse Although the 1997 and 1998 year classes are the highest at age 1 since 1987 they are considered to be poor as compared with strong 1984 and 1985 year classes and therefore indicate only a very small recovery potential in short term as derived from the regression between year class strength at age 1 and 3 (Fig. 5.1.5). The survey estimates for the O-group are considered unrepresentative due to gear specifications and do not allow assessments of year class strength at older ages (Figure 5.1.5).

5.1.2.3 Mean weight at age

Mean weight of the age groups 1–10 years for West, East Greenland and weighted by abundance to the total were listed in Tables 5.1.8–10, respectively. Weight (g) at age calculations are based on the regression $f(x) = 0.00895x^{3.00589}$, x = length (cm), which has been determined on the basis of 3 482 individual measurements. The trends of these values are illustrated in Figure 5.1.6 for the period 1982–2000. They revealed pronounced area and temperature effects. Age groups 2–10 years off East Greenland were found to be bigger than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1–5 displayed a decrease during 1986–87 and remained at low levels until 1991. Since then, the weight at age at ages 3 to 8 years increased significantly and remained at that high level until 1999. However, the 2000 values indicate reduced growth rates for most ages.

5.1.3 Biological sampling of commercial catches

No commercial sampling data were available to assess recent catch in numbers, weight and maturity at age.

5.1.4 Results from the 1996 assessment

The historical stock status was assessed based on the terminal Fs derived from an XSA tuning run applying 1992 as the final year.

Trends in yield and fishing mortality are shown in Figure 5.1.7. An increasing trend in Fbar from 0.1 to 0.4 was determined during the period 1955–68. During the same period, the yield increased from a level of 280 000 t to 380 000 t but decreased drastically to 100 000 t in the early 70s. Thereafter, the fishing mortality was highly variable and seemed to be dependent on the changes in effort directed to the exploitation of individual strong year classes. Periods when Fbar for ages 5–8 years exceeded 0.5 were 1974–1977, 1980–1984 and 1988–1992.

Trends in spawning stock biomass and recruitment were shown in Figure 5.1.8. During 1955 to 1973, the spawning biomass decreased almost continuously from 1.8 million t to 110 000 t, a decrease of 94%. Thereafter, the spawning stock biomass averaged 50 000 t. During the period 1955–73 before the spawning stock decreased below 100 000 t, the recruitment at age 3 varied enormously between 4 million and 700 million and averaged 220 million. Since 1974, the spawning stock varied around the mean of 50 000 t and produced an average recruitment of 41 million representing a mean reduction by 95% and 80%, respectively. The long term mean recruitment was not exceeded for 8 of 19 years from 1955 to 1973, while it has been below that value for 17 of 19 years since then. During the last 29 years, only 2 yearclasses have reached the long term mean recruitment level at age 3, namely those produced in 1973 and 1984.

5.1.5 Estimation of management reference points

Input parameters for the estimation of long-term yield and spawning stock biomass per recruit are listed in Table 5.1.11 for age groups 3–12. Maturity and weight at age vectors were calculated as long-term means covering the period 1955–92. The natural mortality M was increased to 0.3 for age groups 5 and older to account for an emigration to Iceland. The exploitation pattern was derived as Fbar from the three most recent years from the final VPA. Determined F-factors for $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ were scaled according to the mean reference F over the age groups 5–8. The resulting estimates of yield and spawning stock biomass per recruit are illustrated in Figure 5.1.9. The values of $\mathbf{F}_{0.1}$ and $\mathbf{F}_{max}$ are indicated by arrows and amounted to 0.3 and 0.72, respectively. The lack of a well definite peak in the yield per recruit curve is due to increased natural mortality.

Recruitment at age 3 is plotted against the spawning stock biomass in Figure 5.1.10. $\mathbf{F}_{med}$ amounted to 0.09. The corresponding spawning stock biomass per recruit was as high as 4.5 kg. $\mathbf{F}_{high}$ amounted to 0.59 with the accompanied spawning stock biomass per recruit of 1.0 kg.

However, neither the determined Beverton & Holt nor the Ricker model fitted the observed recruitment-spawning stock biomass points well. The Beverton & Holt curve quickly reached the long term mean recruitment level affected by the strong 1973 and 1984 year classes related to low biomass values and extremely poor year classes 1969–72 produced by spawning stock sizes exceeding 250 000 t. The Ricker curve did not reach a maximum over the available range of observed spawning stock sizes. This suggested that, during the period of investigation, the recruitment appeared at all times to be adversely affected by reductions in spawning stock biomass.

Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. An example of restricted recruitment was identified for the period 1969–72 when a continued cold event off West Greenland and an almost complete recruitment failure was observed. Figure 5.1.10 indicates that the reduced recruitment was observed at a SSB of less than 1 000 000 t. Following the instructions given by the SGPAFM this value could be taken as the precautionary reference point $\mathbf{B}_{pa}$. Given the depleted stock status, no limit and precautionary reference points for fishing mortality and biomass were proposed.

5.1.6 By-catch and discard of cod in the shrimp fishery

No information about the amount of by-catch and discard of cod in the shrimp fishery off East and West Greenland was available. Long term simulations based on a recruitment model (Rätz *et al*., 1999) were carried out last year (ICES 1998/ACFM:19) and indicated a significant adverse effect of even low fishing mortality of pre-recruits on the potential stock recovery. However, with the mandatory use of a 22 mm sorting grid since October 1, 2000, the by-catch rates and corresponding F of cod should be substantially reduced in the future.

5.1.7 Management considerations

The assessment of the offshore component of the cod stocks off Greenland revealed that over-fishing was a major 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. Only two strong year classes have been observed in 1976 and 1987 as 3 year olds. An increase in effort directed towards the 1973 and 1984 year classes resulted in high fishing mortality. Both year classes contributed only negligible amounts to the severely declined spawning stock. The most recent trend in the fishery and German survey data, which were not included in this assessment, are consistent with this picture. Further, no indication of a significant stock recovery in the short term was derivable based on the lack of strong pre-recruiting year classes. In the present situation, catches of young cod in the shrimp fishery should be kept to a minimum in order to increase the probability of stock recovery. No fishing should take place until a substantial increase in recruitment and biomass is evident.

5.1.8 Comments on the assessment

The present assessment is based on survey indices only due to the termination of the cod directed offshore fishery in 1992.

The VPA assessment conducted in 1996 was affected by several uncertainties in data as well as ecological factors. The effect of emigration was only directly covered for the 1973 and 1984 year classes and had been taken into account by an increase of the natural mortality to 0.3 for age groups 5 and older. The sampling of commercial catches was historically rather inconsistent and did not cover the 30% taken by miscellaneous gears, mainly longlines and gill nets up to 1977. Since 1991, catch at age and weight at age data had to be calculated using survey data. Maturity data were poorly reported implying uncertainties in spawning stock estimates.

No XSA tuning could be applied since 1997 when low levels in landings, effort and stock abundance were observed. The age disaggregated survey indices had to be adjusted to account for incomplete coverage of the survey area in 1992 and 1994.

Table 5.1.1 Nominal catch (tonnes) of Cod in NAFO Sub-area 1, 1987-2000 as officially reported to NAFO.

Country	1987	1988	1989	1990	1991	1992	1993
Faroe Islands	-	-	-	51	1	-	-
Germany	55	6.574	12.892	7.515	96	-	-
Greenland	12.284	52.135	92.152	58.816	20.238	5.723	1.924
Japan	33	10	-	-	-	-	-
Norway	1	7	2	948	-	-	-
UK	-	927	3780	1.631	-	-	-
Total	12.373	59.653	108.826	68.961	20.335	5.723	1.924
WG estimate	-	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-

Country	1994	1995	1996	1997	1998	1999	2000 [1]
Faroe Islands	-	-	-	-			
Germany	-	-	-	-			
Greenland	2.115	1.710	948	904	319	622	
Japan	-	-	-	-			
Norway	-	-	-	-			
UK	-	-	-	-			
Total	2.115	1.710	948	904	319	622	
WG estimate	-	-	-	-	-	-	-

[1]) Provisional data reported by Greenland authorities
[2]) Includes 3,000 t reported to be caught in ICES Sub-area XIV
[3]) Includes 2,741 t reported to be caught in ICES Sub-area XIV
[4]) Includes 29,513 t caught inshore

Table 5.1.2 Nominal catch (tonnes) of cod in ICES Sub-area XIV, 1987-2000 as officially reported to ICES.

Country	1987	1988	1989	1990	1991	1992	1993
Faroe Islands	-	12	40	-	-	-	-
Germany	5.358	12.049	10.613	26.419	8.434	5.893	164
Greenland	1.550	345	3.715	4.442	6.677	1.283	241
Iceland	1	9	-	-	-	22	-
Norway	-	-	-	17	828	1.032	122
Russia			-	-	-	126	
UK (Engl. and Wales)	-	-	1.158	2.365	5.333	2.532	-
UK (Scotland)	-	-	135	93	528	463	163
United Kingdom	-	-	-	-	-	-	46
Total	6.909	12.415	15.661	33.336	21.800	11.351	-
WG estimate	-	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-	736
							-

Country	1994	1995	1996	1997	1998	1999	2000 [5]
Faroe Islands	1	-	-	-	-	6	
Germany	24	22	5	39	128	13	3
Greenland	73	29	5	32	37	+	
Iceland	-	1	-	-		-	-
Norway	14	+	1 [5]	15 [5]	1	2	4
Portugal					31	-	-
Russia	-	-	-	-			
UK (Engl. and Wales)	-	-	-	-			
UK (Scotland)	-	-	-	-			
United Kingdom	296	232	181	284	149	95	149
Total	408	284	192	370	346	116	156
WG estimate	-	-	-	-	-	-	-

[1]) Excluding 3,000 t assumed to be from NAFO Division 1F and including 42 t taken by Japan

[2]) Excluding 2,741 t assumed to be from NAFO Division 1F and including 1,500 t reported from other areas assumed to be from Sub-area XIV and including 94 t by Japan and 155 t by Greenland (Horsted, 1994)

[3]) Includes 129 t by Japan and 48 t additional catches by Greenland (Horsted, 1994)

[4]) Includes 18 t by Japan

[5]) Provisional data

Table 5.1.3 Cod off Greenland (offshore component). Catches (t) as used by the Working Group, inshore and offshore by gear based on Horsted (1994).

Year	inshore	Offshore Miscellaneous	offshore OBT	offshore total	total
1955	19787	117238	136028	253266	273053
1956	21063	121876	193593	315469	336532
1957	24790	104632	151666	256298	281088
1958	26684	121636	182516	304152	330836
1959	28184	97457	128777	226234	254418
1960	28708	115273	122859	238132	266840
1961	35164	140110	192007	332117	367281
1962	36283	168092	273598	441690	477973
1963	24173	138451	289143	427594	451767
1964	23106	118495	243714	362209	385315
1965	25209	133855	225150	359005	384214
1966	29956	149234	200086	349320	379276
1967	28277	132415	293519	425934	454211
1968	21215	64286	323800	388086	409301
1969	22119	36276	174031	210307	232426
1970	16114	16101	102196	118297	134411
1971	14039	25450	113207	138657	152696
1972	14753	29765	94730	124495	139248
1973	9813	16740	46141	62881	72694
1974	8706	18086	27695	45781	54487
1975	6779	13363	33692	47055	53834
1976	5446	8710	32157	40867	46313
1977	14964	10081	21726	31807	46771
1978	20295	4	26059	26063	46358
1979	36785	36	20056	20092	56877
1980	40122	0	57584	57584	97706
1981	40021	0	40266	40266	80287
1982	26934	2020	49827	51847	78781
1983	26689	3339	40991	44330	71019
1984	19967	5	22358	22363	42330
1985	8488	1	8499	8500	16988
1986	5320	2	6036	6038	11358
1987	8445	1	10836	10837	19282
1988	22814	7	49089	49096	71910
1989	38788	2	85946	85948	124736
1990	29513	948	99535	100483	129996
1991	18950	0	22966	22966	41916
1992	5723	0	11351	11351	17074
1993	1924	0	736	736	2660
1994	2115	0	408	408	2523
1995	1739	0	254	254	1993
1996	953	0	187	187	1140
1997	936	0	338	338	1274
1998	333	0	332	332	665
1999	622	0	116	116	738
2000	281	0	156	156	437

Table 5.1.4 Cod off Greenland (offshore component). Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2000. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

	Abundance					Biomass				
YEAR	WEST	EAST	TOTAL	CI	Spawn. St.	WEST	EAST	TOTAL	CI	Spawn. St.
1982	92276	8090	100366	28	33793	128491	23617	152107	25	79511
1983	50204	7991	58195	25	23889	82374	34157	116531	25	57223
1984	16684	(6603)	(23286)	32	17653	25566	(19744)	(45309)	34	36162
1985	59343	12404	71747	33	17349	35672	33565	69236	39	45630
1986	145682	15234	160915	32	14350	86719	41185	127902	26	48976
1987	786392	41635	828026	59	25467	638588	51592	690181	63	65584
1988	626493	23588	650080	48	128578	607988	52946	660935	46	155556
1989	358725	91732	450459	59	332589	333850	239546	573395	46	514773
1990	34525	25254	59777	43	46355	34431	65964	100395	34	77064
1991	4805	10407	15213	29	6404	5150	32751	37901	36	17756
1992	2043	(658)	(2700)	50	560	607	(1216)	(1823)	69	1091
1993	1437	3301	4738	36	2327	359	5600	5959	41	4024
1994	574	(801)	(1375)	36	457	140	(2792)	(2930)	68	1732
1995	278	7187	7463	93	2340	57	15525	15581	155	10445
1996	811	1447	2257	38	592	373	3599	3973	56	2017
1997	315	4153	4469	75	3411	284	13722	14007	90	10416
1998	1723	1671	3394	54	1133	130	4348	4479	91	3820
1999	912	2769	3681	34	809	240	3917	4157	62	3004
2000	1926	4816	6742	36	3556	570	4778	5349	40	4176

Table 5.1.5 Cod off West Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-2000. *) 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

Table 5.1.6 Cod off East Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-2000. *) 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

Table 5.1.7 Cod off Greenland (offshore component). Age disaggregate abundance indices (1000), 1982-2000. *) 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

Table 5.1.8 Cod off West Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2000.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	190	568	920	1770	2164	2962	4078	5065	6995
1983										
1984	68	136	379	807	1356	1990	2885	3600	4476	6177
1985	96	168	568	981	1475	2010	3121	3341	4408	4014
1986	72	325	498	1118	1697	2217	2784	3889	4159	4493
1987	37	223	697	926	1194	2154	2239	3028		3541
1988	38	211	456	1019	1145	1941	2949	2735	3630	4192
1989	36	159	423	796	1403	1443		2885	3229	4562
1990	38	114	334	599	909	1395	1111			
1991	50	139	356	649	926	1356	1743	920		
1992	75	230	379	668	938		2061			
1993	41	132	405	494	920	920				
1994	45	126	456	608	1111		2461			
1995		186	328	482						
1996	42	104	510	753		3645				
1997	68	334	375	994						
1998	50			1567	1516					
1999	77	340	612	1111		2822				
2000	39	234	405	796						

Table 5.1.9 Cod off East Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2000. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982		423	769	1419	2326	3498	4597	5523	6633	6500
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	109	437	1038	1761	3161	3369	4459	4755	5824	7957
1986	88	375	915	1715	2674	4225	4159	4954	6030	6722
1987	33	283	640	885	1653	3600	4545	5120	6072	7684
1988		275	733	1770	3067	4291	4702	6500	6949	7418
1989	68	252	538	1118	2507	3690	3951	5027	5662	6457
1990	52	419	510	1145	1618	2625	3858	5702	6880	
1991	86	194	402	1173	1864	2315	3355	4374	5139	10198
(1992)	18	402	758	1575	3175	3028	3271	3469		
1993	81	353	728	1333	2315	2834	3600	4827	6135	
(1994)	41		1111	2271	3054	4791	4827		5742	
1995	68	249	430	1508	2949	4176	5233	5926	9645	7442
1996			717	1921	2461	3586	5120	5824		
1997		104	1525	1931	3454	4062	4562	4685		
1998	101	155	1045	1779	3028	3541	3858	6745		
1999	84	269	594	1173	2949	3735	4917		8522	9004
2000	94	184	459	874	1601	2102	3243	5196	6284	8160

Table 5.1.10 Cod off Greenland (offshore component). Weighted mean weight (g., by stratum abundance) at age 1-10 years, 1982, 1984-2000. () Incomplete sampling.

YEAR	1	2	3	4	5	6	7	8	9	10
1982	44	230	572	975	1798	2293	3148	4324	5967	6767
1983										
(1984)	104	331	801	1807	2207	3014	3858	4936	4632	5445
1985	97	225	612	1173	2081	2239	3920	4374	5702	6219
1986	73	325	603	1326	1921	2822	3216	4738	5484	6177
1987	36	237	697	920	1259	2315	2649	3541	6072	6435
1988	61	214	471	1032	1550	2822	3858	3285	4614	6522
1989	37	164	437	845	1584	2250	3951	4791	5046	6219
1990	44	128	359	722	1025	2217	3299	5702	6880	
1991	58	172	375	801	1318	1941	3243	4014	5139	10198
(1992)	63	237	459	1208	1644	3028	3041	3469		
1993	64	141	644	1281	2154	2784	3600	4827	6135	
(1994)	44	126	518	1980	2962	4791	4738		5742	
1995	68	244	426	1427	2949	4176	5233	5926	9645	7442
1996	42	104	594	1864	2461	3586	5120	5824		
1997	68	180	1000	1761	3454	4062	4562	4685		
1998	56	155	1045	1761	2923	3541	3858	6745		
1999	82	294	594	1173	2949	3705	4917		8522	9004
2000	82	207	441	862	1601	2102	3243	5196	6284	8160

Table 5.1.11 Cod off Greenland (offshore component). Input parameters in for calculations of yield and spawning stock biomass per recruit.

Age	WEIGHT (kg)	MATURITY	Exploit. pattern	M
3	0.815	0.001	0.154	0.2
4	1.255	0.004	0.425	0.2
5	1.863	0.15	0.643	0.3
6	2.549	0.449	0.931	0.3
7	3.295	0.795	1.07	0.3
8	4.157	0.946	1.145	0.3
9	4.967	0.99	1.267	0.3
10	5.836	1	1.027	0.3
11	6.447	1	1.027	0.3
12	7.09	1	1.027	0.3

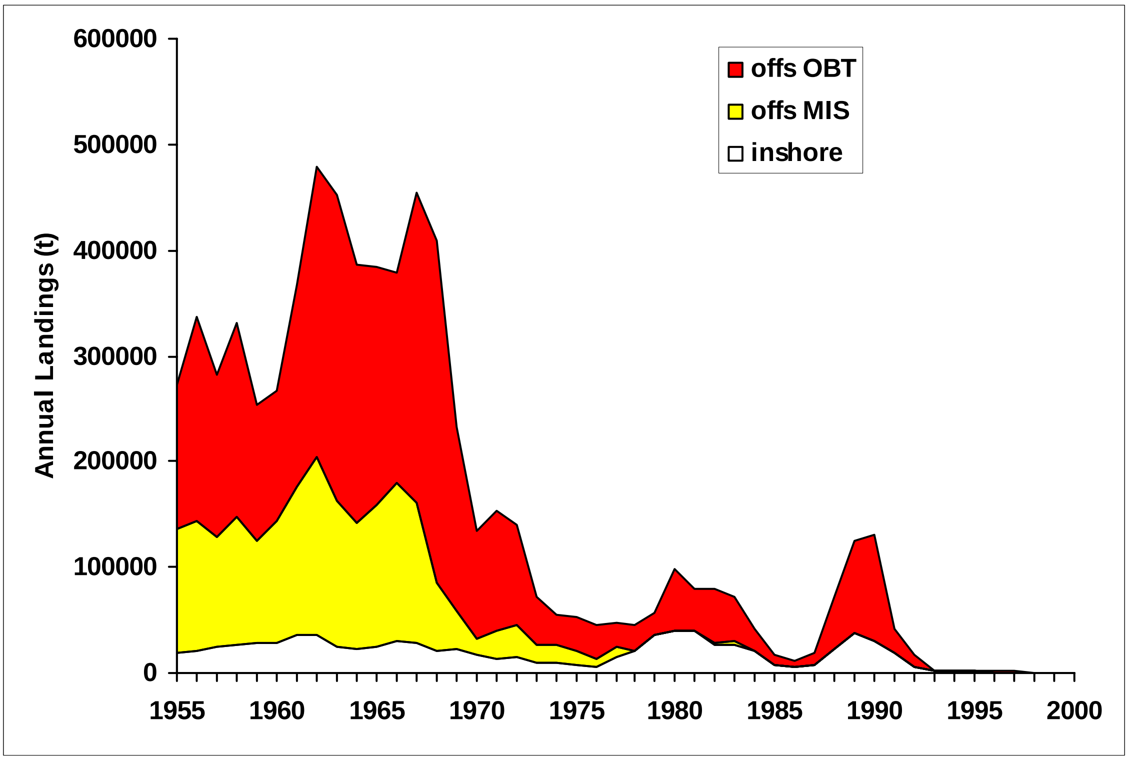


Figure 5.1.1 Cod off Greenland. Catches 1955-2000 as used by the Working Group, inshore and offshore by gear (Horsted, 1994).

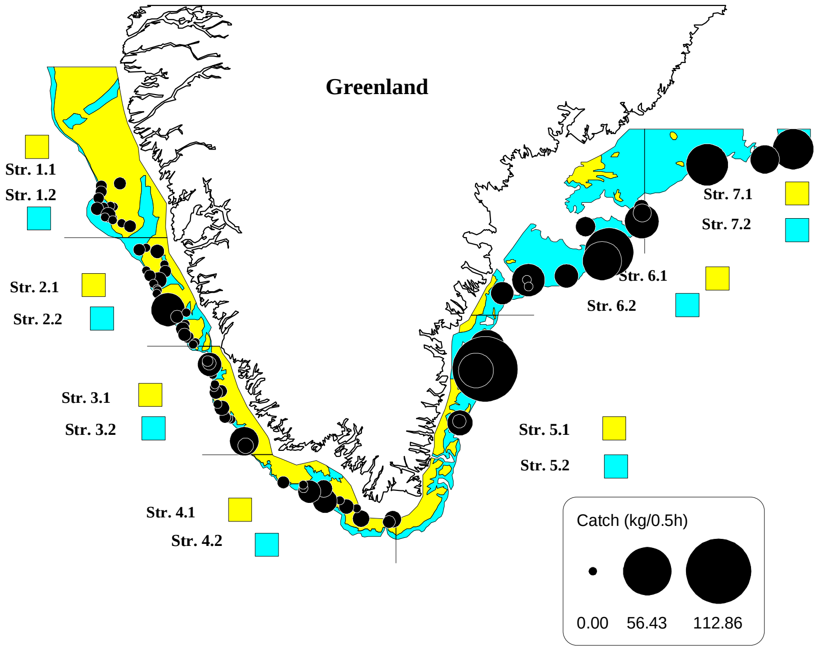


Figure 5.1.2 Cod off Greenland (offshore component). Survey area, stratification and position of hauls carried out in 2000.

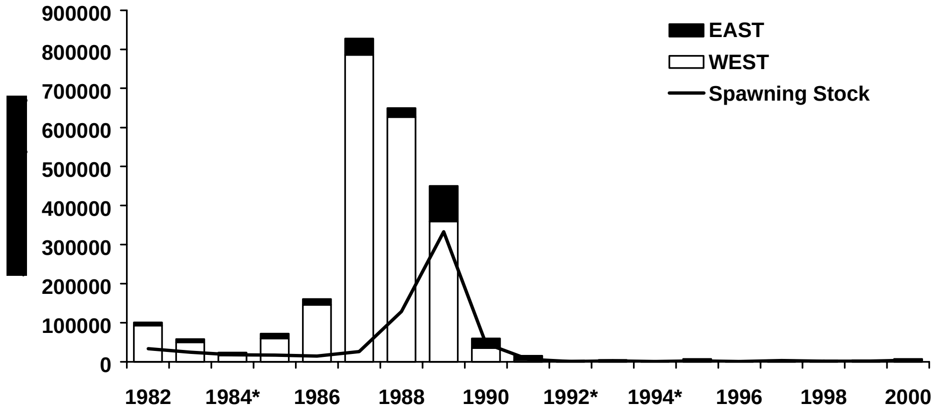


Figure 5.1.3 Cod off Greenland (offshore component). Aggregated survey abundance indices for West and East Greenland and spawning stock size, 1982-2000. *) incomplete survey coverage.

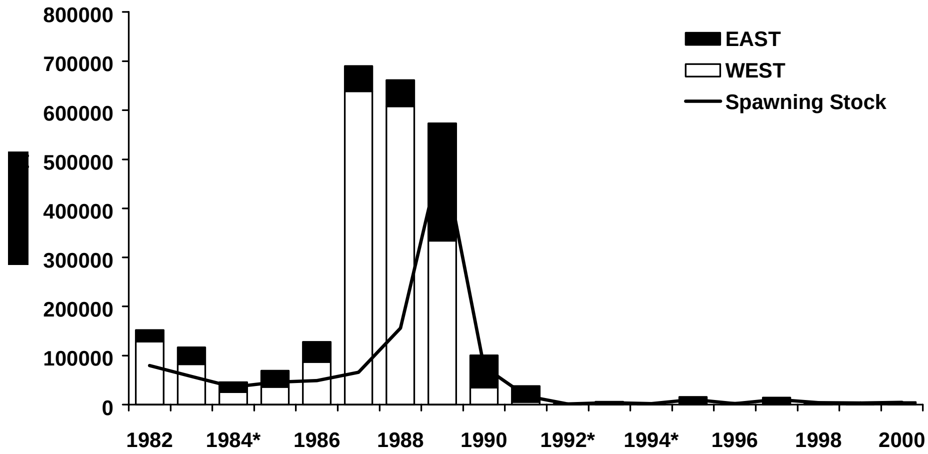


Figure 5.1.4 Cod off Greenland (offshore component). Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-2000. *) incomplete survey coverage.

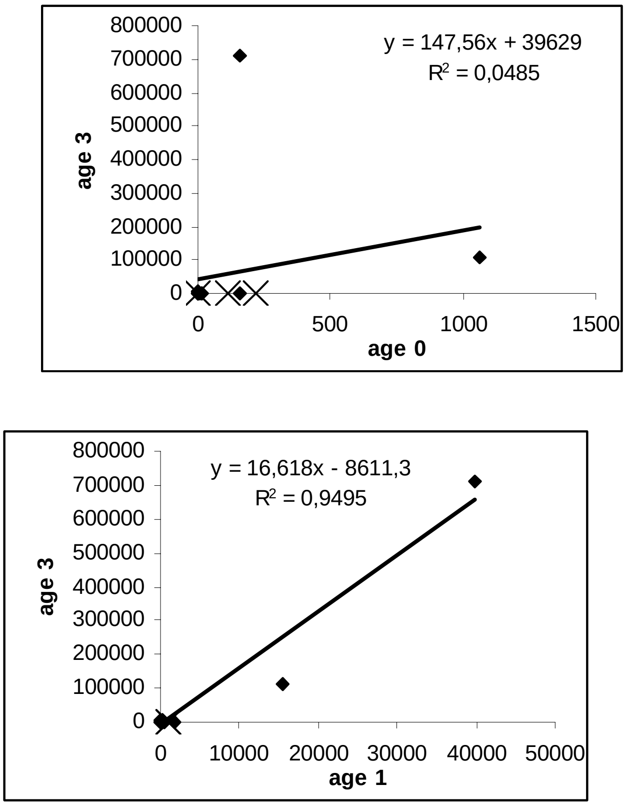


Figure 5.1.5 Cod off Greenland (offshore component). Use of 0 and 1 age group indices to predict year class strength at age 3. The x indicate the 1998, 1999 and 2000 year classes at age 0 and the 1998 and 1999 at age 1, respectively.

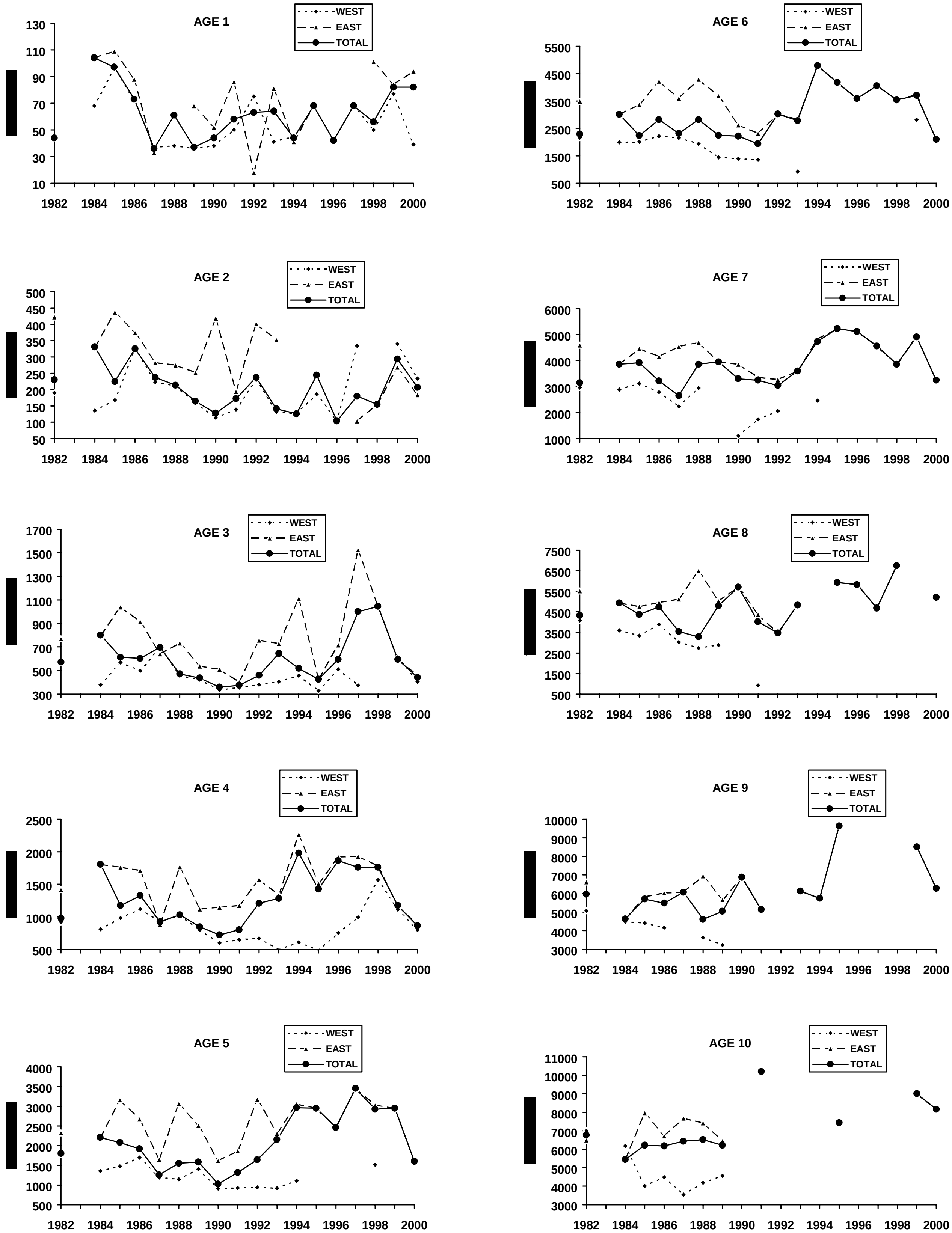


Figure 5.1.6 Cod off Greenland (offshore component). Weighted mean weight at age 1-10 years for West, East Greenland and total, 1982-2000.

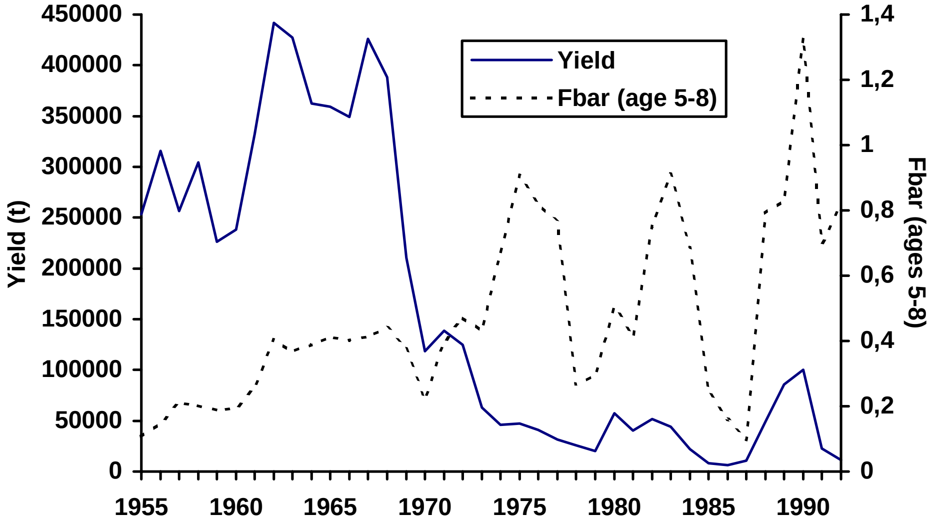


Figure 5.1.7 Greenland cod (offshore component). Trends in yield and fishing mortality.

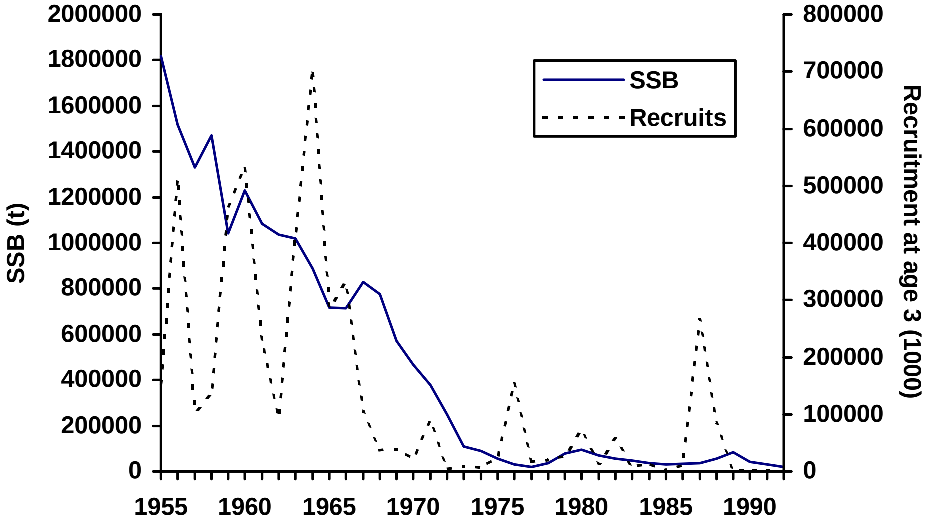


Figure 5.1.8 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

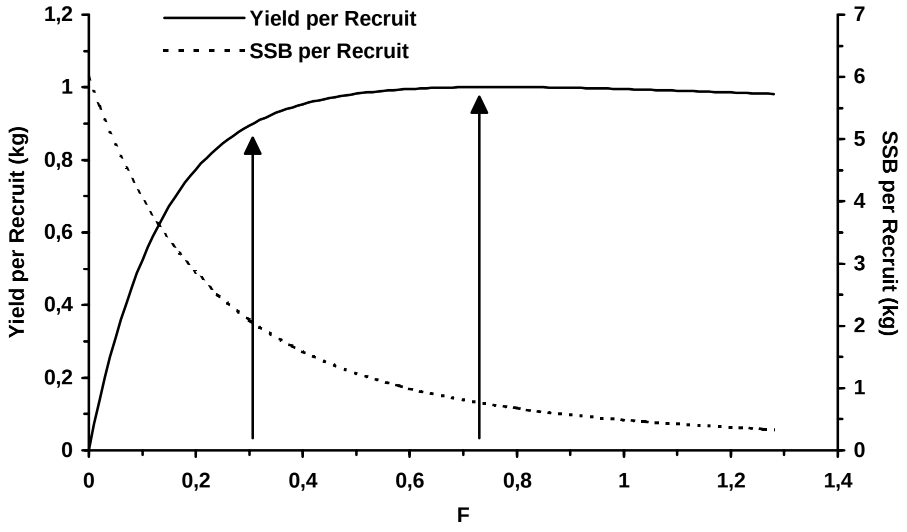


Figure 5.1.9 Greenland cod (offshore component). Long term yield and spawning stock biomass. $\mathbf{F}_{0.1}$ reference age 5-8=0.297; $\mathbf{F}_{max}$ reference age 5-8=0.722.

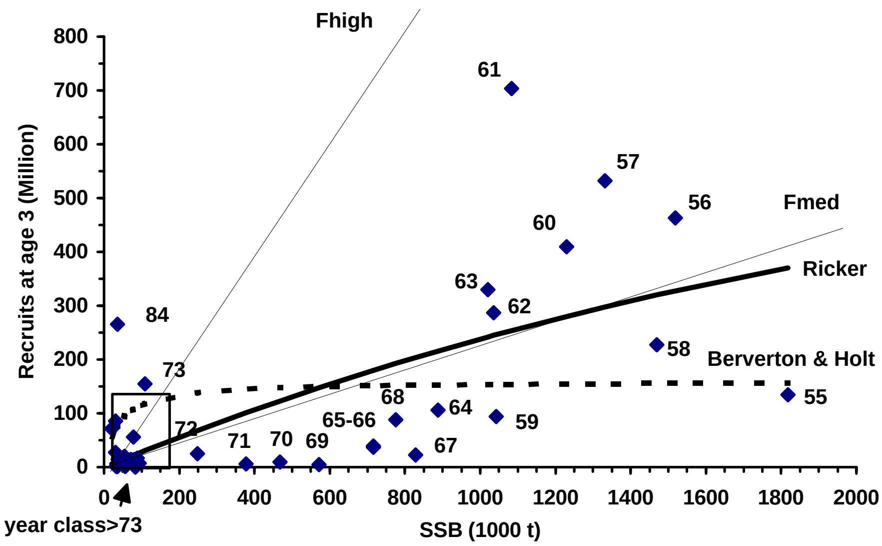


Figure 5.1.10 Greenland cod (offshore component). Spawning stock-recruitment plot for year classes 1955-89 and fitted recruitment curves. $\mathbf{F}_{med}$=0.09 corresponding to a SSB/R=4.44 kg; $\mathbf{F}_{high}$=0.59 corresponding to a SSB/R=0.98 kg.

5.2 Inshore cod stock off Greenland

In the last decade, the inshore cod fishery at West Greenland has contained cod from two different spawning areas. Icelandic cod spawned off South-western Iceland, which in some years are carried by the Irminger Current to settle off South Greenland, and local fjord populations. Spawning cod are found in several fjords of the West Greenland, especially in NAFO Divisions 1B, 1C and 1D. Although tagging experiments suggest a high degree of residency for fjord populations, the recruitment seems to be correlated between the different fjords (Engelstoft 1997).

5.2.1 Trends in Landings and Effort

Historically, the inshore landings have been minor compared to total landings accounting for only 5–10% of the total international catch in NAFO SA 1. Annual landings of 15 000–20 000 t have been taken inshore during the period 1955–1973. Since then the landings have been varying consistently with the recruitment of strong year classes to the offshore fishery. High landings of about 50 000 t in 1980 and 1989 have been followed by periods of very low landings. In recent years the landings has decreased dramatically from about 2000 tons yearly in 1993–1995 to only 281 tons in 2000 (Table 5.1.2).

The inshore fishery takes place from small vessels (< 40 GRT). Pound nets, gillnets and handlines are used to take about 95% of the inshore catch. A commercial pound net CPUE series is available since 1992 (Table 5.2.1). The mean catch pr pound net setting has decreased from 804 t in 1994 to 284 in 1999. No commercial catch or effort data from 2000 was available for 2001.

5.2.2 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes (16.5, 18, 24, 28, and 33 mm) has been conducted since 1985. The objective of the program is 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 inflow of pre-recruited cod from East to West Greenland shows up here.

Analysis of the selectivity of the fleet of gill-nets has shown that selection is best for age 2 cod, whereas only the larger individuals of the age 1 cod are adequately selected. In the 2000 survey a total of 144 net settings were made. Nets were set at bottom and it was attempted to set the fleets at constant depths and to divide the survey effort evenly on the depth zones of 0–5 m, 5–10 m, 10–15 m, and 15–20 m. Technical problems caused that only Division 1D was covered in 1999, and again in 2000 only Div. 1D and Div. 1F was covered.

An index of recruitment is calculated as the mean catch of 2-year old cod per 100 hours net setting taken by all five mesh sizes. The recruitment index is shown in Figure 5.2.1 and reveals a strong 1985 and 1987-year class, a moderate 1990- and 1993-year class and four successive weak year-classes in recent years. The survey results confirm the severely depleted status of the stock, although the very low 1997- and 1998- class year might not be representative due to insufficient survey coverage.

The survey results shows an increased index for Division 1F, which contrast to a number of years with almost no cod abundance in this area.

5.2.3 Assessment of the stocks

No commercial input data was available for the North Western Working Group to assess the latest stock status of the inshore cod, but results from the 2000 assessment are presented.

A Schaefer general production model was fitted to the Greenland inshore cod landing data using the commercial pound net CPUE results for 1993 to 1997 as an index of stock biomass.

The model was fitted using Excel Solver to minimise the sum of squared residuals between the observed CPUE and the predicted CPUE where the predicted CPUE is given by:

$CPUEpre_{dt} = {}_{Bt} * q$

And the biomass is:

$B_{t+1} = B_t + (r*B_t*(1-B_t/k))-C_t$

where C is the catch.

Parameter values obtained the previous year were used as starting values. Parameter values achieved from the general production model are shown in Table 5.2.2. Observed and predicted CPUE-values are shown in Figure 5.2.2. The model parameters are not very stable and need to be constrained. The initial biomass B_t was constrained to be lower than the virgin biomass (k), r was constrained to be between zero and one, while q was constrained to be higher than 0.001. The model implies $\mathbf{F}_{MSY}$ of only 0.01, but the number of parameters is high compared to the number of data points. The decreasing CPUE and the present recruitment failure of the stock do however support this severe stock situation.

5.2.4 Biological reference points

No specific values can be put forward as reference points due to the depleted state of the stocks.

5.2.5 Management Considerations

The inshore fishery exploiting possible self-sustained local fjord populations off West Greenland has historically been small, and the fishery has never been constricted by catch regulations. The data presented indicate that the stock has undergone a series of recruitment failures in recent years. The latest year classes are all estimated to be very poor in the juvenile survey. No fishing should take place until a substantial increase in recruitment and biomass is evident.

Table 5.2.1 Greenland cod (inshore component). Landings, observed and predicted CPUE based on data from inshore pound net fishery.

Year	Predicted biomas	Predicted CPUE	Observed CPUE	Ln(CPUE/B)	Observed Catch
1993	11226	664	730	2.73	1924
1994	9331	591	768	2.50	2215
1995	7151	490	600	2.49	1710
1996	5478	438	536	2.32	948
1997	4563	460	423	2.38	904
1998	3690	489	248	2.70	326
1999	3390	579	284	2.48	622
2000*	2793				

*Predicted

Table 5.2.2 Input values and parameter values obtained from general production model.

Year of Assess	Virgin Biomass	Rate of increase	Q	Init. Biomass
1999	11268	0.3	0.15	7428
2000	15515	0.01	0.08	11226

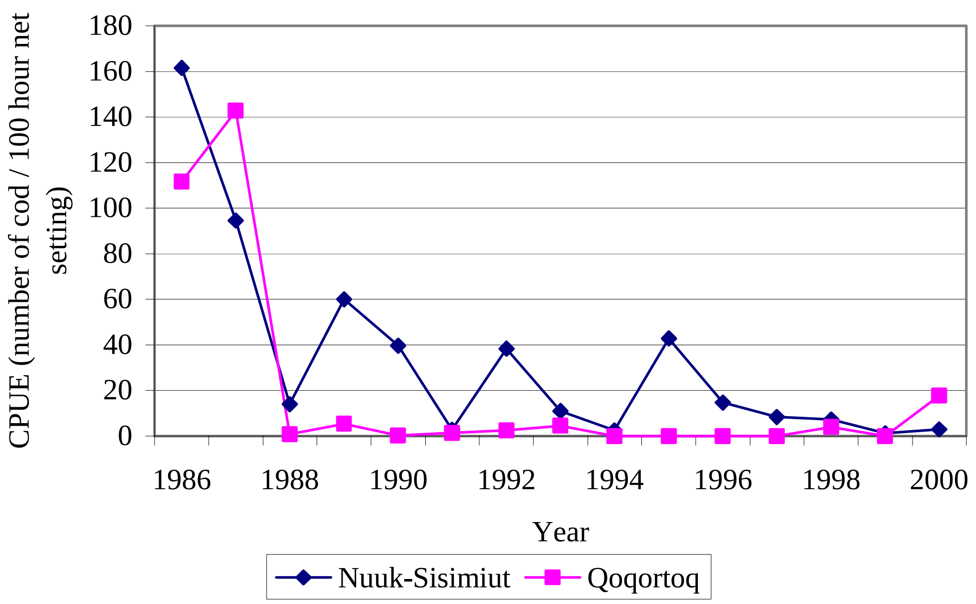


Figure 5.2.1 CPUE (number of age 2 cod caught per 100 hours net setting) in the Greenland Young cod survey 1987-2000.

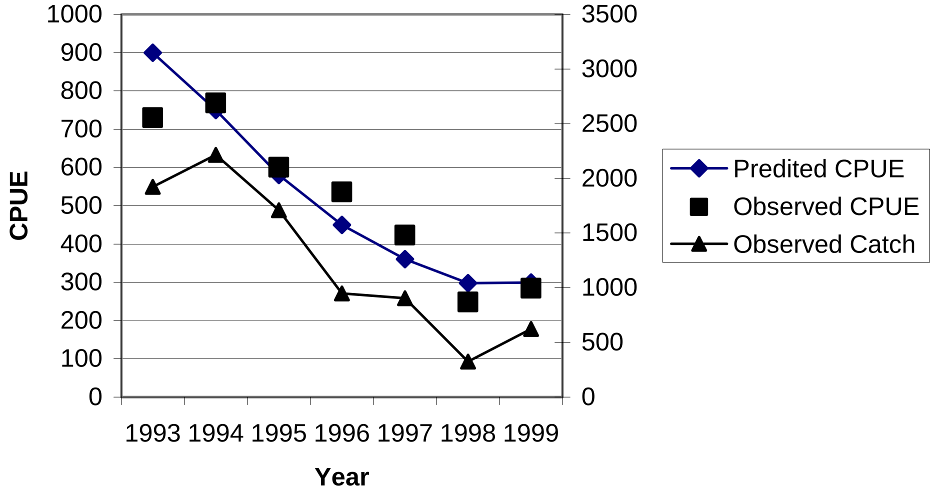


Figure 5.2.2 Greenland cod (inshore component). Observed and model-predicted CPUE rates.

6 GREENLAND HALIBUT IN SUB-AREAS V AND XIV

6.1 Landings, Fisheries, Fleet and Stock perception

Total annual landings in Divisions Va, Vb and Sub-area XIV are presented for the years 1981–2000 in Tables 6.1.1–6.1.5 and from 1961 in Figure 6.1.1. Landings the decade prior to the extention of the EEZ to 200 nm by coastal nations in 1976 was 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. In 2000, landings increased to nearly 26 kt. Landings not officially reported to ICES have been included in the assessment.

Catches in Icelandic waters have, due to quota regulations, decreased from 37 kt in 1990 to 11 kt in 1998 and 1999, but again rising to 14 kt in 2000. Faroese catches in Vb increased from of 1 kt in 1981–1991 to 6.5 kt in 1996, but have been of the order of 4-5 kt in the last 4 years. Catches in division XIVb have increased from below 1 kt in 1987–1991 to 8.5 kt in 1997, but have decreased again to 5 kt in 1999 and 2000.

Most of the fishery for Greenland halibut in Divisions Va, Vb and XIVb is a directed fishery, only minor catches in Va by Iceland, and in XIVb by Germany and the UK are bycatches in redfish fisheries. A detailed description of the fishery performance and areas is given in NWWG report 1998. No major changes were observed in 2000. Table 6.1.6 describes the Working Group's best landings estimates for the year 2000 with respect to area and gear.

Stock perception

The current definition of the Greenland halibut in East Greenland, Iceland and Fareoe waters as one stock, specified by ICES in 1976 was "…based on a strong probability that the spawning grounds [for Greenland halibut in these waters] are the same". A summary of the current state of knowledge on Greenland halibut in the above-mentioned waters shows that key information on the life cycle is lacking (Woll 2000). Information on the spawning location and spawning time of the stock is very limited. It is hypothesised, based on information on one scientific bottom trawl cruise in 1977, that the major spawning grounds are located on the continental slopes west of Iceland at depths around and below 1000 m (Magnusson 1977; Sigurdsson 1977; Sigurdsson and Magnusson 1980). In recent years (1995 and 2000), some spawning has been observed in East Greenland waters (62°N and 64°N) in August (Gundersen *et al.* 1997; Fossen and Gundersen 2000).

Standard 0-group fish surveys have been carried out annually in early fall (mainly in August) in Icelandic and in East Greenland waters since 1970. Larvae are mainly observed along the shelf region off East Greenland and are in some years abundant all over the shelf area south to 60° N, which is the southernmost limit of the survey area. Highest abundance is observed on the continental shelf north of 64° N and just east off the continental shelf south of 64° N. 0-group larvae are only occasionally observed on the Icelandic shelf in very limited numbers. Nursery grounds for young Greenland halibut (ages 1-3, fish less than 45 cm long) are well known in West Greenland waters, where they are most abundant from Store Hellefiske Bank to Disko and in Disko Bay between 66^o-69^o latitude on depths of about 200 m (Riget and Boje 1988). When it comes to knowledge on young fish in East Greenland and Icelandic waters, information is very sparse. A gillnet survey targeting for young Greenland halibut, modelling of advection of eggs and larvae with currents from assumed spawning areas in Icelandic and East Greenland waters (Woll 2000), and results of historic Greenland ichtyoplankton surveys (Boje 1997) indicated that larvae were transported to Southwest Greenland waters before settling, mixing with specimens from the Greenland-Canadian stock complex. Analyses of shrimp surveys in Icelandic and Greenland waters (Boje and Hjørleifsson 2000) concluded that nursery grounds were neither to be found in Icelandic nor in East Greenland waters.

The highest aggregation of commercial sized Greenland halibut is found just south of the Greenland-Iceland ridge. In this area the major portion of the annual catch in the past 10 to 15 years has been taken, mainly at depths between 500 and 1000 meters. Other locations of Greenland halibut in exploitable densities (for trawl fisheries) are found along the north and east coast of Iceland, mainly at depth between 500 to 700 meters, in waters of Faroe Islands as well as along the continental slope off East Greenland. The size of the Greenland halibut in the trawl fisheries depends largely on location and depth, and to some extent on the season. In Icelandic waters, smaller fish are found along the east and north coast, with somewhat larger fish in the deeper waters south of the Faroe-Iceland ridge. Largest fish are, however, always found on the main fishing grounds between Iceland and Greenland.

6.2 Trends in Effort and CPUE

Indices of CPUE for the Icelandic trawl fleet for the period 1985–2000 (Table 6.2.1) were estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the Icelandic trawling fleet in Division Va were used to estimate the total effort for each year (y) for all the fleets fishing for Greenland halibut in areas V and XIV according to:

$$E_{y,V\&XIV} = Y_{y,V\&XIV} / CPUE_{y,Va_{trawl}}$$

where E is total effort, Y is the total reported landings in region V and XIV.

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). A further increase in CPUE of 15% was observed in 1999 and 11% in 2000. For the years 1990–2000, CPUE on the western fishing grounds has been about two to three times higher than for the other fishing grounds in Icelandic waters.

The total effort increased up to 1989, decreased somewhat in the next two years, but increased steeply from 1991 to a maximum in 1996. Effort during 1998-2000 has been less than half that of the three preceeding years. The CPUE was relatively stable in 1985–1989, but declined thereafter by 70% to a historic low in 1996 and 1997. With the increase during the last 3 years the CPUE is now around 60% of the maximum value (Table 6.2.1).

For division XIVb, CPUE from logbooks in the years 1991–2000 were standardised using a multiplicative model taking into account locality, fleet, season and year (Table 6.2.1). CPUE increased from 1991 to 1993, thereafter it remains relatively stable. In the same period the calculated effort has increased continuously until 1996 but declined by 20% until 1999. In 2000, the effort increased and was at the same level as in 1996 (*ca.* 3 300 hours). However, the fishery in XIVb is new and catches have increased from below 500 tons annually before 1991 to 4.5 to 8.0 kts in the last four years. The fishery was therefore assumed to be in the process of learning in the beginning of the CPUE Series.

Information from logbooks from the Faroe otterboard trawl fleet (> 1 000 hp) was available for the years 1995-2000 (Table 6.2.1). The logbooks were standardised using a multiplicative model taking into account locality, fleet, season and year. The fishery in the area has increased from about 1 kt in 1992 to 5 kts in 2000. It is a fairly new fishery and the location of the fishery has changed from the eastern side of the islands in 1995-1998, to the western side in 2000. Therefore, the fishery is assumed to be in the process of learning. The CPUE is stable throughout the period.

6.3 Catch at Age

Age-length keys for 2000 were from: The icelandic trawl fleet operating in Icelandic waters (50 sample, 448 otoliths), the Norwegian fleet operating in Greenlandic waters (13, 557 otoliths), and the German trawl fishery in Greenlandic waters (456 otoliths). These keys were 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	10434	135	14516	Icelandic bottom trawl
Bottom trawl	Iceland-north & east	2670	24	1325	Icelandic bottom trawl
Bottom trawl	Iceland-southeast	1415	5	448	Icelandic bottom trawl
Gill Net (&line)	Faroe Islands	3709	16	3802	Icelandic bottom trawl
Bottom trawl	Faroe Islands	1383	5	1030	Icelandic bottom trawl
Long line	East Greenland	702	26	4733	Norwegian bottom trawl
Bottom trawl [1]	East Greenland	3243		5002	German Bottom trawl
Bottom trawl [2]	East Greenland	3013	48	8998	Norwegian bottom trawl
Total		26569	259	39854	

[1] Germany

[2] Norway

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		German fleet: length-weight conversion at sea.
Bottom trawl	East Greenland	$W = 0.00161 * L^{3.4457}$	Commercial trawl N=2468
Bottom trawl	Faroe Islands	$W = 0.00202 * L^{3.398}$	Trawl survey, N=1916
Gill Net (&line)	Faroe Islands	$W = 0.00202 * L^{3.398}$	Trawl survey, N=1916
Long line	Iceland	$W = 0.01758 * L^{2.84387}$	Same key as 1999
Long line	East Greenland	$W = 0.00208 * L^{3.373}$	Longline survey, N=664

The total catch in numbers (Table 6.3.1) was obtained from the sum of the above weighted with the catch within each group. Apart from 1994 and 1996 – 2000, only Icelandic data has been available.

6.4 Weight at Age

The mean weight at age in 2000 (Table 6.4.1) was derived from the weighted average of the above groups. Weights at age in the catch are also used as weights at age in the stock.

6.5 Maturity at Age

Data on maturity at age were available for the years 1982–1984 and 1991–1995, based on samples from the Icelandic trawl fishery. Data on maturity at age for the years 1985–1990 were not available. The maturity at age for these years was therefore estimated by averaging the data from the years 1982–1984 and 1991 (Table 6.5.1). Due to unreliable data for 1994, 1993 data were applied to 1994. The data on maturity for 1996 to 1999 were based on information from the Icelandic October groundfish survey and the East Greenland June/July groundfish survey. Maturity at age for 2000 was based on information from the Icelandic October groundfish survey and data from commercial Norwegian trawl and longline investigations.

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 1999 but a decrease occurred in 2000 (Figure 6.6.1). Abundance indices of fish equal to or less than 50 cm has increased from the years 1996–97 to 1998–99 but declined again in 2000.

Aged indices from the Icelandic survey are not yet available and it was therefore not possible to use the survey as input into age-based model.

Since 1998, a Greenland survey for Greenland halibut has been carried out in East Greenland waters from 60°N to 67°N at the main commercial fishing grounds at depths of 400-1500 m in late June/early July. In 2000 a total of 75 stations were hauled. Total estimated biomass was estimated to 23 Kt compared to 15 Kt in 1999 and 21 Kt in 1998. The increase is, however, dependant on the inclusion of new strata since 1998. Since the age composition in the catches does not indicate changes in recruitment to the area, the increase in biomass must be considered to be within the error margin of the estimates.

6.7 Stock Assessment

6.7.1 Age based assessement

Age-disaggregated CPUE values for age groups 7–12 from the Icelandic trawling fleet operating in Division Va, have been used in the XSA tuning in past assessments. The XSA assessment of last year was considered unreliable due to poor diagnostics and was thus rejected as a base for advice. This year the working group ran an XSA assessment with the same settings as in last year's report an exploratory exercise. Since the diagnostics of the model was of similarly poor quality as last year (see log(q) residuals in Fig 6.7.1.1), the working group decided that an XSA model was not a reliable estimator of recent stock history

6.7.2 Stock production model

Having rejected the standard age-based VPA approach, the group decided to proceed with a stock-production model approach fitted to indices and catches. ASPIC (Prager 1994, 2000) is available on the ICES web-site and was therefore considered to be an approved program for fitting such a model.

The model requires series of catch data and indices of stock biomass, either corresponding effort, CPUE, or survey catch rates. Corresponding catch and effort data is available for Div. Va (formerly used as a tuning fleet in the XSA) and in addition several CPUE series (Figure 6.2.1) were available:

Fleet and index	Period
Icelandic trawler CPUE from GLIM	1973-2000
Icelandic groundfish survey	1996-2000
Greenland deepwater bottom-trawl survey	1997-2000
Faroese trawler CPUE from GLIM	1995-2000
Icelandic shrimp fishery	1986-1994
Icelandic shrimp survey	1987-2000

The Icelandic shrimp fishery no longer exploits Greenland halibut, because of implementation of sorting grids in recent years. It does thus not provide indices of recent stock trends and was thus not included in the model. Since the shrimp survey covers a relatively limited area, the index was also excluded as an input candidate into the model. A run using the remaining four indices showed conflicting signals for the Faroese trawlers and the East Greenland survey compared with each other and with the Icelandic trawler and survey series, i.e. negative correlations of the CPUE indices. As ASPIC will not run on negatively correlated data series, these two indices were also omitted. For the two remaining indices — Icelandic trawler standardized CPUE and Icelandic groundfish survey — ASPIC was run with following 4 options:

- a reduced time-series from 1985-2000 including both indices
- a reduced time-series from 1985-2000 including only the Icelandic trawler CPUE’s,
- entire period 1973-2000 with both indices
- entire period 1973-2000 with only the Icelandic trawler CPUE’s.

ASPIC requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/$\mathbf{B}_{MSY}$ ratio and *q*, catchability coefficients. Initially ASPIC was run with different starting guesses of these parameters to explore stability of parameter estimation. For an appropriate range of input values, ASPIC results were very stable. The parameter estimates from ASPIC using these four different combinations is given in Table 6.7.2.1. MSY is estimated between 36 and 39 kt and $\mathbf{B}_{MSY}$ between 81 and 103 kt. Biomass in 2000 is estimated to be about 30% below $\mathbf{B}_{MSY}$ and fishing mortality in 2000 slightly below $\mathbf{F}_{MSY}$ in all four runs. All runs give similar perception to the current state of the stock, however, the group decided to adopt the estimates using Icelandic trawler CPUE 1985-2000 and groundfish survey CPUE (Table 6.7.2.2). This is because the CPUE index from 1973 to 1985 may not be reliable because it is based on limited logbook material and may cover a learning period at the the beginning of the fishery. Observed and estimated CPUE’s are given as a plot in Table 6.7.2.2.

The state of the stock relative to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$ is given in the last plot in Table 6.7.2.2. Biomass is increasing from a record low in 1997-98 and in 2000 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 $\mathbf{F}_{MSY}$.

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 2001 would be 30 kt. This is based on the following: TAC in Icelandic waters for the current fishing year (1st September 2000 – 30th August 2001) is 20 kt. Landings from Icelandic fisheries for the 2000/2001 quota year are by April 16 already around 12 kt compared with 5 kt in the 1999/2000 fishing year. Given that the landings in Vb and XIV will be the same as in 2000 and that the Icelandic fleet will catch all its quota, it is anticipated that total landings in the year 2001 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/$\mathbf{B}_{MSY}$) along with biomass trajectory for only option 1 is given in Table 6.7.3.1. By fishing at $\mathbf{F}_{pa}$ (2/3$\mathbf{F}_{MSY}$) it is expected that the biomass will increase to $\mathbf{B}_{MSY}$ by 2004. Fishing at $\mathbf{F}_{sq}$ (~$\mathbf{F}_{MSY}$) is, however, expected to reach $\mathbf{B}_{MSY}$ by 2010, although the confidence interval is wide. Fishing at 30 kt annually is expected to allow recovery to $\mathbf{B}_{MSY}$ by 2007, but with a significant risk (80% confidence intervals) that the stock could collapse.

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. This is in accordance with the suggestion by SGPAFM 1998 that $\mathbf{F}_{MSY}$ should be used as a limit reference point, which should be avoided with high probability. 2/3 of $\mathbf{F}_{MSY}$ is considered a proxy for 75% probability avoidance.

6.8 Management Considerations

Both former XSA and this years stock production model suggest that the Greenland halibut stock biomass has been falling since the late 1980'ies. Also according to both assessment methods, the fishing mortality has been substantially above $\mathbf{F}_{pa}$ for a decade. The decline in biomass seems to have been halted since 1998, but biomass is still well below $\mathbf{B}_{MSY}$. A combination of unreliable maturity data and age readings from recent years still impede any age-disaggregated assessment and therefore also any estimate of SSB and its use in relation to $\mathbf{B}_{pa}$ and SSB as a reference point for management advice for the stock.

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, but with a risk of a stock collapse in the near future.

6.9 Comments on the Assessment

Analytical assessment (XSA) was attempted with same settings as last year, but was rejected due to poor diagnostics and a substantial new perception of the stock size.

The stock production model used to assess the status of the stock relies on the same trawlers CPUE series as previously used in the XSA. Output estimates of biomass and fishing mortality of the production model cannot be taken face value, but should rather be good estimates of state of the stock in relation to MSY parameters.

6.10 References

Boje, J. 1997. Larval Greenland halibut growth and distribution in West Greenland water and the possible influences by hydrographic conditions. ICES CM

Boje, J. & E. Hjørleifsson. 2000. Nursery grounds for the West Nordic Greenland halibut? Where are they? ICES CM 2000/N:03, 12p.

Gundersen, A.C., A.K. Woll, T. Johansen & J. Boje. 1997. Fiske med garn og teiner etter blåkveite (*Reinhardtius hippoglossoides*), Pp. 19-96. *In* A.K. Woll & A.C. Gundersen (eds.), Forsøk med garn og teiner ved Øst-Grønland. Nordisk Ministerråd. TemaNord Fiskeri, 1997:526, 153p.

Fossen, I. & A.C. Gundersen. 2000. Ressursundersøkelse ved Kap Bille Banke og Heimlandsryggen, Øst-Grønland august 2000. Rapport fra Møreforsking Ålesund, Å0018, 44p.

Magnusson, J. V. 1977. Notes on eggs and larvae of Greenland halibut at Iceland. ICES CM 1977/F:47.

Prager, M.H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fish. Bull. (U.S.) 92: 374-389.

Prager, M.H. 2000. User Manual for ASPIC: A Stock-Production Model Incorporating Covariates, Program Version 3.82. Miami Laboratory Document MIA-92/93-55.

Riget,F. & J.Boje. 1988. Fishery and some biological aspects of Greenland halibut (*Reinhardtius hippoglossoides*) in West Greenland waters. NAFO Sci. Coun. Studies, 13:41-52.

Sigurdsson, A. (1977). “On the spawning grounds of Greenland halibut in Icelandic waters.” ICES E.M. 1977/F:28.

Sigurdsson, A. & J. V. Magnusson (1980). “On the nursery grounds of the Greenland halibut spawning in Icelandic waters.” ICES C.M.(1980/G:45): 8 pp.

Woll, A.K. 2000. (Editor) Greenland halibut in East Greenland waters. Recruitment studies and mapping of nursery grounds. Nordic project 1998-1999. Tema Nord, Fiskeri: 2000:585.

Table 6.1.1. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-areas V, XII and XIV 1981-2000, 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]
Denmark		-
Faroe Islands	3 884	4 856
France	-	13
Germany	3 082	3 271
Greenland	200	-
Iceland	11 180	14 369
Norway	1 633	1 514
Russia	138	183
UK (Engl. and Wales)	261	-
UK (Scotland)	69	-
United Kingdom	-	413
Total	20 447	24 619
Working Group estimate	20 784	21 477

1) Provisional data

Table 6.1.2. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-2000, 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 [3]	35 413 [4]							

Country	1999	2000 [1]
Faroe Islands	9	5
Germany	13	22
Greenland	[1]	
Iceland	11 087	14 369
Norway	5 [1]	
UK (E/W/I)	26	
UK Scottland	3	
UK		
Total	11 143	14 396
Working Group estimate		14 519 [5]

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) Includes additional catch of 257 t by Iceland.

5) Includes additional 125 t by Iceland

Table 6.1.3. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-2000, 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 [3]	1 662 [4]	2 269 [5]	-	-		-	-	3826 [7]

Country	1999	2000 [1]
Denmark		
Faroe Islands	3873	4812
France		13 [9]
Germany	22	6
Greenland		
Norway	87 [1]	110
UK (Engl. and Wales)	9	
UK (Scotland)	66	
United Kingdom		151
Total	4057	5092
Working Group estimate	4265 [8]	

1) Provisional data
2) Includes 17 t taken by France
3) Includes 133 t taken in Division IIa (Faroese waters).
4) Includes 317 t taken in Division IIa (Faroese waters) + France 12 t.
5) Includes 63 t taken in Division IIa (Faroese waters).
6) Quantity unknown 1989-1991.
7) Includes 3661 t taken in by Faroe Islands.
8) Includes 4078 t by Faroe Islands, 3 t by France.
9) Reported to Faroese authorities as Vb

Table 6.1.4. GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-2000, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2 893	2 439	1 054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2 893	2 440	1 060	835	753	1 017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3 343	3 301	3 399
Greenland	40	66	437	288	866	533	1 162	1 129	747 [1,10]
Iceland	-	-	-	19	82	7	-	1 803	148
Norway	8	18	196	511	1 120	1 668	1 881	1 897 [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 [1]
Denmark		
Faroe Islands	2	39
Germany	3047	3243
Greenland	200 [1,12]	
Iceland	93	
Norway	1541	1404
Russia	138 [1]	183
UK (Engl. and Wales)	226	
UK (Scotland)		
United Kingdom		262
Total	5247	5131
Working Group estimate	5376 [11]	6958 [13]

1) Provisional data
2) Includes 370 t catches taken by Japan
3) Includes 315 t catch taken by Japan and 159 t by other countries as reported to Greenland.
4) Indicates additional catches taken by Germany (96 t) and UK (17 t) as reported to Greenland.
5) Indicates additional catches taken by Germany (37 t), Norway (238 t), UK (182 t) and Japan (62 t) as reported to Greenland.
6) Total reported to Greenlandic authorities are used in assessment: 159 t trawl (Norwegian charter), 205 t gillnets (Norwegian charter). 405t from Norway not included in working group estimate.
7) Includes 273 t offshore gillnets (Greenland charter)
8) Working group estimates as in Table 6.1.5. Includes 72 t by Germany
9) Includes additional catch of 25 t as reported by Norwegian authorities (1858 t inside 200 EEZ, 64 t outside EEZ)
10) Includes 138 t reported as area unknown.
11) Includes 125 t by Faroe Islands, 206 t by Greenland.
12) Excluding 4732t reproted as area unknown.
13) Includes: 1523 t by Norway 102 t by Faroe Islands, 3343 by Germany, 1910 t by Greenland, 180 t by Russia, as reported to Greenland authorities.

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
Faroe Islands		47			
Norway	2				
Total	2	47	-	-	-

Table 6.1.6. 2000 Catch statistics for Greenland halibut in V and XIV.
Working Group best estimates.

Va	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands				5	5
Germany, Fed. Rep.				22	22
Greenland					0
Iceland	26	14 461	5		14 492
Norway					0
Total	26	14 461	5	27	14 519

Vb	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands	12	1 370	2 991	439	4 812
France		13			13
Germany Fed. Rep.				6	6
Norway				110	110
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom				151	151
Total	12	1 383	2 991	706	5 092

XII	Long line	Trawl	Gill Net	Unknown	SUM
Faroe Islands	0				0
Total	0	0	0	0	0

XIV	Long line	Trawl	Gill Net	Unknown	SUM
Denmark					0
Faroe Islands		102			102
EU (GFR)		3 243			3 243
Greenland		1 910			1 910
Iceland (outside 200 EEZ)					0
Norway (inside 200 EEZ)	702	821			1 523
Norway (outside 200 EEZ)					0
Russia		180			180
UK (England & Wales)					0
UK (Scotland)					0
United Kingdom					0
Total	702	6 256	0	0	6 958

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM
	740	22 100	2 996	733	26 569

Table 6.2.1. CPUE indices of the Icelandic trawl fleet estimated from a GLIM multiplicative model for 1985-2000.

Area	year	cpue	% change in CPUE between years	landings	effort	% change in effort between years
Iceland, Va	85	1.00		32198	32198	
	86	0.94	-6.0	33099	35195	9.3
	87	0.90	-4.1	46767	51868	47.4
	88	0.97	7.2	51307	53071	2.3
	89	0.94	-3.3	61323	65571	23.6
	90	0.76	-19.1	38935	51431	-21.6
	91	0.77	1.6	36882	47968	-6.7
	92	0.66	-13.9	35382	53421	11.4
	93	0.51	-22.7	40844	79813	49.4
	94	0.42	-18.7	37302	89614	12.3
	95	0.32	-24.2	35904	113848	27.0
	96	0.26	-17.1	35857	137197	20.5
	97	0.29	11.8	29751	101811	-25.8
	98	0.47	62.1	20077	42389	-58.4
	99	0.54	14.5	20333	37493	-11.6
	00	0.60	11.2	26000	43125	15.0
East Greenland, XIVb	91	1.00				
	92	1.08				
	93	1.81				
	94	1.95				
	95	1.96				
	96	2.06				
	97	2.25				
	98	2.24				
	99	2.00				
	00	2.10				
Faroe Islands, Vb	95	1.00				
	96	1.01				
	97	0.92				
	98	1.00				
	99	0.90				
	00	0.92				

Table 6.3.1 Catch in numbers.

Catch numbers at age Numbers*10**-3

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,
AGE						
5,	120,	43,	0,	23,	29,	47,
6,	800,	296,	34,	91,	197,	502,
7,	1775,	584,	671,	347,	1605,	1536,
8,	1782,	621,	1727,	1037,	2253,	2630,
9,	1259,	431,	2289,	1214,	3090,	3126,
10,	926,	240,	834,	848,	1693,	2324,
11,	464,	121,	420,	567,	880,	1739,
12,	459,	86,	423,	312,	394,	849,
13,	279,	37,	174,	232,	246,	578,
14,	193,	32,	120,	218,	189,	306,
15,	137,	14,	28,	114,	147,	143,
+gp,	39,	6,	86,	112,	101,	82,
0 TOTALNUM,	8233,	2511,	6806,	5115,	10824,	13862,
TONSLAND,	23494,	6045,	16578,	14349,	23616,	31252,
SOPCOF %,	128,	101,	102,	105,	102,	100,

Catch numbers at age Numbers*10**-3

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
5,	26,	8,	10,	83,	125,	245,	182,	129,	499,	188,
6,	158,	300,	240,	277,	441,	612,	3123,	742,	1657,	463,
7,	580,	1140,	1611,	891,	1018,	1033,	4863,	2068,	4485,	1513,
8,	1160,	2451,	2651,	2139,	2295,	1942,	2586,	2985,	5961,	3515,
9,	1430,	2646,	3060,	3568,	3454,	2983,	2156,	3166,	5763,	4186,
10,	1764,	2456,	2443,	2800,	2749,	3097,	3476,	2966,	3246,	3143,
11,	1299,	1803,	1693,	1825,	1452,	1683,	1847,	1848,	1601,	1224,
12,	664,	963,	978,	1134,	627,	820,	1829,	1761,	1458,	959,
13,	435,	609,	424,	588,	423,	550,	886,	1851,	1237,	568,
14,	252,	331,	174,	363,	137,	202,	243,	701,	506,	358,
15,	176,	195,	37,	92,	36,	59,	31,	216,	362,	137,
+gp,	114,	82,	17,	13,	46,	30,	1,	246,	145,	61,
0 TOTALNUM,	8058,	12984,	13338,	13773,	12803,	13256,	21223,	18679,	26920,	16315,
TONSLAND,	19239,	32441,	30891,	34024,	32075,	32984,	46622,	51118,	61396,	39326,
SOPCOF %,	102,	101,	102,	100,	103,	101,	98,	101,	100,	100,

Catch numbers at age Numbers*10**-3

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	289,	17,	44,	78,	503,	178,	86,	90,	82,	53,
6,	1225,	421,	397,	672,	1587,	1488,	549,	550,	366,	310,
7,	1797,	2023,	1896,	2197,	3031,	2908,	2723,	1882,	1363,	1543,
8,	2866,	3262,	5024,	3815,	3287,	3181,	2579,	2051,	1606,	2256,
9,	2935,	2646,	4324,	3648,	2608,	2119,	2331,	1657,	1828,	1485,
10,	2074,	3019,	2859,	2330,	1963,	1755,	1247,	1067,	1287,	1256,
11,	1130,	1962,	1539,	1715,	1548,	1610,	975,	737,	1018,	1235,
12,	1072,	1278,	1412,	990,	1132,	1216,	937,	710,	762,	1006,
13,	924,	509,	576,	422,	657,	665,	652,	359,	492,	777,
14,	554,	144,	136,	371,	444,	548,	374,	195,	231,	778,
15,	342,	36,	135,	168,	240,	238,	282,	150,	137,	539,
+gp,	82,	56,	7,	177,	211,	323,	262,	106,	119,	174,
0 TOTALNUM,	15290,	15373,	18349,	16583,	17211,	16229,	12997,	9554,	9291,	11412,
TONSLAND,	37950,	35423,	40817,	36958,	36300,	35825,	30267,	20360,	20371,	26569,
SOPCOF %,	101,	100,	100,	100,	100,	103,	110,	107,	111,	107,

1

Table 6.4.1 Catch and stock weight at age.

Catch weights at age (kg)

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,
AGE						
5,	.9680,	1.1570,	1.1570,	.9680,	.9110,	1.1250,
6,	1.1990,	1.5850,	1.0460,	1.1990,	.9420,	1.2830,
7,	1.4230,	1.7680,	1.4290,	1.4230,	1.2780,	1.4870,
8,	1.8540,	2.1800,	1.7940,	1.8540,	1.6760,	1.7560,
9,	2.2560,	2.5700,	2.2280,	2.2560,	2.0720,	2.1530,
10,	2.6070,	3.0180,	2.6870,	2.6070,	2.3330,	2.2790,
11,	3.0810,	3.7300,	3.0170,	3.0810,	2.7230,	2.4980,
12,	3.5910,	4.0520,	3.9140,	3.5910,	3.2970,	3.0590,
13,	4.6040,	4.8150,	4.0400,	4.6040,	3.9850,	3.7830,
14,	4.6950,	5.3480,	4.7140,	4.6950,	4.6680,	4.5070,
15,	5.1510,	5.7520,	5.4010,	5.1510,	4.7920,	5.1390,
+gp,	5.8930,	6.2270,	5.0540,	5.8930,	5.2290,	5.6330,
0 SOPCOFAC,	1.2794,	1.0068,	1.0227,	1.0471,	1.0187,	.9975,

Catch weights at age (kg)

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
5,	1.0710,	1.0100,	.9840,	.9420,	.9950,	1.0300,	1.0300,	1.1290,	.8420,	1.0290,
6,	1.2570,	1.3680,	1.3380,	1.2750,	1.2300,	1.2380,	1.2180,	1.3040,	1.0470,	1.2100,
7,	1.4400,	1.6180,	1.5770,	1.5920,	1.6300,	1.4990,	1.5330,	1.5410,	1.4250,	1.5720,
8,	1.6600,	1.9050,	1.8480,	1.8170,	1.9510,	1.9370,	1.8240,	1.7700,	1.7270,	1.7900,
9,	1.9670,	2.1870,	2.1590,	2.2400,	2.3670,	2.3630,	2.1870,	2.2360,	2.1250,	2.1260,
10,	2.2580,	2.5160,	2.4340,	2.4610,	2.6370,	2.6310,	2.6660,	2.6830,	2.6370,	2.5360,
11,	2.5150,	2.7610,	2.6030,	2.8350,	2.8290,	2.8480,	2.9960,	3.0820,	3.2200,	3.2140,
12,	2.9500,	3.1290,	3.0340,	3.2620,	3.3530,	3.3350,	3.5950,	3.6240,	3.7330,	3.6930,
13,	3.4500,	3.7850,	3.7840,	3.9620,	4.0060,	4.0390,	4.4310,	4.3120,	4.1350,	4.4480,
14,	4.0330,	4.4750,	4.4460,	4.9360,	4.7920,	4.9250,	5.1400,	5.0980,	5.3800,	5.1970,
15,	4.6520,	4.9850,	4.7510,	5.2300,	5.2310,	5.4660,	5.7640,	5.2130,	6.5690,	5.8910,
+gp,	4.7140,	5.6100,	6.2090,	6.9680,	6.3230,	5.7640,	5.7640,	5.7640,	6.4970,	6.0490,
0 SOPCOFAC,	1.0189,	1.0104,	1.0176,	.9953,	1.0258,	1.0069,	.9792,	1.0063,	.9999,	.9998,

Catch weights at age (kg)

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	1.0010,	1.0160,	.9910,	1.1630,	.9500,	1.1010,	.9190,	.8070,	.8610,	.7700,
6,	1.2470,	1.2560,	1.2490,	1.2540,	1.2130,	1.1240,	1.1070,	1.0860,	.9530,	.9680,
7,	1.4720,	1.4010,	1.4010,	1.4880,	1.4130,	1.3460,	1.3340,	1.3630,	1.2880,	1.2720,
8,	1.8100,	1.7180,	1.6850,	1.7360,	1.7030,	1.6490,	1.6400,	1.6580,	1.5650,	1.6070,
9,	2.0880,	2.0490,	1.9820,	2.1500,	2.0280,	1.9250,	1.8810,	1.8860,	1.7390,	1.7690,
10,	2.4400,	2.4360,	2.4250,	2.3520,	2.2790,	2.3420,	2.2400,	2.1670,	2.0120,	2.1220,
11,	2.9350,	2.8680,	2.9520,	2.7360,	2.6430,	2.5950,	2.5380,	2.4150,	2.3510,	2.3140,
12,	3.7370,	3.4780,	3.4290,	3.0820,	2.9920,	3.0130,	2.8460,	2.8440,	2.6340,	2.7220,
13,	4.4010,	4.5100,	4.4790,	3.6070,	3.5680,	3.5150,	3.3850,	3.1730,	3.0310,	3.0100,
14,	5.0220,	4.6810,	6.0430,	4.2420,	4.0680,	4.1230,	4.3590,	4.2370,	3.5320,	3.4230,
15,	5.9910,	6.0100,	5.8320,	5.2930,	5.3020,	4.9960,	4.8510,	4.6560,	3.8740,	4.0660,
+gp,	6.4120,	5.1280,	5.5120,	6.0870,	5.6860,	5.6930,	5.0910,	5.0800,	4.9370,	4.5730,
0 SOPCOFAC,	1.0097,	1.0033,	1.0010,	1.0001,	1.0042,	1.0329,	1.1044,	1.0674,	1.1142,	1.0711,

1

Table 6.5.1 Maturity at age

Proportion mature at age

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,
AGE						
5,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
6,	.0300,	.0300,	.0300,	.0300,	.0300,	.0300,
7,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
8,	.3500,	.3500,	.3500,	.3500,	.3500,	.3500,
9,	.7700,	.7700,	.7700,	.7700,	.7700,	.7700,
10,	.9600,	.9600,	.9600,	.9600,	.9600,	.9600,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	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,

Proportion mature at age

YEAR,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,	1989,	1990,
AGE										
5,	.0000,	.0000,	.0400,	.0000,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
6,	.0300,	.0500,	.0700,	.0800,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
7,	.1000,	.2000,	.1500,	.1900,	.2100,	.2100,	.2100,	.2100,	.2100,	.2100,
8,	.3500,	.3300,	.2800,	.3200,	.3500,	.3500,	.3500,	.3500,	.3500,	.3500,
9,	.7700,	.5000,	.3800,	.4200,	.4600,	.4600,	.4600,	.4600,	.4600,	.4600,
10,	.9600,	.7000,	.6000,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,
11,	1.0000,	.8500,	.8500,	.7500,	.8200,	.8200,	.8200,	.8200,	.8200,	.8200,
12,	1.0000,	.9400,	.9800,	.9300,	.9600,	.9600,	.9600,	.9600,	.9600,	.9600,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Proportion mature at age

YEAR,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	2000,
AGE										
5,	.0100,	.0200,	.0300,	.0300,	.1780,	.3040,	.2240,	.3050,	.2060,	.0910,
6,	.0600,	.0400,	.1200,	.1200,	.1810,	.3100,	.2910,	.3330,	.2750,	.2160,
7,	.2900,	.1100,	.2700,	.2700,	.4770,	.3930,	.3680,	.3510,	.4630,	.3660,
8,	.4800,	.2500,	.4000,	.4000,	.5970,	.4640,	.4380,	.3940,	.5670,	.4760,
9,	.5600,	.4700,	.4500,	.4500,	.5860,	.5260,	.4950,	.4880,	.6340,	.5320,
10,	.6200,	.6800,	.5400,	.5400,	.7050,	.6260,	.5880,	.4760,	.6960,	.6120,
11,	.8500,	.8500,	.6500,	.6500,	.7860,	.6900,	.6680,	.5930,	.7540,	.6390,
12,	1.0000,	.9600,	.7800,	.7800,	.7640,	.7730,	.7450,	.6360,	.7780,	.7050,
13,	1.0000,	1.0000,	.8300,	.8300,	.9610,	.8700,	.8500,	.7840,	.8030,	.7680,
14,	1.0000,	1.0000,	.9700,	.9700,	1.0000,	.9530,	.9480,	.8810,	.8400,	.8580,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9810,	.9710,	.8720,	.8620,	.9500,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9860,	.9090,	.9090,	.9720,

1

Table 6.7.1.1 ASPIC output of central estimates for four different input options.

Parameter/Model	Icelandic trawlers 1973-2000	Icelandic trawlers 1985-2000	Icelandic trawlers 1985-2000 + Icelandic groundfish survey	Icelandic trawlers 1973-2000 + Icelandic groundfish survey
MSY	37 kt	39 kt	37 kt	36 kt
$\mathbf{B}_{MSY}$	99 kt	81 kt	100 kt	103 kt
$B2001/\mathbf{B}_{MSY}$	0.66	0.70	0.77	0.71
$\mathbf{F}_{MSY}$	0.37	0.47	0.36	0.35
2/3 $\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$	0.25	0.32	0.23	0.23
$F2000/\mathbf{F}_{MSY}$	0.95	0.91	0.99	1.07

Table 6.7.2.1. Output from ASPIC (with Icelandic trawler cpue and groundfish survey cpue)

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

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

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

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

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CONTROL PARAMETERS USED (FROM INPUT FILE)

Number of years analyzed:	16	Number of bootstrap trials:	0
Number of data series:	2	Lower bound on MSY:	5.000E+03
Objective function computed:	in effort	Upper bound on MSY:	1.000E+09
Relative conv. criterion (simplex):	1.000E-08	Lower bound on r:	7.000E-02
Relative conv. criterion (restart):	3.000E-08	Upper bound on r:	2.500E+00
Relative conv. criterion (effort):	1.000E-04	Random number seed:	2010417
Maximum F allowed in fitting:	8.000	Monte Carlo search mode, trials:	1 10000

PROGRAM STATUS INFORMATION (NON-BOOTSTRAPPED ANALYSIS) code 0

Normal convergence.

CORRELATION AMONG INPUT SERIES EXPRESSED AS CPUE (NUMBER OF PAIRWISE OBSERVATIONS BELOW)

		1	2
1	input CPUE indices	1.000 16	
2	ICESURVEY indices	0.416 5	1.000 5

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) input CPUE indices	7.344E-01	16	5.246E-02	1.000E+00	1.023E+00	0.786
Loss(2) ICESURVEY indices	1.736E-01	5	5.788E-02	1.000E+00	9.270E-01	-1.139
TOTAL OBJECTIVE FUNCTION:	9.08043005E-01					

Number of restarts required for convergence:	12	
Est. B-ratio coverage index (0 worst, 2 best):	0.9176	< 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 1985	1.412E+00	1.000E+00	1	1
MSY	Maximum sustainable yield	3.666E+04	6.000E+05	1	1
r	Intrinsic rate of increase	7.368E-01	8.000E-01	1	1
....	Catchability coefficients by fishery:				
q(1)	input CPUE indices	7.465E-03	1.000E-02	1	1
q(2)	ICESURVEY indices	7.613E-03	1.000E-02	1	1

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter		Estimate	Formula	Related quantity
MSY	Maximum sustainable yield	3.666E+04	Kr/4	
K	Maximum stock biomass	1.990E+05		
$\mathbf{B}_{MSY}$	Stock biomass at MSY	9.951E+04	K/2	
$\mathbf{F}_{MSY}$	Fishing mortality at MSY	3.684E-01	r/2	
F(0.1)	Management benchmark	3.316E-01	0.9*$\mathbf{F}_{MSY}$	
Y(0.1)	Equilibrium yield at F(0.1)	3.630E+04	0.99*MSY	
B-ratio	Ratio of B(2001) to $\mathbf{B}_{MSY}$	7.684E-01		
F-ratio	Ratio of F(2000) to $\mathbf{F}_{MSY}$	9.899E-01		
F01-mult	Ratio of F(0.1) to F(2000)	9.092E-01		
Y-ratio	Proportion of MSY avail in 2001	9.464E-01	2*Br-Br^2	Ye(2001) = 3.470E+04
....	Fishing effort at MSY in units of each fishery:			
$\mathbf{F}_{MSY}$(1)	input CPUE indices	4.936E+01	r/2q(1)	f(0.1) = 4.442E+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	1985	0.230	1.405E+05	1.397E+05	3.208E+04	3.208E+04	3.067E+04	6.230E-01	1.412E+00
2	1986	0.239	1.391E+05	1.381E+05	3.298E+04	3.298E+04	3.115E+04	6.483E-01	1.398E+00
3	1987	0.359	1.373E+05	1.299E+05	4.662E+04	4.662E+04	3.319E+04	9.742E-01	1.379E+00
4	1988	0.443	1.238E+05	1.154E+05	5.112E+04	5.112E+04	3.566E+04	1.203E+00	1.244E+00
5	1989	0.649	1.084E+05	9.459E+04	6.140E+04	6.140E+04	3.638E+04	1.762E+00	1.089E+00
6	1990	0.484	8.336E+04	8.130E+04	3.933E+04	3.933E+04	3.543E+04	1.313E+00	8.377E-01
7	1991	0.487	7.946E+04	7.787E+04	3.795E+04	3.795E+04	3.493E+04	1.323E+00	7.985E-01
8	1992	0.467	7.644E+04	7.598E+04	3.549E+04	3.549E+04	3.461E+04	1.268E+00	7.681E-01
9	1993	0.576	7.557E+04	7.159E+04	4.125E+04	4.125E+04	3.376E+04	1.564E+00	7.594E-01
10	1994	0.567	6.808E+04	6.555E+04	3.719E+04	3.719E+04	3.238E+04	1.540E+00	6.841E-01
11	1995	0.600	6.327E+04	6.050E+04	3.629E+04	3.629E+04	3.102E+04	1.628E+00	6.358E-01
12	1996	0.658	5.801E+04	5.446E+04	3.586E+04	3.586E+04	2.913E+04	1.787E+00	5.829E-01
13	1997	0.593	5.128E+04	5.019E+04	2.975E+04	2.975E+04	2.766E+04	1.609E+00	5.153E-01
14	1998	0.381	4.919E+04	5.342E+04	2.036E+04	2.036E+04	2.878E+04	1.034E+00	4.943E-01
15	1999	0.321	5.760E+04	6.337E+04	2.037E+04	2.037E+04	3.179E+04	8.724E-01	5.789E-01
16	2000	0.365	6.902E+04	7.285E+04	2.657E+04	2.657E+04	3.401E+04	9.899E-01	6.936E-01
17	2001		7.647E+04						7.684E-01

Table 6.7.2.1 (Continued)

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

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

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1985	1.000E+03	1.043E+03	0.2295	3.208E+04	3.208E+04	0.04216	0.000E+00
2	1986	9.400E+02	1.031E+03	0.2388	3.298E+04	3.298E+04	0.09225	0.000E+00
3	1987	9.020E+02	9.696E+02	0.3589	4.662E+04	4.662E+04	0.07227	0.000E+00
4	1988	9.670E+02	8.613E+02	0.4430	5.112E+04	5.112E+04	-0.11579	0.000E+00
5	1989	9.350E+02	7.061E+02	0.6490	6.140E+04	6.140E+04	-0.28079	0.000E+00
6	1990	7.570E+02	6.069E+02	0.4837	3.933E+04	3.933E+04	-0.22106	0.000E+00
7	1991	7.690E+02	5.813E+02	0.4873	3.795E+04	3.795E+04	-0.27987	0.000E+00
8	1992	6.620E+02	5.672E+02	0.4670	3.549E+04	3.549E+04	-0.15459	0.000E+00
9	1993	5.120E+02	5.344E+02	0.5761	4.125E+04	4.125E+04	0.04282	0.000E+00
10	1994	4.160E+02	4.893E+02	0.5674	3.719E+04	3.719E+04	0.16228	0.000E+00
11	1995	3.150E+02	4.516E+02	0.5998	3.629E+04	3.629E+04	0.36027	0.000E+00
12	1996	2.610E+02	4.065E+02	0.6584	3.586E+04	3.586E+04	0.44312	0.000E+00
13	1997	2.920E+02	3.747E+02	0.5927	2.975E+04	2.975E+04	0.24932	0.000E+00
14	1998	4.740E+02	3.988E+02	0.3811	2.036E+04	2.036E+04	-0.17278	0.000E+00
15	1999	5.420E+02	4.730E+02	0.3214	2.037E+04	2.037E+04	-0.13618	0.000E+00
16	2000	6.030E+02	5.438E+02	0.3647	2.657E+04	2.657E+04	-0.10334	0.000E+00

```
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     0.0422                                             |==
1986     0.0922                                             |====
1987     0.0723                                             |===
1988    -0.1158                                        =====|
1989    -0.2808                                  ===========|
1990    -0.2211                                    =========|
1991    -0.2799                                  ===========|
1992    -0.1546                                       ======|
1993     0.0428                                             |==
1994     0.1623                                             |======
1995     0.3603                                             |==============
1996     0.4431                                             |==================
1997     0.2493                                             |==========
1998    -0.1728                                      =======|
1999    -0.1362                                        =====|
2000    -0.1033                                         ====|
                   ------------------------------------------------------------------------------------
```

RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED) ICESURVEY indices

Data type I0: Start-of-year biomass index Series weight: 1.000

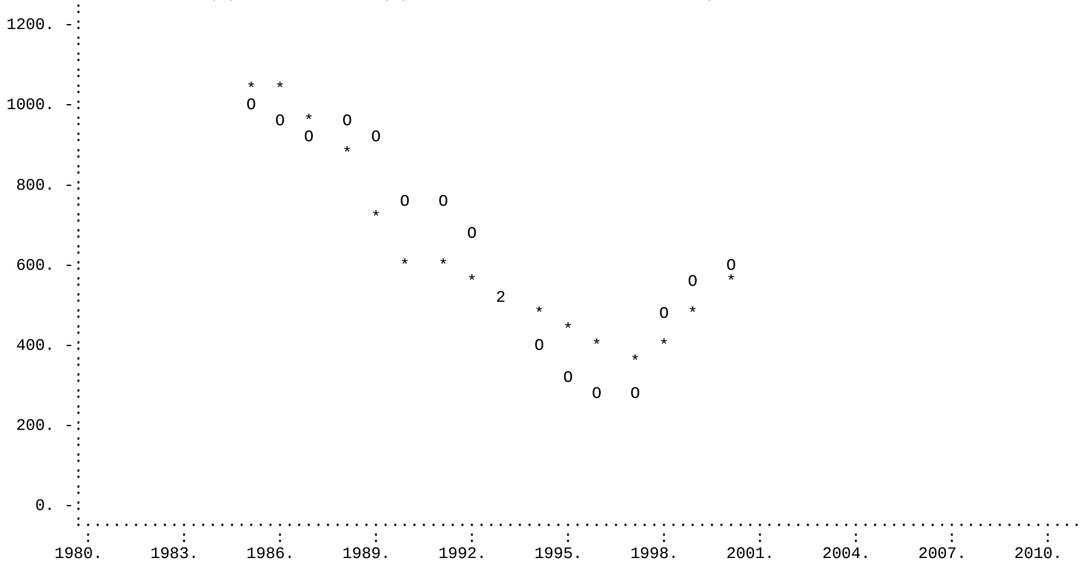
Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1985	0.000E+00	0.000E+00	0.0	*	1.070E+03	0.00000	0.0
2	1986	0.000E+00	0.000E+00	0.0	*	1.059E+03	0.00000	0.0
3	1987	0.000E+00	0.000E+00	0.0	*	1.045E+03	0.00000	0.0
4	1988	0.000E+00	0.000E+00	0.0	*	9.428E+02	0.00000	0.0
5	1989	0.000E+00	0.000E+00	0.0	*	8.251E+02	0.00000	0.0
6	1990	0.000E+00	0.000E+00	0.0	*	6.346E+02	0.00000	0.0
7	1991	0.000E+00	0.000E+00	0.0	*	6.050E+02	0.00000	0.0
8	1992	0.000E+00	0.000E+00	0.0	*	5.820E+02	0.00000	0.0
9	1993	0.000E+00	0.000E+00	0.0	*	5.753E+02	0.00000	0.0
10	1994	0.000E+00	0.000E+00	0.0	*	5.183E+02	0.00000	0.0
11	1995	0.000E+00	0.000E+00	0.0	*	4.817E+02	0.00000	0.0
12	1996	1.000E+00	1.000E+00	0.0	3.640E+02	4.416E+02	-0.19328	-7.761E+01
13	1997	1.000E+00	1.000E+00	0.0	4.470E+02	3.904E+02	0.13532	5.657E+01
14	1998	1.000E+00	1.000E+00	0.0	4.200E+02	3.745E+02	0.11471	4.552E+01
15	1999	1.000E+00	1.000E+00	0.0	5.350E+02	4.386E+02	0.19877	9.644E+01
16	2000	1.000E+00	1.000E+00	0.0	4.070E+02	5.255E+02	-0.25553	-1.185E+02

* 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    -0.1933                                     ========|
1997     0.1353                                             |=====
1998     0.1147                                             |=====
1999     0.1988                                             |========
2000    -0.2555                                   ==========|
                   ------------------------------------------------------------------------------------
```

Table 6.7.2.1 (Continued)

Observed (O) and Estimated (*) CPUE for Data Series # 1 -- input CPUE indices



Observed (O) and Estimated (*) CPUE for Data Series # 2 -- ICESURVEY indices

Table 6.7.2.1 (Continued)

GHL cpue 85 to 00 Page 5

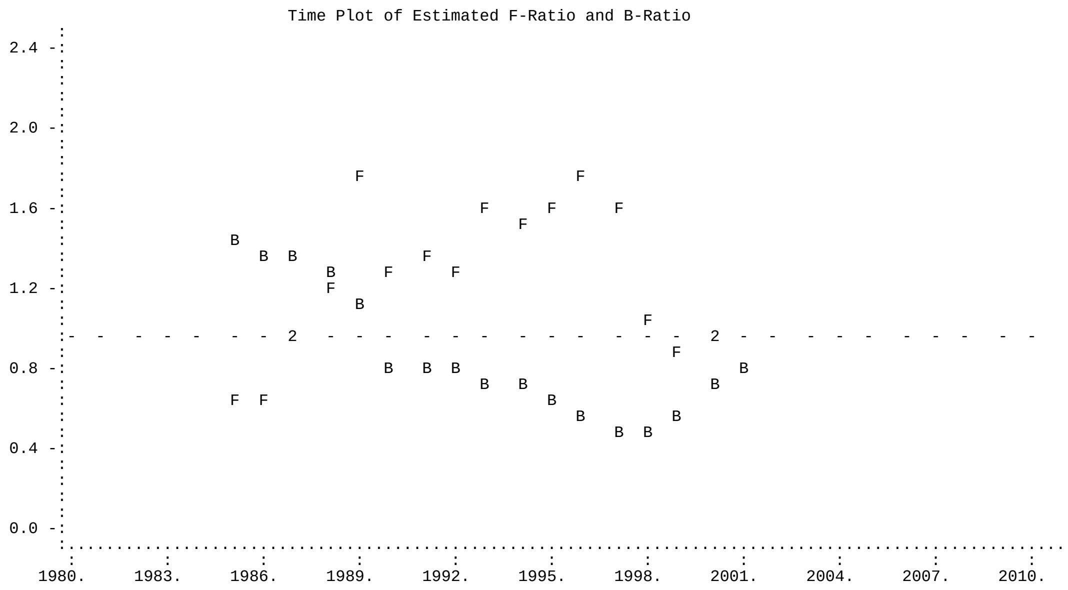


Table 6.7.3.1 Trajectories from an ASPIC production model assuming: a) 2001 catch =30kt and F(2002-2010)=$\mathbf{F}_{pa}$(=2/3$\mathbf{F}_{MSY}$). Additional are provided B-ratio plots for following options: I: 2001 catch =30kt and F(2002-2010)=$\mathbf{F}_{sq}$, and II: 2001-10 catch =30kt.

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	aspic.bio
Name of output file (this file)	ghlboot.out
Number of years of projections	10

CAUTION: ASPIC-P is designed for SHORT-TERM projections. Projections longer than 5 years are increasingly uncertain.

Year	Input data	User data type
2001	3.000E+04	TAC
2002	6.612E-01	F/F(2000)
2003	6.612E-01	F/F(2000)
2004	6.612E-01	F/F(2000)
2005	6.612E-01	F/F(2000)
2006	6.612E-01	F/F(2000)
2007	6.612E-01	F/F(2000)
2008	6.612E-01	F/F(2000)
2009	6.612E-01	F/F(2000)
2010	6.612E-01	F/F(2000)

TRAJECTORY OF RELATIVE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	1.326E+00	1.412E+00	6.44%	7.077E-01	2.269E+00	9.042E-01	1.837E+00	9.328E-01	0.703
1986	1.328E+00	1.398E+00	5.22%	7.949E-01	1.900E+00	9.744E-01	1.682E+00	6.564E-01	0.494
1987	1.320E+00	1.379E+00	4.52%	8.616E-01	1.682E+00	1.051E+00	1.514E+00	4.622E-01	0.350
1988	1.212E+00	1.244E+00	2.65%	8.514E-01	1.461E+00	1.020E+00	1.337E+00	3.162E-01	0.261
1989	1.076E+00	1.089E+00	1.22%	8.136E-01	1.372E+00	9.457E-01	1.212E+00	2.202E-01	0.205
1990	8.592E-01	8.377E-01	-2.51%	6.609E-01	1.156E+00	7.433E-01	9.888E-01	2.455E-01	0.286
1991	8.179E-01	7.985E-01	-2.36%	6.344E-01	1.085E+00	7.126E-01	9.353E-01	2.227E-01	0.272
1992	7.834E-01	7.681E-01	-1.95%	6.180E-01	1.036E+00	6.897E-01	8.931E-01	2.033E-01	0.260
1993	7.649E-01	7.594E-01	-0.73%	6.251E-01	9.870E-01	6.957E-01	8.572E-01	1.614E-01	0.211
1994	6.934E-01	6.841E-01	-1.34%	5.648E-01	9.174E-01	6.242E-01	7.820E-01	1.578E-01	0.228
1995	6.443E-01	6.358E-01	-1.32%	5.295E-01	8.718E-01	5.822E-01	7.341E-01	1.519E-01	0.236
1996	5.929E-01	5.829E-01	-1.69%	4.815E-01	8.389E-01	5.312E-01	6.927E-01	1.615E-01	0.272
1997	5.305E-01	5.153E-01	-2.87%	3.994E-01	8.080E-01	4.454E-01	6.446E-01	1.992E-01	0.375
1998	5.114E-01	4.943E-01	-3.34%	3.435E-01	8.092E-01	4.030E-01	6.413E-01	2.383E-01	0.466
1999	5.813E-01	5.789E-01	-0.41%	3.973E-01	8.497E-01	4.735E-01	7.027E-01	2.293E-01	0.394
2000	6.719E-01	6.936E-01	3.23%	4.522E-01	9.006E-01	5.523E-01	7.834E-01	2.310E-01	0.344
2001	7.138E-01	7.684E-01	7.65%	4.622E-01	9.725E-01	5.839E-01	8.600E-01	2.762E-01	0.387
2002	7.350E-01	8.198E-01	11.54%	4.319E-01	1.047E+00	5.971E-01	9.262E-01	3.291E-01	0.448
2003	8.792E-01	9.676E-01	10.06%	4.994E-01	1.208E+00	6.934E-01	1.076E+00	3.823E-01	0.435
2004	1.004E+00	1.087E+00	8.27%	5.676E-01	1.327E+00	7.972E-01	1.196E+00	3.984E-01	0.397
2005	1.105E+00	1.175E+00	6.35%	6.546E-01	1.398E+00	8.997E-01	1.281E+00	3.816E-01	0.345
2006	1.177E+00	1.236E+00	5.01%	7.073E-01	1.433E+00	9.688E-01	1.330E+00	3.614E-01	0.307
2007	1.229E+00	1.277E+00	3.90%	7.807E-01	1.455E+00	1.030E+00	1.365E+00	3.347E-01	0.272
2008	1.263E+00	1.303E+00	3.18%	8.345E-01	1.471E+00	1.094E+00	1.395E+00	3.006E-01	0.238
2009	1.285E+00	1.319E+00	2.68%	9.149E-01	1.481E+00	1.133E+00	1.410E+00	2.773E-01	0.216
2010	1.298E+00	1.329E+00	2.41%	9.320E-01	1.484E+00	1.150E+00	1.414E+00	2.641E-01	0.203
2011	1.306E+00	1.336E+00	2.23%	9.450E-01	1.483E+00	1.154E+00	1.415E+00	2.606E-01	0.199

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

TRAJECTORY OF RELATIVE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	6.512E-01	6.230E-01	-4.33%	4.640E-01	9.723E-01	5.288E-01	8.381E-01	3.093E-01	0.475
1986	6.745E-01	6.483E-01	-3.88%	5.439E-01	9.305E-01	5.928E-01	8.032E-01	2.104E-01	0.312
1987	1.012E+00	9.742E-01	-3.70%	8.706E-01	1.318E+00	9.266E-01	1.163E+00	2.363E-01	0.234
1988	1.246E+00	1.203E+00	-3.48%	1.109E+00	1.558E+00	1.163E+00	1.399E+00	2.361E-01	0.189
1989	1.789E+00	1.762E+00	-1.55%	1.659E+00	2.089E+00	1.712E+00	1.941E+00	2.289E-01	0.128
1990	1.307E+00	1.313E+00	0.49%	1.160E+00	1.451E+00	1.240E+00	1.378E+00	1.376E-01	0.105
1991	1.320E+00	1.323E+00	0.21%	1.183E+00	1.456E+00	1.262E+00	1.382E+00	1.204E-01	0.091
1992	1.283E+00	1.268E+00	-1.20%	1.179E+00	1.453E+00	1.237E+00	1.356E+00	1.190E-01	0.093
1993	1.591E+00	1.564E+00	-1.71%	1.498E+00	1.836E+00	1.534E+00	1.707E+00	1.730E-01	0.109
1994	1.565E+00	1.540E+00	-1.61%	1.469E+00	1.783E+00	1.510E+00	1.665E+00	1.558E-01	0.100
1995	1.649E+00	1.628E+00	-1.30%	1.438E+00	1.866E+00	1.553E+00	1.751E+00	1.560E-01	0.095
1996	1.772E+00	1.787E+00	0.86%	1.425E+00	2.078E+00	1.627E+00	1.937E+00	2.499E-01	0.141
1997	1.574E+00	1.609E+00	2.18%	1.183E+00	1.912E+00	1.383E+00	1.771E+00	3.885E-01	0.247
1998	1.017E+00	1.034E+00	1.66%	7.650E-01	1.304E+00	8.783E-01	1.166E+00	2.880E-01	0.283
1999	8.855E-01	8.724E-01	-1.48%	6.841E-01	1.135E+00	7.677E-01	1.010E+00	2.418E-01	0.273
2000	1.042E+00	9.899E-01	-4.97%	7.772E-01	1.472E+00	8.708E-01	1.224E+00	3.530E-01	0.339
2001	1.106E+00	1.029E+00	-6.97%	7.820E-01	1.801E+00	9.184E-01	1.380E+00	4.618E-01	0.417
2002	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2003	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2004	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2005	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2006	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2007	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2008	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2009	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339
2010	6.888E-01	6.546E-01	-4.97%	5.139E-01	9.732E-01	5.758E-01	8.093E-01	2.334E-01	0.339

Table 6.7.3.1(Continued)

TABLE OF PROJECTED YIELDS

2001	3.000E+04	3.000E+04	0.00%	3.000E+04	3.000E+04	3.000E+04	3.000E+04	0.000E+00	0.000
2002	2.131E+04	2.150E+04	0.88%	1.797E+04	2.568E+04	1.942E+04	2.353E+04	4.109E+03	0.193
2003	2.471E+04	2.471E+04	0.02%	1.954E+04	3.028E+04	2.199E+04	2.779E+04	5.802E+03	0.235
2004	2.755E+04	2.720E+04	-1.27%	2.159E+04	3.408E+04	2.437E+04	3.091E+04	6.541E+03	0.237
2005	2.965E+04	2.898E+04	-2.23%	2.363E+04	3.702E+04	2.647E+04	3.357E+04	7.099E+03	0.239
2006	3.123E+04	3.019E+04	-3.33%	2.507E+04	3.950E+04	2.800E+04	3.557E+04	7.572E+03	0.242
2007	3.232E+04	3.098E+04	-4.15%	2.612E+04	4.099E+04	2.895E+04	3.666E+04	7.716E+03	0.239
2008	3.288E+04	3.148E+04	-4.27%	2.678E+04	4.171E+04	2.962E+04	3.756E+04	7.945E+03	0.242
2009	3.329E+04	3.179E+04	-4.51%	2.721E+04	4.259E+04	2.995E+04	3.780E+04	7.857E+03	0.236
2010	3.341E+04	3.198E+04	-4.27%	2.744E+04	4.270E+04	3.013E+04	3.792E+04	7.784E+03	0.233

TRAJECTORY OF ABSOLUTE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	1.408E+05	1.405E+05	-0.23%	6.733E+04	3.088E+05	9.242E+04	2.122E+05	1.198E+05	0.851
1986	1.436E+05	1.391E+05	-3.17%	7.995E+04	2.891E+05	1.026E+05	2.010E+05	9.843E+04	0.685
1987	1.447E+05	1.373E+05	-5.12%	8.988E+04	3.023E+05	1.104E+05	2.012E+05	9.082E+04	0.628
1988	1.323E+05	1.238E+05	-6.41%	8.480E+04	2.781E+05	1.031E+05	1.867E+05	8.360E+04	0.632
1989	1.169E+05	1.084E+05	-7.34%	7.506E+04	2.533E+05	9.106E+04	1.641E+05	7.302E+04	0.624
1990	9.117E+04	8.336E+04	-8.57%	5.327E+04	2.111E+05	6.693E+04	1.338E+05	6.686E+04	0.733
1991	8.669E+04	7.946E+04	-8.34%	5.105E+04	2.005E+05	6.386E+04	1.262E+05	6.237E+04	0.719
1992	8.317E+04	7.644E+04	-8.09%	4.944E+04	1.890E+05	6.151E+04	1.187E+05	5.718E+04	0.688
1993	8.175E+04	7.557E+04	-7.56%	5.069E+04	1.806E+05	6.174E+04	1.147E+05	5.293E+04	0.647
1994	7.358E+04	6.808E+04	-7.48%	4.515E+04	1.686E+05	5.539E+04	1.051E+05	4.969E+04	0.675
1995	6.826E+04	6.327E+04	-7.31%	4.204E+04	1.636E+05	5.139E+04	9.863E+04	4.724E+04	0.692
1996	6.236E+04	5.801E+04	-6.99%	3.793E+04	1.538E+05	4.641E+04	9.066E+04	4.425E+04	0.710
1997	5.505E+04	5.128E+04	-6.85%	3.090E+04	1.410E+05	3.952E+04	8.162E+04	4.210E+04	0.765
1998	5.239E+04	4.919E+04	-6.10%	2.633E+04	1.284E+05	3.615E+04	7.760E+04	4.146E+04	0.791
1999	6.011E+04	5.760E+04	-4.17%	3.128E+04	1.267E+05	4.218E+04	8.293E+04	4.075E+04	0.678
2000	7.080E+04	6.902E+04	-2.50%	4.289E+04	1.339E+05	5.377E+04	9.365E+04	3.988E+04	0.563
2001	7.675E+04	7.647E+04	-0.36%	5.054E+04	1.305E+05	6.232E+04	9.585E+04	3.353E+04	0.437
2002	8.147E+04	8.158E+04	0.14%	5.781E+04	1.250E+05	6.906E+04	9.798E+04	2.892E+04	0.355
2003	9.640E+04	9.629E+04	-0.12%	7.207E+04	1.396E+05	8.357E+04	1.132E+05	2.965E+04	0.308
2004	1.096E+05	1.082E+05	-1.28%	8.271E+04	1.568E+05	9.605E+04	1.277E+05	3.167E+04	0.289
2005	1.194E+05	1.169E+05	-2.02%	9.097E+04	1.750E+05	1.050E+05	1.411E+05	3.617E+04	0.303
2006	1.266E+05	1.230E+05	-2.84%	9.474E+04	1.864E+05	1.097E+05	1.483E+05	3.862E+04	0.305
2007	1.311E+05	1.271E+05	-3.09%	9.823E+04	1.972E+05	1.136E+05	1.551E+05	4.147E+04	0.316
2008	1.344E+05	1.296E+05	-3.55%	1.001E+05	2.042E+05	1.160E+05	1.602E+05	4.415E+04	0.329
2009	1.363E+05	1.313E+05	-3.70%	9.997E+04	2.067E+05	1.165E+05	1.619E+05	4.549E+04	0.334
2010	1.369E+05	1.323E+05	-3.35%	9.973E+04	2.071E+05	1.160E+05	1.624E+05	4.645E+04	0.339
2011	1.375E+05	1.329E+05	-3.36%	9.991E+04	2.111E+05	1.165E+05	1.645E+05	4.801E+04	0.349

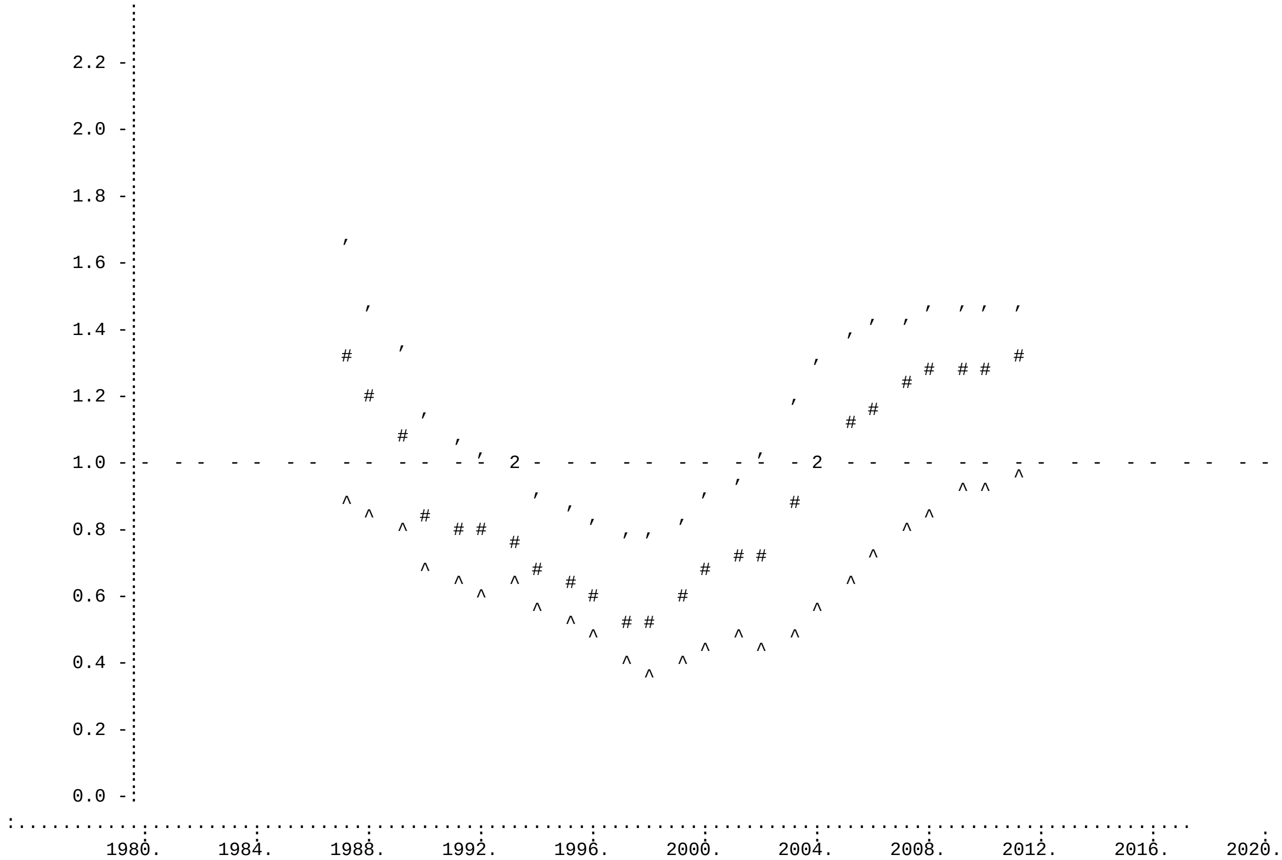
TRAJECTORY OF ABSOLUTE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
1985	2.248E-01	2.295E-01	2.11%	1.088E-01	4.355E-01	1.565E-01	3.271E-01	1.706E-01	0.759
1986	2.272E-01	2.388E-01	5.15%	1.109E-01	3.889E-01	1.673E-01	3.089E-01	1.416E-01	0.623
1987	3.352E-01	3.589E-01	7.09%	1.597E-01	5.338E-01	2.373E-01	4.366E-01	1.993E-01	0.595
1988	4.066E-01	4.430E-01	8.95%	1.923E-01	6.402E-01	2.931E-01	5.298E-01	2.367E-01	0.582
1989	5.863E-01	6.490E-01	10.70%	2.676E-01	9.784E-01	4.180E-01	7.922E-01	3.742E-01	0.638
1990	4.349E-01	4.837E-01	11.21%	1.889E-01	7.553E-01	3.028E-01	6.023E-01	2.995E-01	0.689
1991	4.397E-01	4.873E-01	10.85%	1.960E-01	7.561E-01	3.103E-01	6.058E-01	2.955E-01	0.672
1992	4.237E-01	4.670E-01	10.24%	1.907E-01	7.083E-01	3.045E-01	5.751E-01	2.707E-01	0.639
1993	5.246E-01	5.761E-01	9.82%	2.324E-01	8.653E-01	3.763E-01	7.069E-01	3.306E-01	0.630
1994	5.171E-01	5.674E-01	9.71%	2.234E-01	8.560E-01	3.654E-01	6.990E-01	3.336E-01	0.645
1995	5.487E-01	5.998E-01	9.32%	2.288E-01	9.105E-01	3.847E-01	7.443E-01	3.596E-01	0.655
1996	6.041E-01	6.584E-01	8.99%	2.416E-01	1.048E+00	4.143E-01	8.361E-01	4.219E-01	0.698
1997	5.511E-01	5.927E-01	7.55%	2.215E-01	1.041E+00	3.744E-01	7.850E-01	4.106E-01	0.745
1998	3.601E-01	3.811E-01	5.82%	1.603E-01	7.009E-01	2.547E-01	5.242E-01	2.695E-01	0.748
1999	3.109E-01	3.214E-01	3.38%	1.554E-01	5.488E-01	2.299E-01	4.211E-01	1.912E-01	0.615
2000	3.603E-01	3.647E-01	1.22%	2.028E-01	5.672E-01	2.808E-01	4.577E-01	1.769E-01	0.491
2001	3.789E-01	3.791E-01	0.06%	2.350E-01	5.497E-01	3.067E-01	4.574E-01	1.507E-01	0.398
2002	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2003	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2004	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2005	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2006	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2007	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2008	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2009	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491
2010	2.382E-01	2.412E-01	1.22%	1.341E-01	3.750E-01	1.857E-01	3.027E-01	1.170E-01	0.491

Table 6.7.3.1. (Continued)

2001 catch =30kt and F(2002-2010)=F_{pa}(=2/3F_{MSY})

Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence Interval (^,)(Dashed reference line is 1.0)

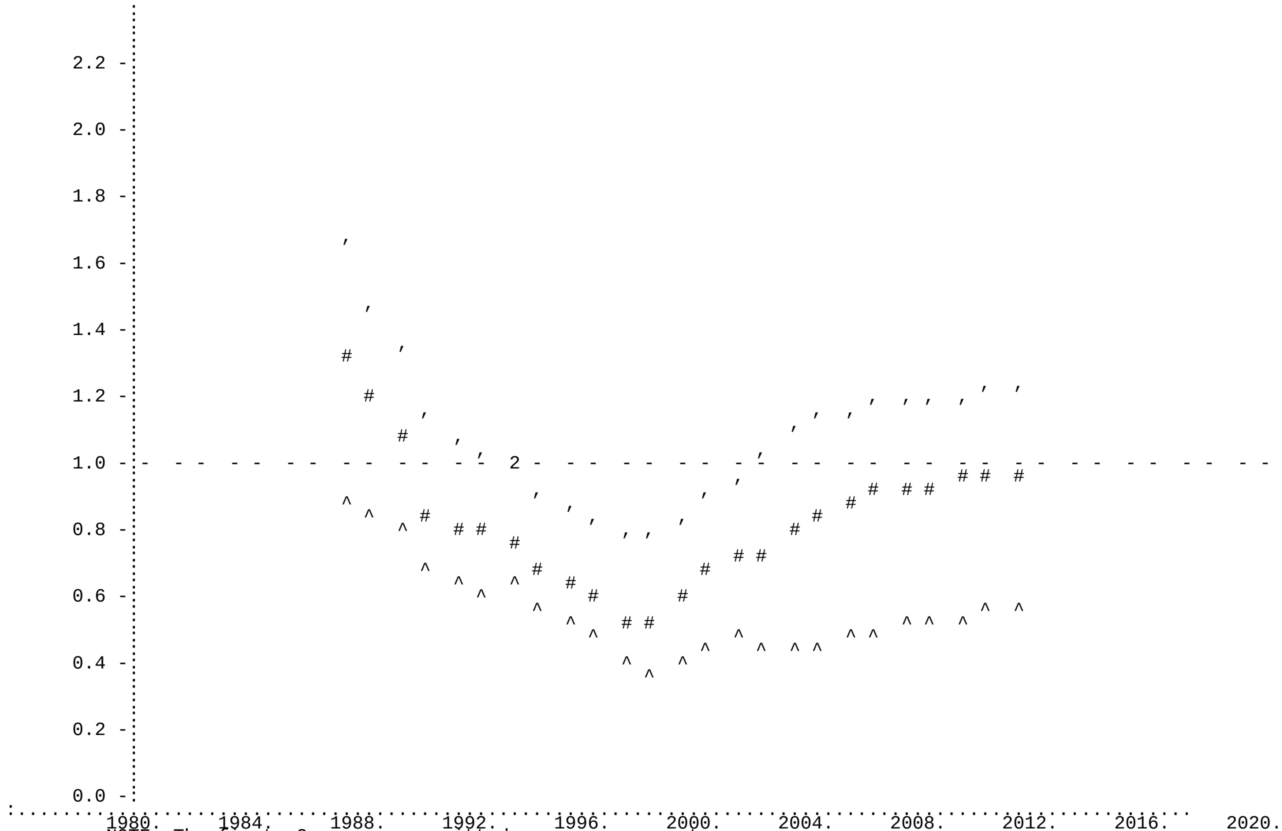


NOTE: The first 2 years are omitted per user request.

NOTE: Estimates beginning in 2002 depend on the user projection data listed on page 1.

2001 catch =30kt and F(2002-2010)=F_{sq}

Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence Interval (^,) (Dashed reference line is 1.0)



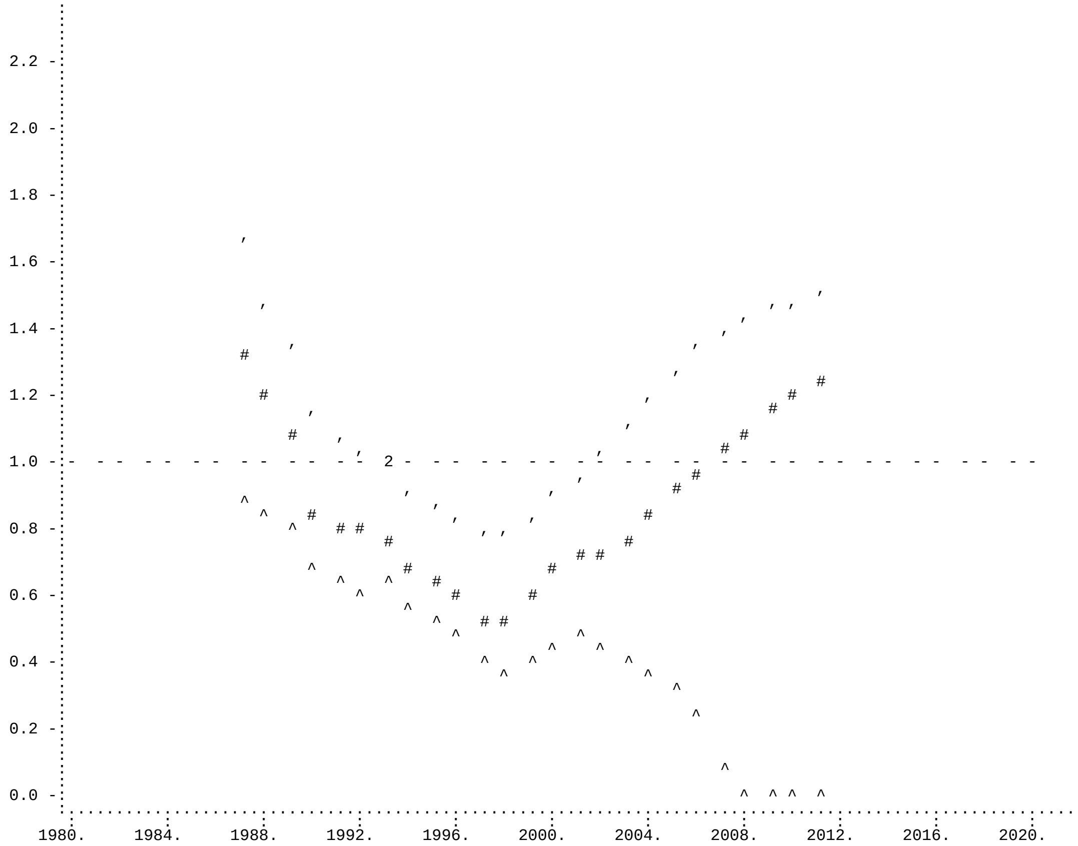
NOTE: The first 2 years are omitted per user request.

NOTE: Estimates beginning in 2002 depend on the user projection data listed on page 1.

Table 6.7.3.1(Continued)

2001-10 catch =30kt.

Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence Interval (^,)
(Dashed reference line is 1.0)



NOTE: The first 2 years are omitted per user request.

NOTE: Estimates beginning in 2002 depend on the user projection data listed on page 1.

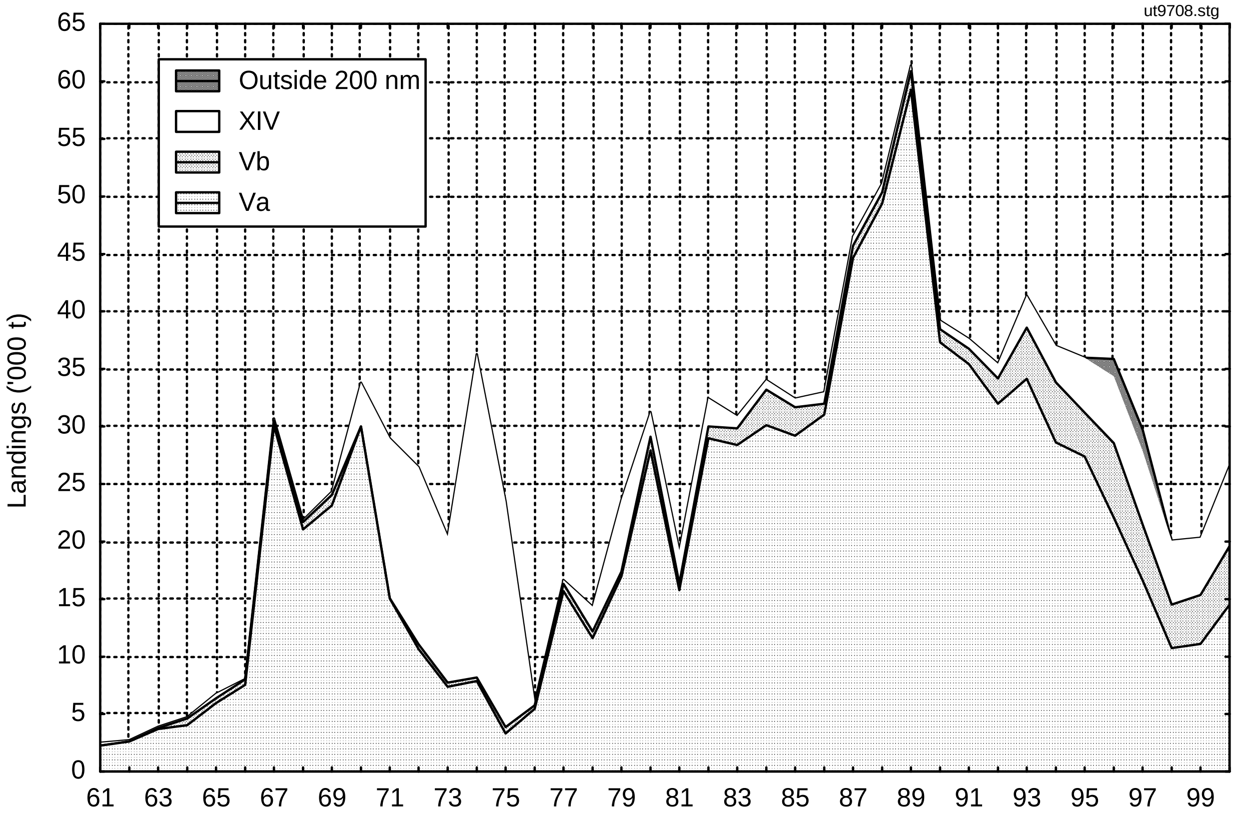


Figure 6.1.1. Landings of Greenland halibut in Divisions Va, Vb and Sub-area XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

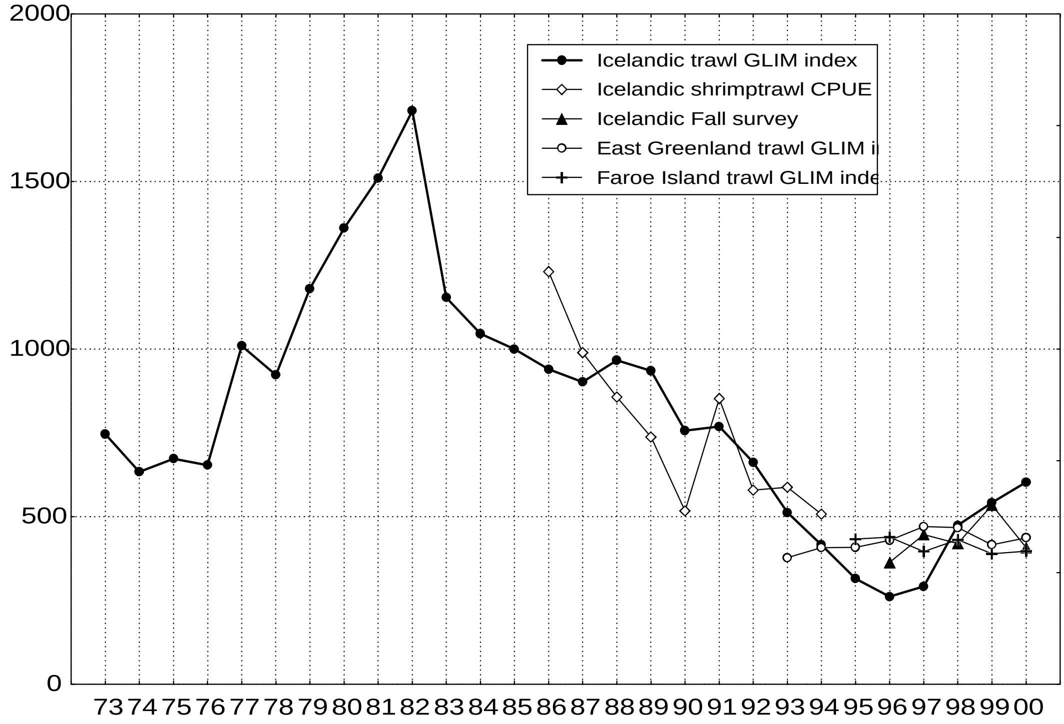


Figure 6.2.1. Various commercial and survey indices of Greenland halibut.

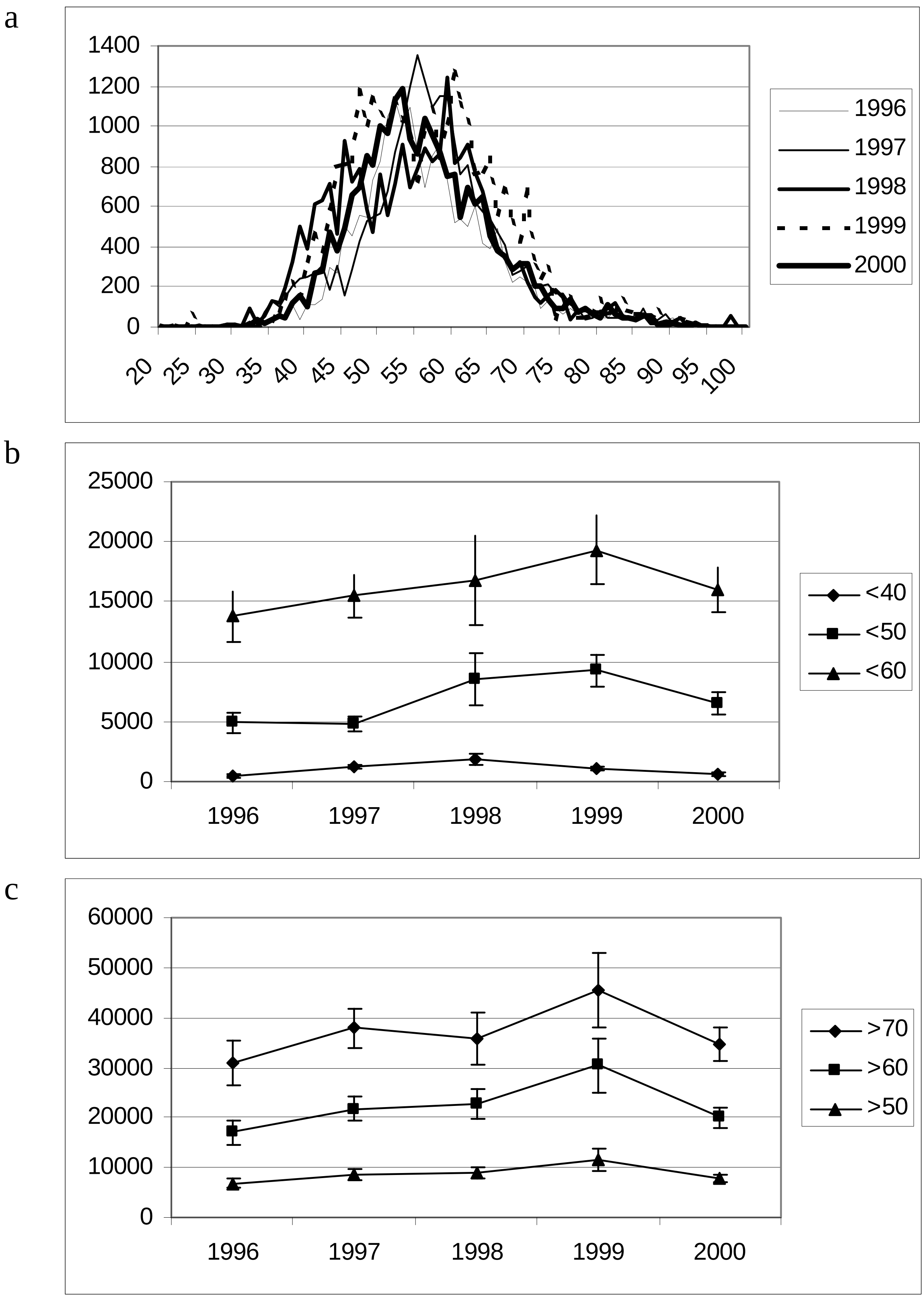


Figure 6.6.1. Greenland halibut in Icelandic fall groundfish suvey a) indices of length distributions, b) abundance indices by lengths smaller than indicated, c) biomass indices of lengths larger than indicated.

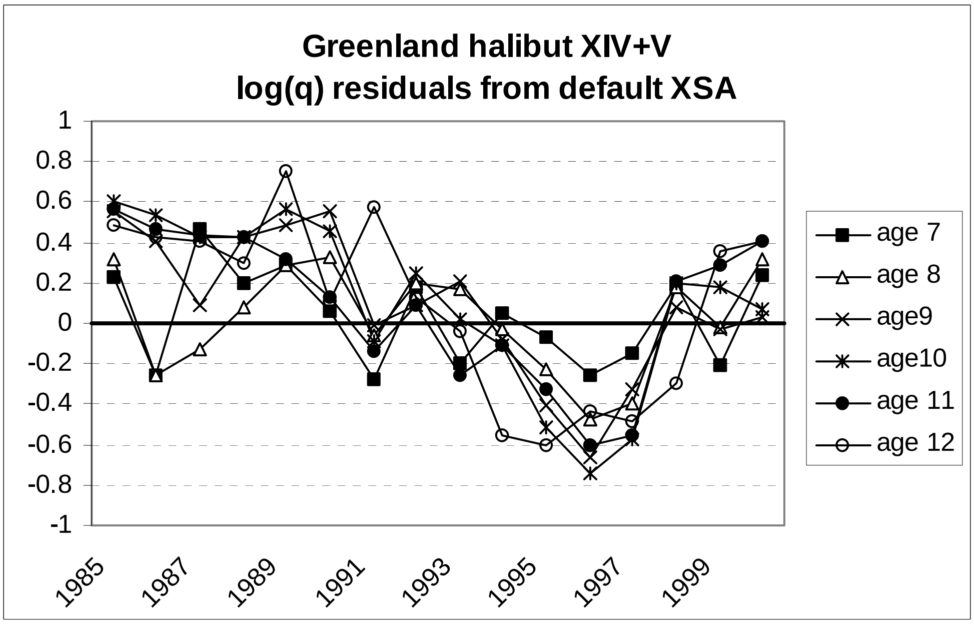


Figure 6.7.1. Plot of log(q) residuals from an XSA using same settings as in 2000 report.

7 REDFISH IN SUB-AREAS V, VI, XII AND XIV

The genus *Sebastes* is very common and widely distributed in the North Atlantic. It is found off the coast of Britain, along Norway, in the Barents Sea and Spitzbergen, off the Faroe Islands, Iceland, East - Greenland, West - Greenland, and along the east coast of North America from Baffin Island South to Cape Cod. All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter - late spring/early summer but copulation occurs in autumn-early winter.

7.1 Description of problems regarding stock identity of the species and stocks in the area

In ICES Divisions V, VI, XII and XIV there are at least 3 species of redfish, *S. marinus*, *S. mentella* and *S. viviparus*. The last has only been of minor commercial value. Iceland has started to fish *S. viviparus* in 2 small areas south of Iceland at depths of 150 - 250 m. The landings of *S. viviparus* decreased from 1,160 t in 1994 to 994 in 1998, 494 in 1999 and to 227 t in 2000.

During recent years the existence of more than one stock of *S. mentella* in the area was discussed. Historically *S. mentella* was fished on the shelves and banks of Faroe Islands, Iceland and East Greenland and was considered as one stock. With the start of a new pelagic fishery in the open Irminger Sea in 1982, a new stock was defined for management purposes for *S. mentella* inhabiting the Irminger Sea. In 1992, the Study Group on Redfish Stocks distinguished between these types as deep-sea *S. mentella* (shelf redfish) and oceanic *S. mentella* (Irminger Sea redfish). In the early 90's, the pelagic fishery in the open Irminger Sea moved to deeper layers beyond 500 m. Some researchers considered that some of the fish caught below 500 m were different to those living above 500 m but resembling more the deep-sea *S. mentella* living on the shelves. This new type of *S. mentella* living below 500 m has been called "pelagic deep-sea *S. mentella*". Recently it has become apparent that distribution of pelagic *S. mentella* has extended significantly southwesternly, compared with early 90's into NAFO Division 1F. It is not known if these types are more than one stock and different hypotheses have been put forward:

The **single stock hypothesis** suggests that all *S. mentella* from Faroes Island to Greenland constitute one stock, segregated according to age/size.

The **two stock hypothesis** suggests that the *S. mentella* living on the shelves (deep-sea *S. mentella*) and that living in deeper pelagic waters of Irminger Sea (pelagic deep-sea *S. mentella*) constitute one stock unit which is separated from the oceanic *S. mentella* living in upper layers of the Irminger Sea.

The **three stock hypothesis** support the idea that each of the described components constitutes a distinct stock.

The uncertainty about stock identity is high. There are at present expanded research work going on (EU-QLK5-CT1999-01222). The project is developed to coordinate and support the international research activities directed towards the most important questions related to the biology and exploitation of the highly migratory and straddling redfish resources. The proposal is divided into three main workpackages: 1. "Population structure", 2. "Reproductive strategies" and 3. "Abundance and demography". Some preliminary results from the project will be available in advance of next years NWWG meeting.

In 1999, The Faroese Fisheries Laboratory initiated a project in order to study the stock structure *of S. mentella* in the North-East Atlantic. Sampling of *S. mentella* was carried out from different locations and depths in the Irminger Sea, off Iceland, Faroes and in the Barents Sea. Several different stock identification methods (incl. morphometrics, fatty acid analysis, electrophoresis and DNA analysis) were applied on the same fishes involving researchers from several countries. Some of the analyses are finished and the results (i.e. from the fatty acid analysis and electrophoresis) have been submitted for publication. The rest of the results will be finished within a year.

7.2 Nominal Catches and Splitting of the Landings in Stocks

The official statistics sent to ICES do not report catch by species/stocks (Tables 7.2.1 - 7.2.5).

Various information (i.e. proportion in samples taken from different fishing areas, information on products etc.) from different laboratories is used to split catches into species/stock. The technique and data for such splitting was described in the 1998 NWWG report.

7.3 Abundance and distribution of 0-group and juvenile redfish

Available data on distribution patterns of 0-group and juvenile *S. marinus* indicate that there are nursery grounds in Icelandic and Greenland waters only. No nursery grounds are known around the Faroe Islands. In the 1983 Redfish Study Group report (ICES C.M. 1983/G:3) and in Magnússon and Jóhannesson (1997) the distribution of *S. marinus* 0-group at East Greenland was evaluated, showing that there are considerable amounts of *S. marinus* at East Greenland mixed with *S. mentella* (Magnússon et al., 1988 and 1990) in variable proportions in different sub-areas and periods (ICES CM 1998/G:3). In Icelandic waters, nursery areas for *S. marinus* are found mostly west and north of Iceland at depths between 50 and approximately 350 m, but also in the south and east (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As length (age) increases, migration of young *S. marinus* along the north coast to the west coast takes place towards the most important fishing areas around Iceland.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970 – 1995. Thereafter, the survey was discontinued. Above or average year class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

Abundance, biomass indices and length compositions have been derived using German annual groundfish surveys covering shelf areas and the continental slope off West and East Greenland down to 400 m depth (WD 7). Due to difficult identification, the juvenile redfish (< 17 cm) were not classified to species but treated as a single unit called *Sebastes spp.* Trends in survey abundance for juvenile redfish (< 17 cm) are shown in Figure 7.3.1 for West and East Greenland. Since 1993, small and unspecified redfish were very abundant and distributed mainly off East Greenland. The 1999-2000 low survey results are similar to those observed in the late 1980's.

7.4 Discards and by-catch of small redfish

7.4.1 Discards of redfish in East and West Greenland

An offshore shrimp fishery with small meshed trawls (44 mm) began in the early 1970s off the west coast of Greenland and expanded to the east coast in the beginning of the 1980s, mainly on the shallower part of Dohrn Bank and on the continental shelf from 65° N to 60° N. Observer samples derived from the Greenland Fishery Licence Control revealed that the shrimp fishery at both West and East Greenland did caught redfish as a by-catch but there was no information available to quantify the by-catches and their length composition in recent years. Since 1.October 2000, sorting grid have been mandatory but their actual effect on the bycatch in the commercial fishery has not yet been documented.

7.5 Special Requests

In the ToR for the Working Group there are several questions regarding stock structure, distribution and fishery information of *S. mentella* in the area. The following paragraphs deal with ToR c, e, and f. Under different redfish chapters the Working Group also deals with these questions, in some cases in more detail.

ToR c) Detailed descriptions of the fishery of different nations are given in chapters 8.2, 9.2 and 10.2, based on various working documents. WD 3 gives the geographical overview of four nations fishery which together are fishing around 50% of the total catches in recent years. Figures 7.5.1-4 show the geographical distribution of the catches by periods and Figure 7.5.5 gives the distribution by year from 1995-2000. The fishery of these four nations (Germany (1995-2000), Iceland (1989-2000), Norway (1990-1999) and Greenland (1999-2000)) indicate that there was a similar pattern in the fishery during the last three years. Fishing usually started in early April and up to the end of June it was prosecuted in area east of 32°W and north of 61°N. In July and August, the fleet moves about 400-500 nautical miles to areas south of 60°N and west of about 34°W where the fishery continues until October. There is very little fishing activity from November until late March. WD 13 gives the locations of part of the Spanish activity in the Irminger Sea, and it shows that they had similar pattern in 2000 as the above-mentioned fleets (Figure 7.5.6). The same applies for the Russian fleet in 2000 (Figure 7.5.7). In the third quarter of the year the fishing has, in general, moved towards the southern part of the area fishing mostly at depths shallower than 500 m, within area XII as well as in NAFO area 1F both outside and inside the Greenlandic EEZ. However, it is important to note that the described fishing pattern of the fleet changed significantly in the most recent 5 years mainly in terms of area and depth expansion. The reasons for such changes do not necessarily reflect stock changes only but might also be due to commercial considerations.

Although there is limited information on fishing depth, except for the Icelandic and the Greenlandic fisheries, the general pattern is that the fishing in the first and second quarter of the year is mostly conducted deeper than 500 m. The mean trawling depth (depth of the headline) of the Icelandic fleet in Apr-June 2001 was 656 m, with 8% of the hauls shallower than 500 m depth. Further, although there are no available data on haul-by-haul information of the German catches, WD 8 describes that the fishery in the first two quarters was characterised by fishing deeper than 450 m and at shallower depths during the third and fourth quarters in 1995-2000. WD 13 describes a similar pattern for the Spanish fishery,. They were fishing deeper than 500 m in the second quarter of the year and in the third quarter fishery continued at depths shallower than 500 m. The Greenland vessel participating in this fishery also report all its catches above 400 m after July, and show same pattern as the Icelandic fleet in the first 2 quarters of the year.

Although the fish in all seasons are sexually mature, the mean length in the second half of the year is about 8 cm shorter than in the first half of the year (Figure 7.5.8).

As has been reported in earlier reports of the working group, Iceland has classified its pelagic catches between oceanic and pelagic deep-sea redfish according to a contentious method. The results of this classification have shown that the proportion of fish classified as oceanic type redfish has been very low during recent years, and only about 5% of the Icelandic catches were classified as oceanic type. Based on the samples, the results also indicate that shallower than 500-600 m depth, the proportion "oceanic" is between 85-100%, as the proportion deeper than 600 m is usually between 0-20%.

The above observations indicate that in last three years a) the fisheries in the northeastern area in the first half of the year are occurring at depths deeper than 500 m and catching larger fish, and b) the fisheries in the southwestern area in the second half of the year are mainly occurring at depths shallower than 500 m catching smaller fish.

The working group recommends that NEAFC asks all nations participating in the pelagic redfish fishery to provide ICES with information on the trawling depth (headline depth for each haul as a log-book data), so ICES can have more detailed description of the fishery by season and areas as a basis for giving its advice on the resource.

ToR e). During the meeting several working documents dealing with the problem were presented. Two of these, working document 5, supported the single-stock hypothesis based on information on parasites pigment patches and on a general overview of the distribution pattern for different life stages. One of the documents, supported the theory of more than one stock, based on genetic results using microsatellite markers. Based on the available information and informations described in previous working group reports, the NWWG stresses that there are still uncertainties in the stock structure of *S .mentella* in ICES Divisions V, XII and XIV and NAFO Div. 1F (see Figure 7.1). In accordance with the precautionary approach the units must, until the problem has been clarified, be treated in such a way that each of the possible components will not be overexploited. This implies that fishing effort and catches should be spread out.

ToR f) Limited information is available for describing the distribution of the stock(s) in the area and there are no new information compared with last years working group meeting. The information from various acoustic estimates in recent years only describes the distribution at one time of the year (acoustic estimate in June/July). Information from the fishery of various nations cannot be used alone as a description of the distribution. Therefore, these sources are probably not representative for the distribution of the different possible stock components. In chapter 10, a short description of the distribution from the 1999 international acoustic survey and description of the fishery are given. Compared with previous acoustic results in June/July, the pelagic redfish shallower than 500 meters was found more westerly and southerly distributed in the 1999 acoustic survey (June/July) into the NAFO Division 1F of southwest Greenland (see Figure 10.3.2), and a substantial fishery in NAFO 1F was also observed in 2000. In the data available to the working group, all information supports that the fishery in the NAFO area 1F exploits the same stock as is fished in western part of ICES Division XII (WD6, WD 13, WD8 and results of acoustic surveys).

"The Redfish-Box" on the East Greenland shelf

The NWWG considered the following request from Denmark in respect of Greenland on regulatory measures on bottom trawling off the east coast of Greenland:

'Denmark (in respect of Greenland and Faroe Islands) request to ICES on requirement on redfish regulatory measures in ICES Div. XIVb

'The so-called "Redfish-box" on the East Greenland shelf was established in 1978 after a recommendation from ICES in order to protect nursery grounds for juvenile redfish. The box was based on high catch rates of small redfish in East Greenland waters as observed from bycatches in cod fisheries from 1950's until the regulation. According to later occasional trial fishery in the box-area, there is a large variation in the bycatch inside as well as outside the box. The composition of the fisheries in East Greenland has changed since then, currently only comprising a directed Greenland halibut fishery (minimum meshsize 140 mm) and a shrimp fishery. The closure of such large area for bottom trawl activity constitutes a management problem, if redfish bycatch from time to time is insignificant.

‘The Greenland Home Rule Government has from 1 October 2000 introduced mandatory use of 22-mm sorting grids into the full geographic range of the Greenland shrimp fishery in order to minimise bycatch of fish.

‘Greenland therefore requests ICES to provide information on the following: Is there a biological justification for maintaining an area within sub-area XIV where bottom trawl activity is prohibited to protect redfish nursery grounds (the so-called "Redfish-Box"). Special emphasis must be put on:

‘1) The present mandatory use of grids in the shrimp fishery.
‘2) Influence of trawling activity on the nursery habitat, i.e. the ecosystem effect.’

We considered the following sources of information: a report on a recent experiment carried out in East Greenland waters to measure the effect of sorting grids on the performance of a shrimp trawl (Engelstoft *et al*. 2000; Engelstoft 2001); data from German bottom-trawl surveys off East Greenland from 1985 through 2000. We observed also that German bottom-trawl surveys and the Greenland shrimp survey alike show that small redfish are widely distributed and that the redfish box does not correspond to exceptional densities.

Most of the redfish, of all sizes, caught by the German bottom-trawl survey in the neighbourhood of the redfish box were caught east of the box, between it and the 400-m isobath (Figure 7.5.9). This was true even of redfish shorter than 17 cm. However, the distribution of survey stations within the redfish box was somewhat limited (Figure 7.5.9). Furthermore, in experimental shrimp fisheries in East Greenland in 1992 and 1998, mean by-catch rates within the box were no higher than elsewhere on the East Greenland shrimp grounds (Engelstoft *et al*. 2000), which now stretch some 5° further to the south than they did when the redfish box was drawn in the early 1980s. **The redfish box does not appear to correspond to the current distribution of small redfish, and there are no biological justifications for maintaining it.**

The working group observed from the results of experimental fishing that sorting grids gave nearly complete protection to redfish larger than about 20 cm, but only about 1/3 protection of a numerous class of 11–12 cm redfish. Qualitatively similar results—i.e. poor protection of the smallest fish—were obtained with other finfish (Engelstoft *et al*. 2000). In spite of this, sorting grids significantly reduced the lifetime risk to a redfish that it would be by-caught.

There is a risk that large year-classes of redfish (cf Engelstoft *et al*. 2000 Figure 1) could appear as significant by-catch in the shrimp fishery for as long as they are shorter than about 15 cm, but ‘the redfish box is a very static solution to a variable and species-specific problem’ (Engelstoft *et al*. 2000). Greenland shrimp trawling regulations already require ships to change grounds by at least 5 miles as soon as bycatch exceeds more than 10% the total catch in haul. In addition to this measure **we recommend standard regulatory measures of flexible and temporary area closures** when, and also where, large year-classes of redfish generate by-catch problems.

The working group was unable to answer the question of whether the ecosystem effect of bottom trawling *per se* on redfish nursery habitat would justify closing the area permanently. We observed that to answer this question, we would need information on what constitutes nursery habitat, what characteristics of the habitat are beneficial to juvenile redfish, and what effect bottom trawling has on those characteristics.

Table 7.2.1. REDFISH. Nominal catches (tonnes) by countries, in Division Va 1994-2000, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000[*]
Belgium	50	-	-	-	-	-	-
Faroe Islands	202	521	309	242	280	255	210
Germany	46	229	233	-	284	428	513
Iceland	95,091	89,474	67,757	73,976	108,380	81,430	84,870
Norway	-	-	134	-[*]	-[*]	18[*]	50
UK (E/W/NI)	-	-	-	-	-	542	…
UK (Scotland)	-	-	-	-	-	149	…
United Kingdom							-
Total	95,389	90,224	68,433	74,218	108,944	82,822	

[*]Preliminary.

Table 7.2.2 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1994-2000, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000[*]
Faroe Islands	8,872	7,978	7,286	7,199	6,484	6,191	5,748
France	90	111	62	98	110[*]		282[3]
Germany	155	91	189	36	-	207	79
Norway	34	36	33	25[*]	39[*]	40[*]	43
Russia	3	-	-	-	-	-	
UK (E/W/NI)	1	2	40	+	4	15	…
UK (Scotland)	18	24	43	36	27	46	…
United Kingdom							253
Total	9,173	8,242	7,653	7,394	6,664		

[*]Preliminary.

Table 7.2.3 REDFISH. Nominal catches (tonnes) by countries, in Division Vb 1986-2000, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000[*]
Faroe Islands	-	2	-	12	-	44	0
France[1]	555	529	489	395	297[*]		
Germany	87	5	9	1	1	+	+
Ireland	-	4	-	10	10	34	
Norway	2	1	7	5[*]	3[*]	8[*]	11
Portugal	-	-	-	-	1	-	-
Russia	-	-	-	-	-	243	461
UK (E/W/NI)	9	105	54	19	12	4	…
UK (Scotland)	118	500	603	518	364	762	…
United Kingdom							424
Total	771	1,146	1,162	960	732		

[*]Preliminary. [1]Golden redfish.

Table 7.2.4 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XII 1986-2000, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000*
Estonia	17,875	16,854	7,092	3,720	3,968	2,108	4,000
Faroe Islands	2,896	3,897[3]	5,424[3]	3,420[3]	5,681[3]	4,656[3]	2,833[3]
France	-	-	-	-	3*		
Germany	6,354	9,673	4,391	8,866	9,746	8,204	1,128
Greenland	-	1,856	3,537	…	1,180*	1,188*	
Iceland	17,892	19,577	3,613	3,856	1,311	5,072	5,100
Latvia	13,205	5,003	1,084	-	-	-	-
Netherlands	-	13	-	-	-	-	-
Norway	4,514	3,893	1,013	2,699*	263*	2,040*	2,238
Poland	-	-	-	662	-	-	-
Russia	10,489	34,730	606	-	89	7,682	9,243
Spain	-	20	410	1,155[1]	1,814[2]		
UK (E/W/NI)	-	-	33	-	+	187	…
UK (Scotland)	-	-	13	-	-	1	…
United Kingdom							-
Total	73,225	95,086	24,919	24,780	20,167		

*Preliminary. [1]Includes 720 t Beaked redfishes, [2]Beaked redfishes. [3] Revised according to NEAFC statistics. Most recent figs will very likely be changed somewhat; this will of course be rep. to Jesper in the beginning of next week.

Table 7.2.5 REDFISH. Nominal catches (tonnes) by countries, in Sub-area XIV 1986-2000, as officially reported to ICES.

Country	1994	1995	1996	1997	1998	1999	2000*
Estonia	-	-	-	-	-	-	3,811
Faroe Islands	164	8	298	123	47	2	4
Germany	22,406	9,702	16,996	11,610	9,709	8,935	7,840
Greenland	422	2,936	2,699	193	296*	3,152*	
Iceland	29,114	8,947	49,381	33,820	6,441	23,770[3]	23,500
Norway	2,546	2,890	6,453	433*	864*	3,248*	3,698
Poland	-	-	-	114	-	-	-
Portugal	1,887	5,125	2,379	3,674	4,133	4,302	3,731[4]
Russia	13,917	9,439	45,142	36,930	25,748	16,652	14,851
Spain	-	4,534	3,897	7,552[1]	2,763[2]		
UK (E/W/NI)	138	48	247	28	43	68	…
UK (Scotland)	4	10	6	-	-	-	…
United Kingdom							45
Total	70,598	43,639	127,498	94,477	50,044		

*Preliminary. [1]Includes 3,718 t Beaked redfishes. [2]Beaked redfishes. [3]Note Excluding 58 t reported as area unknown .

[4]Reported as V/XII/XIV.

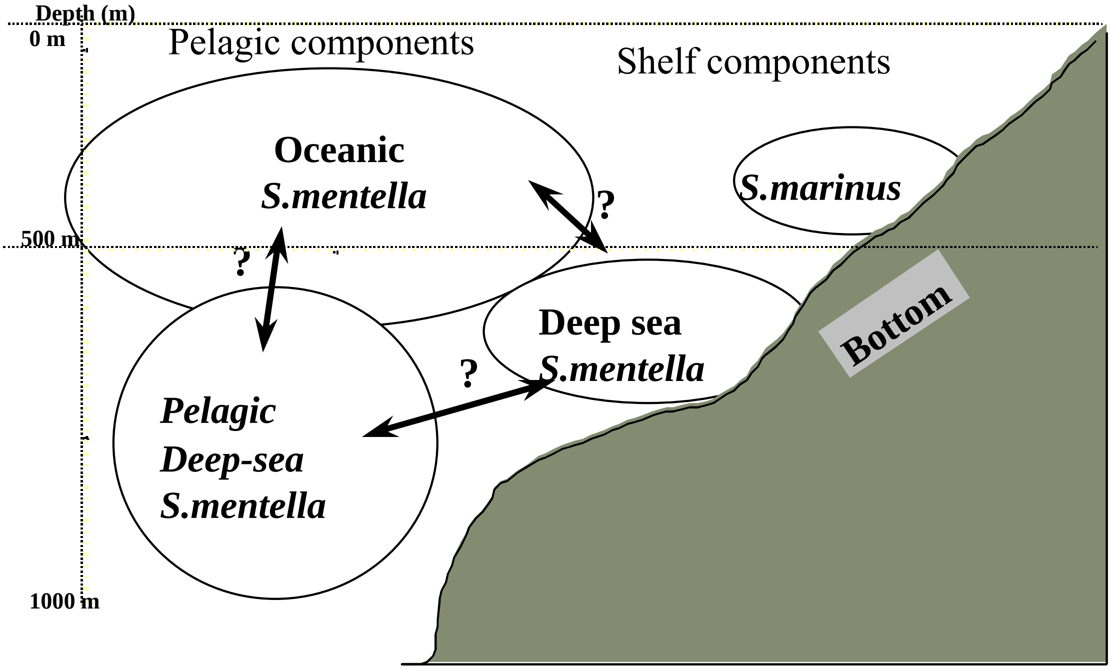


Figure 7.1 Schematically possible relationship between different stocks of redfish in the Irminger Sea and along the continental slope of E-Greenland-Iceland-Faroe Island.

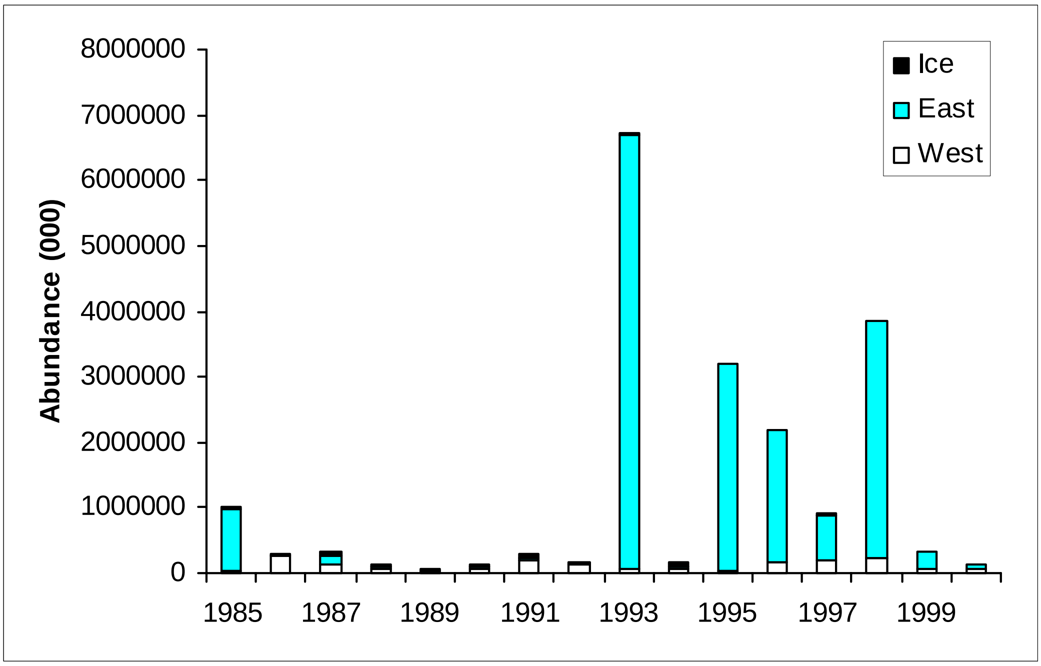


Figure 7.3.1 *Sebastes spp*. (<17 cm). Survey abundance indices for East and West Greenland and Iceland as derived from the German groundfish survey, 1982-2000.

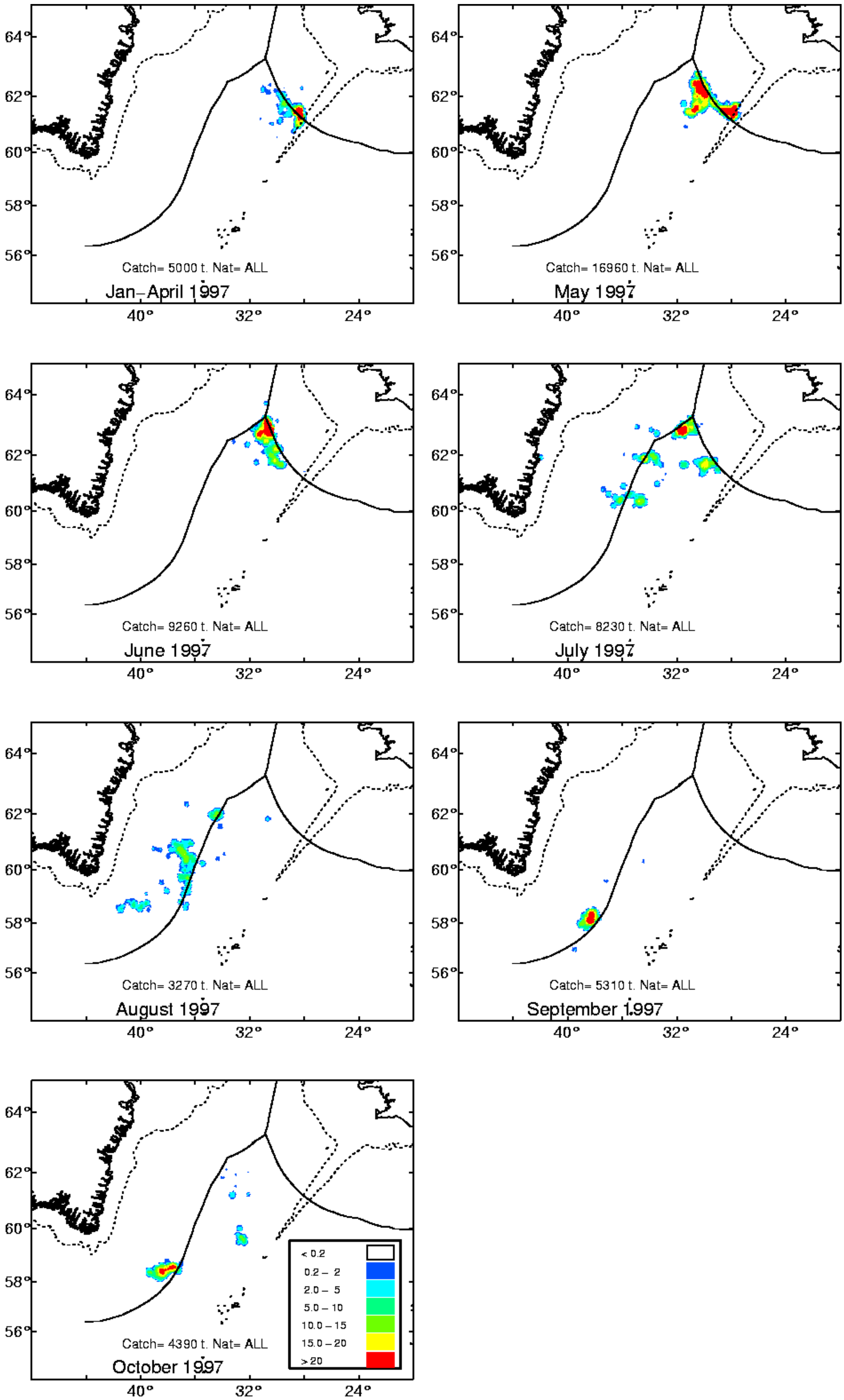


Figure 7.5.1 Fishing areas of the pelagic redfish by periods in 1997, including data from Germany, Iceland, Greenland and Norway. The scale given on the pictures indicates the catches in tonnes per square nautical mile. Total catch registered for each period is also shown on the figures.

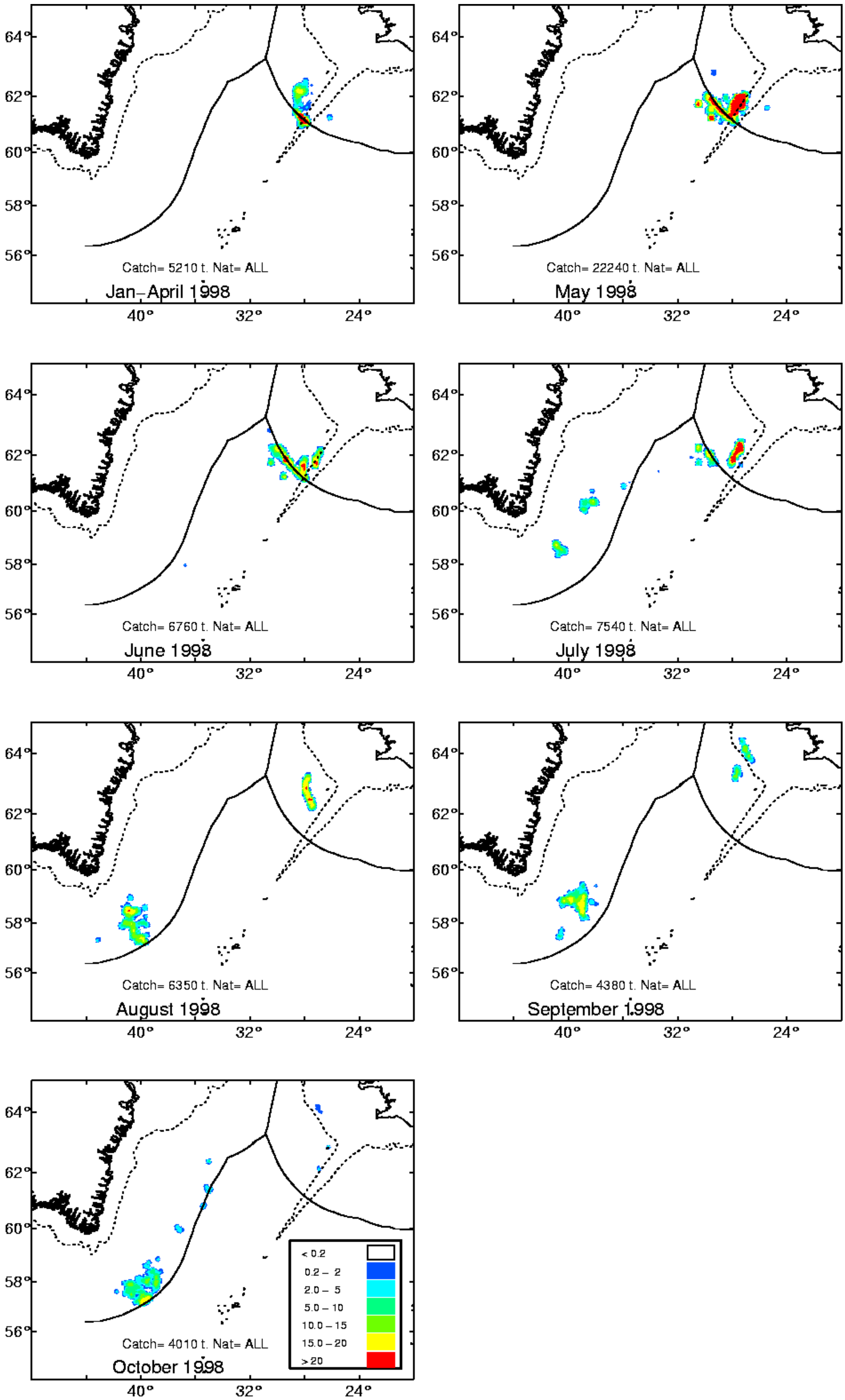


Figure 7.5.2 Fishing areas of the pelagic redfish by periods in 1998, including data from Germany, Iceland, Greenland and Norway. The scale given on the pictures indicates the catches in tonnes per square nautical mile. Total catch registered for each period is also shown on the figures.

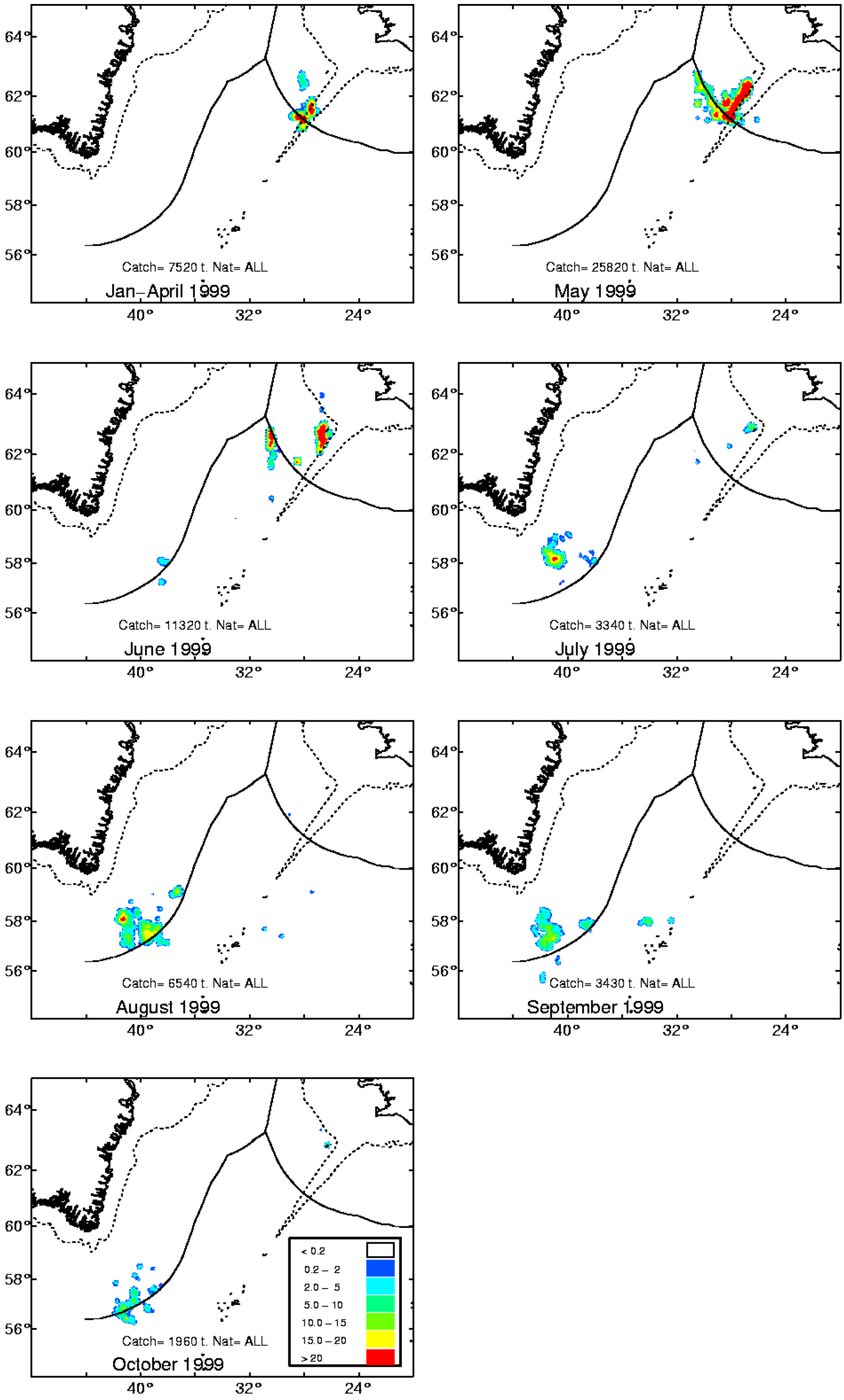


Figure 7.5.3 Fishing areas of the pelagic redfish by periods in 1999, including data from Germany, Iceland, Greenland and Norway. The scale given on the pictures indicates the catches in tonnes per square nautical mile. Total catch registered for each period is also shown on the figures.

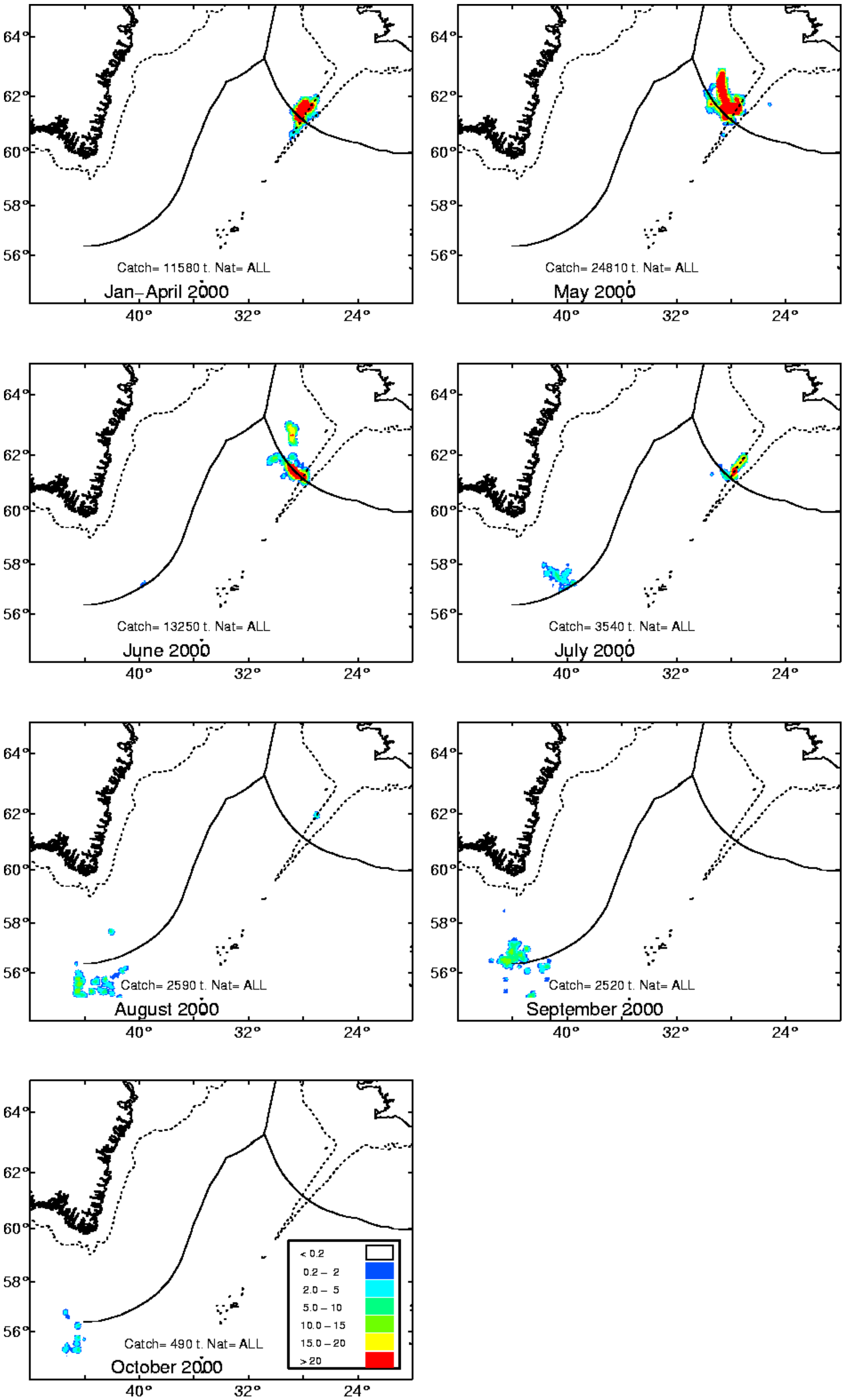


Figure 7.5.4 Fishing areas of the pelagic redfish by periods in 2000, including data from Germany, Iceland and Greenland. The scale given on the pictures indicates the catches in tonnes per square nautical mile. Total catch registered for each period is also shown on the figures.

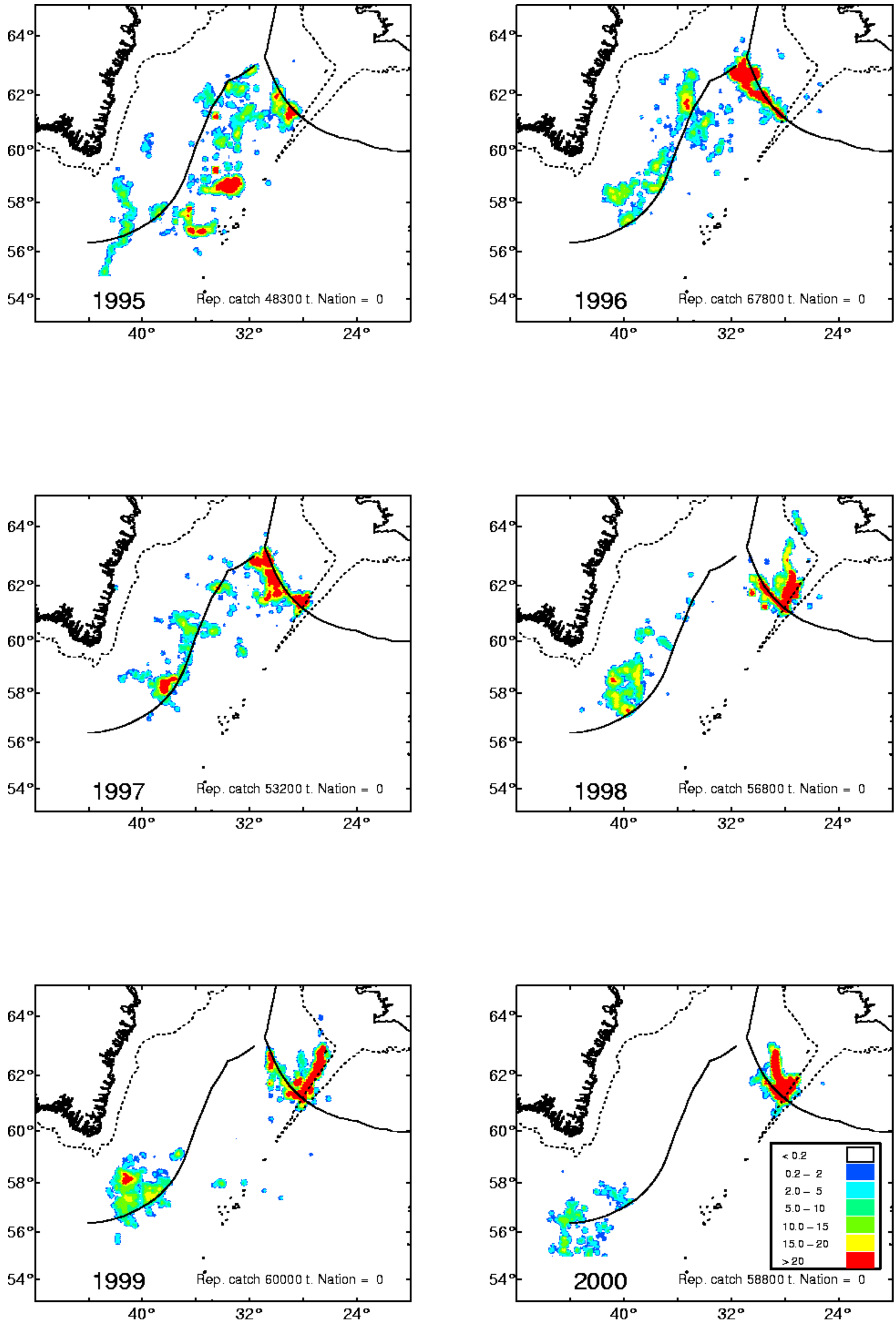


Figure 7.5.5 Fishing areas of the pelagic redfish by year from 1995-2000. Data from Germany (1995-2000), Norway (1995-1999) Greenland (1999-2000) and Iceland (1995-2000). The scale given on the pictures indicates the catches in tonnes per square nautical mile.

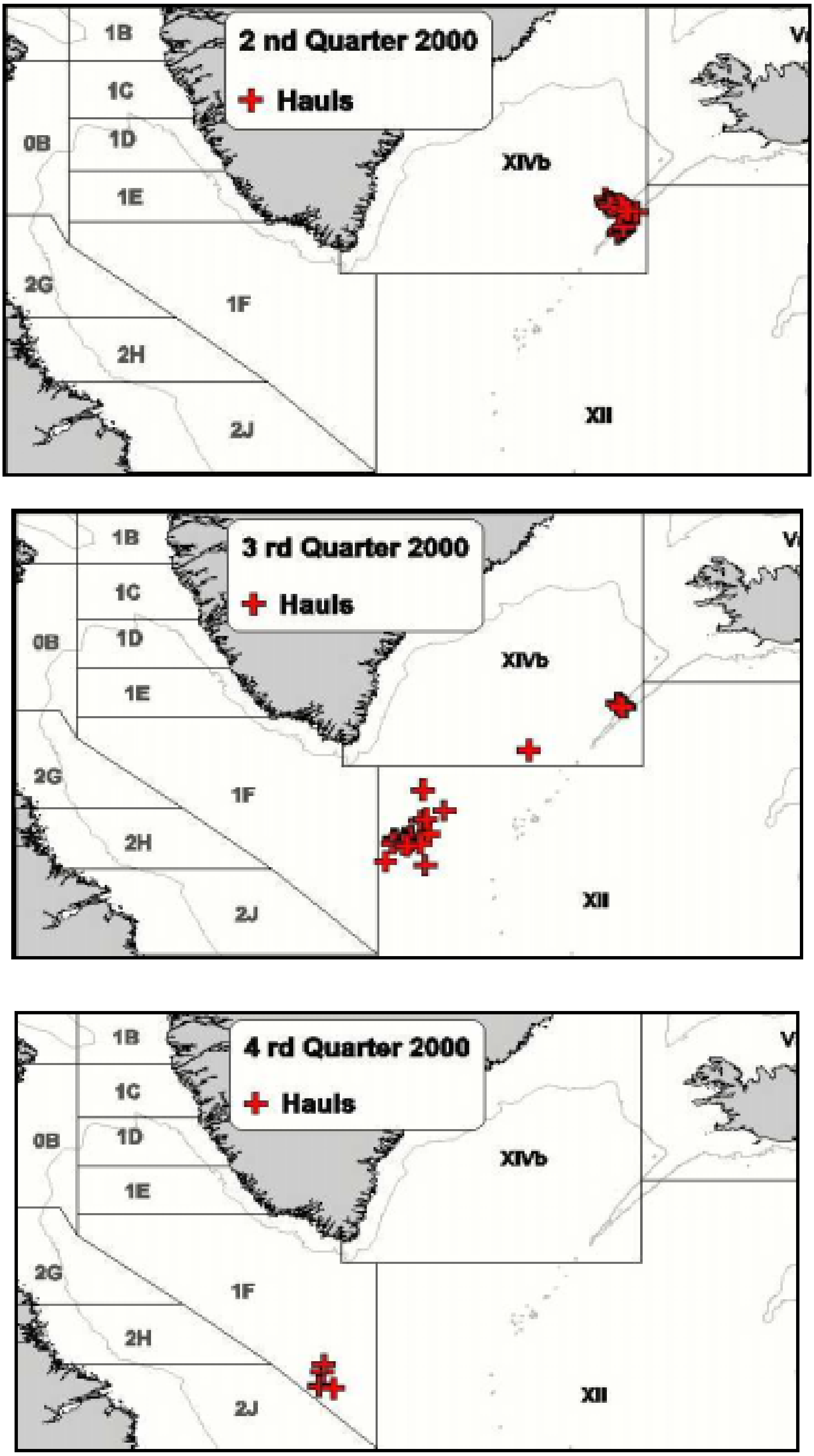


Figure. 7.5.6 Fishing effort distribution by quarter in the Spanish oceanic redfish fishery in 2000.

Figure 7.5.7 Russian fleet monthly position in the Irminger Sea in 2000.

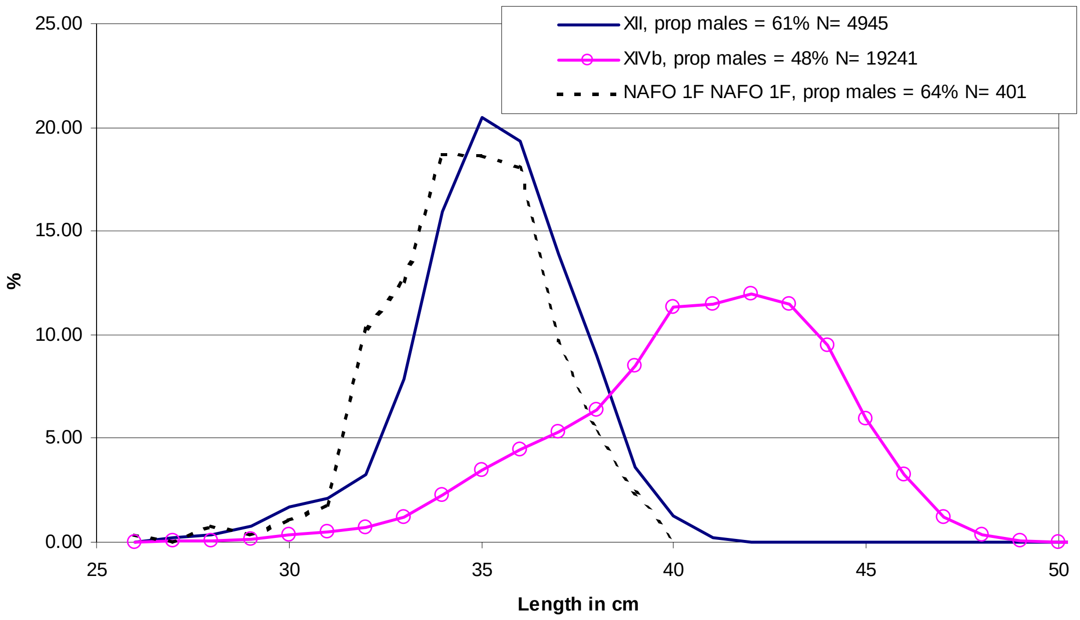


Figure. 7.5.8 Length distribution of the Spanish oceanic redfish fishery in ICES Div. XII, XIV+Va and in NAFO Div. 1F in 2000. The proportion of males is also given.

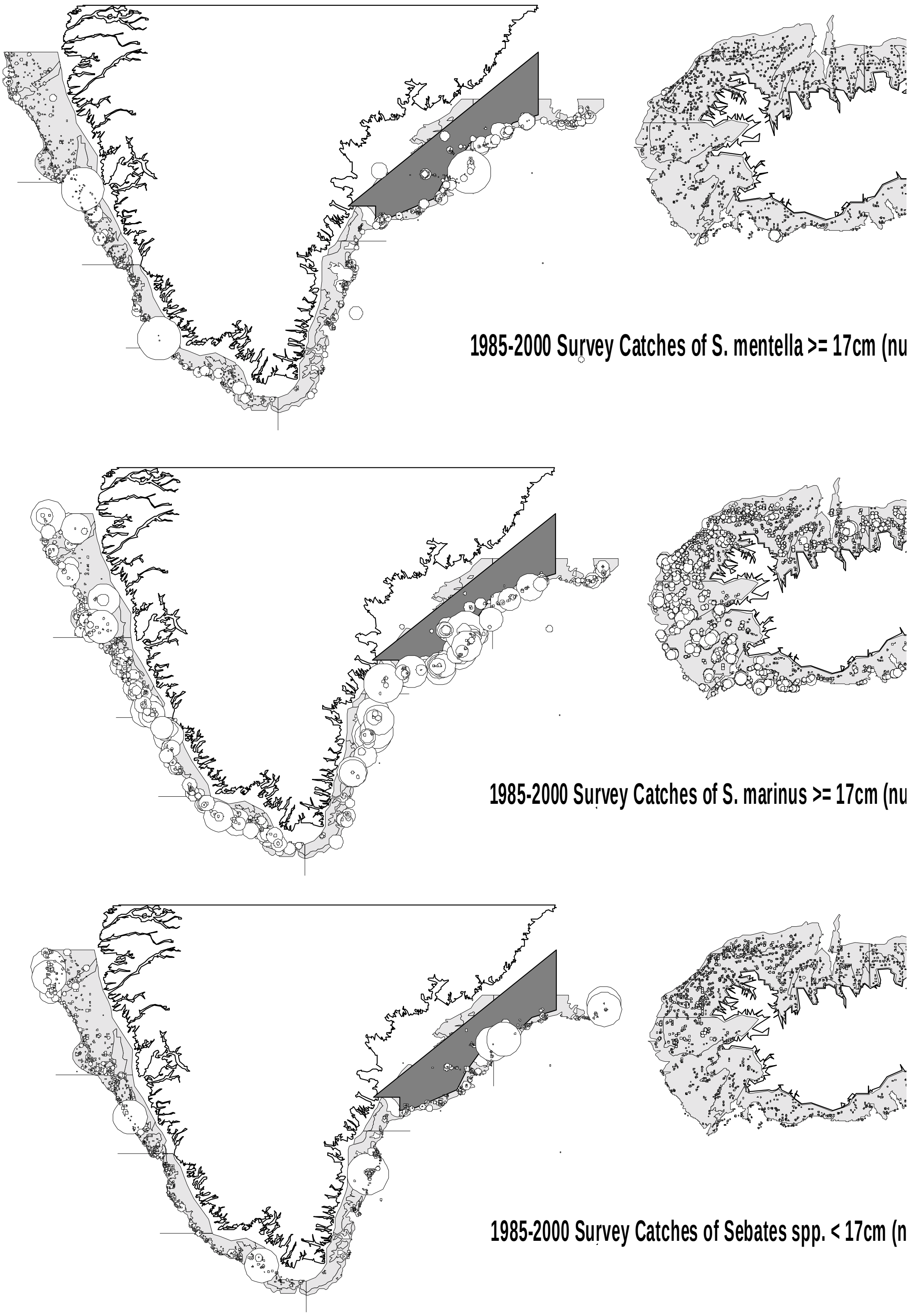


Figure 7.5.9 Distribution of 1985-2000 survey catches of *S. marinus* ≥17cm, *S. mentella* ≥17cm and unspecified juveniles redfish in numbers/0.5h around Greenland and Iceland at 0-400 m depth. The redfish box is dark shaded.

8 SEBASTES MARINUS

8.1 Landings and Trends in the Fisheries

The total catch of golden redfish (*S. marinus*) (Divisions Va, Vb, in the Sub-areas VI and XIV) decreased from about 130 000 t in 1982 to about 40 000 t 1998 (Table 8.1.1). The catch in 1999 was about 42 000 t. and increased further to about 44 000 in 2000. The decline from 1982 of about 70% has more or less been continuous. Since 1990 the overall decrease in the catch has been about 45%. The increases in 1999-2000 are due to increased catches in Sub-areas (Table 8.1.1).

In Division Va catches have declined from about 63 000 t in 1990 t, stabilising around 34 000-36 000 t in 1996-1998. In 1999 an increase to about 40 000 t was observed and was around 41 000 in 2000. The low catch in 1994 was partly due to area closures imposed on the fishery by Iceland in order to reduce the catches of *S. marinus,* but also to reduce the effort on the nursery grounds. However, landings in 1995 increased to approximately 42 000 t. The catches of *S. marinus* in Va in the period 1996-2000 are the lowest since 1978. The length distributions in the Icelandic landings in 1989-2000 along with measurements from the commercial trawler fleet are shown in Figure 8.1.1. The location and number of catches and measured fish by statistical square are given in Figure 8.1.2. About 90-95% of the total *S. marinus* catches in area Va have in recent years been taken by bottom trawlers (both fresh fish and freezer trawlers; length 48-65 m) targeting on redfish. The remainder is taken partly as bycatch in the gillnet and longline fishery. In 2000, as in previous years, most of the catches were taken along the shelf of W, SW and to SE of Iceland, mostly between 12ºW and 27ºW (Figure 8.1.2).

In Division Vb, catches were highest in 1985 (approx. 9 000 t). Catches declined to about 2,100 t in 1991, and have since remained at 2,300-2,600 t (Table 8.1.1). In 1999 and 2000 only 1,400 t and 1,500 were caught. Most of the *S. marinus* catches in Vb have been taken by pair trawlers and single trawlers (< 1000 HP). The CPUE decreased from 1996-1999 by 40% but increased by 13% in 2000 (Figure 8.1.3). No length distribution from the catches was available for 2000.

The catches in Sub-area VI increased since 1978, reaching almost 600 t in 1987. A decline was observed to a low of 40 t in 1992. In 1995-1996 the catches again reached more than 600 t, the highest catches observed in the whole period (Table 8.1.1). The provisional catch in 1999 and 2000 were about 775 t**.** Trawlers have taken the major proportion of the catches. No length distribution was available from the catch.

In Sub-area XIV catches have been more variable than in the other Sub-areas and Divisions. Since the highest catch on record (31 000 t), in 1982 a rapid decrease was observed to about 2 000 t in 1985. During the next 10 years catches varied between 600 and 4 200 t. In 1995-1997 almost no directed fishery for *S. marinus* or *S. mentella* occurred. A minor directed fishery occurred in 1998 and catches increased to 175 t. In 2000 the catch is estimated to be less than 100 t. from direct redfish fishery of large bottom trawlers targeting at *S. mentella*. Some bycatch is reported from the shrimp fishery in the area.

The following text-table shows the fishery related sampling by gear type and Divisions.

Area	Nation	Gear	Landings	Samples	Fish measured
Va	Iceland	Bottom trawl	39,561	325	74036
Va	Germany	Bottom trawl	513	0	0
Va	UK	Bottom trawl	956		
Va	Faroe	Line/hooks	300		
Vb	Faroe	Bottom trawl	1,558		
XIV	Germany	Bottom trawl	85	0	0
VI	UK	Bottom trawl	776	0	0
XIV	Norway	Longline	4	0	0

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey (IGS), data (<400 m depth). The index is a biomass index of the fishable stock, computed by using a sharp fishable stock ogive (from 34-36 cm, L_{50} = 35 cm). The survey (see Pálsson *et.al*, 1989) is stratified (Figure 8.2.3). In Table 8.2.1 the contribution of each stratum to the index is given. The index indicates a decrease in the fishable biomass from 1999, and is now comparable with 1996-1998. The lowest index was in 1995, only about 30% of the maximum in 1987. The increase in the survey index in 1999 is not supported by the results in March 2000 and 2001, and might indicate that the survey estimate in 1999 could have been an overestimate.

Length distribution from IGS shows that the peak in the length distribution (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 in 1995-1999 therefore reflects the recruitment of a strong year class (1985 year class). This indication of strong year class is also confirmed by age readings, which have been going on since 1998.

The1985 year class have been dominating the catches since 1995 (Figure 8.2.5), and in 2000 that year class contributed 34% of the total catch in Va. The survey results have also shown that 1990/1991 year classes are strong, and might be at similar size as the 1985 year class was at similar age. This year class (age 10) contributes about 15% of the total catches in 2000, according to the age readings. The average Z, estimated from this 6 year series of catch at age data is 0.21 for age groups 12-30. In WD 11, age reading results are compared between readers and otolith preparation methods in terms of bias and precision. There were significant differences between readers and between methods, mainly in the higher ages (> 20 years). Precision estimates, involving the high longevity of redfish, were relatively good compared to previous age reading comparisons on redfish species.

Indices of CPUE for the Icelandic trawl fleet for the period 1985-2000 are 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 at depths above 500 m with redfish, exceeding 10% of the total catch were included in the CPUE estimation (Figure 8.2.6). Also, a simple CPUE was calculated (sum of catch / sum of hours trawled for each year, each haul where redfish exceeded 10% of the total catch in each haul). The results from the trawler fleet reflect the situation shown in the groundfish survey. Although the CPUE has been low in recent years it increased in 1997 and has since been relatively stable although a sharp increase in the simple (raw) index was observed in 2000, after a small decrease in the year before.

In summary, the Icelandic groundfish survey as well as the CPUE data seems to indicate a considerable decline in the fishable biomass of S. marinus during the period from 1986 to 1994. The stock may to have started to recover but it is still low. Large proportion of the catches in recent years is caught from one yearclass.

The Icelandic groundfish survey indices (U) may be assumed to be related to overall biomass (B) by a simple linear relationship (U=kB). If catches are assumed to be proportional to stock size and effort (Y=cEB), then it follows that catch over survey index is proportional to effort (Y/U=aE, see Table 8.2.3) and this allows a one-year prediction of catch assuming a *status-quo* effort level.

Although calculated confidence limits in the groundfish survey is quite low, year to year variation incatchability/availability will affect the results drastically while using only the last observation value as a basis for extrapolation of catches in the coming year, based on a constant effort. By using a running average over few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions. The following text table gives the running mean of the IGS index given in Table 8.2.3.

The following text table gives the running mean of the IGS index given in Table 8.2.3.

	Year														
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
3 year running average	1097	1053	986	810	704	567	493	464	406	438	471	539	598	577	536

In Division Vb, CPUE of *S. marinus* were available from the Faroes groundfish survey 1983- 2000. After an increase in the period from 1995-1998 there is decrease in 1999 and 2000. The results also indicate a high variation in the series, and on average, only 43 hauls are behind the value each year (20-61 hauls). The value in 1999 and 2000 is only about 70% of the average value for the whole period since 1983 (Figure 8.2.6).

For the period 1982-2000, 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. However, in 1998 and 2000 a weak signal of possible recovery was observed, although the values are very low compared with the period before 1990. It can be taken from Figures 8.2.7 and 8.2.8 that the redfish around Greenland were mainly distributed off the East coast, while the minor abundance and biomass indices off West Greenland decreased to almost zero. The length frequencies from the German groundfish survey in 1998 are illustrated for West and East Greenland in Figures 8.2.10-8.2.11, along with the length distributions in the IGS. The adults seem to remain almost depleted in East Greenland waters.

During the annual Greenland halibut survey (400-1500m) in XIVb in June/July 2000, *S. marinus* was only observed between 400 and 600 m. *S. marinus* was caught in 12 of the 55 hauls taken. The length distribution ranged from 19 to 54 cm with a peak in the length of 29 cm.

8.2.2 Alternative assessment methods

At the 1999 working group meeting, an alternative model (BORMICON (BOReal MIgration and CONsumption model)) was applied to the stock. The model is described in WD 18 in ICES CM 1999/ACFM:17 and was presented at the SAP symposium in Bergen last December. This model was used this year, adding one year of data.

The main characteristics that distinguish the model from most stock assessment model is that it stores the number and mean weight of fish in each age and length group, not only in each age group as traditional models do. After the growth has been modelled, it is then distributed. Then, certain proportion of the fishes does not grow, some proportion is allowed to grow one length group, some proportion 2 length groups etc. All fleets (predators) in the model have length based selection pattern. This means that fleets catch only the largest individuals of each recruiting age group and therefore affect mean weight at age. The model does not use catch in number directly as input data but rather length distributions, otolith samples and other data used to calculate catch in numbers. An objective function is then used to minimise the discrepancy between the model output and these data. This means that the model can use data that are not sampled regularly enough to calculate catch in number.

Several runs were done, using two types of fleets:

1) The total amount calculated by the fleet is specified and it is distributed on different length groups according to abundance and the selection pattern. The same proportion is caught of each age group in a given length group.

2) The proportion caught (approximate fishing mortality for short time steps) is specified. This proportion is then multiplied by the selection pattern so it is only for the length groups that are fully recruited that this proportion is caught. Fishing mortality refers to this proportion.

In calculation for the past, the total amount caught is specified, but in simulations into the future proportion caught (the fishing mortality) is specified. The formulation used is a relatively simple one and its main characteristics are:

- One area
- Two fleets catching each species, a commercial fleet and a survey. Selection patterns of both fleets are described by a logistic function, whose parameters are estimated
- Growth is described by the von Bertalanffy function.

Data used in the objective function to be minimised are:

- Length distributions from commercial catch and survey
- Age-length keys p(*a/*L) from commercial catch and survey
- Length-disaggregated survey indices
- Mean length at age from survey, and commercial catches
- Understocking (Not enough biomass exists to cover the catch).

Estimated parameters are then:

- Initial number in each age group
- Recruitment each year
- Parameters in the growth equation
- Selection patterns of commercial fleet and survey. Two parameters for each fleet.

Simulation period is from 1970 to 2000. Two time steps are used each year.

Natural mortality is set to 0.15 for the youngest decreasing gradually to 0.05 for age 5 and older. Alternatives with other values on natural mortalities (M=0.1 for age 5+) were tested. They gave a worse fit, and are therefore not incorporated here. The ages used are 1 to 30 years. The oldest age is treated as a plus group. Recruitment was at age 1. Prior to 1989 length at recruitment was 7.1 cm, but 8.1 cm in later years. This was supposed to reflect length of the 1985 and 1990 year classes in the groundfish survey.

Figures 8.5.1-8.5.2 show results of the model run using the same model as was used in last years assessment work, using catches from Icelandic grounds only. Figure 8.5.3 shows the difference in the runs presented here and the one shown in last years report. The model results reflect the survey results and the estimate obtained last year is reduced with the addition of this years results.

In the technical notes from last year, ACFM made the comment that all catch from the stock should be included in the model calculations. This addition increases the estimated stock size as the catch is increased. The proportion of the catch taken in Division Va has though been relatively stable since 1985, with about 85-90% taken in Va. As the tuning data are identical, similar trends in the stock size are to be expected in recent years, with about 10% higher biomass in 2000 than when using only the data from Va. This alternative run presented in Figure 8.5.4 show the results when using total catch for the stock.

The main indicator for recruitment is the groundfish survey, which does not indicate that any strong year class is on the way after the 1990/1991 year class. Here the 1990/91 year class similar to with the 1985 year class. Much less data are available to estimate the recruitment prior to 1985. Simulations were used to determine the value of $\mathbf{F}_{max}$. A year class was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The total yield from the year class was then calculated. $\mathbf{F}_{max}$ was calculated 0.165 using 40 years simulations, and $\mathbf{F_{0.1}}$ was estimated to be 0.09. F here is not fishing mortality but close to it when small time steps are used or mortalities are small. It is also the mortality of a fish where the selection is 1.

Different catch options were tested in the future simulations for fixed catch. As may be seen on Figure 8.5.2 and 8.5.4, the catchable biomass will increase until 2003, using fixed catch after the year 2001 for all catch options below 40 000 t. In next 4 years, catchable biomass will increase for all catch options up to 50 000 t, but the total biomass will at the end of the period be lower than it is now for catches exceeding about 40°000 t annually.

From the above-mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new large year class will recruit until 2010.

The group also tried a stock-production model (Prager 1994) using the ASPIC software (Prager 2000) on the *S. marinus* stock. The results of the runs that were made gave different results depending on the landings used in the input. By using the total caches form the whole distribution area, the model did not find a sensible solution, despite using a wide range of starting guesses. Using only a) Icelandic catches and survey indices and b) Icelandic catches and both the survey indices and the commercial indices gave a B-ratio in 2000 between 0.65-0.73 and F-ratio in 2000 between 1.25-1.31. The general trend in the production model and the current state in relation to reference values are similar to that from the BORMICON model. Since ASPIC does not allow for addition of external informations such as the recruitment indices available for *S. marinus* it was not considered as a basis for forward projections in that stock.

8.2.3 State of the stock and catch projections

All available survey information and CPUE data from Division Va show that the *S. marinus* stock decreased considerably to the lowest recorded biomass in 1995. A small improvement in fishable biomass has, however, been seen in the recent years due to improved recruitment. During the last few years, the 1985year class has contributed significantly to the fishable stock, and the 1990 year class will contribute significantly to the fishable biomass in next years. In Division Vb the CPUE from the Faroes groundfish survey were not available for the last year, but it shows an increase in later years for the available period. CPUE is however still at very low level. The adult stock of *S. marinus* in Sub-area XIV has nearly been exhausted in the most recent years. There are no indications of any considerable recruitment in area XIV.

By assuming same effort in 2002 as it was in 2000 (see chapter 8.2.1) the predicted catch in Va will be around 38 000 t using the following formula: $\text{Catch}_{2002} = \text{Average Survey index}_{1999\text{-}2001} * \text{Effort}_{2000}$.

Based on the BORMICON model the fishable biomass will increase in the next few years, but will decrease thereafter for every catch option above about 35 000 t. This is due to the poor recruitment after the 1990/91 year class. Unless the results of next years surveys (or CPUE) deviates from what is described in the BORMICON model, a TAC of about 35°000 t in next 5 years would keep the fishable stock size above U_{pa} at the end of that period.

In Division Vb the CPUE from the Faroes groundfish survey shows a similar trend as the Icelandic (increase in 1996-1998, but decrease in 1999 and 2000), but in Sub-area XIV the fishable stock of *S. marinus* is almost depleted.

In order to protect the new incoming year class, any fishing effort on this component should be kept low to allow the stock not to decrease in the nearest future. It should also be kept in mind that, based on the groundfish survey there is no indication of new, strong, year classes after the 1990 year class. Therefore as described in 8.2.2, the year classes, 1985 and 1990 needs to be preserved, since it is unlikely that other year classes than these will contribute substantially to catches in the next years. Therefore, the Working Group recommends **that the catches should be kept low in order to keep the stock within safe biological limits.**

8.3 Biological reference points

S. marinus is mainly caught in Division Va and the relative state of the stock can be assessed through survey and CPUE index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max} /5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been below, but close to U_{pa} during the last years. Based on the BORMICON model the corresponding values for reference points (for the period 1985-1999) are then U_{max}= 250 (in 1985); U_{lim}= 50 and U_{pa}= 150, and the stock seems to have been below U_{pa} in the period from 1993- 1996. The survey index series is only available back to 1985.

8.4 "Giant" *S. marinus*

In March 1996 a new fishery with longlines and gillnets started on the Reykjanes Ridge deeper than 500 meters. In addition to traditional bottom longlines, vertical longlines were used on the steep sea mountains. One or two vessels also used gillnets. One of the main species caught in this fishery were the "giant" *Sebastes marinus* (see chapter 7.1). The main fishery has taken place from within the Icelandic EEZ (north to approx. 63°N) and southwards in international waters to approx. 56°N, although occasionally "giant" redfish have been caught south to 52°30'N. ACFM decided in 1997 to treat all *S. marinus* in ICES Sub-areas V, XII and XIV, including the 'giant', as one management unit.

The only landing statistics presented in 1996 were by Iceland, the Faroes and Norway (Table 8.4.1). The total reported landings of "giant" *S. marinus* taken by these countries in Sub-areas XII and XIV in 1996 was 900 t. The fishery since then decreased, with only minor catches reported by Norway in 1997 and there were no reporting of "giant" catch since then. Taking all available information and knowledge into account, it is the view of the Working Group that the demersal *S.marinus* caught on the Reykjanes Ridge in international waters, of which nearly 100% have been documented to belong to a separate genetic pool, the 'giants', should be managed separately and in a very conservative and cautious way.

Table 8.1.1 *S. marinus*. Landings (in tonnes) by area used by the Working Group.

Year	Va	Vb	VI	XII	XIV	Grand Total
1978	31,300	2,039	313	0	15,477	49,129
1979	56,616	4,805	6	0	15,787	77,214
1980	62,052	4,920	2	0	22,203	89,177
1981	75,828	2,538	3	0	23,608	101,977
1982	97,899	1,810	28	0	30,692	130,429
1983	87,412	3,394	60	0	15,636	106,502
1984	84,766	6,228	86	0	5,040	96,120
1985	67,312	9,194	245	0	2,117	78,868
1986	67,772	6,300	288	0	2,988	77,348
1987	69,212	6,143	576	0	1,196	77,127
1988	80,472	5,020	533	0	3,964	89,989
1989	51,852	4,140	373	0	685	57,050
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,460	40	0	746	55,710
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,274	129	0	1,443	42,515
1995	41,516	2,581	606	0	62	44,765
1996	33,558	2,316	664	0	59	36,597
1997	36,342	2,839	542	0	37	39,761
1998	36,771	2,565	379	0	109	39,825
1999	39,824	1,436	773	0	7	42,040
2000	41,110	1,558	776	0	89	43,533

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey by depth.

Depth interv / year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
< 100m	7	2	2	1	1	2	2	1	1	1	0	1	1	2	1	2	2
100-200m	91	86	124	95	101	68	76	62	48	58	36	44	60	57	56	47	33
200-400m	140	180	150	110	118	81	53	59	50	51	45	76	71	71	107	69	67
400-500m	24	12	10	4	11	22	8	9	17	1	11	21	34	3	44	8	6
Total 0 - 400m	237	268	276	206	220	151	130	122	98	110	81	121	133	130	164	117	101
Total	262	281	287	228	234	187	141	133	117	112	93	143	166	133	208	125	107

Table 8.2.2 *S. marinus*. Catch in Va in weight (tonnes) by age.

Year/ Age	1995	1996	1997	1998	1999	2000
7	59	0	33	24	0	0
8	366	354	229	285	367	118
9	1572	808	483	598	1492	595
10	9312	3622	1039	1213	1244	3977
11	2698	8943	2704	1134	1820	1894
12	1314	2072	11563	3257	2651	2524
13	3548	1300	2820	12548	2330	1610
14	5684	1459	1366	2086	15703	2292
15	6000	4398	3123	2039	1171	14272
16	1743	5641	3621	2411	1235	1778
17	859	921	3024	3410	1884	1234
18	371	388	896	2048	2769	1843
19	1148	268	644	1015	2317	2379
20	1158	337	960	726	1219	2201
21	511	1210	448	521	487	571
22	684	1033	544	390	231	619
23	1447	803	691	425	347	226
24	673	0	595	662	226	124
25	773	0	753	516	948	585
26	370	0	271	400	281	503
27	354	0	140	425	587	248
28	736	0	208	359	175	493
29	0	0	155	54	107	471
30	134	0	31	226	234	451

Table 8.2.3 *S. marinus* Results from the Icelandic groundfish survey in Va, total catch in Va and effort towards *S. marinus*.

Year	Survey index	Catch (Va)	Effort
1985	1000	67,312	67
1986	1131	67,772	60
1987	1165	69,212	60
1988	869	80,472	93
1989	928	51,852	56
1990	637	63,156	99
1991	549	49,677	91
1992	515	51,464	100
1993	414	45,890	111
1994	464	38,669	84
1995	342	41,516	122
1996	511	33,558	66
1997	561	36,342	65
1998	549	36,771	67
1999	692	39,824	58
2000	494	41,110	83
2001	426		

Table 8.4.1 Catches of "giant" *S. marinus* in Divisions XII and XIV. No catches are reported in 1998-1999.

	XII		XIV	
	1996	1997	1996	1997
Norway	76	21	750	22
Faroes[1]			80	
Total	76	21	830	22

1) Includes area XII

Catch figures for other areas or nations are not available for the meeting.

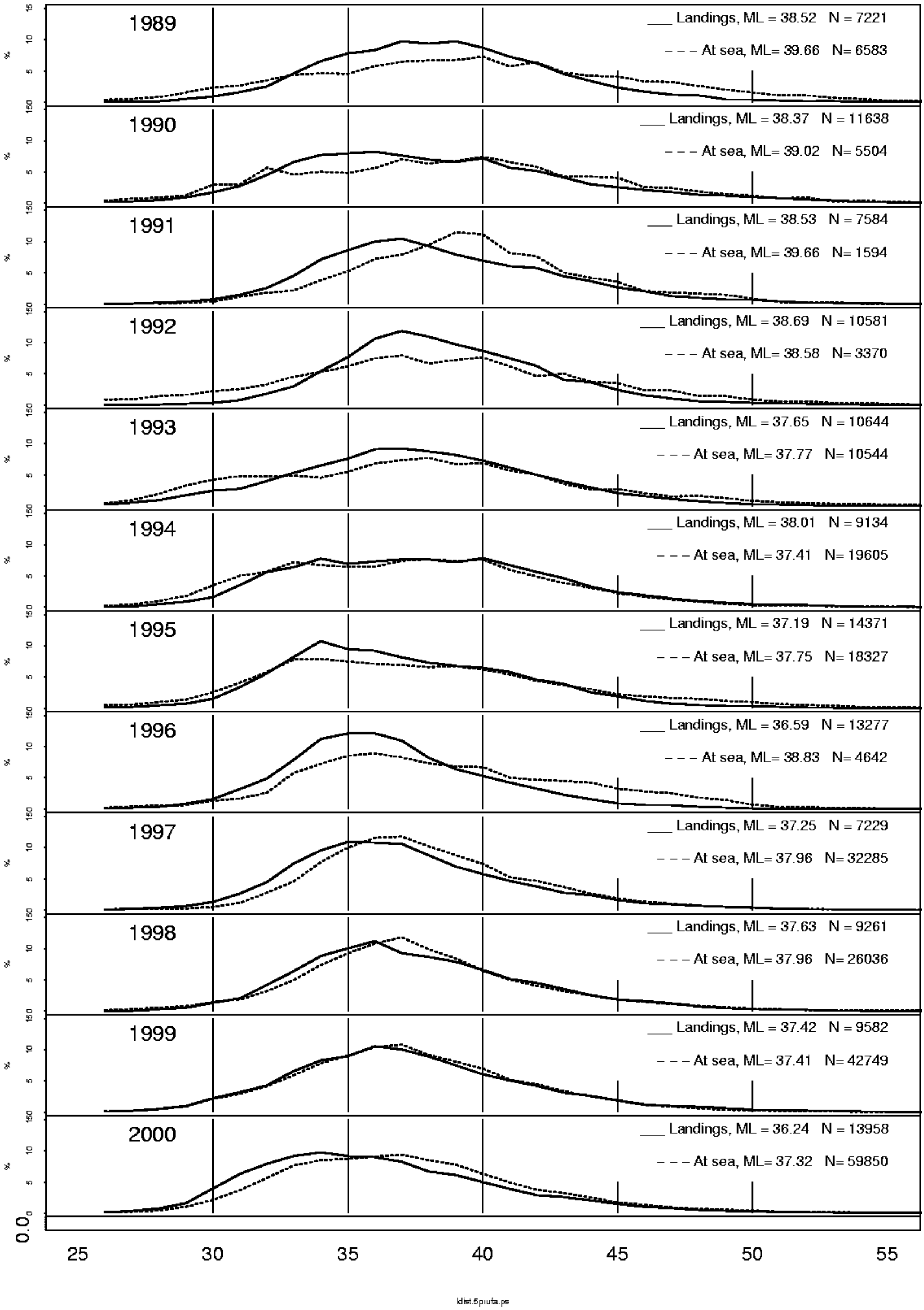


Figure 8.1.1 *S. marinus*. Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-2000.

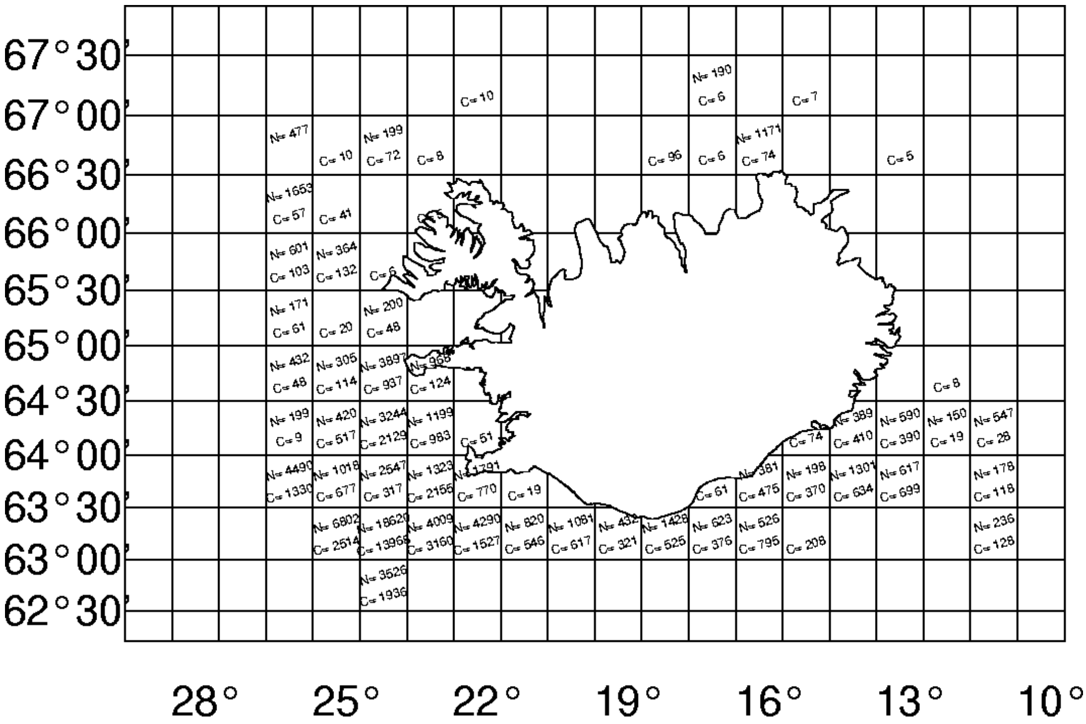


Figure 8.1.2 Number of measrured *S. marinus* and catches (C) from Icelandic catch in 2000 by statistical square.

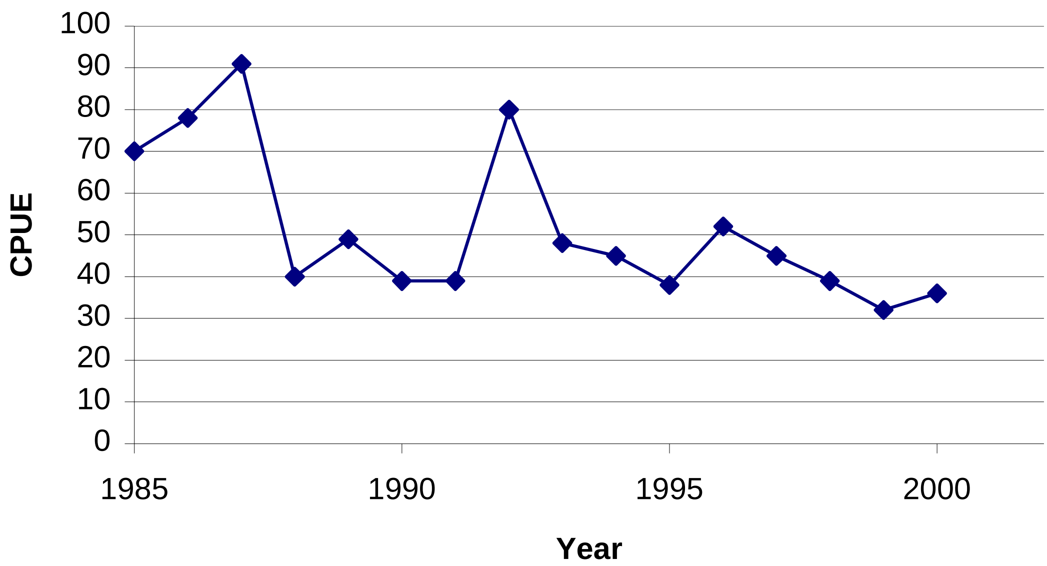


Figure 8.1.3 CPUE from the Faroese pair-trawlers in ICES division 1985-2000.

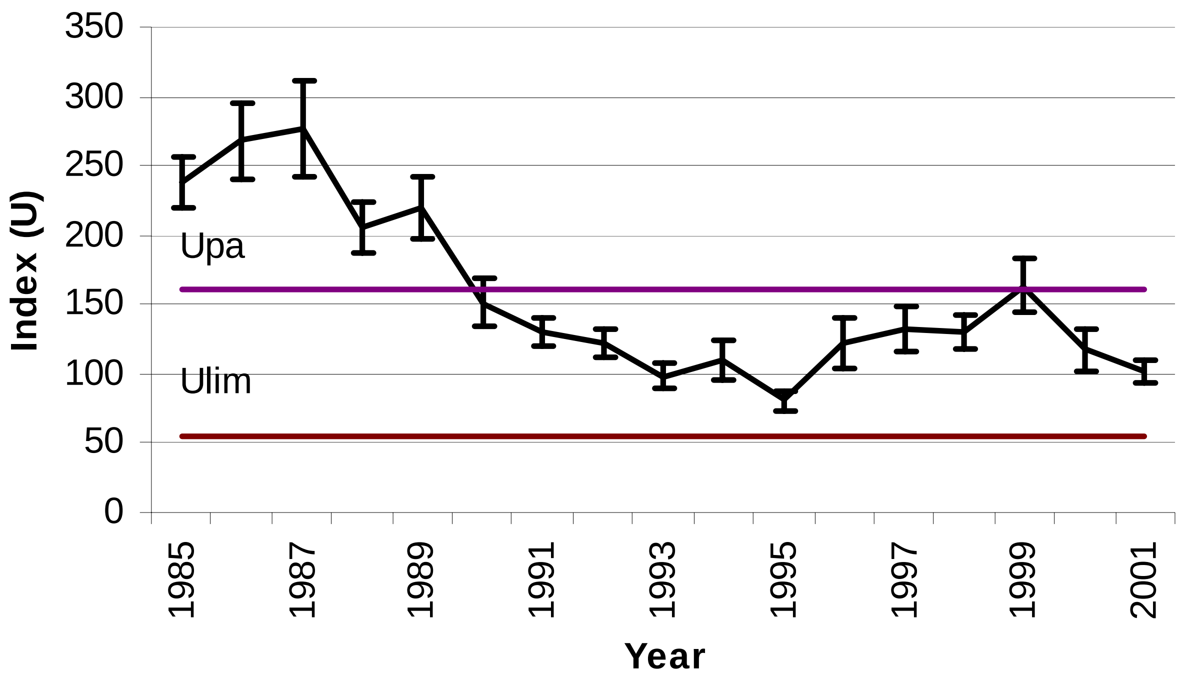


Figure 8.2.1 Index on fishable stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

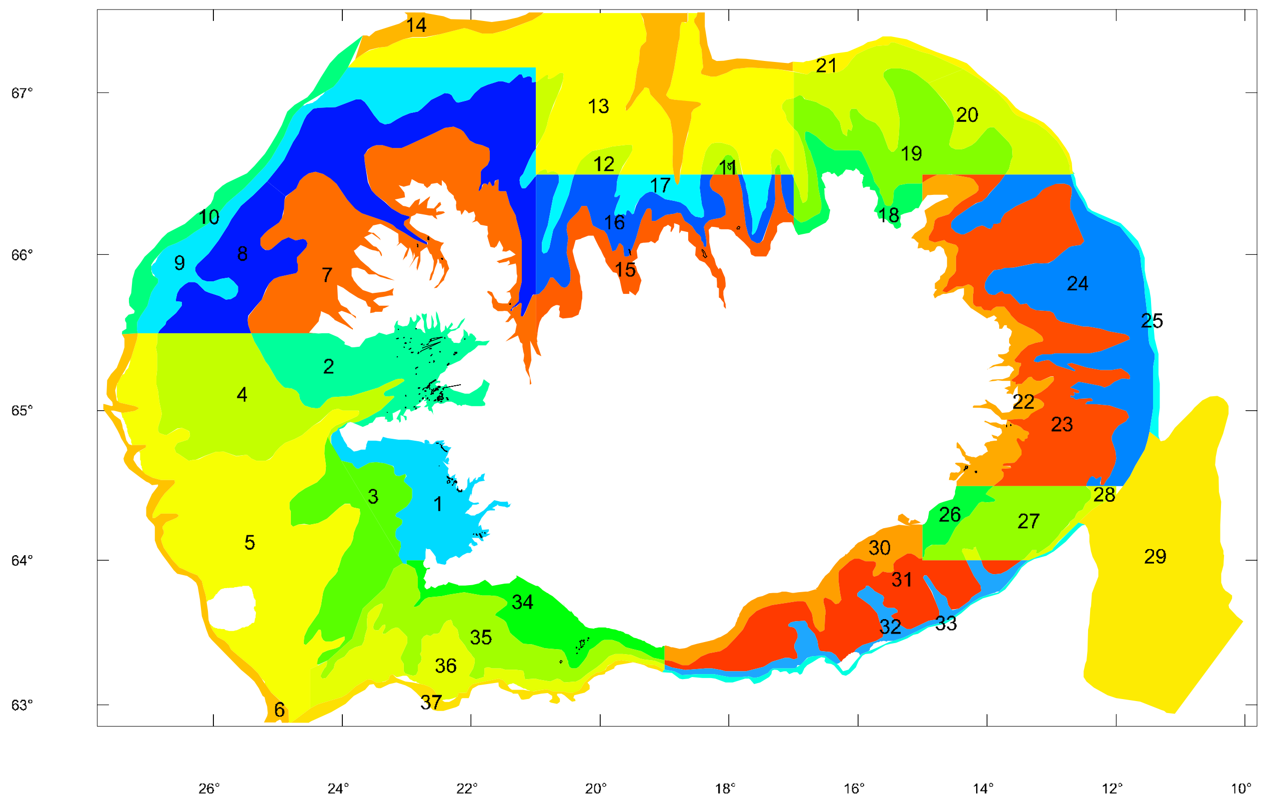


Figure 8.2.3 Stratification in the Icelandic groundfish survey by depth down to 500 m. The numbers show stratified index (Palsson *et al.* 1989). See also table 8.2.1.

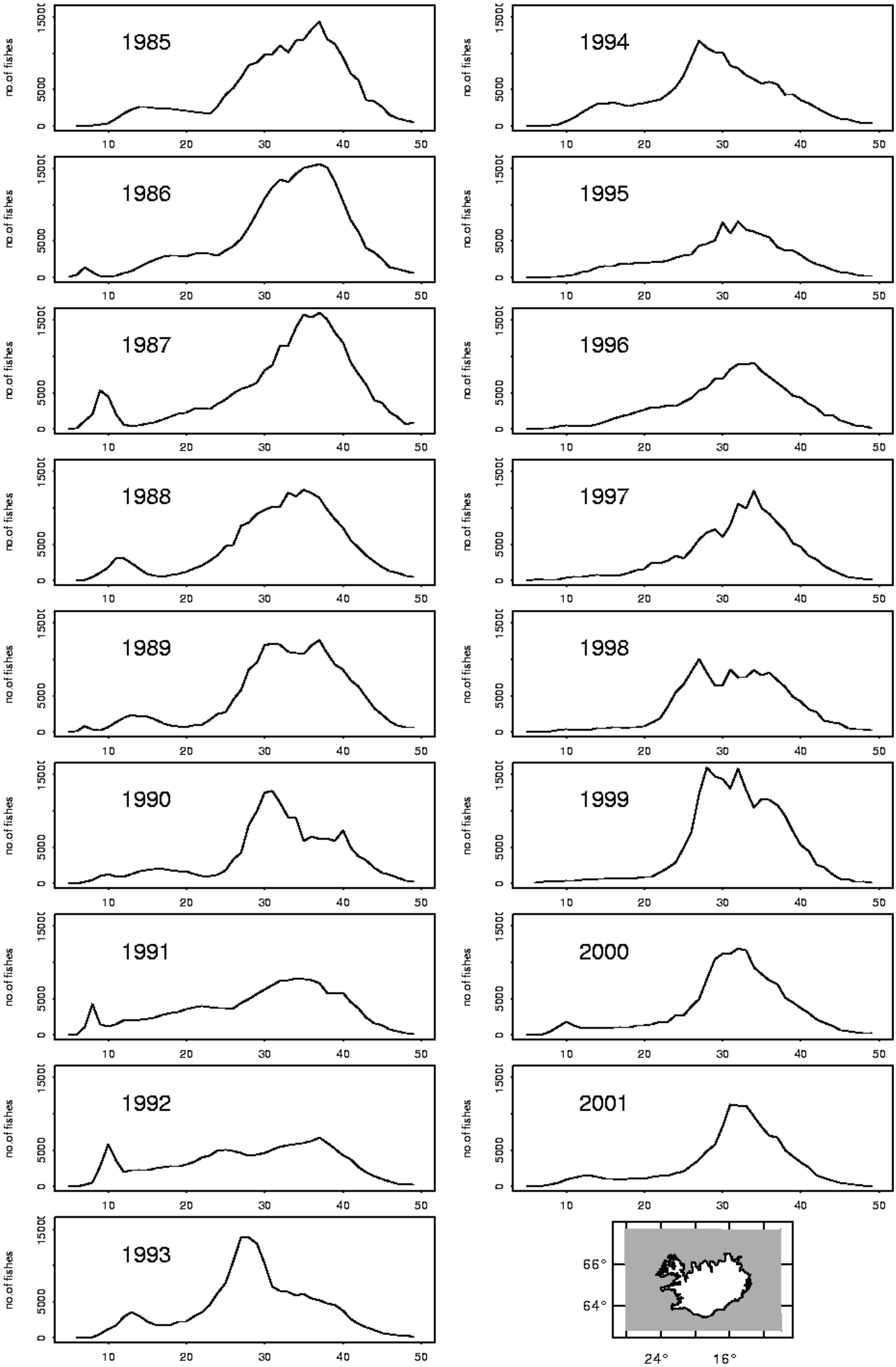


Figure 8.2.4 Length distribution of *S. marinus* in the Icelandic groundfish survey.

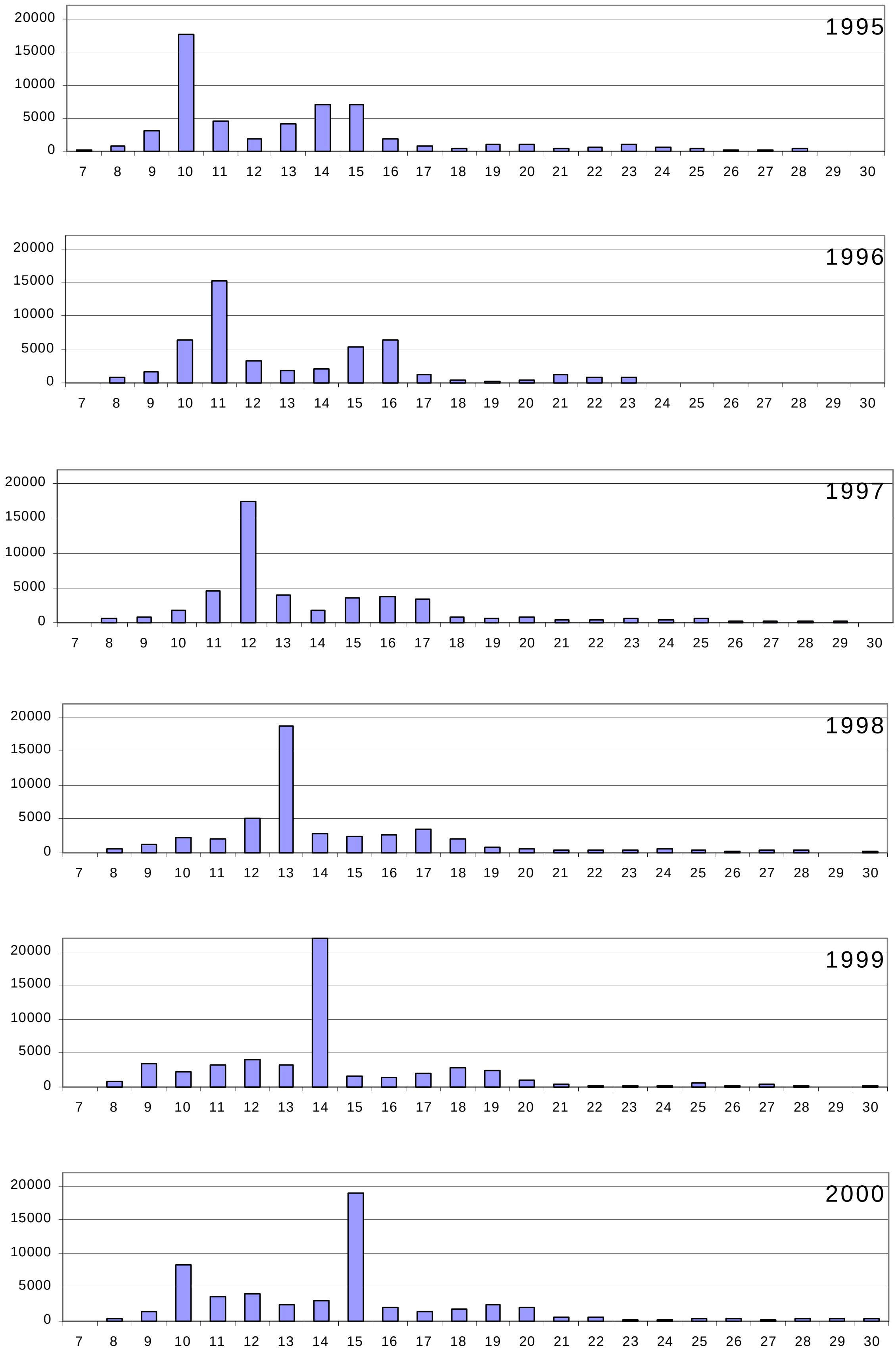


Figure 8.2.5 *S. marinus.* Catch in number by age in ICES Sub-division Va 1995-2000.

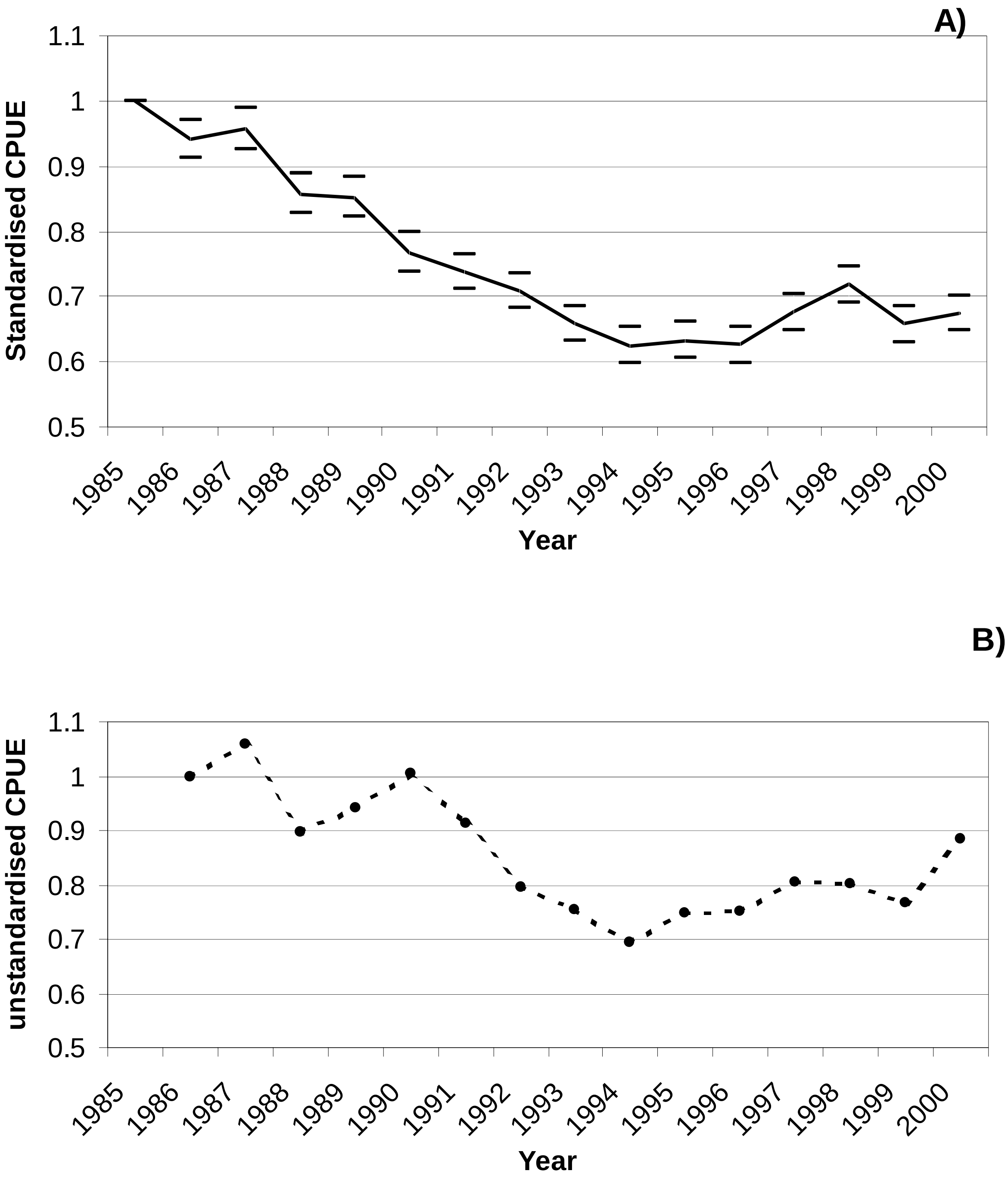


Figure 8.2.6 CPUE in *S. marinus* from Icelandic trawlers, both based on results from GLIM model 1985-2000 (A) with 95% CV) and based on simple mean of hauls where *S. marinus* catch compose 50% or more of the total catch in each haul (B).

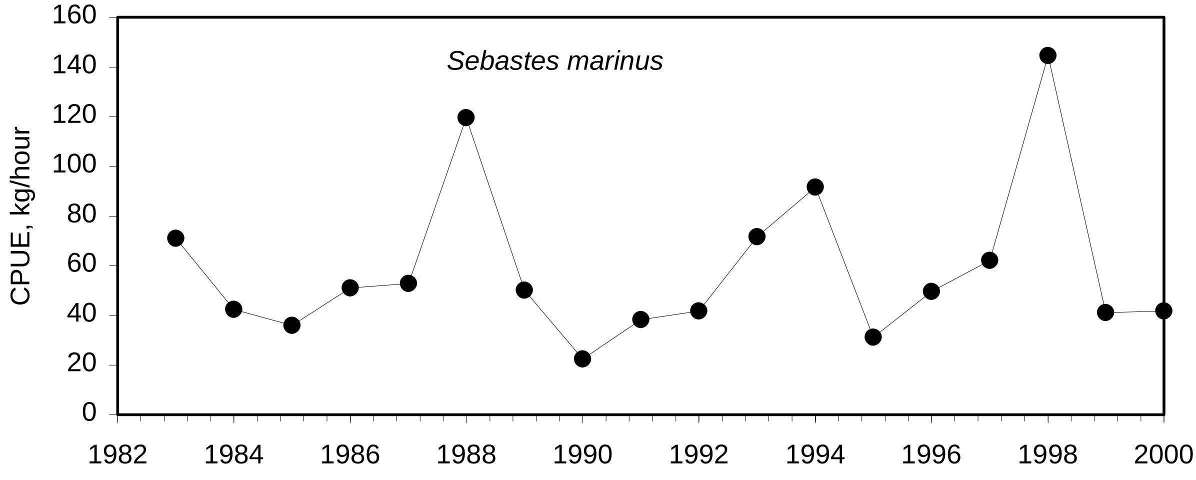


Figure 8.2.7 CPUE of *S. marinus* in the Faroes groundfish survey 1983-2000.

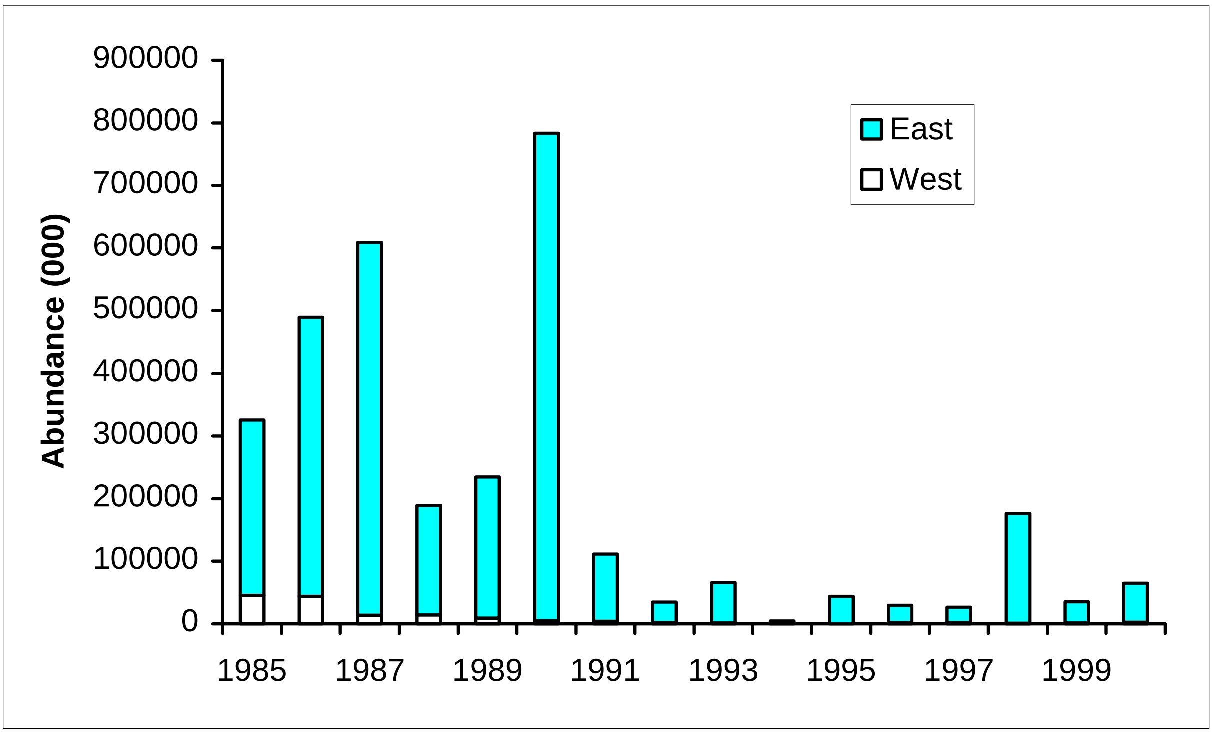


Figure 8.2.8 *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland, 1982-2000.

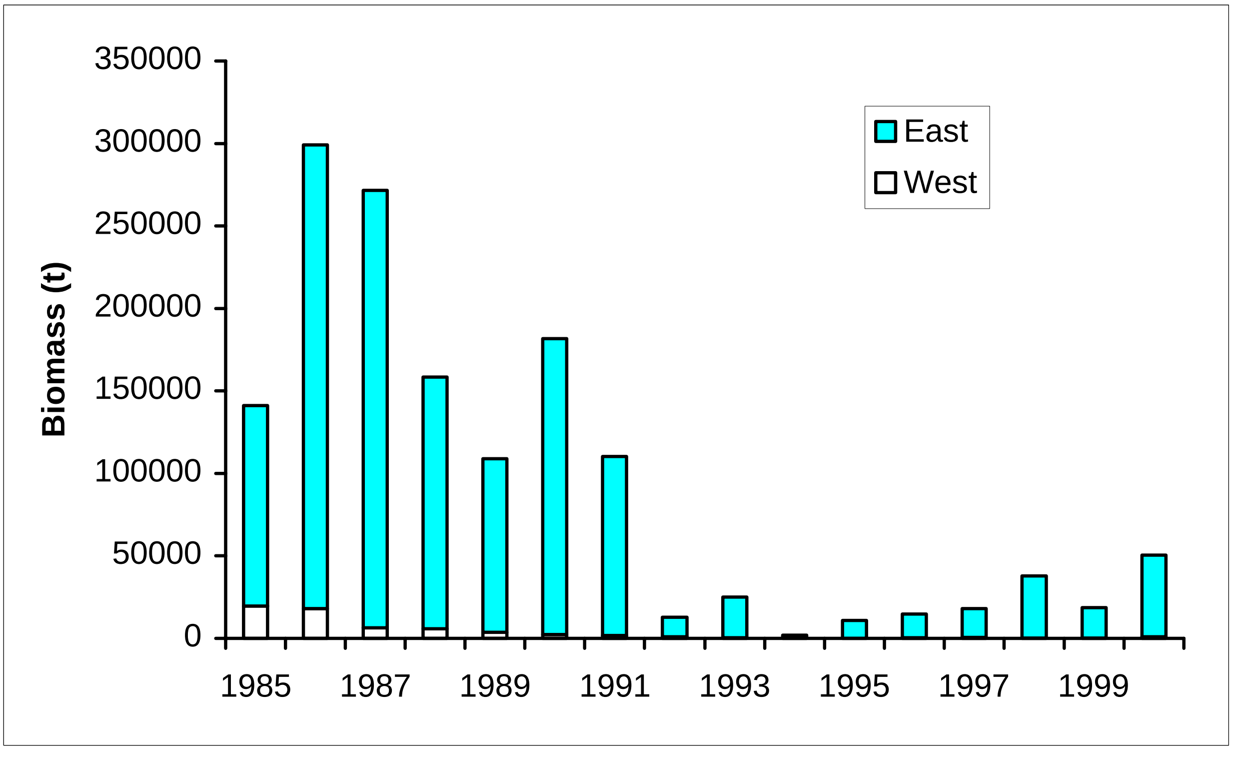


Figure 8.2.9 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland, 1982-2000.

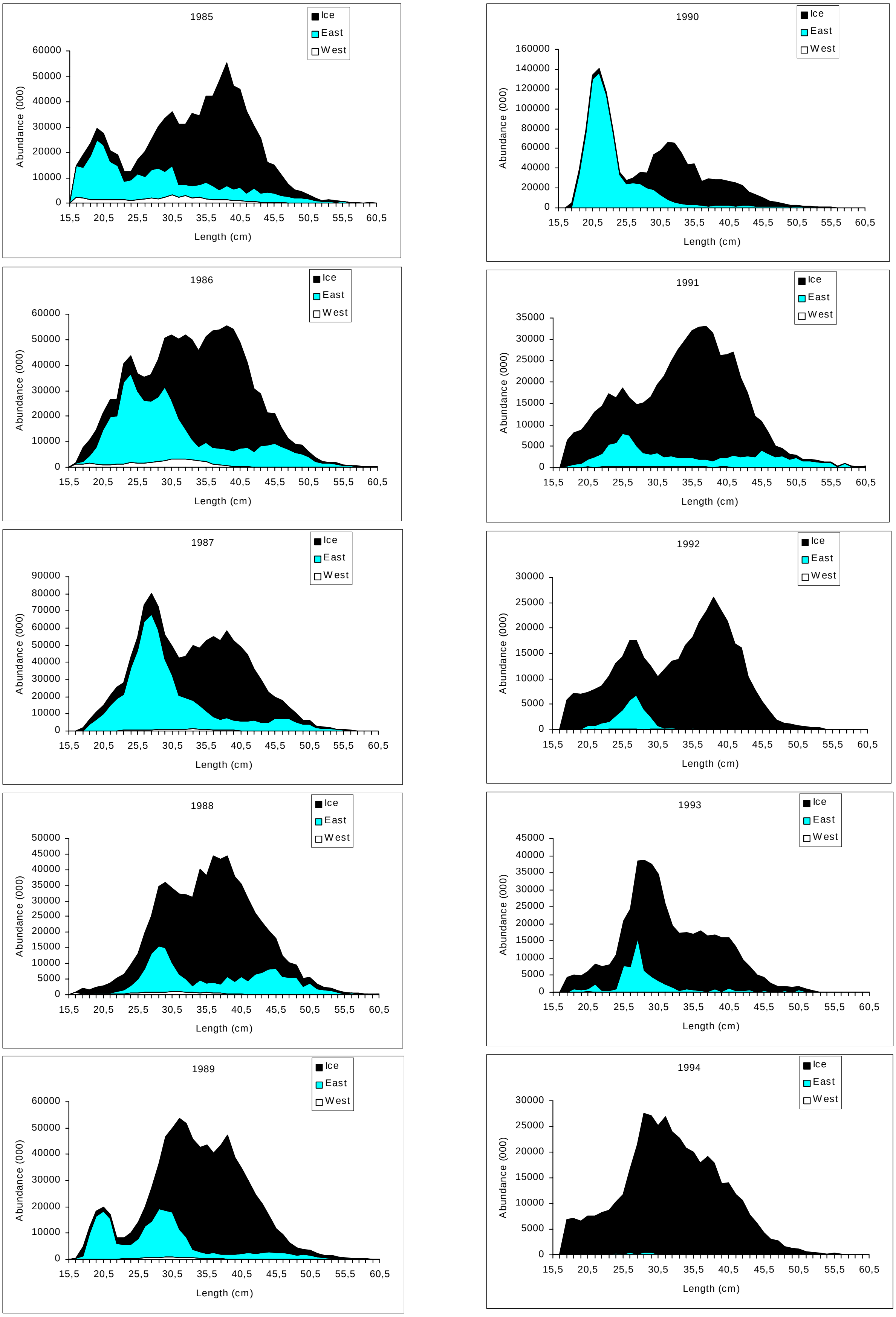


Figure 8.2.10 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1985-1994.

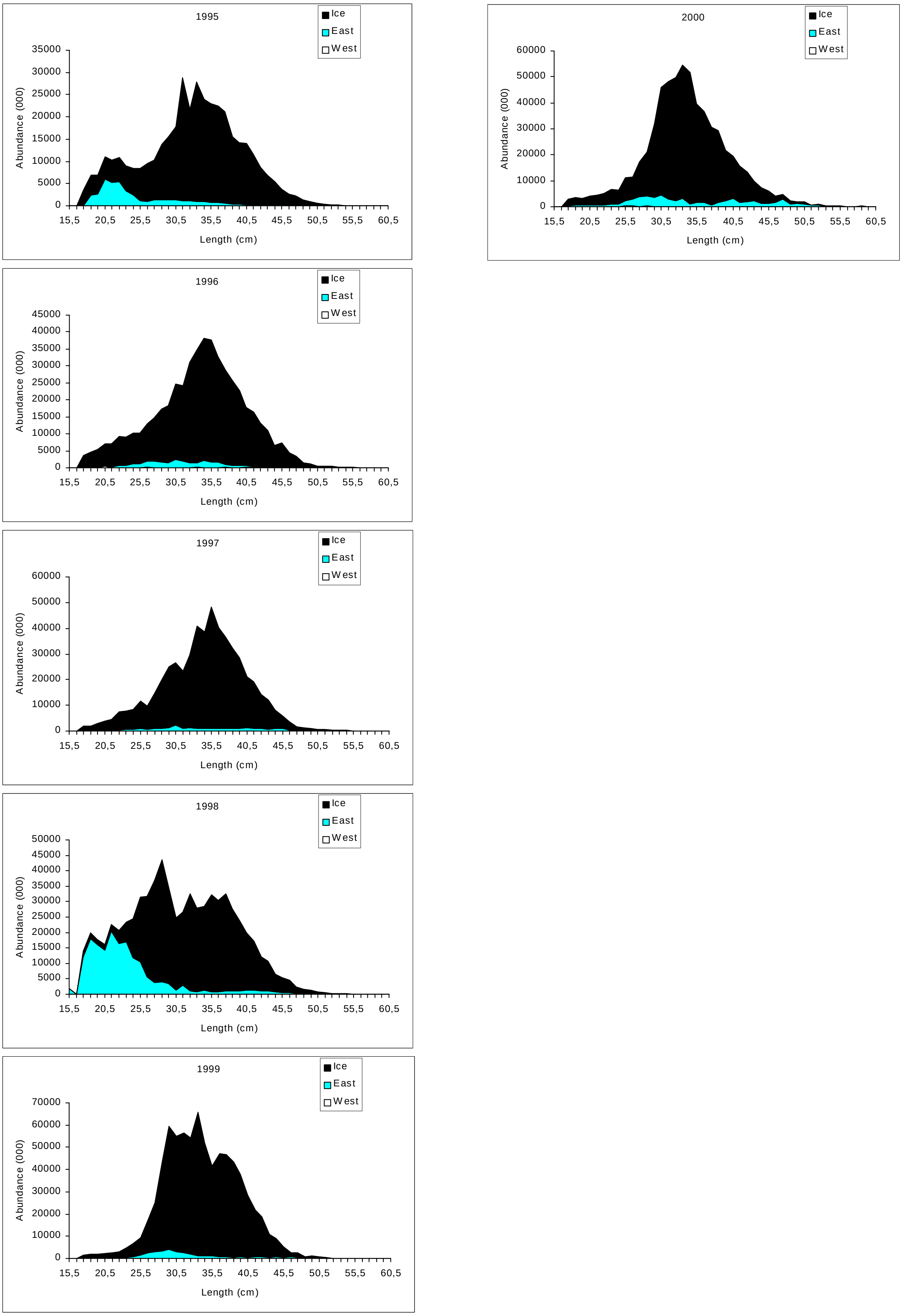


Figure 8.2.11 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1995-2000.

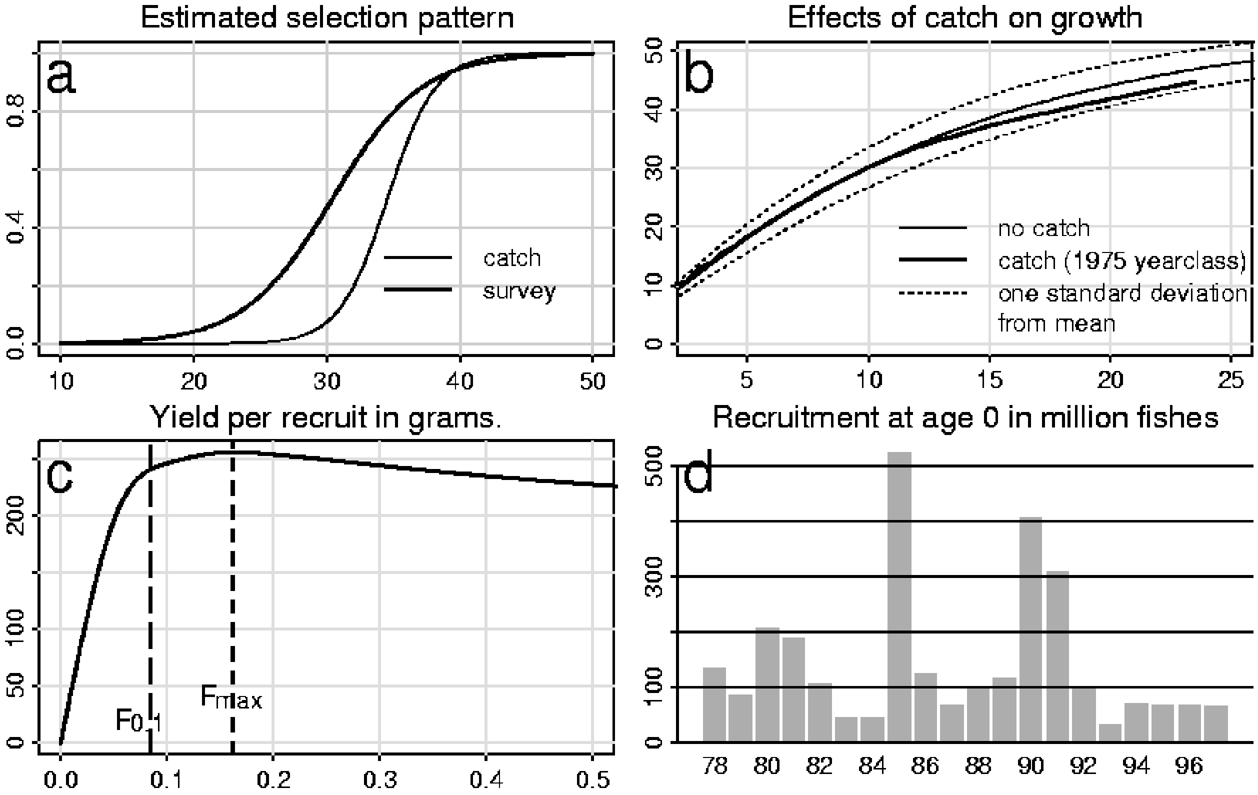


Figure 8.5.1 Results out of the BORMICON model, using catch data from ICES Division Va only. a) estimated selection pattern of the commercial fleet and the survey, b) Mean length (the figure also demonstrates the effect of catch on length at age), c) Yield per recruit and c) estimated recruitment at age 0.

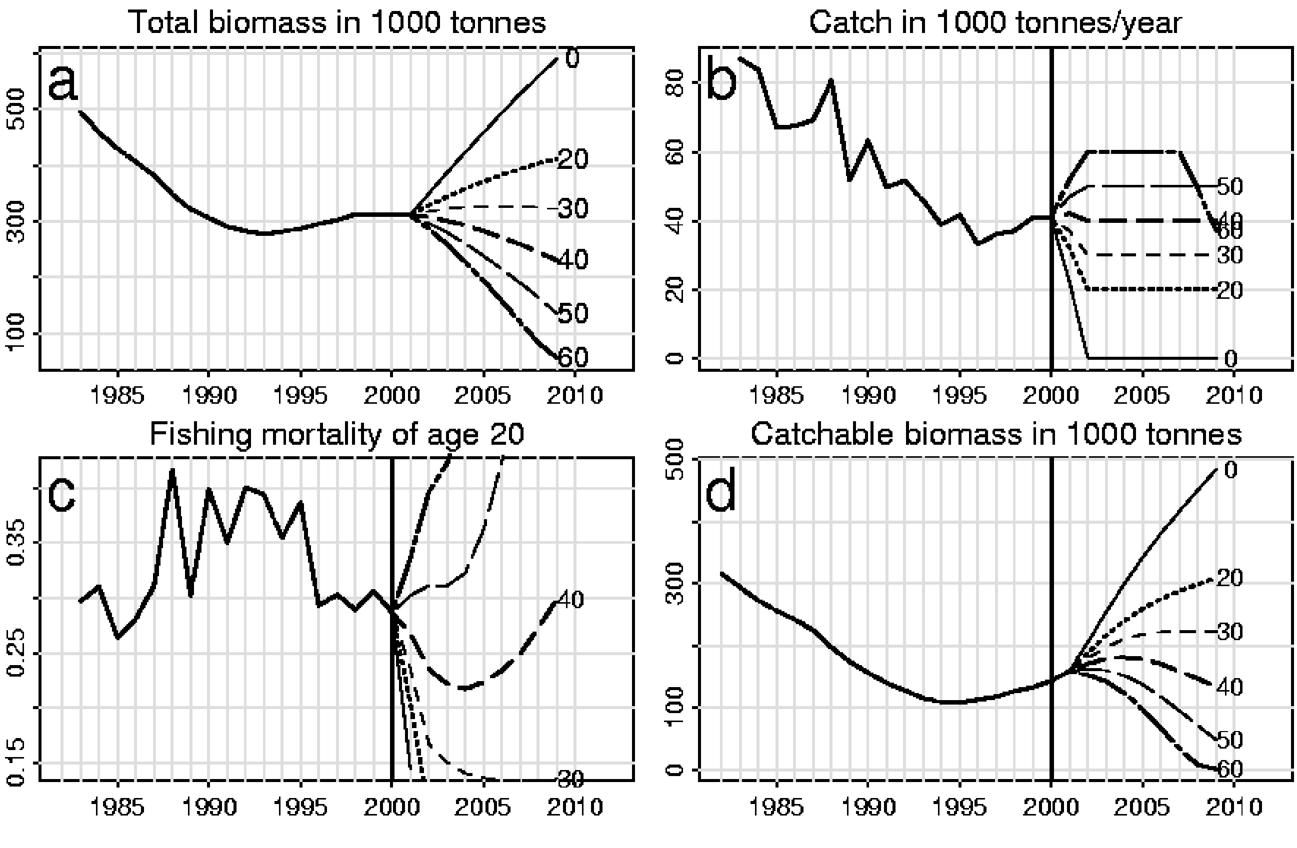


Figure 8.5.2 Results from run using only the catch in ICES Division Va. The figures show the development of biomass and F, using different catch options (0-60°000 t)

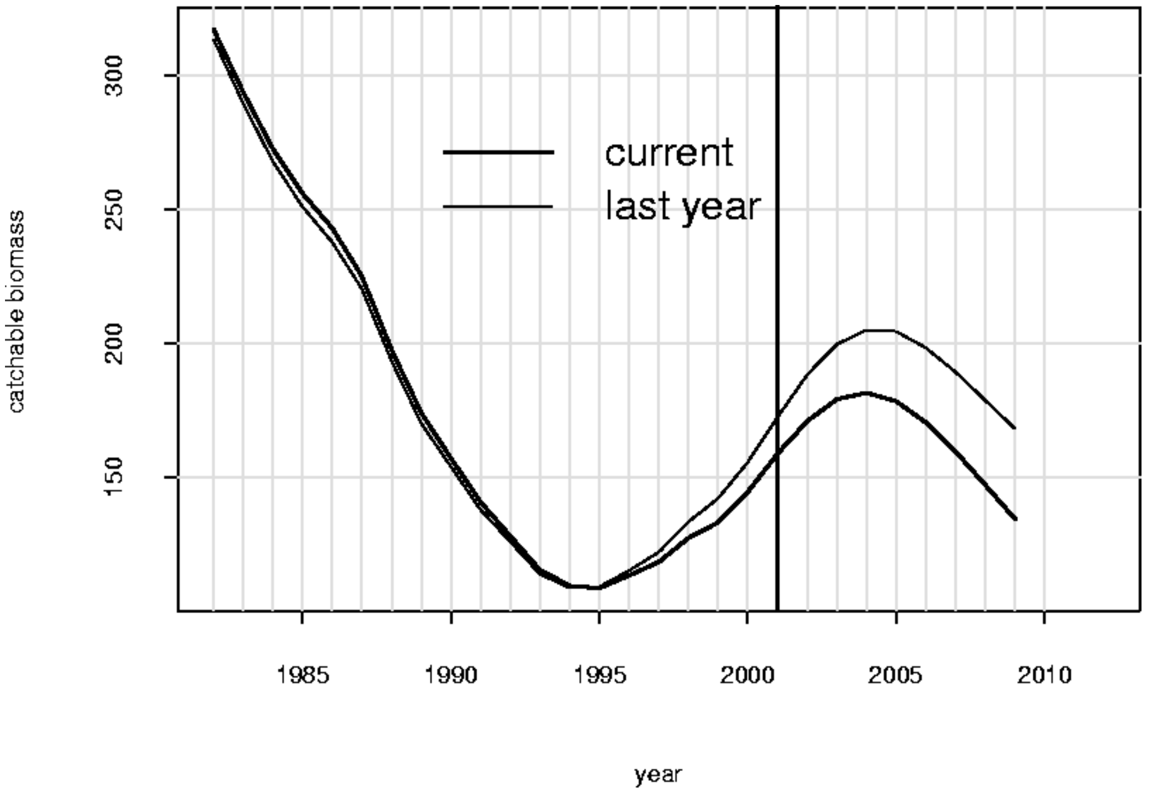


Figure 8.5.3 Comparison of catchable biomas using the data obtained now and last year, for same settings. Results are obtained using only the catch history from in ICES division Va.

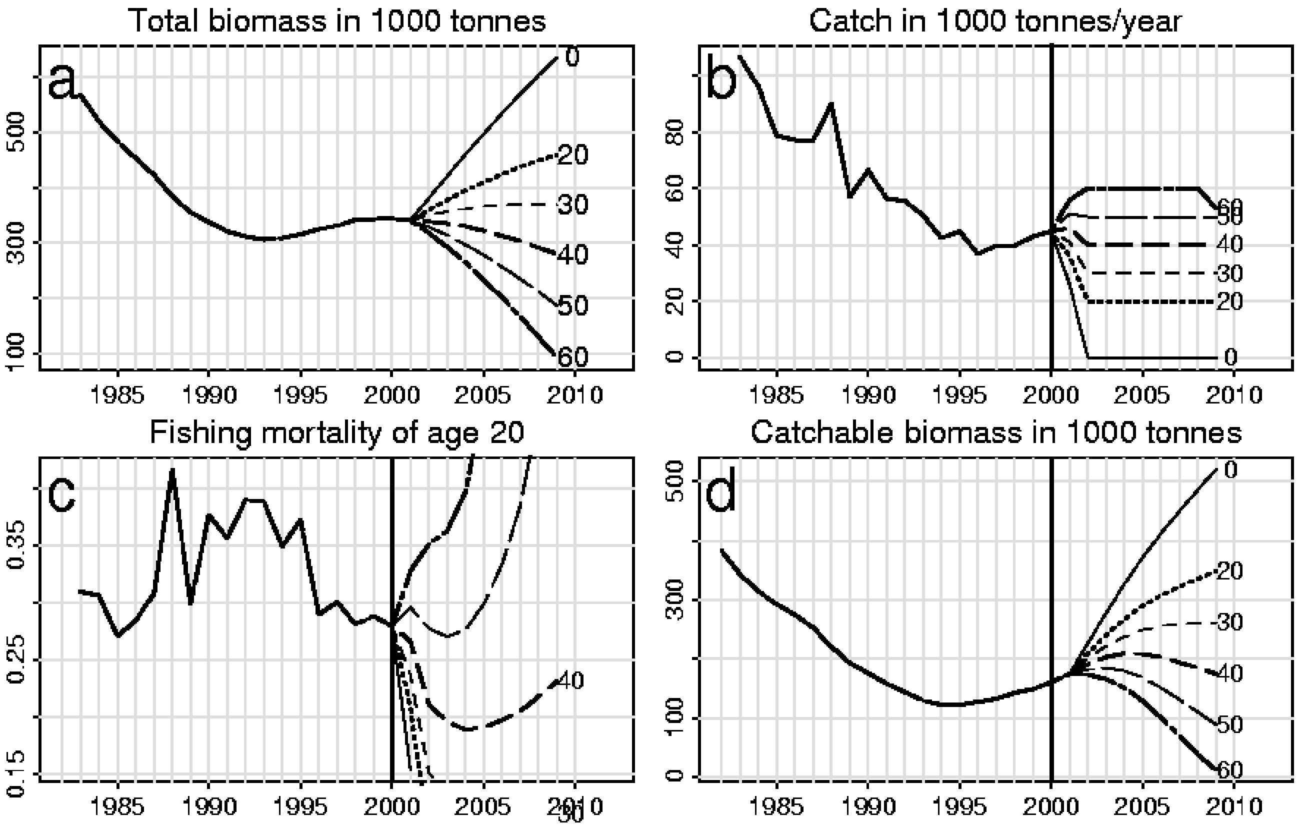


Figure 8.5.4 Results from run using catch from the whole stock. The figures shows the development of the catchable biomass for different catch options (from 0-60 thous. tonnes).

9 DEEP-SEA *S. MENTELLA* ON THE CONTINENTAL SHELF

Traditionally, the *S. mentella* on the shelves and banks around the Faroe Islands, Iceland and at East Greenland have been treated as one stock unit, with a common area of larval extrusion to the SW of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters at East Greenland, and feeding and copulation areas on the shelves and banks around Faroe Islands, Iceland and at East Greenland. In Faroese waters spawning has been observed in some years to the south and west of the islands, implying that there could be a local component in the area; no nursery areas have, however, been found so far (Reinert, 1990). A relationship to other ICES areas (II and IV) has also been suggested (Reinert *et al.*, 1992; Reinert and Lastein, 1992). The question of a possible relationship between the deep-sea *S. mentella* on the shelf in Sub-areas V and XIV and the pelagic deep-sea *S.mentella* in the Irminger Sea has been raised several times. The ICES Working Group on the Application of Genetics in Fisheries and Mariculture (WGAGFM) states that the presence of significant genetic differences between these two deep-sea components probably indicates distinct genetic stocks (ICES 1999). The NWWG therefore continues treating the deep-sea *S. mentella* on the shelf as a separate self-contained stock unit. For management purposes the Icelandic authorities separate the deep-sea *S. mentella* on the shelf (some of which are caught in pelagic trawls) from the pelagic *S. mentella* in the Irminger Sea (both oceanic and pelagic deep-sea type) by straight lines through three positions (Figure 9.1.1).

9.1 Landings and Trends in the Fisheries

The total annual landings of deep-sea *S. mentella* from Divisions Va and Vb and Sub-areas VI and XIV varied considerably in the 1980s mainly in the range 30 000 to 60 000 t. In 1990, the landings were 44 000 t, and reached 67 000 t in 1991, decreased slightly in 1992 (63 000 t) but increased to about 83 000 t in 1994. Since then the landings decreased to approximately 35 000 t in 1999, and in 2000 the landings were 38 000 t (Table 9.1.1).

From Division Va, total landings in 2000 were 31 000 t. about 2 000 t increase from 1999, which was the lowest recorded since 1988. In general, the landings have been decreasing from the record high in 1994 of 57 000 t. In the 1980s landings varied from 10 000-40 000 t. From 1990 to 1994 the landings doubled from 28 000 t to 57 000 t. This increase in the catch coincides with the introduction of large pelagic trawls used by a part of the Icelandic fleet during the autumn and early winter months. This fishery has now decreased to 845 t, which is less than 10% of the 1994 landings. About 95% of the total deep- sea *S .mentella* landings in area Va in 2000 have been taken by bottom trawlers (both fresh fish and freezer trawlers). Length distributions measured by the Icelandic observers in 1989 -2000 are shown in Figure 9.1.2 for the bottom trawl fishery and in Figure 9.1.3 for the pelagic fishery since 1994. An increase in the number of small fish have been shown in recent years, and from the length distributions peak of about 32 cm in 1994 can been followed by a peak at 34, 35, 36 and 37 cm in 1996-2000. Length distributions from the pelagic fishery show decrease in the mean length in 2000, with a peak of about 39 cm. In Division Va the proportion of redfish below 33 cm in the catches exceeds 20% in numbers, the fishing area is closed then.

In Division Vb annual landings of deep-sea *S. mentella* varied from 5 000–8 000 t until 1984. Then landings increased rapidly to about 15 000 t in 1986. The landings declined again to 9 000 t in 1990. They increased to about 13 000 t 1991. Since then they remained very low until 2000 as it increased to 8 000 t, mainly due to Russian catches of more than 2 500 t, which were reported to Faroese authorities (Table 9.1.1). Length distributions of the Faroes catches from Division Vb in 1998-2000 are given in Figure 9.1.5.

In Sub-area VI the annual landings were highest in 1980 (1 100 t), but have varied from 130 - 880 t during recent years, except for 1996 when the landings were about 1 050 t, the highest recorded in the series since 1980 (Table 9.1.1).

In Sub-area XIV, annual landings have varied considerably. In the beginning of the 1980s, the landings were between 10 000-15 000 t, but then decreased to 6 000 t in 1987-1992 and increased to 19 000 t in 1994. At that time the fleet was mainly fishing very small redfish. Since then there was a decrease to only 200 t in 1997, which was a bycatch in the shrimp fishery. In 1998, Germany started again a directed fishery on the juveniles (Figure 9.1.6) with a total catch of about 1 400 t. This fishery has continued and the total landing in 2000 was about 1000 t, and the effort was similar as in 1998-1999.

The 2000 biological sampling from catch and landings of deep-sea *S. mentella* from the continental shelf in each Division and by gear type is shown in the text table below.

Area	Gear	Landings	Nos. samples	Nos. fish measured
Va	Pelagic trawl	844	37	7 995
Va	Bottom trawl	29852	164	33950
Vb	Bottom trawl	5294	20	2195
XIVb	Bottom trawl	804	21	607

9.2 Assessment

9.2.1 Trends in CPUE and survey indices

CPUE of the Icelandic trawler fleet for deep-sea *S. mentella* in Division Va is based on bottom trawl tows taken below 500 m depth and where the total catches of redfish compose a certain percentage of the total catch in each tow (10, 50 and 90%). Data prior to 1986 are poor. In the period from 1986 -1989 CPUE was rather stable. From 1989 to 1993 CPUE declined by about 45% (see text table below and Figure 9.2.1), and it has remained rather low since then although it has started to increase again in 1999-2000. The 2000 value showed a slight increase from 656 kg/h to 672 kg/h. Indices of CPUE for the Icelandic trawl fleet for the period 1986-2000 are also estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effects. All hauls with redfish at depths deeper than 500 m, exceeding 50% of the total catch were included in the CPUE estimation (Figure 9.2.1.b). The results of the GLIM model show a similar trend of unstandardised CPUE, i.e. a relatively stable situation between 1986-1991, a sharp decline from there until 1995 and thereafter a stable, very low level until 1998. The GLIM model shows thereafter an increase both in 1999 and 2000, and the 2000 value is now about 70% of the 1986 value.

Year	CPUE 50% glim	CPUE 10% raw	Total landings	Effort (Glim/raw)
1986	1000	943	18,898	19 / 20
1987	1065	974	19,293	18 / 20
1988	955	877	14,290	15 / 16
1989	926	974	40,269	43 / 41
1990	978	804	28,429	29 / 35
1991	960	770	47,651	50 / 62
1992	753	611	43,414	58 / 71
1993	677	548	51,221	76 / 94
1994	611	488	56,720	93 / 116
1995	635	514	48,708	77 / 95
1996	621	489	34,741	56 / 71
1997	654	564	37,876	58 / 67
1998	530	545	33,125	63 / 61
1999	646	619	28,590	44 / 46
2000	697	634	30,696	44 / 48

The effort in Division Va in the time when the stock was considered in stable condition i.e., from 1986 -1990 was 20°000-40 000 hours. During the period since 1986, the effort increased drastically until 1994. Since then, the effort has decreased by less than 10% each year on average (the advice of ICES has been a 25% reduction annually since 1995). The effort in 2000 is about 40% of the peak in 1994.

Icelandic groundfish survey in Division Va only covers depths down to approximately 500 m and there seem not to be any nursery grounds of major importance in Division Va, these results add little to the current stock evaluation. A recently started deep-water survey (approx. 500-1200 m) around Iceland in autumn may, however, add valuable information about the fishable stock of deep-sea *S. mentella* in near future.

In Division Vb a CPUE-series (1985–1997) of deep-sea *S. mentella* was presented in the 1997 Working Group report. The series shows a decrease since 1993, which seems to have stabilized below 50% of the maximum in the time series. The continuation of the series (Figure 9.2.1b) shows a slow increase in the CPUE since 1996. It should however be noted that the series are not completely comparable as they are calculated differently.

In Division XIV all redfish catches in the period 1982-1997 was as a bycatch. Since 1998, there was a directed fishery for redfish along the continental slope of East Greenland where *S. mentella* was the targeted species. The effort was similar in both years, and the CPUE in 1998 was about 638 kg/h, decreased to 352 kg/h in 1999 and has increased again in 2000 to 433 kg/h.

Survey abundance and biomass estimates and accompanied confidence intervals for deep sea *S. mentella* (≥17 cm) are presented in Figures 9.2.2-9.2.3, broken down by stratum, West and East Greenland, Iceland and aggregated to total. The trends in stock size in numbers and weight are illustrated in Figures 9.2.4-9.2.5. The abundance and biomass figures are clearly dominated by the occurrences off East Greenland, while there were only negligible parts distributed off West Greenland and Iceland at depths of 0-400 m. It can be derived from those figures that the surveys do cover only the immature part of the stock (recruits) since the figures also are dominated by a single strong year class recorded in 1989 for the first time at a mean length of 20 cm (Figure 9.2.4). This cohort grew about 2 cm a year and recruited to the survey gear until 1997 (Figure 9.2.5) when it reached its maximum abundance and biomass at a length of about 27 cm (total abundance 7 billion and biomass 1.5 million tons). During the following two years, this year class seems to have left the surveyed area. Most recently, there are indications of further recruiting yearclasses which seem, however, to be significantly less abundant.

9.2.2 Production model

The group tried the ASPIC (Prager 1992) stock production model for the stock. The model requires catch data and corresponding effort or CPUE data that are reasonable indices of the stock biomass. Corresponding catch and effort data is available for Division Va (Figure 9.2.6) using the GLIM CPUE index from the Icelandic trawl fishery from 1985 onwards and the total catches in Divisions V, VI and XIVb during the same period.

ASPIC requires starting guesses for *r*, the intrinsic rate of increase, MSY, B1/$\mathbf{B}_{MSY}$ ratio and *q*, catchability coefficients. Initially ASPIC was run with different starting guesses of these parameters to explore stability of parameter estimation. For an appropriate range of input values, ASPIC responds were stable for the changes that were tried.

The program was run with the time-series from 1985-2000 including Icelandic trawler CPUE's. MSY is estimated around 46 000 t for all the options tried and $\mathbf{B}_{MSY}$ around 240 000 t, both for the bootstrapped and the un-bootstrapped runs that were made. Fishing mortality in 2000 is estimated to be about 20% below $\mathbf{F}_{MSY}$ and biomass only 5% below $\mathbf{B}_{MSY}$. The outcome of the model is given in Table 9.2.1. Observed and estimated CPUE index and the state of the stock in relation to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$ is given there as a plot, and state of the stock in relation to $\mathbf{F}_{MSY}$ and $\mathbf{B}_{MSY}$ is given in the last plot shown in the output. According to the model, the biomass is increasing after having reached a record low in 1995 and is in 2000 about $\mathbf{B}_{MSY}$. F was in the beginning of the low, then increased from 1991 to 1997 from being 10% higher than $\mathbf{F}_{MSY}$ in 1991-1992 to be close to 80% higher in 1994. Since 1997 the F´s have been reducing and in the last 2 years, they are estimated to be around $\mathbf{F}_{pa}$ (2/3 of the $\mathbf{F}_{MSY}$ value).

9.2.3 State of the stock

All CPUE indices show a drastic reduction from highs in the late 80s, but indices indicate that the stock seems to have started a slow recovery in the 90s from being close to 50% of the maximum in 1994-1996. The GLIM index indicates that after a reduction down to about 65% of the maximum in 1994, the stock was relatively stable but low during the last years, with a slow increase since 1994. Fishermen have reported of less *S. mentella* in the fishing areas Southwest and West of Iceland during recent years, and the increase in the fishable biomass seems to be related to recruiting fish. There are indications that recruitment to the fishable stock (in Division Va) comes 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 stabilized at or below 50% of the maximum in the time series (1985–1997), and the new CPUE series indicate no trend since 1997.

Based on survey results the SSB of deep-sea *S. mentella* on the continental shelf in area XIV remains severely depleted. The strong recruiting cohort(s) observed in 1993-97 emigrated in 1998-2000 and have seemingly recruited both to the pelagic redfish stock and the stock at the shelf.

The ASPIC stock production model used also show the same decrease in the period from 1985-1996, but indicate that the stock might have started to recover from the low. The fishing mortality estimated from the model indicate that the F's have decreased considerably since 1993 and are now about 0.15, which is slightly higher than the estimated $\mathbf{F}_{pa}$ of 0.13.

9.3 Catch projections

It is possible to compute effort as well as a TAC corresponding to different reductions in effort for deep-sea *S. mentella* by using a similar method as described for *S. marinus*, although for the deep-sea *S. mentella*, the survey index is replaced by CPUE index. The management advice given in the recent years was to reduce the effort by 25 % until the stock displays indications of an increase in adult biomass from the present low level. That would lead to a catch of 23 000 t in Va in 2002.

The ASPIC production model allows trajectories of population biomass and fishing mortality based on bootstrap estimates. Trajectories were performed for three different options, all assuming a catch in 2001 at 37,000 t: 1) F(2002-10)=2/3$\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$, 2) F(2002-10)=20 000 and 3) Catch(2001-2010)=50,000 t. Plots of B-ratios (B/$\mathbf{B}_{MSY}$) along with biomass trajectory is given in Figures 9.3.1-9.3.3. Fishing at $\mathbf{F}_{pa}$ will keep the stock well above $\mathbf{B}_{MSY}$ within the next years while fishing at 50000 t, the biomass within the time period has a risk of not reaching $\mathbf{B}_{MSY}$ in the medium term.

The ASPIC model results shows that catching at $\mathbf{F}_{pa}$ (2/3$\mathbf{F}_{MSY}$) would result in a total catch of 35 000 t in 2002. Those catches apply for the whole distribution area.

9.4 Biological reference points

The relative state of the stock can be assessed through survey and CPUE index series (U) from the commercial fishery, which imply a maximum, U_{max}, as well as the present state. Given these data, it has been proposed by ACFM that reference points be defined in terms of the current state with respect to $U_{lim} = U_{max}/5$ and $U_{pa} = U_{max}/2$. Based on these definitions, the stock could be considered close to or below U_{pa}.

The working group considers it appropriate to define $\mathbf{F}_{pa}$ as 2/3 of $\mathbf{F}_{MSY}$ estimated from the ASPIC stock-production, which is in accordance with suggestions made by SGPAFM 1998. 2/3 of $\mathbf{F}_{MSY}$ is considered a proxy for 75% probability avoidance.

9.5 Management considerations

The two types of pelagic redfish in the Irminger Sea (i.e., the oceanic and the pelagic deep-sea *S. mentell*a) in the present context are treated separately from the deep-sea *S. mentella* on the continental shelf. It can, however, not be excluded that there may be a relationship between the demersal deep-sea *S. mentella* on the continental shelves of the Faroe Islands, Iceland, Greenland and the pelagic deep-sea *S. mentella* in the Irminger Sea and this should be considered in the management of this stock (see also chapter 7.5).

The management strategy to reduce the effort in Division Va has resulted in an increase in the catchable biomass since 1995, according the data from the fishery. The results out of the production model used now also confirm this reduction in the fishing mortality and an increase in the fishable biomass. The WG recommends to keep the effort low and that the fishing mortality be kept no higher than $\mathbf{F}_{pa}$. That could correspond to a catch of no more than 35 000 tonnes in the whole distribution area in 2002.

In Sub-area XIV the Working Group recommends maximum protection of the juveniles and **no directed** fishery in order to maximise the probability of stock recovery to safe biological limits.

Table 9.1.1 Deep-sea *S. mentella* on the continental shelf. Landings (in tonnes) by area used by the Working Group.

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	540	0	819	55,737
1996	34,741	5,337	1,048	0	730	41,856
1997	37,876	4,558	418	0	199	43,050
1998	33,125	4,089	298	3	1,376	38,890
1999	28,590	5,294	243	0	865	34,992
2000	30,696	4,893	885	0	994	37,468

Table 9.2.1 Results of the ASPIC fit procedure for shelf *S. mentella*

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                                                                                          29 Apr 2001 at 19:42.57
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:                        16          Number of bootstrap trials:                             0
Number of data series:                            1          Lower bound on MSY:                             5.000E+03
Objective function computed:              in effort          Upper bound on MSY:                             1.000E+09
Relative conv. criterion (simplex):       1.000E-08          Lower bound on r:                               1.000E-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
------------------------------------------------------------------------------------------------------------------------
                                                     Weighted              Weighted       Current     Suggested    R-squared
Loss component number and title                           SSE     N            MSE         weight        weight      in CPUE

Loss(-1)  SSE in yield                              0.000E+00
Loss( 0)  Penalty for B1R > 2                       0.000E+00     1            N/A      1.000E-01          N/A
Loss( 1)  ICE CPUE indices                          8.410E-02    16      6.007E-03      1.000E+00     1.000E+00        0.899
TOTAL OBJECTIVE FUNCTION:                      8.41037856E-02

Number of restarts required for convergence:                6
Est. B-ratio coverage index (0 worst, 2 best):         0.7160               < 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 1985         1.618E+00          1.000E+00            1            1
MSY       Maximum sustainable yield                 4.664E+04          3.000E+04            1            1
r         Intrinsic rate of increase                3.897E-01          5.000E-02            1            1
........  Catchability coefficients by fishery:
q( 1)     ICE CPUE indices                          2.794E-03          1.000E-04            1            1


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

MSY       Maximum sustainable yield                 4.664E+04               Kr/4
K         Maximum stock biomass                     4.787E+05
BMSY      Stock biomass at MSY                     2.394E+05                K/2
FMSY      Fishing mortality at MSY                 1.948E-01                r/2

F(0.1)    Management benchmark                      1.754E-01            0.9*FMSY
Y(0.1)    Equilibrium yield at F(0.1)               4.617E+04            0.99*MSY

B-ratio   Ratio of B(2001) to BMSY                 1.053E+00
F-ratio   Ratio of F(2000) to FMSY                 7.768E-01
F01-mult  Ratio of F(0.1) to F(2000)                1.159E+00
Y-ratio   Proportion of MSY avail in 2001           9.972E-01          2*Br-Br^2     Ye(2001) = 4.651E+04

........  Fishing effort at MSY in units of each fishery:
FMSY( 1)  ICE CPUE indices                         6.974E+01          r/2q( 1)       f(0.1) = 6.277E+01
```

Table 9.2.1, cont.

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	0.118	3.872E+05	3.797E+05	4.495E+04	4.495E+04	3.060E+04	6.077E-01	1.618E+00
2	1986	0.127	3.729E+05	3.661E+05	4.645E+04	4.645E+04	3.355E+04	6.513E-01	1.558E+00
3	1987	0.105	3.600E+05	3.587E+05	3.757E+04	3.757E+04	3.505E+04	5.377E-01	1.504E+00
4	1988	0.087	3.575E+05	3.593E+05	3.143E+04	3.143E+04	3.492E+04	4.490E-01	1.493E+00
5	1989	0.153	3.610E+05	3.517E+05	5.391E+04	5.391E+04	3.634E+04	7.867E-01	1.508E+00
6	1990	0.130	3.434E+05	3.403E+05	4.420E+04	4.420E+04	3.834E+04	6.667E-01	1.435E+00
7	1991	0.210	3.375E+05	3.232E+05	6.788E+04	6.788E+04	4.086E+04	1.078E+00	1.410E+00
8	1992	0.210	3.105E+05	3.002E+05	6.310E+04	6.310E+04	4.359E+04	1.079E+00	1.297E+00
9	1993	0.269	2.910E+05	2.759E+05	7.420E+04	7.420E+04	4.550E+04	1.380E+00	1.216E+00
10	1994	0.344	2.623E+05	2.427E+05	8.357E+04	8.357E+04	4.653E+04	1.767E+00	1.096E+00
11	1995	0.253	2.253E+05	2.204E+05	5.574E+04	5.574E+04	4.634E+04	1.298E+00	9.411E-01
12	1996	0.192	2.159E+05	2.181E+05	4.186E+04	4.186E+04	4.627E+04	9.848E-01	9.019E-01
13	1997	0.194	2.203E+05	2.220E+05	4.305E+04	4.305E+04	4.639E+04	9.953E-01	9.203E-01
14	1998	0.171	2.236E+05	2.275E+05	3.889E+04	3.889E+04	4.652E+04	8.772E-01	9.343E-01
15	1999	0.148	2.313E+05	2.372E+05	3.499E+04	3.499E+04	4.662E+04	7.571E-01	9.661E-01
16	2000	0.151	2.429E+05	2.476E+05	3.747E+04	3.747E+04	4.658E+04	7.768E-01	1.015E+00
17	2001		2.520E+05						1.053E+00

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

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

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1985	1.000E+03	1.061E+03	0.1184	4.495E+04	4.495E+04	0.05892	0.000E+00
2	1986	1.032E+03	1.023E+03	0.1269	4.645E+04	4.645E+04	-0.00898	0.000E+00
3	1987	1.100E+03	1.002E+03	0.1048	3.757E+04	3.757E+04	-0.09327	0.000E+00
4	1988	9.860E+02	1.004E+03	0.0875	3.143E+04	3.143E+04	0.01789	0.000E+00
5	1989	9.560E+02	9.825E+02	0.1533	5.391E+04	5.391E+04	0.02739	0.000E+00
6	1990	1.010E+03	9.508E+02	0.1299	4.420E+04	4.420E+04	-0.06042	0.000E+00
7	1991	9.910E+02	9.031E+02	0.2100	6.788E+04	6.788E+04	-0.09291	0.000E+00
8	1992	7.770E+02	8.388E+02	0.2102	6.310E+04	6.310E+04	0.07658	0.000E+00
9	1993	6.990E+02	7.707E+02	0.2690	7.420E+04	7.420E+04	0.09766	0.000E+00
10	1994	6.310E+02	6.781E+02	0.3443	8.357E+04	8.357E+04	0.07194	0.000E+00
11	1995	6.550E+02	6.157E+02	0.2529	5.574E+04	5.574E+04	-0.06180	0.000E+00
12	1996	6.420E+02	6.094E+02	0.1919	4.186E+04	4.186E+04	-0.05207	0.000E+00
13	1997	6.750E+02	6.202E+02	0.1939	4.305E+04	4.305E+04	-0.08463	0.000E+00
14	1998	5.470E+02	6.357E+02	0.1709	3.889E+04	3.889E+04	0.15025	0.000E+00
15	1999	6.670E+02	6.627E+02	0.1475	3.499E+04	3.499E+04	-0.00644	0.000E+00
16	2000	7.200E+02	6.916E+02	0.1513	3.747E+04	3.747E+04	-0.04017	0.000E+00

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     0.0589                                             |==
1986    -0.0090                                             |
1987    -0.0933                                         ====|
1988     0.0179                                             |=
1989     0.0274                                             |=
1990    -0.0604                                           ==|
1991    -0.0929                                         ====|
1992     0.0766                                             |===
1993     0.0977                                             |====
1994     0.0719                                             |===
1995    -0.0618                                           ==|
1996    -0.0521                                           ==|
1997    -0.0846                                          ===|
1998     0.1503                                             |======
1999    -0.0064                                             |
2000    -0.0402                                           ==|
                   ------------------------------------------------------------------------------------
```

Table 9.3 Bootstrap results from the ASPIC model for shelf *S. mentella*.

```
SMEN cpue 85 to 00                                                                                  Page 1
                                                                                    29 Apr 2001 at 13:45.25
ASPIC -- A Surplus-Production Model Including Covariates (Ver. 3.82)                              BOT 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:                        16           Number of bootstrap trials:                      1000
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:                           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
------------------------------------------------------------------------------------------------------------------------
                                                    Weighted            Weighted      Current    Suggested    R-squared
Loss component number and title                          SSE     N           MSE       weight       weight      in CPUE

Loss(-1)  SSE in yield                             0.000E+00
Loss( 0)  Penalty for B1R > 2                      0.000E+00    1            N/A    1.000E-01          N/A
Loss( 1)  ICE CPUE indices                         8.410E-02   16      6.007E-03    1.000E+00    1.000E+00        0.899
TOTAL OBJECTIVE FUNCTION:                     8.41037857E-02

Number of restarts required for convergence:               3
Est. B-ratio coverage index (0 worst, 2 best):        0.7160             < 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 1985        1.618E+00          1.000E+00            1            1
MSY       Maximum sustainable yield                4.664E+04          1.000E+06            1            1
r         Intrinsic rate of increase               3.897E-01          8.000E-01            1            1
........  Catchability coefficients by fishery:
q( 1)     ICE CPUE indices                         2.794E-03          1.000E-02            1            1


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

MSY       Maximum sustainable yield                4.664E+04               Kr/4
K         Maximum stock biomass                    4.787E+05
BMSY     Stock biomass at MSY                     2.394E+05                K/2
FMSY     Fishing mortality at MSY                 1.948E-01                r/2

F(0.1)    Management benchmark                     1.754E-01           0.9*FMSY
Y(0.1)    Equilibrium yield at F(0.1)              4.617E+04           0.99*MSY

B-ratio   Ratio of B(2001) to BMSY               1.053E+00
F-ratio   Ratio of F(2000) to FMSY               7.767E-01
F01-mult  Ratio of F(0.1) to F(2000)               1.159E+00
Y-ratio   Proportion of MSY avail in 2001          9.972E-01          2*Br-Br^2     Ye(2001) = 4.651E+04

........  Fishing effort at MSY in units of each fishery:
FMSY( 1)  ICE CPUE indices                        6.974E+01          r/2q( 1)       f(0.1) = 6.277E+01
```

Table 9.3 cont.

SMEN cpue 85 to 00 Page 2

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	0.118	3.873E+05	3.797E+05	4.495E+04	4.495E+04	3.060E+04	6.076E-01	1.618E+00
2	1986	0.127	3.729E+05	3.661E+05	4.645E+04	4.645E+04	3.355E+04	6.512E-01	1.558E+00
3	1987	0.105	3.600E+05	3.587E+05	3.757E+04	3.757E+04	3.505E+04	5.376E-01	1.504E+00
4	1988	0.087	3.575E+05	3.593E+05	3.143E+04	3.143E+04	3.492E+04	4.490E-01	1.493E+00
5	1989	0.153	3.610E+05	3.517E+05	5.391E+04	5.391E+04	3.634E+04	7.866E-01	1.508E+00
6	1990	0.130	3.434E+05	3.403E+05	4.420E+04	4.420E+04	3.834E+04	6.666E-01	1.435E+00
7	1991	0.210	3.375E+05	3.232E+05	6.788E+04	6.788E+04	4.086E+04	1.078E+00	1.410E+00
8	1992	0.210	3.105E+05	3.003E+05	6.310E+04	6.310E+04	4.359E+04	1.079E+00	1.297E+00
9	1993	0.269	2.910E+05	2.759E+05	7.420E+04	7.420E+04	4.550E+04	1.380E+00	1.216E+00
10	1994	0.344	2.623E+05	2.427E+05	8.357E+04	8.357E+04	4.653E+04	1.767E+00	1.096E+00
11	1995	0.253	2.253E+05	2.204E+05	5.574E+04	5.574E+04	4.634E+04	1.298E+00	9.412E-01
12	1996	0.192	2.159E+05	2.181E+05	4.186E+04	4.186E+04	4.627E+04	9.848E-01	9.019E-01
13	1997	0.194	2.203E+05	2.220E+05	4.305E+04	4.305E+04	4.639E+04	9.952E-01	9.203E-01
14	1998	0.171	2.236E+05	2.275E+05	3.889E+04	3.889E+04	4.652E+04	8.772E-01	9.343E-01
15	1999	0.148	2.313E+05	2.372E+05	3.499E+04	3.499E+04	4.662E+04	7.571E-01	9.662E-01
16	2000	0.151	2.429E+05	2.476E+05	3.747E+04	3.747E+04	4.658E+04	7.767E-01	1.015E+00
17	2001		2.520E+05						1.053E+00

SMEN cpue 85 to 00 Page 3

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

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

Obs	Year	Observed CPUE	Estimated CPUE	Estim F	Observed yield	Model yield	Resid in log scale	Resid in yield
1	1985	1.000E+03	1.061E+03	0.1184	4.495E+04	4.495E+04	0.05892	0.000E+00
2	1986	1.032E+03	1.023E+03	0.1269	4.645E+04	4.645E+04	-0.00898	0.000E+00
3	1987	1.100E+03	1.002E+03	0.1048	3.757E+04	3.757E+04	-0.09327	0.000E+00
4	1988	9.860E+02	1.004E+03	0.0875	3.143E+04	3.143E+04	0.01789	0.000E+00
5	1989	9.560E+02	9.825E+02	0.1533	5.391E+04	5.391E+04	0.02738	0.000E+00
6	1990	1.010E+03	9.508E+02	0.1299	4.420E+04	4.420E+04	-0.06042	0.000E+00
7	1991	9.910E+02	9.031E+02	0.2100	6.788E+04	6.788E+04	-0.09291	0.000E+00
8	1992	7.770E+02	8.388E+02	0.2102	6.310E+04	6.310E+04	0.07658	0.000E+00
9	1993	6.990E+02	7.707E+02	0.2690	7.420E+04	7.420E+04	0.09766	0.000E+00
10	1994	6.310E+02	6.781E+02	0.3443	8.357E+04	8.357E+04	0.07194	0.000E+00
11	1995	6.550E+02	6.157E+02	0.2529	5.574E+04	5.574E+04	-0.06180	0.000E+00
12	1996	6.420E+02	6.094E+02	0.1919	4.186E+04	4.186E+04	-0.05207	0.000E+00
13	1997	6.750E+02	6.202E+02	0.1939	4.305E+04	4.305E+04	-0.08463	0.000E+00
14	1998	5.470E+02	6.357E+02	0.1709	3.889E+04	3.889E+04	0.15026	0.000E+00
15	1999	6.670E+02	6.627E+02	0.1475	3.499E+04	3.499E+04	-0.00644	0.000E+00
16	2000	7.200E+02	6.916E+02	0.1513	3.747E+04	3.747E+04	-0.04017	0.000E+00

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     0.0589                                             |==
1986    -0.0090                                             |
1987    -0.0933                                         ====|
1988     0.0179                                             |=
1989     0.0274                                             |=
1990    -0.0604                                           ==|
1991    -0.0929                                         ====|
1992     0.0766                                             |===
1993     0.0977                                             |====
1994     0.0719                                             |===
1995    -0.0618                                           ==|
1996    -0.0521                                           ==|
1997    -0.0846                                          ===|
1998     0.1503                                             |======
1999    -0.0064                                             |
2000    -0.0402                                           ==|
                  -----------------------------------------------------------------------------------
```

Table 9.3 cont

SMEN cpue 85 to 00

RESULTS OF BOOTSTRAPPED ANALYSIS

Param name	Bias-corrected estimate	Ordinary estimate	Relative bias	Approx 80% lower CL	Approx 80% upper CL	Approx 50% lower CL	Approx 50% upper CL	Inter-quartile range	Relative IQ range
B1ratio	1.609E+00	1.618E+00	0.52%	1.312E+00	1.940E+00	1.443E+00	1.771E+00	3.282E-01	0.204
K	4.823E+05	4.787E+05	-0.75%	3.829E+05	6.922E+05	4.235E+05	5.773E+05	1.538E+05	0.319
r	3.862E-01	3.897E-01	0.91%	2.461E-01	5.239E-01	3.090E-01	4.620E-01	1.530E-01	0.396
q(1)	2.734E-03	2.794E-03	2.18%	1.826E-03	3.570E-03	2.245E-03	3.197E-03	9.521E-04	0.348
MSY	4.633E+04	4.664E+04	0.65%	4.070E+04	4.987E+04	4.369E+04	4.840E+04	4.711E+03	0.102
Ye(2001)	4.654E+04	4.651E+04	-0.07%	4.112E+04	4.888E+04	4.426E+04	4.803E+04	3.773E+03	0.081
$\mathbf{B}_{MSY}$	2.412E+05	2.394E+05	-0.75%	1.914E+05	3.461E+05	2.118E+05	2.886E+05	7.688E+04	0.319
$\mathbf{F}_{MSY}$	1.931E-01	1.948E-01	0.91%	1.231E-01	2.620E-01	1.545E-01	2.310E-01	7.649E-02	0.396
$\mathbf{F}_{MSY}(1)$	6.985E+01	6.974E+01	-0.16%	5.858E+01	8.101E+01	6.409E+01	7.558E+01	1.149E+01	0.164
F(0.1)	1.738E-01	1.754E-01	0.82%	1.108E-01	2.358E-01	1.391E-01	2.079E-01	6.884E-02	0.396
Y(0.1)	4.587E+04	4.617E+04	0.65%	4.029E+04	4.937E+04	4.325E+04	4.792E+04	4.664E+03	0.102
B-ratio	1.043E+00	1.053E+00	0.90%	8.748E-01	1.193E+00	9.556E-01	1.123E+00	1.675E-01	0.161
F-ratio	7.797E-01	7.767E-01	-0.38%	6.396E-01	9.842E-01	7.000E-01	8.776E-01	1.776E-01	0.228
Y-ratio	1.004E+00	9.972E-01	-0.65%	9.888E-01	1.000E+00	9.965E-01	1.000E+00	3.413E-03	0.003
$\mathbf{F}_{0.1}(1)$	6.287E+01	6.277E+01	-0.15%	5.272E+01	7.291E+01	5.768E+01	6.802E+01	1.034E+01	0.164

NOTES ON BOOTSTRAPPED ESTIMATES

- The bootstrapped results shown were computed from 1000 trials.
- These results are conditional on the constraints placed upon MSY and r in the input file (ASPIC.INP).
- All bootstrapped intervals are approximate. The statistical literature recommends using at least 1000 trials for accurate 95% intervals. The 80% intervals used by ASPIC should require fewer trials for equivalent accuracy. Using at least 500 trials is recommended.
- The bias corrections used here are based on medians. This is an accepted statistical procedure, but may estimate nonzero bias for unbiased, skewed estimators.

Trials replaced for lack of convergence:	0
Trials replaced for MSY out-of-bounds:	0
Trials replaced for r out-of-bounds:	1
Residual-adjustment factor:	1.1547

Table 9.4 Results of the ASPIC model for a fixed F's of F_{pa} (F_{MSY} *2/3).

```
'Project fixed catch'   ## Name of projections
'redfishb.bio'          ## Name of input file
'redfishb.out'          ## Name of output file
0.0d0                   ## Any real number, not used
1                       ## Number of years to scip
10                      ## Number of projection years
3.7d4    'Y'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
0.86d0 'F'
```

REDFISHB.OUT

```
29 Apr 2001 at 14:44.37
SMEN cpue 85 to 00                                                                          Page 1
Project fixed catch                                                           Output from ASPIC-P.EXE
```

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	redfishb.bio
Name of output file (this file)	redfishb.out
Number of years of projections	10

CAUTION: ASPIC-P is designed for SHORT-TERM projections. Projections longer than 5 years are increasingly uncertain.

Year	Input data	User data type
2001	3.700E+04	TAC
2002	8.600E-01	F/F(2000)
2003	8.600E-01	F/F(2000)
2004	8.600E-01	F/F(2000)
2005	8.600E-01	F/F(2000)
2006	8.600E-01	F/F(2000)
2007	8.600E-01	F/F(2000)
2008	8.600E-01	F/F(2000)
2009	8.600E-01	F/F(2000)
2010	8.600E-01	F/F(2000)

TRAJECTORY OF RELATIVE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	1.610E+00	1.618E+00	0.52%	1.312E+00	1.940E+00	1.444E+00	1.773E+00	3.284E-01	0.204
1986	1.554E+00	1.558E+00	0.23%	1.296E+00	1.803E+00	1.411E+00	1.672E+00	2.608E-01	0.168
1987	1.500E+00	1.504E+00	0.24%	1.281E+00	1.702E+00	1.383E+00	1.597E+00	2.136E-01	0.142
1988	1.489E+00	1.493E+00	0.32%	1.293E+00	1.651E+00	1.383E+00	1.568E+00	1.847E-01	0.124
1989	1.500E+00	1.508E+00	0.56%	1.312E+00	1.625E+00	1.404E+00	1.561E+00	1.568E-01	0.105
1990	1.429E+00	1.435E+00	0.37%	1.273E+00	1.542E+00	1.351E+00	1.481E+00	1.304E-01	0.091
1991	1.405E+00	1.410E+00	0.37%	1.260E+00	1.500E+00	1.334E+00	1.449E+00	1.158E-01	0.082
1992	1.297E+00	1.297E+00	0.01%	1.190E+00	1.401E+00	1.243E+00	1.344E+00	1.012E-01	0.078
1993	1.218E+00	1.216E+00	-0.21%	1.121E+00	1.326E+00	1.168E+00	1.267E+00	9.893E-02	0.081
1994	1.103E+00	1.096E+00	-0.66%	1.012E+00	1.237E+00	1.053E+00	1.162E+00	1.090E-01	0.099
1995	9.536E-01	9.412E-01	-1.31%	8.477E-01	1.125E+00	8.994E-01	1.036E+00	1.370E-01	0.144
1996	9.136E-01	9.019E-01	-1.28%	8.004E-01	1.089E+00	8.533E-01	9.972E-01	1.438E-01	0.157
1997	9.286E-01	9.203E-01	-0.89%	8.151E-01	1.089E+00	8.690E-01	1.009E+00	1.401E-01	0.151
1998	9.404E-01	9.343E-01	-0.65%	8.229E-01	1.100E+00	8.787E-01	1.024E+00	1.449E-01	0.154
1999	9.688E-01	9.662E-01	-0.27%	8.334E-01	1.123E+00	9.005E-01	1.047E+00	1.464E-01	0.151
2000	1.010E+00	1.015E+00	0.50%	8.557E-01	1.159E+00	9.300E-01	1.088E+00	1.579E-01	0.156
2001	1.043E+00	1.053E+00	0.90%	8.748E-01	1.193E+00	9.556E-01	1.123E+00	1.675E-01	0.161
2002	1.081E+00	1.092E+00	1.01%	8.985E-01	1.241E+00	9.893E-01	1.169E+00	1.802E-01	0.167
2003	1.130E+00	1.139E+00	0.76%	9.357E-01	1.293E+00	1.033E+00	1.221E+00	1.881E-01	0.166
2004	1.171E+00	1.178E+00	0.61%	9.639E-01	1.333E+00	1.067E+00	1.265E+00	1.976E-01	0.169
2005	1.203E+00	1.210E+00	0.54%	9.951E-01	1.365E+00	1.097E+00	1.298E+00	2.009E-01	0.167
2006	1.229E+00	1.236E+00	0.59%	1.019E+00	1.388E+00	1.119E+00	1.322E+00	2.037E-01	0.166
2007	1.250E+00	1.257E+00	0.54%	1.037E+00	1.404E+00	1.140E+00	1.341E+00	2.009E-01	0.161
2008	1.266E+00	1.273E+00	0.55%	1.052E+00	1.417E+00	1.161E+00	1.356E+00	1.947E-01	0.154
2009	1.281E+00	1.286E+00	0.42%	1.064E+00	1.426E+00	1.176E+00	1.367E+00	1.905E-01	0.149
2010	1.292E+00	1.296E+00	0.34%	1.071E+00	1.431E+00	1.188E+00	1.375E+00	1.867E-01	0.145
2011	1.301E+00	1.304E+00	0.25%	1.085E+00	1.436E+00	1.201E+00	1.382E+00	1.802E-01	0.139

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

Table 9.4 cont.

SMEN cpue 85 to 00 Page 2
Project fixed catch Output from ASPIC-P.EXE

TRAJECTORY OF RELATIVE FISHING MORTALITY RATE (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	6.097E-01	6.076E-01	-0.34%	5.006E-01	7.723E-01	5.545E-01	6.934E-01	1.390E-01	0.228
1986	6.538E-01	6.512E-01	-0.39%	5.520E-01	8.117E-01	6.014E-01	7.326E-01	1.312E-01	0.201
1987	5.396E-01	5.376E-01	-0.37%	4.628E-01	6.605E-01	5.008E-01	5.942E-01	9.341E-02	0.173
1988	4.507E-01	4.490E-01	-0.39%	3.946E-01	5.483E-01	4.219E-01	4.958E-01	7.384E-02	0.164
1989	7.907E-01	7.866E-01	-0.51%	6.984E-01	9.520E-01	7.424E-01	8.642E-01	1.218E-01	0.154
1990	6.703E-01	6.666E-01	-0.55%	5.958E-01	8.038E-01	6.307E-01	7.305E-01	9.977E-02	0.149
1991	1.082E+00	1.078E+00	-0.37%	9.657E-01	1.278E+00	1.018E+00	1.166E+00	1.481E-01	0.137
1992	1.083E+00	1.079E+00	-0.36%	9.669E-01	1.263E+00	1.019E+00	1.161E+00	1.428E-01	0.132
1993	1.383E+00	1.380E+00	-0.17%	1.231E+00	1.604E+00	1.307E+00	1.485E+00	1.784E-01	0.129
1994	1.755E+00	1.767E+00	0.67%	1.531E+00	2.013E+00	1.641E+00	1.882E+00	2.417E-01	0.138
1995	1.281E+00	1.298E+00	1.33%	1.079E+00	1.472E+00	1.174E+00	1.379E+00	2.044E-01	0.160
1996	9.720E-01	9.848E-01	1.32%	8.180E-01	1.143E+00	8.894E-01	1.059E+00	1.693E-01	0.174
1997	9.878E-01	9.952E-01	0.75%	8.326E-01	1.190E+00	9.042E-01	1.090E+00	1.862E-01	0.188
1998	8.744E-01	8.772E-01	0.32%	7.288E-01	1.065E+00	7.956E-01	9.706E-01	1.750E-01	0.200
1999	7.555E-01	7.571E-01	0.21%	6.253E-01	9.396E-01	6.845E-01	8.459E-01	1.615E-01	0.214
2000	7.797E-01	7.767E-01	-0.38%	6.396E-01	9.842E-01	7.000E-01	8.776E-01	1.776E-01	0.228
2001	7.440E-01	7.394E-01	-0.61%	6.085E-01	9.714E-01	6.636E-01	8.481E-01	1.845E-01	0.248
2002	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2003	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2004	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2005	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2006	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2007	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2008	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2009	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228
2010	6.705E-01	6.680E-01	-0.38%	5.501E-01	8.464E-01	6.020E-01	7.547E-01	1.528E-01	0.228

TABLE OF PROJECTED YIELDS

2001	3.700E+04	3.700E+04	0.00%	3.700E+04	3.700E+04	3.700E+04	3.700E+04	0.000E+00	0.000
2002	3.477E+04	3.477E+04	0.00%	3.327E+04	3.595E+04	3.396E+04	3.540E+04	1.438E+03	0.041
2003	3.614E+04	3.611E+04	-0.07%	3.410E+04	3.770E+04	3.509E+04	3.695E+04	1.855E+03	0.051
2004	3.727E+04	3.721E+04	-0.15%	3.481E+04	3.905E+04	3.599E+04	3.812E+04	2.131E+03	0.057
2005	3.821E+04	3.811E+04	-0.26%	3.555E+04	4.014E+04	3.686E+04	3.917E+04	2.310E+03	0.060
2006	3.899E+04	3.884E+04	-0.39%	3.631E+04	4.103E+04	3.761E+04	4.002E+04	2.410E+03	0.062
2007	3.963E+04	3.941E+04	-0.56%	3.699E+04	4.171E+04	3.826E+04	4.074E+04	2.476E+03	0.062
2008	4.017E+04	3.987E+04	-0.75%	3.751E+04	4.229E+04	3.880E+04	4.131E+04	2.513E+03	0.063
2009	4.057E+04	4.023E+04	-0.85%	3.795E+04	4.270E+04	3.921E+04	4.175E+04	2.532E+03	0.062
2010	4.089E+04	4.051E+04	-0.93%	3.828E+04	4.304E+04	3.952E+04	4.214E+04	2.617E+03	0.064

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

Table 9.5 ASPIC production model results for shelf *S.mentella* with a fixed TAC of 50 000t.

30 Apr 2001 at 10:06.40
SMEN cpue 85 to 00 Page 1
Project fixed catch Output from ASPIC-P.EXE

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	redfishb.bio
Name of output file (this file)	redfishb.out
Number of years of projections	10

CAUTION: ASPIC-P is designed for SHORT-TERM projections. Projections longer than 5 years are increasingly uncertain.

Year	Input data	User data type
2001	5.000E+04	TAC
2002	5.000E+04	TAC
2003	5.000E+04	TAC
2004	5.000E+04	TAC
2005	5.000E+04	TAC
2006	5.000E+04	TAC
2007	5.000E+04	TAC
2008	5.000E+04	TAC
2009	5.000E+04	TAC
2010	5.000E+04	TAC

TRAJECTORY OF RELATIVE BIOMASS (BOOTSTRAPPED)

Year	Bias-corrected estimate	Ordinary estimate	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	1.610E+00	1.618E+00	0.52%	1.312E+00	1.940E+00	1.444E+00	1.773E+00	3.284E-01	0.204
1986	1.554E+00	1.558E+00	0.23%	1.296E+00	1.803E+00	1.411E+00	1.672E+00	2.608E-01	0.168
1987	1.500E+00	1.504E+00	0.24%	1.281E+00	1.702E+00	1.383E+00	1.597E+00	2.136E-01	0.142
1988	1.489E+00	1.493E+00	0.32%	1.293E+00	1.651E+00	1.383E+00	1.568E+00	1.847E-01	0.124
1989	1.500E+00	1.508E+00	0.56%	1.312E+00	1.625E+00	1.404E+00	1.561E+00	1.568E-01	0.105
1990	1.429E+00	1.435E+00	0.37%	1.273E+00	1.542E+00	1.351E+00	1.481E+00	1.304E-01	0.091
1991	1.405E+00	1.410E+00	0.37%	1.260E+00	1.500E+00	1.334E+00	1.449E+00	1.158E-01	0.082
1992	1.297E+00	1.297E+00	0.01%	1.190E+00	1.401E+00	1.243E+00	1.344E+00	1.012E-01	0.078
1993	1.218E+00	1.216E+00	-0.21%	1.121E+00	1.326E+00	1.168E+00	1.267E+00	9.893E-02	0.081
1994	1.103E+00	1.096E+00	-0.66%	1.012E+00	1.237E+00	1.053E+00	1.162E+00	1.090E-01	0.099
1995	9.536E-01	9.412E-01	-1.31%	8.477E-01	1.125E+00	8.994E-01	1.036E+00	1.370E-01	0.144
1996	9.136E-01	9.019E-01	-1.28%	8.004E-01	1.089E+00	8.533E-01	9.972E-01	1.438E-01	0.157
1997	9.286E-01	9.203E-01	-0.89%	8.151E-01	1.089E+00	8.690E-01	1.009E+00	1.401E-01	0.151
1998	9.404E-01	9.343E-01	-0.65%	8.229E-01	1.100E+00	8.787E-01	1.024E+00	1.449E-01	0.154
1999	9.688E-01	9.662E-01	-0.27%	8.334E-01	1.123E+00	9.005E-01	1.047E+00	1.464E-01	0.151
2000	1.010E+00	1.015E+00	0.50%	8.557E-01	1.159E+00	9.300E-01	1.088E+00	1.579E-01	0.156
2001	1.043E+00	1.053E+00	0.90%	8.748E-01	1.193E+00	9.556E-01	1.123E+00	1.675E-01	0.161
2002	1.028E+00	1.038E+00	1.01%	8.483E-01	1.183E+00	9.351E-01	1.111E+00	1.764E-01	0.172
2003	1.012E+00	1.024E+00	1.18%	8.276E-01	1.176E+00	9.200E-01	1.106E+00	1.858E-01	0.184
2004	9.983E-01	1.010E+00	1.17%	7.962E-01	1.166E+00	8.945E-01	1.092E+00	1.979E-01	0.198
2005	9.839E-01	9.960E-01	1.22%	7.661E-01	1.157E+00	8.726E-01	1.083E+00	2.105E-01	0.214
2006	9.703E-01	9.819E-01	1.19%	7.356E-01	1.150E+00	8.497E-01	1.074E+00	2.239E-01	0.231
2007	9.548E-01	9.677E-01	1.35%	7.007E-01	1.143E+00	8.257E-01	1.066E+00	2.399E-01	0.251
2008	9.409E-01	9.534E-01	1.33%	6.601E-01	1.139E+00	7.994E-01	1.059E+00	2.592E-01	0.275
2009	9.246E-01	9.387E-01	1.53%	6.128E-01	1.132E+00	7.681E-01	1.051E+00	2.826E-01	0.306
2010	9.076E-01	9.237E-01	1.78%	5.650E-01	1.129E+00	7.350E-01	1.045E+00	3.102E-01	0.342
2011	8.909E-01	9.083E-01	1.96%	5.104E-01	1.126E+00	7.015E-01	1.035E+00	3.330E-01	0.374

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

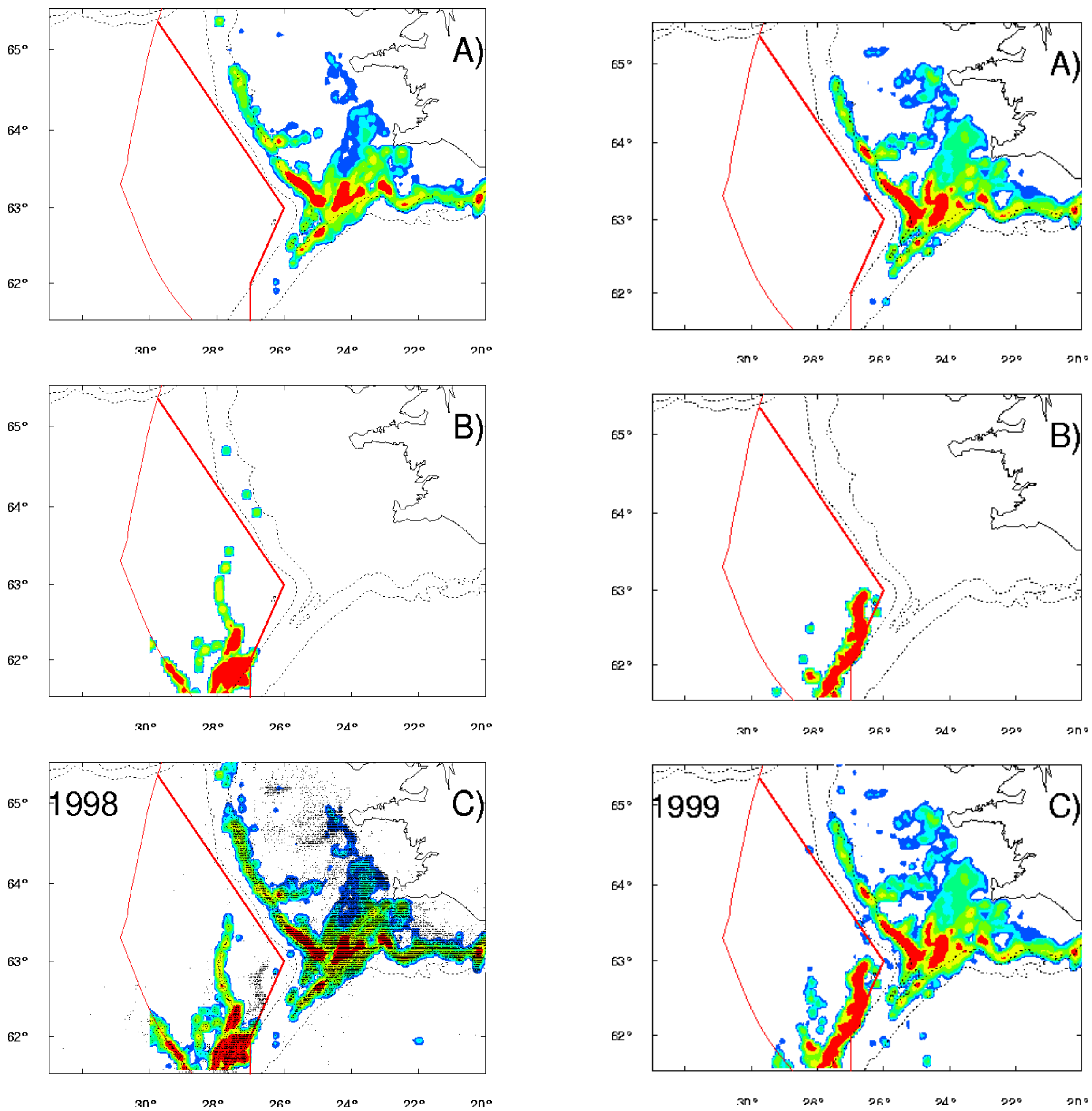

Figure 9.1.1 Map showing the line used by Icelandic authorities to separate the landing statistics between deep-sea. The figures also show the fishing grounds of demersal fishing for redfish (a), the oceanic redfish fishery in 1998 and in 1999 (b) and all redfish fishery (c), as record in the log-books.

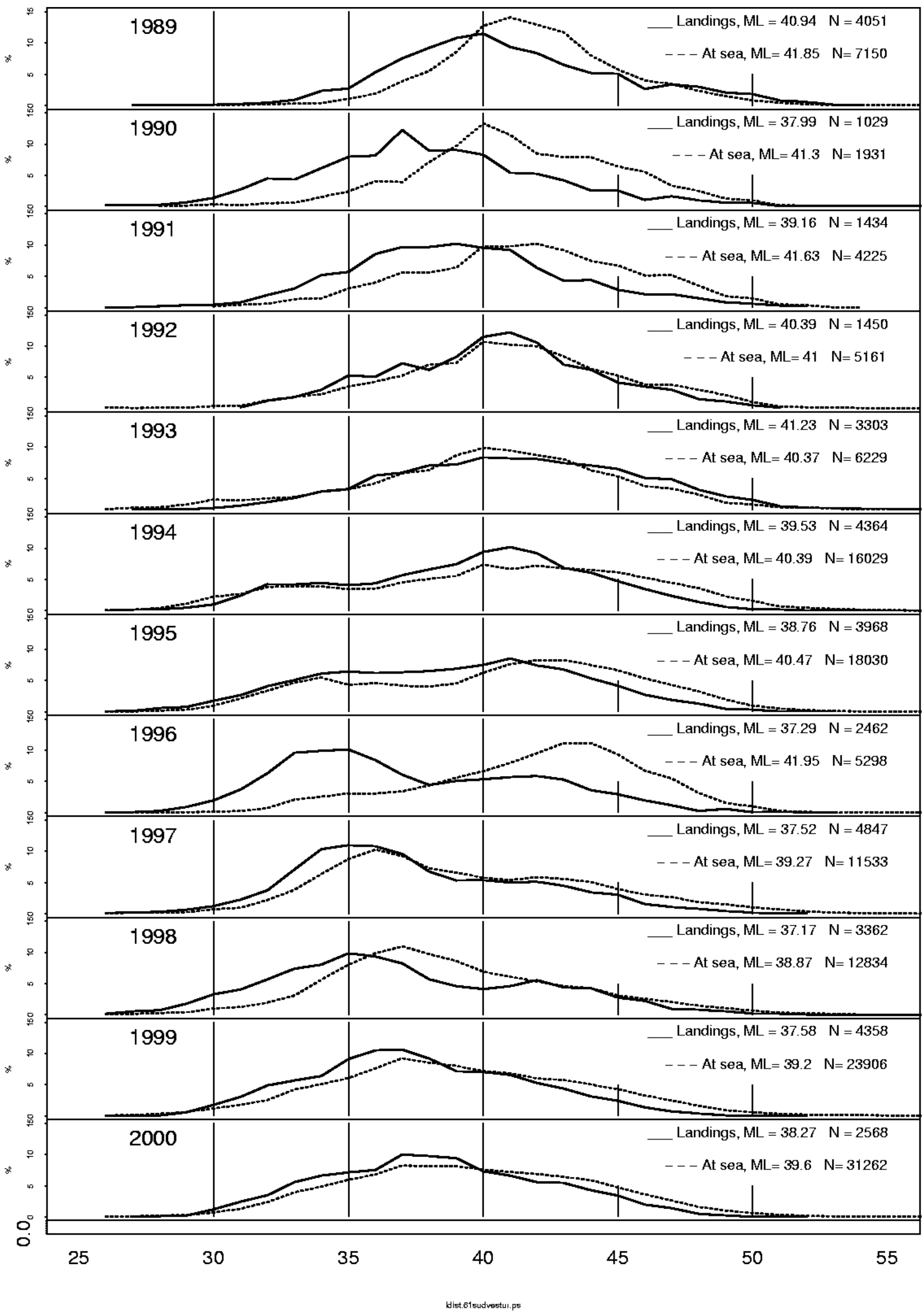

Figure 9.1.2 Length distributions of deep-sea *S. mentella* catch and landings from the Icelandic bottom trawl fishery in 1989-2000.

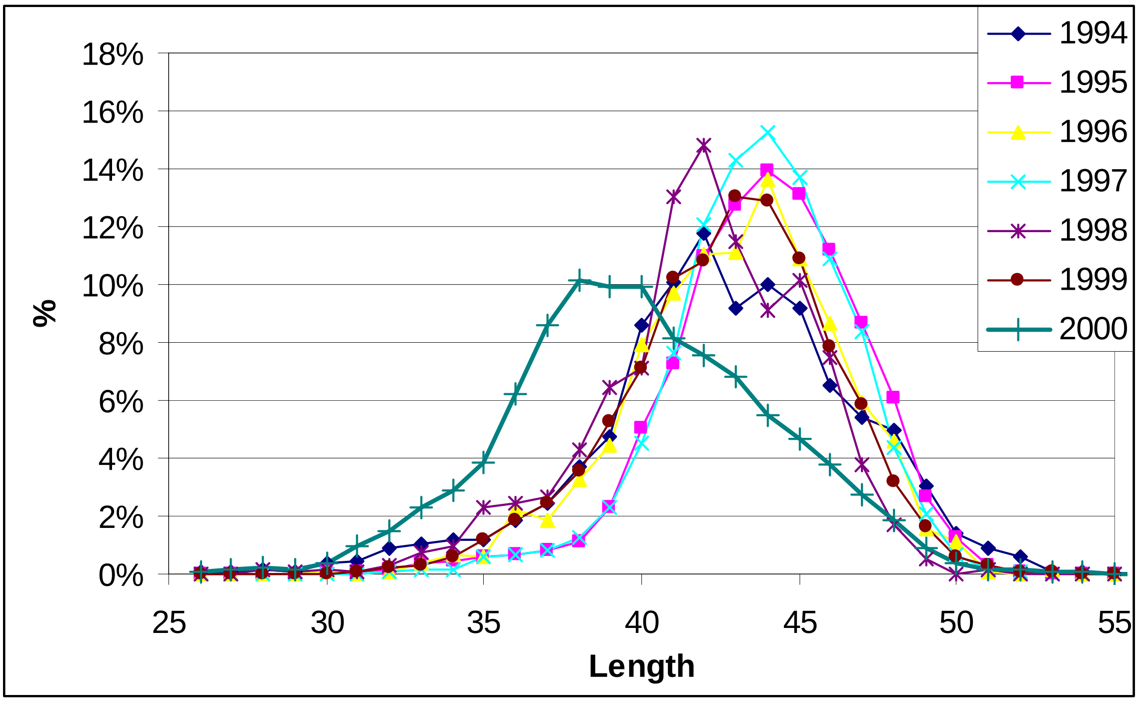

Figure 9.1.3 Length distributions of deep-sea *S. mentella* catch and landings from the Icelandic pelagic trawl fishery in 1994-2000.

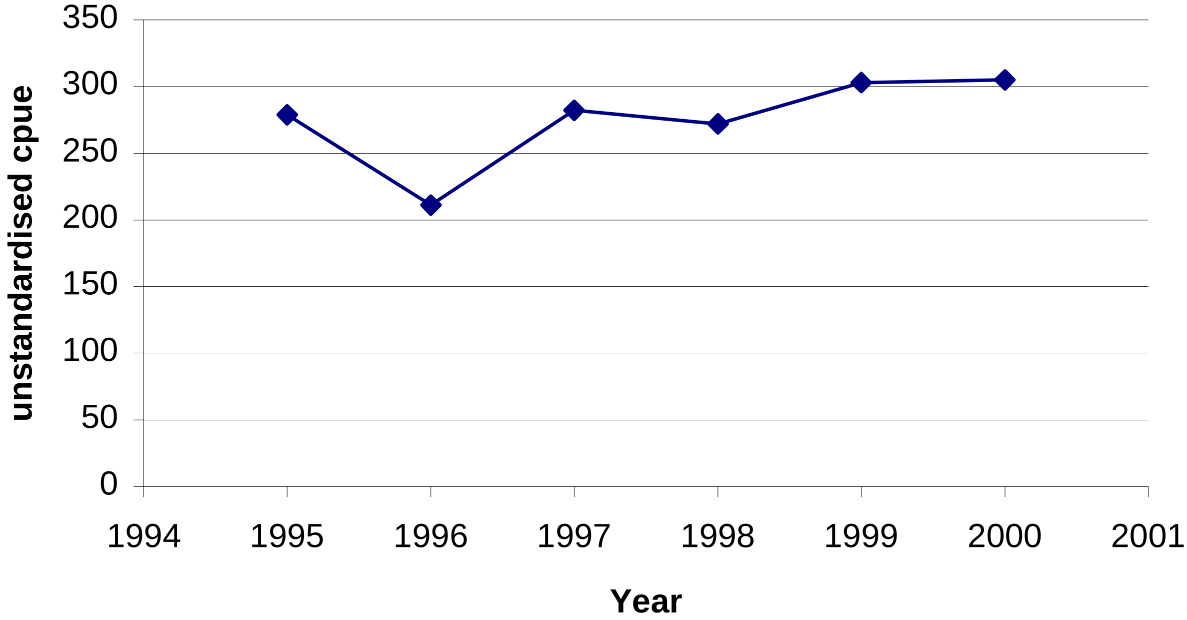

Figure 9.1.4. CPUE from the Faroese bottom trawl fleet.

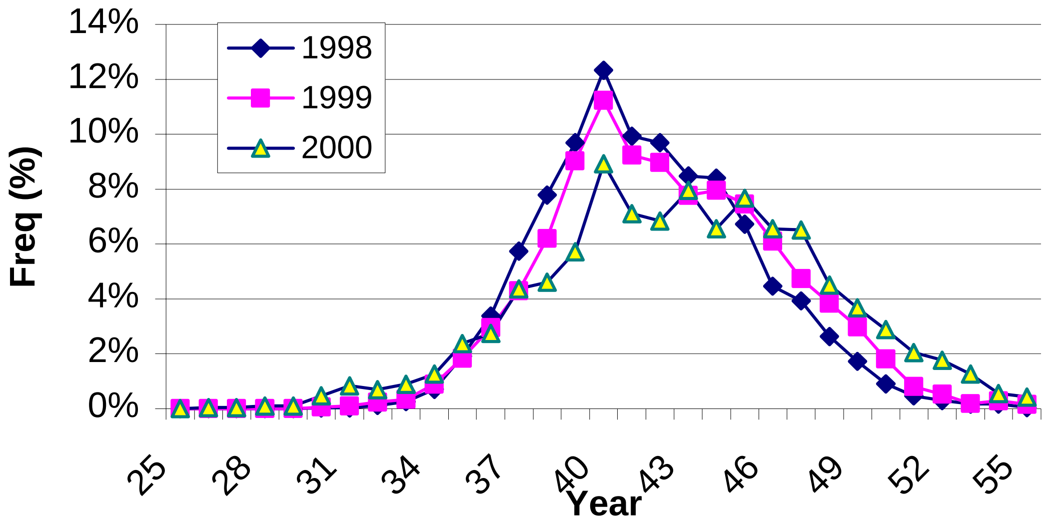

Figure 9.1.5 Length distribution of deep-sea *S. mentella* caught by Faroes otterboard trawlers in Division Vb in 1998 -2000.

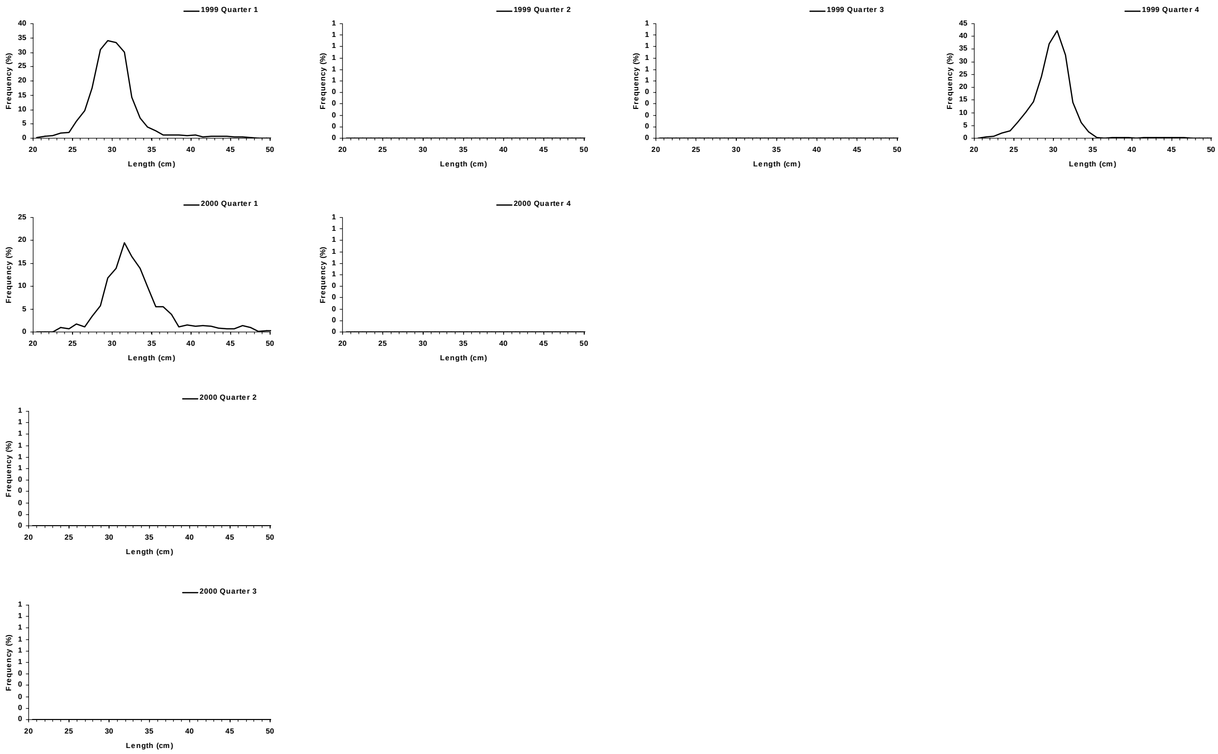

Figure 9.1.6 Length distribution of deep-sea *S. mentella* caught by German bottom trawl fishery in Division XIVb in 1999-2000 by quarter.

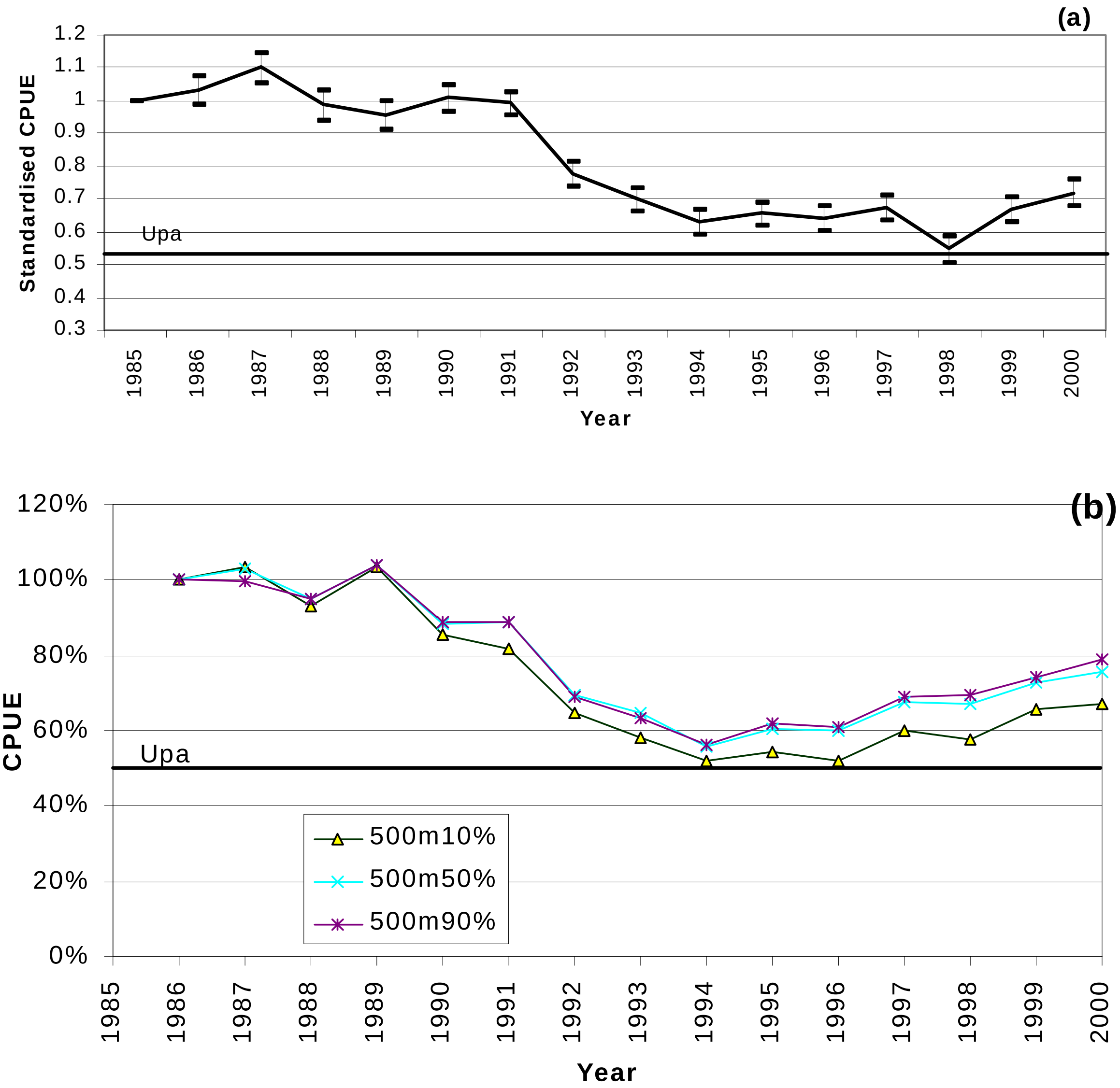

Figure 9.2.1 CPUE, relative to 1986, from the Icelandic bottom trawl fishery for deep-sea *S. mentella* on the continental shelf, based on a GLIM model (a) and based on simple mean (b). The GLIM model shows the modelled development using GLIM including hauls where redfish deeper than 500 m compose 50% ore more of the total catch in each haul. Simple mean means CPUE calculated on hauls where redfish deepest than 500 m compose 10% (50 70 or 90% lines are also shown) or more of the total catch in each haul.

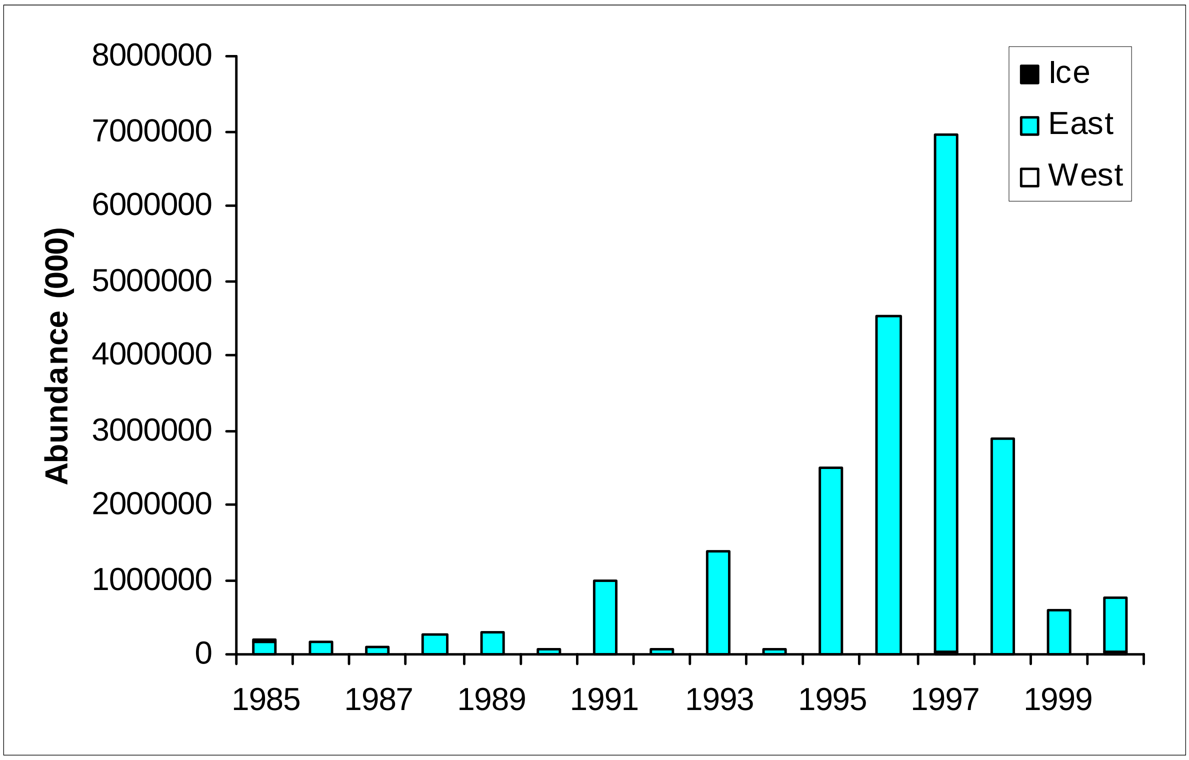

Figure 9.2.2 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985–2000.

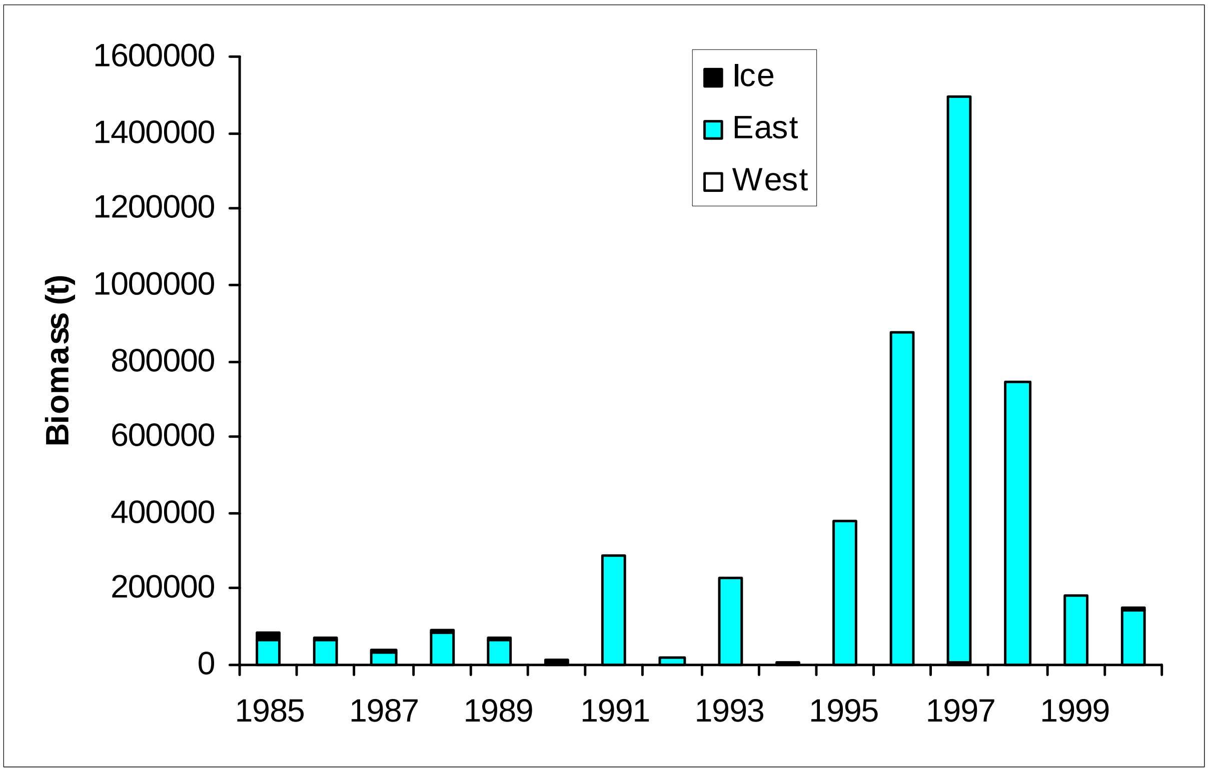

Figure 9.2.3 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland and Iceland, as derived from the German and Icelandic groundfish surveys, 1985-2000

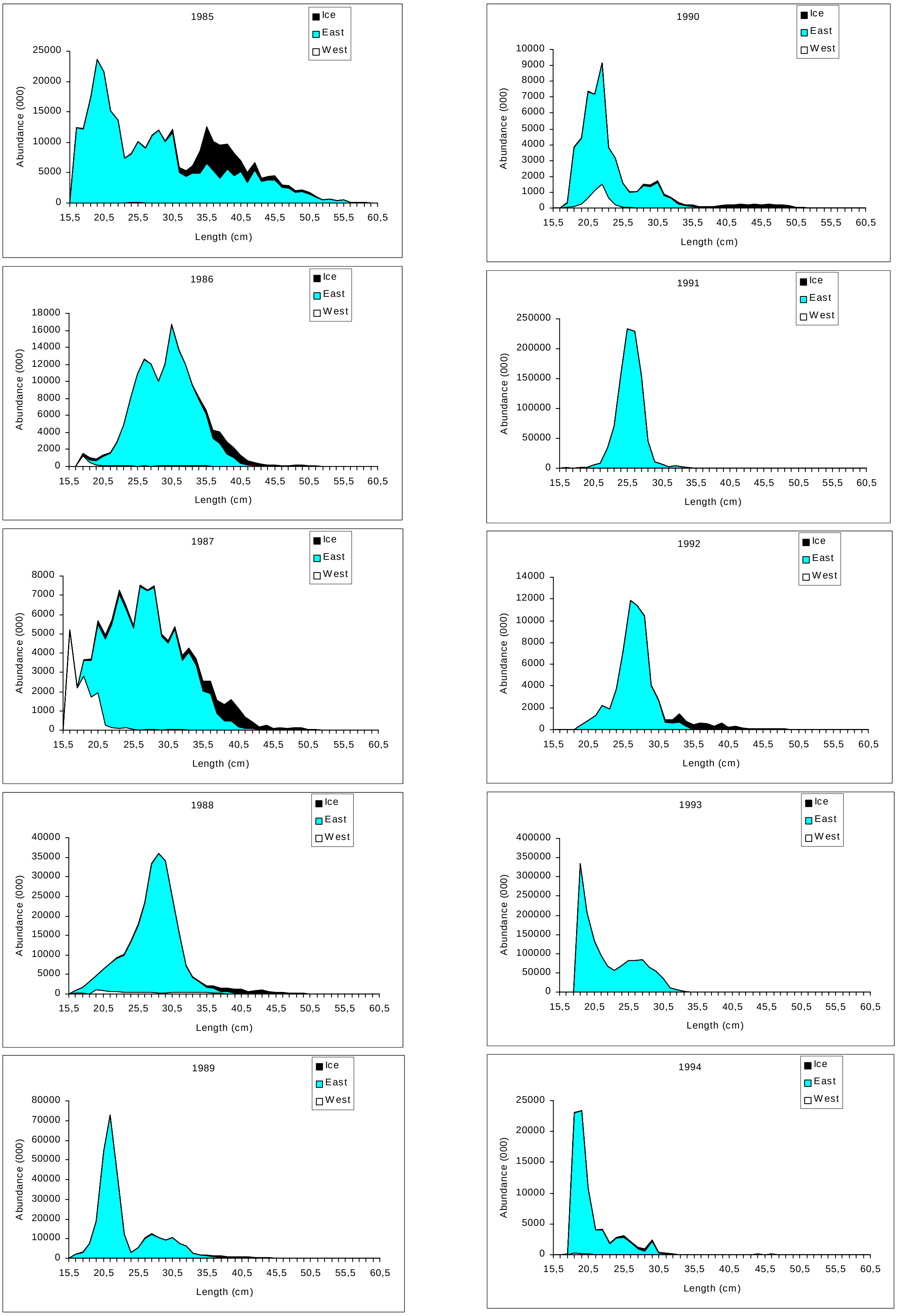

Figure 9.2.4 Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1985-1994.

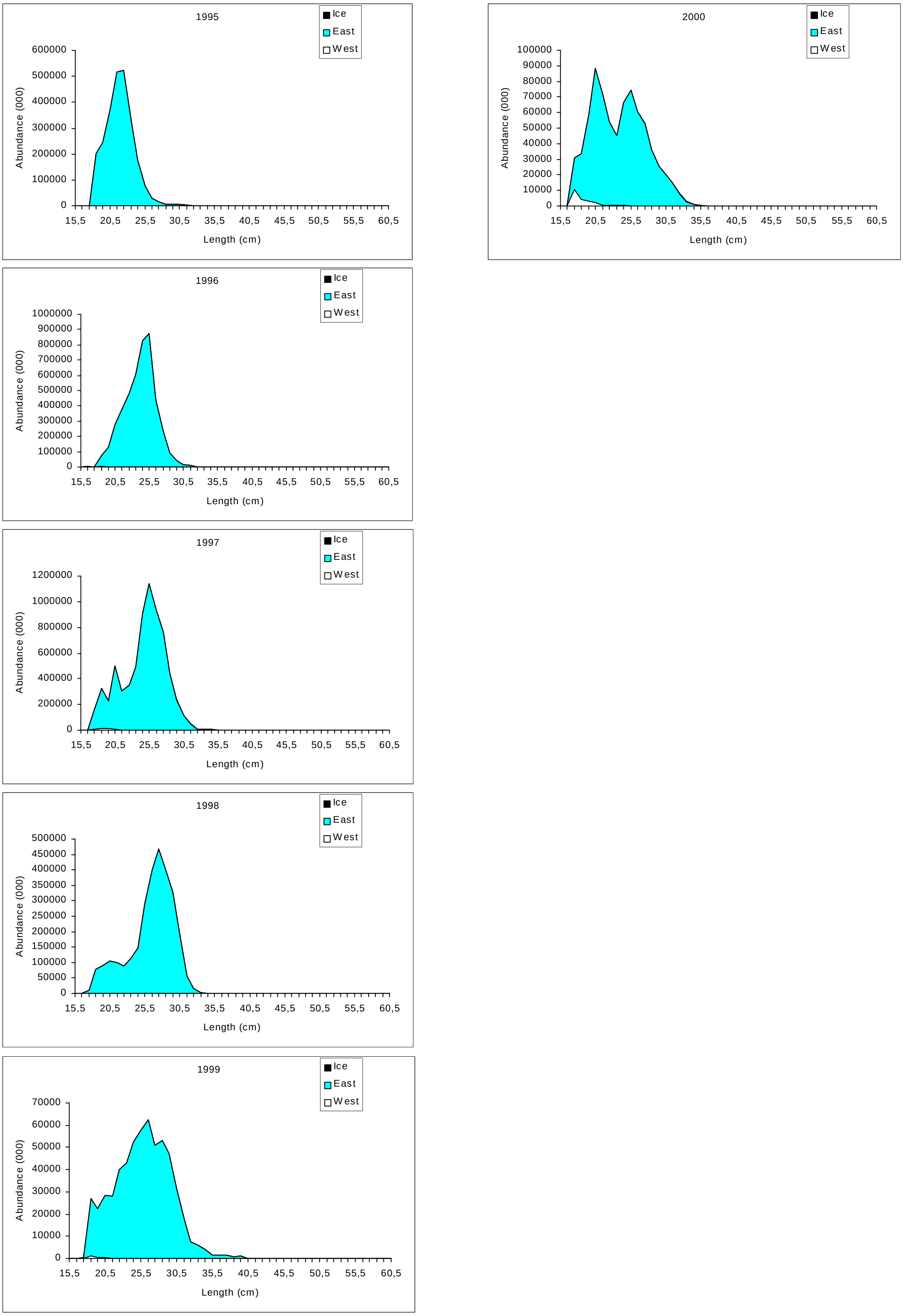

Figure 9.2.5 Deep-sea *S. mentella* (15-35 cm) on the continental shelf. Length composition off Greenland and Iceland as derived from the German and Icelandic groundfish surveys, 1995-2000.

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SMEN cpue 85 to 00
Page  4
                Observed (O) and Estimated (*) CPUE for Data Series # 1 -- ICE CPUE indices
           :
    1200. -:
           :
           :
           :                       O
           :
    1050. -:                 *
           :                    2            O
           :                 O     *   2  *      O
           :                              O  *
           :
     900. -:                                     *
           :
           :                                        *
           :
           :                                        O  *
     750. -:
           :                                                                   O
           :                                           O   *         O         *
           :                                                  O            2
           :                                               O  *  O   *  *
     600. -:                                                     *
           :
           :                                                            O
           :
           :
     450. -:
           :
           :
           :
           :
     300. -:
:.................................................................................................
.......
            :         :         :         :         :         :         :         :         :
:         :
         1980.     1983.     1986.     1989.     1992.     1995.     1998.     2001.     2004.
2007.     2010.

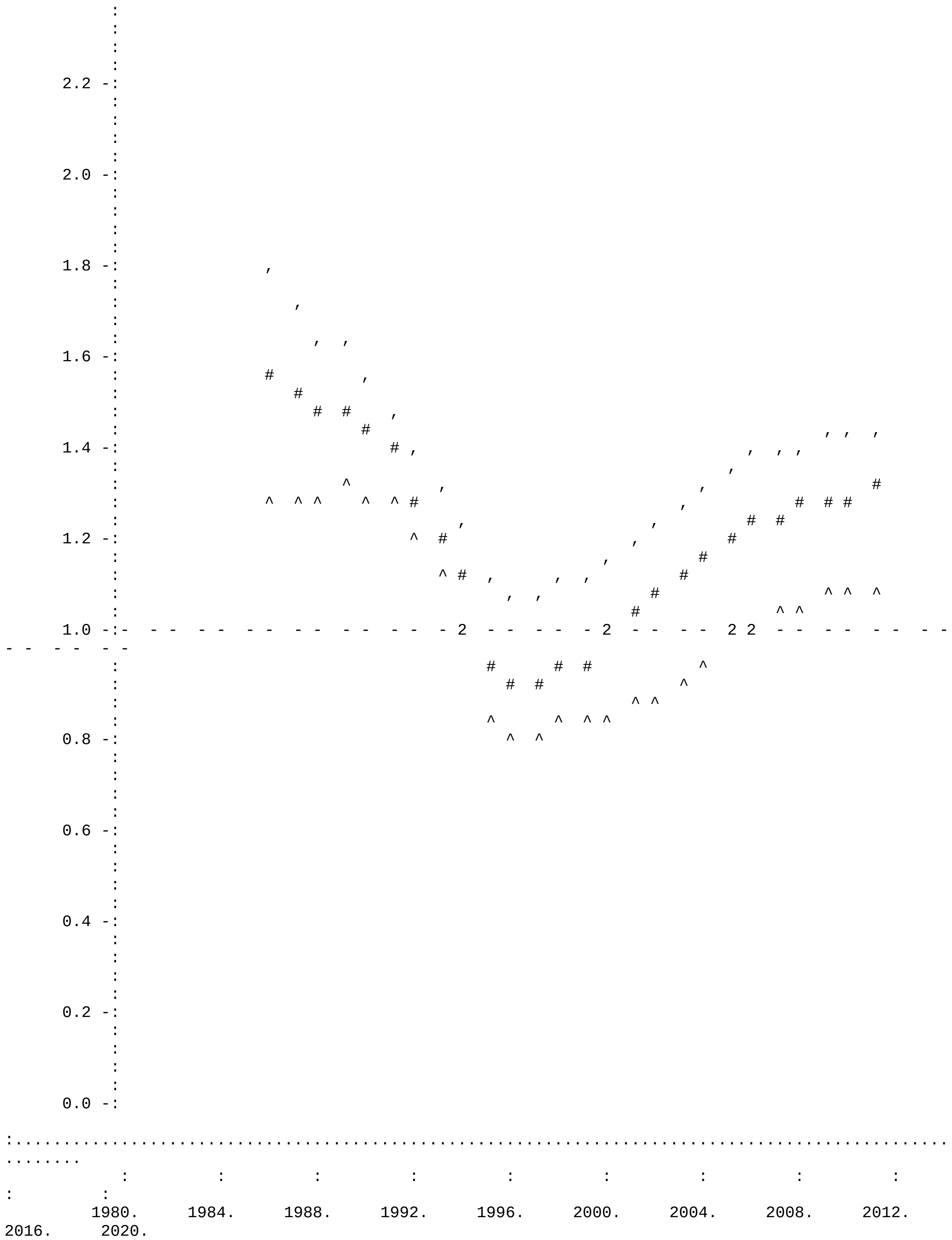

                                   Time Plot of Estimated F-Ratio and B-Ratio
           :
      2.4 -:
           :
           :
           :
           :
      2.0 -:
           :
           :
           :                                               F
           :
      1.6 -:                 B
           :                    B  B   B  B
           :                                 B   B
           :                                           F
           :                                        B         F
      1.2 -:                                           B
           :                                               B
           :                                     F  F                          B  B
           :-   -   -  -  -  -  -  -   -  -  -   -  -  -   -  2  2   3  2  2   -  -  -   -  -  -
-  -  -   -  -
           :                                                     B      F
      0.8 -:                              F                                    F
           :                                                               F
           :                 F  F            F
           :                       F
           :                           F
      0.4 -:
           :
           :
           :
           :
      0.0 -:
:.................................................................................................
.......
            :         :         :         :         :         :         :         :         :
:         :
         1980.     1983.     1986.     1989.     1992.     1995.     1998.     2001.     2004.
2007.     2010.
```

Figure 9.2.6 Observed and estimated CPUE and time plot of estimated F and B ratio for *S. mentella*, using the ASPIC production model.

SMEN cpue 85 to 00
Page 5
Project fixed catch
Output from ASPIC-P.EXE

Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence Interval (^,)

(Dashed reference line is 1.0)



NOTE: The first 1 years are omitted per user request.

NOTE: Estimates beginning in 2002 depend on the user projection data listed on page 1.

Figure 9.3.1 Bias corrected time plot of B-ratio with approximately 80% confidence intervals fishing at fixed F (**F**$_{pa}$) from 2002 and onwards.

```
                   Bias-Corrected Time Plot of B-Ratio (#) with Approximate 80% Confidence
Interval (^,)
                   (Dashed reference line is 1.0)
           :
           :
           :
           :
      2.2 -:
           :
           :
           :
           :
      2.0 -:
           :
           :
           :
           :
      1.8 -:               ,
           :                  ,
           :                    ,  ,
           :
      1.6 -:
           :               #         ,
           :                  #
           :                    #  #    ,
           :                         #
      1.4 -:                            # ,
           :
           :                       ^         ,
           :               ^  ^ ^    ^  ^ #
           :                                   ,
      1.2 -:                              ^  #                   , ,
           :                                                  ,       , ,  , ,  ,
           :                                 ^ # ,      ,  ,                     ,  , ,  ,
           :                                       ,  ,
           :                                                     # #
      1.0 -:-  - -  - -  - -  - -  - -  - 2  - -  - -  - 2  - -  2 2  2 -  - -  - -  - -  - -
- -  - -  - -
           :                                     #      #  #                #  # #
           :                                       #  #                              # #
           :                                                     ^                        #
           :                                     ^      ^  ^ ^    ^  ^
      0.8 -:                                       ^  ^                ^
           :                                                              ^
           :                                                                ^  ^
           :                                                                     ^
           :
      0.6 -:                                                                        ^
           :                                                                          ^
           :                                                                             ^
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      0.4 -:
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      0.2 -:
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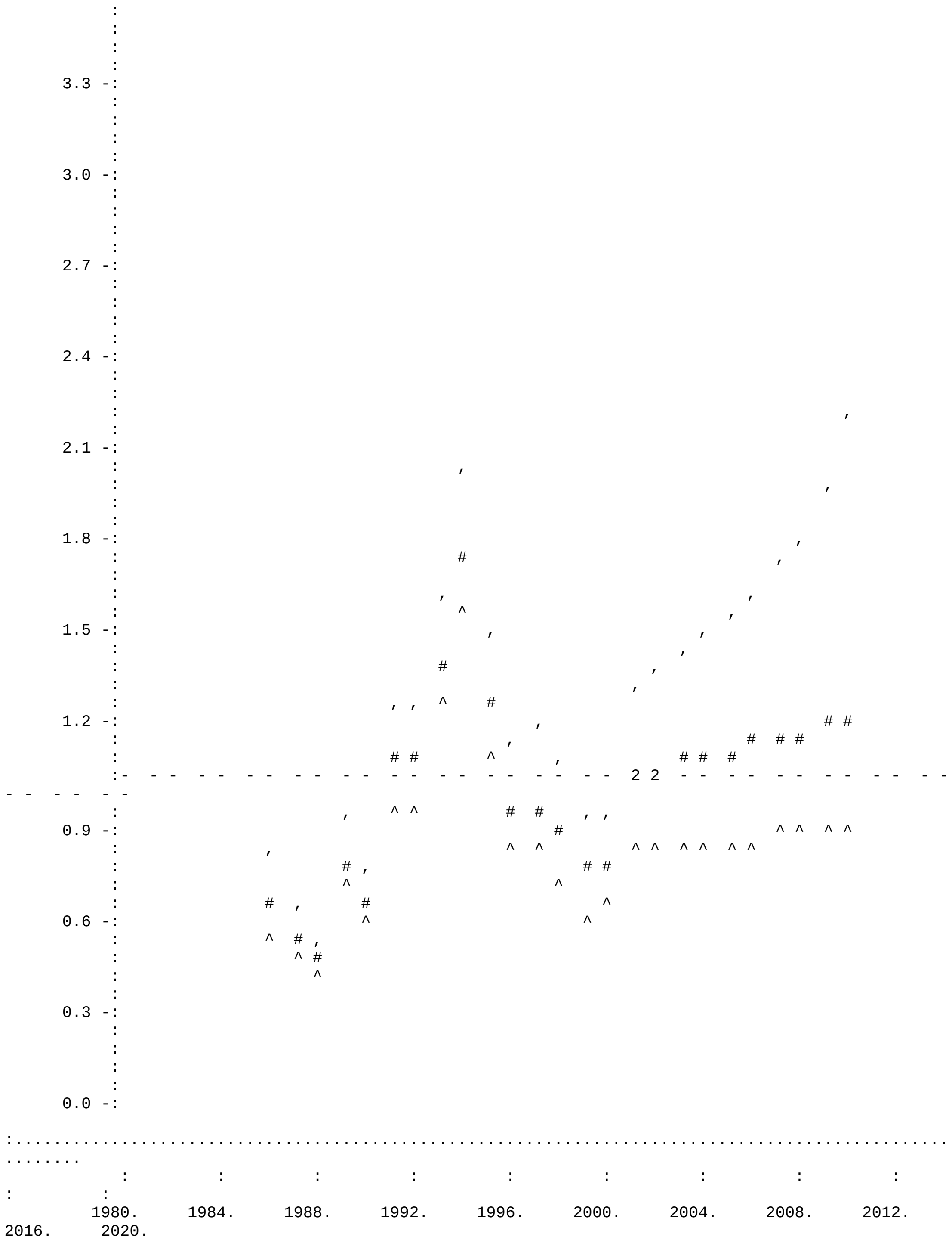
           :
      0.0 -:
:...........................................................................................
........
            :         :         :         :         :         :         :         :         :
:         :
         1980.     1984.     1988.     1992.     1996.     2000.     2004.     2008.     2012.
2016.     2020.
         NOTE: The first  1 years are omitted per user request.
         NOTE: Estimates beginning in 2002 depend on the user projection data listed on page 1.
```

Figure 9.3.2 Bias corrected time plot with approximately 80% confidence intervals fishing at fixed catch of 50 000 t 2002 and onwards.

SMEN cpue 85 to 00
Page 6
Project fixed catch
Output from ASPIC-P.EXE

Bias-Corrected Time Plot of F-Ratio (#) with Approximate 80% Confidence Interval (^,)

(Dashed reference line is 1.0)



NOTE: The first 1 years are omitted per user request.

NOTE: Estimates beginning in 2001 depend on the user projection data listed on page 1.

Figure 9.3.3 Bias corrected time plot of F-ratio with approximate 80% confidence interval for a Fixed TAC of 50 000 t after 2001.

10 PELAGIC SEBASTES MENTELLA

This section includes information on the pelagic fishery for *S. mentella* both shallower and at depths below 500 m in the Irminger Sea (Sub-area XII, parts of Division Va, Sub-area XIV and eastern part of NAFO division 1F).

Under chapter 7.5, comments are made on special requests in the ToR. Aside from what is said there, the WG refers to last year's reports on the matter of stock/delineation in the area.

10.1 Fishery

10.1.1 Historical development of the fishery

Russian trawlers started fishing pelagic S. *mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from Russia in 1984. Total catches increased from 60 600 t in 1982 to 105 000 t. in 1986. Since 1987, the total landings decreased to a minimum in 1991 of 28 000 t. The main reason for this decrease was a reduction in fishing effort, especially by the Russian fleet. Since 1989, the number of countries, participating in the pelagic S. *mentella* fishery gradually increased. As a consequence, total catches have also increased and reached the historically highest level in 1996 at 180 000 t (Tables 10.1.1−10.1.2). In 1999 and 2000, the WG estimate of the catch has been between 110 000 and 127 000 t, respectively.

In the period 1982−1992, the fishery was carried out mainly from April to August. In 1993−1994, the fishing season was prolonged considerably, and in 1995 the fishery was conducted from March to December. In 1997 and 1998, the main fishing season occurred during the second quarter, but fishery has also been prolonged. In last 3-4 years there has been a similar pattern in the fishery. 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 1998-2000 at a depth range of 200 to 950 m, but mainly deeper than 600 m in the first and second quarter but at depths above 500 m in third and fourth quarter.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2000:

Faroes	2 factory trawlers
Germany	8 factory trawlers
Greenland	1 factory trawler
Iceland	25 factory trawlers and 1 freshfish trawlers
Norway	2 factory trawlers
Russia	25 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 10.1.3.

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 above 500 m although some trials were made down to about 700 m. From 1992 onwards, several trawlers have made trips to this area fishing almost exclusively below 5-600 m.

In 1999, the Faroese fishery in the international parts of the Irminger Sea started late April and continued until late August. 5 trawlers participated in the fishery and all hauls were deeper than 600 m. From to September, two of the trawlers fished within the Greenlandic EEZ; all hauls were shallower than 600 m.

In 2000, the Faroese fishery started in international waters in the NE part of the Irminger Sea in the middle of April (ICES Division XIV). Up to late July, the fishing area was mainly between 61°15’-62°00’N and 27°15’-30°00’W, then they moved somewhat to the SW, to about 60°15’N and 32°00’W. The fishing depth in the whole period was exclusively deeper than 600 m. From the end of July, the fishing area changed to ICES Division XII, between 56°25’-

58°15'N and 40°-42°W, mostly within the Greenlandic EEZ. Most hauls were shallower than 600 m. The fishery ended in the middle of August in international waters, close to the border to the NAFO area, fishing below 600 m.

10.1.2.2 Germany

The reported German fishing effort in 2000 is the lowest observed in the last six years and amounted to 12 800 hours only, a 28 % decrease as compared with 1999. As observed in previous years, the majority of the 2000 effort was applied during the second and third quarters. During the second quarter in 2000, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Division XIV between the Greenland and Icelandic EEZs. For the first time, significant fishing effort was exerted in the NAFO Sub-area 1F both within the Greenland EEZ and the NAFO Regulatory Area during the third and fourth quarters in 2000. The decrease of annual catches continued since 1996 with a catch figure of 12 500 tons in 2000. In 2000, 36 % or 4 500 tons of the total catch was 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, the CPUE was calculated to amount to 1 050 kg/h confirming the low level observed previously. Catch rates recorded in NAFO Div. 1F are similarly low like those achieved in the adjacent ICES Div. XII. Given the technical, temporal, geographical and depth changes of the fishing activities the relevance of the estimated reduction in CPUE, as indicator of stock abundance remained difficult to assess. However, the continued reduction in CPUE during 1996-2000 should be interpreted as reaction of the stock to removed biomass (WD 8). While the females were almost constantly around 2 cm bigger than males, both sexes displayed higher lengths around 39-42 cm during the second quarters when the fleet was fishing at greater depths. The information of bigger fish comprising the catches taken during the second quarters in 1996-2000 is consistent with the recently observed trend to fish in deeper layers during that period. In the second and third quarters in 1999, a clear recruitment signal was recorded for the first time with fish around 28 cm in mean length occurring at all depths. Until the third quarter in 2000, those recruits seem to have grown by 2 cm as indicated from the length distribution. The recruits are believed to originate from the East Greenland shelf areas, where a previously abundant recruiting year class declined recently.

10.1.2.3 Greenland

Greenland was fishing in the same area as Iceland (see below), except that the fishery of the only Greenlandic vessel was prolonged until late October, shifting from the northern area in early July to the southern part of Division XII and further into NAFO area 1F in September and October.

10.1.2.4 Iceland

Catches in 1995-2000 were usually concentrated in the area between the Greenlandic EEZ and the Reykjanes Ridge, and 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 in northward direction in May-July. In the springtime and until June, the largest proportions of the catches were taken at depths exceeding 500 m. In 1998, the fishery expanded further north in July, August and September. In 1999, a similar observation was made, except that the fishery did not continue close to the shelf of Iceland in July-September, as it did in 1998. Instead, the few vessels that had quota left at that time, moved about 480 nautical miles to southwest, to the area S-SE of Cape Farewell (Division XII), where they fished above 500 m depth. In 2000, the fishery started in April at the same locations as it has done for the past years and moved slowly northward until the fishery ended in July due to the fact that they had reached their quotas. 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 above 500 m depth and no catches were reported at depths above 400 m. The length distribution from the catch is shown in Figure 10.1.2.

10.1.2.5 Norway

Information on the fishery in 1998 and 1999 indicated a depth shift in the fishery, from fishing 95% of its catch above 500 m in 1998 to fishing entirely in the layer below 500 m in 1999. The catches in 1999 were taken in areas XII and XIV from April to August, with a share of about 2:3. In 2000, Norway fished 6 075 t whereof 3 823 t were taken in ICES Division XIV and 2 252 t in Division XII. The fishing season was from April – September. There is no information on the depth of trawling nor length distributions from the catch.

10.1.2.6 Russia

The first Russian regular commercial fishery for pelagic redfish has been carried out in the Irminger Sea 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. In 1994, with a shifting of the fishery to the depths below 500m, and due to the use of large-sized trawls, an increase in fishing efficiency was observed. The reduction in redfish catches from the depths below 500m 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 (WD 6).

In 2000, the Russian fleet conducted the pelagic fishery for the Irminger Sea redfish in April-November (WD 4). 25 trawlers of seven types, ranging from 1770 to 5300 kW propulsion, participated in the fishery. 54 % of the annual catch and 49 % of annual effort were registered in May-June. The fishery started in April in traditional fishing areas near the border of the Icelandic EEZ. The fleet moved southward during the third quarter. The fleet distribution in June-August was wider than usual, with a maximum number of 8 fishing areas in July. The CPUE for most types of the trawlers was higher than in previous years.

Pelagic redfish aggregations in NAFO Div. 1F were for the first time found by the USSR research and scouting vessels in 1980. In 1990-1991, the fishery on redfish was carried out by Russian vessels in Div. 1F to the south from the 200-mile zone of Greenland. Fishing efficiency was 13.9-14.5 t per vessel/fishing day. The total catch in 1990 and 1991 amounted to 385 t and 458 t, respectively. In July-November 1999, the Russian fleet operated in Div. 1F with fishing efficiency of 6,2 t per vessel/fishing day and a total catch of 380 t. In July-October 2000, the Russian fleet conducted the pelagic fishery to the west of 42°W in NAFO Div. 1F at 280-350m depths. Fishing efficiency was 19.0 t per vessel/fishing day. Total catch in 2000 constituted preliminary 5259 t.

10.1.2.7 Spain

Although the Working Group has no information on the total Spanish catches, the WG had information on the fishery from the biological observer program, which has been ongoing since Spain first participated in this fishery in 1995. A number of freezer trawlers usually fish *Sebastes mentella* in the ICES Division XII and XIV. This represents four vessels in 1995-1997 and arose to 6 vessels since 1998 onwards. The trawl used by the fleet is a Gloria-type pelagic trawl, with a maximum vertical opening of 80-120 m. In 2000, two of the trawlers prolonged it's fishery into NAFO Division 1F in October.

Since 1997, the fishery showed a significant seasonal pattern in terms of its geographical distribution and fishing depth. The fishing season comprises the second and third quarter. During the second quarter, the fleet operates in international waters of ICES Division XIV and depth of hauls is greater than 500m. In the third quarter, the fleet moves to the international waters of ICES Division XII and works on depths less than 500m. The yields of the second quarter are much greater than those from the third and fourth quarters.

Mean lengths of catches during the third quarter, mainly caught in Division XII, are smaller than those from the second quarter, caught in XIV (Figure 7.5.8).

10.1.2.8 Other nations

No information on the fishing areas, seasons and depths of the fleets of other nations was available for the Working Group.

10.1.3 Discards

Prior to 1996, Icelandic landings of oceanic redfish have been raised by 16% due to discards of redfish infected with *Sphyrion lumpi*. This value of was based on measurements from 1991−1993 when the fishery was mostly on depths above 500 m. During the 1997 fishing season measuring was made on discard from different depths and on 10 different vessels in the period from May to July, showing a discard rate of 10%, which was then added to the landings in 1996 and 1997. A new measurement from 1998 shows that the discard rate has decreased to 2%. Information from observers in 2000 indicate that there were no discards in 2000, and therefore no catches were added to the Icelandic landings.

Norwegian fishermen currently report approximately 3% discards of redfish infected with the parasite. This percentage has in recent years become less due to a change in the production from Japanese cut to mainly fillets at present.

The Spanish discards are based on measurements made by the scientific observers. However, it can be safely assumed that these reflect approximately the behaviour of the rest of the non-surveyed Spanish trawlers. In 1995, 4 % of the total catches were discarded. In 1996, it was 6.5 %, and since 1997, the discards of the Spanish fleet have been insignificant, representing less than 1 %.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Trends in landings and fisheries

A Working Group estimate of catches in 2000 is estimated to be about 127 000 t, which was similar to the total catches observed since 1997. In 1995 and 1996, the catches amounted 176 000 and 180 000, respectively, representing the highest catches on record (Table 10.1.1-10.1.2). The actual catches in 2000 might increase due to the lack of reporting from some countries participating in the fishery.

At the beginning of the fishery in 1982, catches of pelagic redfish were reported from both Sub-areas XII and XIV. But most of the catches were taken in Sub-area XII (40 000-60 000 t) until 1985, thereafter the greater part of the catches were reported from Sub-area XIV. The landings from Sub-area 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 Sub-area Va and Division XIV (Table 10.1.1). In 2000, a considerable amount of the catches was taken in NAFO Div. 1F, as observed in this magnitude for the first time.

Pelagic *S. mentella* fishery in Division Va started in 1992. The catch varied from 2 000-14 000 from 1992-1995. Since 1995, the catches in Va have increased to about 37 000 and 45 000 t in 1999 and 2000, respectively (Table 10.1.1).

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian and Spanish commercial catches were reported for 2000 and are given in Figure 10.1.2. A bimodal distribution over the past 3 years could be observed.

The 2000 biological sampling from catches and landings of pelagic *S. mentella* in each 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	12499	53	35229
Iceland	XIV and Va	Pelagic	45232	61	5041
Russia	XII, XIV and NAFO 1F	Pelagic	29353	?	29102
Spain	XII, XIV and NAFO 1F	Pelagic	32[1]	146	24595

1) only NAFO Div. 1F

10.1.5 Age readings

Several nations have increased their effort to age pelagic redfish, using different ageing methods and thus making a comparison of age readings difficult.

The catches in 1999 and 2000, and also the acoustic survey in 1999, suggest that a new cohort is entering into the fishable stock of pelagic redfish. This cohort (probably not more than 1-2 year classes) could therefore be used as a basis for investigating different methods for age readings.

10.2 Assessment

10.2.1 Acoustic assessment

Trawl-acoustic surveys have for many years been carried out in the Irminger Sea and adjacent waters. Because of the limited depth range coverage (down to 500 meters) the surveys have mainly covered the oceanic *S. mentella*, and should therefore only be used as an index for this component.

An international acoustic survey of pelagic redfish was carried out in the Irminger Sea and adjacent waters in June/July 1999 with participation of Iceland, Germany and Russia. The acoustically estimated biomass of the oceanic *S. mentella* in upper 500 m of the water column was 0.6 mill. t, compared with 2.2 and 1.6 mill. t in 1994 and 1996, as estimated from the catches, respectively (Table 10.2.1). The observed decrease in survey abundance is very drastic and exceeds the removed biomass by a factor of 2. The area covered in the 1999 survey was the most extensive in the time series, but covered only a portion of the current horizontal distribution of the oceanic stock. Therefore, the estimate of 0.6 mill t is considered an underestimate.

The summer 1999 survey provided for the first time an estimate on the abundance of the pelagic deep-sea *S. mentella* (>500 m depth) on the order of 0.5 million tonnes (Table 10.2.2). Hydrographic observations indicated that the highest concentrations of redfish below 500 were associated with eddies and fronts.

The stock above 500 m was observed more southwesterly and deeper than it has been during former acoustic surveys in this decade. During the same period, a gradual increase in temperature in the observation area has been observed (WD 6, Fig. 10.2.4). This may have influenced the distribution pattern of the redfish in June-July 1999 as the highest concentrations were found in the colder, i.e. southwestern part of the survey area.

It must be noted that none of the consistent international June/July surveys of the past decade has succeeded in identifying the distribution boundaries of pelagic *S. mentella*. However, the overall distribution of pelagic redfish in depths shallower than 500 m has been relatively stable over the past decade with the exceptions in 1996 and 1999 when there was a major southwestern move of the stock observed. In 1999, there were very few redfish encountered in the traditional distribution area along the Greenland EEZ off East Greenland but highest concentrations were observed in the NAFO Regulatory Area (Div. 1F). One third of the stock in numbers and biomass was found in the NAFO Division 1F. However, these survey estimates should be interpreted as underestimated due to the limited area coverage southwest of Greenland. Information on redfish distribution deeper than 500 m has become available only since a few years. In the layer deeper than 500 m, there was a clear decreasing trend in abundance evident from east to southwest.

Length distributions from the 1999 survey indicate recruitment both above and below 500 m depth. The lengths of these pre-recruits were similar to the length of the abundant juveniles growing up at the shelf of East Greenland.

The following text table gives the results of acoustic estimates during the period 1991-1999.

Year	*Acoustic estimate down to 500 m (thousand tonnes)*	*Area surveyed, thousand sq. nautical miles*
1991	2235	105
1992	2165	190
1993	2556	120
1994	2190	190
1995	2481	167
1996	1600	256
1997	1240	159
1999	614	296

In June/July 2001, an international hydroacoustic survey on pelagic redfish will be carried out with participation of Iceland, Germany, Norway and Russia (ICES CM 2001/D:04). The survey area will extend more to the west than in previous surveys to account for the recently observed high concentrations of pelagic redfish in NAFO 1F and therefore aiming to cover the entire distribution area.

10.2.2 CPUE

In Table 10.2.3, the CPUE series for Bulgarian, German, Icelandic, Norwegian, Russian, and Spanish fleets are given. Figures 10.2.3.a and 10.2.3.b show the overall CPUE from different fleets in recent years, in depths shallower and deeper than 500m, respectively. In Figure 10.2.3.a, the estimated biomass derived from the international and Russian hydroacoustic surveys is given. The trend in biomass in depths shallower than 500m indicates a steep downward trend since 1995. In recent years, there is no clear signal in CPUE (Figures 10.2.3.a-10.2.3.b).

In Figure 10.2.3.c, the standardised CPUE, derived from a GLM model (WD 3) incorporating data from Germany, Iceland, Greenland and Norway since 1995. While a downward trend in CPUE could be observed since 1995, the value for 2000 indicates a slight increase.

The German data on CPUE in second quarter (mainly fishing from the lower layer in area XIVb) show considerably lower values as 1999 (Figure 10.2.5). In the third and forth quarter of the year, the fishery in last years has mostly been from depths not exceeding 500 m in area XII. In that layer, the results show a continuous decreasing trend during the recent years.

10.2.3 Ichthyoplankton assessment

The traditional ichthyoplanktonic survey, conducted by Russia in 1982-1995 has not been carried out in 1995. The historical series of ichthyoplanktonic surveys was presented in last year's Working Group Report.

10.2.4 State of the stock

The 1999 survey indicated a continued reduction in the stock abundance and biomass above 500 m. The estimated biomass of 600 000 t is interpreted as being biased downward due to significant changes in horizontal and vertical stock distribution patterns. A similar negative trend can be derived from the CPUE series reported from some of the major fishing fleets fishing above 500 m. Given the technical, seasonal, geographical and depth changes of the fishing activities, the relevance of the estimated reduction in CPUE as indicator of stock abundance remains difficult to assess both above and below 500 m. The CPUE data do, however, indicate a more stable stock situation below 500 m. A biomass index of around 500 000 t was estimated below 500 m, based on the 1999 survey results.

Although there is considerable uncertainty related with the used stocks' indicators, the stock is indicated to be at or below the level of 50% of the virgin biomass of around 3 million tonnes (= MBAL). Based on the survey biomass estimates, the recent catches although being significantly reduced from a high level in 1994-1996 might be above the 5 % exploitation rate being previously considered as sustainable.

For the first time, a considerably high recruitment was observed in the length distribution data from the international hydroacoustic survey in the Irminger Sea in June/July 1999 in the layers above and below 500 m. This recruitment is likely to originate from the East Greenland shelf, since the high numbers of young redfish observed during 1995-1997 disappeared from the East Greenland shelf in the past 3 years.

10.3 Management considerations

An update on the pelagic fishery, in particular with respect to seasonal and area distribution, was requested by the ToR. Catch rates above 500 m remained steady but low, and below 500 m remained steady. Recruitment has increased; this was confirmed by the 1999 international survey. The main new feature of the fishery was an increasingly clear distinction between two widely separated grounds fished at different seasons and different depths. The more southwesterly fishing ground extended into NAFO Div. 1F (Fig. 7.5.5). The parameters analysed so far do not suggest, however, that the newly discovered aggregations in Div. 1F form a separate stock component. The genetic structure of the pelagic and demersal stocks of deep-sea redfish (*S. mentella*) in the North Atlantic remains poorly known, but further research is currently being carried out.

Given this pattern of seasonally localised fishing, a seasonal or geographic dimension for management of the fishery on the different grounds could be considered from a management perspective. This would also account for depth separation and reduce the risk of overexploitation or depletion of possibly separate stocks or components, which will exist as long as they are managed under a common TAC.

The international hydroacoustic-trawl survey planned for June/July 2001 (ICES CM 2001/D:04) will make it possible for ACFM to provide projections of the development of the stock and the catches.

10.4 Precautionary approach

Based on the status of the knowledge of the stock(s) in the area, the Working Group could not come up with any new information on reference points in addition to last year's report.

Considering the uncertainty related to definition of stock units, action must be taken in accordance with the precautionary approach and attempts be made to assess each stock component separately until better knowledge on the relationship between each stock or stock components are known. Such assessment must be based on what information is currently available. Furthermore, there exists considerable concern about the precision of the used stocks indicators.

Table 10.1.1 Pelagic *S. mentella*. Landings (in tonnes) by area as used by the Working Group. Due to the lack of area reportings for some countries, the exact share in Divisions XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	NAFO 1F	Total
1978	0	0	0	0	0		0
1979	0	0	0	0	0		0
1980	0	0	0	0	0		0
1981	0	0	0	0	0		0
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[1]	44,677	0	0	20,172	51,451	10,944	127,244

1) Provisional data

Table 10.1.2 Pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, XII, XIV and NAFO Div. 1 F 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	others	Total
1978																					
1979																					
1980																					
1981																					
1982														581		60,000					60,581
1983						155										60,079					60,234
1984	2,961					989								239		60,643					64,832
1985	5,825					5,438								135		60,273					71,671
1986	11,385			5		8,574								149		84,994					105,107
1987	12,270			382		7,023								25		71,469					91,169
1988	8,455			1,090		16,848										65,026					91,419
1989	4,546			226		6,797	567	3,816						112		22,720					38,784
1990	2,690					7,957		4,537					7,085			9,632					31,901
1991			2,195	115		571		8,783					6,197			9,747					27,608
1992	628		1,810	3,765	2	6,447	9	15,478		780	6,656		14,654			15,733					65,962
1993	3,216		6,365	7,121		17,813	710	22,908		6,803	7,899		14,990			25,229			2,782		115,835
1994	3,600		17,875	2,896	606	17,152		53,332		13,205	7,404		7,357		1,887	17,814			5,561		148,689
1995	3,800	602	16,854	5,239	226	18,985	1,856	34,631	1,237	5,003	22,893	13	7,457		5,125	44,182	4,555		3,185		175,842
1996	3,500	650	7,092	6,271		21,245	3,537	62,903	415	1,084	10,649		6,842		2,379	45,748	7,229	260	518		180,322
1997		111	3,720	3,945		20,476		41,276	31				3,179	778	3,674	36,930	8,707				122,935
1998			3,968	7,474		18,047	1,463	48,519	31		1,768		1,139	12	4,133	25,837	4,577				116,968
1999			2,108	4,656		16,489	4,269	43,923					5,435	6	4,302	17,957	10,332	188			109,665
2000[1]			11,811	2,837		12,499	4,204	45,232			450		6,188		3,731	29,353	32[4]	45		10,862	127,244

1) Provisional data.
2) Former USSR until 1991.
3) Former GDR and GFR.
4) only NAFO Div. 1F

Table 10.1.3 Pelagic *S. mentella* landings (in tonnes) in 2000 by countries and depth (A), and in 1996-2000 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	11,811	100 %		
Faroes	2,837	100 %		
Germany	12,499		45 %	55 %
Greenland	4,204	100 %		
Iceland	45,232		27 %	73 %
Latvia	450	100 %		
Norway	6,188	100 %		
Portugal	3,731	100 %		
Russia	29,353	100 %		
Spain	32[1]	100 %		
UK	45	100 %		
others	10,862	100 %		
Total	127,244			

Derived from effort data
1) only NAFO Div. 1F

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	127,244	45 %	14 %	31 %

Table 10.1.4 Results of dividing the Icelandic pelagic redfish catch (t) according to the Icelandic samples from the fishery.

Year	Oceanic	Deep sea	Not classified	Catch Oceanic	Catch Deep sea	Total Catch
1995	72%	27%	0%	25186	9445	34631
1996	45%	52%	3%	29182	33721	62903
1997	36%	64%	0%	14859	26417	41276
1998	10%	85%	4%	5504	46780	52284
1999	15%	85%	0%	6765	37159	43924
2000	5%	95%	0%	2454	42500	45001

Table 10.2.1 Biomass, abundance and area coverage for pelagic redfish *Sebastes mentella* at depth down to 500 m. Results from international acoustic surveys conducted in 1994, 1996 and 1999. Sub-areas are shown in Figure 10.2.1.

		Sub area					
Year		A	B	C	D	E	Total
1994	Total numbers (millions)	1109	1964	-	95	328	3496
	Biomass ('000 t)	673	1228	-	63	226	2190
	Total area (nm^2)	75307	88132	-	7342	18348	189129
1996	Total numbers (millions)	1055	1217	-	57	265	2594
	Biomass ('000 t)	639	749	-	33	155	1576
	Total area (nm^2)	89198	112086	-	11409	38852	252546
1999	Total numbers (millions)	123	609	27	71	336	1165
	Biomass ('000 t)	72	317	16	42	167	614
	Total area (nm^2)	106688	138865	6291	6291	37988	296122

Table 10.2.2 Biomass, abundance and area coverage for pelagic redfish *Sebastes mentella* at depths between 500 and 950 m. Results from international acoustic surveys in 1999. Sub-areas are shown on Figure 10.2.1.

	Sub area						
	A	B	C	D	E	Total	Units
Total numbers	217	314	11	25	72	638	Thous.
Area covered	11524	124014	8403	4201	27435	274577	Nm^2
Mean weight	864	795	945	554	505		g
Total weight	187	249	10	14	36	497	Thous. tonnes

Table 10.2.3 Pelagic *S. mentella*. Catch per unit effort (t/h) by country in Sub-areas XII and XIV.

Year	Bulgaria	Germany[2]	Iceland	Norway	USSR-Russia (BMRT)	Spain
1982	-	-	-	-	1.99	-
1983	-	-	-	-	1.60	-
1984	1.25	-	-	-	1.48	-
1985	1.85	-	-	-	1.68	-
1986	2.04	-	-	-	1.35	-
1987	1.22	0.79	-	-	1.10	-
1988	0.82	1.28	-	-	1.00	-
1989	-	0.70	1.11	-	1.00	-
1990	-	0.89	1.02	1.09	0.99	-
1991	-	-	1.52	1.42	0.80	-
1992	-	-	1.66	1.79	0.63	-
1993	-	-	3.27	2.02	0.63	-
1994	-	-	2.64	2.83	1.70	-
1995	-	2.06	2.00	2.05	1.00	0.71
1996	-	1.45	1.74	1.20	1.30	0.97
1997	-	1.31	1.11	0.66	-[3]	0.83
1998	-	1.30	1.56	0.75	-	0.81
1999	-	0.97	1.55	0.97	-	1.10
2000[1]	-	1.05	1.98	1.12	-	1.17

1 Preliminary
2 1987-1990 reported as GDR (FVSIV)
3 Since 1997, Russian effort data are only available as fishing days

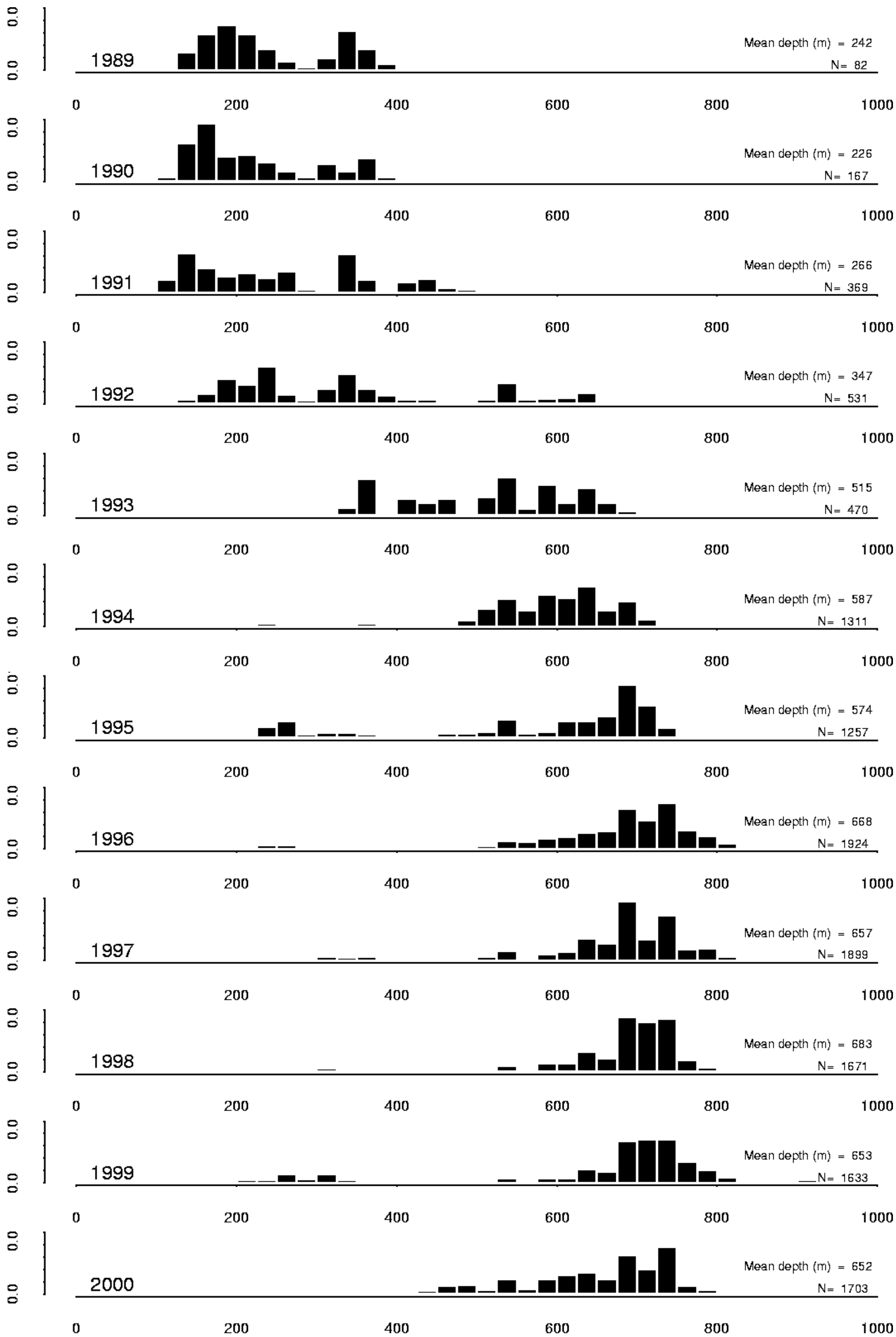


Figure 10.1.1 Depth distribution of Icelandic trawl hauls for pelagic redfish as reported in the log-books since Iceland began its pelagic redfish fishery in 1989.

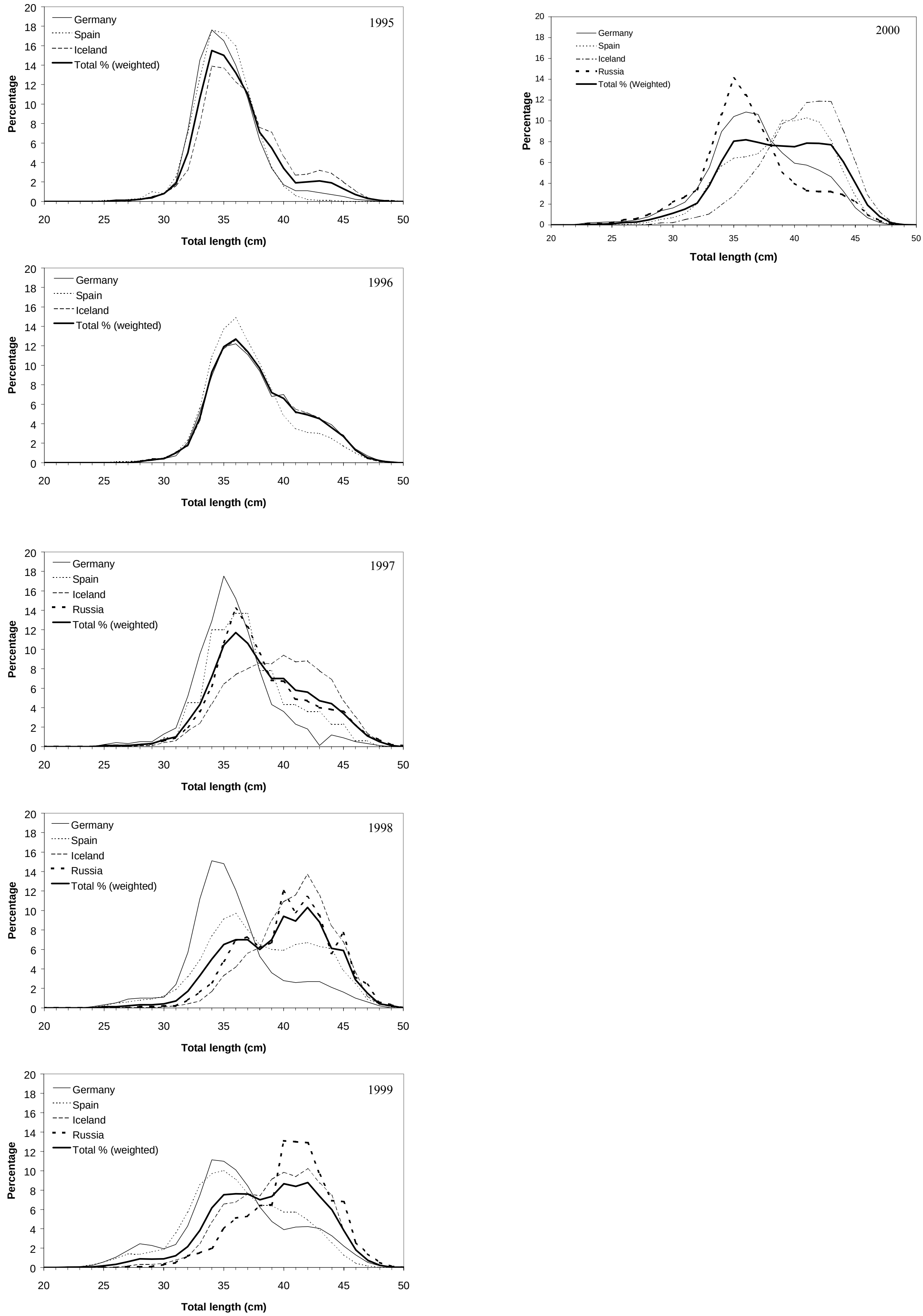


Figure 10.1.2 Length distributions from landings of pelagic *S. mentella* in 1995-2000.

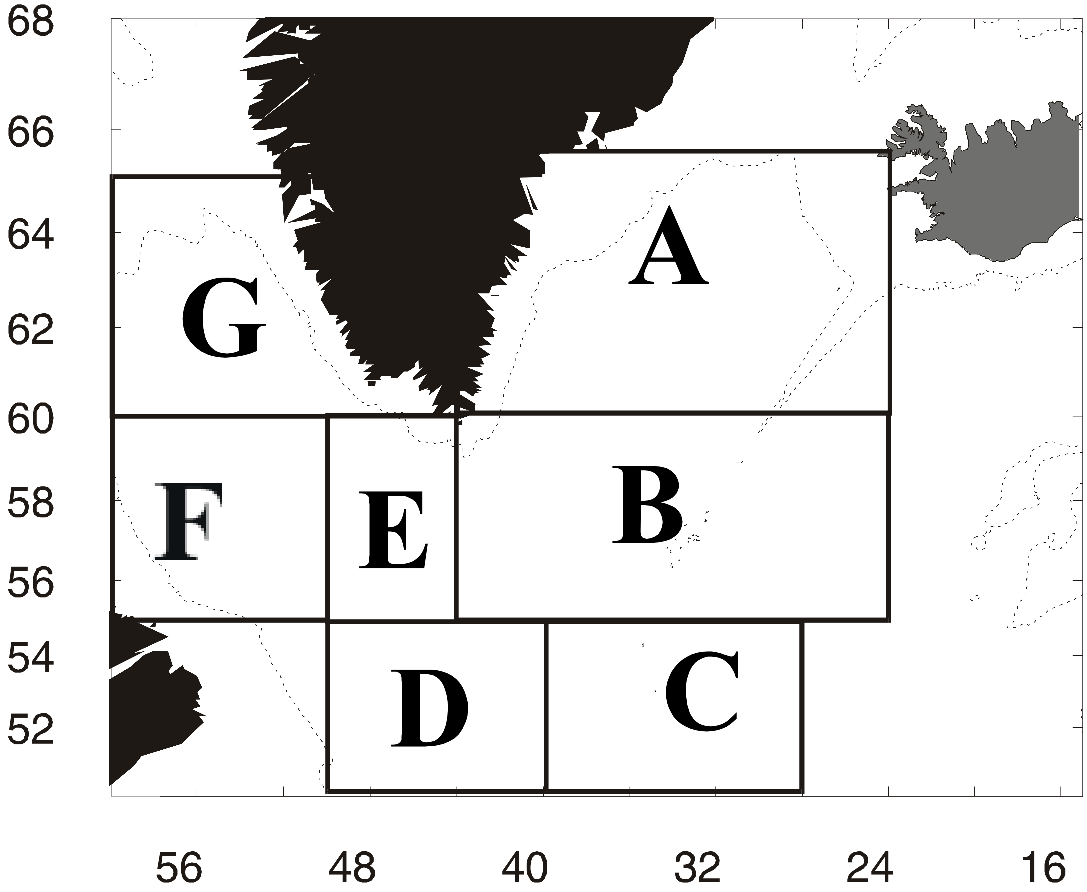


Figure 10.2.1 Sub-areas used on international surveys for redfish in the Irminger Sea and adjacent waters.

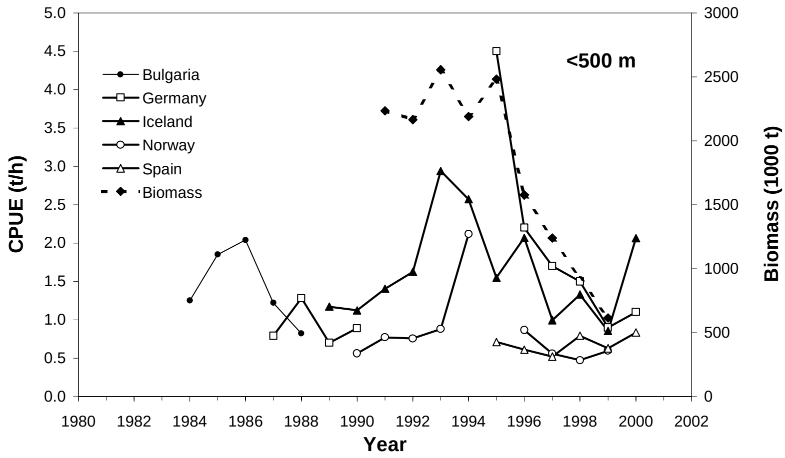


Figure 10.2.3.a Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, shallower than 500m, and estimated acoustic biomass from surveys.

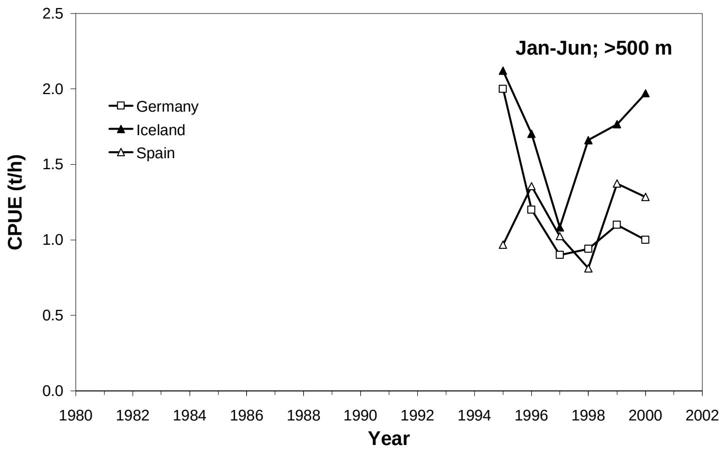


Figure 10.2.3.b Trends in CPUE of pelagic *S. mentella* fishery in the Irminger Sea, deeper than 500m, and estimated acoustic biomass from surveys.

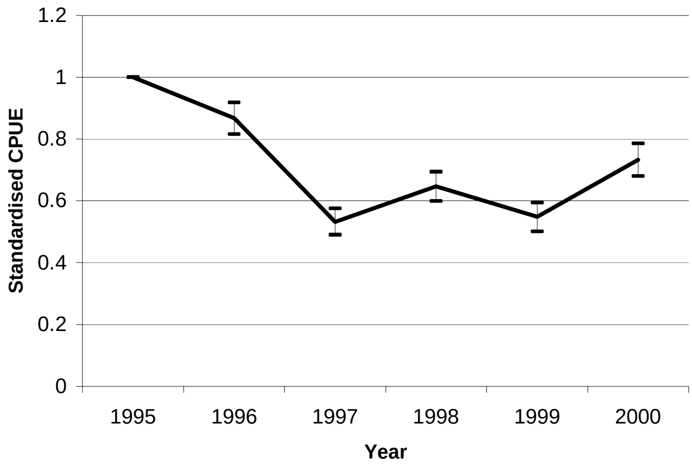


Figure 10.2.3.c Standardised CPUE, as calculated by using data from Germany (1995-2000), Iceland (1995-2000), Greenland (1999-2000) and Norway (1995-1999) in the GLM model (see chapter 10.2.2).

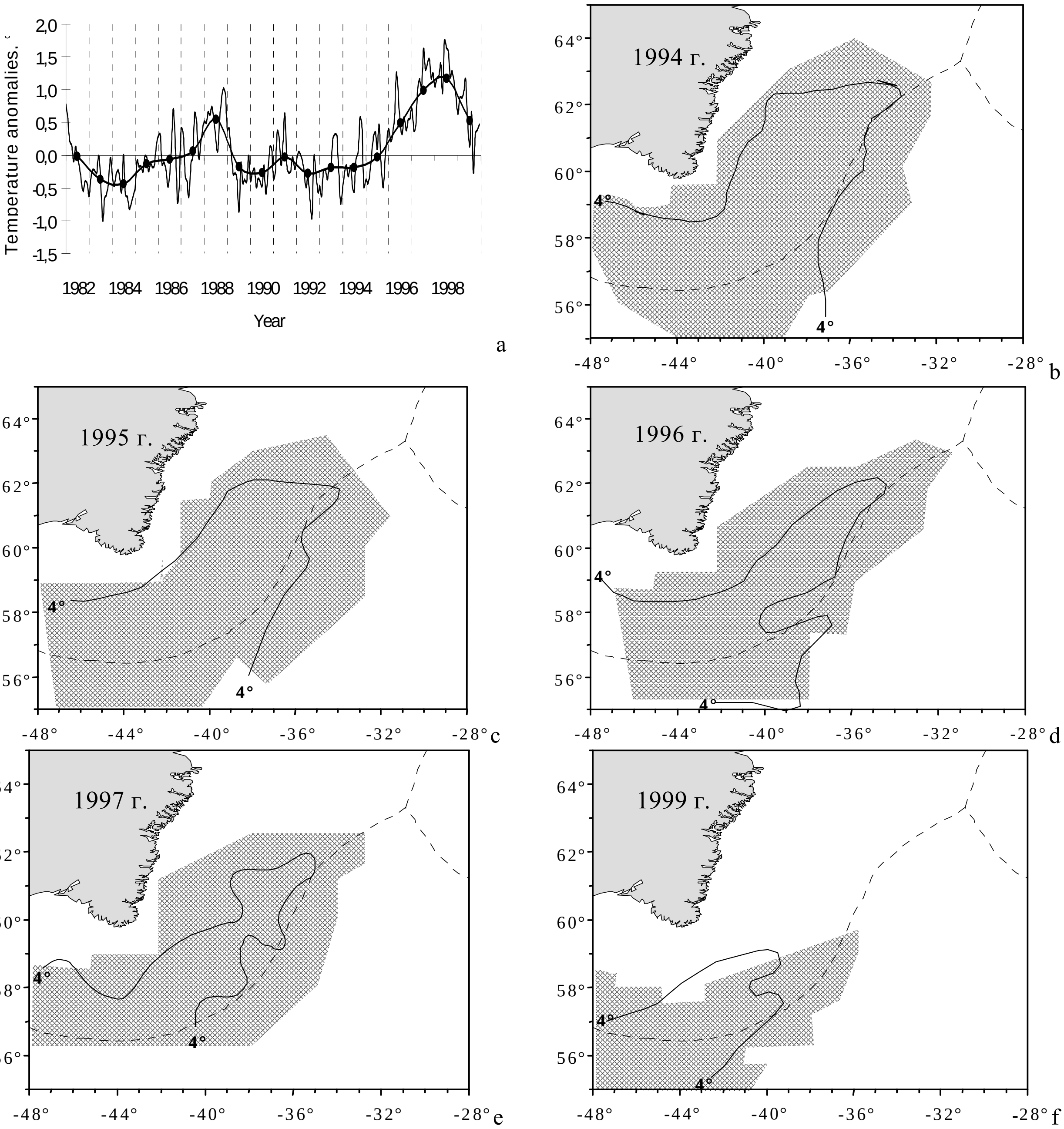


Figure 10.2.4 Monthly and annual (marked) anomalies SST on the feeding ground (a). Locations of mean values of area back scattering strength of redfish more than 10 m^2/nm^2 at depths above 500 m and 4°C isotherm on 200 m in the Irminger Sea in June/July 1994-1999 (b-f).

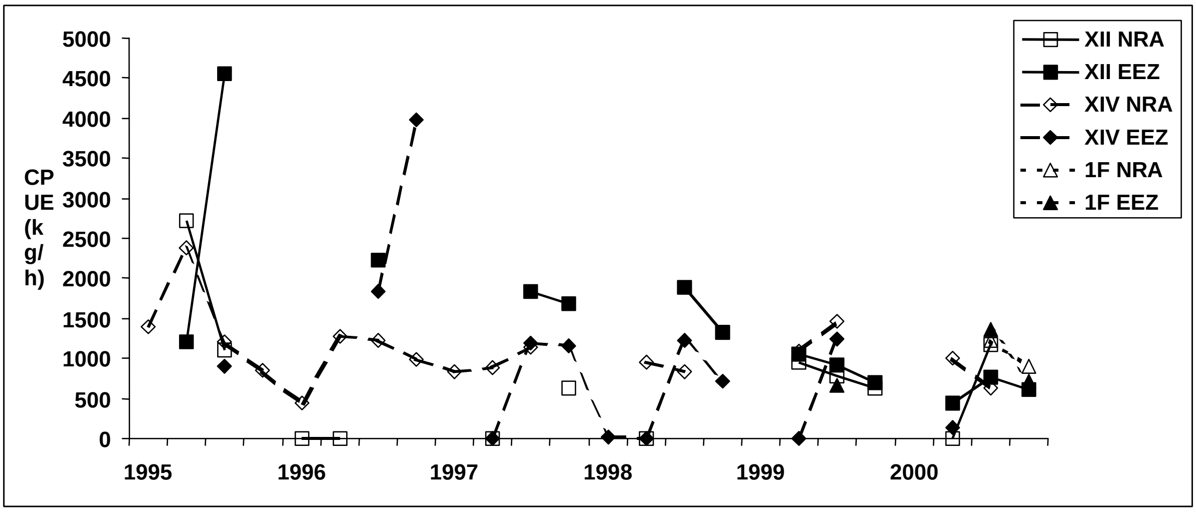


Figure 10.2.5 Unstandardised mean CPUE (kg/h) of the German fleet for oceanic *S. mentella* by year, quarter and area (NEAFC and NAFO NRA and Greenland EEZ in ICES Div. XII and XIV, NAFO Div.1F), 1995-2000.

11 WORKING DOCUMENTS NWWG 2001

1. T. Sigurdsson and H. Björnsson: Redfish in ICES Division Va

2. T. Sigurdsson: Information on the Icelandic Fishery of Oceanic redfish (*S. mentella* TRAVIN); information based on logbook data and sampling from the commercial fishery.

3. T. Sigurdsson, H. Rätz, K. Nedereaas and B. Bárdarsson: Fishery on pelagic redfish (*S. mentella*, Travin): Information based on log-book data from Germany, Greenland, Iceland and Norway.

4. V. N. Shibanov, S. P. Melnikov, V. G. Anikeev and A. M. Safronov: Preliminary information about Russian fishery for the oceanic *S. mentella* in ICES Sub-areas XII, XIV. In NAFO Division 1F in 2000 and biological sampling from commercial catches.

5. Yu. I Bakay and S.P. Melnikov: Peculiarities of aggregations of redfish *S.* probably *mentella* in the Irminger pelagical.

6. S.P. Melnikov, A.P. Pedchenko and V.N. Shibanov: Results from the Russian investigations on pelagic redfish (*Sebastes mentella* TRAVIN) in the Irminger Sea and in NAFO Div. 1F.

7. H.J. Rätz and T. Sigurdsson: Abundance and length composition for *Sebastes marinus* L., deep sea *S. mentella* and juvenile redfish (*Sebastes spp*.) of Greenland and Iceland based on groundfish surveys 1985-2000.

8. H.J. Rätz: On the German fishery and biological characteristics of Oceanic redfish (*Sebastes mentella* Travin).

9. H.J. Rätz: Data on German catches and effort for Greenland halibut (*Reinhardtius hippoglossoides*), redfish (*Sebastes marinus*) and deep sea *S. mentella*), and cod (*Gadus morhua*) in ICES Div. Va, Vb, VIa and XIV, 1995-2000.

10. C. Stransky: Preliminary results of a shape analysis of redfish otoliths:comparison of areas and species.

11. C. Stransky, S. Gudmundsdottir, S. Sigurdsson, S. Lemvig and K. Nedreaas: Age readings of *Sebastes marinus* otoliths: bias and precision between readers and otoliths preparation methods

12. J. J. Engelstoft: The effect of sorting grids on bycatch in the redfish box, East Greenland.

13. S. Junquera and F. González: Spanish pelagic redfish (*Sebastes mentella*) fishery in the NAFO regulatory area (Div. 1F) in 2000.

14. A. Danielsdottir and D. Gislason: Genetic differentiation of pelagic and deep-sea *Sebastes mentella* in the Irminger Sea based on microsatellite markers.

15. H. J. Rätz: Groundfish survey results for cod off Greenland (offshore component) 1982-2000.

16. P. Steingrund: Preliminary assessment of Faroe Plateau cod.

17. B. Mikkelsen: Assessment of Faroe saithe 2000

18. B. Steinarsson and H. Björnsson: Cod in Division Va.

19. G. Guðmundsson: Time series models used in assessment of Icelandic cod and saithe.

20. S. Jonsson: Saithe in Icelandic waters: Updated information and some preliminary assessments.

21. J. Reinert: Preliminary assessment of Faroe haddock

22. B. Steinarsson and H. Björnsson: Icelandic haddock

23. A.C. Gundersen, I. Fossen and J. Boje: Trawl fishery for Greenland halibut in ICES Div XIVb, 2000.

24. A.C. Gundersen and I. Fossen: Longline survey in ICES XIVb, East Greenland, August 2000.

25. L.H. Ofstad and J. Boje: Logbook data on Faroese trawl catches of Greenland halibut 1995-2000

26. J. Boje: The fishery for Grenland halibut in ICES Div. XIVb in 2000.

27. O.A. Jørgensen: Survey for Greenland halibut in ICES Division 14B June-July 2000

28. Å. Høines: Information about the Norwegian fishery for pelagic *Sebastes mentella* in the Irminger Sea, *S.marinus* and Greenland halibut in ICES Sub-areas XII and XIV in 1999 (revised) and 2000 (provisional).

29. E. Hjörleifsson: A short note on Greenland halibut.

30. J. Reinert: Some information on redfish in ICES Division Vb

APPENDIX 1

Denmark (in respect of Greenland and Faroe Islands) request to ICES on requirement on redfish regulatory measures in ICES Div. XIVb

Re.: "The Redfish-Box" on the East Greenland shelf

On behalf of the Greenland Home Rule the Danish Ministry of Food, Agriculture and Fisheries ask the International Council for the Exploration of the Sea for scientific advice regarding the so-called Redfish-Box (enclosed: The Greenland request).

The Redfish-Box is defined in Greenland Home Rule departmental order No. 20 of August 9th 2000 on fisheries regulation by technical measurements, in which section 10 reads:

" § 10. Fisheries by bottom trawl is prohibited in an area off the Greenland east coast, bounded by latitude 67° 00' N and lines between the following points:

- 67° 00' N, 32° 00' W
- 65° 40' N, 32° 00' W
- 65° 30' N, 33° 10' W
- 65° 10' N, 34° 00' W
- 65° 10' N, 35° 00' W
- 64° 20' N, 36° 20' W
- 63° 55' N, 36° 45' W
- 63° 31' N, 38° 45' W
- 63° 27' N, 39° 30' W
- 63° 45' N, 39° 30' W
- a point at the Greenland east coast by 63° 45' N.

Yours sincerely,

Knud Larsen

cc: Greenland Home Rule

Danish Institute for Fisheries Research

Denmark (in respect of Greenland and Faroe Islands) request to ICES on requirement on redfish regulatory measures in ICES Div. XIVb

The so-called "Redfish-box" on the East Greenland shelf was established in 1978 after a recommendation from ICES in order to protect nursery grounds for juvenile redfish. The box was based on high catch rates of small redfish in East Greenland waters as observed from bycatches in cod fisheries from 1950'ies until the regulation. According to later occasional trial fishery in the box-area, there is a large variation in the bycatch inside as well as outside the box. The composition of the fisheries in East Greenland has changed since then, currently only comprising a directed Greenland halibut fishery (minimum meshsize 140 mm) and a shrimp fishery. The closure of such large area for bottom trawl activity constitutes a management problem, if redfish bycatch from time to time is insignificant.

The Greenland Home Rule Government has from 1' October 2000 introduced mandatory use of 22-mm sorting grids into the full geographic range of the Greenland shrimp fishery in order to minimise bycatch of fish.

Greenland therefore requests ICES to provide information on the following: Is there a biological justification for maintaining an area within sub-area XIV where bottom trawl activity is prohibited to protect redfish nursery grounds (the so-called "Redfish-Box"). Special emphasis must be put on:

1) The present mandatory use of grids in the shrimp fishery.

2) Influence of trawling activity on the nursery habitat, i.e. the ecosystem effect.