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Report of the North Western Working Group

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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: E. Hjorleifsson, Iceland) will meet at ICES Headquarters from 27 April–6 May 2004 to

a) assess the status of and provide catch options for 2005 for the stocks of redfish in Subareas V, XII and XIV, Greenland halibut in Subareas V and XIV, cod in Subarea XIV, NAFO Subarea 1, and Division Va, saithe in Division Va and haddock in Division Va;

b) assess the status of and provide effort options and expected corresponding catches for 2005 for cod, haddock, and saithe in Division Vb as these stocks are under effort control;

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

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

e) update information on the stock composition, distribution and migration of the redfish stocks in Subareas V and XIV, and consider the report of SGSIMUR with regard to implications for assessment and advice on pelagic "deep-sea" *Sebastes mentella* and the *Sebastes mentella* fished in demersal fisheries on the continental shelf and slope;

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

g) provide specific information on possible deficiencies in the 2004 assessments including, at least, any major inadequacies in the data on catches, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation, including inadequacies in available software. The consequences of these deficiencies for the assessment of the status of the stocks and for the projection should be clarified;

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

i) document fully the methods to be applied in subsequent update assessments and list factors that would warrant reconsideration of doing an update, and consider doing a benchmark ahead of schedule, for stocks for which benchmark assessments are done.

In addition to the ToR from ICES the NWWG is asked to address the NEAFC request to ICES on the following issues:

*"**Regarding redfish** stocks: a) submit new information on stock identity of the components of redfish such as "pelagic deep-sea" Sebastes mentella, "oceanic" Sebastes mentella fished in the pelagic fisheries and the "deep-sea" Sebastes mentella fished in demersal fisheries on the continental shelf and slope. NEAFC requests ICES to include in its advice all relevant information, including the outcome of the ICES Study Group on Stock Identity and Management Units of Redfishes, planned in August 2004;"*

Since SGSIMUR (ICES ToR-e above) will not meet until the fall and since the advice by ACFM on S. mentella will not be until the fall 2004 (after a special NWWG fall meeting), the work on S. mentella during the current meeting related only to updating informations on catches and the fisheries (ToR c and f). A full stock assessment is however provided for the S. marinus since it is the understanding of the working group that ACFM will provide advice on that stock this spring.

Although ToR d, has been part of the ToR of this working group for a number of years, it has not been considered by the working group during this meeting.

No systematic attempt were made to identify possible deficiencies in the inadequacies of the observables and model formulations (ToR g) beyond that what is provided in the individual chapters. The inadequacies of available ICES software has been commentented on in earliear reports of this working group.

In last years report it was noted that changes in the structure of the report (Annex, "Quality Control") needed intersessional work. Since this work was not done prior to this meeting it was decided to keep the current format of the report. Full documentation of methods to be applied in subsequent update assessment (ToR i) is thus only available as specified in individual assessments. Part of the reasons is that the working group has in addition to focusing on providing a point numbers for advisory purpose been exploring tools that may help in understanding better the limitation of the observables as well as influence on various model assumptions.

1.3 Stocks assessed by NWWG

Introduction

The stocks dealt with by NWWG can be divided into two classes: those for which data are sufficient to allow an age-based analytical assessment, and those for which either the data is limited or for which the quality of the data is questionable, impeding analytical assessments. All gadoid stocks are in the first class except for Faroe Bank cod, where a short time-series and incomplete biological sampling of the landings inhibit standard ICES analytical assessment, and the offshore cod in Greenland, where a ceased fishery prevents a VPA. In the second class are most of the redfish management units as well as Greenland halibut. One redfish stock, *S. marinus*, sits in the middle of these two extremes, being assessed by a length-based model (Bormicon).

Age-based analytical assessements

For most of the stocks for which age-based analytical assessments were carried out, the terminal fishing mortality was estimated by tuning aged catch data with selected fleet age-disaggregated commercial or survey indices. In the final run only the Faroe saithe was based on a commercial tuning series since no reliable survey index is available for that stock. Overview of the observables, models and principal assumptions used for the gadoid stocks that are analytically assessed by the NWWG are shown in table 1.1.1, including a comparison with last year's setttings.

Faroe stocks

In the last two years two survey indices have been made available as a tuning fleet to the catch at age data of cod and haddock. In last years assessment the tuning of the cod was only based on the autumn survey. Post-stratification of the spring survey, that was done this year, resulted in that series being used in addition to the autumn survey in the final assessment of the cod (a benchmark assessment). As last year, both the spring and the summer survey were used in the assessment of the haddock, an updated assessment based on SPALY settings. Since the saithe assessment was an update it was assessed using, with some minor modifications, the commercial cuba tuning fleet.

The assessment on the Faroese stocks has historically been based on the Lowestoft software. This year the working group experimented with the ADAPT as implemented in the NOOA Fisheries Toolbox (http://nft.nefsc.noaa.gov) in particular since it provides some indication of the noise in the observables thorough easily executable bootstrapping. The working group thought this tool was of great value to judge the quality of the assessment although point estimators used as the basis of forward projections were still based on the XSA.

Icelandic stocks

The results from the studies indicate that the input data for the cod is not very sensitive to the model assumptions made. The point estimator for forward projection of the cod was based on the same assumption and settings as last year since point estimators from other models were not considered statistically different from that. As indicated in last years assessment the 2003 spring survey for the haddock can be considered as an outlier. It still influences to quite extent the terminal estimators which in addition to very high observed indices in recent year (outside historical experience) make terminal estimates of the haddock more uncertain than experienced in the past. Although the haddock is considered an update assessment some minor changes were made to last years settings to reduce the influence of inertia terms (shrinkage). The saithe was not assessed by ICES last year. The point estimators in the adopted run was based on the model assumption as was run in last years domestic assessment at MRI, Reykjavik.

In recent years icelandic cod, haddock and saithe have been assessed by using various software packages. The reason for the use of different software is a result of the preference and expertise of the individual user that does the assessment. All the models are based on catch-at-age analysis (i.e. using the stock and the catch equation) using survey information as additional information. Various different assumptions are then explored by the different individuals running the different software – the final choice of settings is based on personal judgement (sometimes referred to as expert opinion).

Stock	Assessment year	Assessment model	Name of tuning fleetq	Year range for tuning	Age range for tuning	Time series weights	Power model	q plateau	shrinkage year range	shrinkage age range	S.E. for shrinkage	min S.E. for fleet estimates	selectivity platau	Selectivity	Selectivity functions	F contraints
Faroe cod	2003	XSA	Summer survey	1996-2002	2-8	None	2	6+	5	5	2.0	0.3				
	2004	XSA	Summer survey	1996-2003	2-8	None	2	6+	5	5	2.0	0.3				
			<u>Spring survey</u>	1994-2004	2-9											
Faroe haddock	2003	XSA	Summer survey	1996-2002	1-8	None	2-	6+	5	5	0.5	0.3				
			Spring survey	1994-2003	1-5											
	2004	XSA	Summer survey	1996-2003	1-8	None	2-	6+	5	5	0.5	0.3				
			Spring survey	1994-2004	1-5											
Faroe saithe	2003	XSA	Cuba logbooks	1985-2002	3,5-11	Yes	5-	9+	5	3	0.5	0.3				
	2004	XSA	Cuba logbooks	1985-2003	**<u>3-11</u>**	Yes	5-	9+	5	3	0.5	0.3				
Icelandic saithe	2003*	CAMERA	March survey	1985-2003	2-8	None	None	6+					8+	fixed	non parametric	None
	2004	CAMERA	March survey	1985-2004	2-8	None	None	6+					8+	fixed	non parametric	None
Icelandic cod	2003	ADCAM	March survey	1985-2003	1-10	None	1-5	None					None	RW	non parametric	RW
	2004	ADCAM	March survey	1985-2004	1-10	None	1-5	None					None	RW	non parametric	RW
Icelandic haddock	2003	ADCAM	March survey	1985-2003	1-9	None	None	None							non parametric	RW
	2004	ADCAM	March survey	1985-2004	1-9	None	None	None							non parametric	**<u>RW**</u>**

* Not assessed by ICES in 2003. Setting of the domestic assessment at MRI, Reykjavik

** The inertia term was reduced

RW: Random walk

Table 1.1.1. Overview of the observables, models and principal assumptions used for the gadoid stocks that are analytically assessed by the NWWG. Comparisons in settings are made between the present assessment year and 2003. Changes in settings between years are shown as underlined and bold.

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

2.1 Overview

2.1.1 Fisheries

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese fishermen, whereas the major part of the pelagic fisheries are conducted by foreign fishermen licensed through bilateral and multilateral fisheries agreements.

Pelagic Fisheries. Three main species of pelagic fish are fished in Faroese waters: blue whiting, herring and mackerel; several nations participate. The Faroese pelagic fisheries are almost exclusively conducted by purse seiners and larger purse seiners also equipped for pelagic trawling. The pelagic fishery by Russian vessels is conducted by large factory trawlers. Other countries use purse seiners and factory trawlers.

Demersal Fisheries. Although they are conducted by a variety of different vessels, the demersal fisheries can be grouped into fleets of vessels operating in a similar manner. Some vessels change between longlining, jigging and trawling, and they therefore can appear in different fleets. In the following there is first a description of the Faroese fleets followed by the fleets of foreign nations.

Open boats. These vessels are below 5 GRT. They use longline and to some extent automatic, jigging engines and operate mainly on a day-to-day basis, targeting cod, haddock and to a lesser degree saithe. The large number of open boats participating in the fisheries (above 1400 licenses) are often operated by non-professional fishermen.

Smaller vessels using hook and line. This category includes all the smaller vessels, between 5 and 110 GRT operating mainly on a day-to-day basis, although the larger vessels behave almost like the larger longliners above 110 GRT with automatic baiting systems and longer trips. The area fished is mainly nearshore, using longline and to some extent automatic, jigging engines. The target species are cod and haddock. The number of licenses is about 90.

Longliners > 110 GRT. This group refers to vessels with automatic baiting systems. The main species fished are cod, haddock, ling and tusk. The target species at any one time is dependent on season, availability and market price. In general, they fish mainly for cod and haddock from autumn to spring and for ling and tusk during the summer. During summer they also make a few trips to Icelandic waters. There are 19 vessels in this fleet.

Otter board trawlers < 500 HP. This refers to smaller fishing vessels with engine powers up to 500 Hp. The main areas fished are on the banks outside the areas closed for trawling. They mainly target cod and haddock. Some of the vessels are licensed during the summer to fish within the twelve nautical mile territorial fishing limit, targeting lemon sole and plaice.

Otter board trawlers 500-1000 HP. These vessels fish mainly for cod and haddock. They fish primarily in the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Otter board trawlers >1000 HP. These vessels, also called the deep-water trawlers, consist of 13 vessels. They target several deep-water fish species, especially redfish, blue ling, Greenland halibut, grenadier and black scabbard fish. Saithe is also a target species and in recent years they have been allocated individual quotas for cod and haddock on the Faroe Plateau.

Pair trawlers <1000 HP. These vessels fish mainly for saithe, however, they also have a significant by-catch of cod and haddock. The main areas fished are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands.

Pair trawlers >1000 HP. This category targets mainly saithe, but their by-catch of cod and haddock is important to their profit margin. In addition, some of these vessels during the summers have special licenses to fish in deep water for greater silver smelt. The areas fished by these vessels are the deeper parts of the Faroe Plateau and the banks to the southwest of the islands . Number of vessels in the two pair trawlers fleets is 31.

Gill netting vessels. This category refers to vessels fishing mainly Greenland halibut and monkfish. They operate in deep waters off the Faroe Plateau, Faroe Bank, Bill Bailey's Bank, Lousy Bank and the Faroe-Iceland Ridge. This fishery is regulated by the number of licensed vessels (8) and technical measures like depth and gear specifications.

Jiggers. Consist of a mixed group of smaller and larger vessels using automatic jigging equipment. The target species are saithe and cod. Depending on availability, weather and season, these vessels operate throughout the entire Faroese region. Most of them can change to longlines and in recent years jigging effort has decreased as compared to longlines.

Foreign longliners. These are mainly Norwegian vessels of the same type as the Faroese longliners larger than 110 GRT. They target mainly ling and tusk with by-catches of cod, haddock and blue ling. Norway has in the bilateral fishery agreement with the Faroes achieved a total quota of these species; numbers of vessels can vary from year to year.

Foreign trawlers. These are mainly otter board trawlers of the same type as the Faroese otter board trawlers larger than 1 000 HP. Participating nations are United Kingdom, France, Germany and Greenland. The smaller vessels, mainly from the United Kingdom and Greenland, target cod, haddock and saithe, whereas the larger vessels, mainly French and German trawlers, target saithe and deep-see species like redfish, blue ling, grenadier and black scabbardfish. As for the longliners, the different nations have in their bilateral fishery agreement with the Faroes achieved a total quota of these species; numbers of vessels can vary from year to year

2.1.2 Fisheries and management measures

The fishery around the Faroe Islands has for centuries been an almost free international fishery involving several countries. Apart from a local fishery with small wooden boats, the Faroese offshore fishery started in the late 19th century. The Faroese fleet had to compete with other fleets, especially from the United Kingdom with the result that a large part of the Faroese fishing fleet became specialised in fishing in other areas. So except for a small local fleet most of the Faroese fleet were fishing around Iceland, at Rockall, in the North Sea and in more distant waters like the Grand Bank, Flemish Cap, Greenland, the Barents Sea and Svalbard.

Up to 1959, all vessels were allowed to fish around the Faroes outside the 3 nm zone. During the 1960s, the fisheries zone was gradually expanded, and in 1977 an EEZ of 200 nm was introduced in the Faroe area. The demersal fishery by foreign nations has since decreased and Faroese vessels now take most of the catches. The fishery may be considered a multi-fleet and multi-species fishery as described below.

During the 1980s and 1990s the Faroese authorities have regulated the fishery and the investment in fishing vessels. In 1987 a system of fishing licences was introduced. The demersal fishery at the Faroe Islands has been regulated by technical measures (minimum mesh sizes and closed areas). In order to protect juveniles and young fish, fishing is temporarily prohibited in areas where the number of small cod, haddock and saithe exceeds 30% in the catches; after 1–2 weeks the areas are again opened for fishing. A reduction of effort has been attempted through banning of new licences and buy-back of old licences.

A new quota system, based on individual quotas, was introduced in 1994. The fishing year started on 1 September and ended on 31 August the following year. The aim of the quota system was, through restrictive TACs for the period 1994–1998, to increase the SSBs of Faroe Plateau cod and haddock to 52 000 t and 40 000 t, respectively. The TAC for saithe was set higher than recommended scientifically. It should be noted that cod, haddock and saithe are caught in a mixed fishery and any management measure should account for this. Species under the quota system were Faroe Plateau cod, haddock, saithe, redfish and Faroe Bank cod.

The catch quota management system introduced in the Faroese fisheries in 1994 was met with considerable criticism and resulted in discarding and in misreportings of substantial portions of the catches. Reorganisation of enforcement and control did not solve the problems. As a result of the dissatisfaction with the catch quota management system, the Faroese Parliament discontinued the system as from 31 May 1996. In close cooperation with the fishing industry, the Faroese government has developed a new system based on individual transferable effort quotas in days within fleet categories. The new system entered into force on 1 June 1996. The fishing year from 1 September to 31 August, as introduced under the catch quota system, has been maintained.

The individual transferable effort quotas apply to 1) the longliners less than 100 GRT, the jiggers, and the single trawlers less than 400 HP, 2) the pair trawlers and 3) the longliners greater than 100 GRT. The single trawlers greater than 400 HP do not have effort limitations, but they are not allowed to fish within the 12 nautical mile limit and the areas closed to them, as well as to the pair trawlers, have increased in area and time. Their catch of cod and haddock is limited by maximum by-catch allocation. The single trawlers less than 400 HP are given special licenses to fish inside 12 nautical miles with a by-catch allocation of 30% cod and 10% haddock. In addition, they are obliged to use sorting devices in their trawls. One fishing day by longliners less than 100 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners less than 100 GRT could therefore double their allocation by converting to jigging. Table 2.1.1 shows the number of fishing days used by fleet category for 1985–1995 and 1998–2003 and Table

2.1.2 shows the number of allocated days inside the outer thick line in Figure 2.1.1. Holders of individual transferable effort quotas who fish outside this line can fish for 3 days for each day allocated inside the line. Trawlers are generally not allowed to fish inside the 12 nautical mile limit. Inside the innermost thick line only longliners less than 100 GRT and jiggers less than 100 GRT are allowed to fish. The Faroe Bank shallower than 200 m is closed to trawling.

The effort quotas are transferable within gear categories. The allocations of number of fishing days by fleet categories was made such that together with other regulations of the fishery they should result in average fishing mortalities on each of the 3 stocks of 0.45, corresponding to average annual catches of 33% of the exploitable stocks in numbers. Built into the system is also an assumption that the day system is self-regulatory, because the fishery will move between stocks according to the relative availability of each of them and no stock will be overexploited.

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 is 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 as mentioned above are still in effect.

2.1.3 The marine environment

The waters around the Faroe Islands are in the upper 500 m dominated by the North Atlantic current, which to the north of the islands meets the East Icelandic current. Clockwise current systems create retention areas on the Faroe Plateau (Faroe shelf) and on the Faroe Bank. In deeper waters to the north and east is deep Norwegian Sea water, and to the south and west is Atlantic water. From the late 1980s the intensity of the North Atlantic current passing the Faroe area decreased, but it has increased again in the most recent years. The productivity of the Faroese waters was very low in the late 1980s and early 1990s. This applies also to the recruitment of many fish stocks, and the growth of the fish was poor as well. From 1992 onwards the conditions have returned to more normal values which also is reflected in the fish landings. There has been observed a very clear relationship, from primary production to the higher trophic levels (including fish and seabirds), in the Faroe shelf ecosystem, and all trophic levels seem to respond quickly to variability in primary production in the ecosystem (Gaard, E. et al. 2001). In the section below on catchability analysis this is further discussed.

2.1.4 Catchability analysis

In an effort management regime with a limited numbers of fishing days, it is expected that vessels will try to increase their efficiency (catchability) as much as possible in order to optimise the catch they get and its value from the number of days allocated. "Technological creeping" should therefore be monitored closely in such a system. However, catchability of the fleets can change for other reasons, e.g. availability of the fish to the gears. If such effects are known or believed to exist, catchability changes may need to be incorporated in the advice on fisheries. In the following analysis catchability was calculated from the catch per unit of effort (in numbers) divided by the stock estimators for each age group. The average catchability was calculated using the same age groups as are used in the calculation of reference F for each stock. Figure 2.1.2., which gives an overview of the average catchability of the principal fleets for the three major stocks in Divison Vb, does not indicate that there are any long term positive or negative trends in catchability for the period 1985 to 2003. Of notice however is that there are substantial short term trends in the catchability of both the cod and the haddock and these were investigated further.

The primary production of the Faroe Shelf ecosystem may vary by as much as a factor of five and given the link between primary production and recruitment and growth (production) of cod as demonstrated by Steingrund & Gaard (submitted), this could have pronounced effects on catchability and stock assessment as a whole. For cod there seems to be an inverse relationship between primary production and fishing mortality in recent years (Fig. 2.1.3). The growth of cod seems to be negatively correlated with the catchability of longlines (Fig. 2.1.4), suggesting that cod prefer longline baits when natural food abundance is low. Since longliners usually take a large proportion of the cod catch, the total fishing mortality fluctuates in the same way as the longline catchability and thus there is a negative relationship between cod growth and fishing mortality (Fig. 2.1.5).

For haddock there may be be a similar mechanism as for cod since there are indications that growth and fishing mortality is inversly related, at least in recent years (figure 2.1.6).

For saithe no clear relationship was observed between the catchability for Cuba trawlers (pair trawlers take the majority of the catch) and other variables such as primary production, growth and stock size.

The chair of ACFM had written to the chair of the NWWG requesting an evaluation of possible changes in catchability due to the introduction of the effort management system. The analysis reported above suggests that natural factors may have a larger influence than technological ones, at least for Faroe cod and haddock. In addition, the available data indicates that there has not been sufficient time since the implementation of the effort management system in 1996 to detect convincing changes in catchability. However, from a management perspective, if the hypothesis that catchability is related to productivity is true, and if productivity in 2004 and 2005 is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort for the next fishing season.

2.1.5 Summary of the 2004 assessment of Faroe Plateau cod, haddock and saithe (figure 2.1.7)

Landings of cod, haddock and saithe on the Faroes appear to be closely linked with the total biomass of the stocks. For cod, the peaks and valleys are generally of the same height, suggesting that the exploitation ratio has remained relatively stable over time. For haddock, the difference at the beginning of the series suggest that the exploitation rate was decreasing during that period, while it would have been relatively steady since the mid 1970s. For saithe, there is a suggestion that the exploitation rate was increasing at the beginning of the period with reasonable stability since the mid to late 1970s.

Fishing mortality estimates from the assessment do not confirm this perception, but that is partly due to unstable estimates of fishing mortality at the oldest, poorly sampled ages. The ratio of landings to biomass could therefore provide a more stable indication of the exploitation status of the resource

The plot of exploitation ratio over time does support the above hypothesised trends in fishing mortality for haddock and saithe. The overall ratio (sum of cod, haddock and saithe landings over the sum of their biomass) is remarkably stable between 0.20 and 0.25 over the period 1961 to 1985, with possibly a slight increasing trend. The ratio has been more variable since for both individual species and for the aggregate. Although variable, there appears to be an increasing trend from 0.14 in 1995 to 0.24 in 2003. The most recent biomass estimates, however, are most likely to change in future assessments, and the trend could therefore change as a result of future stock assessments.

The same data can be shown differently with area graphs. This suggests that the landings of saithe have taken an increasing part of the total biomass in the area.

2.1.6 References:

Gaard. E., Hansen, B., Olsen, B and Reinert, J. 2001. Ecological features and recent trends in physical environment, plankton, fish stocks and sea birds in the Faroe plateau ecosystem. *In: K- Sherman and H-R Skjoldal (eds). Changing states of the Large Marine Ecosystems of the North Atlantic.*

Steingrund, P. and Gaard, E. (submitted). Relationship between phytoplankton production and cod production on the Faroe shelf. ICES Journal of Marine Science.

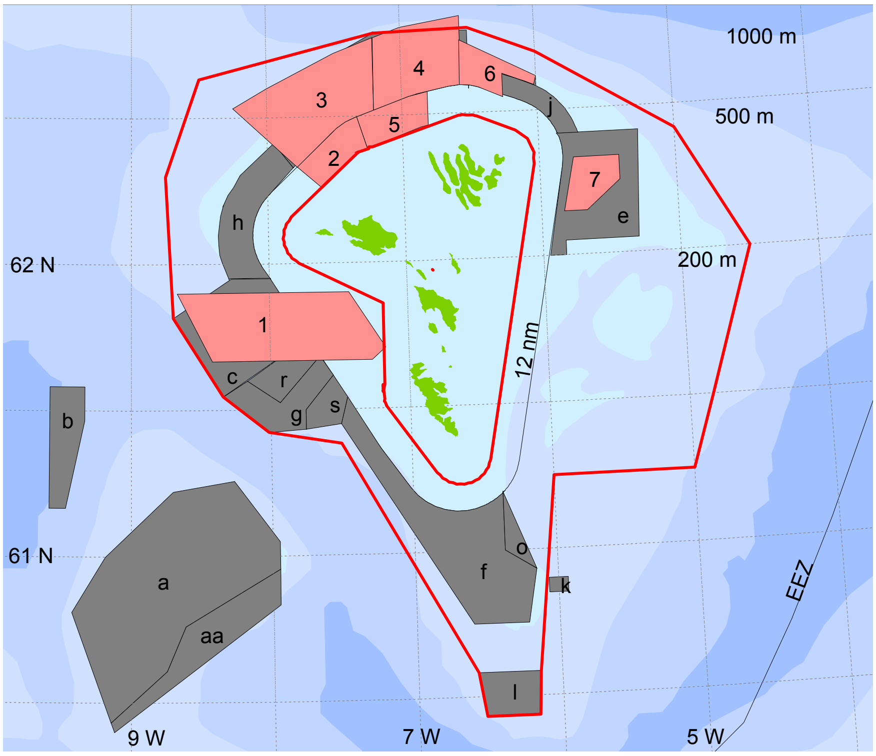
Table 2.1.1 Number of fishing days used by various fleet groups in Vb1 1985-1995 and 1998-2003. For other Fleets there are no effort limitations. Catches of cod, haddock, saithe and redfish are also regulated by by-catch percentages given in the text. In addition there are special fisheries regulated by licenses. (This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears).

(This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears)			
Year	Longliner 0-110 GRT, jiggers, trawlers < 400 HP	Longliners > 110 GRT	Pairtrawlers > 400 HP
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
Average(85-95)	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
2003*	27642	2196	6624
Average(98-01)	25945	2458	6776

* Preliminary, not all days included

	Fleets	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	No. of licenses
Group 1	Single trawlers > 400 HP	Regulated by area and by-catch limitations								13
Group 2	Pair trawlers > 400 HP	8225	7199	6839	6839	6839	6839	6771	6636	28
Group 3	Longliners > 110 GRT	3040	2660	2527	2527	2527	2527	2502	2452	19
Group 4	Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	9320	9328	8861	8861	8861	8861	8772	8597	106
Group 5	Longliners and jiggers < 15 GRT	22000	23625	22444	22444	22444	22444	22220	21776	>1400

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



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 2.1.1 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

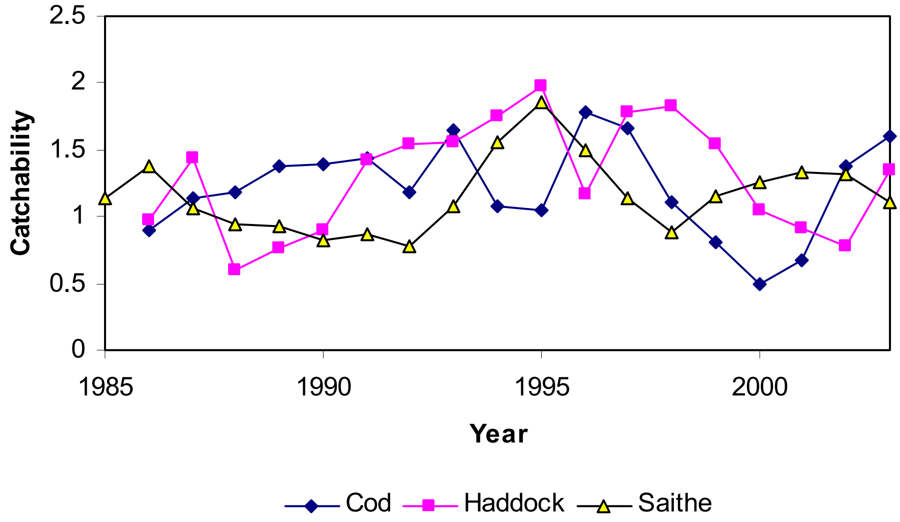


Figure 2.1.2. Catchability trend in the principal fleets for cod, haddock and saithe in Division Vb. The catchability for the cod and the haddock is based on the long line fleet (age groups 3-7) and the saithe on the cuba trawl fleet (age groups 4-8).

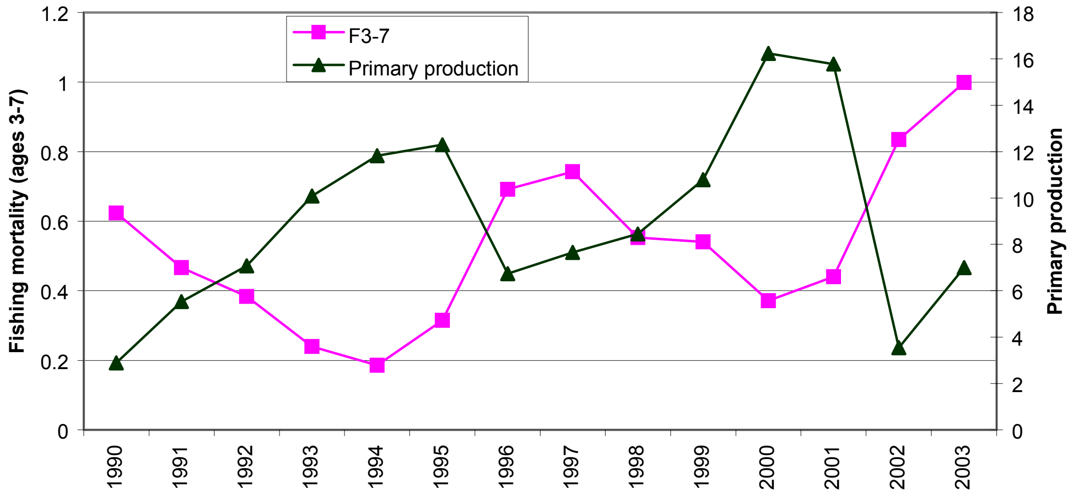


Figure 2.1.3. Faroe Plateau cod. Fishing mortality and primary production by year.

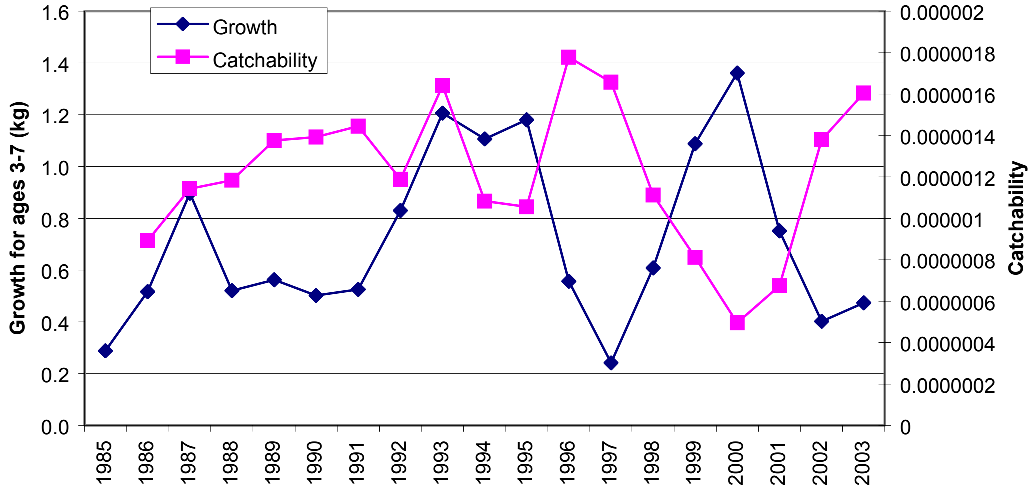


Figure 2.1.4. Faroe Plateau cod. Growth and catchability with longlines by year.

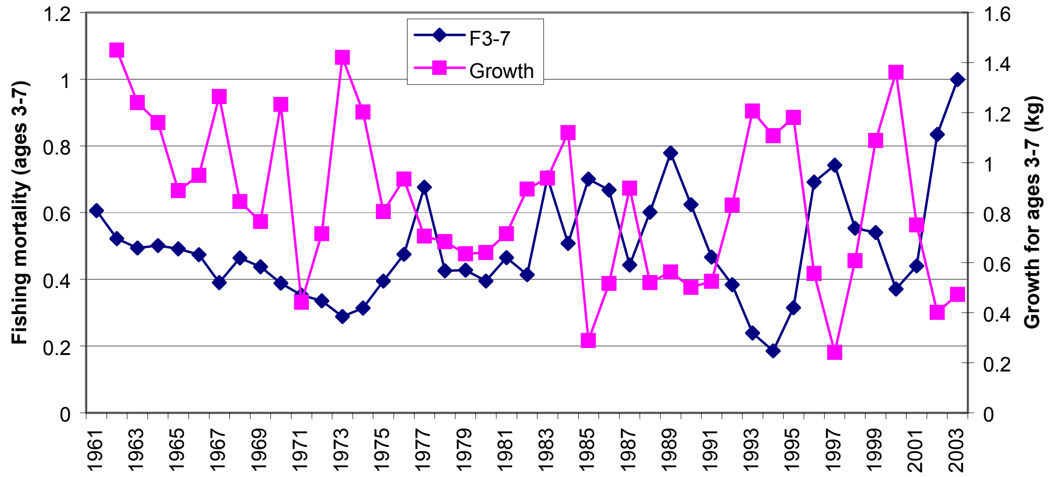


Figure 2.1.5. Faroe Plateau cod. Growth and fishing mortality by year.

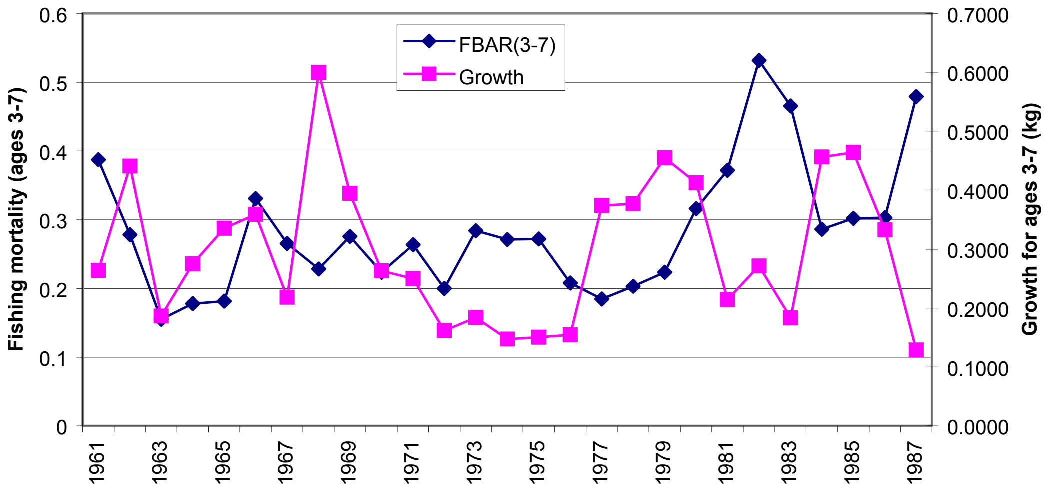
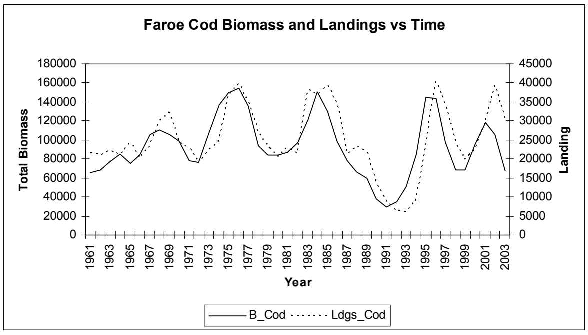
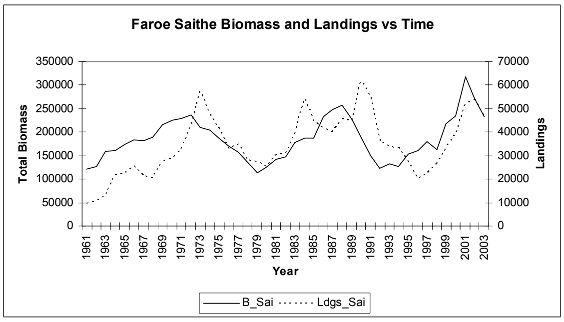
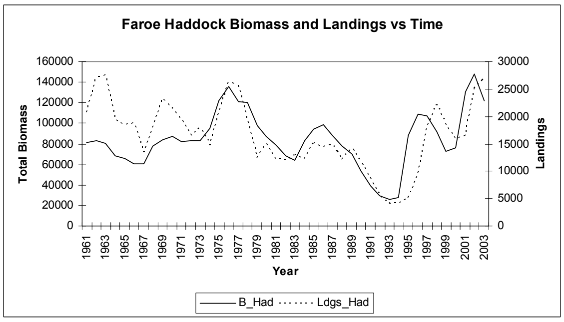
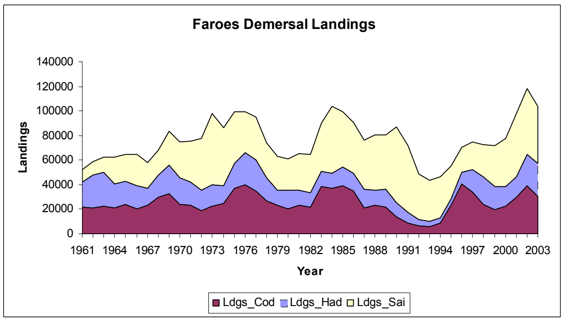


Figure 2.1.6. Faroe haddock. Growth and fishing mortality by year.









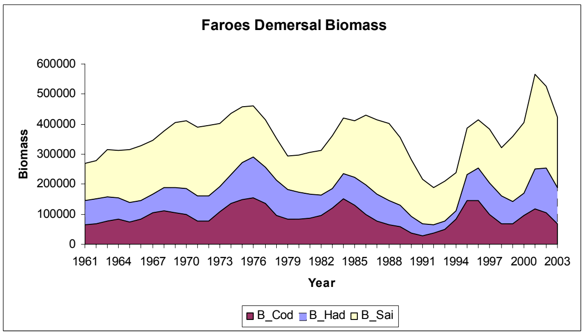


Figure 2.1.7. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2004 stock summary

2.2 Faroe Plateau Cod

2.2.1 Stock definition

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

2.2.2 Trends in landings

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

The relatively high recruitment in 1980-1983 allowed a good fishery for cod in the period 1983 to 1986 when landings some years reached almost 40 000 t. Landings decreased afterwards to only 6 000 tonnes in 1993, the lowest on record. In 1995 the officially reported landings increased to slightly above 19 000 t. Information from the fishing industry indicated misreporting in the order of 3 330 t (3 000t. gutted weight) for 1995 which were added to the officially reported landings in Table 2.2.2.2. 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 and increased availability.

In recent years, statistics for the Faroese fishery in that part of Sub-division IIa 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 2.2.2.2 under the row labeled "Used in the assessment". No information on the Faroese landings from IIa were available for 1993-1996. The French landings of Faroe Plateau cod in 1989 and 1990 as reported to the Faroese authorities are also included. Scottish catches 1991-1999 reported from the Faroe Bank (Vb2) were in the 2001 assessment moved to the Faroe Plateau (Vb1), by advice from the Faroese Coastal Guard.

Since the introduction of the EEZ, the Faroe Plateau cod has almost entirely been exploited by the Faroese fishing fleets. In recent years, the longliners and the pair trawlers have usually taken most of the catches. Since autumn 1999 single trawlers > 1000 HP have increased their share of the total catches considerably as a result of a special quota (in tonnes, not fishing days) allocated to them in shallow water (< 200 m) on a half year basis (September 1 and March 1).

The nominal landings of cod (1986-2003) from the Faroe Plateau by nations as officially reported to ICES, are given in Table 2.2.2.1. Table 2.2.2.2 shows the figures used in the assessment. In 2003, the catches exceeded 30 thousand tonnes, which is slightly above the long term average. Table 2.2.2.3 shows the landings for the most important fleet categories.

2.2.3 Catch-at-age

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

Landings-at-age were updated to account for a change in the nominal landings for 2001 and 2002. Landings-at-age for 2003 are provided for the Faroese fishery in Table 2.2.3.1. 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 2003 are shown in Table 2.2.3.2. Catch curves are shown in Fig. 2.2.3.1. They show atypical patterns in 1996 and to some extent in 2001-2002 when there appears to be an increase over the previous year for ages where a decrease would normally have been expected. This could be due to catchability for longliners depending on fish growth, causing atypical catch curves for longliners.

Samples from commercial fleets in 2003.

Fleet	Size	Samples	Length	Otoliths	Weights
Open boats		23	3,994	600	420
Longliners	<100 GRT	49	9,784	898	420
Longliners	>100 GRT	64	12,877	1,260	720
Jiggers		5	1,041	0	0
Sing. trawlers	<400 HP	3	564	59	59
Sing. trawlers	400-1000 HP	57	10,928	1,200	180
Sing. trawlers	>1000 HP	14	2,625	301	180
Pair trawlers	<1000 HP	9	1,674	172	119
Pair trawlers	>1000 HP	66	12,936	1,319	1,198
Total		267	52,429	5,209	2,876

2.2.4 Mean weight-at-age

Mean weight-at-age data for 1961-2003 are provided for the Faroese fishery in Table 2.2.4.1. These were calculated using the length/weight relationship based on individual length/weight measurements of samples from the landings. The sum-of-products-check for 2002 showed a discrepancy of less than 1 %.

Figure 2.2.4.1 shows the mean weight-at-age for 1961 to 2003. The weights increased from 1998 to 2000, but have decreased since.

2.2.5 Maturity-at-age

The proportion of mature cod by age during the Faroese groundfish surveys carried out during the spawning period (March) are given in Table 2.2.5.1 (1961 - 2003) and shown in Figure 2.2.5.1 (1983 - 2004). The average maturity at age for 1983 to 1996 was used in years prior to 1983. The values for 1994-1997 were revised in 2003 (Working Document 14 in 2003) in connection with the correction of the spring groundfish survey, but values prior to 1994 were not changed. The working document deals with the correction of maturities for 1994-1997. On about half of the stations, many fish were incorrectly classified as “maturing”, which is highly unlikely for a spring spawner. They were reclassified as “immature” or “spent” according to criteria derived from the years 1999-2002, which data were assumed to be correct. The maturities were calculated in the same way as previously: pooling all fish with information on age and maturity and obtaining the proportion mature directly. Full maturity is generally reached at age 5 or 6, but considerable changes have been observed in the proportion mature for younger ages between years.

2.2.6 Groundfish surveys

The spring groundfish surveys in Faroese waters with the research vessel *Magnus Heinason* were initiated in 1983. Up to 1991 three cruises per year were conducted between February and the end of March, with 50 stations per cruise selected each year based on random stratified sampling (by depth) and on general knowledge of the distribution of fish in the area. In 1992 the period was shortened by dropping the first cruise and one third of the 1991-stations were used as fixed stations. Since 1993 all stations are fixed stations. The standard abundance estimates is the stratified mean catch per hour in numbers at age calculated using smoothed age/length keys. In last year’s assessment, the same strata were used as in the summer survey and calculated in the same way (see below). All cod less than 25 cm were set to 1 year old.

In the current assessment, however, the traditional stratification used in the spring survey was found to be insufficient as large catches on the spawning areas were allocated to large areas that were not associated with spawning. A new stratification was adopted where five new strata were added on the spawning grounds (Figure 2.2.6.1). The new stratification gave lower, but more stable estimates (Figure 2.2.6.2) which were consistent with the estimates from the summer survey (Figure 2.2.6.3). The catch curves showed a normal pattern (Figure 2.2.6.4). Also, the coefficients of variation were lower with the new stratification compared to the traditional one.

The overall mean catch of cod per unit effort 1983-2004 is given in Figure 2.2.6.5. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased from 2002 to 2004. Normally the stratified mean catch per trawl hour increases for the first 3-4 years of life of a year class, and decreases afterwards. From 1994 to 1995, however, there was an increase for all year classes, possibly because of increased availability. A more normal pattern was observed from 1996-2003.

In 1996, a new summer (August-September) groundfish survey was initiated, having 200 fixed stations distributed within the 500 m contour of the Faroe Plateau. Half of the stations were the same as in the spring survey. The overall mean catch of cod per unit effort (kg/trawl hour) 1996-2003 is shown in Figure 2.2.6.5, and catch curves in Figure 2.2.6.6. The catch curves show that the fish are fully recruited to the survey gear at an age of 3 or 4.

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

2.2.7 Stock assessment

2.2.7.1 Tuning and estimates of fishing mortality

The two tuning series used in NWWG 1998, the single trawlers 400-1000 HP and longliners > 100 GRT both with fishing effort measured in days were replaced in NWWG 1999 by two tuning series based on logbook data for five longliners > 100 GRT and eight pair trawlers > 1000 HP. In these series, effort was measured in 1000 hooks for the longliners and trawl hours for the pair trawlers.

The assessment of Faroe Plateau cod in 2004 is a benchmark assessment. Thus it was investigated whether there were differences between the individual Cuba trawlers and other pair trawlers regarding CPUE for cod. It is important to note that three of the eight Cuba trawlers went out of the fleet in 2003 and logbooks with two other pair trawlers ("Jaspis" and "Ametyst") were made available for 1995-2003. It was found that there was no difference between the three left out Cuba trawlers (mean CPUE during 1991-2002 = 45 kg/hour) and the remaining Cuba trawlers (46 kg/hour). Also there was no difference between the remaining Cuba trawlers (mean CPUE during 1997-2003 = 48 kg/hour) and the new pair trawlers (49 kg/hour). Thus all pair trawlers were pooled for all years, *i.e.* the tuning series could possibly be renamed the "pair trawler series", but that is not done this year.

A similar investigation was done for the longliners. It is important to note that one of the five longliners ("Jógvan Norði") sank in November 2003 so there may be changes in the longliner tuning series in the 2005 assessment. The CPUE for the individual boats varied much between sets, month, and area so it was not possible to tell whether any boat had a different efficiency than the others. Thus all boats were pooled. On the other hand, the CPUE depended to some extent on the calculation of the CPUE, *i.e.* whether all months (January, June-December, see below) were pooled or an average was taken per month and then averaging the months. The adopted calculation method was the one pooling all the months. The justification was that the sample size was small for some months and those, possibly biased CPUE values, would have too large influence on the overall result if the averaging per month was used.

Both tuning series are shown in Figure 2.2.7.1.1 (kg/1000 hooks and kg/hour). The two series show very similar trends for most of the years, except in the latest two years where the longliners have a substantially higher CPUE. The NWWG 2002 decided to use only the summer groundfish survey as tuning series in the 2002 assessment (see last years report, ICES, 2002), and this procedure was repeated in the assessment in 2003. This year, however, the spring survey was included as a tuning series.

Information about the longliners and Cuba trawlers is found in the report for 2002 (ICES, 2002). The criteria for selecting settings or hauls for CPUE-calculations was changed in 2003: Instead of using the whole year (January-December), the period February-May was excluded in order to avoid the spawning migration and spawning of cod. During the spawning migration and spawning, mature cod are less accessible (longliners) or not accessible at all (Cuba trawlers). In addition CPUEs may not be an appropriate estimate of stock biomass when the fish are moving and/or are densely aggregated.

Since the assessment of Faroe cod in 2004 is a benchmark assessment, all four potential indices of stock sizes were examined: the summer survey (1996 – 2003, ages 2 to 6), the spring survey (1994 -2004, ages 2 to 6), the longline cpue (1986 – 2003, ages 3 to 6) and the Cuba cpue (1985 – 2003, ages 2 to 6). Age by age plots of each potential index obtained from an ADAPT run using the four indices and ages as in the initial XSA calibration were presented to the WG. The correlations were not very good for the Cuba trawlers cpue and there were clear trends in the relationships for some ages. In addition, a single or a few observations had disproportionate influence. In order to use the Cuba series, careful grooming of the years and ages would therefore be required. Based only on the age by age plots, ages 4 and 5 from the longline cpue series could have been considered as potential indices, but as discussed in the catchability section, the longline catchability has the potential to vary considerably from year to year, and it would therefore have the potential to be misleading.

Figure 2.2.7.1.2. shows the time trends of SSB estimated in assessment done with each potential index separately. The ADAPT runs using the summer surveys, that with the spring survey as well as that of the Cuba cpue suggest that the biomass has declined in recent years, while that with the longline cpue suggests a steep increase in SSB, an illustration of the potential for being mislead by changes in longline catchability. This confirms that the longline cpue should not be used in the calibration. The Cuba cpue, although providing SSB and fishing mortality estimates consistent with those of the surveys was rejected as an index of stock size because of lack of fit and trends in residuals.

The working group thus adopted an XSA run having the two surveys as tuning series. The log catchability residuals are shown in Figure 2.2.7.1.3. There are no overall trends although the residuals for the summer survey are negative in 2003, *i.e.* the observed CPUE values were lower than the expected values from the XSA run. The results from five XSA runs (spring survey, summer survey, longliners, Cuba trawlers and the adopted run with the two surveys as tuning series) are presented in Figure 2.2.7.1.6. The overall picture was the same for all XSA runs, except for the longliners which gave considerably more optimistic results than the others.

The results from the retrospective analysis of the XSA (Figure 2.2.7.1.4) show that there was a tendency to overestimate fishing mortality and underestimate recruitment, stock biomass and spawning stock biomass in the past, but this pattern is reversed in 2003 which gives lower estimates of recruitment, stock size and spawning stock biomass than the run up to 2002.

Figure 2.2.7.1.5 shows the retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8. There is a tendency to slightly overestimate SSB in recent years, but the consecutive estimates are surprisingly close given the absence of any shrinkage.

The estimated fishing mortalities are shown in Tables 2.2.7.1.3 and 2.2.7.1.5 and Figure 2.2.7.1.7. The average F for age groups 3 to 7 in 2003 (F3-7) is estimated at 0.99, considerably higher than $\mathbf{F}_{max}$ = 0.45. The exploitation ratio (yield per biomass of 3 year and older cod) (Fig. 2.2.7.1.8) shows the same as F3-7 that the fishing mortality in 2002-2003 is amongst the highest observed during the assessment period.

2.2.7.2 Stock estimates and recruitment

The stock size in numbers is given in Tables 2.2.7.1.4. A summary of the VPA, with recruitment, biomass and fishing mortality estimates is given in Table 2.2.7.1.5 and in Figure 2.2.7.1.7. The stock-recruitment relationship is presented in Figure 2.2.7.2.1.

Figure 2.2.7.2.2 shows the F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. The figure also shows the F and SSB from the XSA assessment. The XSA results fall in the cloud of the bootstrapped F and SSB pairs with the SSB close to the median of the bootstrapped SSB values, but the fishing mortality comparatively lower than the median of the bootstrapped F values.

The assessment shows the poor recruitment for the 1984 to 1991 year classes, and the strong 1992 and 1993 year classes. Due to the continuous poor recruitment from 1984 to 1991 and the high fishing mortalities, the spawning stock biomass declined steadily from 1983 to 1992 when it was the lowest on record at 21 000 t. It increased sharply to above 80 000 t in 1996 and 1997 before declining to about 48 000 t in 1999. The 1998 year class is above average strength and the 1999 year class was in the 2003 assessment estimated to be as strong as the highest observed (1982 year class: 48 millions as 2 years old). In the current assessment the 1999 year class is estimated at 34 millions as 2 years old. The 2000-2001 year classes are estimated to be below average strength, and the 2002 year class seems to be of average strength.

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 2.2.8.1.1. The RCT3 program was not used this year because the estimate of year classes 2001-2002 was taken from the XSA run. The 2003-2004 year classes were estimated as the geometric mean for the period 1961-2003. Estimates of stock size (ages 2+) were taken directly from the VPA stock numbers. The exploitation pattern was estimated as the average fishing mortality for 2001-2003 (rescaled to 2003 values). The weights at age in the catches in 2004 were estimated from the weights for the longliners during January-February 2004. Age 2 was estimated from the spring survey (March). Regression analyses were made between weights in January-February (or March), and the weights during the whole year 1996-2003. The regressions were done separately by ages 2-6 and the ages 7-9 were pooled. The weight in the catches in 2004 were predicted from the regressions. The weights in the catches in 2005-2006 were set to the values in 2003. The proportion mature in 2004 was set to the 2004 values from the spring groundfish survey, and for 2005-2006 to the average values for 2002-2004.

Table 2.2.8.1.2 shows that the landings in 2004 are expected to be 23 000 tonnes. The spawning stock biomass is expected to be 30 000 tonnes in 2004, 25 000 tonnes in 2005 and eventually 23 000 tonnes in 2006. The current short term prediction is considerably more pessimistic than the prediction done last year, mainly because the 1999 and 2000 year classes (48 and 25 millions, respectively) now are believed to be considerably weaker compared to the 2003 assessment (34 and 13 millions).

2.2.8.2 Biological reference points

The stock trajectory with respect to existing reference points is illustrated in Figure 2.2.8.2.1.

In its 2003 report, the WG described reasons to review reference points for the three Faroese stocks, particularly for increases in $\mathbf{F}_{pa}$. There remains a need to review the reference points, but more time is necessary to consider the implications of the updated assessment results as well as those evaluate the consequences of the possible influence of productivity and growth on catchability. The WG expects to make proposals for new reference points at its 2005 meeting.

2.2.8.3 Medium-term prediction

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

2.2.8.4 Long-term prediction

The input data for the yield-per-recruit calculations (long-term predictions) are given in Table 2.2.8.4.1. The exploitation pattern was taken as an average for the years 1999-2003. The weights at age were set to the average values for 1978-2003, since no long term trend was present. The proportion mature was set to the average for 1983-2004.

The output from the yield-per-recruit calculations is shown in Table 2.2.8.4.2. and in Figure 2.2.8.4.1. $\mathbf{F}_{0.1}$ was calculated as 0.25 and $\mathbf{F}_{max}$ as 0.45. The present average fishing mortality (F3-7) in 2003 of 0.99 is substantially above $\mathbf{F}_{max}$ = 0.45 and $\mathbf{F}_{med}$ = 0.41 (Figure 2.2.8.2.1).

2.2.9 Management considerations

The 2004 assessment confirms the high fishing mortalities on cod estimated in the 2003 assessment. In addition, biomass is estimated to have decreased markedly as opposed to the increasing trend in the 2003 assessment. With the smaller estimate of the 1999 year class in the current assessment, the biomass is expected to decrease further, possibly close to those seen in the early 1990s. If the hypothesis that catchability is related to productivity is true, and if productivity in 2004 and 2005 is low, there is the potential for very high fishing mortality to be exerted on cod. It could therefore be prudent to consider substantial reductions in fishing effort (50% or more) for the next fishing season.

The management system with individual transferable days introduced in 1996 had as an objective to decrease fishing mortality. The current assessment shows that instead, fishing mortality increased from 0.32 in 1995 to 0.99 in 2003.

2.2.10 Comment on the assessment

New or changed things compared to last years report: The assessment was not done in the same way as last year. The Faroese spring groundfish survey (new stratification) was introduced as tuning series, so two surveys were used as tuning series this year compared to only one last year (the summer groundfish survey). The spring survey (shifted back to December) had information about 1 year old fish which was included in the XSA run. Zeros for age 1 were put in the appropriate input files (catch in numbers, weights in catch and stock). The natural mortality of age 1 was set at 0.2. The RCT3 program was not used this year and information about incoming year classes was taken from the XSA.

The main problem in the short term prediction is the uncertainty about the large 1999 year class as well as the year classes 2000-2002. This years assessment shows that the 1999 year class is considerably weaker than expected. Although no data are available, it seems to be clear (many open boats and small longliners fishing close to land) that the 1999 year class (and possibly the 2000 year class) was abundant outside the survey area in 2003, *i.e.* in very shallow waters (0-50 m depth). If correct, the present perception of the 1999 and 2000 year classes may be too pessimistic. The selection pattern was more normal in the current assessment compared to the 2003 assessment. There seemed to be a trend in the fishing mortality (average of ages 3-7) so the selection pattern was rescaled to 2003. The short term prediction predicted the catch in 2003 to be about 23 000 tonnes. This is somewhat less than expected, since the landings the first three months in 2004 are similar to the same period in 2003 (and the catch in 2003 was 30 000 tonnes). A statistical catch-at-age model (see Icelandic cod and haddock) predicted a catch in the range of 20-30 000 tonnes.

The most important change compared to the 2003 assessment is the perception of recruitment and stock size. The 1999-2000 year classes were estimated to 48 and 23 millions, respectively, in the 2003 assessment. These figures are changed to 34 and 13 millions, respectively, in the current assessment. The total biomasses in 2001-2002 were estimated to 135 and 138 kt, respectively, in the 2003 assessment. This is changed to 118 and 106 kt in the current assessment. The perception of fishing mortalities is similar in the current assessment compared to the 2003 assessment. It shows that the fishing mortality in 2002-2003 has been amongst the highest observed during the assessment period, and as high or higher than the fishing mortalities prior to the large decrease in the cod stock in 1992. The short term prediction also suggests that the cod stock may not be far away from a similarly low stock biomass.

2.2.10.1 References

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

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

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

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

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

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

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

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

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

Table 2.2.2.1. Faroe Plateau (Sub-division Vb1) COD. Nominal catches (tonnes) by countries, 1986-2003, as officially reported to ICES.

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

	1999	2000	2001	2002	2003 *
Denmark	-				
Faroe Islands	19,156				
France	- *	1	9 [2]	20	15 [3]
Germany	39	2	9	6	7 [2]
Iceland	-	-	-	5	-
Norway	450	374	544 *	732	527
Greenland	-	-	-	29 [2*]	-
UK (E/W/NI)[2]	51	18	50	42	-
UK (Scotland)[1]	-	-	-	-	-
United Kingdom					[1]
Total	19,696	395	612	834	549

* Preliminary

1) Included in Vb2.

2) Reported as Vb.

3) Includes 2 t reported as Vb.

Table 2.2.2.2. Nominal catch (tonnes) of COD in sub-division Vb1 (Faroe Plateau) 1986-2003, as used in the assessment.

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

	1999	2000	2001	2002	2003 *
Officially reported	19,696	395	612	834	549
Faroese catches in Vb1		21,793 *	28,838 *	38,347 *	29,382
Greenland					40
Catches reported as Vb2:					
UK (E/W/NI)	-	-	-	-	-
UK (Scotland)	210	245	288	218	
United Kingdom				-	244
Used in the assessment	19,906	22,433	29,738	39,399	30,215

*) Preliminary

Table 2.2.2.3. Faroe Plateau (sub-division Vb1) COD. The landings of faroese fleets (in percents) of total catch.

Year	Open boats	Longliners <100 GRT	Singletrawl <400 HP	Gill net	Jiggers	Singletrawl 400-1000 HP	Singletrawl >1000 HP	Pairtrawl <1000 HP	Pairtrawl >1000 HP	Longliners >100 GRT	Industrial trawlers	Others	Total Round.weig
1986	9.5	15.1	5.1	1.3	2.9	6.2	8.5	29.6	14.9	5.1	0.4	1.3	34,492
1987	9.9	14.8	6.2	0.5	2.9	6.7	8.0	26.0	14.5	9.9	0.5	0.1	21,303
1988	2.6	13.8	4.9	2.6	7.5	7.4	6.8	25.3	15.6	12.7	0.6	0.2	22,272
1989	4.4	29.0	5.7	3.2	9.3	5.7	5.5	10.5	8.3	17.7	0.7	0.0	20,535
1990	3.9	35.5	4.8	1.4	8.2	3.7	4.3	7.1	10.5	19.6	0.6	0.2	12,232
1991	4.3	31.6	7.1	2.0	8.0	3.4	4.7	8.3	12.9	17.2	0.6	0.1	8,203
1992	2.6	26.0	6.9	0.0	7.0	2.2	3.6	12.0	20.8	13.4	5.0	0.4	5,938
1993	2.2	16.0	15.4	0.0	9.0	4.1	3.6	14.2	21.7	12.6	0.8	0.4	5,744
1994	3.1	13.4	9.6	0.5	19.2	2.7	5.3	8.3	23.7	13.7	0.5	0.1	8,724
1995	4.2	17.9	6.5	0.3	24.9	4.1	4.7	6.4	12.3	18.5	0.1	0.0	19,079
1996	4.0	19.0	4.0	0.0	20.0	3.0	2.0	8.0	19.0	21.0	0.0	0.0	39,406
1997	3.1	28.4	4.4	0.5	9.8	5.1	2.9	4.8	11.3	29.7	0.0	0.1	33,556
1998	2.4	31.2	6.0	1.3	6.5	6.3	5.5	3.1	8.6	29.1	0.1	0.0	23,308
1999	2.7	24.0	5.4	2.3	5.4	5.2	11.8	6.4	14.5	21.9	0.4	0.1	19,156
2000	2.3	19.3	9.1	0.9	10.5	9.6	12.7	5.7	13.9	15.7	0.1	0.1	21,793
2001	3.7	28.3	7.4	0.2	15.6	6.4	6.4	5.2	9.2	17.8	0.0	0.0	28,838
2002	3.8	32.9	5.8	0.3	9.9	6.7	6.6	2.5	7.2	24.4	0.0	0.0	38,347
2003	4.9	28.7	4.0	1.5	7.4	3.0	14.4	2.2	7.4	26.5	0.0	0.0	29,382

Table 2.2.3.1. Faroe Plateau COD. Catch in numbers at age per fleet in 2003. Numbers are in thousands and the catch is in tonnes, round weight.

Age\Fleet	Open boats longline	Open boats jiggers	Longliners < 100 GRT	Jiggers	Single trwl 0-399HP	Single trwl 400-1000H	Single trwl > 1000 HP	Pair trwl 700-999 HI	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Sum Catch-at-age	Scaled Catch-at-age
2	84	12	494	159	20	12	9	1	4	148	0	943	837
3	132	40	1234	271	118	82	247	31	118	684	1	2958	2624
4	299	112	2205	543	297	212	619	79	366	1620	6	6358	5638
5	104	46	716	211	112	74	436	36	206	713	28	2682	2376
6	23	17	267	90	31	20	104	9	49	264	16	890	789
7	6	3	92	17	8	6	25	1	8	74	7	247	218
8	3	4	32	18	3	3	9	1	4	43	6	126	112
9	3	2	48	10	2	2	7	2	5	75	5	161	142
10+	0	0	16	2	0	0	6	0	1	2	1	28	25
Sum	654	236	5104	1321	591	411	1462	160	761	3623	70	14393	12761
G.weight	1065	459	8890	2301	1229	896	4467	442	2284	8208	457	30698	27221

Table 2.2.3.2. Faroe Plateau COD. Catch in numbers at age 1961-2003.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)   COD_ind_Surveys.txt

At 3/05/2004 17:06

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

YEAR,	1961,	1962,	1963,
AGE			
1,	0,	0,	0,
2,	3093,	4424,	4110,
3,	2686,	2500,	3958,
4,	1331,	1255,	1280,
5,	1066,	855,	662,
6,	232,	481,	284,
7,	372,	93,	204,
8,	78,	94,	48,
9,	29,	22,	30,
TOTALNUM,	8887,	9724,	10576,
TONSLAND,	21598,	20967,	22215,
SOPCOF %,	91,	94,	96,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	2033,	852,	1337,	1609,	1529,	878,	402,	328,	875,	723,
3,	3021,	3230,	970,	2690,	3322,	3106,	1163,	757,	1176,	3124,
4,	2300,	2564,	2080,	860,	2663,	3300,	2172,	821,	810,	1590,
5,	630,	1416,	1339,	1706,	945,	1538,	1685,	1287,	596,	707,
6,	350,	363,	606,	847,	1226,	477,	752,	1451,	1021,	384,
7,	158,	155,	197,	309,	452,	713,	244,	510,	596,	312,
8,	79,	48,	104,	64,	105,	203,	300,	114,	154,	227,
9,	41,	63,	33,	27,	11,	92,	44,	179,	25,	120,
TOTALNUM,	8612,	8691,	6666,	8112,	10253,	10307,	6762,	5447,	5253,	7187,
TONSLAND,	21078,	24212,	20418,	23562,	29930,	32371,	24183,	23010,	18727,	22228,
SOPCOF %,	98,	113,	109,	102,	106,	109,	99,	123,	125,	105,

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	2161,	2584,	1497,	425,	555,	575,	1129,	646,	1139,	2149,
3,	1266,	5689,	4158,	3282,	1219,	1732,	2263,	4137,	1965,	5771,
4,	1811,	2157,	3799,	6844,	2643,	1673,	1461,	1981,	3073,	2760,
5,	934,	2211,	1380,	3718,	3216,	1601,	895,	947,	1286,	2746,
6,	563,	813,	1427,	788,	1041,	1906,	807,	582,	471,	1204,
7,	452,	295,	617,	1160,	268,	493,	832,	487,	314,	510,
8,	149,	190,	273,	239,	201,	134,	339,	527,	169,	157,
9,	141,	118,	120,	134,	66,	87,	42,	123,	254,	104,
TOTALNUM,	7477,	14057,	13271,	16590,	9209,	8201,	7768,	9430,	8671,	15401,
TONSLAND,	24581,	36775,	39799,	34927,	26585,	23112,	20513,	22963,	21489,	38133,
SOPCOF %,	104,	100,	103,	70,	102,	101,	107,	107,	104,	99,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	4396,	998,	210,	257,	509,	2237,	243,	192,	205,	120,
3,	5234,	9484,	3586,	1362,	2122,	2151,	2849,	451,	455,	802,
4,	3487,	3795,	8462,	2611,	1945,	2187,	1481,	2152,	466,	603,
5,	1461,	1669,	2373,	3083,	1484,	1121,	852,	622,	911,	222,
6,	912,	770,	907,	812,	2178,	1026,	404,	303,	293,	329,
7,	314,	872,	236,	224,	492,	997,	294,	142,	132,	96,
8,	82,	309,	147,	68,	168,	220,	291,	93,	53,	33,
9,	34,	65,	47,	69,	33,	61,	50,	53,	30,	22,
TOTALNUM,	15920,	17962,	15968,	8486,	8931,	10000,	6464,	4008,	2545,	2227,
TONSLAND,	36979,	39484,	34595,	21391,	23182,	22068,	13487,	8750,	6396,	6107,
SOPCOF %,	99,	97,	97,	98,	102,	98,	101,	109,	108,	107,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	573,	2615,	351,	200,	455,	1288,	2230,	4128,	2130,	837,
3,	788,	2716,	5164,	1278,	745,	1080,	2812,	3967,	7461,	2624,
4,	1062,	2008,	4608,	6710,	1558,	869,	834,	2217,	3454,	5638,
5,	532,	1012,	1542,	3731,	5140,	1204,	455,	388,	1712,	2376,
6,	125,	465,	1526,	657,	1529,	2420,	719,	387,	481,	789,
7,	176,	118,	596,	639,	159,	477,	863,	758,	546,	218,
8,	39,	175,	147,	170,	118,	65,	111,	461,	423,	112,
9,	23,	44,	347,	51,	28,	19,	8,	38,	297,	142,
TOTALNUM,	3318,	9153,	14281,	13436,	9732,	7422,	8032,	12344,	16504,	12736,
TONSLAND,	9046,	23045,	40422,	34304,	24005,	19906,	22433,	29738,	39399,	30215,
SOPCOF %,	103,	103,	100,	104,	104,	102,	104,	101,	100,	101,

Table 2.2.4.1. Faroe Plateau COD. Catch weight at age 1961-2003.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys.txt
At 3/05/2004 17:06

Table 2 Catch weights at age (kg)

YEAR, AGE	1961,	1962,	1963,
1,	.0000,	.0000,	.0000,
2,	1.0800,	1.0000,	1.0400,
3,	2.2200,	2.2700,	1.9400,
4,	3.4500,	3.3500,	3.5100,
5,	4.6900,	4.5800,	4.6000,
6,	5.5200,	4.9300,	5.5000,
7,	7.0900,	9.0800,	6.7800,
8,	9.9100,	6.5900,	8.7100,
9,	8.0300,	6.6600,	11.7200,
SOPCOFAC,	.9068,	.9444,	.9573,

YEAR, AGE	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.9700,	.9200,	.9800,	.9600,	.8800,	1.0900,	.9600,	.8100,	.6600,	1.1100,
3,	1.8300,	1.4500,	1.7700,	1.9300,	1.7200,	1.8000,	2.2300,	1.8000,	1.6100,	2.0000,
4,	3.1500,	2.5700,	2.7500,	3.1300,	3.0700,	2.8500,	2.6900,	2.9800,	2.5800,	3.4100,
5,	4.3300,	3.7800,	3.5100,	4.0400,	4.1200,	3.6700,	3.9400,	3.5800,	3.2600,	3.8900,
6,	6.0800,	5.6900,	4.8000,	4.7800,	4.6500,	4.8900,	5.1400,	3.9400,	4.2900,	5.1000,
7,	7.0000,	7.3100,	6.3200,	6.2500,	5.5000,	5.0500,	6.4600,	4.8700,	4.9500,	5.1000,
8,	6.2500,	7.9300,	7.5100,	7.0000,	7.6700,	7.4100,	10.3100,	6.4800,	6.4800,	6.1200,
9,	6.1900,	8.0900,	10.3400,	11.0100,	10.9500,	8.6600,	7.3900,	6.3700,	6.9000,	8.6600,
SOPCOFAC,	.9824,	1.1262,	1.0905,	1.0224,	1.0598,	1.0851,	.9943,	1.2264,	1.2481,	1.0485,

YEAR, AGE	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.0800,	.7900,	.9400,	.8700,	1.1120,	.8970,	.9270,	1.0800,	1.2300,	1.3380,
3,	2.2200,	1.7900,	1.7200,	1.7900,	1.3850,	1.6820,	1.4320,	1.4700,	1.4130,	1.9500,
4,	3.4400,	2.9800,	2.8400,	2.5300,	2.1400,	2.2110,	2.2200,	2.1800,	2.1380,	2.4030,
5,	4.8000,	4.2600,	3.7000,	3.6800,	3.1250,	3.0520,	3.1050,	3.2100,	3.1070,	3.1070,
6,	5.1800,	5.4600,	5.2600,	4.6500,	4.3630,	3.6420,	3.5390,	3.7000,	4.0120,	4.1100,
7,	5.8800,	6.2500,	6.4300,	5.3400,	5.9270,	4.7190,	4.3920,	4.2400,	5.4420,	5.0200,
8,	6.1400,	7.5100,	6.3900,	6.2300,	6.3480,	7.2720,	6.1000,	4.4300,	5.5630,	5.6010,
9,	8.6300,	7.3900,	8.5500,	8.3800,	8.7150,	8.3680,	7.6030,	6.6900,	5.2160,	8.0130,
SOPCOFAC,	1.0432,	1.0033,	1.0285,	.7026,	1.0228,	1.0055,	1.0680,	1.0674,	1.0428,	.9901,

YEAR, AGE	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.1950,	.9050,	1.0990,	1.0930,	1.0610,	1.0100,	.9450,	.7790,	.9890,	1.1550,
3,	1.8880,	1.6580,	1.4590,	1.5170,	1.7490,	1.5970,	1.3000,	1.2710,	1.3640,	1.7040,
4,	2.9800,	2.6260,	2.0460,	2.1600,	2.3000,	2.2000,	1.9590,	1.5700,	1.7790,	2.4210,
5,	3.6790,	3.4000,	2.9360,	2.7660,	2.9140,	2.9340,	2.5310,	2.5240,	2.3120,	3.1320,
6,	4.4700,	3.7520,	3.7860,	3.9080,	3.1090,	3.4680,	3.2730,	3.1850,	3.4770,	3.7230,
7,	5.4880,	4.2200,	4.6990,	5.4610,	3.9760,	3.7500,	4.6520,	4.0860,	4.5450,	4.9710,
8,	6.4660,	4.7390,	5.8930,	6.3410,	4.8960,	4.6820,	4.7580,	5.6560,	6.2750,	6.1590,
9,	6.6280,	6.5110,	9.7000,	8.5090,	7.0870,	6.1400,	6.7040,	5.9730,	7.6190,	7.6140,
SOPCOFAC,	.9872,	.9695,	.9715,	.9755,	1.0153,	.9810,	1.0064,	1.0857,	1.0770,	1.0652,

YEAR, AGE	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	1.1940,	1.2180,	1.0160,	.9010,	1.0040,	1.0500,	1.4160,	1.1640,	1.0170,	.8200,
3,	1.8430,	1.9860,	1.7370,	1.3410,	1.4170,	1.5860,	2.1700,	2.0760,	1.7680,	1.3620,
4,	2.6130,	2.6220,	2.7450,	1.9580,	1.8020,	2.3500,	3.1870,	3.0530,	2.8050,	2.1270,
5,	3.6540,	3.9250,	3.8000,	3.0120,	2.2800,	2.7740,	3.7950,	3.9760,	3.5290,	3.3290,
6,	4.5840,	5.1800,	4.4550,	4.1580,	3.4780,	3.2140,	4.0480,	4.3940,	4.0950,	4.0920,
7,	4.9760,	6.0790,	4.9780,	4.4910,	5.4330,	5.4960,	4.5770,	4.8710,	4.4750,	4.6700,
8,	7.1460,	6.2410,	5.2700,	5.3120,	5.8510,	8.2760,	8.1820,	5.5630,	4.6500,	6.0000,
9,	8.5640,	7.7820,	5.5930,	6.1720,	7.9700,	9.1290,	11.8950,	7.2770,	6.2440,	6.7270,
SOPCOFAC,	1.0303,	1.0299,	1.0026,	1.0367,	1.0376,	1.0178,	1.0430,	1.0052,	1.0020,	1.0060,

Table 2.2.5.1. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2003. From 1961-1982 the average from 1983-1996 is used.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys.txt
At 3/05/2004 17:06

Table 5 Proportion mature at age

YEAR, AGE	1961	1962	1963
1	.0000	.0000	.0000
2	.1700	.1700	.1700
3	.6400	.6400	.6400
4	.8700	.8700	.8700
5	.9500	.9500	.9500
6	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000

YEAR, AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
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

YEAR, AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.1700	.1700	.1700	.1700	.1700	.1700	.1700	.1700	.1700	.0300
3	.6400	.6400	.6400	.6400	.6400	.6400	.6400	.6400	.6400	.7100
4	.8700	.8700	.8700	.8700	.8700	.8700	.8700	.8700	.8700	.9300
5	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9500	.9400
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

YEAR, AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0700	.0000	.0000	.0000	.0600	.0500	.0000	.0000	.0600	.0300
3	.9600	.5000	.3800	.6700	.7200	.5400	.6800	.7200	.5000	.7300
4	.9800	.9600	.9300	.9100	.9000	.9800	.9000	.8600	.8200	.7800
5	.9700	.9600	1.0000	1.0000	.9700	1.0000	.9900	1.0000	.9800	.9100
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9600	1.0000	1.0000	.9900
7	1.0000	1.0000	.9600	1.0000	1.0000	1.0000	.9800	1.0000	1.0000	1.0000
8	1.0000	1.0000	.9400	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

YEAR, AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.0500	.0900	.0400	.0000	.0000	.0200	.0200	.0700	.0400	.0000
3	.3300	.3500	.4300	.6400	.6200	.4300	.3900	.4700	.3700	.2900
4	.8800	.3300	.7400	.9100	.9000	.8800	.6900	.8600	.7600	.7900
5	.9600	.6600	.8500	.9700	.9900	.9800	.9200	.9400	.9700	.8800
6	1.0000	.9700	.9400	1.0000	.9900	1.0000	.9900	1.0000	.9300	.9800
7	.9600	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	.9700	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Table 2.2.7.1.1. Faroe Plateau (sub-division Vb1) COD. Summer survey tuning series (number of individuals per 200 stations) and spring survey tuning series (number of individuals per 100 stations).

```
FAROE PLATEAU COD (ICES SUBDIVISION VB1)        Surveys.TXT
102
SUMMER SURVEY
1996 2003
1 1 0.6 0.7
2 8
 200  829.7   6317.1   3840.5   1416.5   703     244.4   51.4
 200  566.2   1839.8   6263.6   1597.7   179     140.3   30.2
 200  518.4    548.4   1104.9   3517.5   973.8   53.6   37.2
 200  372.3   1267.1    778.8   754     1298.3  256.5   38.7
 200 1344.3   1132.3    697.2    315.5   434.6  614.9   35.5
 200 3375.1   2471.4   1524.7    429.5   246.6  297.3  248.6
 200 2289.2   5198.4   1794.4    806.5   145.3   85.8   70.5
 200  349.7   1095.1   2115.8    599.2   130.1   18.2   12.2
SPRING SURVEY (shifted back to december)
1993 2003
1 1 0.9 1.0
1 8
100   523.6    365.4     850.9     510.8     159.8    202      28.7     0
100   699.7    746.1    1458.9    1443.1    1171.2    338.2   396.3    55.3
100   399.7   3834.5    3790.4    1858.1    1362.7    431.8    88.9   188.2
100   101     1120.8    5247.7    2411.4     377.9    244.5    59        5.7
100    76.9    497.9    2026.1    4386.4    1263.8     89      41.1    36.6
100   522.4    698.8    1105.5    1340.6    1845.2    281.9    24.6    13.7
100   284.5   1363.7     796.6     469.8     493.2    783.2    62.4     3.1
100   906.1   2249.1    1934.2     471.2     351.2    551.1   135.2     3.8
100   356.7   4161.1    2852.6    1446.4     336.4    224.2   188.8   136.9
100    81.3    795.9    4236.6    1354.2     573.8     63.1    51.2    39
100   418.4    450.3     849.4    1112.9     313.8     68.5    21.6    12.2
```

Table 2.2.7.1.2. Faroe Plateau (sub-division Vb1) COD. Final XSA run.

```
Lowestoft VPA Version 3.1

    3/05/2004  17:04

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                COD_ind_Surveys.txt

 CPUE data from file Surveys.TXT

 Catch data for  43 years. 1961 to 2003. Ages  1 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2003,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2003,   1,     8,   .900,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability dependent on stock size for ages <    3

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


      Catchability independent of age for ages >=    6


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning had not converged after   30 iterations


 Total absolute residual between iterations
 29 and  30 =     .00056

 Final year F values
 Age         ,      1,      2,      3,      4,      5,      6,      7,      8,      9
 Iteration 29,  .0000,  .1412,  .4231,  .6422, 1.0539, 1.2229, 1.5851, 1.8568, 2.1840
 Iteration 30,  .0000,  .1412,  .4231,  .6422, 1.0539, 1.2230, 1.5853, 1.8568, 2.1842



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

Table 2.2.7.1.2 (Cont'd)

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.025	.069	.029	.034	.086	.099	.126	.143	.206	.141
3	.112	.161	.189	.142	.170	.300	.326	.344	.414	.423
4	.190	.460	.448	.400	.258	.306	.401	.464	.574	.642
5	.249	.278	.795	.820	.616	.325	.260	.329	.813	1.054
6	.211	.359	.895	.999	1.011	.672	.329	.370	.890	1.223
7	.165	.317	1.128	1.347	.707	1.098	.540	.695	1.474	1.585
8	.335	.246	.837	1.300	1.027	.721	.839	.629	1.152	1.857
9	.231	.794	1.126	.810	.770	.435	.173	.797	1.168	2.184

1

XSA population numbers (Thousands)

	AGE								
YEAR	1	2	3	4	5	6	7	8	9
1994	5.31E+04	2.53E+04	8.22E+03	6.79E+03	2.67E+03	7.25E+02	1.28E+03	1.51E+02	1.23E+02
1995	1.64E+04	4.34E+04	2.02E+04	6.02E+03	4.60E+03	1.70E+03	4.80E+02	8.87E+02	8.87E+01
1996	8.13E+03	1.34E+04	3.32E+04	1.41E+04	3.11E+03	2.85E+03	9.74E+02	2.86E+02	5.68E+02
1997	7.48E+03	6.65E+03	1.07E+04	2.25E+04	7.37E+03	1.15E+03	9.54E+02	2.58E+02	1.02E+02
1998	1.84E+04	6.12E+03	5.27E+03	7.58E+03	1.24E+04	2.66E+03	3.47E+02	2.03E+02	5.76E+01
1999	2.55E+04	1.51E+04	4.60E+03	3.64E+03	4.80E+03	5.47E+03	7.91E+02	1.40E+02	5.96E+01
2000	4.18E+04	2.09E+04	1.12E+04	2.79E+03	2.19E+03	2.84E+03	2.29E+03	2.16E+02	5.57E+01
2001	1.54E+04	3.42E+04	1.51E+04	6.60E+03	1.53E+03	1.38E+03	1.67E+03	1.09E+03	7.65E+01
2002	8.58E+03	1.26E+04	2.43E+04	8.74E+03	3.40E+03	9.02E+02	7.83E+02	6.83E+02	4.76E+02
2003	2.27E+04	7.02E+03	8.41E+03	1.31E+04	4.03E+03	1.24E+03	3.03E+02	1.47E+02	1.77E+02

Estimated population abundance at 1st Jan 2004

	0.00E+00	1.86E+04	4.99E+03	4.51E+03	5.66E+03	1.15E+03	2.98E+02	5.08E+01	1.88E+01

Taper weighted geometric mean of the VPA populations:

	1.83E+04	1.48E+04	1.12E+04	6.94E+03	3.68E+03	1.79E+03	8.24E+02	3.41E+02	1.44E+02

Standard error of the weighted Log(VPA populations) :

	.5607	.5606	.5444	.5420	.5381	.5691	.6059	.6552	.7589

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	No data for this fleet at this age									
2	99.99	99.99	-.18	.15	.18	-1.03	-.10	.30	.97	-.30
3	99.99	99.99	.11	-.02	-.51	.55	-.43	.06	.37	-.12
4	99.99	99.99	.25	.24	-.50	-.09	.13	.09	.04	-.15
5	99.99	99.99	.82	.09	.23	-.55	-.68	.03	.18	-.13
6	99.99	99.99	.33	-.06	.81	.15	-.51	-.33	-.09	-.30
7	99.99	99.99	.50	.11	-.25	.74	.19	-.12	-.10	-.63
8	99.99	99.99	-.02	-.15	.12	.34	-.11	.08	-.37	-.13

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

Age	3	4	5	6	7	8
Mean Log q	-6.8117	-6.4234	-6.2584	-6.3220	-6.3220	-6.3220
S.E(Log q)	.3616	.2472	.4705	.4240	.4368	.2147

Table 2.2.7.1.2 (Cont'd)

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,	.96,	.098,	7.81,	.53,	8,	.61,	-7.75,

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,	.90,	.506,	7.06,	.82,	8,	.35,	-6.81,
4,	.93,	.526,	6.60,	.91,	8,	.24,	-6.42,
5,	.89,	.412,	6.47,	.72,	8,	.45,	-6.26,
6,	.79,	1.012,	6.58,	.80,	8,	.34,	-6.32,
7,	.76,	1.380,	6.37,	.85,	8,	.31,	-6.27,
8,	1.11,	-.864,	6.42,	.92,	8,	.24,	-6.35,

Fleet : SPRING SURVEY (shift

Age	1993
1	-.05
2	-.72
3	-.69
4	-.46
5	-.43
6	-.62
7	-.45
8	99.99

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1	-.34	.37	-.08	-.22	.47	-.36	.11	.33	-.31	.08
2	-.95	.10	.08	.02	.47	.21	.38	.48	-.03	-.04
3	-.03	.07	-.07	.07	.19	.12	.15	.25	.24	-.30
4	.04	.67	.07	.15	-.08	-.35	.01	.33	.09	-.45
5	.71	.34	-.06	.31	-.02	-.67	-.29	.09	.29	-.26
6	.87	.40	-.17	-.17	.15	.13	.11	-.03	-.38	-.30
7	.42	.05	-.30	-.43	-.54	-.06	-.88	-.09	.11	.30
8	.75	.12	-1.69	.72	-.29	-1.69	-1.81	-.04	-.33	.71

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

Age	3	4	5	6	7	8
Mean Log q	-6.0072	-5.8210	-5.7090	-5.8510	-5.8510	-5.8510
S.E(Log q)	.2788	.3366	.3992	.4068	.4282	1.0931

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1,	.83,	1.117,	8.76,	.83,	11,	.31,	-8.54,
2,	.94,	.250,	7.10,	.68,	11,	.48,	-6.95,

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3,	.95,	.345,	6.17,	.85,	11,	.28,	-6.01,
4,	.93,	.450,	6.05,	.81,	11,	.33,	-5.82,
5,	.92,	.448,	5.90,	.78,	11,	.38,	-5.71,
6,	1.07,	-.280,	5.74,	.65,	11,	.46,	-5.85,
7,	1.11,	-.519,	5.96,	.73,	11,	.45,	-6.02,
8,	.87,	.314,	6.14,	.43,	10,	.94,	-6.21,

Table 2.2.7.1.2 (Cont'd)

```
Terminal year survivor and F summaries :

Age  1   Catchability dependent on age and year class strength

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
SPRING SURVEY (shift,     20087.,   .330,       .000,    .00,   1,  .743,     .000

  P shrinkage mean  ,     14808.,    .56,,,,                         .257,     .000

  F shrinkage mean  ,         0.,   2.00,,,,                         .000,     .000

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    18574.,       .28,      .15,    2,    .544,   .000



Age  2   Catchability dependent on age and year class strength

Year class = 2001

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      3711.,   .695,       .000,    .00,   1,  .117,     .186
SPRING SURVEY (shift,      4000.,   .296,       .129,    .44,   2,  .646,     .173

  P shrinkage mean  ,     11178.,    .54,,,,                         .220,     .066

  F shrinkage mean  ,      5346.,   2.00,,,,                         .016,     .132

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4994.,       .24,      .25,    5,   1.033,   .141


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

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      4928.,   .338,       .428,   1.26,   2,  .274,     .393
SPRING SURVEY (shift,      4329.,   .204,       .202,    .99,   3,  .713,     .437

  F shrinkage mean  ,      6467.,   2.00,,,,                         .012,     .313

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     4508.,       .17,      .15,    6,    .865,   .423



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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      5750.,   .230,       .171,    .74,   3,  .426,     .635
SPRING SURVEY (shift,      5527.,   .186,       .197,   1.06,   4,  .562,     .654

  F shrinkage mean  ,     10270.,   2.00,,,,                         .012,     .403

Weighted prediction :
```

Table 2.2.7.1.2 (Cont'd)

```
Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     5664.,       .15,      .12,    8,    .800,   .642


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

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,      1137.,   .216,       .049,    .22,   4,  .407,    1.062
SPRING SURVEY (shift,      1113.,   .177,       .129,    .73,   5,  .571,    1.076

  F shrinkage mean  ,      3564.,   2.00,,,,                        .021,     .472

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     1150.,       .14,      .09,   10,    .625,  1.054



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

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,       253.,   .228,       .139,    .61,   5,  .423,    1.341
SPRING SURVEY (shift,       320.,   .191,       .132,    .69,   6,  .546,    1.172

  F shrinkage mean  ,       763.,   2.00,,,,                        .031,     .660

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      298.,       .16,      .11,   12,    .681,  1.223


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

Year class = 1996

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        42.,   .224,       .177,    .79,   6,  .432,    1.742
SPRING SURVEY (shift,        55.,   .195,       .104,    .54,   7,  .522,    1.526

  F shrinkage mean  ,       132.,   2.00,,,,                        .046,     .913

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       51.,       .17,      .11,   14,    .671,  1.585



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

Year class = 1995

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        16.,   .226,       .053,    .23,   7,  .668,    1.995
SPRING SURVEY (shift,        20.,   .203,       .117,    .58,   8,  .261,    1.814

  F shrinkage mean  ,        71.,   2.00,,,,                        .071,     .883

Weighted prediction :
```

Table 2.2.7.1.2 (Cont'd)

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
19.,	.21,	.11,	16,	.529,	1.857

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

Year class = 1994

Fleet, ,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N, ,	Scaled, Weights,	Estimated F
SUMMER SURVEY ,	11.,	.186,	.058,	.31,	7,	.506,	2.504
SPRING SURVEY (shift,	15.,	.163,	.107,	.66,	8,	.316,	2.230
F shrinkage mean ,	49.,	2.00,,,,				.177,	1.288

Weighted prediction :

Survivors, at end of year,	Int, s.e,	Ext, s.e,	N, ,	Var, Ratio,	F
16.,	.37,	.16,	16,	.424,	2.184

Table 2.2.7.1.3. Faroe Plateau (sub-division Vb1) COD. Fishing mortality at age.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1) COD_ind_Surveys.txt

At 3/05/2004 17:06

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,
AGE			
1,	.0000,	.0000,	.0000,
2,	.3346,	.2701,	.2534,
3,	.5141,	.4982,	.4138,
4,	.4986,	.4838,	.5172,
5,	.5737,	.7076,	.5124,
6,	.4863,	.5569,	.5405,
7,	.9566,	.3662,	.4879,
8,	.8116,	.6826,	.3269,
9,	.6715,	.5641,	.4806,
FBAR 3- 7,	.6059,	.5226,	.4944,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1086,	.1209,	.0829,	.0789,	.1010,	.1099,	.0530,	.0309,	.0464,	.0657,
3,	.2997,	.2518,	.1969,	.2389,	.2318,	.3063,	.2081,	.1337,	.1476,	.2322,
4,	.4523,	.4498,	.2552,	.2687,	.3949,	.3806,	.3654,	.2225,	.2070,	.3048,
5,	.5229,	.5622,	.4499,	.3442,	.5339,	.4180,	.3409,	.3845,	.2497,	.2813,
6,	.5659,	.6604,	.5016,	.5779,	.4472,	.5709,	.3709,	.5572,	.6058,	.2526,
7,	.6677,	.5305,	.9680,	.5203,	.7132,	.5118,	.6559,	.4651,	.4686,	.3722,
8,	.3531,	.4345,	.8520,	1.0438,	.3331,	.8457,	.4208,	.7528,	.2464,	.3259,
9,	.5164,	.5318,	.6106,	.5556,	.4882,	.5499,	.4339,	.4800,	.3578,	.3091,
FBAR 3- 7,	.5017,	.4909,	.4743,	.3900,	.4642,	.4375,	.3882,	.3526,	.3358,	.2886,

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0816,	.0774,	.0933,	.0481,	.0588,	.0433,	.0544,	.0523,	.0586,	.0991,
3,	.1568,	.3193,	.1723,	.3036,	.1896,	.2623,	.2391,	.2877,	.2227,	.4671,
4,	.2046,	.4359,	.3665,	.4748,	.4291,	.4308,	.3695,	.3408,	.3602,	.5584,
5,	.2953,	.4134,	.5568,	.7532,	.4289,	.5049,	.4337,	.4368,	.3886,	.6409,
6,	.3797,	.4544,	.5167,	.7333,	.4850,	.4906,	.5181,	.5643,	.4046,	.7834,
7,	.5330,	.3504,	.7619,	1.1138,	.5968,	.4480,	.4119,	.6939,	.6925,	1.0777,
8,	.3052,	.4485,	.6429,	.7776,	.5674,	.6902,	.6437,	.5015,	.5526,	.9414,
9,	.3457,	.4235,	.5738,	.7783,	.5054,	.5170,	.4790,	.5115,	.4834,	.8085,
FBAR 3- 7,	.3139,	.3947,	.4748,	.6757,	.4259,	.4273,	.3945,	.4647,	.4137,	.7055,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1072,	.0656,	.0245,	.0282,	.0671,	.1680,	.0752,	.0323,	.0200,	.0131,
3,	.3709,	.3541,	.3534,	.2191,	.3396,	.4432,	.3350,	.1949,	.0997,	.1015,
4,	.5786,	.5070,	.6217,	.4732,	.5574,	.7113,	.6330,	.4575,	.3169,	.1860,
5,	.6607,	.6127,	.7018,	.4840,	.5449,	.7450,	.6798,	.6035,	.3566,	.2446,
6,	.4531,	.9227,	.8235,	.5538,	.7703,	.9463,	.6675,	.5497,	.6475,	.2095,
7,	.4760,	1.1070,	.8383,	.4871,	.7931,	1.0464,	.8021,	.5235,	.4941,	.4533,
8,	.4789,	1.3193,	.5396,	.6197,	.8555,	1.0817,	1.0745,	.6449,	.3763,	.2170,
9,	.5338,	.9034,	.7117,	.5278,	.7110,	.9160,	.7791,	.5604,	.4414,	.2635,
FBAR 3- 7,	.5079,	.7007,	.6678,	.4435,	.6011,	.7784,	.6235,	.4658,	.3830,	.2390,

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR **-**
AGE											
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0253,	.0688,	.0293,	.0338,	.0857,	.0992,	.1257,	.1430,	.2064,	.1412,	.1635,
3,	.1120,	.1608,	.1886,	.1420,	.1700,	.3002,	.3259,	.3441,	.4144,	.4231,	.3939,
4,	.1896,	.4603,	.4485,	.3996,	.2577,	.3065,	.4009,	.4636,	.5740,	.6422,	.5599,
5,	.2488,	.2784,	.7948,	.8202,	.6155,	.3249,	.2605,	.3288,	.8125,	1.0539,	.7318,
6,	.2115,	.3590,	.8948,	.9989,	1.0112,	.6717,	.3286,	.3698,	.8905,	1.2230,	.8278,
7,	.1652,	.3168,	1.1275,	1.3470,	.7073,	1.0977,	.5397,	.6949,	1.4743,	1.5853,	1.2515,
8,	.3348,	.2461,	.8372,	1.2998,	1.0269,	.7207,	.8386,	.6289,	1.1519,	1.8568,	1.2126,
9,	.2311,	.7942,	1.1258,	.8098,	.7697,	.4346,	.1728,	.7965,	1.1679,	2.1842,	1.3829,
FBAR 3- 7,	.1854,	.3151,	.6908,	.7416,	.5523,	.5402,	.3711,	.4402,	.8331,	.9855,	

Table 2.2.7.1.4. Faroe Plateau (sub-division Vb1) COD. Stock number at age.

Run title : COD FAROE PLATEAU (ICES SUBDIVISION Vb1)   COD_ind_Surveys.txt

At 3/05/2004 17:06

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,
AGE			
1,	25227,	24782,	26668,
2,	12019,	20654,	20290,
3,	7385,	7042,	12907,
4,	3747,	3616,	3503,
5,	2699,	1863,	1825,
6,	666,	1245,	752,
7,	668,	335,	584,
8,	155,	210,	190,
9,	66,	56,	87,
TOTAL,	52630,	59804,	66807,

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
1,	10100,	22676,	28643,	21475,	11390,	10514,	14569,	26041,	15356,	37229,
2,	21834,	8269,	18566,	23451,	17582,	9325,	8608,	11928,	21320,	12573,
3,	12893,	16037,	5999,	13990,	17744,	13012,	6840,	6684,	9469,	16664,
4,	6986,	7823,	10207,	4034,	9020,	11522,	7843,	4548,	4788,	6689,
5,	1710,	3639,	4085,	6475,	2525,	4976,	6447,	4456,	2981,	3187,
6,	895,	830,	1698,	2133,	3757,	1212,	2682,	3754,	2483,	1901,
7,	358,	416,	351,	842,	980,	1967,	561,	1516,	1760,	1109,
8,	294,	151,	200,	109,	410,	393,	965,	238,	779,	902,
9,	112,	169,	80,	70,	31,	240,	138,	519,	92,	499,
TOTAL,	55183,	60009,	69829,	72579,	63439,	53161,	48654,	59683,	59029,	80752,

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
1,	46804,	22687,	12208,	13128,	18319,	28806,	17102,	27036,	30745,	58376,
2,	30480,	38320,	18575,	9995,	10748,	14998,	23585,	14002,	22135,	25172,
3,	9640,	23000,	29035,	13853,	7799,	8298,	11759,	18288,	10879,	17092,
4,	10816,	6747,	13683,	20010,	8372,	5282,	5227,	7580,	11230,	7129,
5,	4037,	7217,	3572,	7765,	10190,	4463,	2811,	2957,	4413,	6413,
6,	1969,	2460,	3908,	1676,	2993,	5433,	2206,	1491,	1564,	2450,
7,	1209,	1103,	1279,	1909,	659,	1509,	2723,	1076,	694,	854,
8,	626,	581,	636,	489,	513,	297,	789,	1477,	440,	284,
9,	533,	378,	304,	274,	184,	238,	122,	339,	732,	207,
TOTAL,	106115,	102493,	83200,	69098,	59778,	69325,	66323,	74246,	82834,	117978,

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
1,	21205,	11695,	12498,	10592,	19521,	4526,	8163,	13980,	12422,	30927,
2,	47794,	17362,	9575,	10232,	8672,	15982,	3706,	6684,	11446,	10170,
3,	18665,	35153,	13311,	7649,	8145,	6640,	11061,	2814,	5298,	9185,
4,	8772,	10546,	20199,	7654,	5030,	4748,	3490,	6478,	1896,	3926,
5,	3340,	4027,	5200,	8881,	3904,	2359,	1909,	1517,	3357,	1131,
6,	2766,	1412,	1787,	2110,	4481,	1853,	917,	792,	679,	1924,
7,	916,	1440,	460,	642,	993,	1698,	589,	385,	374,	291,
8,	238,	466,	390,	163,	323,	368,	488,	216,	187,	187,
9,	91,	121,	102,	186,	72,	112,	102,	137,	93,	105,
TOTAL,	103787,	82220,	63521,	48110,	51142,	38288,	30425,	33003,	35752,	57847,

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	GMST 61-**	AMST 61-**
AGE													
1,	53061,	16393,	8128,	7480,	18409,	25477,	41832,	15415,	8580,	22687,	0,	18512,	21503,
2,	25321,	43443,	13421,	6655,	6124,	15072,	20859,	34249,	12621,	7025,	18574,	15139,	17590,
3,	8218,	20213,	33202,	10671,	5268,	4602,	11175,	15060,	24306,	8406,	4994,	11045,	12747,
4,	6795,	6015,	14091,	22511,	7580,	3639,	2791,	6605,	8741,	13149,	4508,	6799,	7882,
5,	2669,	4602,	3108,	7368,	12359,	4796,	2193,	1530,	3401,	4031,	5664,	3679,	4267,
6,	725,	1704,	2852,	1149,	2656,	5468,	2837,	1384,	902,	1236,	1150,	1834,	2138,
7,	1278,	480,	974,	954,	347,	791,	2287,	1673,	783,	303,	298,	845,	1001,
8,	151,	887,	286,	258,	203,	140,	216,	1091,	683,	147,	51,	342,	424,
9,	123,	89,	568,	102,	58,	60,	56,	76,	476,	177,	19,	139,	188,
TOTAL,	98341,	93825,	76631,	57147,	53003,	60044,	84245,	77083,	60493,	57159,	35257,		

Table 2.2.7.1.5. Faroe Plateau (sub-division Vb1) COD. Summary table.

Year	RECRUITS Age 1	RECRUITS Age 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1961	25227	12019	65428	46439	21598	0.4651	0.6059
1962	24782	20654	68225	43326	20967	0.4839	0.5226
1963	26668	20290	77602	49054	22215	0.4529	0.4944
1964	10100	21834	84666	55362	21078	0.3807	0.5017
1965	22676	8269	75043	57057	24212	0.4244	0.4909
1966	28643	18566	83919	60629	20418	0.3368	0.4743
1967	21475	23451	105289	73934	23562	0.3187	0.39
1968	11390	17582	110433	82484	29930	0.3629	0.4642
1969	10514	9325	105537	83487	32371	0.3877	0.4375
1970	14569	8608	98398	82035	24183	0.2948	0.3882
1971	26041	11928	78218	63308	23010	0.3635	0.3526
1972	15356	21321	76439	57180	18727	0.3275	0.3358
1973	37229	12572	107682	80516	22228	0.2761	0.2886
1974	46804	30481	136664	95831	24581	0.2565	0.3139
1975	22687	38320	149775	105677	36775	0.348	0.3947
1976	12208	18575	154920	116736	39799	0.3409	0.4748
1977	13128	9995	136018	111863	34927	0.3122	0.6757
1978	18319	10748	94340	76609	26585	0.347	0.4259
1979	28806	14998	83771	65381	23112	0.3535	0.4273
1980	17102	23584	84541	58388	20513	0.3513	0.3945
1981	27036	14002	86915	62063	22963	0.37	0.4647
1982	30745	22135	96642	64704	21489	0.3321	0.4137
1983	58376	25172	121680	76950	38133	0.4956	0.7055
1984	21205	47794	150315	94898	36979	0.3897	0.5079
1985	11695	17361	129747	83238	39484	0.4744	0.7007
1986	12498	9575	98748	73066	34595	0.4735	0.6678
1987	10592	10232	78251	61750	21391	0.3464	0.4435
1988	19521	8672	66363	52226	23182	0.4439	0.6011
1989	4526	15982	59322	38900	22068	0.5673	0.7784
1990	8163	3706	38299	29288	13487	0.4605	0.6235
1991	13980	6683	28918	21286	8750	0.4111	0.4658
1992	12422	11446	35623	20607	6396	0.3104	0.383
1993	30927	10170	51006	32904	6107	0.1856	0.239
1994	53061	25321	84703	43058	9046	0.2101	0.1854
1995	16393	43443	144861	53643	23045	0.4296	0.3151
1996	8128	13421	144038	85484	40422	0.4729	0.6908
1997	7480	6655	97636	81856	34304	0.4191	0.7416
1998	18409	6124	68218	57493	24005	0.4175	0.5523
1999	25477	15072	68602	47640	19906	0.4178	0.5402
2000	41832	20859	95383	48108	22433	0.4663	0.3711
2001	15415	34249	118232	61399	29738	0.4843	0.4402
2002	8580	12621	105676	59673	39399	0.6602	0.8331
2003	22687	7025	67137	45663	30215	0.6617	0.9855
Arith. Mean	21230	17229	93331	64214	25077	0.3973	0.5001
Units	Thousands	Thousands	Tonnes	Tonnes	Tonnes		

Table 2.2.8.1.1. Faroe Plateau (sub-division Vb1) COD. Input to management option table.

Recruitment

	XSA	RCT3	Geomean 61-03
YC2001	7025		
YC2002	18574		
YC2003			14808
YC2004			14808

Stock size

2004
18574
4994
4508
5664
1150
298
51
19

Directly from XSA output

Maturity

Age	Observed 2004	Av.02-04 2005	Av.02-04 2006
2	0	0.01	0.01
3	0.51	0.39	0.39
4	0.78	0.78	0.78
5	0.92	0.92	0.92
6	0.89	0.93	0.93
7	0.87	0.95	0.95
8	1	1	1
9	1	1	1
10	1	1	1

Exploitation pattern
(rescaled to 2003 values)

Av01-03 2004	Av01-03 2005	Av01-03 2006
0.2140	0.2140	0.2140
0.5155	0.5155	0.5155
0.7329	0.7329	0.7329
0.9577	0.9577	0.9577
1.0834	1.0834	1.0834
1.6380	1.6380	1.6380
1.5870	1.5870	1.5870
1.8099	1.8099	1.8099
0.9855	0.9855	0.9855

Weights

Est.from longliners 2004	As2003 2005	As2003 2006
0.9672	0.8200	0.8200
1.1820	1.3620	1.3620
1.9372	2.1270	2.1270
2.8092	3.3290	3.3290
3.7709	4.0920	4.0920
5.2122	4.6700	4.6700
5.8166	6.0000	6.0000
6.7270	6.7270	6.7270
6.8099	6.8099	6.8099

Table 2.2.8.1.2. Faroe Plateau (sub-division Vb1) COD. Management option table.

MFDP version 1
Run: Run1
Index file 4/5-2002
Time and date: 07:55 04/05/04
Fbar age range: 3-7

2004				
Biomass	SSB	FMult	FBar	Landings
54826	30096	1	0.9855	22640

2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
49074	24654	0	0	0	71263	43177
.	24654	0.1	0.0986	2748	67852	40327
.	24654	0.2	0.1971	5284	64699	37708
.	24654	0.3	0.2957	7627	61780	35298
.	24654	0.4	0.3942	9796	59074	33078
.	24654	0.5	0.4928	11807	56562	31031
.	24654	0.6	0.5913	13673	54228	29141
.	24654	0.7	0.6899	15406	52055	27393
.	24654	0.8	0.7884	17019	50031	25776
.	24654	0.9	0.887	18522	48143	24278
.	24654	1	0.9855	19924	46380	22888
.	24654	1.1	1.0841	21233	44732	21597
.	24654	1.2	1.1826	22457	43189	20398
.	24654	1.3	1.2812	23603	41744	19282
.	24654	1.4	1.3797	24677	40388	18242
.	24654	1.5	1.4783	25685	39115	17273
.	24654	1.6	1.5768	26632	37918	16369
.	24654	1.7	1.6754	27522	36793	15525
.	24654	1.8	1.7739	28360	35733	14735
.	24654	1.9	1.8725	29150	34734	13996
.	24654	2	1.971	29895	33791	13304

Input units are thousands and kg - output in tonnes

Table 2.2.8.4.1. Faroe Plateau (sub-division Vb1) COD. Input to yield per recruit calculations (long term prediction).

Input to Yield per recruit

	Exploitation pattern	Weightatage	PropMature
	Average 1999-2003 Not rescaled	Average 1978-2003	Average 1983-2004
Age 2	0.1431	1.0641	0.0291
Age 3	0.3615	1.6202	0.5427
Age 4	0.4774	2.3299	0.8395
Age 5	0.5561	3.1504	0.9436
Age 6	0.6967	3.893	0.9836
Age 7	1.0784	4.8399	0.9882
Age 8	1.0394	5.9106	0.9973
Age 9	0.9512	7.4775	1

Table 2.2.8.4.2. Faroe Plateau (sub-division Vb1) COD. Output from yield per recruit calculations (long term prediction).

MFYPR version 1
Run: YLD3
Time and date: 10:33 06/05/04
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	4.4029	12.8353	2.9072	10.7944	2.9072	10.7944
0.1000	0.0634	0.1736	0.6321	3.9972	10.8190	2.5172	8.8179	2.5172	8.8179
0.2000	0.1268	0.2925	0.9925	3.6767	9.3002	2.2113	7.3354	2.2113	7.3354
0.3000	0.1902	0.3765	1.1940	3.4189	8.1368	1.9673	6.2054	1.9673	6.2054
0.4000	0.2536	0.4381	1.3030	3.2081	7.2305	1.7694	5.3299	1.7694	5.3299
0.5000	0.3170	0.4848	1.3582	3.0329	6.5125	1.6065	4.6405	1.6065	4.6405
0.6000	0.3804	0.5214	1.3826	2.8852	5.9344	1.4704	4.0891	1.4704	4.0891
0.7000	0.4438	0.5510	1.3894	2.7589	5.4617	1.3551	3.6413	1.3551	3.6413
0.8000	0.5072	0.5756	1.3865	2.6496	5.0695	1.2564	3.2725	1.2564	3.2725
0.9000	0.5706	0.5965	1.3783	2.5541	4.7397	1.1709	2.9647	1.1709	2.9647
1.0000	0.6340	0.6147	1.3674	2.4698	4.4589	1.0962	2.7047	1.0962	2.7047
1.1000	0.6974	0.6306	1.3554	2.3947	4.2172	1.0303	2.4826	1.0303	2.4826
1.2000	0.7608	0.6447	1.3430	2.3274	4.0071	0.9718	2.2912	0.9718	2.2912
1.3000	0.8243	0.6575	1.3308	2.2666	3.8228	0.9195	2.1246	0.9195	2.1246
1.4000	0.8877	0.6690	1.3190	2.2113	3.6599	0.8724	1.9785	0.8724	1.9785
1.5000	0.9511	0.6796	1.3078	2.1609	3.5147	0.8297	1.8494	0.8297	1.8494
1.6000	1.0145	0.6892	1.2970	2.1146	3.3847	0.7910	1.7347	0.7910	1.7347
1.7000	1.0779	0.6982	1.2868	2.0719	3.2674	0.7556	1.6321	0.7556	1.6321
1.8000	1.1413	0.7064	1.2772	2.0324	3.1612	0.7232	1.5399	0.7232	1.5399
1.9000	1.2047	0.7141	1.2681	1.9958	3.0644	0.6934	1.4567	0.6934	1.4567
2.0000	1.2681	0.7213	1.2594	1.9616	2.9760	0.6658	1.3812	0.6658	1.3812

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.634
FMax	0.7105	0.4505
F0.1	0.3906	0.2476
F35%SPR	0.6673	0.4231
Flow	0.0411	0.0261
Fmed	0.6478	0.4107
Fhigh	1.4752	0.9353

Weights in kilograms

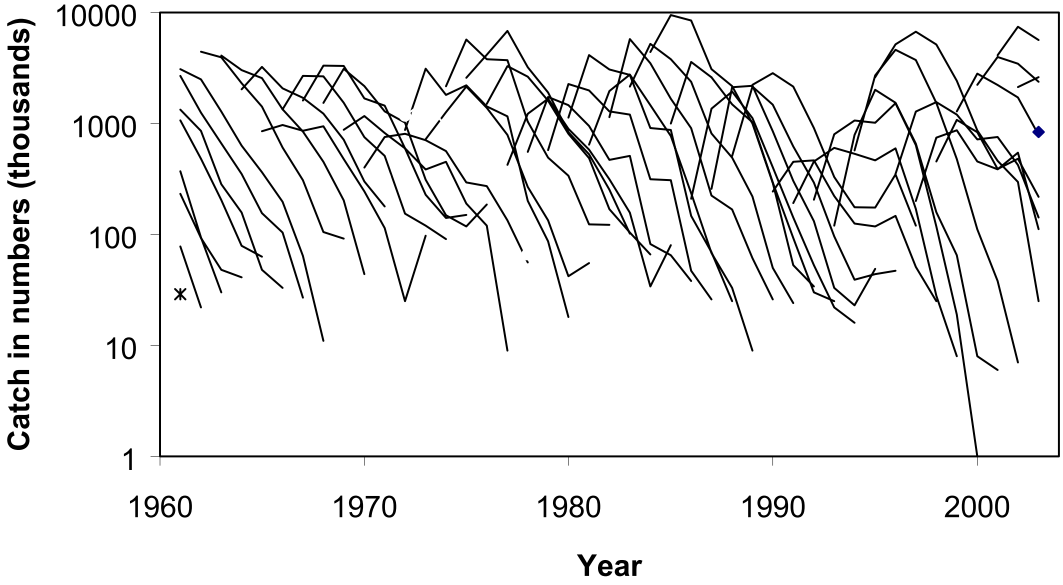


Figure 2.2.3.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers.

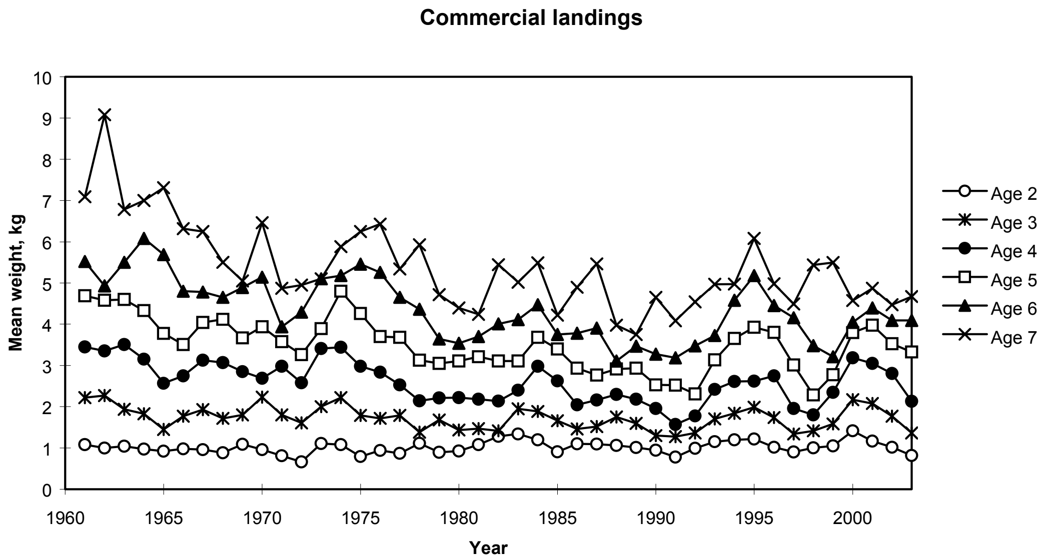


Figure 2.2.4.1. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2003.

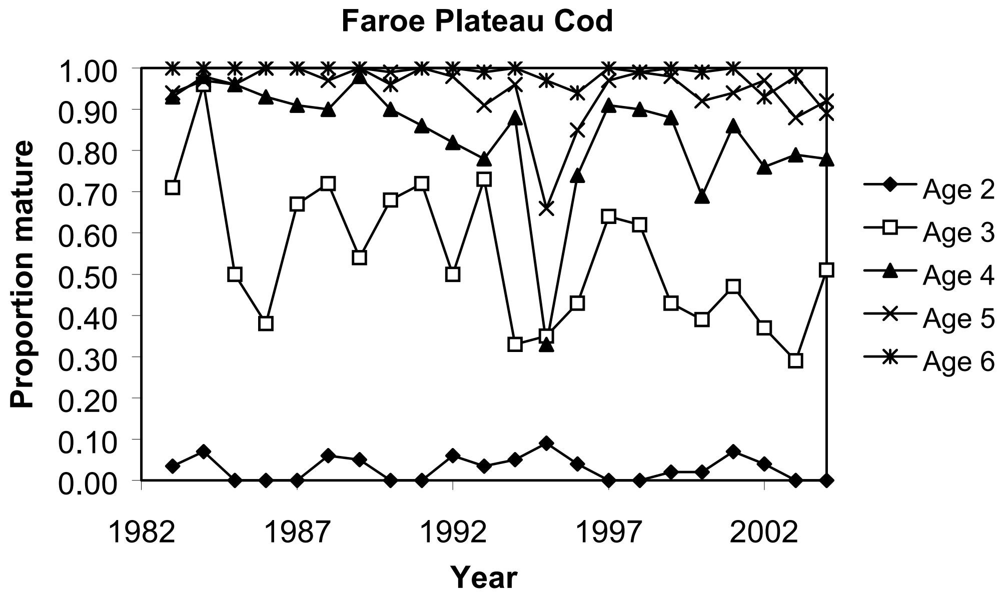


Figure 2.2.5.1. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey.

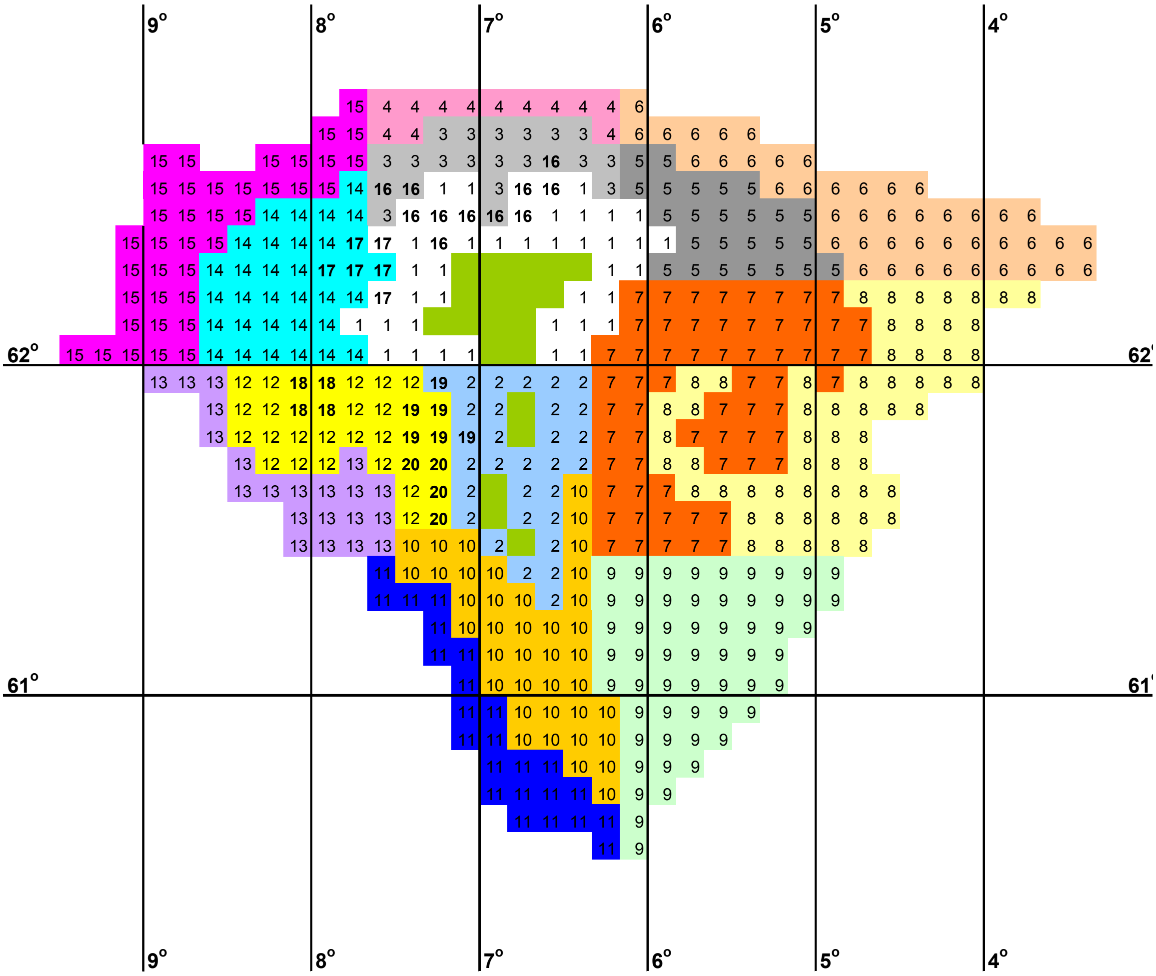


Figure 2.2.6.1. The figure shows the new stratification of the spring survey. The colours refer to the traditional stratification (15 stations) but note that the numbers inside the squares refer to the actual stratification (the strata 16-20 are added).

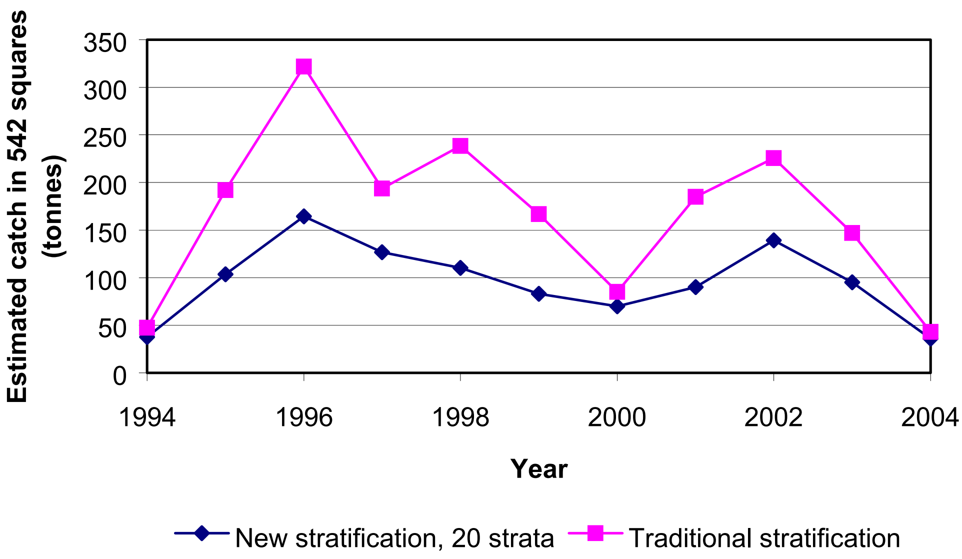


Fig. 2.2.6.2. Estimated catch in all 542 squares with the traditional stratification and the new stratification.

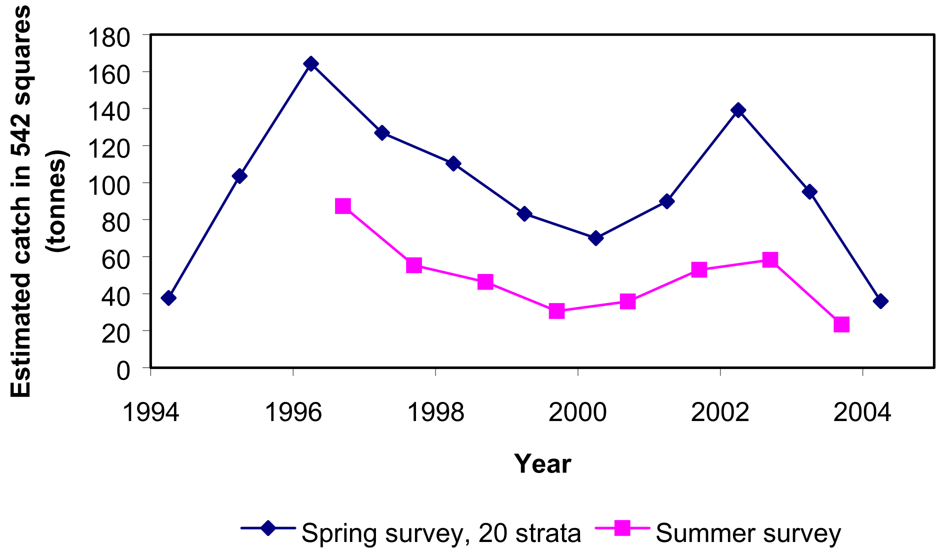


Figure 2.2.6.3. Estimated catch in all 542 squares in the spring survey (new stratification) and the summer survey (traditional stratification).

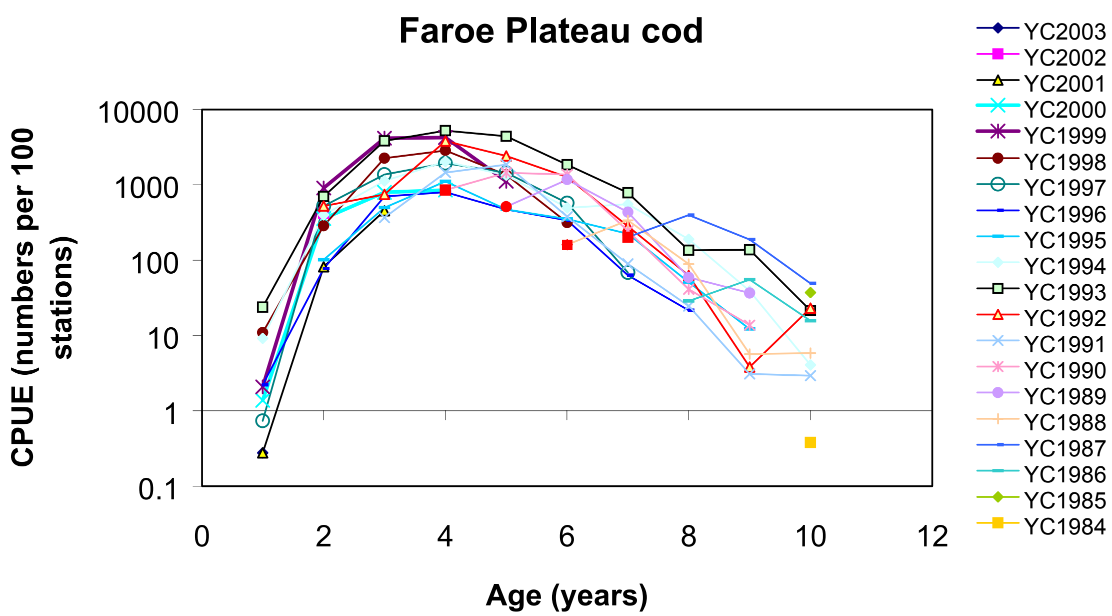


Figure 2.2.6.4. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey. The values for 1994 are marked red.

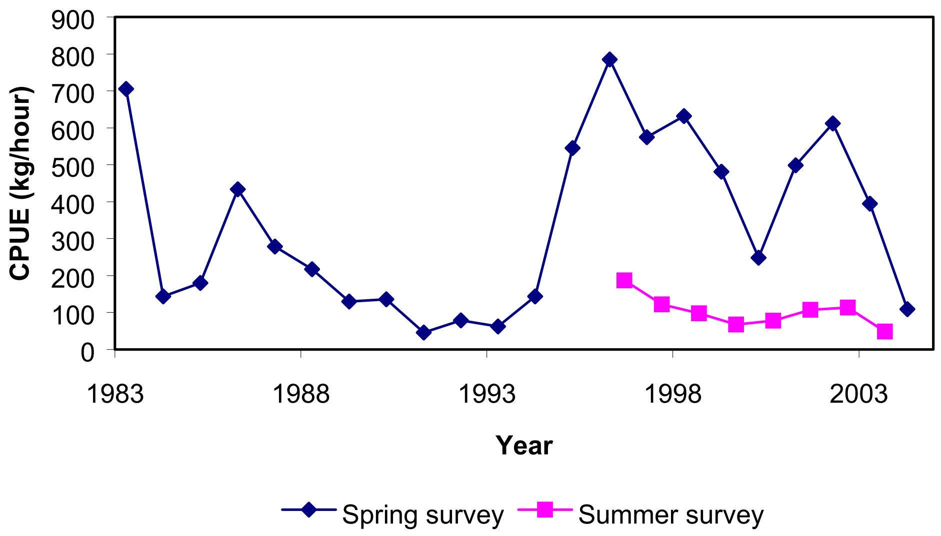


Figure 2.2.6.5. Faroe Plateau (sub-division VB1) COD. Catch per unit effort (kg/hour) in the spring, and summer groundfish survey.

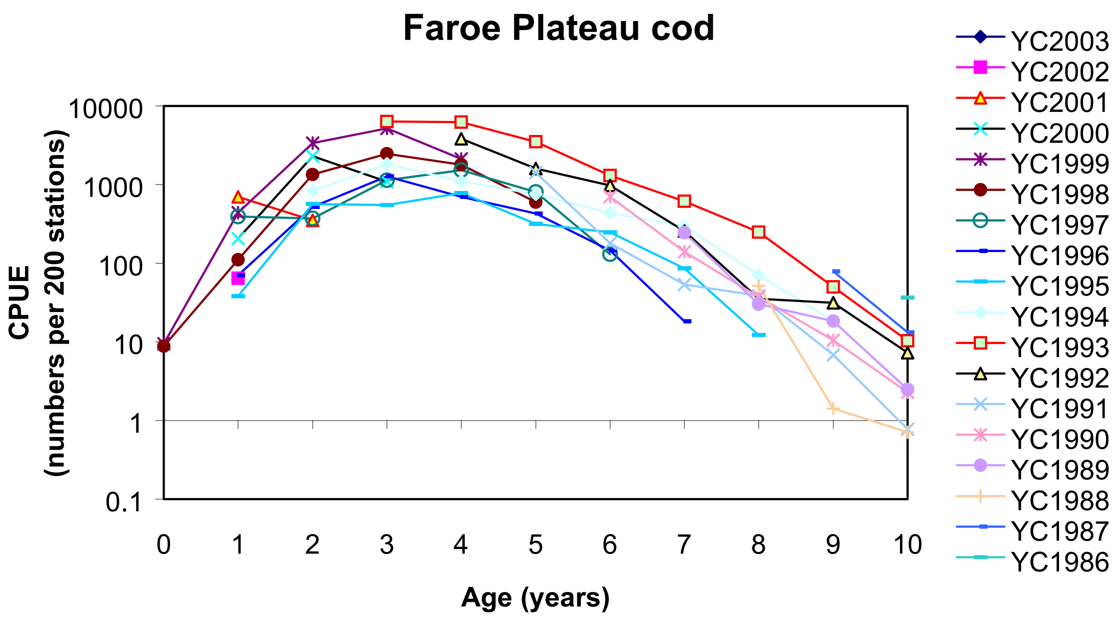


Figure 2.2.6.6. Faroe Plateau (sub-division VB1) COD. Catch curves from the summer groundfish survey.

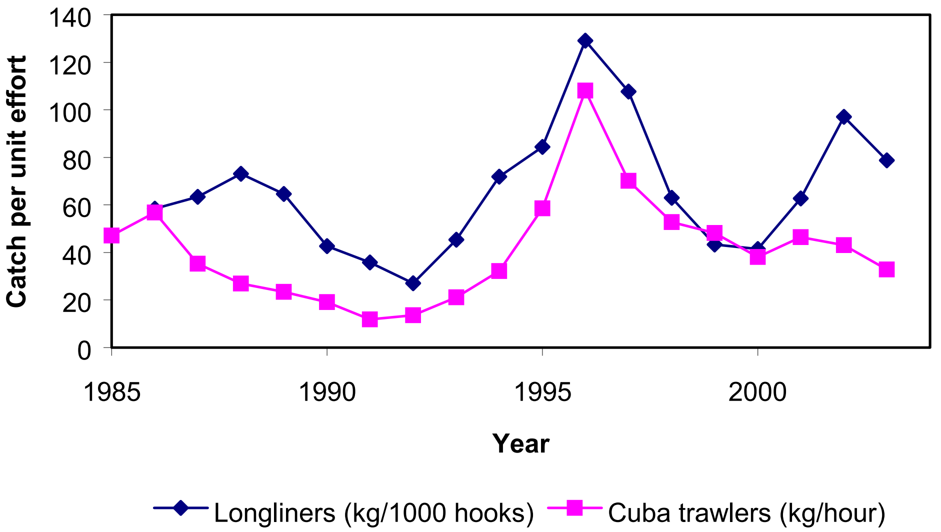
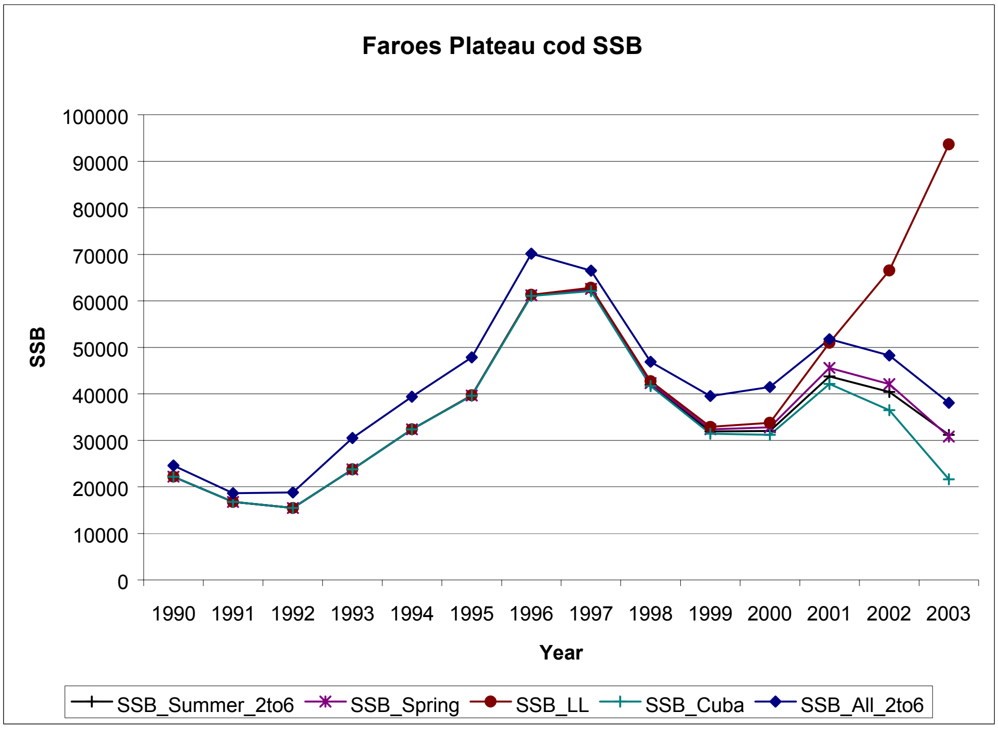


Figure 2.2.7.1.1. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for Cuba trawlers and longliners.



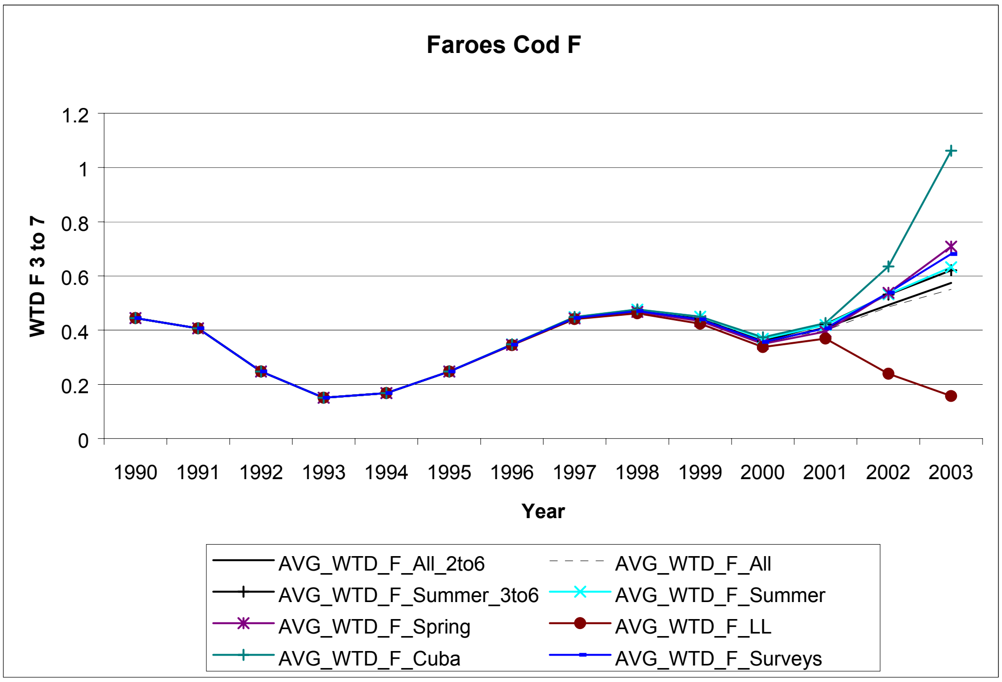


Figure 2.2.7.1.2. Time trends of SSB and F estimated in ADAPT assessments done with each potential index separately.

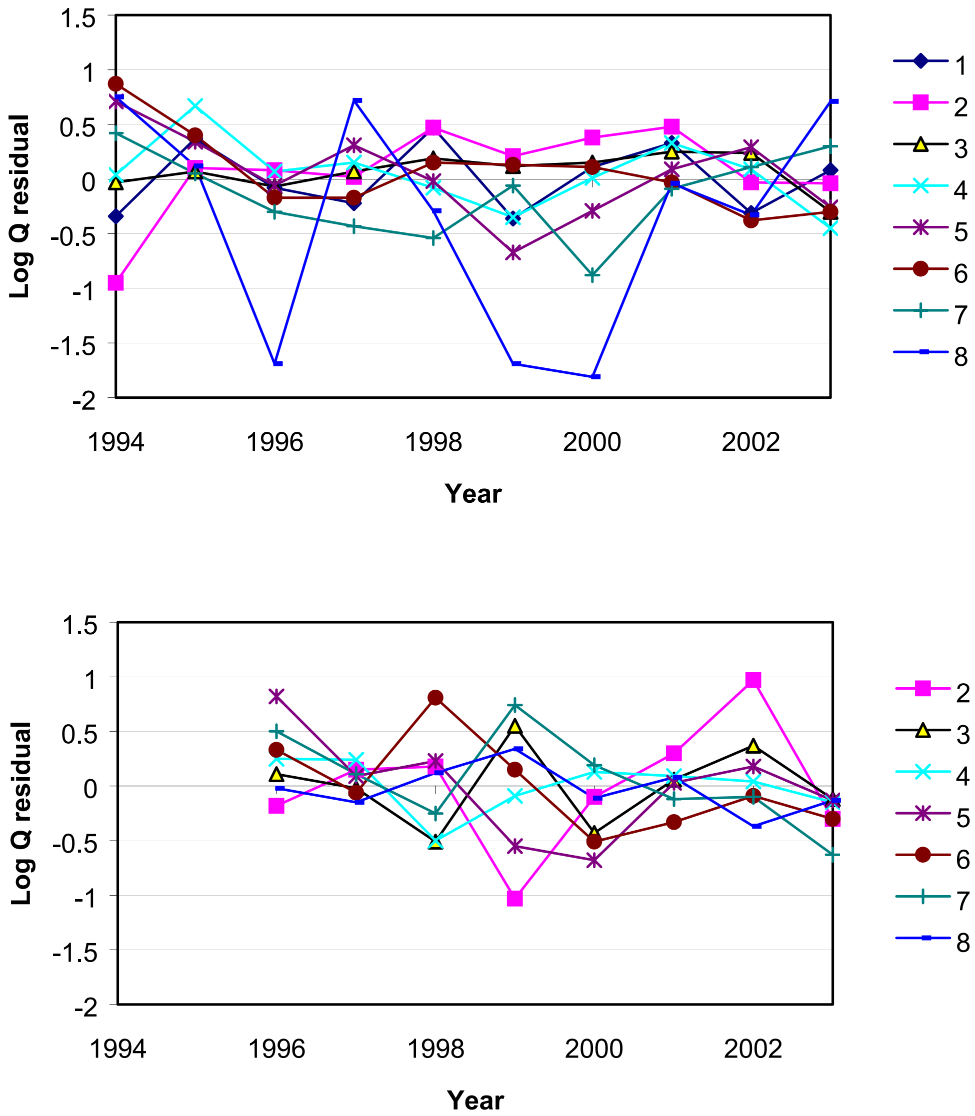


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey.

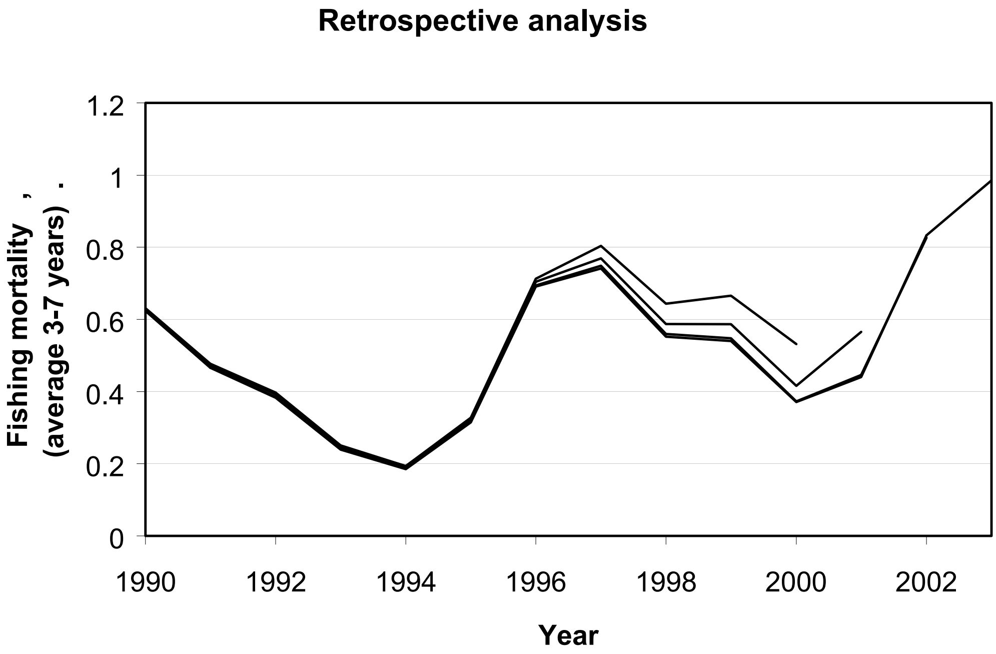


Figure 2.2.7.1.4. Faroe Plateau (sub-division VB1) COD. Results from retrospective analysis.

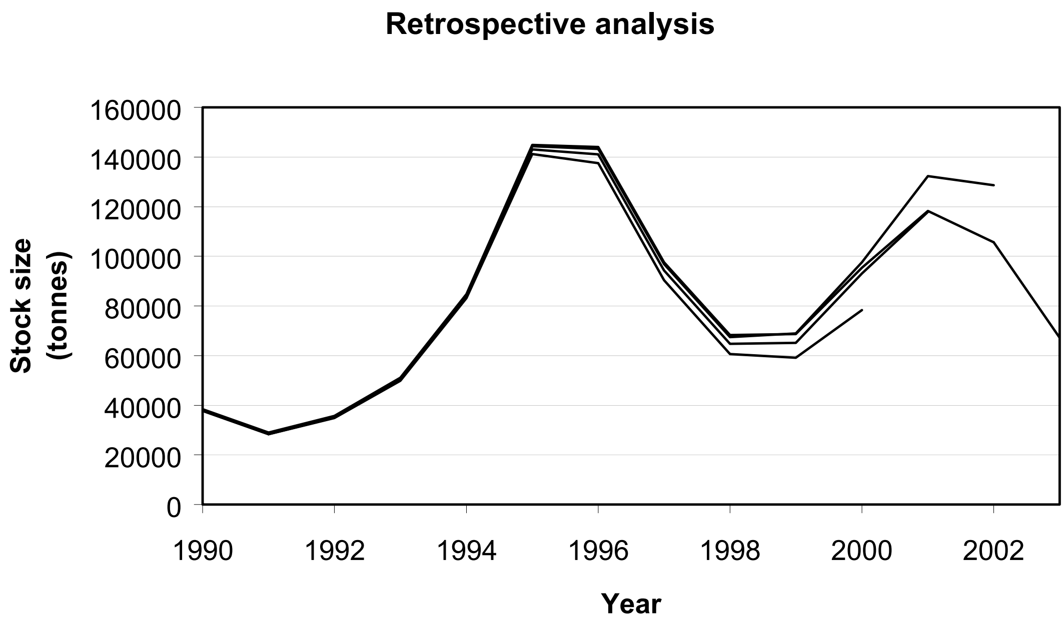


Figure 2.2.7.1.4. Faroe Plateau (sub-division VB1) COD. Results from retrospective analysis. Continued.

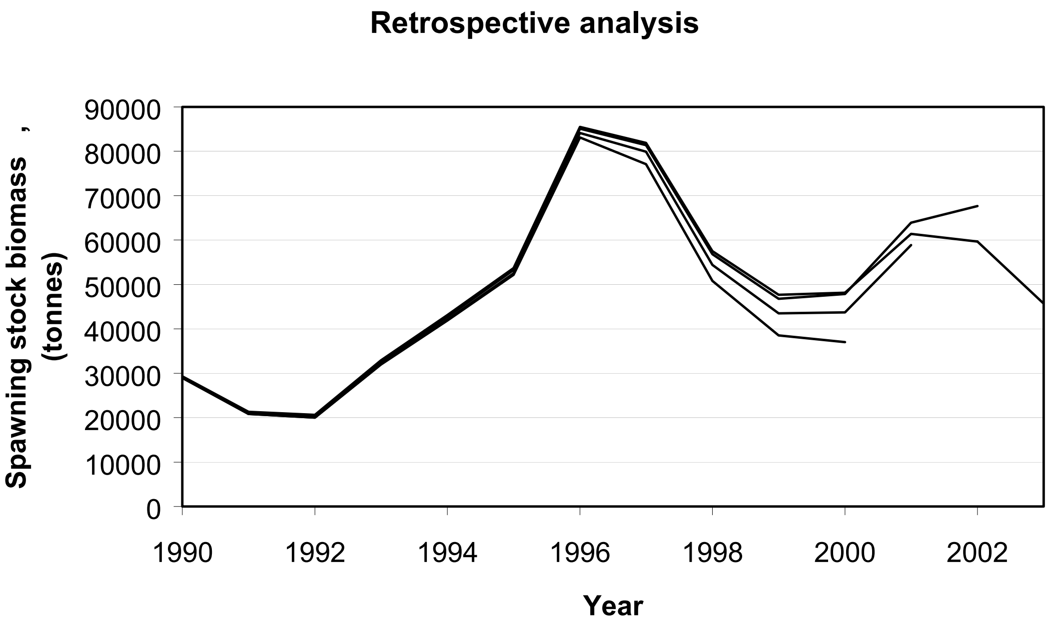
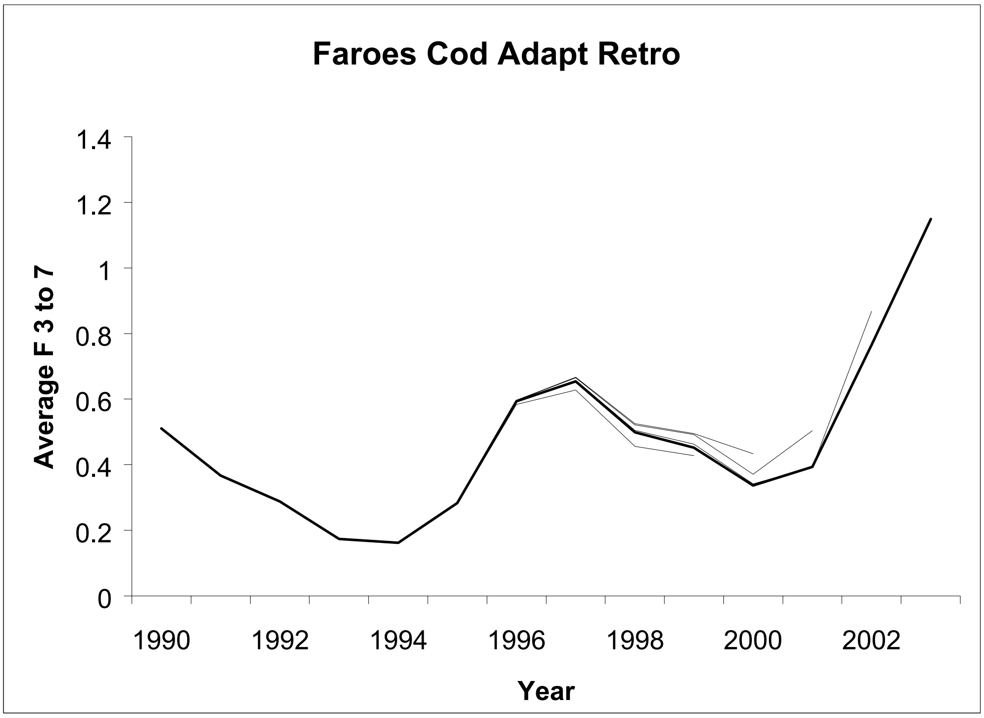


Figure 2.2.7.1.4. Faroe Plateau (sub-division VB1) COD. Results from retrospective analysis. Continued.



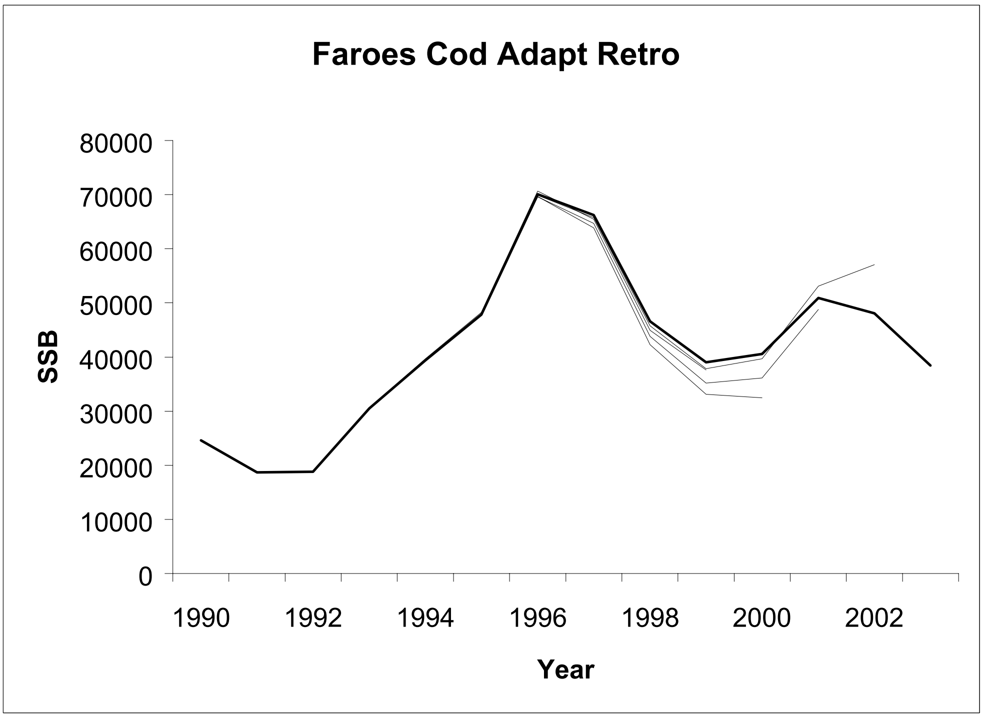


Figure 2.2.7.1.5. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8.

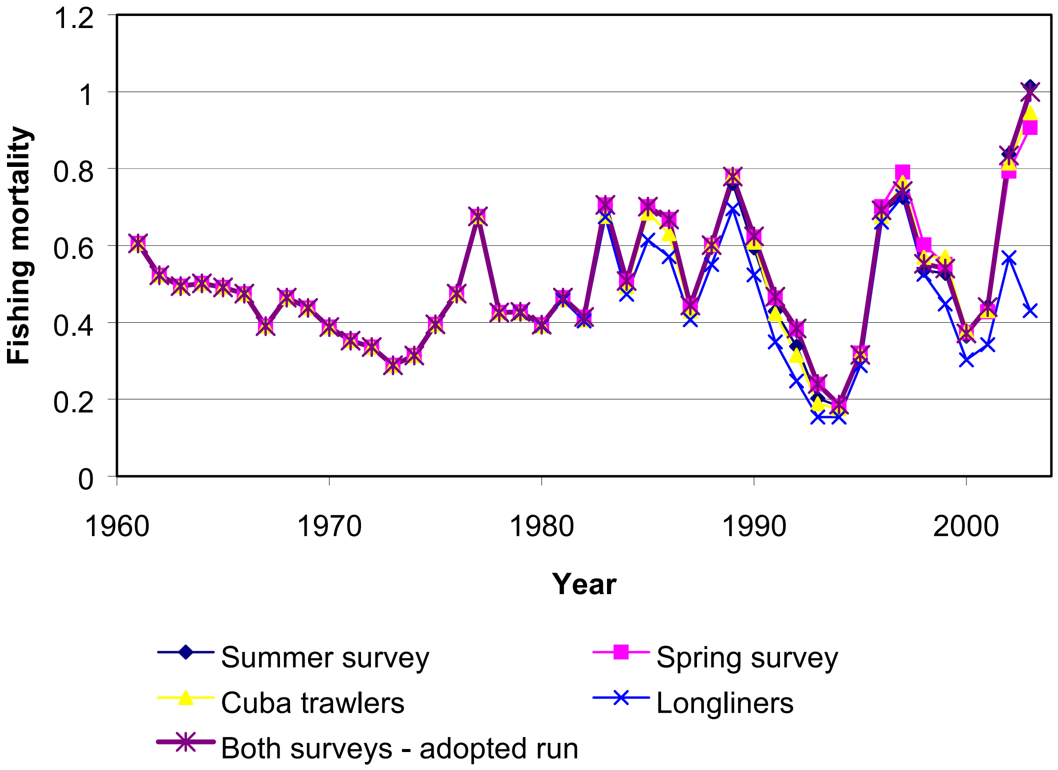


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Results from different XSA runs.

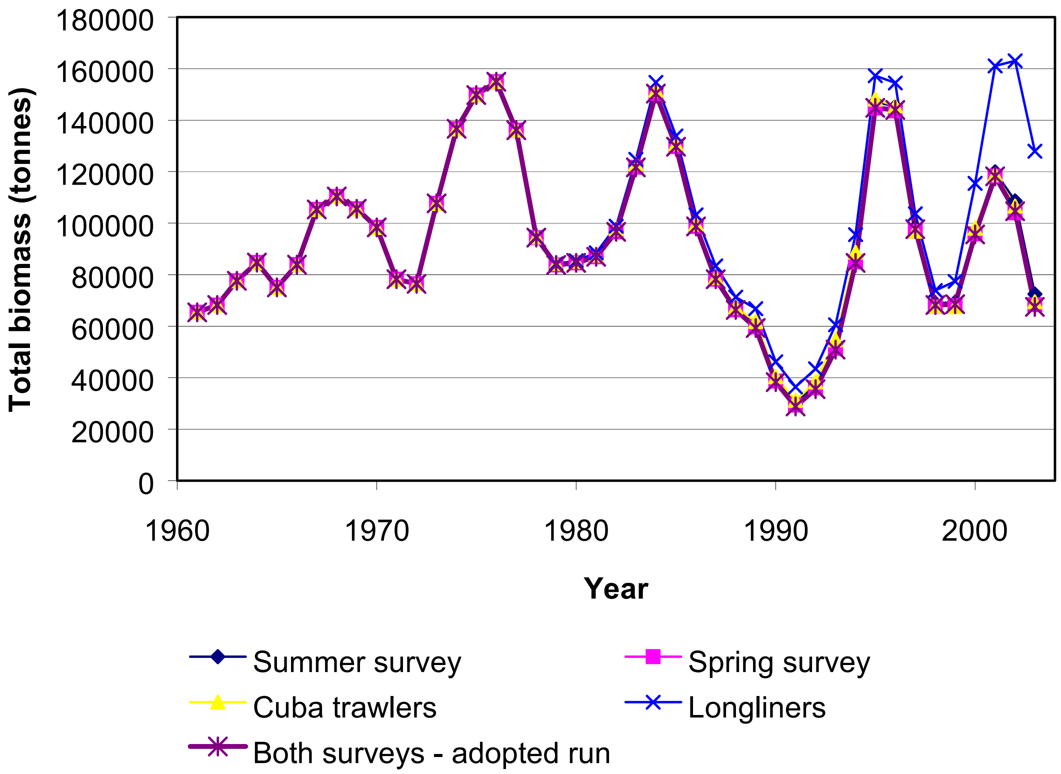


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Results from different XSA runs. Continued.

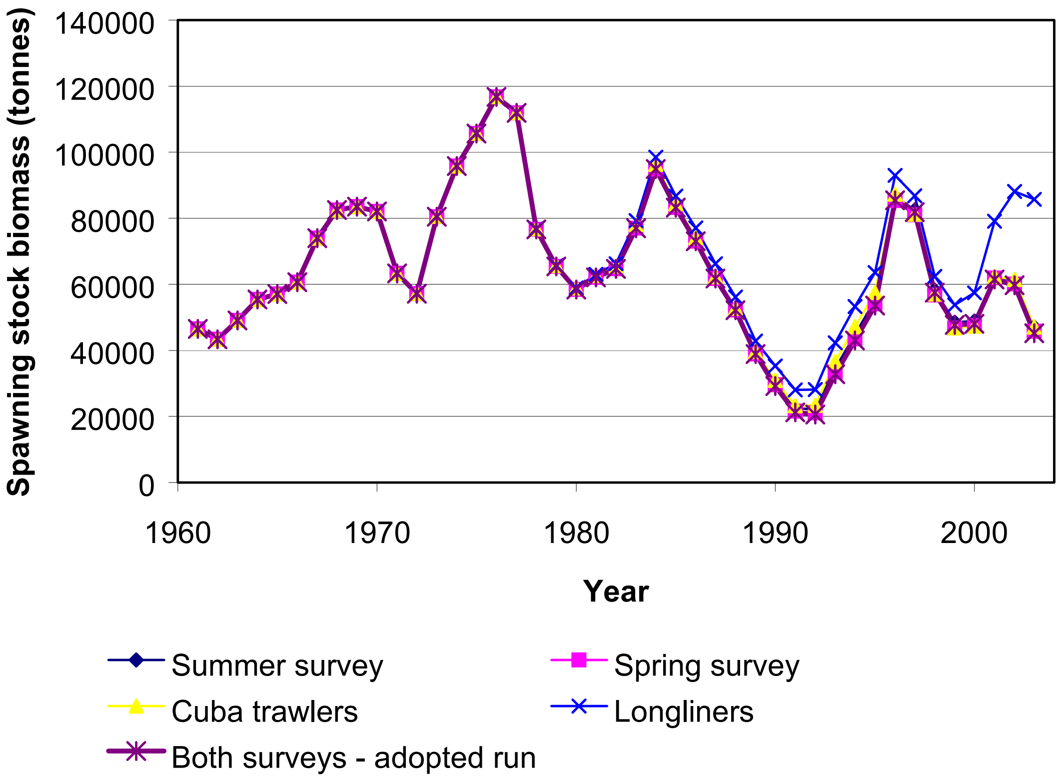


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Results from different XSA runs. Continued.

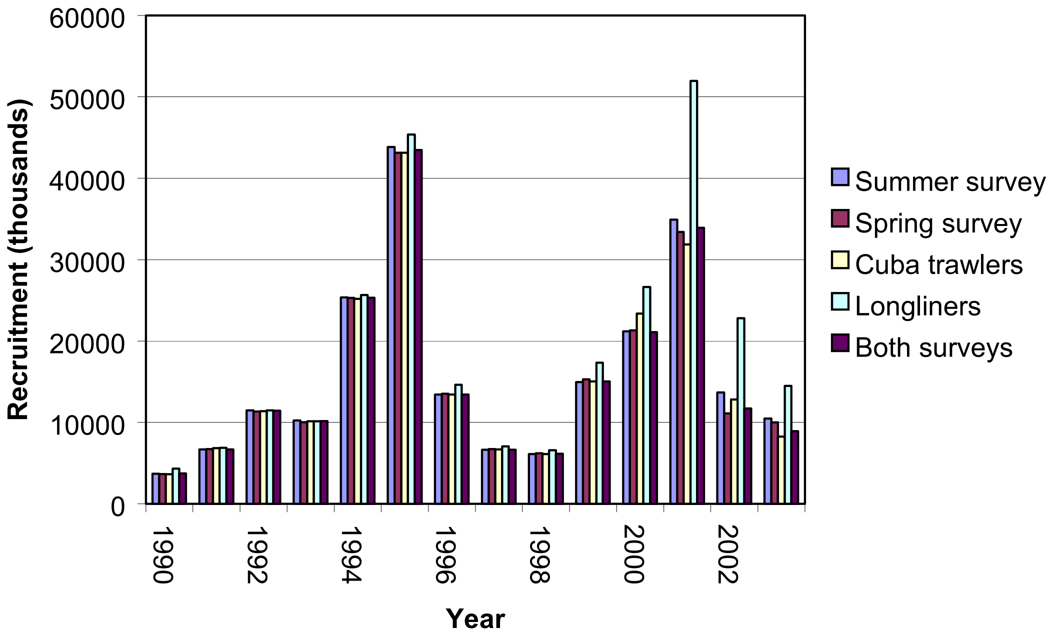
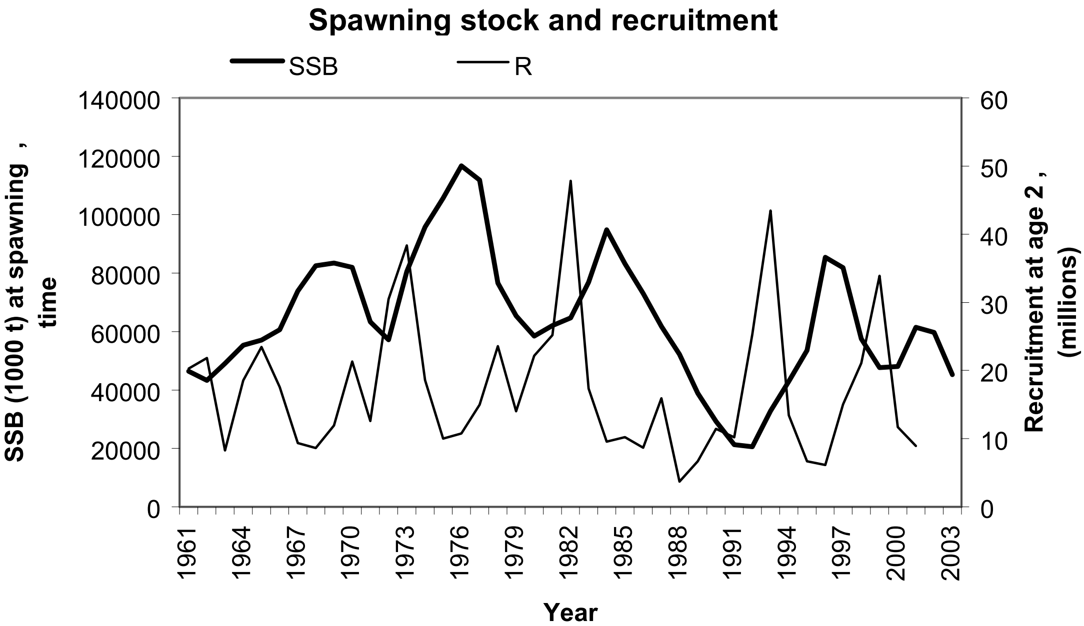


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Results from different XSA runs. Continued.



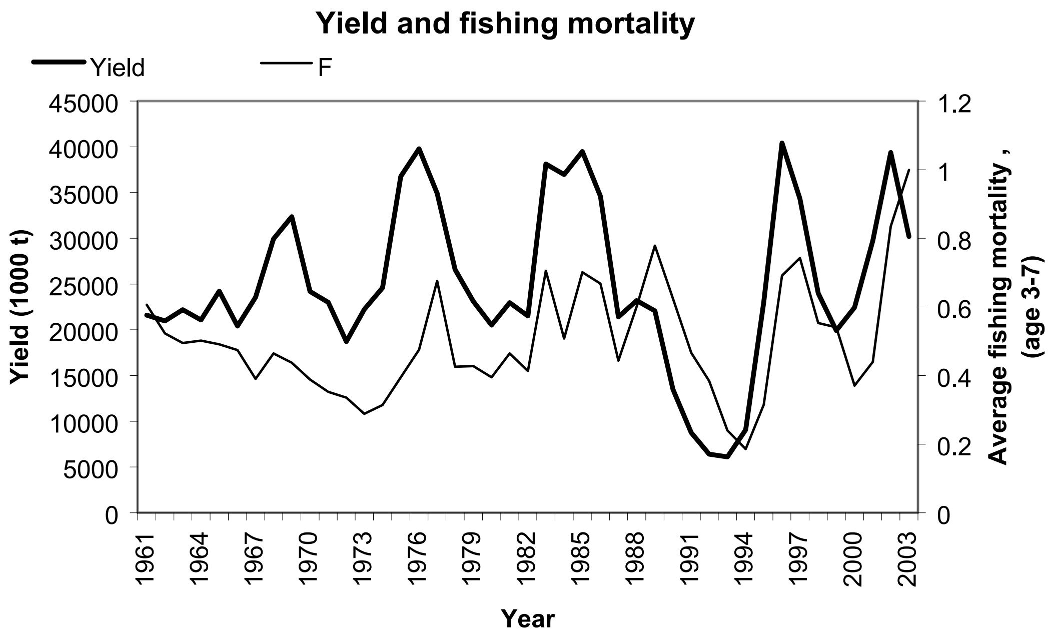


Figure 2.2.7.1.7. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year.

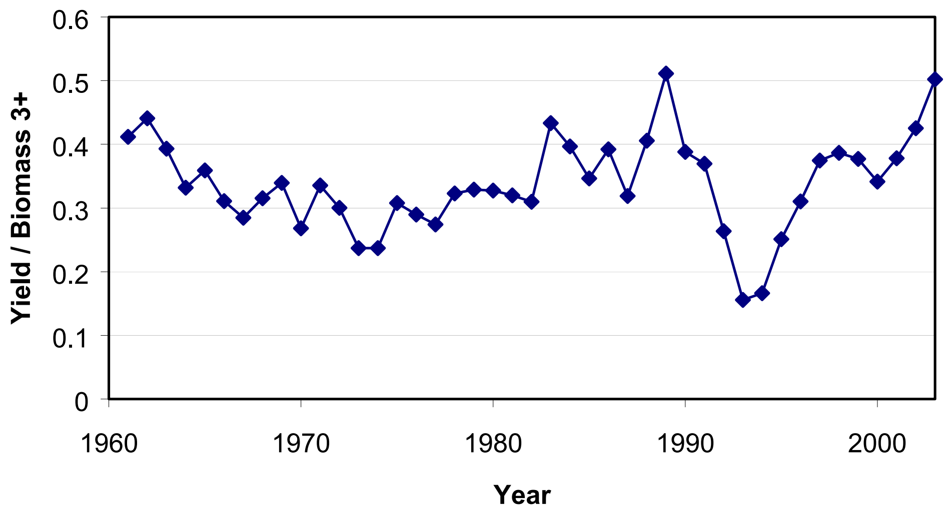


Figure 2.2.7.1.8. Faroe Plateau (sub-division VB1) COD. Yield divided by exploitable biomass (ages 3 and older).

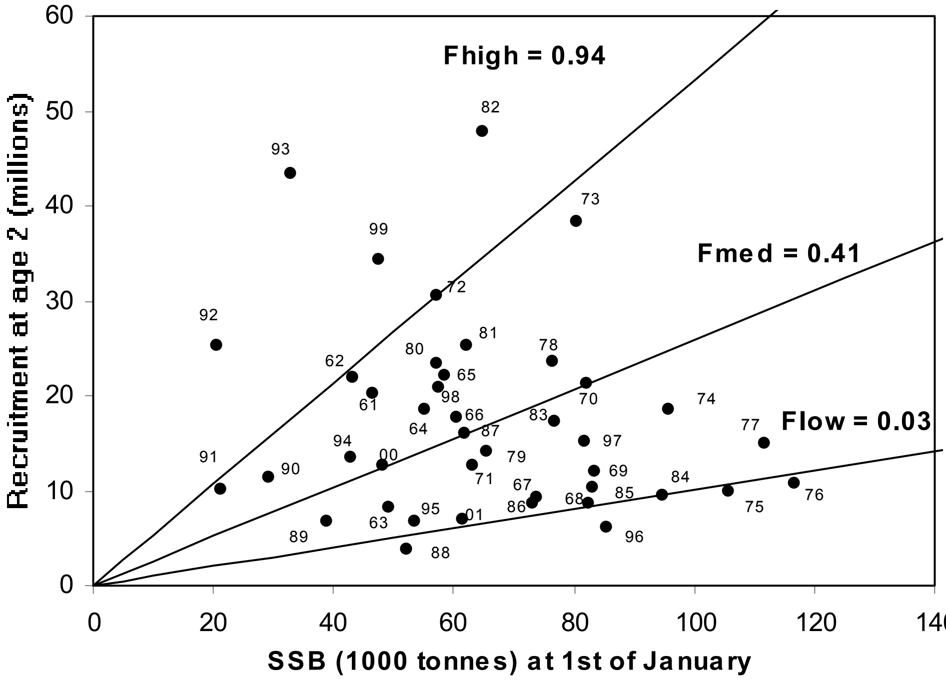


Figure 2.2.7.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2001. Years are shown at each data point.

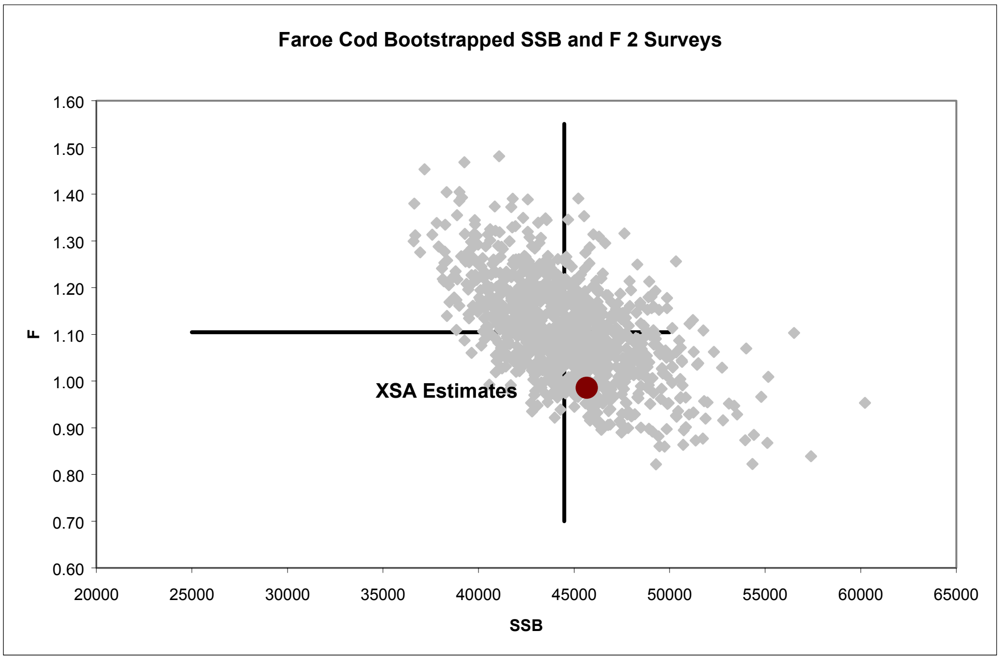


Figure 2.2.7.2.2. F and SSB's for 2003 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimates are also shown.

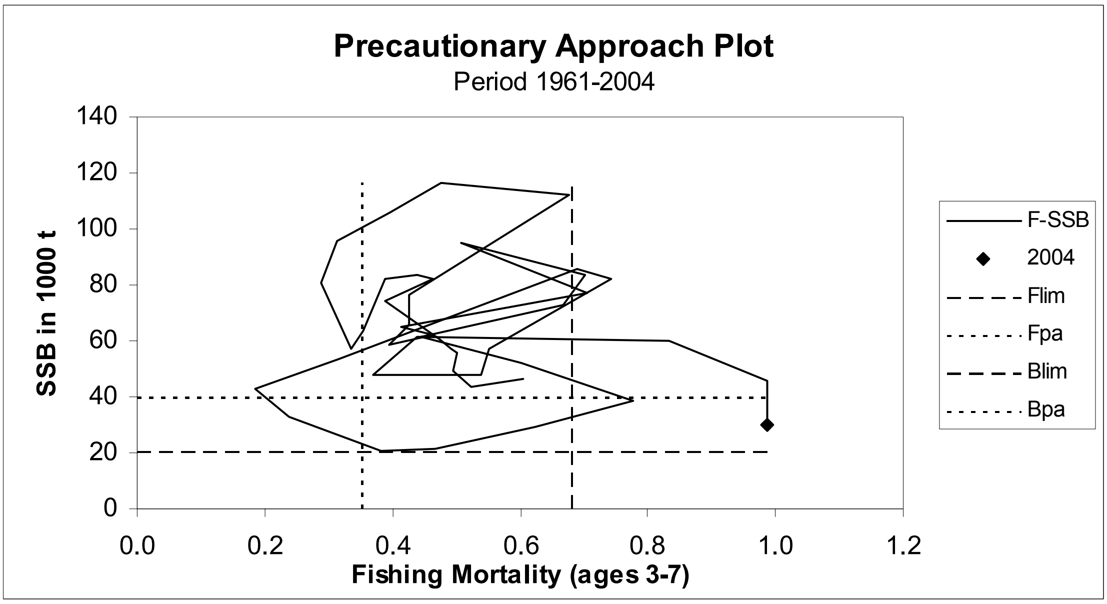
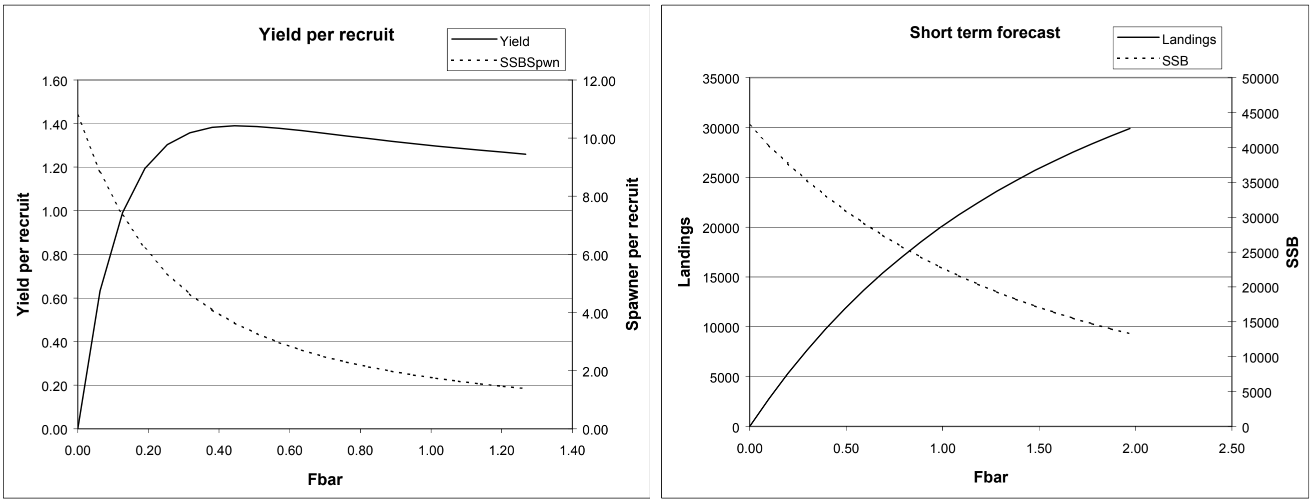


Figure 2.2.8.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2004. Output from standard graph software.



MFYPR version 1
Run: YLD3
Time and date: 10:33 06/05/04

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.6340
FMax	0.7105	0.4505
F0.1	0.3906	0.2476
F35%SPR	0.6673	0.4231
Flow	0.0411	0.0261
Fmed	0.6478	0.4107
Fhigh	1.4752	0.9353

Weights in kilograms

MFDP version 1
Run: Run1
Index file 4/5-2002
Time and date: 07:55 04/05/04
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.2.8.4.1. 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 2003 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 cod fishery on the Bank, with peak landings exceeding slightly 5 000t in 1973. The evolution of landings has been smoother since 1987, declining from about 3 500t in 1987 to only 330 t in 1992 before increasing to 3 600t in 1997. In 2003, landings increased sharply to 5 000t, nearly exceeding the previous peak in 1973, as a result of a substantial increase in longline fishing effort (Figure 2.3.1.2). Most of the Faroese catch has been taken by pair trawlers and longliners (Table 2.3.1.2).

The decreasing trend in 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 2003 sampling intensity is shown in the text table below) and from the groundfish survey since 1983. In 2000, an attempt was made to assess the stock using XSA with catch at age for 1992-1999, using the spring groundfish survey as a tuning series (1995-1999) but the WG and ACFM concluded that it could only be taken as indicative due to scarce catch-at-age data. No attempt was made to update the XSA in subsequent years given the poor sampling for age composition particularly for trawl landings.

Sampling from commercial fleets in 2003 is as follows :

Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2003.

Fleet	Size	Samples	Length	Otoliths	Weights
Longliners	<100 GRT	7	1,350	120	120
Longliners	>100 GRT	44	9,241	970	480
Jiggers		0	0	0	0
Sing. trawlers	<400 HP	0	0	0	0
Sing. trawlers	400-1000 HP	0	0	0	0
Sing. trawlers	>1000 HP	0	0	0	0
Pair trawlers	<1000 HP	1	206	61	61
Pair trawlers	>1000 HP	2	412	60	60
Total		54	11,209	1,211	721

The Faroese groundfish surveys (spring and summer) 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 of the spring survey was low during 1988 to 1995, varying between 246 and 637 kg/tow since 1996. The 2003 value (717.5) is higher than the value in 2002 (443.8). Although noisy, the survey suggests higher, possibly increasing biomass since 1995. The spring survey was not carried out in 2004 and there is a possibility that it will no longer be conducted.

The length distributions in the 2001-2003 spring survey are illustrated in Figure 2.3.2.2.. In 2001 and in 2003 the proportion of small fish may indicate good recruitment.

Figure 2.3.2.3 shows a positive correlation between the spring survey index and the landings in the same year. The ratio of landings to the spring survey cpue index provides an exploitation ratio (Figure 2.3.2.4), which can be used as a proxy to relative changes in fishing mortality. The results suggest that fishing mortality has decreased over time but increasing since 2001 due to larger landings. The agreement between the catches and the summer survey is good for 1996 to 2002, but the summer survey does not suggest a large increase in 2003. The ratio of the catches to the spring survey would suggest that current exploitation is low compared with past estimates. The summer survey is shorter, and it would suggest that the exploitation rate in 2003 was about twice those observed in previous years. In 2004 a statistical catch at age model based on spring indices was used to assess the stock. The relative fishing mortality from the separable model suggests an even higher mortality in 2003 than the exploitation ratio (Figure 2.3.2.5)

2.3.2.1 Comment on the assessment

An XSA was attempted in the 2000 assessment but not since. 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

2.3.3 Reference points

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

2.3.4 Management considerations

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

Table 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Nominal catches (tonnes) by countries 1986-2003 as officially reported to ICES. From 1992 the catches by Faroe Islands and Norway are used in the assessment.

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

	1999	2000 *	2001	2002	2003
Faroe Islands	1,001				*
Norway	88	49	50 *	25	72
UK (E/W/NI)	- [2]	[2]	[2]		
UK (Scotland)	210	245	288	218	
United Kingdom		- [2]			244 [2]
Total	1,299	294	338	243	316 *
Used in assessment	1,089	1,243	1219	1745	5092 *

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 boats	LL<100	ST<400	Gillnet	Jiggers	ST<1000	ST>1000	PT<1000	PT>1000	LL>100	Ind.trwl	Others	Total, gut.w.
1992	0.0	8.0	0.0	0.0	16.0	7.0	7.0	11.0	40.0	11.0	0.0	0.0	100
1993	0.0	9.3	16.9	0.0	4.6	6.3	0.0	5.5	26.6	30.4	0.0	1.3	237
1994	0.5	8.8	31.2	2.6	5.1	8.1	6.4	2.8	20.0	12.6	1.6	0.5	645
1995	1.0	3.6	3.6	0.4	23.0	0.2	9.5	11.1	16.0	31.5	0.0	0.0	505
1996	2.3	1.2	3.2	0.1	24.3	5.0	1.6	23.9	36.7	1.5	0.0	0.1	1846
1997	0.4	1.9	0.4	1.5	11.4	4.5	3.4	16.9	38.4	21.2	0.0	0.0	3101
1998	0.1	3.8	0.5	1.3	5.7	3.1	10.1	12.8	32.4	29.8	0.3	0.0	2783
1999	0.4	10.5	0.1	1.7	17.9	1.8	3.0	0.1	0.9	63.6	0.0	0.1	901
2000	0.3	5.9	0.3	0.0	1.3	0.0	9.3	17.7	51.2	14.0	0.0	0.0	1062
2001	4.1	9.2	2.3	0.5	4.8	2.9	9.2	12.6	26.9	27.3	0.2	0.0	1434
2002	10.3	3.5	0.0	0.0	0.3	0.0	1.5	5.9	33.4	45.3	0.0	0.0	1442
2003	2.3	16.8	0.0	0.0	3.5	0.0	1.3	0.0	16.3	59.6	0.0	0.0	1996

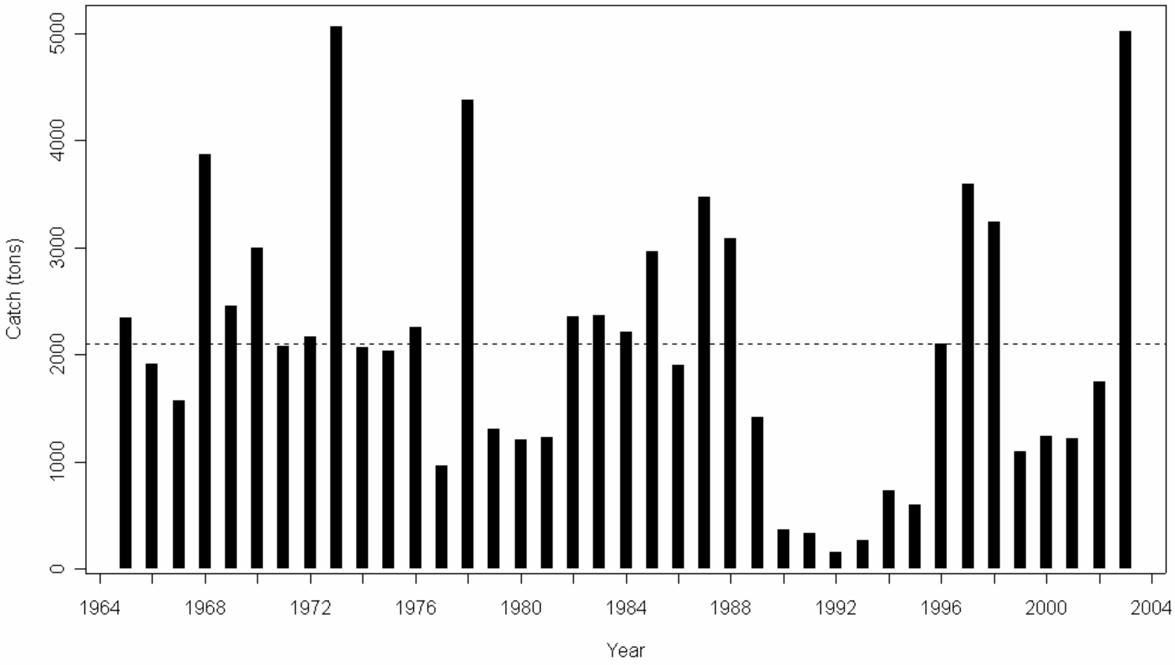


Figure 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2003. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank.

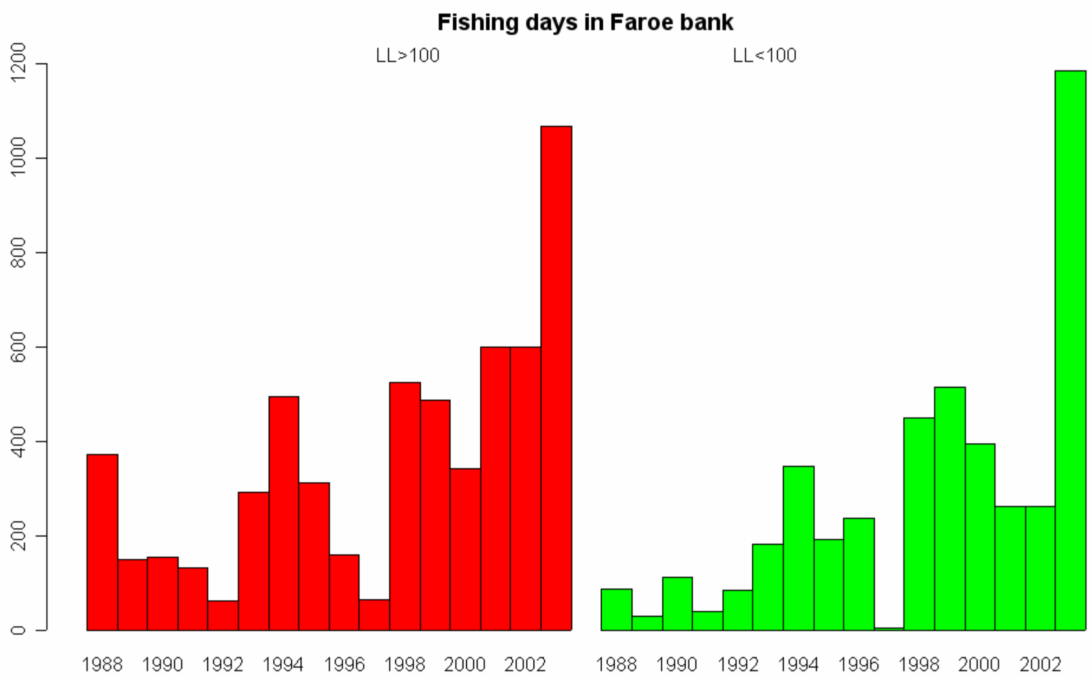


Figure 2.3.1.2 Fishing days for longline gear type in the Faroe Bank (exerted).

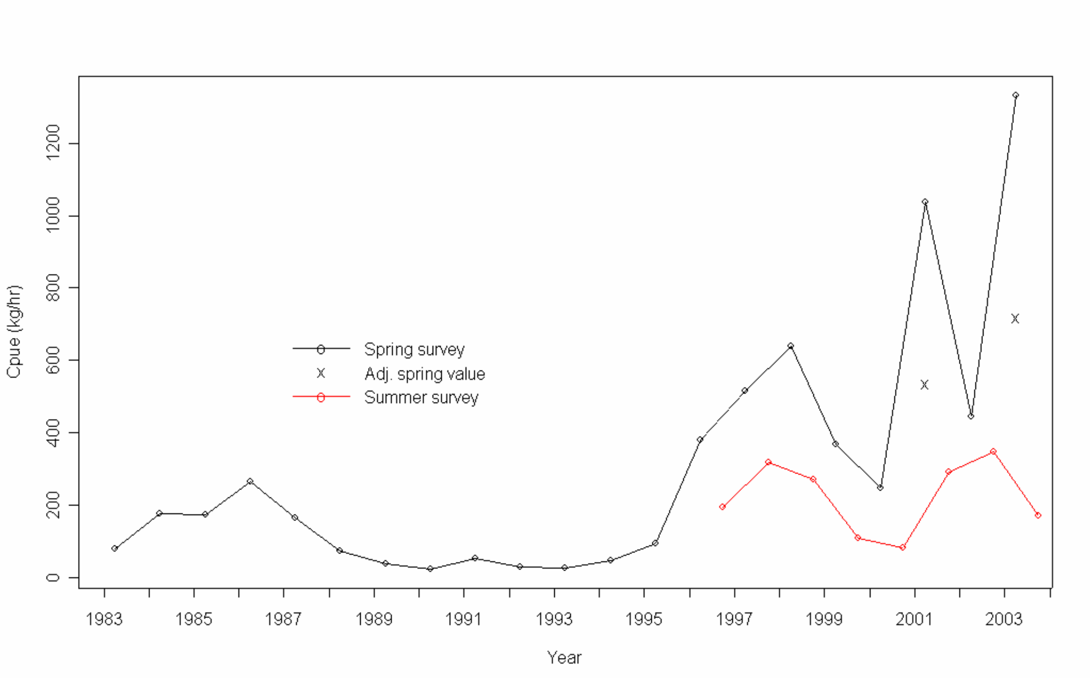


Figure 2.3.2.1. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and autumn groundfish survey . Large hauls are replaced by more typical values from the particular station.

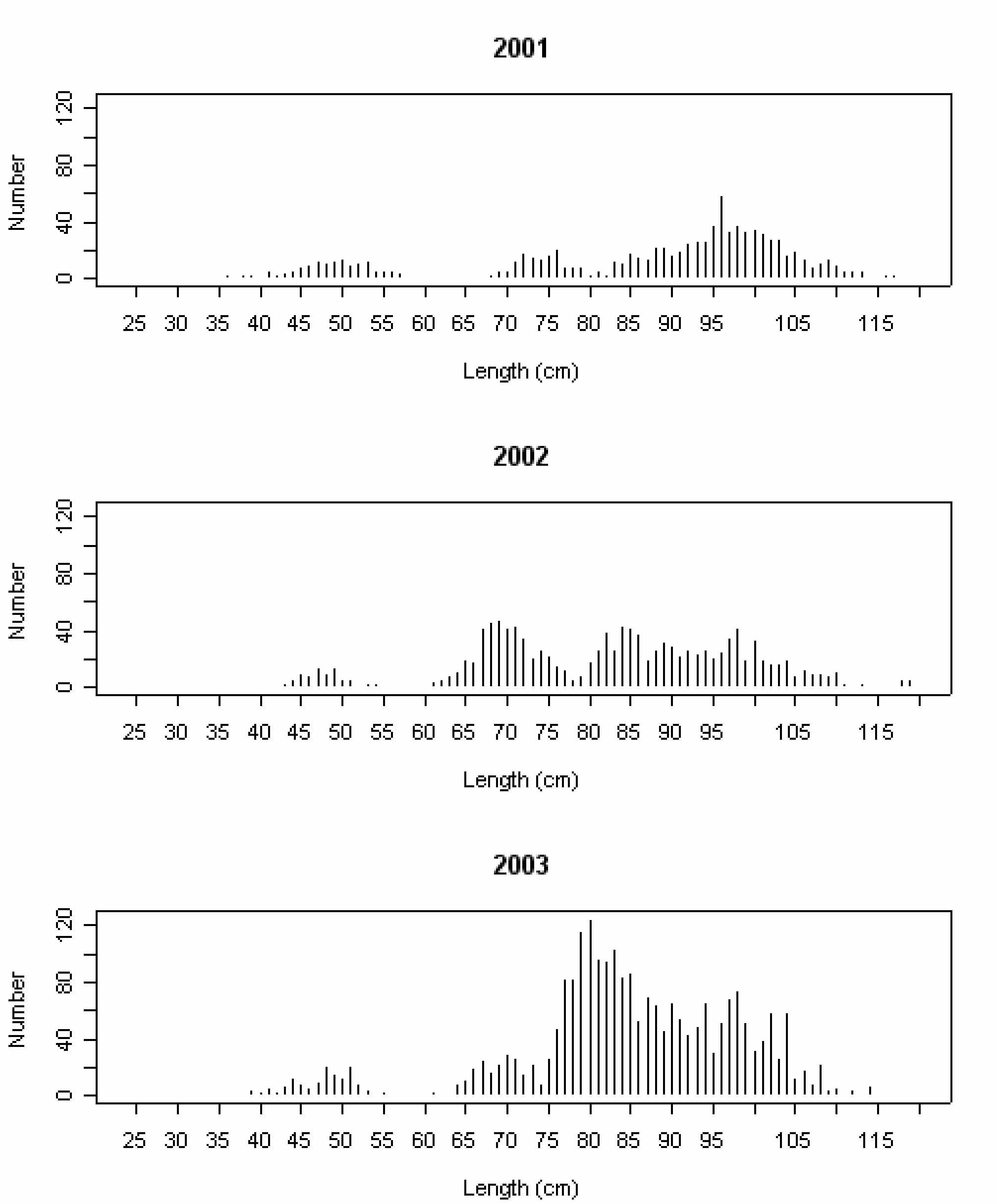


Figure 2.3.2.2.Faroe Bank (sub-division Vb2) cod. Length distributions in the spring survey .

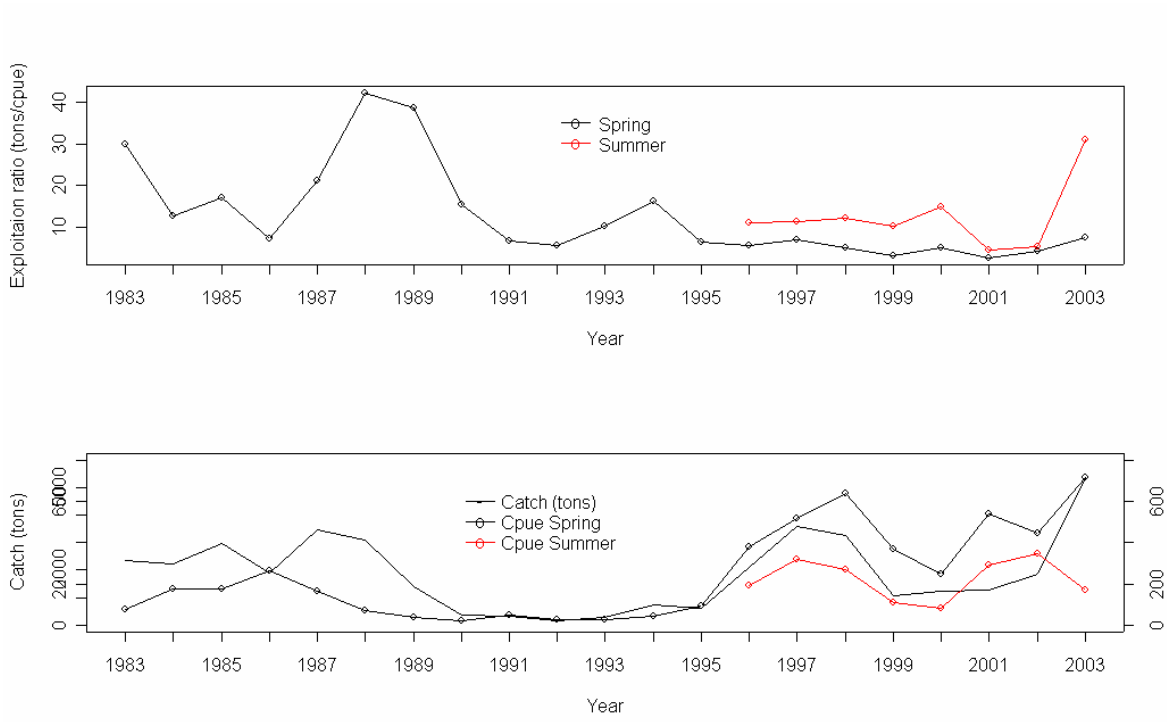


Figure 2.3.2.3. Faroe Bank (Sub-division Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate.)
Lower plot: Landings and cpue (kg/hr) in spring and summer survey

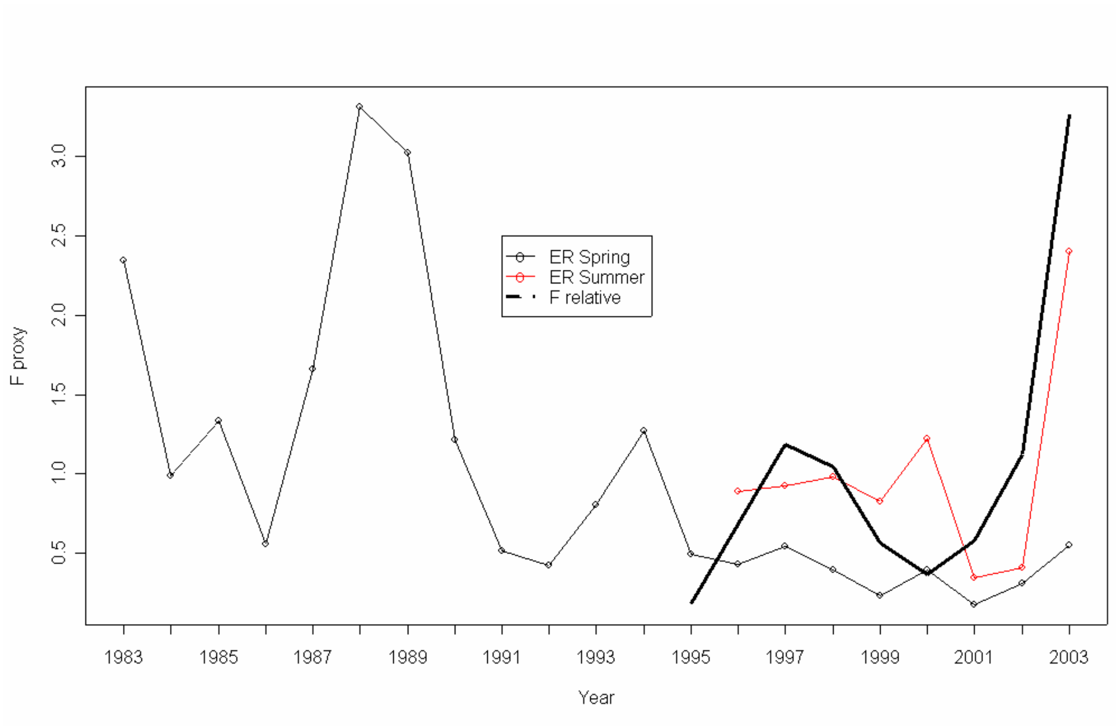


Figure 2.3.2.4. Faroe Bank (Sub-division Vb2) cod .Relation between exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate.) and relative fishing mortality from statistical catch at age.

2.4 Faroe Haddock

2.4.1 Introduction

Haddock in Faroese Waters, i.e. ICES Sub-Divisions Vb1 and Vb2 and in the southern part of ICES Division IIa, close to the border of Sub-Division Vb1, are generally believed to belong to the same stock and are treated as one management unit named Faroe haddock. Haddock is distributed all over the Faroe Plateau and the Faroe Bank from shallow water down to more than 450 m. Spawning takes place from late March to the beginning of May with a peak in the middle of April and occurs in several areas on the Faroe Plateau and on the Faroe Bank. Neither does the haddock form as dense spawning aggregations like cod and saithe, nor does it perform ordinary spawning migrations. After spawning, eggs and fry are pelagic for about 4 months over the Plateau and Bank and settling starts in August. This is a prolonged process and pelagic juveniles can be found at least until September. Also during the first years of life they can be pelagic and this vertical distribution seems to be connected to year class strength, with large year classes staying pelagic for a longer time period. No special nursery areas can be found, because young haddock are distributed all over the Plateau and Bank. After settling the haddock is regarded very stationary as seen in tagging experiments. Different growth in different parts of the distribution area as well as a large degree of heterogeneity in genetic investigations support this.

2.4.2 Trends in landings and fisheries

Nominal landings of Faroe haddock have in recent years increased very rapidly from only 4 000 t in 1993 to almost 27 000 t in 2003. Most of the landings are taken from the Faroe Plateau, but the landings from the Faroes Bank (Sub-Division Vb2) have in recent years been increasing and were in 2003 about 4 400t (Tables 2.4.1 and 2.4.2). As can be seen from Figure 2.4.1, landings in 2002-2003 reached historical highs. The cumulative landings by month (Figure 2.4.2) suggest that landings are expected to stay high in 2004. In the short term prediction last year landings were predicted even higher; this could be explained by a behavioural avoidance of the fleet from haddock grounds, especially where small haddock is prevalent, because of very low market prices. This is supported by anecdotal information and might be indicated in Figure 2.4.2 by a smaller increase in the monthly cumulative landings.

Faroese vessels have taken almost the entire catch in recent years (Figure 2.4.1). Table 2.4.3 shows the Faroese landings since 1985 and the proportion taken by each fleet category. The longliners have been taken most of the catches in recent years followed by the pair trawlers.

The 2003 monthly Faroese landings of haddock by fleet category from Subdivisions Vb1 and Vb2, are shown in Figure 2.4.3. As usual, the landings from the Plateau were high in the first month of the year until the end of the spawning time in April/May, stayed low during the summer and increased again in late autumn. On the Faroe Bank, the monthly landings in 2003 showed almost the same pattern.

2.4.3 Catch-at-age

For the Faroese landings, catch-at-age data were provided for fish taken from the Faroe Plateau and the Faroe Bank. The sampling intensity in 2003, which has increased slightly compared to 2002, is shown in the table below.

Sampling of Faroese landings of haddock from Vb in 2003 - as used in calculation of c@age and w@age

	Open Boats	LLiners < 100GRT	LLiners > 100GRT	OB. trawl. < 400HP	OB. trawl. 400-999HP	OB. trawl. > 1000HP	Pair trawl. < 1000HP	Pair trawl. > 1000HP	Total
No. of samples	14	67	111	0	45	2	8	54	301
No. of length measurements	2724	13484	21790	0	8960	350	1385	12080	60773
No. of aged fish	358	1494	2758	0	840	60	300	1018	6828
No. of weighted fish	300	599	1319	0	120	60	240	958	3596

As has been the practise in the past, samples from each fleet category were disaggregated by season and then raised by the catch proportions to give the 2003 catch-at-age in numbers for each fleet (Table 2.4.4). Catches of some minor fleets have been included under the "Others" heading. No catch-at-age data were available from other nations fishing in Faroese waters. Therefore, catches by UK and France trawlers were assumed to have the same age composition as Faroese otter board trawlers larger than 1 000 HP. The Norwegian longliners were assumed to have the same age distribution as the Faroese longliners greater than 100 GRT. The most recent data were revised according to the final catch figures. The resulting total catch-at-age in numbers is given in Tables 2.4.4 and 2.4.5, and in Figure 2.4.4 the LN (catch-at-age in numbers) is shown for the whole period of analytical assessments.

In general the catch-at-age matrix in recent years appears consistent, except for the behaviour of a few small year classes, both in numbers and mean weights at age. Also there are some problems with what ages should be included in the plus group; there are some periods where no or only a few fishes are older than 9 years, and other period with a quite substantial plus group (10+). These problems have been addressed in former reports of this WG and will not be further dealt with here, although the plus group in 2003 was large.

No estimates of discards of haddock are available. However, since almost no quotas are used in the management of this stock, the incitement to discard in order to high grade the catches should be low. Moreover there is a ban on discarding.. The landings statistics is therefore regarded as being adequate for assessment purposes.

2.4.4 Weight-at-age

Mean weight-at-age data are provided for the Faroese fishery (Table 2.4.6). Figure 2.4.5 shows the mean weights-at-age in the landings for age groups 2-7 since 1976. During the period, weights have shown cyclical changes, and have decreased again in 2003 except for age 2 (Figure 2.4.6), after having increased for all ages during a few years. The mean weight at age in the stock are assumed equal to those in the landings.

2.4.5 Maturity-at-age

Maturity-at-age data is available from the Faroese Spring Groundfish Surveys 1982–2004. The survey is carried out in February-March, so the maturity-at-age is determined just prior to the spawning of haddock in Faroese waters and the determinations of the different maturity stages is 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, the routine by the WG has been to use a 3-year running average in the assessment. For the years prior to 1982, average maturity-at-age from the surveys 1982–1995 was adopted (Table 2.4.7 and Figure 2.4.7).

2.4.6 Assessment

2.4.6.1 Tuning and estimates of fishing mortality

Commercial cpue series. Several commercial catch per unit effort series are updated every year, but as discussed in last years report it is questionable to use them directly for tuning of the VPA due to changes in catchability caused by productivity variations in the area (see Faroe Plateau cod), to a different behaviour of the fleets after the introduction of the new management system and, recently, to the low prices which apparently make fleets try to avoid grounds with high abundances of haddock, especially the younger age groups. However, the age-aggregated cpue series are presented and compared to the present VPA estimates of biomass (Figure 2.4.7). Except for the otter-board trawlers larger than 1000 HP, there is a general agreement between the series and the VPA biomass estimates, although in some periods the trawlers are more in accordance with the VPA estimates, and in other years the longliners are closer.

Fisheries independent cpue series. Two annual groundfish surveys are available, one carried out in February-March since 1982 (100 stations per year down to 500 m depth), and the other in August-September since 1996 (200 stations per year down to 500 m depth). Biomass estimates (kg/hour) are available for both series, age disaggregated data is available for the summer series, but due to problems with the database (see last years report), age disaggregated data for the spring survey are only available since 1994. Figure 2.4.8 shows the cpue indices from the surveys (kg/hour) compared to the VPA estimates of the biomass of haddock age 3 and older; in general, there is a good agreement between these series.

Since the Faroe haddock this year is on the update list, it was decided to carry on with the same tuning series as last year, i.e the spring and the summer survey (Table 2.4.8), and to use exactly the same settings in the XSA (Table 2.4.9).

Log q residuals for the two surveys are shown in Figures 2.4.9 and 2.4.10; they are except for some slight differences comparable to those in last year's assessment. LN(numbers at age) for the surveys are presented in Figures 2.4.11-2.4.12 and show consistent patterns, especially the summer survey. Further analysis of the performances of the two series are shown in figures 2.4.13 – 2.4.17. In general, although not so convincing for the youngest ages, there is a good relationship between the indices for one year class in two successive years (Figures 2.4.13-2.4.14). The same applies when comparing the corresponding indices at age from the two surveys (Figure 2.4.15) and also when relating the two survey indices at age to this years VPA estimates of the same ages (Figures 2.4.16-2.4.17).

The retrospective pattern of this XSA is shown in Figure 2.4.18. Being in general acceptable, a overestimate of fishing mortality and corresponding underestimate of spawning stock biomass is evident.

Results. The fishing mortalities from the final XSA run are given in Table 2.4.10 and in Figure 2.4.22B. According to this the fishing mortality showed an overall decline since the early 1960s and 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 it was estimated above 0.5, but decreased again to being about 0.3 in 2000-2002. However, the point estimate for Fbar (3-7) in 2003 has increased to almost 0.5. The reference ages include high F-values for the very small 1996 and 1997 yearclasses and these fishing mortalities might be poorly estimated due to sampling problems. In Figure 2.4.19, two different ways of calculating reference F(3-7) and the exploitation rates (the ratio between the landings and the biomass age 3+) are shown; values for 2003 F's are ranging from 0.22 to 0.48. Using unweighted F(3-7), the uncertain estimates of small yearclasses is given too high influence on the reference F and often result in high values. Using F(3-7) weighted by population number the estimates become smaller especially due to the younger ages not fully recruited to the fishery. Although not directly comparable, the exploitation rate seem to follow the weighted F's. The truth might be somewhere in between.

2.4.6.2 Stock estimates and recruitment

Compared to former assessments, the 2000 assessment changed the perception of stock size (and fishing mortality) considerably and this year's assessment is consistent with this. The stock size in numbers is given in Table 2.4.11 and a summary of the "VPA" with the biomass estimates is given in Tables 2.4.12 and 2.4.18 and in Figure 2.4.22. According to this assessment, the spawning stock biomass has shown big changes in recent years. It decreased from 67 000 t in 1987 to 22 000 t in 1994, increased again to 82 000 t in 1997, decreased to about 52 000 t in 2000 and has increased since to above 96 000 t in 2003 (Figure 2.4.22). The decline in the spawning stock began in the late 1970s due to very poor recruitment in the years before. The stabilization at relatively high SSB's in the mid–1980s was due to the relatively good 1982 and 1983 year classes, but the decline since was partly due to poor year classes since the mid–1980s, as well as the pronounced decline in the mean weights-at-age in the stock. The main reason for the very abrupt increase in the spawning stock biomass is the recruitment and growth of the very large 1993 year class and the well-above-average 1994 year class. The most recent increase in the spawning stock is due to new strong year classes entering the fishery. In the past there have been considerable doubts about the sizes of incoming year classes. Due to the lack of reliable recruitment indices it has been usual to replace XSA estimates with the geometric mean of a reference periods recruitments at age 2. With the presence of two survey series and inclusion of indices from them for ages outside the commercial catch at age the information on incoming yearclasses has improved; it was not felt worthwhile to repeat the use of RCT3 estimates as at least the same information is derived directly from the XSA. The 1999 YC is now confirmed being the highest on record at age 2 (108 mio.) and the YC's from 2000 and 2002 are estimated above average (about 42 mio.), Tables 2.4.12, 2.4.18 and Figure 2.4.22.

2.4.7 Prediction of catch and biomass

2.4.7.1 Input data

2.4.7.1.1 Short-term prediction

The input data for the short-term predictions are given in Tables 2.4.13-14. All year classes up to 2002 are from the final VPA, the 2003-2004 year classes at age 2 are estimated from the XSA at ages 0 and 1 and applying a natural mortality of 0.2 in a forward calculation of the numbers using basic VPA equations. The YC 2004 at age 2 in 2006 is estimated as the geometric mean of the 2-year-olds in 1980-2005.

The exploitation pattern used in the prediction was derived from averaging the 2001–2003 fishing mortality matrices from the final VPA without rescaling to the recent value. The reason for this is, that the high point estimate of reference F (ages 3-7) in 2003 is due to the high estimates of fishing mortalities on ages 6 and 7. These are the small yearclasses from 1996 and 1997 which might be poorly sampled, and the high 2003 estimates are believed more to reflect noise than the reality (see section 2.4.6.1). The same exploitation pattern was used for all three years.

The mean weight-at-age for ages 2-10 in 2004-2006 was calculated as last year using the cohort approach as described in last year's report. The weights at age in 2003 were used as starting points. By inspecting the weights at age 2 for recent years (Figure 2.4.5), they appear very stable and the value for year 2003 were assumed for all the years. Then the remaining weights at age were derived by adding the corresponding Geometric mean growth for each cohort age a to age a+1. The mean weights for the +group in 2003 was also applied in 2004-2006. The same weights-at-age were used for the catch and for the stock as was done in the assessment.

The maturity ogive for 2004 is based on samples from the Faroese Groundfish Spring Survey 2004 and the ogives in 2005-2006 are estimated as the average of the smoothed 2002-2004 values.

2.4.7.1.2 Long-term Prediction

The input data for the long-term yield and spawning stock biomass (yield-per-recruit calculations) are listed in Table 2.4.16. Mean weights-at-age (stock and catch) are averages for the 1977–2003 period. The maturity ogives are averages for the years 1982-2003. The exploitation pattern was derived from the fishing mortality matrix from the final VPA as average F-values for 1999-2003 without any rescaling, as was done in the short term prediction.

2.4.7.2 Biological reference points

The yield- and spawning stock biomass per recruit (age 2) based on the long-term data are shown in Table 2.4.17 and Figure 2.4.21. $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are indicated here as 0.58 and 0.19, respectively. From Figure 2.4.20, showing the recruit/spawning stock relationship, and from Table 2.4.17, $\mathbf{F}_{med}$, and $\mathbf{F}_{high}$ were calculated at 0.25 and 0.97, 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 was considerably higher when the spawning stock biomass is above this value (Figure 2.4.20) and ACFM established $\mathbf{B}_{lim}$ = 40 000 t. In the 1998 assessment, the $\mathbf{B}_{pa}$ was calculated as the value lying 2 standard deviations above $\mathbf{B}_{lim}$, that is 65 000 t. By examining among other things the SSB-R plot, ACFM instead proposed $\mathbf{B}_{pa}$ = 55 000 t. The reference point $\mathbf{F}_{pa}$ was proposed by ACFM as the $\mathbf{F}_{med}$ value of 0.25. The $\mathbf{F}_{lim}$ is defined being two standard deviations above $\mathbf{F}_{pa}$ and was set by ACFM at 0.40. The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested that $\mathbf{B}_{lim}$ for Faroe haddock could be decreased to 20 000t, considering that two strong year classes have been produced at SSB below $\mathbf{B}_{lim}$. The Working Group last year considered it premature to change $\mathbf{B}_{lim}$ at that time. Of the 5 year classes produced at SSB below $\mathbf{B}_{lim}$, three were very small, and two strong. The strong year classes are believed to be due to favourable environmental conditions, and there are no guarantee that similarly good environmental conditions would occur again should the SSB decrease below $\mathbf{B}_{lim}$.

As stated above, the working group in its 2003 report described reasons to review reference points for the three Faroese stocks, particularly for increases in $\mathbf{F}_{pa}$. There remains a need to review the reference points, but more time is necessary to consider the implications of the updated assessment results as well as those evaluating the consequences of the possible influence of productivity and growth on catchability. The WG expects to make proposals for new reference points at its 2005 meeting.

2.4.7.3 Projections of catch and biomass

2.4.7.3.1 Short-term prediction

In the light of the performance of the new management system, it is not unrealistic to assume fishing mortalities in 2004 as the average of some recent years, here the unscaled average of F(2001-2003); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the enviroment) could undermine this assumption. The fleet is almost the same and the number of fishing days per fleet was only reduced by 2% for the fishing year 2003-2004. The landings in 2004 are then predicted to be about 26 000 t (slightly lower than in 2003), and continuing with this fishing mortality will result in 2005 landings of about 24 000 t.. The SSB will decrease to 86 000 t in 2004, 82 000 t in 2005, and to 68 000 t in 2006. The results of the short-term prediction are shown in Table 2.4.15 and in Figure 2.4.21.

2.4.8 Medium-term projections

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

2.4.9 Management considerations

2.4.10 Comments on the assessment

Since the 2004 assessment of Faroe haddock was on the update list, the assessment presented is based on the same updated information (VPA and tuning input files) as last year with the same settings of the XSA. However, adding new data resulted in following changes in the 2002 estimates as compared to last year:

Assessment year	Recruitment age 2	Exploitable biomass	Spawning stock biomass	Fishing mortality (F_{3-7})
2003	48 000 000	132 000 t	73 000 t	0.45
2004	42 000 000	148 000 t	88 000 t	0.30

Since the 2001 estimates of recruitment in this years assessment are higher and the fishing mortalities considerable smaller, the perception of stock status now is more optimistic.

During the 2004 NWWG meeting, the ADAPT component of the assessment toolbox developed by the USA National Marine Fisheries Service (*http://nft.nefsc.noaa.gov/*) has been systematically applied to the main stocks in the Faroes (Faroe Plateau cod, haddock and saithe). One of the objectives of the exercise was to use the bootstrap feature of the toolbox to evaluate the uncertainties in the assessment. A second objective was to compare the absolute estimates obtained with the two assessment methods, using similar data and assumptions.

Inspecting the age by age plots of each index from an ADAPT run with both indices show that a few points have a large influence on the relationship, particularly for older ages and the relationship for age 1 in the spring survey is not very good (Files are available in the WG folder). ADAPT results consistently estimated very high fishing mortality for ages 7 and 8 in 2003. Consequently, those year classes were not estimated and their size was derived from the average fishing mortality assuming partial recruitment of 1.0 for those ages. Therefore, ages 1 to 5 and 8 from the summer survey and ages 1 to 6 from the spring survey were used in the calibration.

Figure 2.4.23 shows the time trends in SSB of ADAPT calibrations with each index separately and with both indices combined. The figure also shows the XSA SSB estimate. There is a wide range of SSB estimates in 2003 from 63 000t when the spring survey is used alone to 96 000t with the XSA. The summer survey alone gives a SSB of 84 000t while the ADAPT with the two surveys together appears to give slightly more weight to the spring survey with an SSB of 70 000t closer to the spring survey alone than to the summer survey alone.

Figure 2.4.24 shows the retrospective pattern. There is no systematic bias with some years being overestimated and other being underestimated.

Figure 2.4.25 shows the F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. The figure also shows the F and SSB from the XSA assessment. The XSA results fall at the margins of the cloud of bootstrapped ADAPT results, with unlikely low F and high SSB. This is due to different size of the 1999 year class, 56 million at age 4 in 2003 in the XSA assessment compared with 36 million in the ADAPT assessment.

Although some time was spent examining model diagnostics, a more careful examination would be necessary if this approach were the main basis for providing advice. ADAPT, as implemented in the NMFS Toolbox, provides few knobs to tweak. Therefore the changes in assessment results from year to year are likely to results from changes in the data (or selection of data) rather than in changing the settings of the assessment software

Table 2.4.1 Faroe Plateau (Sub-division Vb1) HADDOCK. Nominal catches (tonnes) by countries
1982-2003, as officially reported to ICES , and the total Working Group estimate in Vb.

Country	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Denmark	-	-	-	-	1	8	4	-	-	-	4,655
Faroe Islands	10,319	11,898	11,418	13,597	13,359	13,954	10,867	13,506	11,106	8,074	164
France[1]	2	2	20	23	8	22	14	-	-	-	-
Germany	1	+	+	+	1	1	-	+	+	+	
Norway	12	12	10	21	22	13	54	111	94	125	71
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-	54
UK (Scotland)[3]	1	-	-	-	-	-	-	-	-	-	-
United Kingdom											
Total	10,335	11,912	11,448	13,641	13,391	14,000	10,939	13,617	11,207	8,199	4,944
Working Group estimate[4,5]	11,937	12,894	12,378	15,143	14,477	14,882	12,178	14,325	11,726	8,429	5,476

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002 [2]	2003 [2]
Faroe Islands	3,622	3,675	4,549	9,152	16,585	19,135	16,643	[8]	[8]	[8]	[8]
France[1]	-					2 [2,7]	- [2]	6	8 [2]	2	18 [#]
Germany	-		5	-	-		33	1	2	6	1
Greenland							30 [6]	22 [6]	0 [6]	4 [2,7]	
Iceland										4	
Norway	28	22	28	45	45 [2]	71	411	355	260 [2]	253 [2]	292
UK (Engl. and Wales)	81	31	23	5	22	30 [1]	59 [7]	19 [7]	4 [7]	11 [7]	
UK (Scotland)[9]	-	-	-	…	…	…					
United Kingdom											
Total	3,731	3,728	4,605	9,202	16,652	19,238	17,176	14,023	14,249	21,253	22,426
Working Group estimate[4,5,8]	4,026	4,252	4,948	9,642	17,924	22,210	18,482	15,821	16,530	25,131	26,865

1) Including catches from Sub-division Vb2. Quantity unknown 1989-1991, 1993 and 1995-2001.
2) Preliminary data
3)From 1983 to 1996 catches included in Sub-division Vb2.
4) Includes catches from Sub-division Vb2 and Division IIa in Faroese waters.
5)Includes French and Greenlandic catches from Division Vb, as reported to the Faroese coastal guard service
6) Reported as Division Vb, to the Faroese coastal guard service.
7) Reported as Division Vb.
8) WG estimates includes Faroese landings reported to the NWWG by the Faroese Fisheries Laboratory
9) Included in Vb2
10) Includes 14 reported as Vb

Table 2.4.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries, 1982-2003, as officially reported to ICES, and the total Working Group estimate in Vb2.

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

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003[2]
Faroe Islands	185	353	303	338	1,133	2,810	1,110				
France[1]	-	-	-	-	-						
Norway	8	1	1	40	4	60	3	48	64[2]	28[2]	55
UK (Engl. and Wales)	+	+	...[1]	…[1]	…[1]	…[1]	[1]	[1]	[1]		
UK (Scotland)[3]	102	170	39	62	135[1]	102	193	185	148	177	
United Kingdom											187[4]
Total	295	524	343	440	1,272	2,972	1,306	1,798	2,281	3,878 2	4,439
Working Group estimate											

1) Catches included in Sub-division Vb1.

2) Provisional data

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

4) Reported as Division Vb.

5) WG estimates (Tabel 2.4.1) includes Faroese landings reported to the NWWG by the Faroese Fisheries Laboratory

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

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Haddock %
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	18
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	38
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	21
Otterboard trawlers < 400HP	1	2	2	2	1	1	2	2	8	8	7	6	3	2	2	4	2	2	1	11
Otter board trawlers 400-999HP	6	3	5	4	3	3	1	1	3	2	5	7	6	6	5	5	5	4	3	12
Otterboard trawlers > 1000HP	8	5	2	2	2	2	2	1	1	3	2	2	3	3	7	5	5	11	3	1
Pairtrawlers < 1000HP	19	20	17	11	7	5	7	11	13	10	8	7	6	5	6	7	6	4	4	7
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	8	4
Nets	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jigging	1	0	0	0	1	1	1	0	0	0	0	1	1	0	0	0	1	2	1	1
Other gears	0	1	1	2	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	6
Total catch, tonnes gutted	13570	12967	13829	10697	12866	10319	7469	4103	3275	3629	4371	8535	15890	19669	16062	13881	13555	21842	22516	

Table 2.4.4 Haddock in ICES Division Vb 2003

Catch at age in numbers by fleet category

Age	Vb1 Open Boats	Vb1 LLiners < 100GRT	Vb1 LLiners > 100GRT	Vb1 OB. trawl. < 400HP	Vb1 OB. trawl. 400-999HP	Vb1 OB. trawl. > 1000HP	Vb1 Pair trawl. < 1000HP	Vb1 Pair trawl. > 1000HP	Vb 1 Others	Vb1 All Faroese Fleets	Vb2 All Faroese LLiners	Vb2 All Faroese Pairtrawlers	Vb2 All Faroese Fleets	Vb Foreign Trawlers	Vb Foreign LLiners	Vb Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	8	48	0	1	0	0	3	4	67	48	15	63	0	1	132
3	266	1349	1046	36	84	37	19	192	195	3222	100	44	144	12	32	3410
4	623	4165	4648	159	353	366	433	958	753	12451	639	194	834	119	142	13546
5	48	592	896	27	60	81	119	172	128	2121	17	14	32	26	27	2207
6	25	393	324	11	26	12	29	30	55	905	15	8	23	4	10	942
7	1	16	88	1	3	5	11	13	9	148	7	2	9	2	3	161
8	5	70	161	3	8	5	12	15	18	299	20	6	26	2	5	332
9	16	249	382	10	26	16	33	42	50	825	8	2	10	5	12	852
10	22	340	331	19	46	16	29	35	54	891	7	1	9	5	10	914
11	0	4	2	0	0	1	1	2	1	11	0	0	0	0	0	12
12	0	0	0	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	0	0	0
14	0	0	2	0	0	0	0	0	0	2	0	0	0	0	0	2
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	1009	7185	7927	267	607	540	685	1461	1266	20943	861	287	1149	175	243	22509
Catch, t.	901	7506	8597	286	658	573	822	1475	1336	22154	1166	385	1551	186	263	24154

Notes: Numbers in 1000'
Catch, gutted weight in tonnes
Others includes netters, jiggers, other small categories and catches not otherwise accounted for
LLiners = Longliners OB.trawl. = Otterboard trawlers Pair Trawl. = Pair trawlers

Table 2.4.5 Faroe Haddock. Catch number-at-age.

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2004 11:34

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

YEAR,	1961,	1962,	1963,
AGE			
0,	0,	0,	0,
1,	0,	0,	0,
2,	7932,	9631,	13552,
3,	7330,	13977,	8907,
4,	5134,	5233,	7403,
5,	1937,	2361,	2242,
6,	1305,	1407,	1539,
7,	838,	868,	860,
8,	236,	270,	257,
9,	59,	72,	75,
+gp,	0,	0,	0,
0 TOTALNUM,	24771,	33819,	34835,
TONSLAND,	20831,	27151,	27571,
SOPCOF %,	89,	90,	90,

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	2284,	1368,	1081,	1425,	5881,	2384,	1728,	717,	750,	3300,
3,	7457,	4286,	3304,	2405,	4097,	7539,	4855,	4393,	3744,	8388,
4,	3899,	5133,	4804,	2599,	2812,	4567,	6581,	4727,	4179,	1236,
5,	2360,	1443,	2710,	1785,	1524,	1565,	1624,	3267,	2706,	2786,
6,	1120,	1209,	1112,	1426,	1526,	1485,	1383,	1292,	1171,	916,
7,	728,	673,	740,	631,	923,	1224,	1099,	864,	696,	1051,
8,	198,	1345,	180,	197,	230,	378,	326,	222,	180,	150,
9,	49,	43,	54,	52,	68,	114,	68,	147,	113,	68,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	11,
0 TOTALNUM,	18095,	15500,	13985,	10520,	17061,	19256,	17664,	15629,	13539,	17906,
TONSLAND,	19490,	18479,	18766,	13381,	17852,	23272,	21361,	19393,	16485,	17976,
SOPCOF %,	101,	94,	109,	102,	103,	108,	103,	99,	98,	98,

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

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	5633,	7337,	4396,	255,	32,	1,	143,	74,	539,	441,
3,	2899,	7952,	7858,	4039,	1022,	1161,	58,	455,	934,	1969,
4,	3970,	2097,	6798,	5168,	4248,	1754,	3724,	202,	784,	383,
5,	451,	1371,	1251,	4918,	4054,	3341,	2583,	2586,	298,	422,
6,	976,	247,	1189,	2128,	1841,	1850,	2496,	1354,	2182,	93,
7,	466,	352,	298,	946,	717,	772,	1568,	1559,	973,	1444,
8,	535,	237,	720,	443,	635,	212,	660,	608,	1166,	740,
9,	68,	419,	258,	731,	243,	155,	99,	177,	1283,	947,
+gp,	147,	187,	318,	855,	312,	74,	86,	36,	214,	795,
0 TOTALNUM,	15145,	20199,	23086,	19483,	13104,	9320,	11417,	7051,	8373,	7234,
TONSLAND,	14773,	20715,	26211,	25555,	19200,	12418,	15016,	12233,	11937,	12894,
SOPCOF %,	97,	117,	107,	98,	99,	104,	100,	109,	92,	106,

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	1195,	985,	230,	283,	655,	63,	105,	77,	40,	113,
3,	1561,	4553,	2549,	1718,	444,	1518,	1275,	1044,	154,	298,
4,	2462,	2196,	4452,	3565,	2463,	658,	1921,	1774,	776,	274,
5,	147,	1242,	1522,	2972,	3036,	2787,	768,	1248,	1120,	554,
6,	234,	169,	738,	1114,	2140,	2554,	1737,	651,	959,	538,
7,	42,	91,	39,	529,	475,	1976,	1909,	1101,	335,	474,
8,	861,	61,	130,	83,	151,	541,	885,	698,	373,	131,
9,	388,	503,	71,	48,	18,	133,	270,	317,	401,	201,
+gp,	968,	973,	712,	334,	128,	81,	108,	32,	162,	185,
0 TOTALNUM,	7858,	10773,	10443,	10646,	9510,	10311,	8978,	6942,	4320,	2768,
TONSLAND,	12378,	15143,	14477,	14882,	12178,	14325,	11726,	8429,	5476,	4026,
SOPCOF %,	106,	106,	101,	102,	97,	100,	102,	106,	106,	104,

Table 2.4.5 (cont.) Faroe Haddock. Catch number-at-age.

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	277,	804,	326,	77,	106,	174,	1461,	4557,	1527,	132,
3,	191,	452,	5234,	2913,	1055,	1142,	3061,	3254,	14151,	3410,
4,	307,	235,	1019,	10517,	5269,	942,	210,	2520,	2902,	13546,
5,	153,	226,	179,	710,	9856,	4677,	682,	180,	1209,	2207,
6,	423,	132,	163,	116,	446,	6619,	2685,	469,	134,	942,
7,	427,	295,	161,	123,	99,	226,	2846,	1198,	241,	161,
8,	383,	290,	270,	93,	87,	26,	79,	1431,	850,	332,
9,	125,	262,	234,	220,	95,	20,	1,	17,	1104,	852,
+gp,	301,	295,	394,	516,	502,	192,	71,	18,	34,	926,
0 TOTALNUM,	2587,	2991,	7980,	15285,	17515,	14018,	11096,	13644,	22152,	22508,
TONSLAND,	4252,	4948,	9642,	17924,	22210,	18482,	15821,	16530,	25131,	26865,
SOPCOF %,	100,	103,	100,	103,	101,	100,	104,	100,	100,	100,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2004 11:34

Table 2 Catch weights at age (kg)

YEAR,	1961,	1962,	1963,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,
2,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,
0 SOPCOFAC,	.8938,	.9011,	.8964,

Table 2 Catch weights at age (kg)

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,	3.5500,
0 SOPCOFAC,	1.0131,	.9401,	1.0920,	1.0166,	1.0278,	1.0835,	1.0274,	.9874,	.9795,	.9776,

1

Table 2 Catch weights at age (kg)

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.4700,	.4700,	.4700,	.3110,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,
3,	.7300,	.7300,	.7300,	.6330,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,
4,	1.1300,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,
5,	1.5500,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,
6,	1.9700,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,
7,	2.4100,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,
8,	2.7600,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,
9,	3.0700,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,
+gp,	3.5500,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,
0 SOPCOFAC,	.9718,	1.1712,	1.0746,	.9784,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,

Table 2.4.6 (cont.) Faroe Haddock. Catch weight-at-age.

Table 2 Catch weights at age (kg)

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.6810,	.5280,	.6080,	.6050,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,
3,	1.0110,	.8590,	.8870,	.8310,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,
4,	1.2550,	1.3910,	1.1750,	1.1260,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,
5,	1.8120,	1.7770,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,
6,	2.0610,	2.3260,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,
7,	2.0590,	2.4400,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,
8,	2.1370,	2.4010,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,
9,	2.3680,	2.5320,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,
+gp,	2.6860,	2.6860,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,
0 SOPCOFAC,	1.0602,	1.0559,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0361,

Table 2 Catch weights at age (kg)

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.7540,	.6660,	.5340,	.5190,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,
3,	1.1030,	1.0540,	.8580,	.7710,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,
4,	1.2540,	1.4890,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,
5,	1.4650,	1.7790,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,
6,	1.5930,	1.9400,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,
7,	1.8040,	2.1820,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,
8,	2.0490,	2.3570,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,
9,	2.2250,	2.4900,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,
+gp,	2.4230,	2.6780,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,
0 SOPCOFAC,	.9969,	1.0331,	1.0043,	1.0250,	1.0106,	.9975,	1.0363,	.9964,	1.0008,	1.0003,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2004 11:34

Table 5 Proportion mature at age

YEAR,	1961,	1962,	1963,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.4.7 (cont.) Faroe Haddock. Proportion mature-at-age.

Table 5 Proportion mature at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0600,	.0800,	.0800,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,
5,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0800,	.0300,	.0300,	.0500,	.0500,	.0200,	.0800,	.1600,	.1800,	.1100,
3,	.7600,	.6200,	.4300,	.3200,	.2400,	.2200,	.3700,	.5800,	.6500,	.5000,
4,	.9800,	.9600,	.9500,	.9100,	.8900,	.8700,	.9000,	.9300,	.9100,	.8500,
5,	1.0000,	1.0000,	.9900,	.9800,	.9800,	.9900,	1.0000,	1.0000,	1.0000,	.9700,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,
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,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0500,	.0300,	.0300,	.0100,	.0100,	.0100,	.0200,	.0900,	.0800,	.0700,
3,	.4200,	.4700,	.4700,	.4700,	.3600,	.3500,	.3600,	.5400,	.4900,	.4500,
4,	.8600,	.9100,	.9300,	.9100,	.8700,	.8600,	.8700,	.9300,	.9700,	.9700,
5,	.9600,	.9600,	.9800,	1.0000,	.9900,	.9900,	.9900,	1.0000,	1.0000,	.9900,
6,	.9900,	.9900,	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 Faroe haddock. Spaly tuning files.

FAROE	Haddock	(ICES	SUBDIVISI VB)		COMB-SURVEY-SPALY.dat			
102								
SUMMER	SURVEY							
1996	2003							
1	1	0.6	0.7					
1	8							
200	72162.43	30779.82	63552.89	1729.67	215.02	273.61	252.65	426.64
200	92544.30	9956.23	29234.27	44161.34	1079.06	176.28	82.31	164.08
200	21020.47	1624.49	3446.12	15319.19	17887.29	303.13	90.97	74.63
200	18854.27	8834.36	5848.11	1611.97	8698.55	9904.61	193.37	7.86
200	168129.70	17172.19	8140.46	575.70	1578.78	5019.44	5432.45	87.29
200	136589.10	99542.02	12671.66	4803.72	208.54	720.33	2703.14	3074.09
200	110902.24	49150.39	58779.90	6210.10	1936.48	181.01	438.59	1255.99
200	76599.17	36728.90	27474.91	36825.81	4043.70	633.23	103.44	436.59
SPRING	SURVEY	SHIFTED						
1993	2003							
1	1	0.95	1					
0	6							
100	16196.00	1927.80	281.60	333.90	217.00	311.70	349.10	
100	40991.50	19065.10	1349.30	250.70	161.70	61.90	148.20	
100	27375.80	29044.60	21355.90	850.10	121.70	78.40	63.60	
100	3191.60	7215.50	16758.60	25078.00	718.70	132.60	44.20	
100	3628.60	355.40	4193.90	10696.30	12426.70	359.80	9.40	
100	5180.30	6727.10	121.20	1535.20	4317.00	3256.30	55.80	
100	26833.10	8255.60	4781.30	248.20	530.10	1825.50	1811.80	
100	30855.60	36159.40	3604.10	1167.00	32.80	136.50	438.70	
100	22182.00	9302.10	30604.80	5001.40	1167.10	54.60	111.30	
100	20184.30	25265.00	7205.60	14489.10	1570.80	371.20	8.30	
100	7057.00	22190.80	6929.20	14163.90	1408.90	305.40	5.00	

Table 2.4.9 Faroe haddock 2004 xsa

```
Lowestoft VPA Version 3.1

   1/05/2004  11:32

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb)                 HAD1_IND

CPUE data from file D:\Vpa\vpa2004\Tuning\comb-survey-spaly.dat

Catch data for  43 years. 1961 to 2003. Ages  0 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
SUMMER SURVEY       ,   1996, 2003,   1,     8,   .600,   .700
SPRING SURVEY SHIFTED,  1993, 2003,   0,     6,   .950,  1.000


Time series weights :

     Tapered time weighting not applied


Catchability analysis :

     Catchability dependent on stock size for ages <    2

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


     Catchability independent of age for ages >=    6


Terminal population estimation :

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

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

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

     Prior weighting not applied


Tuning had not converged after   50 iterations


Total absolute residual between iterations
49 and  50 =     .00025
```

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 49	.0000	.0000	.0074	.1215	.3086	.3790	.6288	.9566	.7251	.5392
Iteration 50	.0000	.0000	.0074	.1215	.3086	.3790	.6288	.9565	.7252	.5391

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	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
1	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	.049	.009	.008	.010	.034	.012	.067	.048	.041	.007
3	.164	.105	.077	.092	.181	.613	.306	.209	.205	.121
4	.257	.313	.363	.220	.241	.244	.211	.446	.292	.309
5	.144	.305	.418	.467	.331	.350	.281	.281	.399	.379
6	.205	.179	.378	.529	.609	.388	.348	.318	.350	.629
7	.244	.215	.345	.550	1.296	.732	.286	.257	.267	.957
8	.239	.260	.313	.343	1.005	1.911	.618	.228	.293	.725
9	.219	.256	.346	.455	.715	.666	.316	.255	.276	.539

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XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1994	6.70E+04	1.17E+05	6.43E+03	1.39E+03	1.50E+03	1.26E+03	2.52E+03	2.18E+03	1.99E+03	7.03E+02
1995	1.29E+04	5.48E+04	9.58E+04	5.01E+03	9.67E+02	9.49E+02	8.91E+02	1.68E+03	1.40E+03	1.28E+03
1996	5.20E+03	1.06E+04	4.49E+04	7.77E+04	3.70E+03	5.79E+02	5.72E+02	6.10E+02	1.11E+03	8.84E+02
1997	2.37E+04	4.25E+03	8.68E+03	3.65E+04	5.89E+04	2.10E+03	3.12E+02	3.21E+02	3.54E+02	6.65E+02
1998	3.71E+04	1.94E+04	3.48E+03	7.03E+03	2.72E+04	3.87E+04	1.08E+03	1.51E+02	1.52E+02	2.06E+02
1999	1.61E+05	3.04E+04	1.59E+04	2.76E+03	4.80E+03	1.75E+04	2.27E+04	4.81E+02	3.37E+01	4.55E+01
2000	6.25E+04	1.32E+05	2.49E+04	1.28E+04	1.22E+03	3.08E+03	1.01E+04	1.26E+04	1.89E+02	4.08E+00
2001	2.96E+04	5.12E+04	1.08E+05	1.90E+04	7.74E+03	8.11E+02	1.90E+03	5.84E+03	7.77E+03	8.35E+01
2002	5.99E+04	2.42E+04	4.19E+04	8.45E+04	1.27E+04	4.06E+03	5.01E+02	1.14E+03	3.70E+03	5.06E+03
2003	2.18E+04	4.91E+04	1.98E+04	3.29E+04	5.64E+04	7.73E+03	2.23E+03	2.89E+02	7.11E+02	2.26E+03

Estimated population abundance at 1st Jan 2004

0.00E+00	1.79E+04	4.02E+04	1.61E+04	2.39E+04	3.39E+04	4.33E+03	9.74E+02	9.09E+01	2.82E+02

Taper weighted geometric mean of the VPA populations:

2.83E+04	2.37E+04	1.95E+04	1.52E+04	9.89E+03	5.71E+03	3.39E+03	1.92E+03	1.00E+03	4.69E+02

Standard error of the weighted Log(VPA populations) :

1.0178	1.0226	1.0274	1.0067	1.0104	.9697	.9751	1.0163	1.1470	1.4575

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	No data for this fleet at this age									
1	99.99	99.99	1.12	3.30	-5.74	-6.74	2.89	2.79	2.48	-.10
2	99.99	99.99	-.23	.28	-.60	-.44	-.19	.09	.33	.76
3	99.99	99.99	-.07	-.08	-.52	1.23	-.18	-.19	-.15	-.03
4	99.99	99.99	-.08	.30	.03	-.49	-.17	.26	-.08	.22
5	99.99	99.99	-.14	.22	.03	.11	.10	-.59	.10	.18
6	99.99	99.99	.14	.40	-.24	.05	.16	-.13	-.16	-.22
7	99.99	99.99	-.03	-.37	.97	.20	-.03	.03	-.15	.23
8	99.99	99.99	-.12	.09	.58	.42	.26	-.15	-.26	.61

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

Age	2	3	4	5	6	7	8
Mean Log q	-5.3082	-5.2455	-5.6146	-5.7504	-5.8003	-5.8003	-5.8003
S.E(Log q)	.4498	.5186	.2632	.2625	.2270	.4126	.3890

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	5.08	-2.609	-20.16	.06	8	4.34	-4.19

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.88	.826	5.87	.89	8	.41	-5.31
3	1.29	-1.454	3.88	.81	8	.62	-5.25
4	.89	2.120	6.03	.98	8	.19	-5.61
5	.91	1.509	5.97	.98	8	.22	-5.75
6	1.01	-.194	5.78	.98	8	.25	-5.80
7	1.12	-1.094	5.57	.94	8	.44	-5.69
8	1.16	-2.510	5.51	.98	8	.30	-5.62

1

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

Fleet : SPRING SURVEY SHIFTED

Age	1993
0	-.99
1	-.13
2	-.27
3	-.27
4	.04
5	-.12
6	.82
7	No data for this fleet at this age
8	No data for this fleet at this age

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	1.53	2.40	-.76	-2.04	-1.81	-.16	1.06	1.18	.29	-.69
1	-.70	.45	.80	-1.09	.13	-.13	-.23	-.54	1.14	.31
2	.02	.04	.56	.82	-1.79	.34	-.33	.32	-.19	.49
3	-.12	-.24	.38	.30	.09	-.37	-.66	.30	-.13	.71
4	.02	.23	.71	.66	.39	.03	-1.42	.54	.20	-1.39
5	-.69	-.02	1.11	.87	.02	.26	-.67	-.25	.17	-.69
6	.22	.39	.66	-.13	.49	.70	.06	.33	-.90	-2.63
7	No data for this fleet at this age									
8	No data for this fleet at this age									

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

Age	2	3	4	5	6
Mean Log q	-5.9430	-5.8466	-6.4067	-6.5868	-7.2659
S.E(Log q)	.6973	.3974	.7361	.5957	.9955

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	1.90	-1.928	.85	.34	11	1.50	-5.43
1	.93	.355	5.91	.73	11	.69	-5.58

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	.82	1.378	6.64	.86	11	.55	-5.94
3	.87	1.885	6.30	.96	11	.31	-5.85
4	.97	.181	6.47	.82	11	.75	-6.41
5	1.08	-.508	6.47	.81	11	.67	-6.59
6	.89	.473	7.29	.68	11	.93	-7.27

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

```
 Terminal year survivor and F summaries :

 Age  0   Catchability dependent on age and year class strength

 Year class = 2003

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,         1.,   .000,       .000,    .00,   0,  .000,     .000
 SPRING SURVEY SHIFTED,     8943.,  1.600,       .000,    .00,   1,  .290,     .000

   P shrinkage mean  ,     23726.,   1.02,,,,                         .710,     .000

   F shrinkage mean  ,         0.,    .50,,,,                         .000,     .000

 Weighted prediction :

 Survivors,         Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
     17879.,       .86,       .82,    2,    .954,   .000


 Age  1   Catchability dependent on age and year class strength

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,     36165.,  4.605,       .000,    .00,   1,  .015,     .000
 SPRING SURVEY SHIFTED,    54530.,   .667,       .006,    .01,   2,  .693,     .000

   P shrinkage mean  ,     19536.,   1.03,,,,                         .292,     .000

   F shrinkage mean  ,         0.,    .50,,,,                         .000,     .000

 Weighted prediction :

 Survivors,         Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
     40167.,       .56,       .32,    4,    .574,   .000


1
 Age  2   Catchability constant w.r.t. time and dependent on age

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,     35106.,   .475,       .173,    .36,   2,  .353,     .003
 SPRING SURVEY SHIFTED,    37426.,   .493,       .231,    .47,   3,  .327,     .003

   F shrinkage mean  ,      2887.,    .50,,,,                         .320,     .041

 Weighted prediction :

 Survivors,         Int,       Ext,    N,    Var,     F
 at end of year,   s.e,       s.e,     ,   Ratio,
     16102.,       .28,       .65,    6,   2.293,   .007
```

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

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

Year class = 2000

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	28762.,	.359,	.184,	.51,	3,	.345,	.102
SPRING SURVEY SHIFTED,	32983.,	.316,	.315,	1.00,	4,	.449,	.089
F shrinkage mean ,	8670.,	.50,,,,				.206,	.304

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
23883.,	.21,	.27,	8,	1.239,	.121

1

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

Year class = 1999

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	39036.,	.232,	.104,	.45,	4,	.535,	.273
SPRING SURVEY SHIFTED,	25145.,	.296,	.267,	.90,	5,	.296,	.397
F shrinkage mean ,	36673.,	.50,,,,				.169,	.288

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
33908.,	.17,	.12,	10,	.718,	.309

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

Year class = 1998

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	4404.,	.187,	.125,	.67,	5,	.606,	.374
SPRING SURVEY SHIFTED,	3777.,	.272,	.214,	.79,	6,	.246,	.424
F shrinkage mean ,	5101.,	.50,,,,				.148,	.330

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
4333.,	.15,	.10,	12,	.643,	.379

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

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

Year class = 1997

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	926.,	.169,	.109,	.65,	6,	.648,	.653
SPRING SURVEY SHIFTED,	624.,	.282,	.414,	1.47,	7,	.164,	.861
F shrinkage mean ,	1705.,	.50,,,,				.189,	.405

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
974.,	.15,	.16,	14,	1.031,	.629

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

Year class = 1996

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	78.,	.158,	.155,	.98,	7,	.625,	1.056
SPRING SURVEY SHIFTED,	44.,	.289,	.216,	.75,	7,	.120,	1.468
F shrinkage mean ,	188.,	.50,,,,				.255,	.573

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
91.,	.17,	.17,	15,	1.026,	.957

1

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

Year class = 1995

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	290.,	.151,	.140,	.93,	8,	.668,	.711
SPRING SURVEY SHIFTED,	325.,	.265,	.243,	.92,	7,	.123,	.654
F shrinkage mean ,	237.,	.50,,,,				.208,	.819

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
282.,	.15,	.10,	16,	.666,	.725

Table 2.4.9 (cont.) Faroe haddock 2004 xsa

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

Year class = 1994

Fleet,	Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,	Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUMMER SURVEY ,	1069.,	.153,	.066,	.43,	7,	.649,	.543
SPRING SURVEY SHIFTED,	1522.,	.264,	.088,	.33,	7,	.119,	.410
F shrinkage mean ,	928.,	.50,,,,				.232,	.605

Weighted prediction :

Survivors,	Int,	Ext,	N,	Var,	F
at end of year,	s.e,	s.e,	,	Ratio,	
1079.,	.16,	.06,	15,	.359,	.539

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 1/05/2004 11:34

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1961,	1962,	1963,
AGE			
0,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,
2,	.1875,	.3232,	.3801,
3,	.4162,	.5866,	.5639,
4,	.4209,	.5980,	.7261,
5,	.4387,	.3480,	.5591,
6,	.5879,	.6706,	.4026,
7,	.9483,	1.0499,	1.2493,
8,	.8742,	.9736,	1.1139,
9,	.6600,	.7351,	.8185,
+gp,	.6600,	.7351,	.8185,
0 FBAR 3- 7,	.5624,	.6506,	.7002,

Table 2.4.10 (cont.) Faroe haddock. Fishing mortality (F) at age.

Table 8 Fishing mortality (F) at age

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0876,	.0691,	.0609,	.0641,	.1261,	.0860,	.0552,	.0526,	.0253,	.1672,
3,	.3723,	.2354,	.2370,	.1873,	.2647,	.2364,	.2528,	.1937,	.4228,	.4308,
4,	.5193,	.4767,	.4515,	.2971,	.3483,	.5320,	.3345,	.4187,	.2855,	.2385,
5,	.5369,	.3678,	.5006,	.2997,	.2847,	.3330,	.3639,	.2755,	.4519,	.3134,
6,	.6107,	.5882,	.5421,	.5406,	.4540,	.4975,	.5559,	.5560,	.1495,	.2695,
7,	.3375,	.9618,	.9128,	.6906,	.8367,	.8276,	.8739,	.8378,	.6720,	.1946,
8,	1.2027,	2.3618,	.7509,	.6634,	.5851,	1.0631,	.5429,	.4224,	.4059,	.2907,
9,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5060,	.3956,	.2627,
+gp,	.6472,	.9619,	.6373,	.5022,	.5057,	.6566,	.5386,	.5060,	.3956,	.2627,
0 FBAR 3- 7,	.4753,	.5260,	.5288,	.4030,	.4377,	.4853,	.4762,	.4563,	.3963,	.2893,

Table 8 Fishing mortality (F) at age

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1266,	.1230,	.0908,	.0108,	.0010,	.0004,	.0325,	.0237,	.0383,	.0251,
3,	.2172,	.2650,	.1878,	.1128,	.0547,	.0457,	.0285,	.1373,	.4615,	.1915,
4,	.3730,	.2412,	.3810,	.1814,	.1665,	.1254,	.2024,	.1313,	.3707,	.3478,
5,	.1279,	.2115,	.2216,	.5273,	.2115,	.1912,	.2749,	.2111,	.2915,	.3496,
6,	.1714,	.0957,	.2871,	.7246,	.3819,	.1407,	.2135,	.2263,	.2773,	.1381,
7,	.2134,	.0859,	.1601,	.3903,	.5759,	.2721,	.1701,	.2003,	.2522,	.2988,
8,	.1433,	.1599,	.2538,	.3787,	.4967,	.3302,	.3953,	.0919,	.2264,	.3099,
9,	.2067,	.1595,	.2621,	.4437,	.3689,	.2129,	.2525,	.1729,	.2852,	.2905,
+gp,	.2067,	.1595,	.2621,	.4437,	.3689,	.2129,	.2525,	.1729,	.2852,	.2905,
0 FBAR 3- 7,	.2206,	.1799,	.2475,	.3873,	.2781,	.1550,	.1779,	.1813,	.3306,	.2652,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0329,	.0279,	.0096,	.0335,	.0392,	.0049,	.0122,	.0284,	.0166,	.0709,
3,	.1165,	.1692,	.0938,	.0923,	.0676,	.1200,	.1296,	.1621,	.0730,	.1655,
4,	.3892,	.2388,	.2486,	.1839,	.1854,	.1353,	.2195,	.2681,	.1741,	.1800,
5,	.2169,	.3470,	.2591,	.2616,	.2357,	.3307,	.2314,	.2166,	.2707,	.1813,
6,	.3332,	.4157,	.3581,	.3071,	.3051,	.3189,	.3543,	.3142,	.2575,	.2013,
7,	.0852,	.2081,	.1570,	.4733,	.2073,	.5147,	.4199,	.3992,	.2640,	.1952,
8,	.2926,	.1717,	.5168,	.5830,	.2370,	.3864,	.4592,	.2654,	.2269,	.1558,
9,	.2648,	.2778,	.3097,	.3641,	.2353,	.3393,	.3390,	.2944,	.2398,	.1835,
+gp,	.2648,	.2778,	.3097,	.3641,	.2353,	.3393,	.3390,	.2944,	.2398,	.1835,
0 FBAR 3- 7,	.2282,	.2757,	.2233,	.2636,	.2002,	.2839,	.2710,	.2720,	.2079,	.1846,

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0488,	.0093,	.0081,	.0099,	.0342,	.0122,	.0671,	.0476,	.0411,	.0074,
3,	.1644,	.1049,	.0774,	.0925,	.1813,	.6126,	.3058,	.2092,	.2046,	.1215,
4,	.2567,	.3128,	.3634,	.2200,	.2408,	.2443,	.2105,	.4457,	.2924,	.3086,
5,	.1444,	.3054,	.4180,	.4666,	.3308,	.3499,	.2806,	.2815,	.3991,	.3790,
6,	.2050,	.1788,	.3779,	.5288,	.6092,	.3881,	.3477,	.3176,	.3504,	.6288,
7,	.2436,	.2155,	.3448,	.5503,	1.2965,	.7324,	.2864,	.2570,	.2674,	.9565,
8,	.2391,	.2599,	.3131,	.3431,	1.0048,	1.9111,	.6183,	.2277,	.2930,	.7252,
9,	.2188,	.2558,	.3460,	.4555,	.7149,	.6658,	.3156,	.2548,	.2757,	.5391,
+gp,	.2188,	.2558,	.3460,	.4555,	.7149,	.6658,	.3156,	.2548,	.2757,	.5391,
0 FBAR 3- 7,	.2029,	.2235,	.3163,	.3716,	.5317,	.4655,	.2862,	.3022,	.3028,	.4789,

Table 2.4.11 Faroe haddock. Stock number (N) at age.

Run title : FAROE HADDOCK (ICES DIVISION Vb)   HAD1_IND

At 1/05/2004 11:34

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,
AGE			
0,	70656,	44919,	33781,
1,	47070,	57849,	36777,
2,	51279,	38537,	47362,
3,	23796,	34806,	22837,
4,	16517,	12850,	15850,
5,	6028,	8877,	5786,
6,	3245,	3182,	5132,
7,	1512,	1476,	1332,
8,	448,	480,	423,
9,	135,	153,	148,
+gp,	0,	0,	0,
0 TOTAL,	220684,	203129,	169429,

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

YEAR,	1964,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,
AGE										
0,	30143,	37827,	81817,	47691,	53084,	23050,	49494,	35343,	78076,	104524,
1,	27658,	24679,	30970,	66986,	39046,	43461,	18872,	40522,	28936,	63923,
2,	30110,	22644,	20206,	25356,	54844,	31968,	35583,	15451,	33177,	23691,
3,	26515,	22586,	17302,	15565,	19470,	39581,	24016,	27569,	12001,	26484,
4,	10638,	14961,	14613,	11176,	10567,	12234,	25584,	15270,	18597,	6438,
5,	6278,	5182,	7605,	7618,	6798,	6107,	5884,	14992,	8225,	11445,
6,	2708,	3005,	2937,	3774,	4622,	4187,	3584,	3348,	9318,	4285,
7,	2809,	1204,	1366,	1398,	1800,	2403,	2084,	1683,	1572,	6570,
8,	313,	1641,	377,	449,	574,	638,	860,	712,	596,	657,
9,	114,	77,	127,	146,	189,	262,	180,	409,	382,	325,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	0,	52,
0 TOTAL,	137286,	133806,	177319,	180159,	190994,	163892,	166142,	155299,	190881,	248395,

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

YEAR,	1974,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,
AGE										
0,	83512,	39082,	52377,	4156,	7378,	5210,	23636,	29301,	60882,	58967,
1,	85577,	68373,	31997,	42883,	3403,	6040,	4265,	19352,	23990,	49846,
2,	52336,	70064,	55979,	26197,	35110,	2786,	4945,	3492,	15844,	19641,
3,	16411,	37752,	50725,	41854,	21218,	28716,	2280,	3920,	2792,	12484,
4,	14094,	10813,	23714,	34420,	30613,	16447,	22460,	1814,	2797,	1441,
5,	4153,	7947,	6955,	13264,	23505,	21220,	11879,	15019,	1303,	1581,
6,	6849,	2992,	5266,	4563,	6410,	15576,	14350,	7388,	9957,	797,
7,	2680,	4724,	2226,	3235,	1810,	3582,	11078,	9491,	4824,	6178,
8,	4428,	1772,	3550,	1553,	1793,	833,	2234,	7651,	6360,	3069,
9,	402,	3141,	1237,	2255,	871,	893,	490,	1232,	5714,	4152,
+gp,	865,	1396,	1515,	2613,	1109,	424,	423,	249,	947,	3463,
0 TOTAL,	271306,	248057,	235541,	176993,	133217,	101728,	98043,	98910,	135409,	161618,

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

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	39635,	14146,	28112,	21224,	14221,	4529,	4001,	2723,	9593,	142852,
1,	48278,	32450,	11582,	23016,	17377,	11643,	3708,	3276,	2229,	7854,
2,	40810,	39527,	26568,	9482,	18844,	14227,	9533,	3036,	2682,	1825,
3,	15682,	32331,	31470,	21544,	7507,	14835,	11591,	7710,	2416,	2159,
4,	8440,	11427,	22351,	23459,	16084,	5745,	10773,	8336,	5368,	1839,
5,	833,	4682,	7368,	14271,	15981,	10940,	4108,	7082,	5220,	3692,
6,	913,	549,	2710,	4656,	8995,	10337,	6435,	2668,	4669,	3260,
7,	568,	535,	297,	1551,	2804,	5428,	6152,	3697,	1596,	2955,
8,	3751,	427,	356,	208,	791,	1866,	2656,	3310,	2031,	1003,
9,	1843,	2292,	295,	174,	95,	511,	1038,	1374,	2078,	1325,
+gp,	4570,	4406,	2934,	1200,	671,	309,	412,	138,	835,	1214,
0 TOTAL,	165323,	142773,	134042,	120785,	103370,	80370,	60407,	43349,	38716,	169980,

Table 2.4.11 Faroe haddock. Stock number (N) at age.

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

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE											
0,	66957,	12942,	5195,	23686,	37116,	161499,	62539,	29560,	59924,	21838,	0,
1,	116958,	54820,	10596,	4253,	19393,	30388,	132224,	51202,	24202,	49062,	17879,
2,	6431,	95757,	44883,	8675,	3482,	15877,	24880,	108256,	41921,	19815,	40167,
3,	1392,	5014,	77672,	36452,	7033,	2755,	12842,	19048,	84509,	32940,	16102,
4,	1498,	967,	3696,	58856,	27208,	4803,	1223,	7744,	12651,	56386,	23883,
5,	1257,	949,	579,	2104,	38671,	17509,	3080,	811,	4060,	7732,	33908,
6,	2522,	891,	572,	312,	1080,	22743,	10103,	1905,	501,	2230,	4333,
7,	2183,	1682,	610,	321,	151,	481,	12631,	5842,	1135,	289,	974,
8,	1990,	1401,	1110,	354,	152,	34,	189,	7767,	3699,	711,	91,
9,	703,	1283,	884,	665,	206,	45,	4,	84,	5064,	2260,	282,
+gp,	1684,	1436,	1478,	1544,	1072,	431,	288,	88,	155,	2430,	2240,
0 TOTAL,	203574,	177141,	147276,	137223,	135564,	256566,	260003,	232307,	237822,	195693,	139860,

Table 2.4.12 Faroe haddock. Stock summary VPA 2004.

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	Recruits	Recruits	Total	Total	Landings	Yield/SSB	FBAR(3-7)
Year	Age 0	Age 2	Biomass	SSB			
1961	70656	51279	81164	47797	20831	0.4358	0.5624
1962	44919	38537	83420	51875	27151	0.5234	0.6506
1963	33781	47362	80753	49547	27571	0.5565	0.7002
1964	30143	30110	68577	44128	19490	0.4417	0.4753
1965	37827	22644	65655	45555	18479	0.4056	0.526
1966	81817	20206	60934	43953	18766	0.427	0.5288
1967	47691	25356	60206	41959	13381	0.3189	0.403
1968	53084	54844	78075	45380	17852	0.3934	0.4377
1969	23050	31968	83815	53422	23272	0.4356	0.4853
1970	49494	35583	87298	59859	21361	0.3569	0.4762
1971	35343	15451	81753	62909	19393	0.3083	0.4563
1972	78076	33177	83081	61977	16485	0.266	0.3963
1973	104524	23691	82756	61581	17976	0.2919	0.2893
1974	83512	52336	95419	64635	14773	0.2286	0.2206
1975	39082	70064	121795	75410	20715	0.2747	0.1799
1976	52377	55979	135627	89228	26211	0.2938	0.2475
1977	4156	26197	121057	96388	25555	0.2651	0.3873
1978	7378	35110	120598	97248	19200	0.1974	0.2781
1979	5210	2786	97711	85418	12418	0.1454	0.155
1980	23636	4945	87665	81928	15016	0.1833	0.1779
1981	29301	3492	78994	75877	12233	0.1612	0.1813
1982	60882	15844	68340	56832	11937	0.21	0.3306
1983	58967	19641	64007	51844	12894	0.2487	0.2652
1984	39635	40810	83455	53870	12378	0.2298	0.2282
1985	14146	39527	94106	62673	15143	0.2416	0.2757
1986	28112	26568	98721	65708	14477	0.2203	0.2233
1987	21224	9482	87875	67456	14882	0.2206	0.2636
1988	14221	18844	77680	62096	12178	0.1961	0.2002
1989	4529	14227	69867	51945	14325	0.2758	0.2839
1990	4001	9533	53909	43952	11726	0.2668	0.271
1991	2723	3036	39087	34932	8429	0.2413	0.272
1992	9593	2682	29419	27257	5476	0.2009	0.2079
1993	142852	1825	26268	23521	4026	0.1712	0.1846
1994	66957	6431	27781	21908	4252	0.1941	0.2029
1995	12942	95757	87927	23051	4948	0.2147	0.2235
1996	5195	44883	108937	49968	9642	0.193	0.3163
1997	23686	8675	107264	82265	17924	0.2179	0.3716
1998	37116	3482	91852	81810	22210	0.2715	0.5317
1999	161499	15877	72310	62402	18482	0.2962	0.4655
2000	62539	24880	76167	52126	15821	0.3035	0.2862
2001	29560	108256	130950	62073	16530	0.2663	0.3022
2002	59924	41921	148136	88143	25131	0.2851	0.3028
2003	21838	19815	121687	96387	26865	0.2787	0.4789
Arith.							
Mean	42260	29142	84235	59495	16461	0.2827	0.3419
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.4.13 Management option tables INPUT DATA FAROE HADDOCK

Stock size

The yearclasses up to 2002 included are derived from the final 2003 VPA.
The yearclasses 2003-2004 at age 2 are estimated using XSA tuned with surveys including indices for age 0-2
and apply a natural mortality of 0.2 in forward calculations of the numbers using standard VPA equations
The yearclass 2004 at age 2 in 2006 is estimated as the geomean of the yearclasses since 1980

	Age0	Age1	Age2
YC2002	59924	40167	32886
YC2003	21838	17879	14638
YC2004			14453
0.818731			

Age	2004	2005	2006
2	40167	14600	14500
3	16102		
4	23883		
5	33908		
6	4333		
7	974		
8	91		
9	282		
10+	2240		

Predicted values rounded

Year	age 2	Geomean(1980-2003)
1980	4945	
1981	3492	
1982	15844	
1983	19641	
1984	40810	
1985	39527	
1986	26568	
1987	9482	
1988	18844	14453
1989	14227	
1990	9533	
1991	3036	
1992	2682	
1993	1825	
1994	6431	
1995	95757	
1996	44883	
1997	8675	
1998	3482	
1999	15877	
2000	24880	
2001	108256	
2002	41921	
2003	19815	
2004	40167	
2005	14600	
2006	14500	

Proportion mature at age

Age	2004	2005	2006		2002	2003	2004	Avg(02-04)
2	0.00	0.05	0.05		0.08	0.07	0.00	0.05
3	0.31	0.42	0.42		0.49	0.45	0.31	0.42
4	0.96	0.97	0.97		0.97	0.97	0.96	0.97
5	0.99	0.99	0.99		1.00	0.99	0.99	0.99
6	1.00	1.00	1.00		1.00	1.00	1.00	1.00
7	1.00	1.00	1.00		1.00	1.00	1.00	1.00
8	1.00	1.00	1.00		1.00	1.00	1.00	1.00
9	1.00	1.00	1.00		1.00	1.00	1.00	1.00
10+	1.00	1.00	1.00		1.00	1.00	1.00	1.00

The maturity at age 2005-2006 is estimated as the
average of the maturity at age 2002-2004 (running 3-yrs average)

Catch/stock weights at age

Age	2004	2005	2006
2	0.571	0.571	0.571
3	0.783	0.783	0.783
4	0.928	1.015	1.015
5	1.296	1.192	1.305
6	1.834	1.546	1.423
7	2.078	1.994	1.681
8	2.226	2.212	2.123
9	2.365	2.288	2.273
10+	2.792	2.792	2.792

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

	2003	2004	2005	2006	
2	0.571	0.571	0.571	0.571	Age 2 = age 2 in 2003
3	0.715	0.783	0.783	0.783	
4	1.008	0.928	1.015	1.015	
5	1.537	1.296	1.192	1.305	
6	1.911	1.834	1.546	1.423	
7	2.091	2.078	1.994	1.681	
8	2.301	2.226	2.212	2.123	
9	2.406	2.365	2.288	2.273	
10+	2.792	2.792	2.792	2.792	Age 10+ = age 10+ in 2003

Growth estimated her as the geomean since 1975

Exploitation pattern

Age	2003	2004	2005		2001	2002	2003		Average F for 2001-03	
2	0.0320	0.0320	0.0320		0.0476	0.0411	0.0074		2	0.0320
3	0.1784	0.1784	0.1784		0.2092	0.2046	0.1215		3	0.1784
4	0.3489	0.3489	0.3489		0.4457	0.2924	0.3086		4	0.3489
5	0.3532	0.3532	0.3532		0.2815	0.3991	0.379		5	0.3532
6	0.4323	0.4323	0.4323		0.3176	0.3504	0.6288		6	0.4323
7	0.4936	0.4936	0.4936		0.257	0.2674	0.9565		7	0.4936
8	0.4153	0.4153	0.4153		0.2277	0.293	0.7252		8	0.4153
9	0.3565	0.3565	0.3565		0.2548	0.2757	0.5391		9	0.3565
10+	0.3565	0.3565	0.3565		0.2548	0.2757	0.5391		10+	0.3565
Avg3-7	0.3613	0.3613	0.3613		0.3022	0.3028	0.4789		Fbar(3-7)	0.3613

The exploitation pattern is estimated from the average fishing mortality matrix 2001-2003 from the final VPA in 2003.

Mean	42260	29142	84235	59495	16461	0.2827	0.3419
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.4.14 Faroe haddock. Management option table - Input data

MFDP version 1
Run: man
Time and date: 23:50 5/2/04
Fbar age range: 3-7

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	40167	0.2	0	0	0	0.571	0.0320	0.571
3	16102	0.2	0.31	0	0	0.783	0.1784	0.783
4	23883	0.2	0.96	0	0	0.928	0.3489	0.928
5	33908	0.2	0.99	0	0	1.296	0.3532	1.296
6	4333	0.2	1	0	0	1.834	0.4323	1.834
7	974	0.2	1	0	0	2.078	0.4936	2.078
8	91	0.2	1	0	0	2.226	0.4153	2.226
9	282	0.2	1	0	0	2.365	0.3565	2.365
10	2240	0.2	1	0	0	2.792	0.3565	2.792

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14600	0.2	0.05	0	0	0.571	0.0320	0.571
3	.	0.2	0.42	0	0	0.783	0.1784	0.783
4	.	0.2	0.97	0	0	1.015	0.3489	1.015
5	.	0.2	0.99	0	0	1.192	0.3532	1.192
6	.	0.2	1	0	0	1.546	0.4323	1.546
7	.	0.2	1	0	0	1.994	0.4936	1.994
8	.	0.2	1	0	0	2.212	0.4153	2.212
9	.	0.2	1	0	0	2.288	0.3565	2.288
10	.	0.2	1	0	0	2.792	0.3565	2.792

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14500	0.2	0.05	0	0	0.571	0.0320	0.571
3	.	0.2	0.42	0	0	0.783	0.1784	0.783
4	.	0.2	0.97	0	0	1.015	0.3489	1.015
5	.	0.2	0.99	0	0	1.305	0.3532	1.305
6	.	0.2	1	0	0	1.423	0.4323	1.423
7	.	0.2	1	0	0	1.681	0.4936	1.681
8	.	0.2	1	0	0	2.123	0.4153	2.123
9	.	0.2	1	0	0	2.273	0.3565	2.273
10	.	0.2	1	0	0	2.792	0.3565	2.792

Input units are thousands and kg - output in tonnes

Table 2.4.15 Faroe haddock. Management option table - Results

MFDP version 1
Run: man
Index file 02/05/2004
Time and date: 23:50 5/2/04
Fbar age range: 3-7

2004				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
118746	85785	1	0.3613	25623

2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
100876	77992	0	0	0	107125	92919
.	77992	0.1	0.0361	2818	104180	90010
.	77992	0.2	0.0723	5539	101340	87205
.	77992	0.3	0.1084	8164	98601	84500
.	77992	0.4	0.1445	10698	95958	81892
.	77992	0.5	0.1806	13144	93409	79376
.	77992	0.6	0.2168	15506	90949	76949
.	77992	0.7	0.2529	17787	88576	74609
.	77992	0.8	0.289	19989	86285	72351
.	77992	0.9	0.3252	22116	84074	70172
.	77992	1	0.3613	24171	81940	68070
.	77992	1.1	0.3974	26156	79880	66041
.	77992	1.2	0.4335	28074	77891	64083
.	77992	1.3	0.4697	29927	75971	62193
.	77992	1.4	0.5058	31717	74116	60369
.	77992	1.5	0.5419	33448	72325	58608
.	77992	1.6	0.5781	35121	70595	56908
.	77992	1.7	0.6142	36739	68924	55266
.	77992	1.8	0.6503	38303	67310	53681
.	77992	1.9	0.6864	39815	65750	52150
.	77992	2	0.7226	41278	64242	50671

Input units are thousands and kg - output in tonnes

Table 2.4.16 Faroe haddock. Long-term Prediction - Input data

MFYPR version 1
Run: ypr
Index file 02/05/2004
Time and date: 23:53 5/2/04
Fbar age range: 2-10

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.559	0.0351	0.559
3	0.2	0.47	0	0	0.819	0.2907	0.819
4	0.2	0.91	0	0	1.102	0.3003	1.102
5	0.2	0.99	0	0	1.446	0.3380	1.446
6	0.2	1.00	0	0	1.763	0.4065	1.763
7	0.2	1.00	0	0	2.054	0.4999	2.054
8	0.2	1.00	0	0	2.262	0.7551	2.262
9	0.2	1.00	0	0	2.500	0.4102	2.500
10	0.2	1.00	0	0	2.825	0.4102	2.825

Weights in kilograms

Table 2.4.17 Faroe haddock. Long-term Prediction - Results

MFYPR version 1
Run: ypr-final
Time and date: 10:36 5/3/04
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0	0	0	0	5.5167	8.7534	4.076	7.7965	4.076	7.7965
0.1	0.0383	0.135	0.2421	4.8443	7.0704	3.4075	6.1175	3.4075	6.1175
0.2	0.0766	0.2292	0.3879	4.3761	5.9424	2.9431	4.9934	2.9431	4.9934
0.3	0.1149	0.2986	0.4794	4.0314	5.144	2.6021	4.1988	2.6021	4.1988
0.4	0.1532	0.3521	0.5386	3.7663	4.5545	2.3406	3.6129	2.3406	3.6129
0.5	0.1914	0.3947	0.5778	3.5556	4.104	2.1334	3.166	2.1334	3.166
0.6	0.2297	0.4296	0.604	3.3833	3.7498	1.9646	2.8153	1.9646	2.8153
0.7	0.268	0.4589	0.6218	3.2394	3.4646	1.824	2.5335	1.824	2.5335
0.8	0.3063	0.4838	0.6339	3.1168	3.2301	1.7047	2.3023	1.7047	2.3023
0.9	0.3446	0.5054	0.642	3.0109	3.0339	1.602	2.1093	1.602	2.1093
1	0.3829	0.5243	0.6474	2.9181	2.8673	1.5123	1.9458	1.5123	1.9458
1.1	0.4212	0.5411	0.6509	2.836	2.7239	1.4333	1.8055	1.4333	1.8055
1.2	0.4595	0.5562	0.653	2.7626	2.5991	1.363	1.6837	1.363	1.6837
1.3	0.4978	0.5697	0.654	2.6966	2.4894	1.2999	1.5769	1.2999	1.5769
1.4	0.5361	0.5821	0.6544	2.6367	2.3922	1.2429	1.4826	1.2429	1.4826
1.5	0.5743	0.5933	0.6543	2.5822	2.3055	1.1912	1.3986	1.1912	1.3986
1.6	0.6126	0.6037	0.6537	2.5322	2.2275	1.144	1.3233	1.144	1.3233
1.7	0.6509	0.6132	0.6529	2.4862	2.157	1.1008	1.2555	1.1008	1.2555
1.8	0.6892	0.622	0.6519	2.4437	2.093	1.061	1.1941	1.061	1.1941
1.9	0.7275	0.6303	0.6508	2.4044	2.0346	1.0242	1.1382	1.0242	1.1382
2	0.7658	0.6379	0.6496	2.3677	1.9811	0.9902	1.0872	0.9902	1.0872

Reference point	F multiplier	Absolute F
Fbar(2-10)	1	0.3829
FMax	1.4166	0.5424
F0.1	0.5034	0.1928
F35%SPR	0.6285	0.2407
Flow	-99	
Fmed	0.6542	0.2505
Fhigh	2.5252	0.9669

Weights in kilograms

Table 2.4.18 Faroe haddock Stock Summary Table for Standard Graph.

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1961	51279	47797	20831	0.5624
1962	38537	51875	27151	0.6506
1963	47362	49547	27571	0.7002
1964	30110	44128	19490	0.4753
1965	22644	45555	18479	0.5260
1966	20206	43953	18766	0.5288
1967	25356	41959	13381	0.4030
1968	54844	45380	17852	0.4377
1969	31968	53422	23272	0.4853
1970	35583	59859	21361	0.4762
1971	15451	62909	19393	0.4563
1972	33177	61977	16485	0.3963
1973	23691	61581	17976	0.2893
1974	52336	64635	14773	0.2206
1975	70064	75410	20715	0.1799
1976	55979	89228	26211	0.2475
1977	26197	96388	25555	0.3873
1978	35110	97248	19200	0.2781
1979	2786	85418	12418	0.1550
1980	4945	81928	15016	0.1779
1981	3492	75877	12233	0.1813
1982	15844	56832	11937	0.3306
1983	19641	51844	12894	0.2652
1984	40810	53870	12378	0.2282
1985	39527	62673	15143	0.2757
1986	26568	65708	14477	0.2233
1987	9482	67456	14882	0.2636
1988	18844	62096	12178	0.2002
1989	14227	51945	14325	0.2839
1990	9533	43952	11726	0.2710
1991	3036	34932	8429	0.2720
1992	2682	27257	5476	0.2079
1993	1825	23521	4026	0.1846
1994	6431	21908	4252	0.2029
1995	95757	23051	4948	0.2235
1996	44883	49968	9642	0.3163
1997	8675	82265	17924	0.3716
1998	3482	81810	22210	0.5317
1999	15877	62402	18482	0.4655
2000	24880	52126	15821	0.2862
2001	108256	62073	16530	0.3022
2002	41921	88143	25131	0.3028
2003	19815	96387	26865	0.4789
2004	40167	85785		0.3613
Average	29393	60093	16461	0.3424

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3-7	Yield/R	SSB/R
Average last 3 years	0.361	0.646	2.118
$\mathbf{F}_{max}$	0.589	0.661	1.452
$\mathbf{F}_{0.1}$	0.211	0.585	3.079
$\mathbf{F}_{med}$	0.264	0.617	2.655

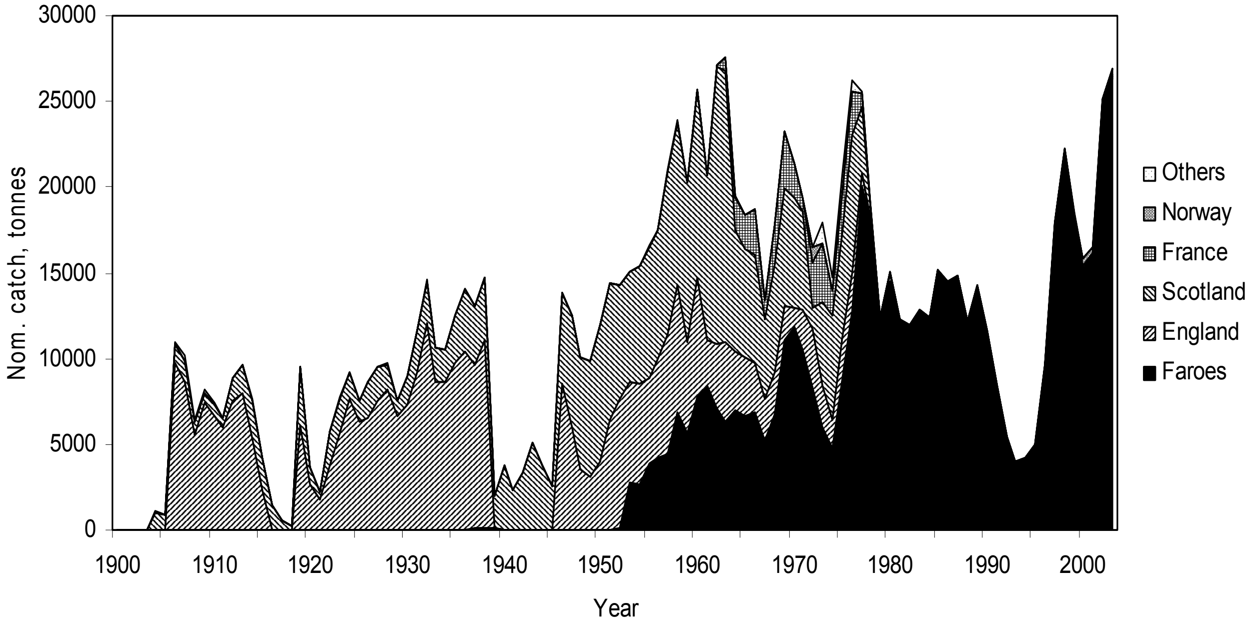


Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1903-2003.

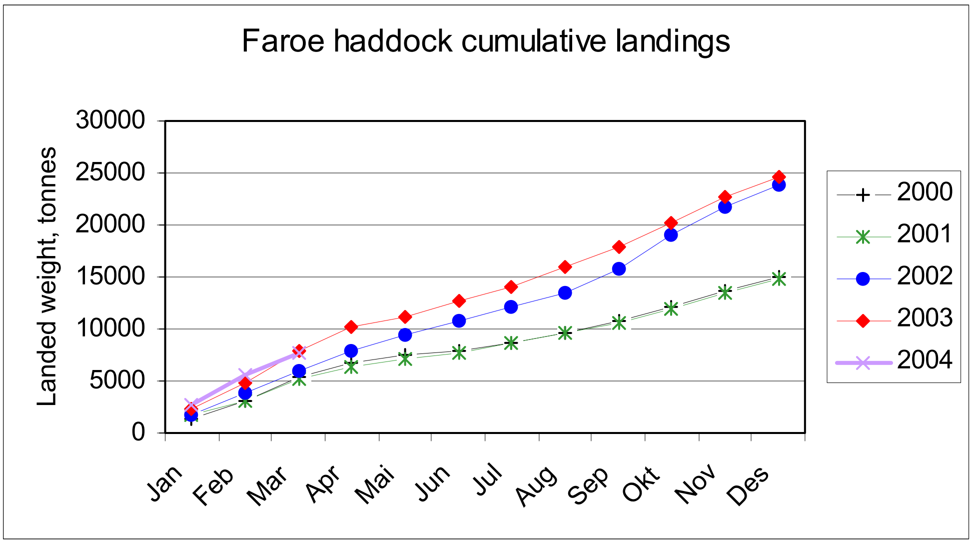


Figure 2.4.2. Faroe Haddock Cumulative Faroese Landings from Vb.

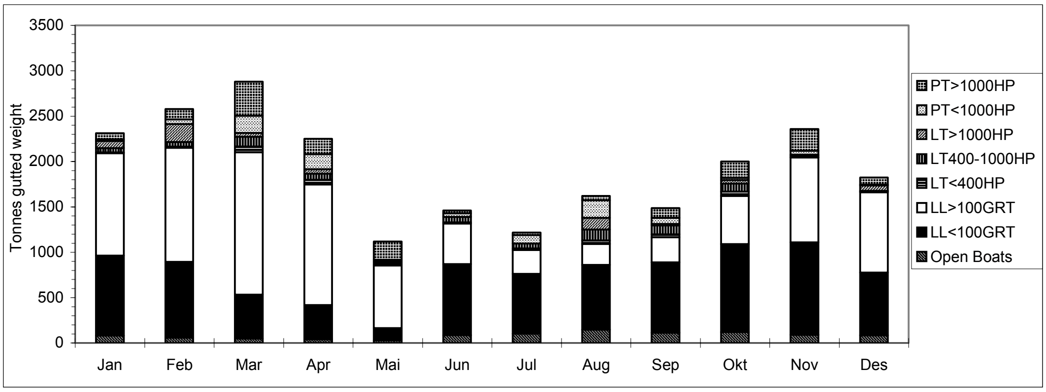


Figure 2.4.3.A. Faroese landings of haddock from Vb1 in 2003 by fleet. Tonnes ungutted weight.

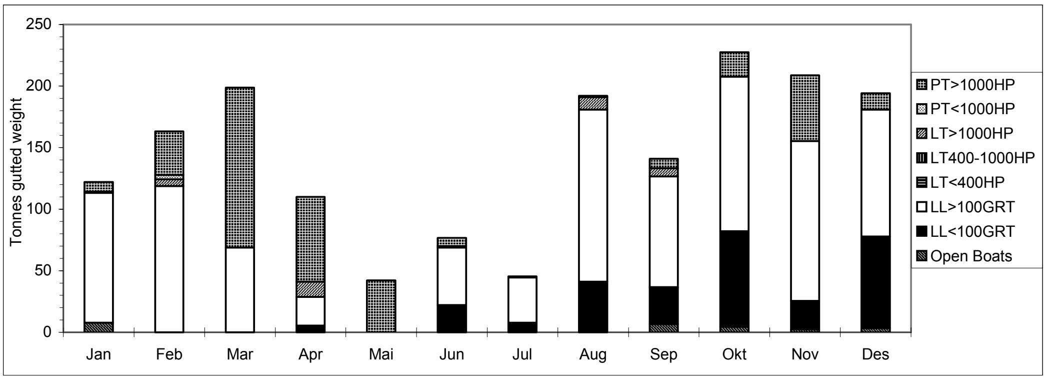


Figure 2.4.3.B. Faroese landings of haddock from Vb2 in 2003 by fleet. Tonnes ungutted weight.

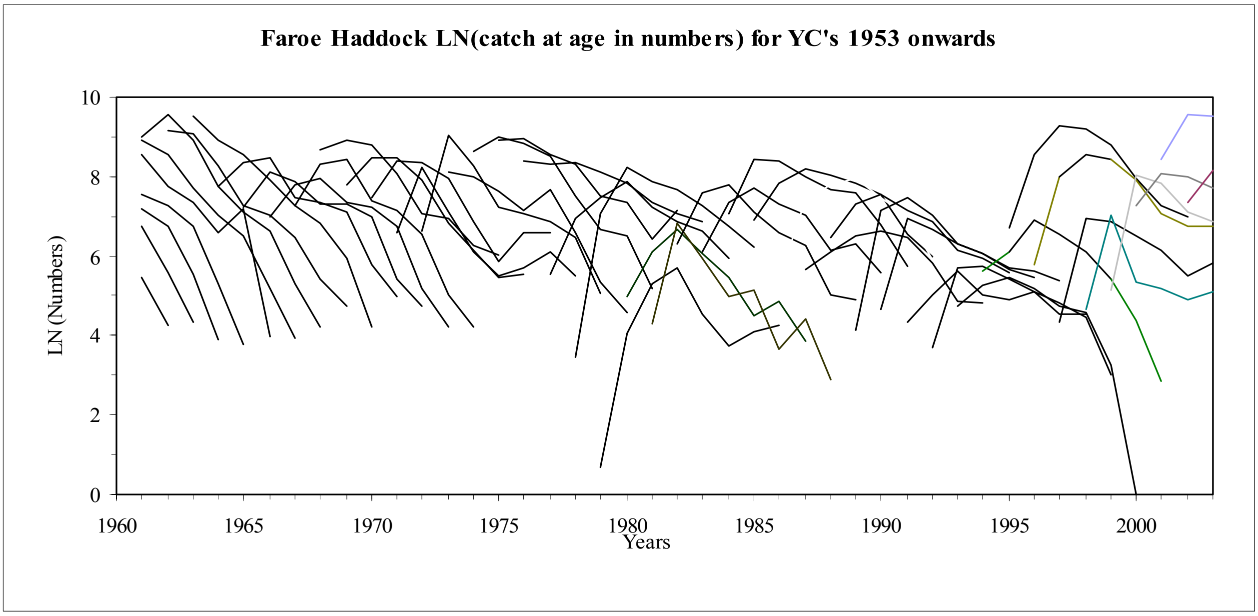


Table 2.4.5a. Faroe Haddock. LN (catch-at-age in numbers) for YC's 1953 onwards.

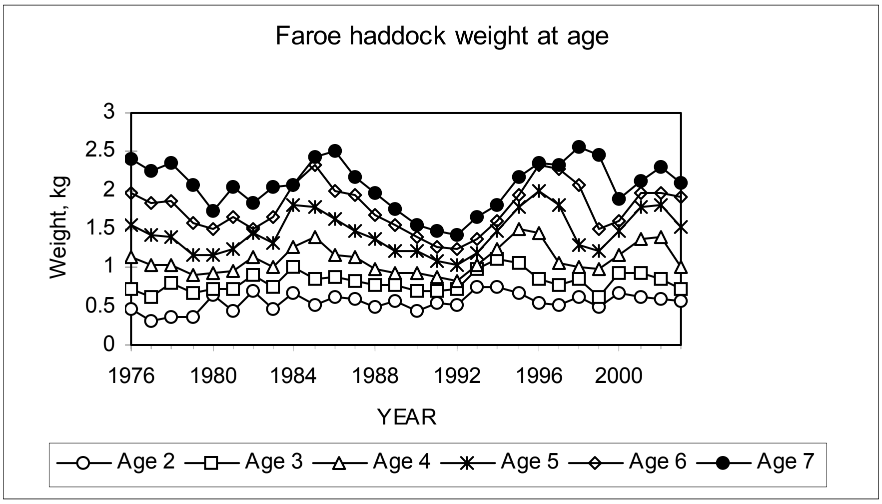
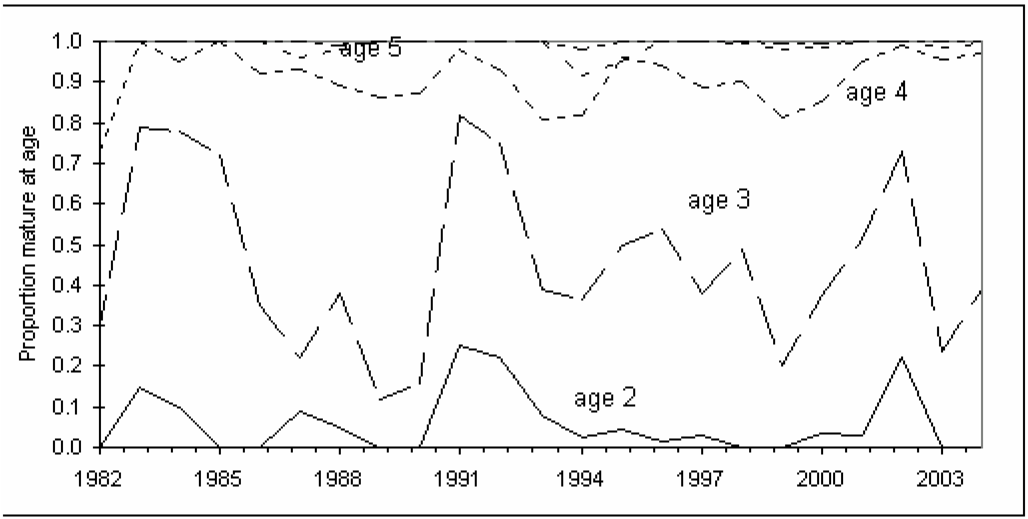
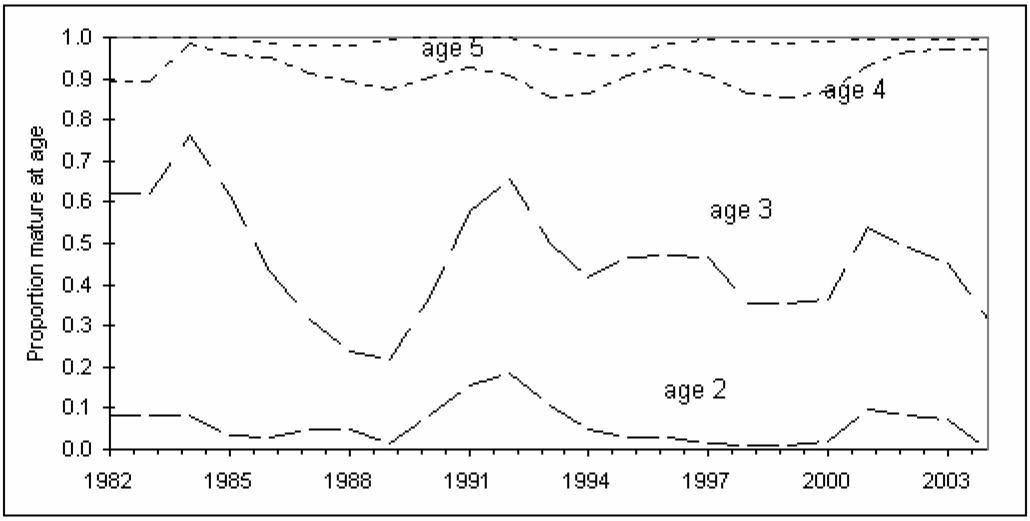


Figure 2.4.5b. Faroe Haddock. Mean weight at age (2-7).



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



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

Figure 2.4.6. Faroe haddock. Maturity-at-age based on samples from the spring survey since 1982.

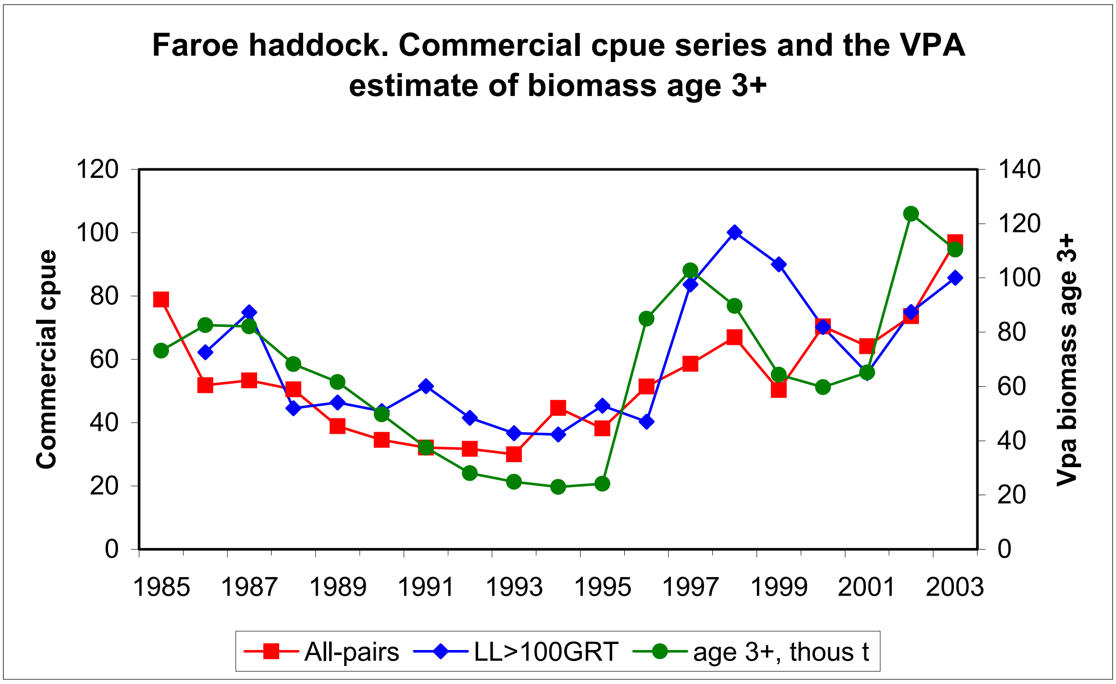


Figure 2.4.7. Commercial CPUE from pairtrawlers (kg/hour) and longliners (kg/1000 hooks) and the current VPA estimate of the biomass age 3+ (Thous. t)

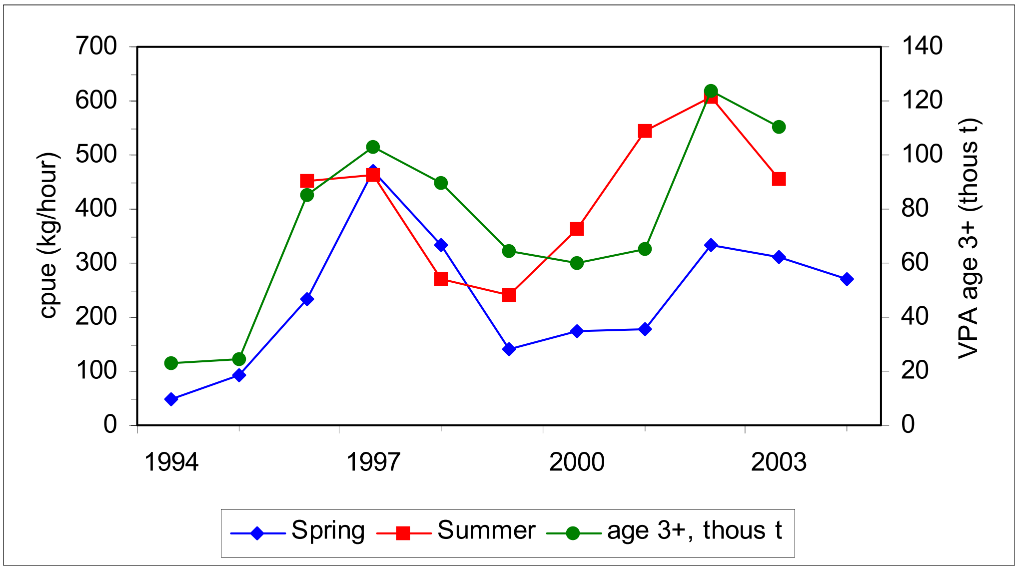


Figure 2.4.8. Faroe Haddock. CPUE (kg/trawlhour) in the Faroese spring and summer groundfish surveys and the current VPA estimate of the biomass age 3+ (Thous. t.).

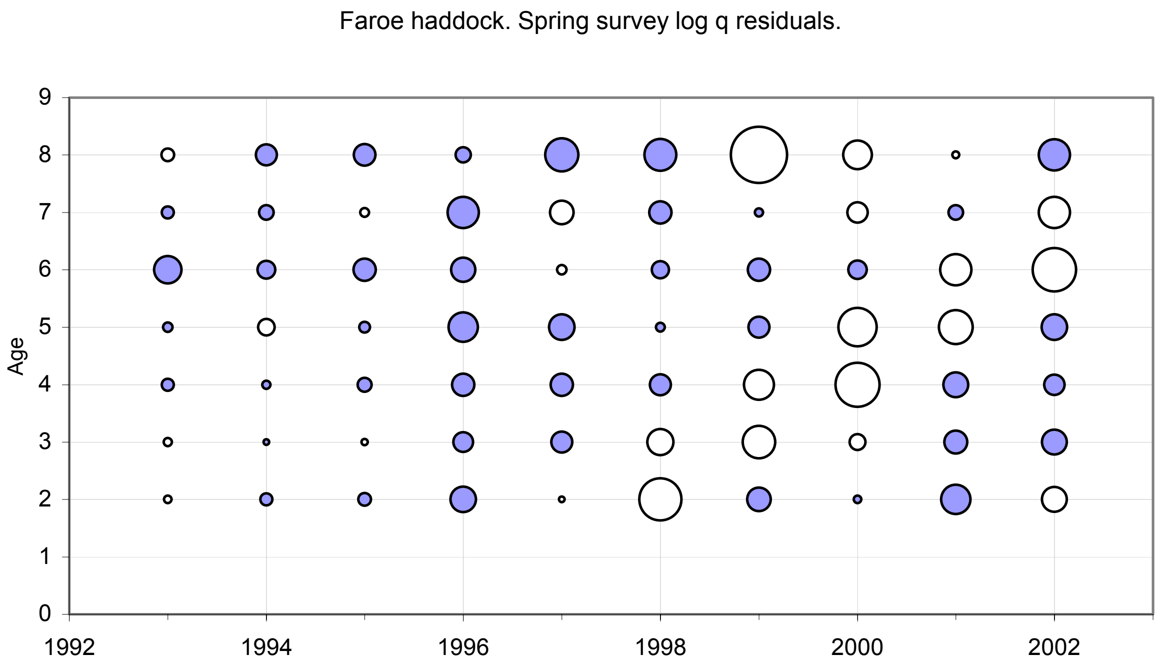


Figure 2.4.9. (Filled symbols positive, open symbols negative).

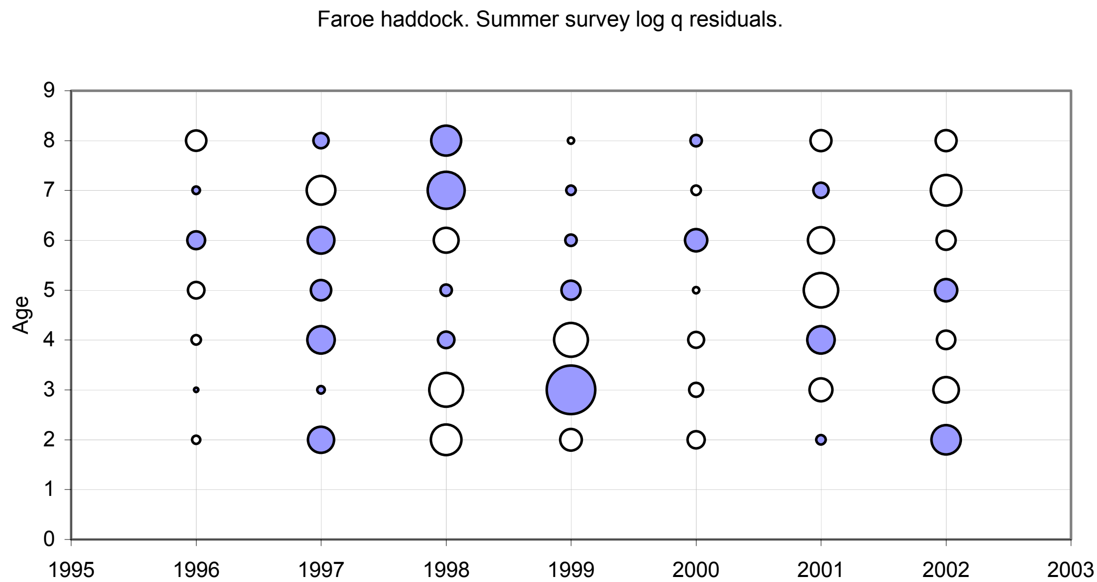


Figure 2.4.10. (Filled symbols positive, open symbols negative).

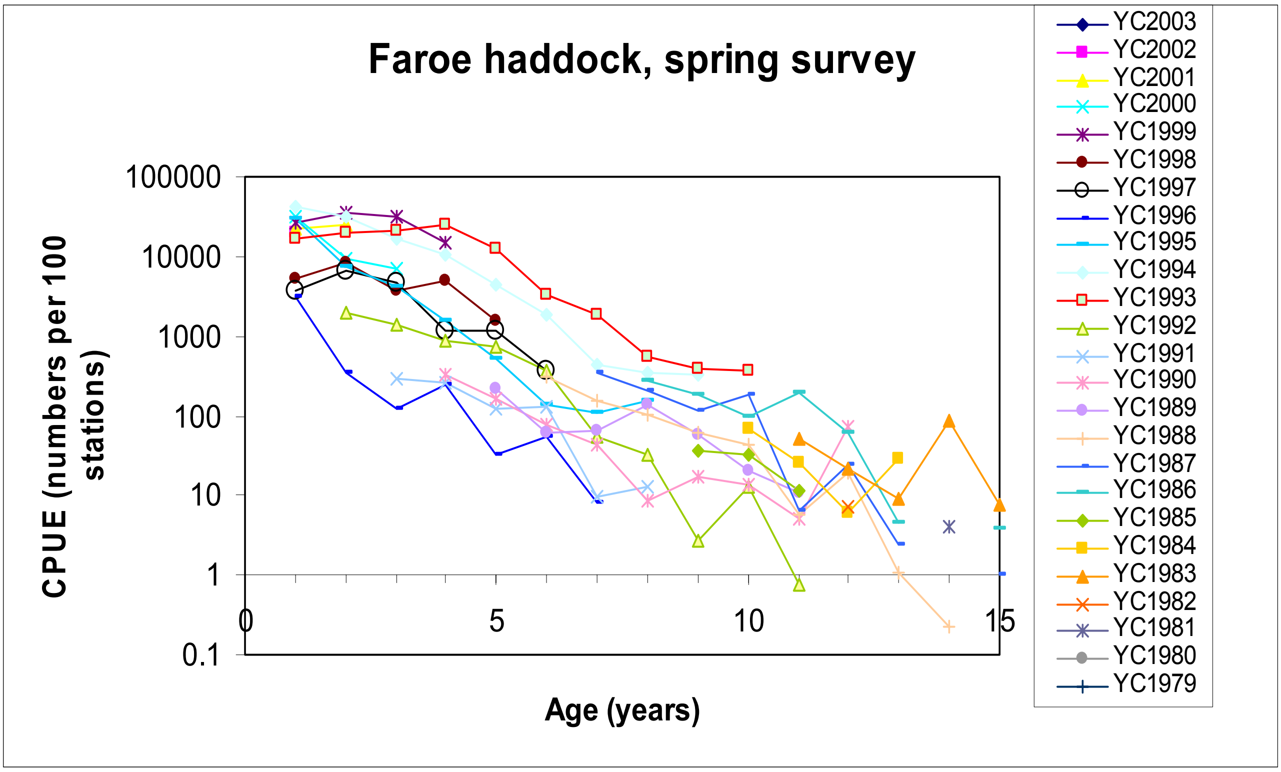


Figure 2.4.11. Faroe haddock. LN (c@age in numbers) in the spring survey.

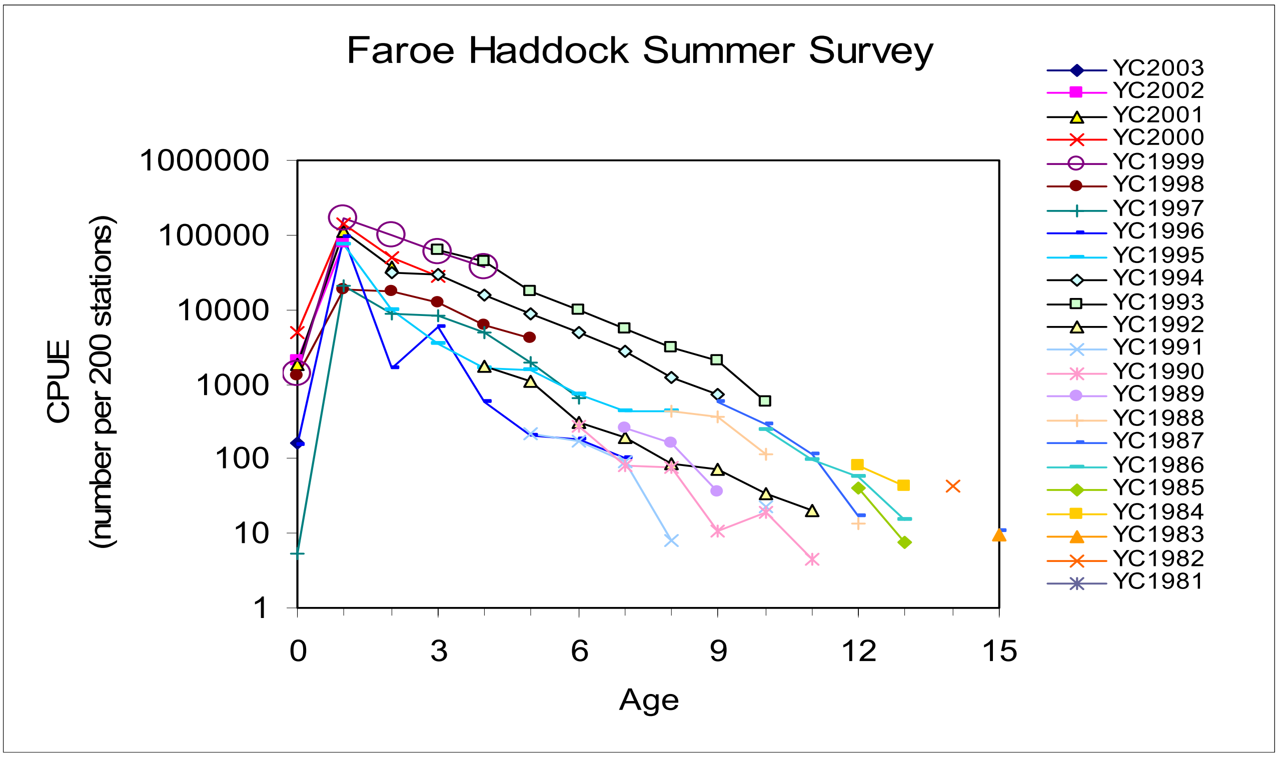


Figure 2.4.12. Faroe haddock. LN (c@age in numbers) in the summer survey.

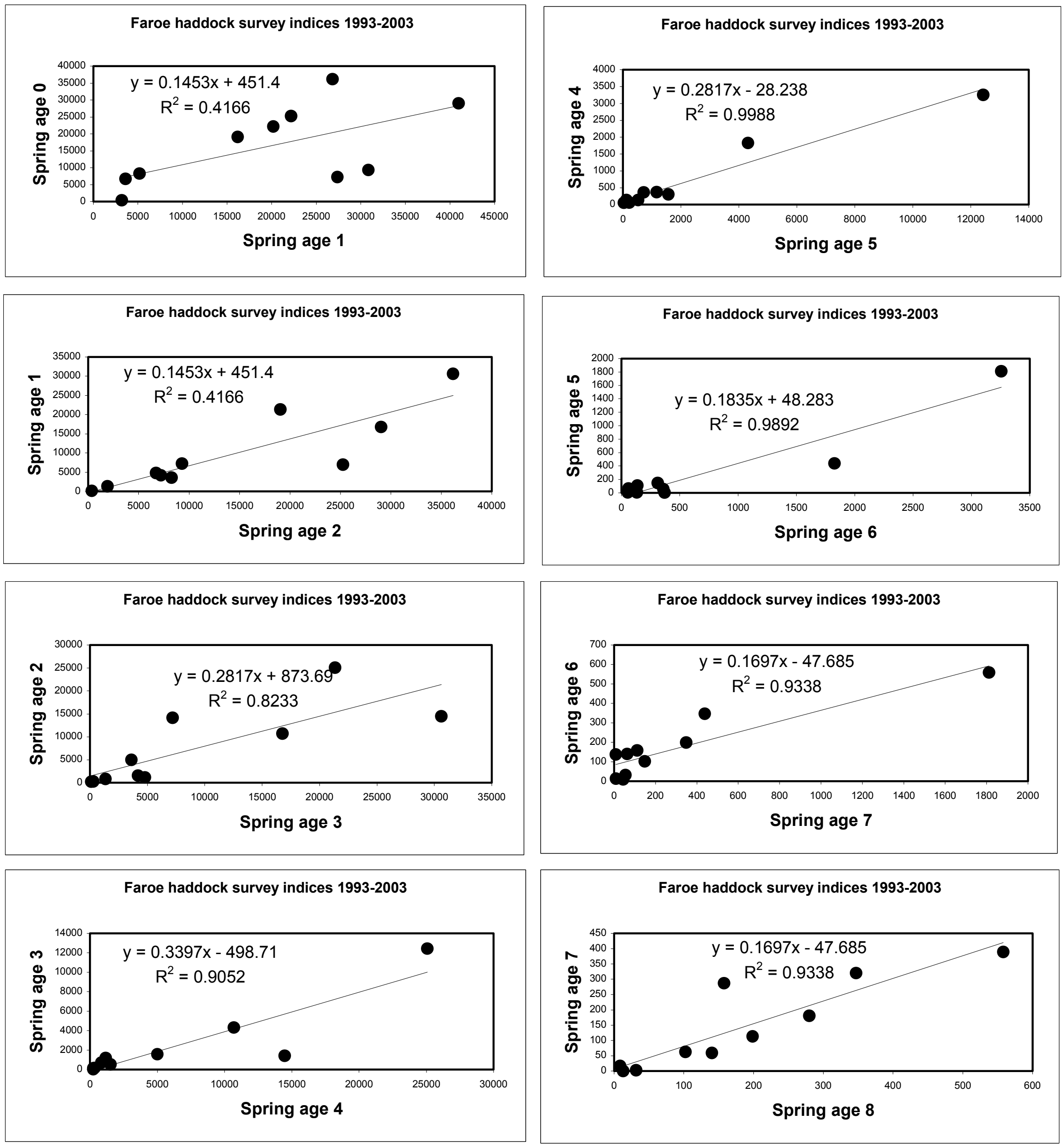


Figure 2.4. 13. Faroe haddock. Comparison between spring survey indices at age and the indices of the same YC one year later.

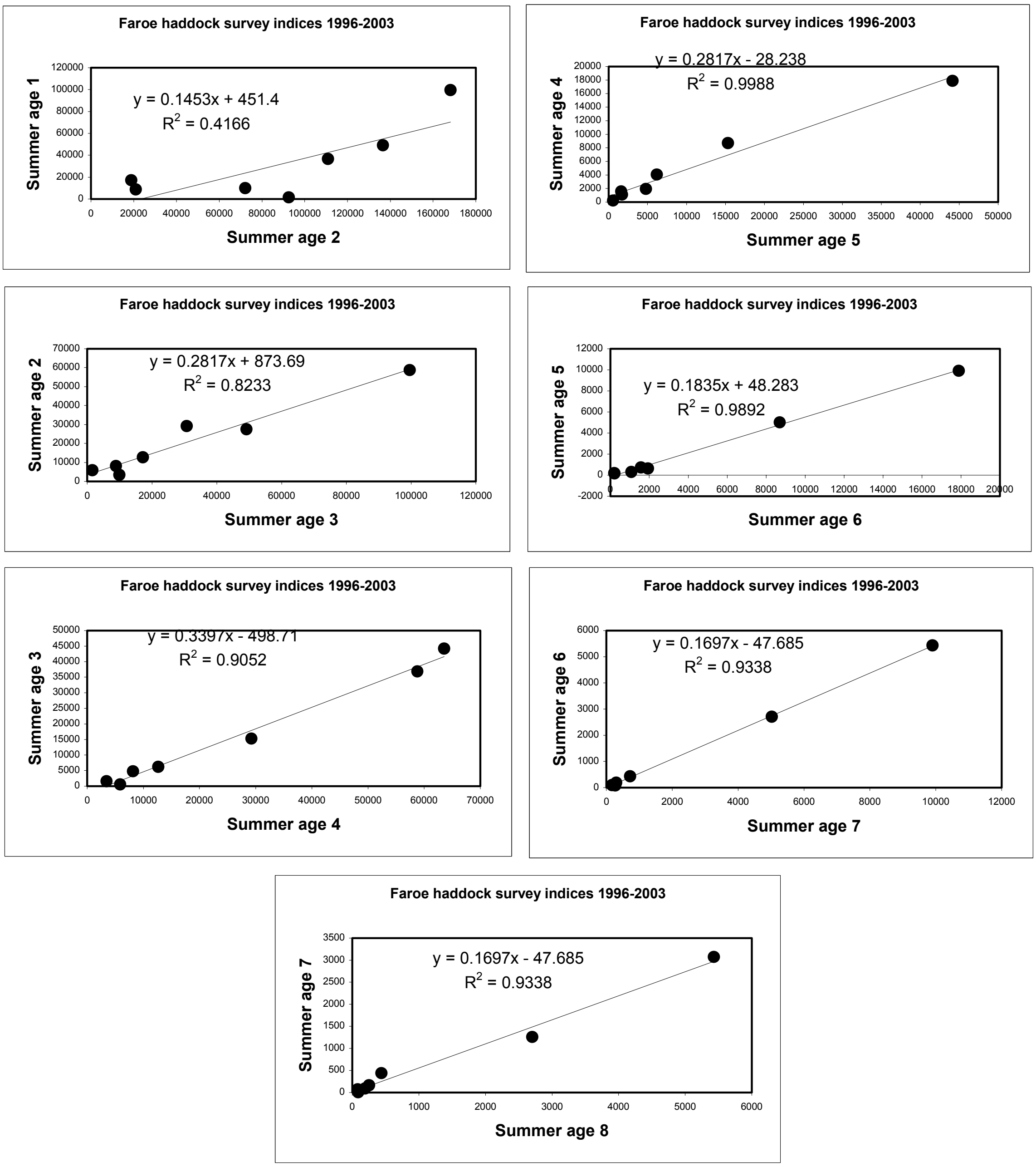


Figure 2.4. 14. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

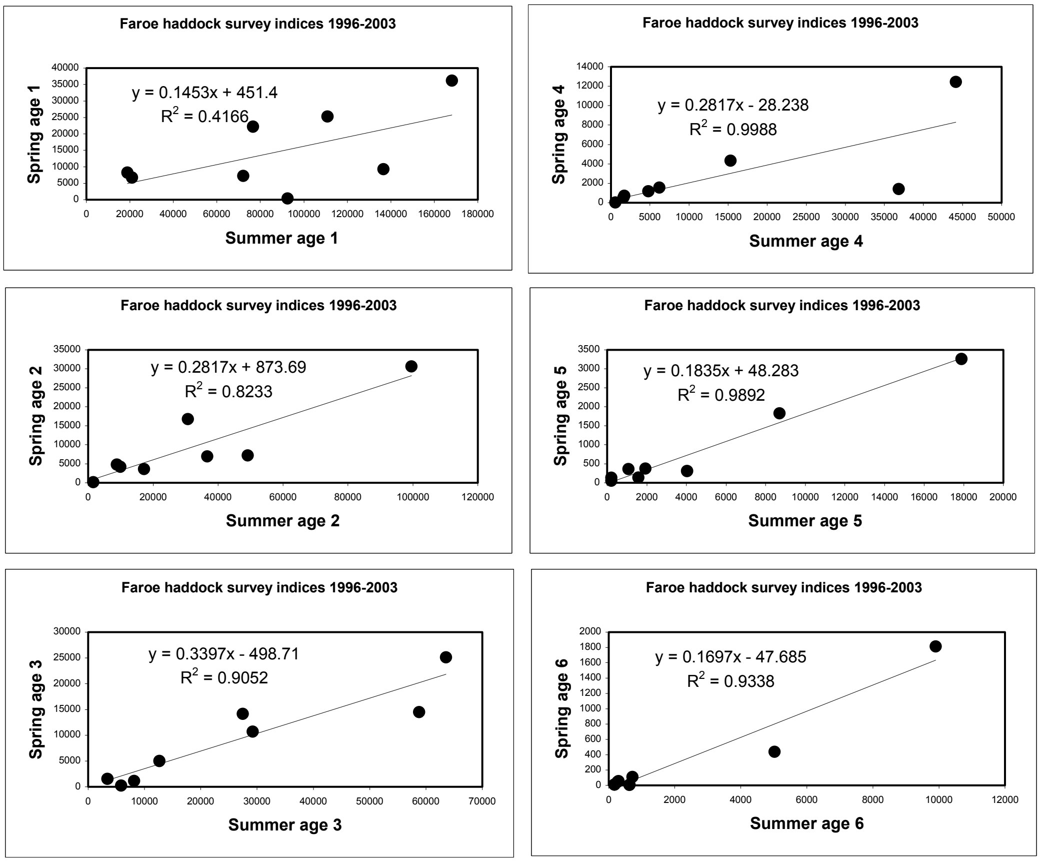


Figure 2.4. 15. Faroe haddock. Comparison between indices at age from the spring and summer surveys.

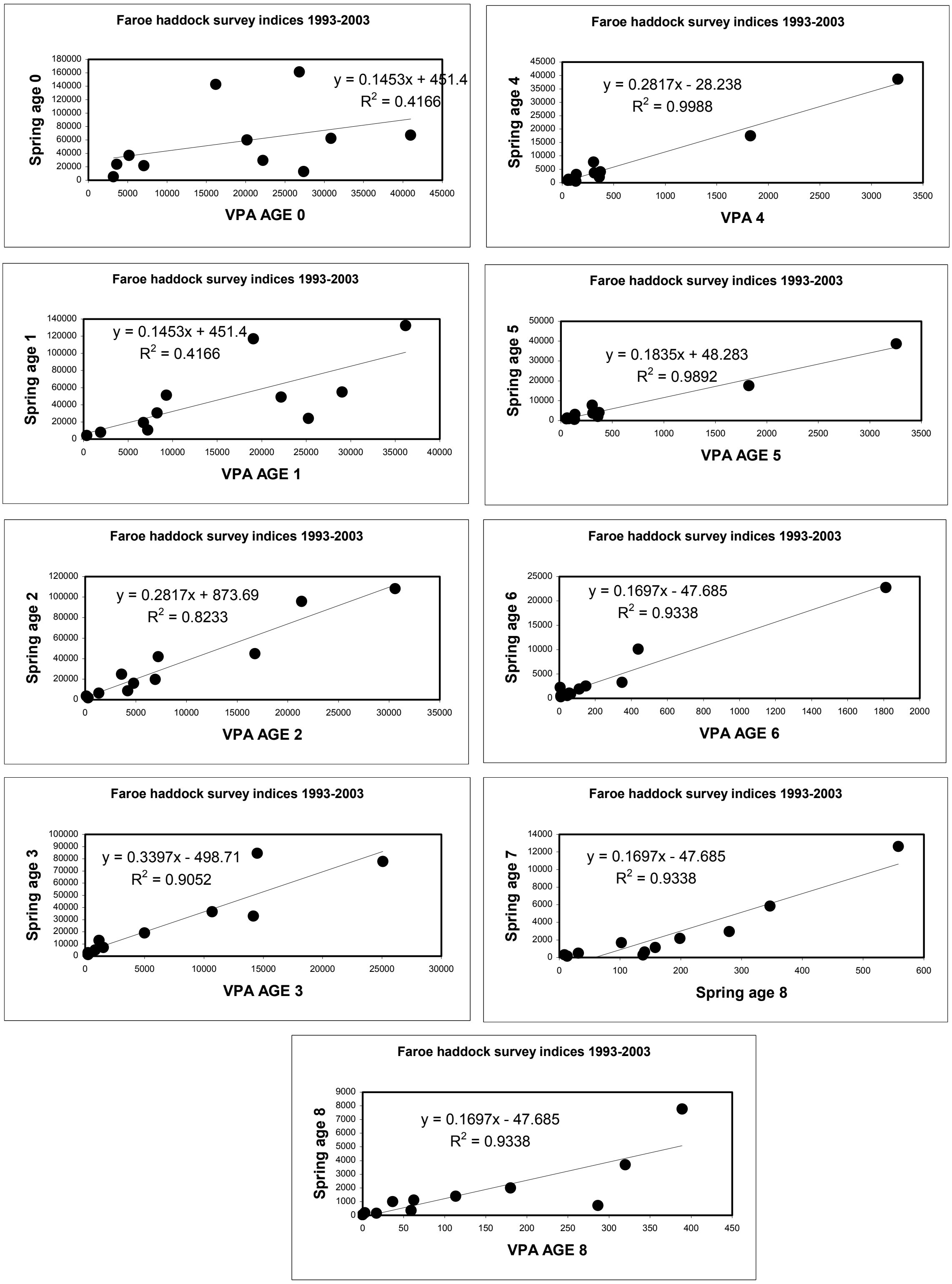


Figure 2.4. 16. Faroe haddock. Comparison between spring survey indices at age and the corresponding VPA estimates at age.

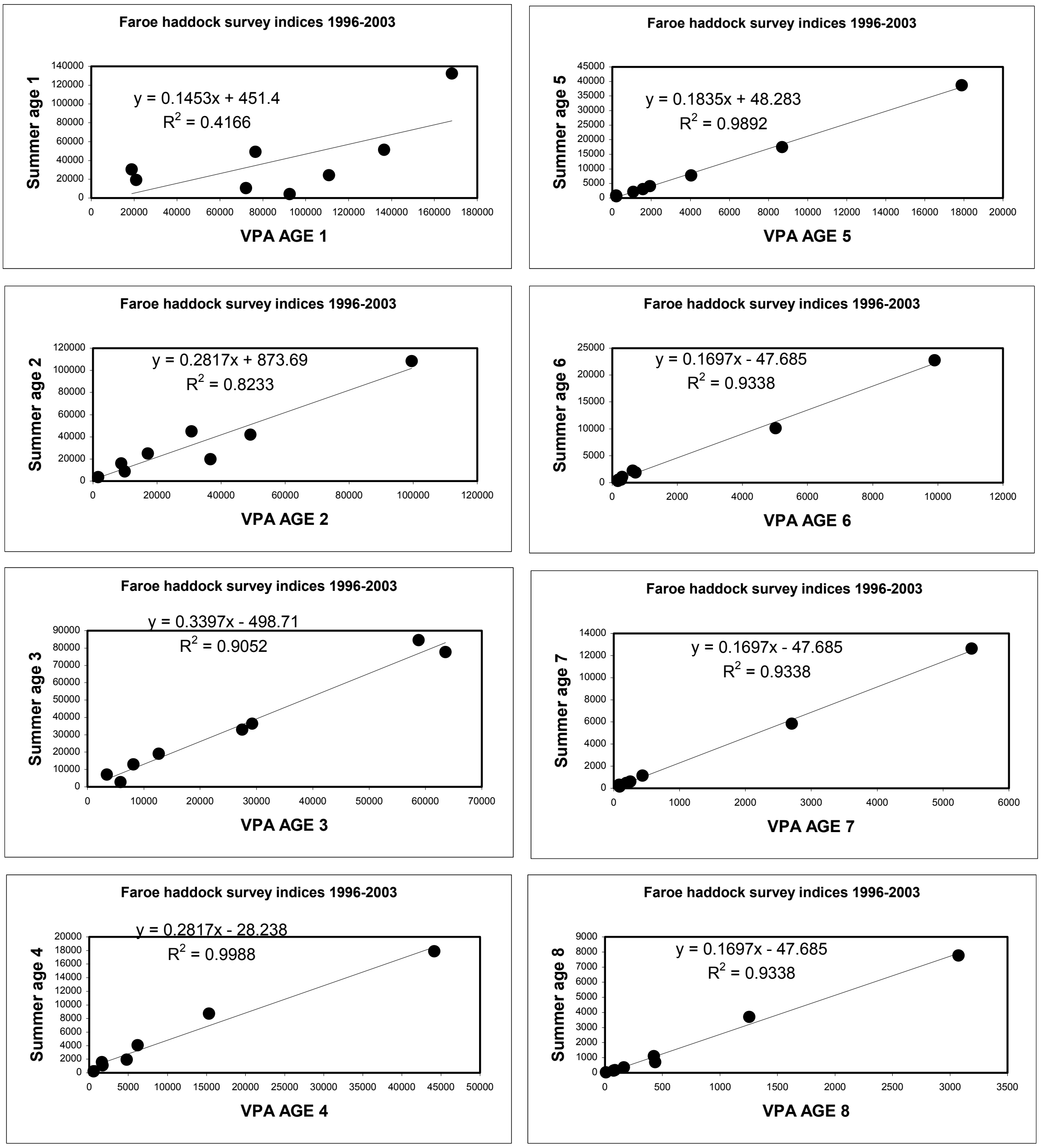


Figure 2.4. 17. Faroe haddock. Comparison between summer survey indices at age and the corresponding VPA estimates at age.

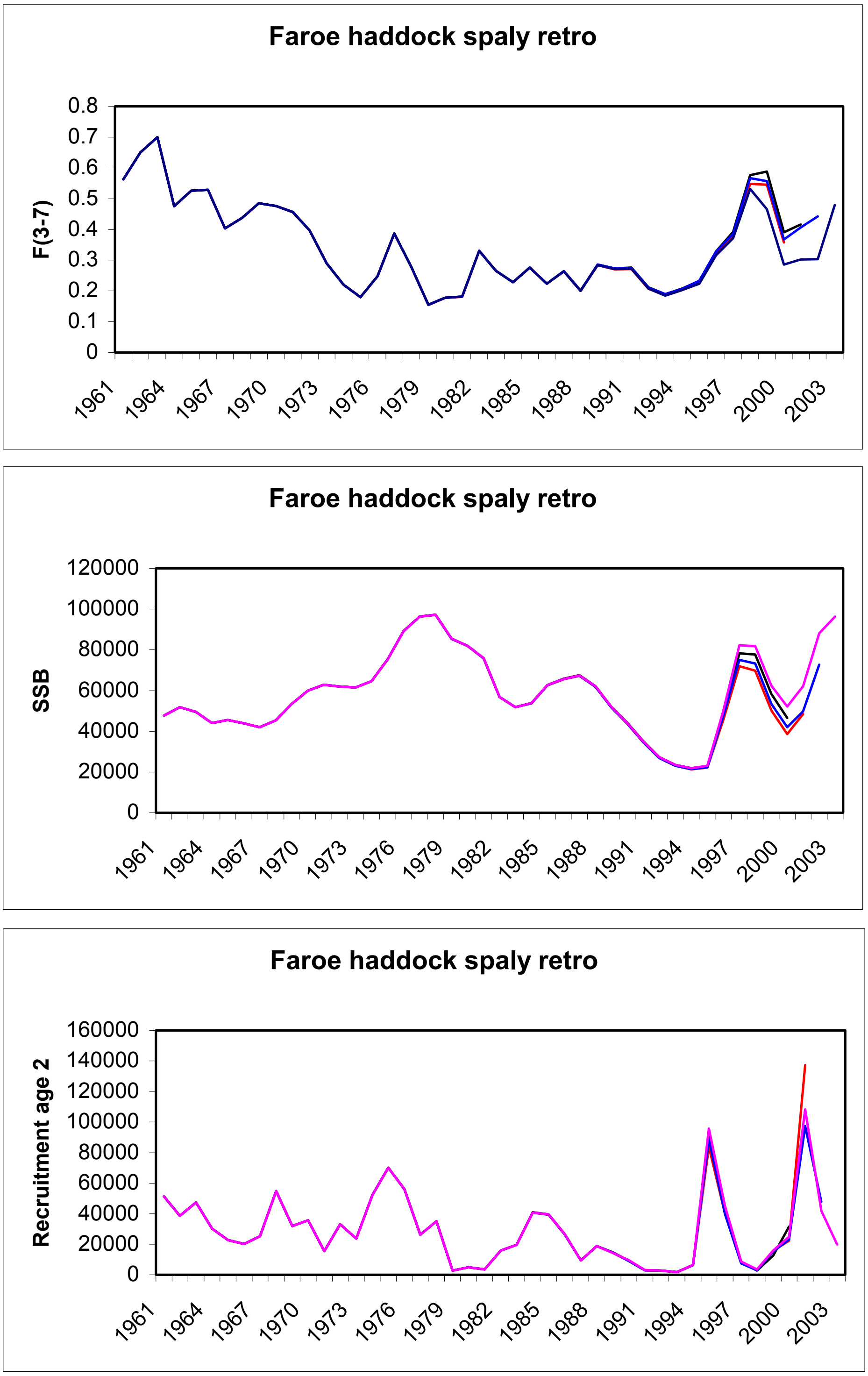


Figure 2.4.18. Faroe haddock. Retrospective analysis on the accepted 2004 XSA (SPALY run).

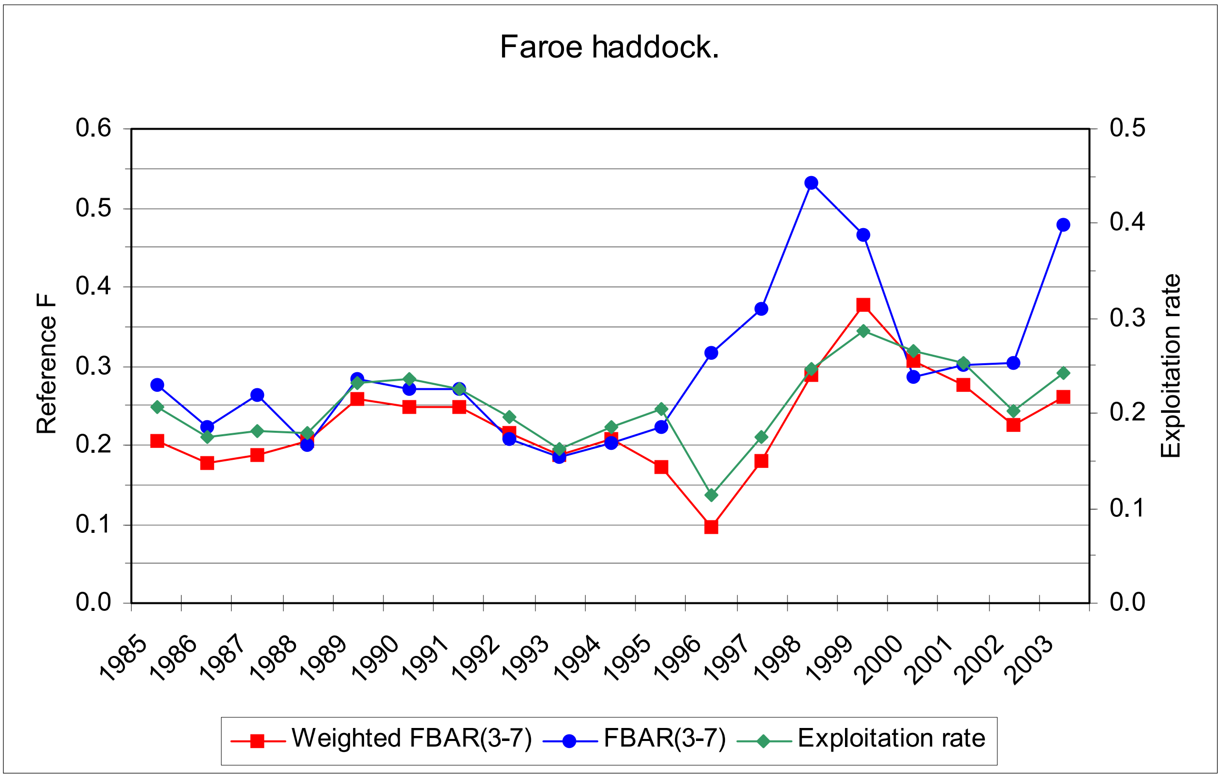


Figure 2.4.19. Weighted (by population numbers) and unweighted F reference values (age 3-7). Also shown is the exploitation rate expressed as the landings:biomass age 3 ratio.

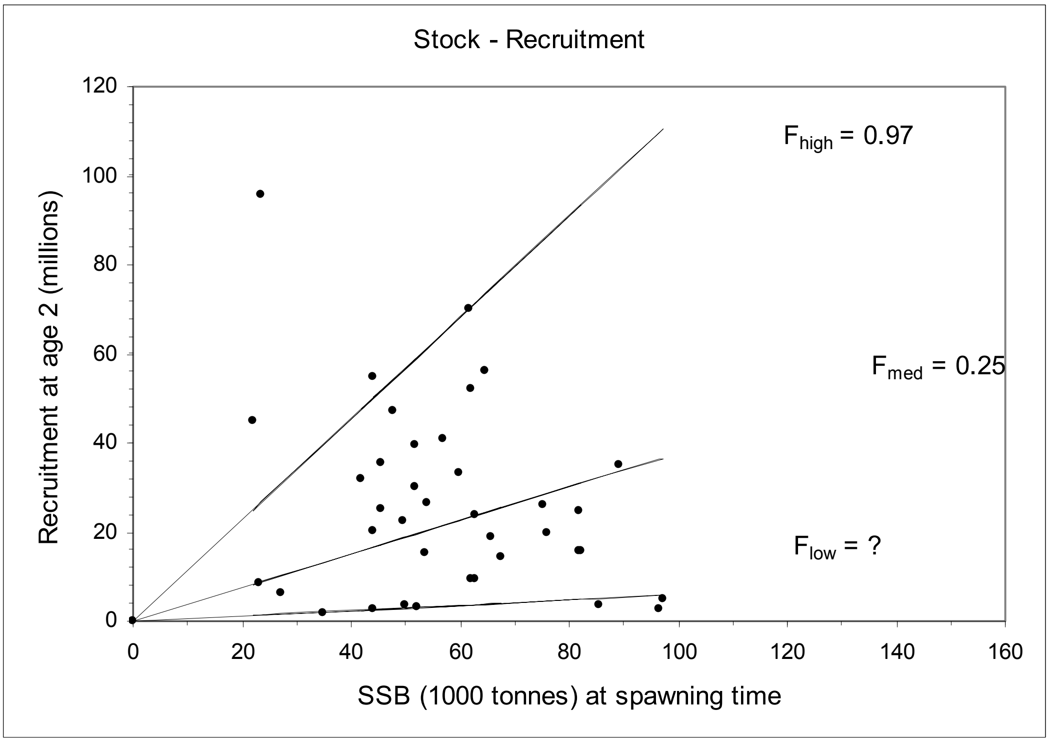
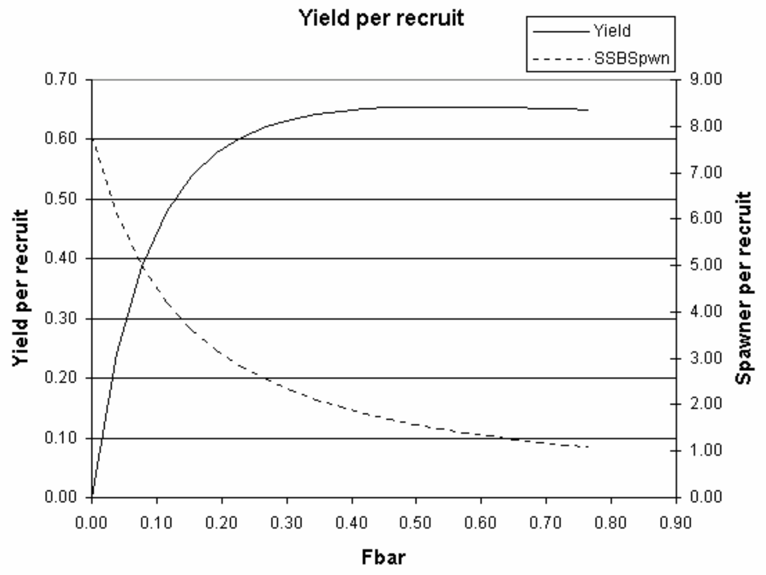
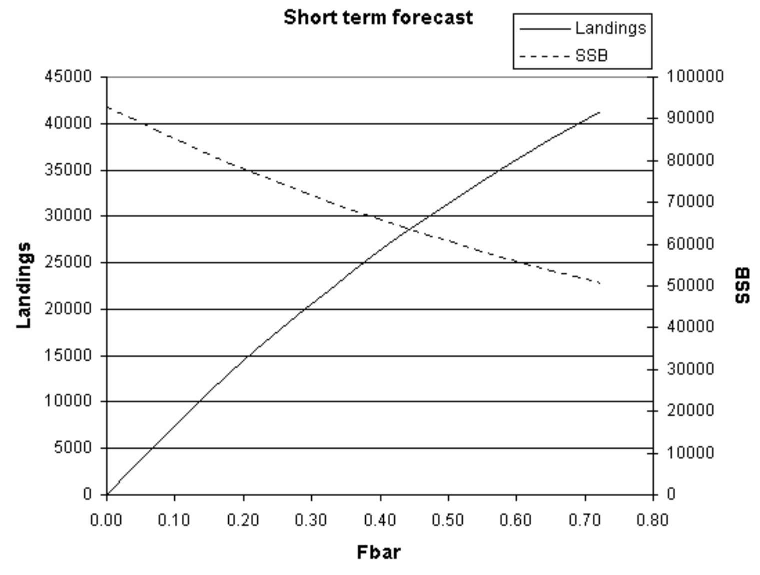


Figure 2.4.20. Faroe haddock. SSB-R plot.





MFYPR version 1
Run: final1
Time and date: 15:11 5/5/04

Reference point	F multiplier	Absolute F
Fbar(2-10)	1.0000	0.3829
FMax	1.4166	0.5424
F0.1	0.5034	0.1928
F35%SPR	0.6285	0.2407
Flow	-99	
Fmed	0.6542	0.2505
Fhigh	2.5252	0.9669

Weights in kilograms

MFDP version 1
Run: man
Index file 02/05/2004
Time and date: 23:50 5/2/04
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Figure 2.4.21. Faroe haddock prediction outputs.

Figure 2.4.22. Faroe haddock (Division Vb) standard graphs from the 2004 assessment.

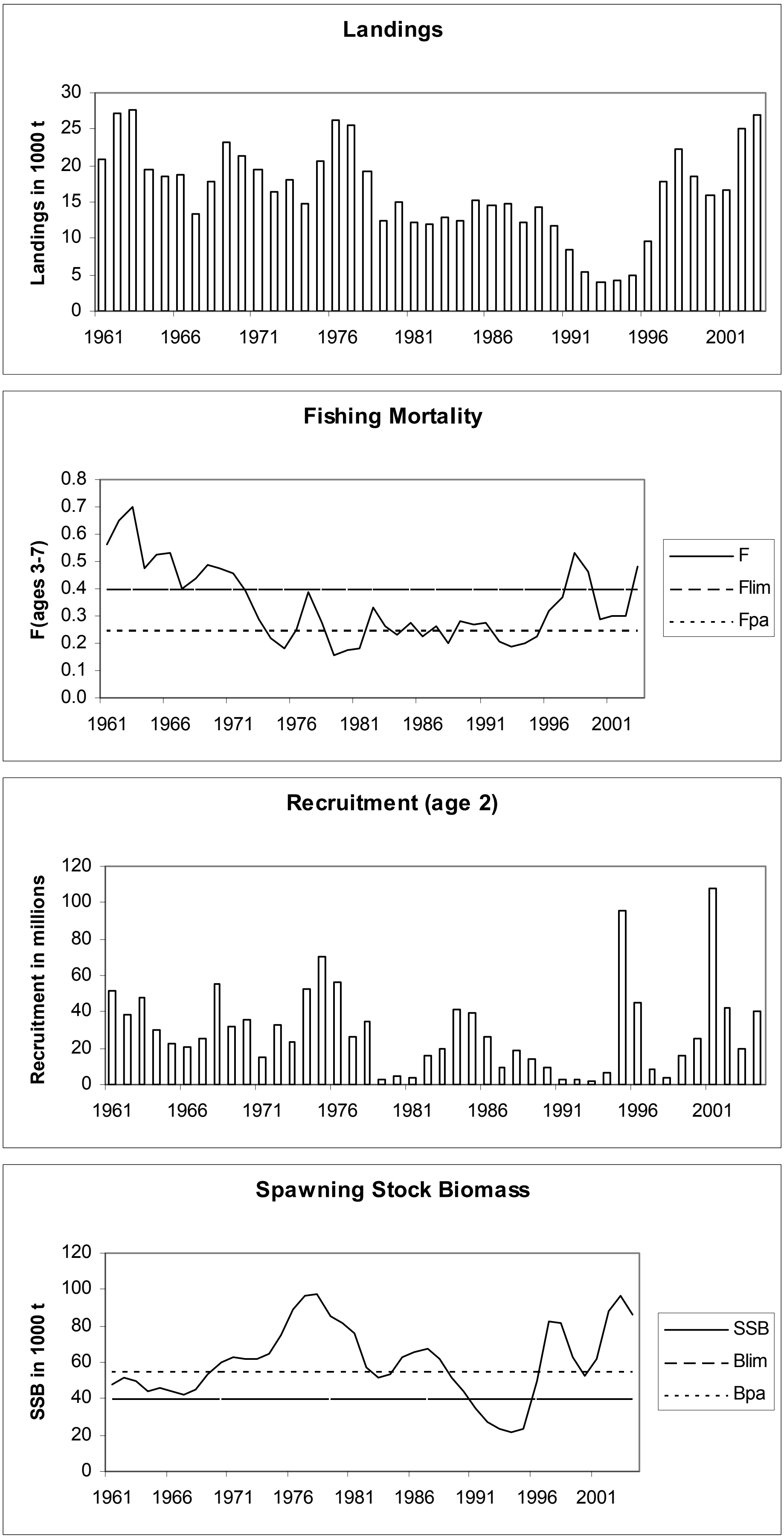
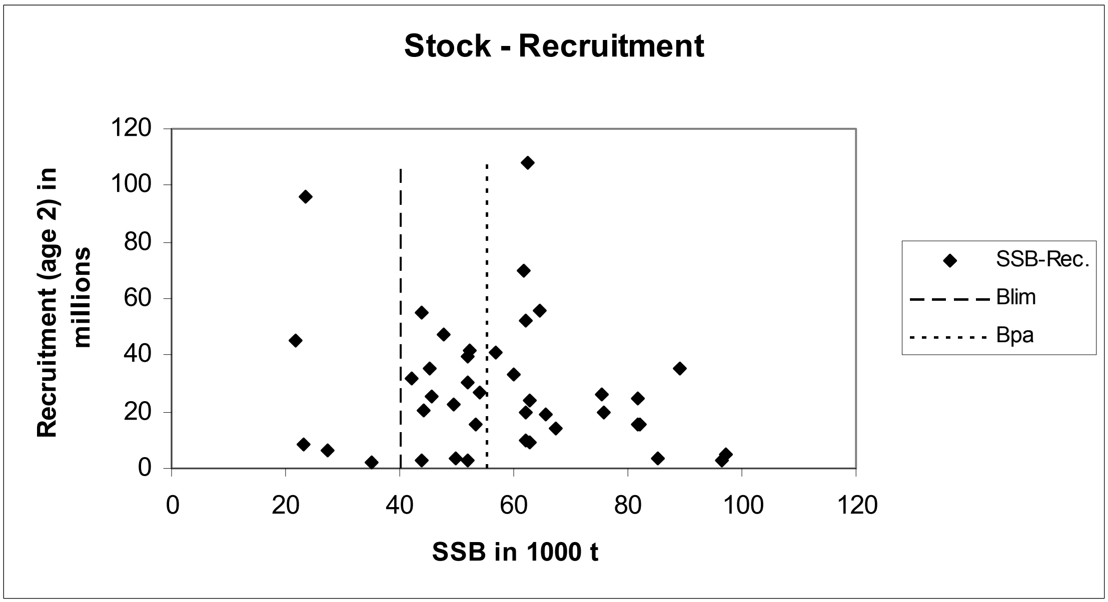
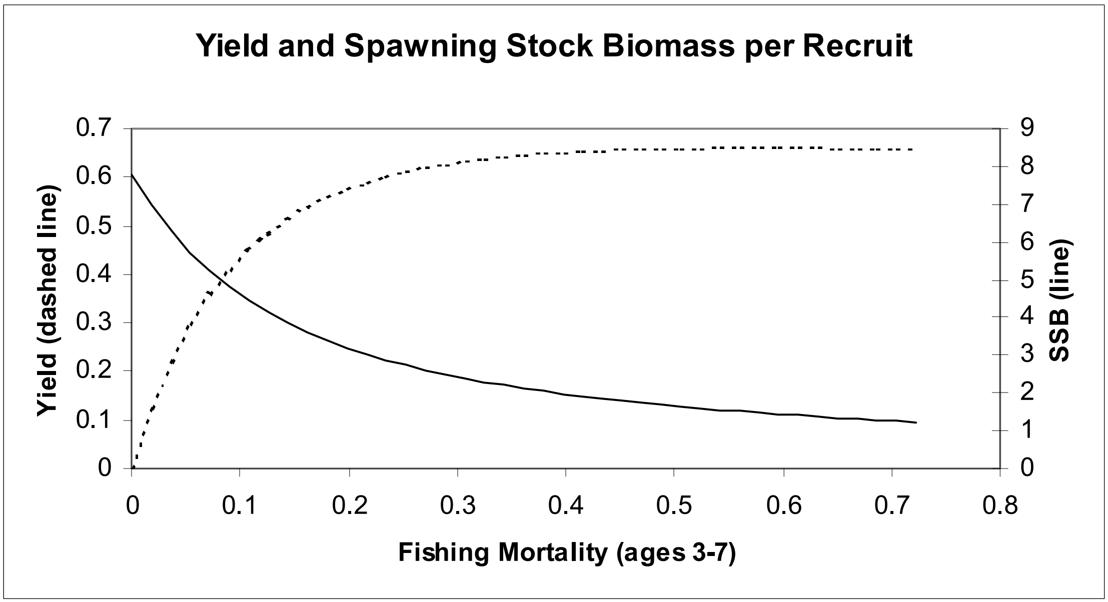
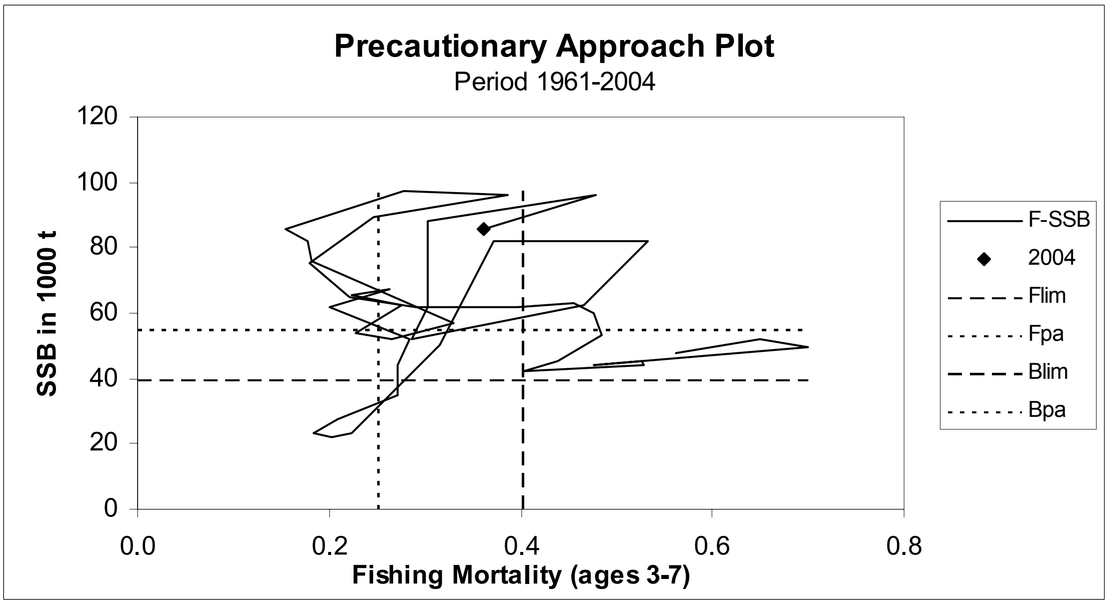


Figure 2.4.22 (Cont.). Faroe haddock (Division Vb) standard graphs from the 2004 assessment.







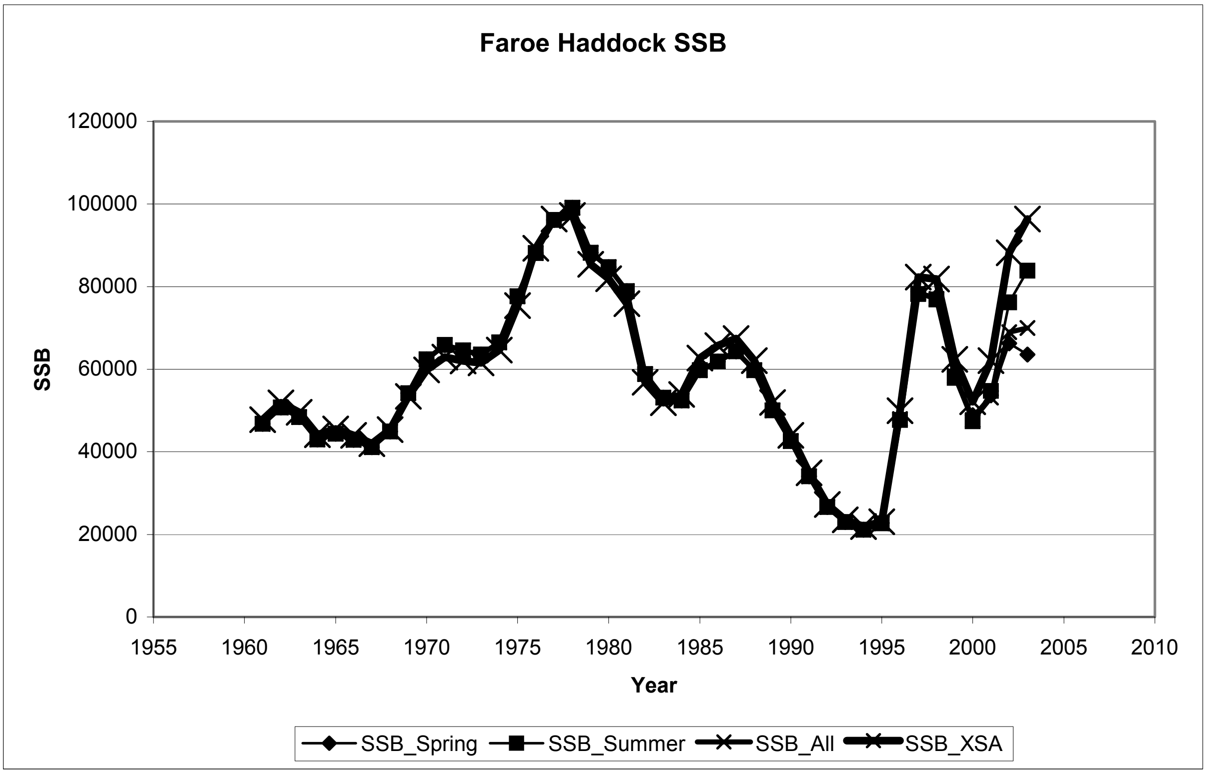
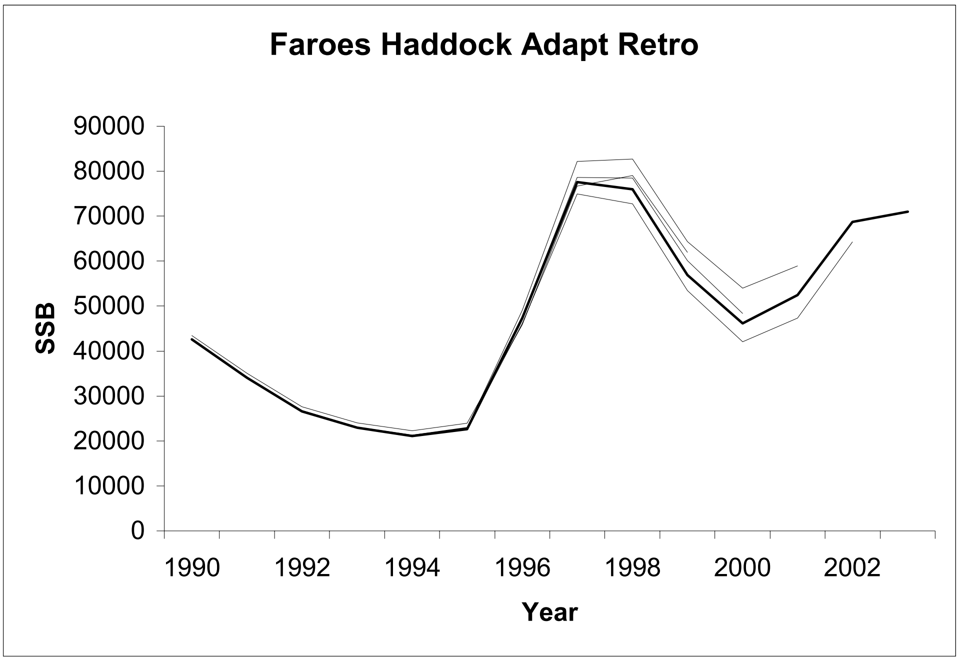


Figure 2.4.23. Time trends of SSB estimated in ADAPT assessments done with each potential index separately as well as the accepted XSA.



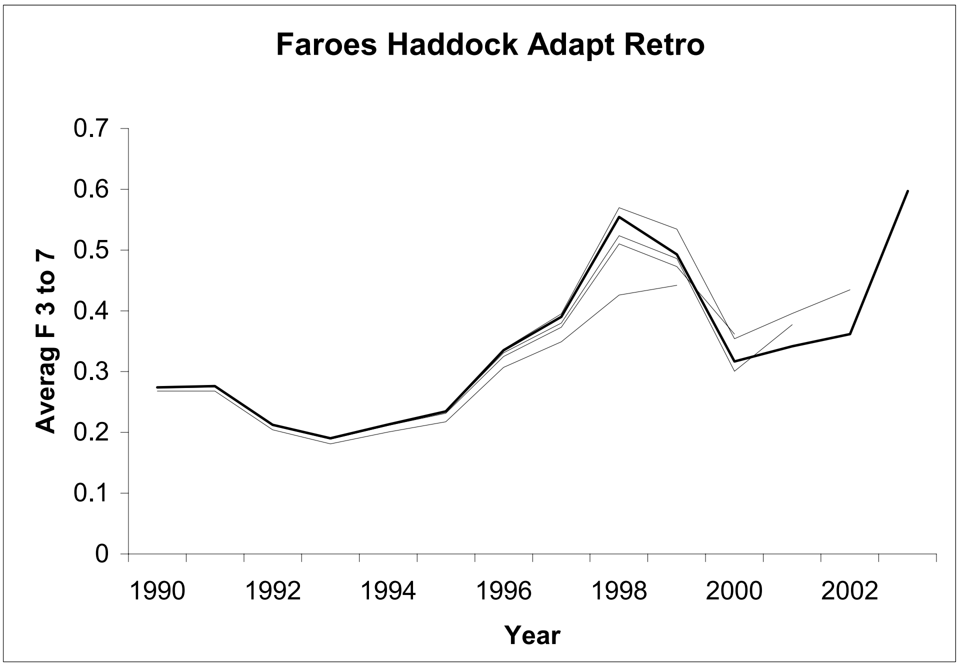


Table 2.4.24. The retrospective pattern from the ADAPT calibrated with the summer and the spring surveys.

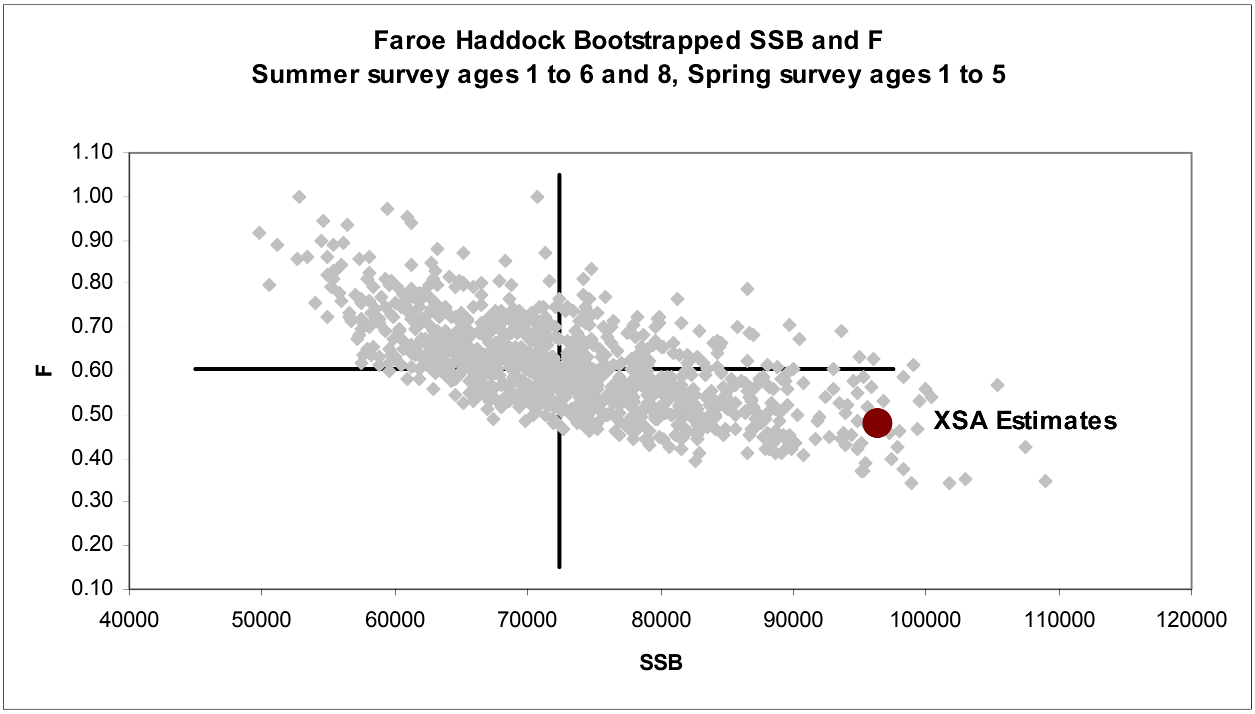


Figure 2.4.25. The F and SSB's from a 1000 bootstraps of the ADAPT with the two surveys. Inserted are the F and SSB from the accepted XSA assessment.

2.5 Faroe Saithe

2.5.1 Landings and trends in the fishery

Nominal landings of saithe from the Faroese grounds (Division Vb) have varied between 10 000 t and 60 000 t since 1960. After a record high of about 60 000 t in 1990, landings declined steadily to 20 000 t in 1996. Since then landings have increased steadily to 53 500 tonnes in 2002 (Table 2.5.1.1, Figure 2.5.1.1). In 2003 the landings decreased to 46 500 tonnes.

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 1993-2003 (Table 2.5.1.2). The smaller pair trawlers (<1000 HP) have a more mixed fishery and they account for about 10-20% of the total landings of saithe in 1993-2003. During the last decade the proportion of saithe in the catches has generally increased for larger pair trawlers and larger single trawlers (>1000 HP) but decreased for the smaller pair trawlers and jiggers. In 2003 the saithe catches decreased for larger single trawlers and increased for smaller pair trawlers. Other vessel categories report only small catches of saithe as by-catch.

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. Little discarding is thought to occur in this fishery.

2.5.2 Catch at age

Catch at age is based on length and otolith samples from Faroese landings of 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 2003 was similar to that in 2002:

Fleet	Samples	Lengths	Otoliths	Weights
Single trawlers 400 – 999 HP	7	1388	180	0
Single trawlers 1000 – 1499 HP	2	427	119	60
Single trawlers 1500 - 1999 HP	7	1636	60	60
Single trawlers > 2000 HP	13	2896	540	300
Pair trawlers 700 – 999 HP	29	6393	960	239
Pair trawlers 1000 – 1499 HP	152	34812	3719	2999
Total	**210**	**47552**	**5578**	**3658**

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2003. For example, the mean weights at age 5 varied between about 1.6 kg in 1973 and 3.3 kg in 1980 while at age 7 it varied between 2.6 kg in 1991 and 5.3 kg in 1985 (Table 2.5.3.1 and Figure 2.5.3.1). Mean weights at age were generally high during the early 1980s and they subsequently decreased from the mid 1980s to the early 1990s. The mean weights increased again in the period 1992-96 but have shown a general decreased since, especially for age 3-7 in 2003. The SOP for 2003 was 100%.

2.5.4 Maturity at age

Maturity at age data is from the spring survey and they are available from 1983 onward (Steingrund, 2003). Due to poor sampling in 1988 the proportion mature for that year was calculated as the average of the two adjacent years. A model was used, described in the 1993 Working Group report (ICES C.M.1993/Assess:18), for predicting maturity at age in order to alleviate some of the problems involved with the sampling data. The basic model used was a GLM with a Logit link function describing maturity at age as a function of age, year class strength, mean weight at age and a year effect. This model was applied to predict the entire maturity at age for 1983-2003 (Table 2.5.4.1 and Figure 2.5.4.1).

For the GLM maturity model, weigth is the mean weigth at age in the catch and year class strength is from the final XSA run in assessment year 2003. Because age 3 is generally not derived directly from the assessment, the year class strength at age 3 is the geometric mean for period 1983 – 2002. The model output is shown in table 2.5.4.2.

2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

The Faroe saithe assessment was intended to be an update only. However, because two of the fishing units (four trawlers) used in the tuning have been replaced, a run using strictly the "Same Precidier as Last Year" (SPALY) was not possible. This is discussed further below.

The summer survey (1996-2003), similar to last year, showed large standard errors of log q, and there was a marked trend in residuals. The results of a spring survey (1994-2003) were investigated but showed poor internal consistency.

The single CPUE series used in the assessment since 2000 was introduced in 1998 (ICES C.M. 1998/ACFM:19), and consists of saithe catch at age and effort in hours, referred to as the Cuba Logbook series. The series extends back to 1985 and consists of data from 8 pair trawlers greater than 1000 HP (Cuba trawlers) which specialize in fishing on saithe and account for 5 000-10 000 t of saithe each year (described in annex). In 2003, 4 of these trawlers left the fleet. The 4 remaining trawlers have larger CPUE, but they show the same trends. In the Cuba Logbook series, information for each haul was supplied and only those hauls where saithe contributed more than 50% of the total catches of cod, haddock and saithe were used (Table 2.5.5.1).

The exploitation pattern shows an increasing trend from 1991 to 1996, but the estimates have been reasonably stable for the period 1997-2002 (ICES C:M: 2003/ACFM:24). The estimates, however, are calculated from an assessment calibrated with the CPUE series, and recent values are dependent on the CPUE series. The Working Group accepted the XSA calibrated with Cuba trawler CPUE serie.

The final XSA run in the current assessment was made with almost the same parameters as in 2003, except that age 4 is included and the tuning serie is on 4 Cuba trawlers. The CPUE series used are shown in table 2.5.5.1. The XSA diagnostics are in Table 2.5.5.2 and the output from the XSA is presented in Tables 2.5.5.3-5. The values of S.E. (log q) are high, but for the principal year classes they appear reasonable. The log catchability residuals from the XSA tuning for age groups 3 -11 (Figure 2.5.5.1) show more negative values in the first eight years than in the last ten years of the 18 years time series. The large residual in year 1996 is probably because of an error in catch at age in the tuning fleet. The WG recommends that the age composition of the tuning fleet be recalculated prior to the next assessment in 2005.

Other XSA calibrations are discussed in the section comment on the assessment.

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 last tree years. This implies that biomass was correspondingly underestimated (Figure 2.5.5.3).

The fishing mortalities for 1961-2003 are presented in Table 2.5.5.3 and in Figure 2.5.5.4. The average fishing mortality for age groups 4-8 was 0.39 in 2003.

2.5.5.2 Stock estimates and recruitment

Recruitment in the 1980s was above or close to average (28 millions). The strongest year class since 1986 was produced in the 1990s and the average for that decade is about 39 million (Figure 2.5.5.5). The 1998 year class is the largest ever (> 102 mill.) and can be seen in the modal length progression in the summer survey from 1999 to 2003 (Figure 2.5.5.8). Even though recruitment had been above average in the 1960s and 1970s, SSB declined from nearly 112 000 t in 1985 to 71 000 t in 1991 as a result of high fishing mortality yielding the highest (1990) and third highest (1996) landings of the whole 1961-2001 period. The historically low SSB persisted in 1992-1995 (Table 2.5.5.5 and Figure 2.5.5.6). The SSB has increased since 1996 with the maturation of the 1992, 1994, 1996 and 1998 year-classes. SSB was estimated to be 94 000 t in 2003, close to the average SSB. The relation between stock and recruitment is showed in Figure 2.5.5.7.

2.5.6 Prediction of catch and biomass

2.5.6.1 Input data

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

Population numbers for the short term prediction up to the 2000 year class are from the final VPA run whereas values for the 2001-2003 year classes are the geometric mean of the 1977 to 2000 year classes. Mean weights for the stock and for the catches are the same for 2004-2006, the arithmetic mean for 2001-2003 (Table 2.5.6.1.A). There was also a projection with management options done based on modelled catch weight at age data. A simple linear model was fitted to the catch weight at age data (age groups 4-8) based on mean weights of the year classes in the previous year and year class strength for the period 1986-2003 (Table 2.5.6.1.B). Catch weight at age for year 2004-2006 was predicted in the same way with the usual input data predicted for year class strength. In the long term prediction (yield per recruit) mean weights for 1961-2003 were used.

In the short term prediction the fitted proportion mature values from the model for 2004 were used for that year. For 2005 and 2006 the average of fitted values for 2002-2004 was used. In the long term prediction the average of fitted values for 1983-2004 was used.

For all three years in the short term prediction the average exploitation pattern in the final VPA for 2001-2003, unscaled to Fbar (ages 4-8) in 2003 in view of a retrospective problem (as suggested by ACFM), was used. In the long term prediction the exploitation pattern was set equal to the average of exploitation patterns for 1999-2003 as suggested from ACFM and not to the average of 1961-2003.

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 2003 average fishing mortality of 0.36 in age groups 4-8, $\mathbf{F}_{max}$ is 0.37, $\mathbf{F}_{0.1}$ is 0.11, $\mathbf{F}_{med}$ is 0.32 and $\mathbf{F}_{high}$ is 0.85 (Table 2.5.6.3, Figure 2.5.6.1 and Figure 2.5.6.2).

Yield and spawning biomass per Recruit F-reference points:

	Fish Mort Ages 4-8	**Yield/R**	**SSB/R**
Average last 3 years	0.466	1.548	3.177
$\mathbf{F}_{max}$	0.441	1.548	3.308
$\mathbf{F}_{0.1}$	0.131	1.347	7.586
$\mathbf{F}_{med}$	0.382	1.546	3.673

In its 2003 report (ICES C.M. 2003/Assess:24), the WG described reasons to review reference points for the three Faroese stocks, particularly for increases in $\mathbf{F}_{pa}$. There remains a need to review the reference points, but more time is necessary to consider the implications of the updated assessment results as well as those evaluate the consequences of the possible influence of productivity and growth on catchability. The WG expects to make proposals for new reference points at its 2005 meeting.

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. Catches at status quo F would be 66 500 t in 2004 and 56 000 t in 2005. The spawning stock biomass would be about 1.6 times higher than $\mathbf{B}_{pa}$ in 2003 and 2004.

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 2004 and weight composition in SSB by year classes in 2005 is presented in Figure 2.5.6.4. The catch in 2004 is predicted to rely on the four most recent year classes (89%). In 2005 the 1998 year class are expected to contribute about 50% of the SSB, and 1999, 1997, 1996 year classes with 42%.

2.5.7 Management considerations

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

2.5.8 Comments on the assessment

The XSA settings are the same as last year but the tuning fleets had to be changed because of the replacement of vessels in the commercial index tuning fleet.

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

The question of migration has been brought up previously. Although tagging data indicates that saithe migrate between management areas, and some indications are seen in the assessment as well, no attempts have been made to quantify the migration rate of saithe.

The 2004 assessment indicates that the point estimator of biomass is lower than in the 2003 assessment (2003 SSB = 150 000t compared with 94 000t) and the fishing mortality is almost the same. The difference in SSB is because of correction on proportion mature data, but also because of the downward revision of the 1998 year class. In the 2003 assessment, the estimates of the 1998 year class from the XSA calibration was adjusted down to the highest previously observed. In 2004 the large 1998 year class has been in the fishery for 3 years and the XSA estimate was used directly and therefore became the 1998 year class the new recruitment maximum.

Additional XSA tuning have been tried and all of them gave very similar estimates of Fbar (4-8) in 2003, SSB in 2004 and recruits (Figure 2.5.8.1, 2.5.8.2, 2.5.8.3). A new tuning fleet of 2 pair trawlers >1000 HP was presented (J&A) and the CPUE had the same trends as the Cuba trawlers. XSA for that fleet showed a little higher SSB and lower Fbar. Another XSA included the two fleets combined (4cuba+J&A). The new pair of trawlers and the Cuba trawlers are in the same fleet and they are mainly fishing saithe, so all the data for the 6 trawlers was tried as one fleet for the period from 1997 to 2003 (C&J&A).

Large residuals in 1996 appear to be due to an error in the catch at age of the tuning fleets. Calibrations with the new vessels (J&A) in the saithe fleet (tuning from 1997 onwards) gave very similar results, suggesting that the error does not effect recent population estimates. The catch at age of the tuning fleet should be verified for the whole length of the available time series. It is expected that the new pair trawlers (J&A) will be added to the tuning fleet in next years assessment in depth review of the assessment.

The assessment is calibrated exclusively with commercial cpue data. The WG recognises that these are high quality data, but the problems associated with the use of commercial cpue data (e.g. increased efficiency due to technological creep etc.) may affect the assessment. In addition, the fleet is small and it can be expected to become even smaller in the future as aging vessels are replaced. Progressive inclusion of the new vessels in the tuning may be possible however.

The Faroe saithe is and update assessment and consequently the tuning of the Cuba trawling fleet was only examined in detail. The exploratory ADAPT run indicate that there is a slight tendency to overestimate F and consequently underestimate SSB in the terminal year (Figure 2.5.8.4). The point estimator of the SSB historical time trajectory from the ADAPT and the XSA deviate only in the final year (Figure 2.5.8.5). Given the data and the model assumptions the bootstrap probability profile (Figure 2.5.8.6) for the SSB and the reference F in 2003 show that the point estimator from the final XSA run does not differ significantly from the ADAPT results. The 10% lower and the 90% pseudoconfidence interval from the bootstrap run show that the SSB in 2003 is between 78 to 111 thousand tonnes and the F between 0.35 to 0.56.

2.5.9 Annex

Stock definition

Saithe are widely distributed around the Faroes, from the shallow inshore waters to depths of 500 m. The main spawning areas are found at 150-250 meters depth east and north of the Faroes. Spawning takes place from January to April, with the main spawning in the second-half of February. The pelagic eggs and larvae drift with the anti-clockwise current around the islands until May/June, when the juveniles, at lengths of 2.5-3.5 cm, migrate inshore. The nursery areas during the first two years of life are in very shallow waters in the littoral zone. Young saithe are also distributed in shallow depths, but at increasing depths with increasing age. Saithe enter the adult stock at the age of 3 or 4 years

(Jákupsstovu 1999). Tagging experiments of saithe has demonstrated migrations between the Faroes, Iceland, Norway, west of Scotland and the North Sea (Jákupsstovu 1999).

Description of the Cuba pair trawlers and Jaspis & Ametyst

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

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

The new tuning fleet called J&A consists of two identical trawlers, "Jaspis" and "Ametyst", built at the same shipyard in the Faroe Islands in 1986. They have been operating as pair-trawlers since the introduction. The vessels have been stationed at the village of "Saltangará", the same place as the Cuba trawlers, since origin, but have been in the property and administrated by various companies, the present being "Snaraløkur" Ltd.

The vessels have since the introduction in 1986 beed fishing groundfish in Faroese waters and the North Sea. In Faroese waters, they have been fishing for cod, haddock and saithe, but have in later years been mainly targeting for saithe. The engine power is 1350 HP. The engines of both boats were overhauled in 2000. Improvements have been carried out when needed (*e.g.* winsh and engines). Both vessels were equipped with new gear and other equipment in 2002 replaced principally by Norwegian equipment. Total length is about 30 m. The mesh size in the trawl is 135 mm. Loading capacity is approximately 2 500 boxes of fish corresponding to *ca*. 125 tons catch per vessel. The catch is stored on ice on board the trawlers and landed as fresh fish.

The data on which the tuning series are based origin from all available log-books from the Cuba trawlers since 1985 and the new tuning series are based origin from all available log-books from the J&A-trawlers since 1996. The data are stored in the database on the Faroese Fisheries Laboratory in Torshavn, and they corrected and quality controlled.

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

References

ICES C.M. 1993/Assess:18.

ICES C.M. 1998/ACFM:19.

ICES C.M. 2003/ACFM:24.

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

Table 2.5.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1990-2003, as officially reported to ICES.

Country	1990	1991	1992	1993	1994	1995	1996
Denmark	2	-	-	-	-	-	-
Faroe Islands	59,821	53,321	35,979	32,719	32,406	26,918	19,297
France [3]	-	-	120	75	19	10	12
German Dem.Rep.	-	-	5	2	1	41	3
German Fed. Rep.	15	32		-	-	-	
Netherlands	67	65	-	32			
Norway	46	103	85	279	156	10	16
UK (Eng. & W.)	-	5	74	425	151	21	53
UK (Scotland)	33	79	98		438	200	580
USSR/Russia [2]	30	-	12	-	-	-	18
Total	60,014	53,605	36,373	33,532	33,171	27,200	19,979
Working Group estimate [4,5]	61,628	54,858	36,487	33,543	33,182	27,209	20,029

Country	1997	1998	1999	2000 [1]	2001 [1]	2002 [1]	2003 [1]
Estonia	16	-	-	-	-	-	-
Faroe Islands	21,721	25,995	32,439				
France	9	17	-	273	934	606	555
Germany	5	-	100	230	667	422	281
Greenland	-	-	-			442	
Irland					5		
Norway	67	53	160	72	80	136	94
Russia	28	-	-	20	1	10	32
UK (E/W/NI)	-	19	67	32	80	58	
UK (Scotland)	460	337	441	534	708	540	
United Kingdom							626
Total	22,306	26,421	33,207	1,161	2,475	2,214	1,588
Working Group estimate [4,5,6]	22,306	26,421	33,207	39,020	51,786	53,546	46,555

[1] Preliminary.

[2] As from 1991.

[3] Quantity unknown 1989-91.

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

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

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

Table 2.5.1.2. Saithe in the Faroes (Division Vb). Total Faroese landings (rightmost column) and the contribution (%) by each fleet category. Averages for 1985-2003 are given at the bottom.

Year	*Open boats*	*Long-liners <100 GRT*	*Single trawl <400 HP*	*Gill-nets*	*Jiggers*	*Single trawl 400-1000 HP*	*Single trawl >1000 HP*	*Pair trawl <1000 HP*	*Pair trawl >1000HP*	*Long-liners >100 GRT*	*Indust-rial trawlers*	*Others*	*Total round weight (tonnes)*
1985	0.2	0.1	0.1	0.0	2.6	6.6	33.7	28.2	28.2	0.1	0.2	0.2	42598
1986	0.3	0.2	0.1	0.1	3.6	2.8	27.3	27.5	36.5	0.1	0.7	0.9	40107
1987	0.7	0.1	0.3	0.4	5.6	4.1	20.4	22.8	44.2	0.1	1.1	0.0	39627
1988	0.4	0.3	0.1	0.3	6.5	6.8	20.8	19.6	43.6	0.1	1.3	0.1	43940
1989	0.9	0.1	0.3	0.2	9.3	5.4	17.7	23.5	41.1	0.1	1.3	0.0	44547
1990	0.6	0.2	0.2	0.2	7.4	3.9	19.6	24.0	42.8	0.2	0.9	0.0	60740
1991	0.6	0.1	0.1	0.6	9.8	1.3	13.9	26.5	46.2	0.1	0.8	0.0	54290
1992	0.4	0.4	0.0	0.0	10.5	0.5	7.1	24.4	55.6	0.1	1.0	0.0	34934
1993	0.6	0.2	0.1	0.0	9.3	0.6	6.5	21.4	60.6	0.1	0.7	0.0	32313
1994	0.4	0.4	0.1	0.0	12.6	1.1	6.8	18.5	59.1	0.2	0.7	0.0	32405
1995	0.2	0.1	0.4	0.0	9.6	0.9	9.9	17.7	60.9	0.3	0.0	0.0	26915
1996	0.0	0.0	0.1	0.0	9.2	1.2	6.8	23.7	58.6	0.2	0.0	0.0	19262
1997	0.0	0.1	0.1	0.0	8.9	2.5	10.7	17.8	58.9	0.4	0.4	0.0	21713
1998	0.1	0.4	0.1	0.0	8.1	2.8	13.8	16.5	57.6	0.3	0.4	0.0	25993
1999	0.0	0.1	0.1	0.0	5.7	1.2	12.6	18.5	60.0	0.2	1.6	0.0	33057
2000	0.1	0.1	0.2	0.0	3.7	0.3	15.0	17.5	62.3	0.1	0.7	0.0	37450
2001	0.1	0.1	0.1	0.0	2.8	0.3	20.2	16.5	58.8	0.2	0.8	0.1	49395
2002	0.1	0.2	0.1	0.0	1.4	0.1	23.9	9.5	54.8	0.1	0.0	0.0	53698
2003	0.0	0.0	1.7	0.0	0.8	0.4	16.0	13.5	59.4	0.1	0.0	0.0	46555
Average	0.3	0.2	0.2	0.1	6.7	2.2	15.9	20.4	52.1	0.2	0.7	0.1	38923

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

Age	*Jiggers*	*ST>1000 Hk*	*PT<1000 Hk*	*PT>1000Hk*	*Others*	*Tot. Faroe*	*Foreign*	*Total*
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	2	51	76	141	10	316	14	330
4	23	194	337	1494	65	2377	55	2432
5	88	1428	1236	6560	241	10747	405	11152
6	31	510	423	2373	85	3849	144	3994
7	30	680	586	2263	81	4094	193	4287
8	2	86	58	197	7	393	24	417
9	3	71	61	212	7	398	21	419
10	1	80	40	124	4	281	23	304
11	0	24	14	35	1	84	7	91
12	0	15	5	11	1	36	4	40
13	0	1	2	0	0	3	0	3
14	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0
Total No.	181	3140	2839	13409	502	22579	891	23470
Catch, t.	344	6909	5817	25620	951	44596	1959	46555

Notes: Numbers in 1000'
Catch, round weight in tonnes
ST- single trawlers and PT- pair trawlers
Others includes longliners, small single trawlers, industrial trawlers and catches not otherwise accounted for

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND
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Table 1 Catch numbers at age Numbers*10**-3

YEAR	1961	1962	1963
AGE			
3	183	562	614
4	379	542	340
5	483	617	340
6	403	495	415
7	216	286	406
8	129	131	202
9	116	129	174
10	82	113	158
11	45	71	94
+gp	82	105	274
TOTALNUM	2118	3051	3017
TONSLAND	9592	10454	12693
SOPCOF %	108	93	96

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	684	996	488	595	614	1191	1445	2857	2714	2515
4	1908	850	1540	796	1689	2086	6577	3316	1774	6253
5	1506	1708	1201	1364	1116	2294	1558	5585	2588	7075
6	617	965	1686	792	1095	1414	1478	1005	2742	3478
7	572	510	806	1192	548	1118	899	828	1529	1634
8	424	407	377	473	655	589	730	469	1305	693
9	179	306	294	217	254	580	316	326	1017	550
10	150	201	205	190	128	239	241	164	743	403
11	100	156	156	97	89	115	86	100	330	215
+gp	174	285	225	140	187	190	132	100	210	186
TOTALNUM	6314	6384	6978	5856	6375	9816	13462	14750	14952	23002
TONSLAND	21893	22181	25563	21319	20387	27437	29110	32706	42663	57431
SOPCOF %	99	92	98	104	102	97	96	109	100	120

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	3504	2062	3178	1609	611	287	996	411	387	2483
4	4126	3361	3217	2937	1743	933	877	1804	4076	1103
5	4011	3801	1720	2034	1736	1341	720	769	994	5052
6	2784	1939	1250	1288	548	1033	673	932	1114	1343
7	1401	1045	877	767	373	584	726	908	380	575
8	640	714	641	708	479	414	284	734	417	339
9	368	302	468	498	466	247	212	343	296	273
10	340	192	223	338	473	473	171	192	105	98
11	197	193	141	272	407	368	196	92	88	98
+gp	265	298	287	330	535	691	786	1021	902	540
TOTALNUM	17636	13907	12002	10781	7371	6371	5641	7206	8759	11904
TONSLAND	47188	41576	33065	34835	28138	27246	25230	30103	30964	39176
SOPCOF %	113	116	107	104	100	102	99	96	96	100

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	368	1224	1167	1581	866	451	294	1030	521	1316
4	11067	3990	1997	5793	2950	5981	3833	5125	4067	2611
5	2359	5583	4473	3827	9555	5300	10120	7452	3667	4689
6	4093	1182	3730	2785	2784	7136	9219	5544	2679	1665
7	875	1898	953	990	1300	793	5070	3487	1373	858
8	273	273	1077	532	621	546	477	1630	894	492
9	161	103	245	333	363	185	123	405	613	448
10	52	38	104	81	159	83	61	238	123	245
11	65	26	67	43	27	55	60	128	63	54
+gp	253	275	158	97	60	39	79	118	108	52
TOTALNUM	19566	14592	13971	16062	18685	20569	29336	25157	14108	12430
TONSLAND	54665	44605	41716	40020	45285	44477	61628	54858	36487	33543
SOPCOF %	100	94	94	96	99	97	98	99	105	102

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
AGE										
3	690	398	297	344	163	322	811	1125	302	330
4	3961	1019	1087	832	1689	655	2830	2452	8399	2432
5	2663	3468	1146	2440	1934	3096	1484	8437	5962	11152
6	2368	1836	1449	1767	3475	2551	4369	2155	9786	3994
7	746	1177	1156	1335	1379	4113	2226	3680	862	4287
8	500	345	521	624	683	915	2725	1539	1280	417
9	307	241	132	165	368	380	348	1334	465	419
10	303	192	77	71	77	147	186	293	362	304
11	150	104	64	29	32	24	56	90	33	91
+gp	49	117	82	100	73	69	25	56	45	43
TOTALNUM	11737	8897	6011	7707	9873	12272	15060	21161	27496	23469
TONSLAND	33182	27209	20029	22306	26421	33207	39020	51786	53546	46555
SOPCOF %	102	102	103	100	102	102	102	100	100	100

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

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Table 2 Catch weights at age (kg)

YEAR / AGE	1961	1962	1963
3	1.4300	1.2730	1.2800
4	2.3020	2.0450	2.1970
5	3.3480	3.2930	3.2120
6	4.2870	4.1910	4.5680
7	5.1280	5.1460	5.0560
8	6.1550	5.6550	5.9320
9	7.0600	6.4690	6.2590
10	7.2650	6.7060	8.0000
11	7.4970	7.1500	7.2650
+gp	9.3399	9.0237	8.8589
SOPCOFAC	1.0779	.9342	.9590

YEAR / AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	1.1750	1.1810	1.3610	1.2730	1.3020	1.1880	1.2440	1.1010	1.0430	1.0880
4	2.0550	2.1250	2.0260	1.7800	1.7370	1.6670	1.4450	1.3160	1.4850	1.4610
5	3.2660	2.9410	3.0550	2.5340	2.0360	2.3020	2.2490	1.8180	2.0550	1.5820
6	4.2550	4.0960	3.6580	3.5720	3.1200	2.8530	2.8530	2.9780	2.8290	2.2490
7	5.0380	4.8780	4.5850	4.3680	4.0490	3.6730	3.5150	3.7020	3.7910	3.6870
8	5.6940	5.9320	5.5200	5.3130	5.1830	5.0020	4.4180	4.2710	4.1750	4.3850
9	6.6620	6.3210	6.8370	5.8120	6.2380	5.7140	5.4440	5.3880	4.8080	5.1280
10	6.8370	7.2880	7.2650	6.5540	7.5200	6.4050	5.7330	5.9720	5.2940	5.2760
11	7.6860	8.0740	7.6620	7.8060	8.0490	6.5540	6.6620	6.4900	6.9480	6.7270
+gp	8.5591	8.9035	9.2233	8.1494	9.0925	8.0870	8.5844	8.0047	7.5146	8.0307
SOPCOFAC	.9933	.9220	.9769	1.0357	1.0194	.9663	.9634	1.0935	1.0043	1.2006

YEAR / AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	1.4300	1.1140	1.0880	1.2230	1.4930	1.2200	1.2300	1.3100	1.3370	1.2080
4	1.5250	1.6580	1.6760	1.6410	2.3240	1.8800	2.1200	2.1300	1.8510	2.0290
5	2.2070	2.2600	2.8780	2.6600	3.0680	2.6200	3.3200	3.0000	2.9510	2.9650
6	2.5000	3.1200	3.0810	3.7900	3.7460	3.4000	4.2800	3.8100	3.5770	4.1430
7	3.1200	3.5570	4.2870	4.2390	4.9130	4.1800	5.1600	4.7500	4.9270	4.7240
8	4.6010	4.0960	4.3520	5.5970	4.3680	4.9500	6.4200	5.2500	6.2430	5.9010
9	5.5590	5.1280	4.7900	5.3500	5.2760	5.6900	6.8700	5.9500	7.2320	6.8110
10	5.7140	6.0940	5.9120	5.9120	5.8320	6.3800	7.0900	6.4300	7.2390	7.0510
11	6.2590	7.1960	6.6190	6.8370	6.0530	7.0200	7.9300	7.0000	8.3460	7.2480
+gp	8.0104	8.5982	7.8941	7.7085	7.5756	8.6262	9.2153	8.9618	10.0411	10.0547
SOPCOFAC	1.1296	1.1607	1.0680	1.0442	1.0049	1.0248	.9937	.9564	.9632	.9997

YEAR / AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	1.4310	1.4010	1.7180	1.6090	1.5000	1.3090	1.2230	1.2400	1.2640	1.4080
4	1.9530	2.0320	1.9860	1.8350	1.9750	1.7350	1.6330	1.5680	1.6020	1.8600
5	2.4700	2.9650	2.6180	2.3950	1.9780	1.9070	1.8300	1.8640	2.0690	2.3230
6	3.8500	3.5960	3.2770	3.1820	2.9370	2.3730	2.0520	2.2110	2.5540	3.1310
7	5.1770	5.3360	4.1860	4.0670	3.7980	3.8100	2.8660	2.6480	3.0570	3.7300
8	6.3470	7.2020	5.5890	5.1490	4.4190	4.6670	4.4740	3.3800	4.0780	4.3940
9	7.8250	6.9660	6.0500	5.5010	5.1150	5.5090	5.4240	4.8160	5.0120	5.2090
10	6.7460	9.8620	6.1500	6.6260	6.7120	5.9720	6.4690	5.5160	6.7680	6.5400
11	8.6360	10.6700	9.5360	6.3430	9.0400	6.9390	6.3430	6.4070	7.7540	8.4030
+gp	10.0976	11.9501	10.2181	10.2439	9.3369	9.9364	8.2869	7.7285	8.2297	8.0501
SOPCOFAC	.9991	.9415	.9419	.9620	.9928	.9698	.9811	.9938	1.0506	1.0169

YEAR / AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	1.5030	1.4560	1.4320	1.4760	1.3880	1.3740	1.4770	1.3300	1.1420	1.1230
4	1.9510	2.1770	1.8750	1.7830	1.7110	1.7120	1.6060	1.5900	1.4600	1.3040
5	2.2670	2.4200	2.4960	2.0320	1.9540	1.9050	2.0770	1.7850	1.6520	1.6140
6	2.9360	2.8950	3.2290	2.7780	2.4050	2.3960	2.3600	2.5860	1.9690	1.9770
7	4.2140	3.6510	3.7440	3.5980	3.3000	2.8450	2.9770	3.0590	3.1300	2.5320
8	4.9710	5.0640	4.9640	4.7660	4.2200	4.1240	3.4800	3.8710	3.5890	3.9700
9	5.6570	5.4400	6.3750	5.9820	4.9990	5.2560	4.8510	4.3740	4.5130	4.8340
10	5.9500	6.1670	6.7450	7.6580	6.3910	5.5260	5.2680	5.5650	5.1380	5.4990
11	6.8910	7.0800	7.4660	7.8820	6.6650	6.9560	6.5230	6.7030	6.4220	6.0990
+gp	9.1086	7.5392	7.9806	9.2453	8.4847	8.5237	5.9024	6.9076	7.5192	6.9154
SOPCOFAC	1.0240	1.0205	1.0319	.9994	1.0221	1.0182	1.0154	1.0017	1.0004	1.0012

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

Run title : FAROE SAITHE (ICES Division Vb)   SAI_IND

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Table 5   Proportion mature at age

AGE	1961	1962	1963
3	.0400	.0400	.0400
4	.2600	.2600	.2600
5	.5700	.5700	.5700
6	.8200	.8200	.8200
7	.9100	.9100	.9100
8	.9800	.9800	.9800
9	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000

AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
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

AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0200
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2300
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.7400
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.9400
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9700
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	1.0000
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

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	.0300	.0300	.0500	.0400	.0400	.0300	.0200	.0200	.0200	.0300
4	.2500	.2500	.2300	.2400	.2600	.2000	.1700	.1500	.1600	.2000
5	.5700	.7500	.6400	.5600	.4900	.4500	.4200	.4000	.4500	.5400
6	.9300	.8900	.8600	.8300	.7800	.6900	.5800	.6200	.6900	.8200
7	.9800	.9900	.9400	.9400	.9100	.9100	.8000	.7300	.8200	.9100
8	1.0000	1.0000	.9900	.9900	.9700	.9800	.9700	.9200	.9600	.9700
9	1.0000	1.0000	1.0000	.9900	.9900	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

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.0300	.0300	.0300	.0300	.0300	.0400	.0400	.0400	.0200	.0200
4	.2200	.2700	.2300	.1900	.1900	.1700	.2100	.1900	.1800	.1100
5	.5200	.5700	.5800	.4700	.4200	.4200	.4400	.4600	.3900	.4100
6	.7800	.7700	.8400	.7400	.6700	.6400	.6500	.6800	.6000	.5800
7	.9500	.9000	.9000	.8900	.8400	.7700	.7800	.8100	.8000	.7400
8	.9900	.9900	.9900	.9800	.9600	.9600	.9200	.9400	.9200	.9500
9	1.0000	.9900	1.0000	1.0000	.9900	.9900	.9900	.9800	.9800	.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 2.5.4.2. Saithe in the Faroes (Division Vb). Summary of model output on proportion mature at age.

```
> summary(glmfit)

Call:
glm(formula = pm ~ age + yrclass + mw, family = binomial(link = logit),
    data = Maturity.Saithe.from1983, maxit = 30)

Deviance Residuals:
      Min         1Q      Median         3Q        Max
-7.145e-01  -7.168e-02   1.792e-05   1.154e-01   5.895e-01

Coefficients:
              Estimate   Std. Error  z value  Pr(>|z|)
(Intercept) -5.509e+00  1.811e+00  -3.043  0.00235 **
age4         1.599e+00  1.401e+00   1.142  0.25359
age5         2.493e+00  1.424e+00   1.751  0.07995 .
age6         2.796e+00  1.576e+00   1.774  0.07605 .
age7         2.708e+00  1.854e+00   1.461  0.14406
age8         2.861e+00  2.423e+00   1.181  0.23764
age9         3.452e+00  3.652e+00   0.945  0.34455
age10        1.997e+01  9.812e+03   0.002  0.99838
age11        1.875e+01  9.703e+03   0.002  0.99846
age12        1.869e+01  8.525e+03   0.002  0.99825
yrclass      4.472e-06  1.407e-05   0.318  0.75050
mw           1.322e+00  6.735e-01   1.964  0.04957 *
---
Signif. codes:  0 `***' 0.001 `**' 0.01 `*' 0.05 `.' 0.1 ` ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 162.2398  on 219  degrees of freedom
Residual deviance:   9.6488  on 208  degrees of freedom
AIC: 92.899

Number of Fisher Scoring iterations: 21
```

Table 2.5.5.1. Saithe in the Faroes (Division Vb). Effort (hours) and catch in number at age for 4 commercial Cuba Logbook pair trawlers.

```
Faroe Saithe (ICES Div. Vb)     4cubaskip3-11.dat
101
Cuba Logbook series 4 skip
1985 2003
1 1 0 1
3 11
3145    31  174  402   84  104   14   5     1   2
3203    59  112  311  223   62   65  16     6   3
4766    89  350  296  235   88   46  24     5   4
3810    38  158  504  177   72   30  20     5   1
3476    34  387  329  416   48   28   9     5   3
4571    15  162  490  474  261   24   7     3   3
4948    23  193  337  272  171   84  10    10   7
3210     5  113  119  100   50   29  25     5   3
3870    45  177  287  103   55   33  24    14   3
4756    58  428  264  247   79   56  36    33  16
4786    47  180  577  236  146   49  24    19  14
3096    20   30  106  110  134  103  50    13   7
4529    53  104  273  200  154   70  16     8   3
4838    12  156  187  325  138   68  38     7   2
6758    37   89  429  390  635  154  67    22   4
5407    82  298  178  536  274  338  41    23   7
6034   137  321 1103  260  414  167 138    28   7
5201    23  677  675 1173   89  116  42    30   4
4689    25  260 1143  413  394   34  37    22   6
```

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

```
Lowestoft VPA Version 3.1

   30/04/2004   9:23

 Extended Survivors Analysis

 FAROE SAITHE (ICES Division Vb)                 SAI_IND

 CPUE data from file D:\Stovnsmeting\Ices2004\Xsa\4cubaskip3-11.DAT

 Catch data for  43 years. 1961 to 2003. Ages  3 to  12.

      Fleet            First Last First Last Alpha  Beta
                        year year  age   age
 Cuba Logbook series    1985 2003   3    11   .000  1.000

 Time series weights :

      Tapered time weighting applied
      Power =    3 over  20 years

 Catchability analysis :

      Catchability dependent on stock size for ages <    5

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

      Catchability independent of age for ages >=    9

 Terminal population estimation :

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

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

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

      Prior weighting not applied

 Tuning converged after   15 iterations

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

Fishing mortalities

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	.047	.011	.014	.012	.014	.006	.023	.012	.010	.013
4	.274	.090	.039	.049	.073	.074	.063	.091	.118	.104
5	.333	.411	.139	.116	.154	.187	.240	.269	.331	.228
6	.606	.405	.301	.330	.241	.313	.438	.655	.576	.387
7	.613	.706	.484	.502	.466	.500	.497	.832	.601	.539
8	.661	.649	.808	.528	.524	.656	.745	.783	.801	.668
9	.497	.801	.557	.656	.695	.631	.563	1.084	.577	.676
10	.725	.678	.652	.672	.751	.673	.746	1.506	1.045	.978
11	.643	.591	.502	.550	.750	.555	.592	1.063	.659	.836

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1994	1.67E+04	1.83E+04	1.04E+04	5.76E+03	1.80E+03	1.14E+03	8.66E+02	6.50E+02	3.49E+02
1995	3.86E+04	1.30E+04	1.14E+04	6.10E+03	2.57E+03	7.99E+02	4.83E+02	4.31E+02	2.58E+02
1996	2.38E+04	3.13E+04	9.75E+03	6.17E+03	3.33E+03	1.04E+03	3.42E+02	1.78E+02	1.79E+02
1997	3.26E+04	1.92E+04	2.46E+04	6.95E+03	3.74E+03	1.68E+03	3.79E+02	1.60E+02	7.57E+01
1998	1.25E+04	2.64E+04	1.50E+04	1.79E+04	4.09E+03	1.85E+03	8.12E+02	1.61E+02	6.70E+01
1999	6.31E+04	1.01E+04	2.01E+04	1.05E+04	1.15E+04	2.10E+03	8.98E+02	3.32E+02	6.23E+01
2000	3.91E+04	5.14E+04	7.69E+03	1.36E+04	6.29E+03	5.73E+03	8.93E+02	3.91E+02	1.39E+02
2001	1.03E+05	3.13E+04	3.95E+04	4.96E+03	7.20E+03	3.13E+03	2.23E+03	4.16E+02	1.52E+02
2002	3.37E+04	8.32E+04	2.34E+04	2.47E+04	2.11E+03	2.57E+03	1.17E+03	6.17E+02	7.55E+01
2003	2.78E+04	2.73E+04	6.05E+04	1.38E+04	1.14E+04	9.46E+02	9.42E+02	5.39E+02	1.78E+02

Table 2.5.5.2. (Continued)

```
Estimated population abundance at 1st Jan 2004

        0.00E+00 2.24E+04 2.02E+04 3.95E+04 7.65E+03 5.43E+03 3.97E+02 3.93E+02 1.66E+02

 Taper weighted geometric mean of the VPA populations:

        3.15E+04 2.53E+04 1.78E+04 9.38E+03 4.45E+03 1.85E+03 8.35E+02 3.52E+02 1.29E+02

 Standard error of the weighted Log(VPA populations) :

           .5627    .5820    .6253    .5718    .6329    .5653    .5237    .5092    .5356

Log catchability residuals.

 Fleet : Cuba Logbook series

  Age    1985  1986  1987  1988  1989  1990  1991  1992  1993
     3    .79   .54   .81   .07   .49  -.61  -.32 -1.52   .93
     4    .77   .21   .26  -.38  1.26  -.03   .59   .17   .75
     5    .75   .60   .25  -.10  -.29   .20   .24   .10   .46
     6   -.25   .46   .13   .18  -.10  -.04  -.04  -.10   .06
     7   -.13  -.23  -.25  -.27  -.53  -.24  -.37  -.57  -.29
     8   -.63   .13  -.39  -.48  -.47 -1.01  -.62  -.98  -.60
     9   -.91   .33  -.32  -.18  -.83 -1.50 -1.14  -.54  -.64
    10  -1.90  -.06  -.17  -.82  -.70 -1.69  -.48  -.46  -.57
    11   -.44  -.14   .00  -.55  -.43  -.86  -.18  -.21  -.32

  Age    1994  1995  1996  1997  1998  1999  2000  2001  2002  2003
     3   1.33   .19   .13   .59  -.48 -1.07   .75   .30  -.72  -.28
     4   1.66   .55 -2.41  -.61  -.40  -.79  -.27   .20   .59   .40
     5    .24   .96  -.27  -.64  -.57  -.35  -.03   .07   .27  -.09
     6    .37   .18  -.21  -.10  -.67  -.25   .08   .36   .37  -.07
     7    .17   .46   .45   .11  -.18  -.01  -.02   .29   .03  -.09
     8    .17   .38  1.37   .00  -.19   .22   .26   .07   .06  -.12
     9   -.04   .26  1.67   .09   .14   .25  -.04   .36  -.25  -.01
    10    .26   .09  1.02   .26   .09   .15   .28   .61   .25   .16
    11    .12   .26   .33  -.02  -.28   .07   .07   .06   .18  -.09

 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  -12.1230  -11.6133  -11.3820  -11.2532  -11.2763  -11.2763  -11.2763
 S.E(Log q)     .4276     .2976     .2925     .5590     .6696     .5613     .2675

Regression statistics :

 Ages with q dependent on year class strength

 Age Slope  t-value  Intercept RSquare No Pts Reg s.e Mean Log q

  3    1.30    -.699     16.63     .35     19     .80  -15.18
  4    1.51    -.978     14.76     .27     19    1.01  -13.20

 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    1.17    -.698     12.53     .62     19     .51  -12.12
  6    1.14    -.789     11.97     .75     19     .35  -11.61
  7    1.06    -.398     11.56     .81     19     .32  -11.38
  8    1.26    -.680     12.23     .40     19     .72  -11.25
  9    1.81   -1.185     14.96     .18     19    1.19  -11.28
 10    1.25    -.601     12.55     .36     19     .72  -11.19
 11     .92     .603     10.77     .83     19     .25  -11.31

 Terminal year survivor and F summaries :

 Age  3   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet                    Estimated    Int       Ext    Var    N Scaled  Estimated
                          Survivors    s.e       s.e   Ratio     Weights    F
 Cuba Logbook series         17022.   .843       .000    .00   1  .166     .017

   P shrinkage mean       25257.    .58                          .354     .012
   F shrinkage mean       22626.    .50                          .480     .013
```

Table 2.5.5.2. (Continued)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
22437.	.35	.22	3	.627	.013

Age 4 Catchability dependent on age and year class strength

Year class = 1999

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook series	15403.	.663	.548	.83	2	.237	.134
P shrinkage mean	17805.	.63				.298	.117
F shrinkage mean	25072.	.50				.465	.084

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
20174.	.34	.25	4	.743	.104

Age 5 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
Cuba Logbook series	40843.	.379	.163	.43	3	.574	.221
F shrinkage mean	37654.	.50				.426	.237

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
39451.	.30	.11	4	.346	.228

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

Year class = 1997

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook series	8181.	.241	.126	.52	4	.724	.366
F shrinkage mean	6399.	.50				.276	.448

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7646.	.22	.11	5	.508	.387

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

Year class = 1996

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook series	5625.	.199	.139	.70	5	.742	.524
F shrinkage mean	4888.	.50				.258	.584

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5425.	.20	.11	6	.571	.539

Age 8 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 series	416.	.204	.091	.45	6	.631	.645
F shrinkage mean	366.	.50				.369	.709

Table 2.5.5.2. (Continued)

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
397.	.22	.07	7	.326	.668

Age 9 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 series	428.	.242	.076	.31	7	.488	.635
F shrinkage mean	362.	.50				.512	.717

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
393.	.28	.07	8	.237	.676

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

Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook series	158.	.247	.081	.33	8	.439	1.007
F shrinkage mean	172.	.50				.561	.955

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
166.	.30	.06	9	.183	.978

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

Year class = 1992

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Cuba Logbook series	59.	.255	.060	.24	9	.591	.874
F shrinkage mean	69.	.50				.409	.782

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
63.	.25	.06	10	.221	.836

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 30/04/2004 9:24

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963
AGE			
3	.0226	.0465	.0307
4	.0556	.0863	.0358
5	.0994	.1208	.0716
6	.1219	.1402	.1115
7	.0933	.1192	.1634
8	.0852	.0752	.1157
9	.0972	.1150	.1355
10	.0916	.1295	.2012
11	.0916	.1069	.1514
+gp	.0916	.1069	.1514
FBAR 4- 8	.0911	.1083	.0996

YEAR	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
AGE										
3	.0478	.0495	.0250	.0248	.0321	.0328	.0479	.0885	.0935	.1272
4	.1260	.0773	.1007	.0518	.0910	.1452	.2548	.1481	.0728	.3228
5	.2198	.1588	.1492	.1217	.0955	.1720	.1539	.3581	.1650	.4585
6	.1798	.2137	.2326	.1388	.1358	.1684	.1598	.1405	.2987	.3489
7	.2213	.2217	.2785	.2564	.1345	.2001	.1537	.1262	.3288	.2922
8	.2567	.2424	.2537	.2616	.2184	.2095	.1944	.1119	.2997	.2427
9	.1424	.2983	.2771	.2269	.2183	.3064	.1657	.1244	.3762	.1983
10	.1658	.2356	.3347	.2904	.2027	.3290	.2009	.1213	.4603	.2498
11	.1891	.2601	.2901	.2610	.2141	.2832	.1878	.1196	.3812	.2314
+gp	.1891	.2601	.2901	.2610	.2141	.2832	.1878	.1196	.3812	.2314
FBAR 4- 8	.2007	.1828	.2029	.1661	.1350	.1790	.1833	.1769	.2330	.3330

YEAR	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
AGE										
3	.2295	.1507	.2058	.1481	.0840	.0377	.0930	.0138	.0296	.0697
4	.3171	.3598	.3710	.2983	.2373	.1785	.1546	.2430	.1846	.1104
5	.3546	.5445	.3157	.4261	.2889	.2899	.2036	.1973	.2047	.3666
6	.3279	.2894	.3435	.4148	.1921	.2789	.2308	.4416	.4877	.4698
7	.2299	.1959	.2051	.3669	.2007	.3226	.3232	.5585	.3236	.5047
8	.1772	.1754	.1769	.2541	.4127	.3585	.2564	.6370	.5440	.5385
9	.1962	.1185	.1667	.2029	.2648	.3883	.3143	.5640	.5776	.8627
10	.1811	.1487	.1204	.1743	.3024	.4713	.5128	.5250	.3331	.3800
11	.1856	.1481	.1553	.2114	.3286	.4088	.3635	.5802	.4886	.5989
+gp	.1856	.1481	.1553	.2114	.3286	.4088	.3635	.5802	.4886	.5989
FBAR 4- 8	.2813	.3130	.2824	.3520	.2663	.2857	.2337	.4155	.3489	.3980

YEAR	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
AGE										
3	.0159	.0635	.0211	.0366	.0217	.0176	.0159	.0469	.0298	.0632
4	.4989	.2382	.1399	.1387	.0889	.2045	.2037	.4161	.2634	.2049
5	.3637	.5085	.4593	.4330	.3562	.2281	.6329	.7691	.5997	.5522
6	.5766	.3126	.7784	.5858	.6568	.4948	.7860	.8938	.7100	.6081
7	.6485	.5830	.4484	.4811	.6053	.3901	.8110	.8027	.5743	.5184
8	.4792	.4274	.7952	.4874	.6413	.5563	.4317	.6752	.4872	.4149
9	.5342	.3331	.8782	.6140	.7413	.3961	.2292	.8206	.5851	.4849
10	.3836	.2276	.6683	.8394	.6821	.3664	.2179	.9381	.6383	.4913
11	.4692	.3363	.7994	.6544	.7665	.5331	.4956	.9777	.6988	.6521
+gp	.4692	.3363	.7994	.6544	.7665	.5331	.4956	.9777	.6988	.6521
FBAR 4- 8	.5134	.4139	.5243	.4252	.4697	.3748	.5731	.7114	.5269	.4597

YEAR	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	FBAR **-**
AGE											
3	.0468	.0115	.0139	.0117	.0145	.0057	.0232	.0122	.0099	.0132	.0118
4	.2742	.0903	.0392	.0491	.0734	.0742	.0628	.0906	.1183	.1035	.1042
5	.3330	.4114	.1391	.1160	.1542	.1870	.2398	.2694	.3309	.2278	.2760
6	.6064	.4046	.3008	.3299	.2408	.3128	.4376	.6550	.5762	.3871	.5394
7	.6126	.7056	.4838	.5023	.4661	.5003	.4966	.8319	.6014	.5394	.6576
8	.6607	.6489	.8079	.5280	.5238	.6561	.7451	.7832	.8015	.6681	.7509
9	.4974	.8010	.5567	.6556	.6950	.6308	.5635	1.0840	.5773	.6759	.7791
10	.7247	.6779	.6522	.6722	.7508	.6729	.7456	1.5062	1.0454	.9776	1.1764
11	.6434	.5907	.5022	.5501	.7500	.5549	.5917	1.0632	.6593	.8355	.8527
+gp	.6434	.5907	.5022	.5501	.7500	.5549	.5917	1.0632	.6593	.8355	
FBAR 4- 8	.4974	.4522	.3541	.3051	.2917	.3461	.3964	.5260	.4857	.3852	

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 30/04/2004 9:24

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
3	9046	13662	22428
4	7739	7241	10677
5	5643	5993	5438
6	3881	4183	4348
7	2680	2812	2977
8	1746	1999	2044
9	1384	1313	1518
10	1036	1028	958
11	568	774	740
+gp	1032	1141	2147
TOTAL	34754	40146	53275

YEAR / AGE	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973
3	16189	22799	21824	26870	21507	40786	34121	37269	33592	23275
4	17807	12635	17765	17427	21461	17053	32315	26629	27928	25047
5	8434	12853	9576	13151	13547	16043	12074	20506	18801	21261
6	4145	5543	8978	6753	9533	10082	11059	8476	11735	13051
7	3185	2835	3665	5825	4813	6814	6975	7717	6030	7127
8	2070	2090	1860	2271	3690	3444	4567	4897	5569	3554
9	1491	1311	1343	1181	1431	2429	2287	3079	3585	3379
10	1085	1058	797	833	771	942	1464	1587	2226	2015
11	641	753	685	467	510	515	555	980	1151	1150
+gp	1111	1367	981	670	1067	846	848	977	726	990
TOTAL	56157	63244	67472	75448	78331	98954	106266	112116	111344	100848

YEAR / AGE	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
3	18885	16288	18885	12916	8379	8581	12390	33095	14673	40775
4	16780	12291	11469	12586	9119	6307	6766	9242	26724	11663
5	14849	10005	7022	6480	7647	5889	4320	4746	5935	18191
6	11005	8528	4752	4193	3465	4690	3608	2885	3190	3960
7	7539	6491	5228	2760	2267	2341	2905	2345	1519	1603
8	4357	4904	4369	3487	1566	1519	1388	1722	1098	900
9	2282	2988	3369	2997	2214	848	869	879	746	522
10	2268	1536	2173	2335	2003	1391	471	520	410	343
11	1285	1550	1084	1577	1606	1212	711	231	252	240
+gp	1720	2383	2196	1904	2096	2257	2829	2535	2554	1309
TOTAL	80971	66963	60548	51235	40362	35035	36256	58200	57099	79507

YEAR / AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
3	25817	22002	61678	48573	44609	28571	20648	24847	19601	23753
4	31137	20804	16906	49442	38337	35739	22984	16639	19411	15577
5	8551	15479	13423	12035	35238	28719	23849	15349	8985	12212
6	10323	4866	7621	6942	6390	20204	18717	10369	5824	4039
7	2027	4748	2915	2865	3164	2713	10085	6983	3473	2344
8	793	868	2170	1524	1450	1414	1504	3669	2562	1601
9	430	402	463	802	766	625	664	799	1529	1289
10	180	206	236	158	355	299	344	432	288	697
11	192	101	135	99	56	147	170	227	138	125
+gp	740	1057	313	220	122	103	221	205	234	118
TOTAL	80189	70533	105859	122660	130488	118535	99185	79520	62047	61755

YEAR / AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 61-**	AMST 61-**
3	16691	38627	23766	32588	12542	63084	39094	102853	33713	27769	0	24226	28234
4	18256	13041	31265	19189	26370	10121	51357	31274	83191	27329	22437	17740	20305
5	10391	11363	9755	24614	14958	20062	7693	39487	23386	60511	20174	11777	13672
6	5756	6098	6165	6950	17945	10497	13624	4956	24695	13752	39451	6830	7788
7	1800	2570	3331	3737	4091	11548	6286	7201	2108	11364	7646	3848	4398
8	1143	799	1039	1681	1851	2102	5733	3132	2566	946	5425	2098	2443
9	866	483	342	379	812	898	893	2228	1172	942	397	1144	1417
10	650	431	178	160	161	332	391	416	617	539	393	620	858
11	349	258	179	76	67	62	139	152	76	178	166	343	534
+gp	113	287	227	258	151	177	61	93	102	83	92		
TOTAL	56014	73956	76247	89633	78947	118881	125271	191792	171625	143413	96181		

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 30/04/2004 9:24

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	121964	83792	9592	.1145	.0911
1962	13662	126454	85629	10454	.1221	.1083
1963	22428	158226	100624	12693	.1261	.0996
1964	16189	160414	98375	21893	.2225	.2007
1965	22799	174754	107203	22181	.2069	.1828
1966	21824	184119	108763	25563	.2350	.2029
1967	26870	181609	104614	21319	.2038	.1661
1968	21507	189751	115933	20387	.1759	.1350
1969	40786	214963	123757	27437	.2217	.1790
1970	34121	224363	129094	29110	.2255	.1833
1971	37269	228326	139438	32706	.2346	.1769
1972	33592	236929	147492	42663	.2893	.2330
1973	23275	210404	136591	57431	.4205	.3330
1974	18885	203919	137496	47188	.3432	.2813
1975	16288	187238	137747	41576	.3018	.3130
1976	18885	169541	121868	33065	.2713	.2824
1977	12916	156088	113924	34835	.3058	.3520
1978	8379	137083	95827	28138	.2936	.2663
1979	8581	112680	83319	27246	.3270	.2857
1980	12390	124283	88566	25230	.2849	.2337
1981	33095	141353	75881	30103	.3967	.4155
1982	14673	148450	82618	30964	.3748	.3489
1983	40775	177025	95297	39176	.4111	.3980
1984	25817	187846	94328	54665	.5795	.5134
1985	22002	186611	111353	44605	.4006	.4139
1986	61678	232714	89195	41716	.4677	.5243
1987	48573	247634	86396	40020	.4632	.4252
1988	44609	257472	96215	45285	.4707	.4697
1989	28571	226330	94400	44477	.4712	.3748
1990	20648	189205	85843	61628	.7179	.5731
1991	24847	148603	64332	54858	.8527	.7114
1992	19601	123018	55375	36487	.6589	.5269
1993	23753	132484	60474	33543	.5547	.4597
1994	16691	126622	59046	33182	.5620	.4974
1995	38627	152481	60313	27209	.4511	.4522
1996	23766	161067	68206	20029	.2937	.3541
1997	32588	179576	72038	22306	.3096	.3051
1998	12542	163039	75900	26421	.3481	.2917
1999	63084	217386	80624	33207	.4119	.3461
2000	39094	234672	88123	39020	.4428	.3964
2001	102853	317692	98821	51786	.5240	.5260
2002	33713	272732	90227	53546	.5935	.4857
2003	27769	233376	94342	46555	.4935	.3852
Arith. Mean	28350	185128	96265	34453	.3762	.3372
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.5.6.1. Saithe in the Faroes (Division Vb). Predictions with management table. **A)** input data based on the 3 years average on catch weight at age **B)** input data based on modelled catch weight at age.

A)
MFDP version 1a
Run: man2
Time and date: 15:16 01/05/2004
Fbar age range: 4-8

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4	22437	0.2	0.13	0	0	1.451	0.104	1.451
5	20174	0.2	0.35	0	0	1.684	0.276	1.684
6	39451	0.2	0.65	0	0	2.177	0.539	2.177
7	7646	0.2	0.77	0	0	2.907	0.658	2.907
8	5425	0.2	0.94	0	0	3.810	0.751	3.810
9	397	0.2	0.98	0	0	4.574	0.779	4.574
10	393	0.2	1.00	0	0	5.401	1.176	5.401
11	166	0.2	1.00	0	0	6.408	0.853	6.408
12	92	0.2	1.00	0	0	7.114	0.853	7.114

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4.		0.2	0.14	0	0	1.451	0.104	1.451
5.		0.2	0.36	0	0	1.684	0.276	1.684
6.		0.2	0.57	0	0	2.177	0.539	2.177
7.		0.2	0.76	0	0	2.907	0.658	2.907
8.		0.2	0.92	0	0	3.810	0.751	3.810
9.		0.2	0.98	0	0	4.574	0.779	4.574
10.		0.2	1.00	0	0	5.401	1.176	5.401
11.		0.2	1.00	0	0	6.408	0.853	6.408
12.		0.2	1.00	0	0	7.114	0.853	7.114

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4.		0.2	0.14	0	0	1.451	0.104	1.451
5.		0.2	0.36	0	0	1.684	0.276	1.684
6.		0.2	0.57	0	0	2.177	0.539	2.177
7.		0.2	0.76	0	0	2.907	0.658	2.907
8.		0.2	0.92	0	0	3.810	0.751	3.810
9.		0.2	0.98	0	0	4.574	0.779	4.574
10.		0.2	1.00	0	0	5.401	1.176	5.401
11.		0.2	1.00	0	0	6.408	0.853	6.408
12.		0.2	1.00	0	0	7.114	0.853	7.114

Input units are thousands and kg - output in tonnes

Table 2.5.6.1. Continued

B)

MFDP version 1a

Run: man1_b

Time and date: 15:28 01/05/2004

Fbar age range: 4-8

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4	22437	0.2	0.13	0	0	1.415	0.104	1.415
5	20174	0.2	0.35	0	0	1.632	0.276	1.632
6	39451	0.2	0.65	0	0	2.003	0.539	2.003
7	7646	0.2	0.77	0	0	2.437	0.658	2.437
8	5425	0.2	0.94	0	0	3.100	0.751	3.100
9	397	0.2	0.98	0	0	4.574	0.779	4.574
10	393	0.2	1.00	0	0	5.401	1.176	5.401
11	166	0.2	1.00	0	0	6.408	0.853	6.408
12	92	0.2	1.00	0	0	7.114	0.853	7.114

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4.		0.2	0.14	0	0	1.546	0.104	1.546
5.		0.2	0.36	0	0	1.808	0.276	1.808
6.		0.2	0.57	0	0	2.037	0.539	2.037
7.		0.2	0.76	0	0	2.182	0.658	2.187
8.		0.2	0.92	0	0	2.959	0.751	2.959
9.		0.2	0.98	0	0	4.574	0.779	4.574
10.		0.2	1.00	0	0	5.401	1.176	5.401
11.		0.2	1.00	0	0	6.408	0.853	6.408
12.		0.2	1.00	0	0	7.114	0.853	7.114

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
3	29502	0.2	0.02	0	0	1.198	0.012	1.198
4.		0.2	0.14	0	0	1.546	0.104	1.546
5.		0.2	0.36	0	0	1.955	0.276	1.955
6.		0.2	0.57	0	0	2.269	0.539	2.269
7.		0.2	0.76	0	0	2.513	0.658	2.513
8.		0.2	0.92	0	0	2.393	0.751	2.393
9.		0.2	0.98	0	0	4.574	0.779	4.574
10.		0.2	1.00	0	0	5.401	1.176	5.401
11.		0.2	1.00	0	0	6.408	0.853	6.408
12.		0.2	1.00	0	0	7.114	0.853	7.114

Input units are thousands and kg - output in tonnes

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

MFYPR version 2a
Run: yr2
Index file 3/5/2003
Time and date: 17:48 05/05/2004
Fbar age range: 3-8

Age	M	Mat	PF	PM	SWt	Sel	CWt
3	0.2	0.029	0	0	1.312	0.013	1.312
4	0.2	0.198	0	0	1.810	0.090	1.810
5	0.2	0.494	0	0	2.424	0.251	2.424
6	0.2	0.728	0	0	3.155	0.474	3.155
7	0.2	0.861	0	0	4.005	0.594	4.005
8	0.2	0.960	0	0	4.933	0.731	4.933
9	0.2	0.993	0	0	5.733	0.706	5.733
10	0.2	1.000	0	0	6.443	0.990	6.443
11	0.2	1.000	0	0	7.299	0.741	7.299
12	0.2	1.000	0	0	8.611	0.741	8.611

Weights in kilograms

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

MFYPR version 2a
Run: yr2
Time and date: 17:48 05/05/2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.4049	3.3212	18.3137	3.3212	18.3137
0.1000	0.0359	0.1550	0.8036	4.7450	16.6429	2.5664	12.6101	2.5664	12.6101
0.2000	0.0717	0.2455	1.1620	4.2954	13.5209	2.1328	9.5425	2.1328	9.5425
0.3000	0.1076	0.3058	1.3400	3.9972	11.5958	1.8496	7.6682	1.8496	7.6682
0.4000	0.1435	0.3493	1.4344	3.7820	10.3013	1.6487	6.4212	1.6487	6.4212
0.5000	0.1793	0.3827	1.4866	3.6175	9.3739	1.4977	5.5385	1.4977	5.5385
0.6000	0.2152	0.4094	1.5161	3.4863	8.6767	1.3794	4.8833	1.3794	4.8833
0.7000	0.2511	0.4314	1.5327	3.3782	8.1323	1.2836	4.3784	1.2836	4.3784
0.8000	0.2870	0.4501	1.5417	3.2870	7.6940	1.2041	3.9775	1.2041	3.9775
0.9000	0.3228	0.4662	1.5462	3.2085	7.3324	1.1368	3.6513	1.1368	3.6513
1.0000	0.3587	0.4802	1.5477	3.1399	7.0280	1.0790	3.3805	1.0790	3.3805
1.1000	0.3946	0.4927	1.5475	3.0792	6.7674	1.0285	3.1519	1.0285	3.1519
1.2000	0.4304	0.5039	1.5460	3.0248	6.5412	0.9841	2.9561	0.9841	2.9561
1.3000	0.4663	0.5140	1.5438	2.9758	6.3426	0.9445	2.7864	0.9445	2.7864
1.4000	0.5022	0.5232	1.5411	2.9311	6.1664	0.9091	2.6378	0.9091	2.6378
1.5000	0.5380	0.5317	1.5381	2.8903	6.0087	0.8770	2.5066	0.8770	2.5066
1.6000	0.5739	0.5395	1.5349	2.8526	5.8664	0.8479	2.3897	0.8479	2.3897
1.7000	0.6098	0.5467	1.5316	2.8177	5.7373	0.8213	2.2849	0.8213	2.2849
1.8000	0.6456	0.5535	1.5283	2.7853	5.6194	0.7968	2.1903	0.7968	2.1903
1.9000	0.6815	0.5598	1.5251	2.7550	5.5112	0.7743	2.1045	0.7743	2.1045
2.0000	0.7174	0.5657	1.5218	2.7266	5.4114	0.7534	2.0263	0.7534	2.0263

Reference point	F multiplier	Absolute F
Fbar(3-8)	1.0000	0.3587
FMax	1.0299	0.3694
F0.1	0.3055	0.1096
F35%SPR	0.4011	0.1439
Flow	0.2213	0.0794
Fmed	0.8928	0.3203
Fhigh	2.375	0.8519

Weights in kilograms

Table 2.5.6.4. Saithe in the Faroes (Division Vb). Prediction with management table. **A)** input data based on the 3 years average on catch weight at age **B)** input data based on modelled catch weight at age.

A)

MFDP version 1a
Run: man2
Index file 1/5/2004
Time and date: 15:16 01/05/2004
Fbar age range: 4-8

2004				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
236334	114972	1.0000	0.4656	66501

2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
203932	95718	0.0000	0.0000	0	244699	134501
.	95718	0.1000	0.0466	7152	236458	127534
.	95718	0.2000	0.0931	13901	228696	120994
.	95718	0.3000	0.1397	20274	221381	114855
.	95718	0.4000	0.1862	26293	214486	109090
.	95718	0.5000	0.2328	31981	207984	103674
.	95718	0.6000	0.2794	37358	201852	98587
.	95718	0.7000	0.3259	42443	196064	93805
.	95718	0.8000	0.3725	47254	190601	89311
.	95718	0.9000	0.4191	51809	185442	85084
.	95718	1.0000	0.4656	56121	180568	81110
.	95718	1.1000	0.5122	60208	175961	77370
.	95718	1.2000	0.5587	64081	171606	73851
.	95718	1.3000	0.6053	67754	167486	70539
.	95718	1.4000	0.6519	71239	163587	67420
.	95718	1.5000	0.6984	74547	159897	64482
.	95718	1.6000	0.7450	77688	156401	61714
.	95718	1.7000	0.7916	80674	153089	59106
.	95718	1.8000	0.8381	83512	149949	56647
.	95718	1.9000	0.8847	86211	146971	54328
.	95718	2.0000	0.9312	88780	144145	52140

Input units are thousands and kg - output in tonnes

Table 2.5.6.4. Continued

B)
MFDP version 1a
Run: man1_b
Index file 1/5/2004
Time and date: 15:28 01/05/2004
Fbar age range: 4-8

2004 Biomass	SSB	FMult	FBar	Landings
220153	103645	1.0000	0.4656	60124

2005 Biomass	SSB	FMult	FBar	Landings	2006 Biomass	SSB
190077	82898	0.0000	0.0000	0	227639	114190
.	82898	0.1000	0.0466	6176	220909	108630
.	82898	0.2000	0.0931	12013	214560	103408
.	82898	0.3000	0.1397	17533	208567	98502
.	82898	0.4000	0.1862	22755	202907	93892
.	82898	0.5000	0.2328	27697	197560	89558
.	82898	0.6000	0.2794	32377	192505	85482
.	82898	0.7000	0.3259	36811	187726	81648
.	82898	0.8000	0.3725	41014	183204	78040
.	82898	0.9000	0.4191	45000	178924	74644
.	82898	1.0000	0.4656	48781	174871	71446
.	82898	1.1000	0.5122	52371	171031	68434
.	82898	1.2000	0.5587	55781	167391	65595
.	82898	1.3000	0.6053	59020	163938	62919
.	82898	1.4000	0.6519	62101	160662	60395
.	82898	1.5000	0.6984	65031	157552	58014
.	82898	1.6000	0.7450	67820	154598	55768
.	82898	1.7000	0.7916	70476	151790	53646
.	82898	1.8000	0.8381	73006	149120	51643
.	82898	1.9000	0.8847	75418	146579	49750
.	82898	2.0000	0.9312	77719	144161	47960

Input units are thousands and kg - output in tonnes

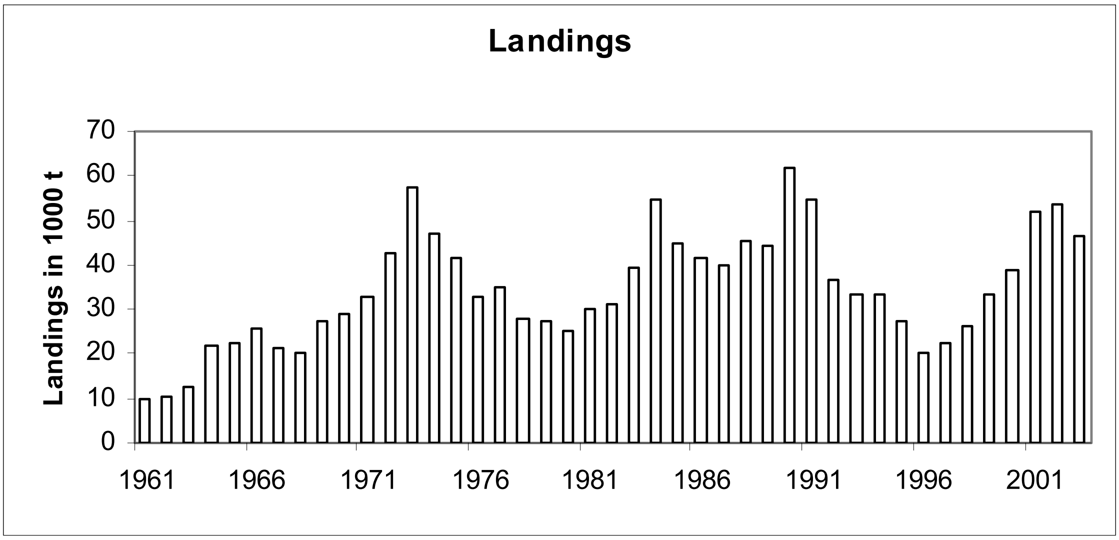


Figure 2.5.1.1. Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

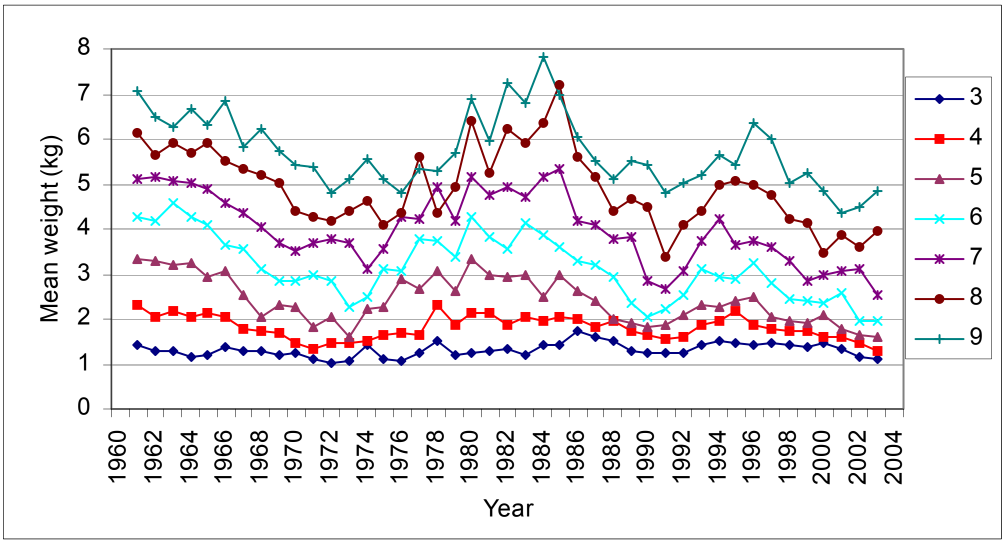
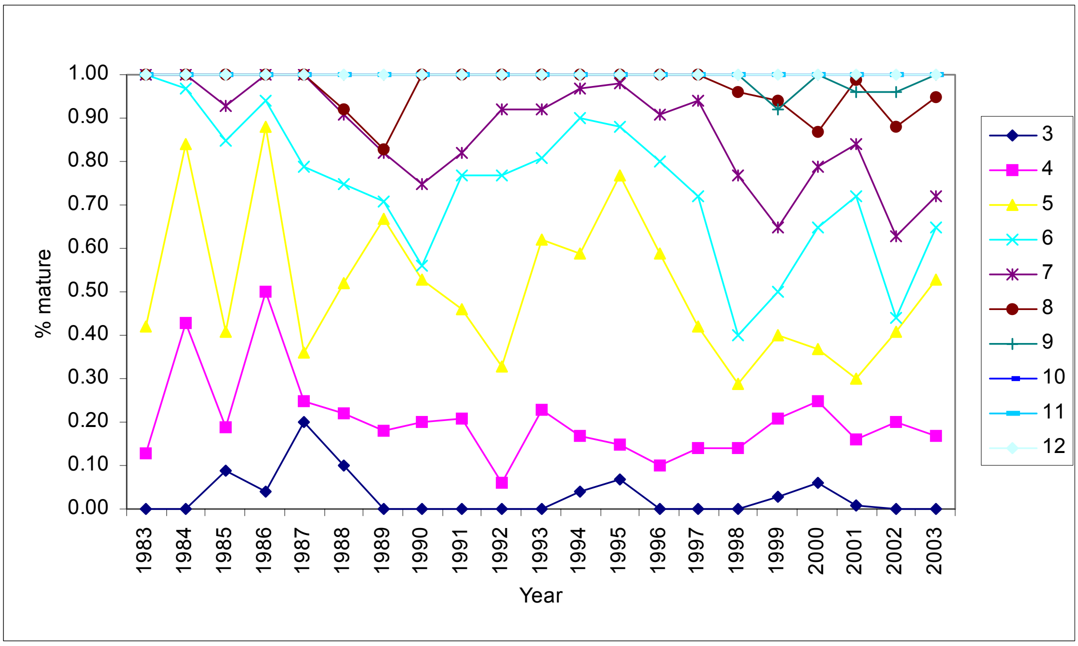


Figure 2.5.3.1. Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2003.



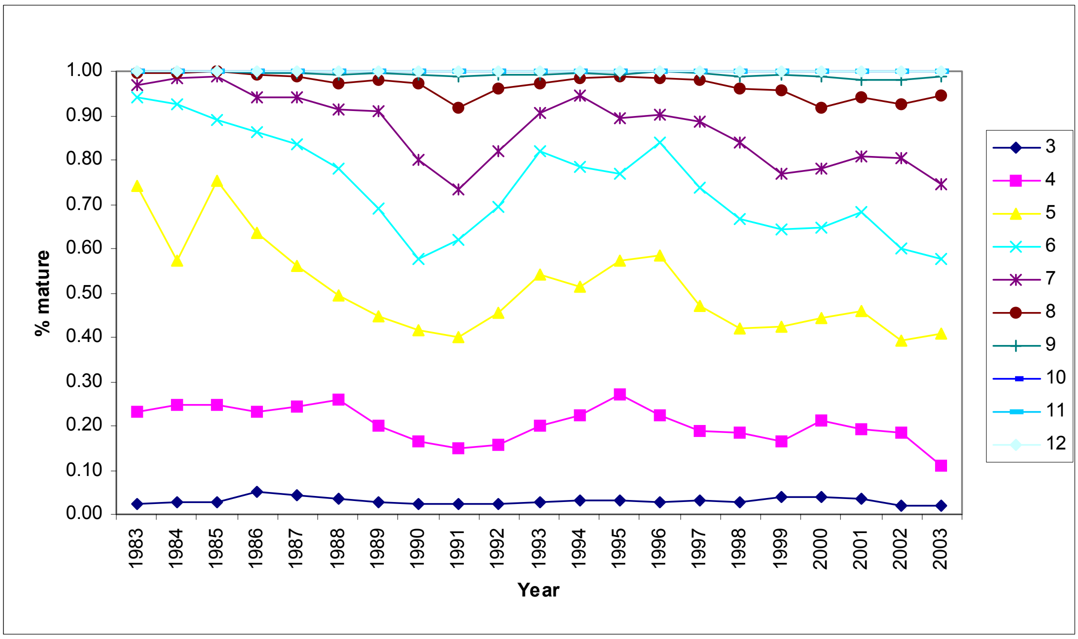


Figure 2.5.4.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and fitted values (lower figure) proportion mature at age for the period 1983-2003.

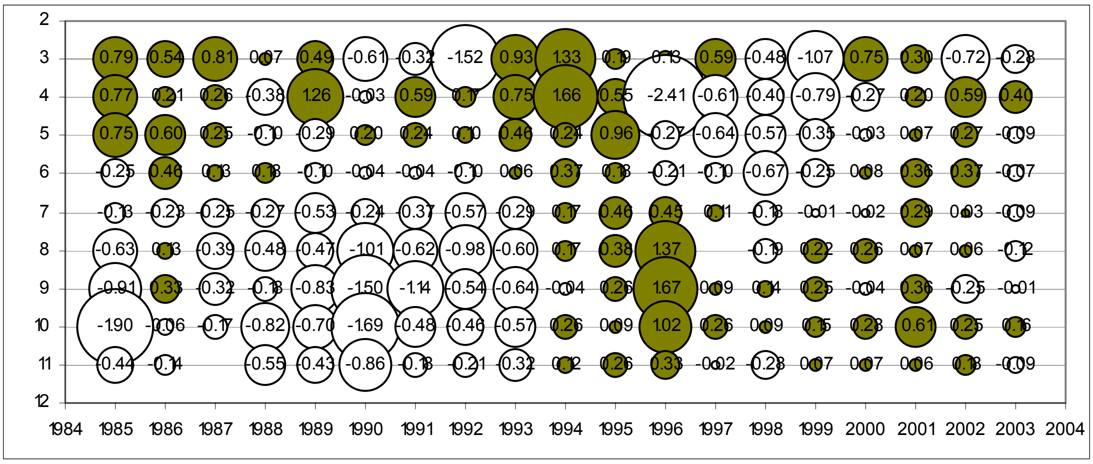


Figure 2.5.5.1. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 -11 from XSA.

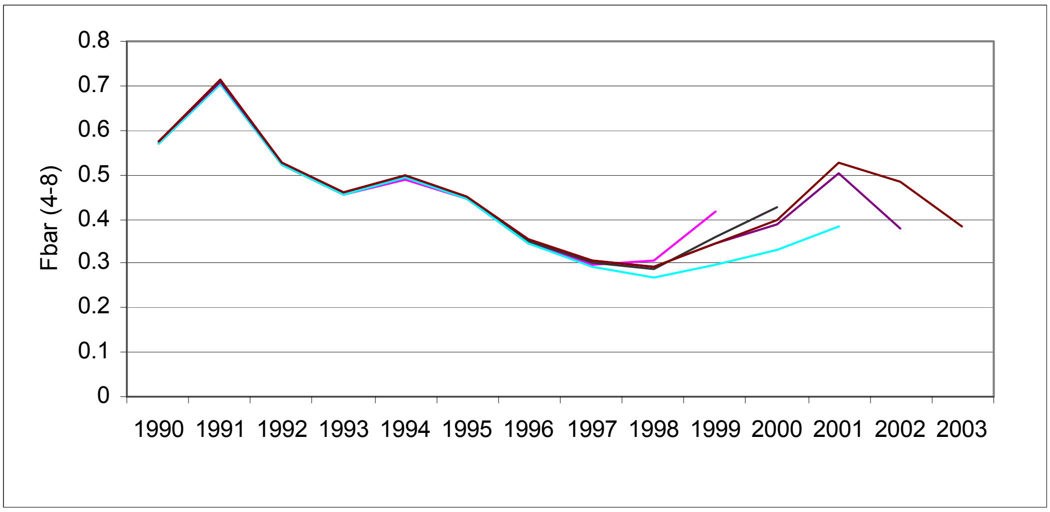


Figure 2.5.5.2. Saithe in the Faroes (Division Vb). Retrospective analysis of average fishingmortality of age groups 4-8 from XSA for the years 1996-2003.

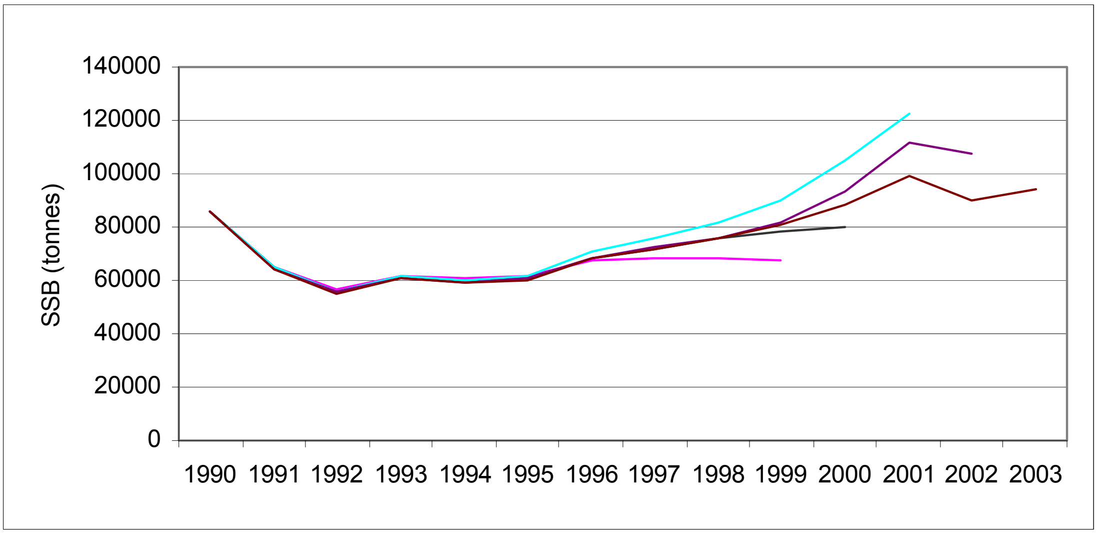


Figure 2.5.5.3. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from XSA for the years 1996-2003.

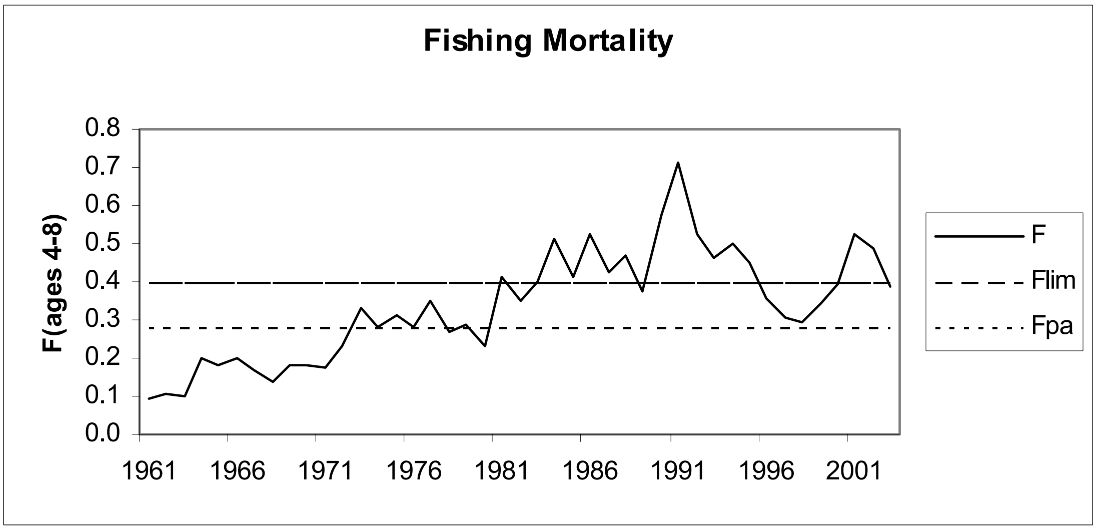


Figure 2.5.5.4. Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

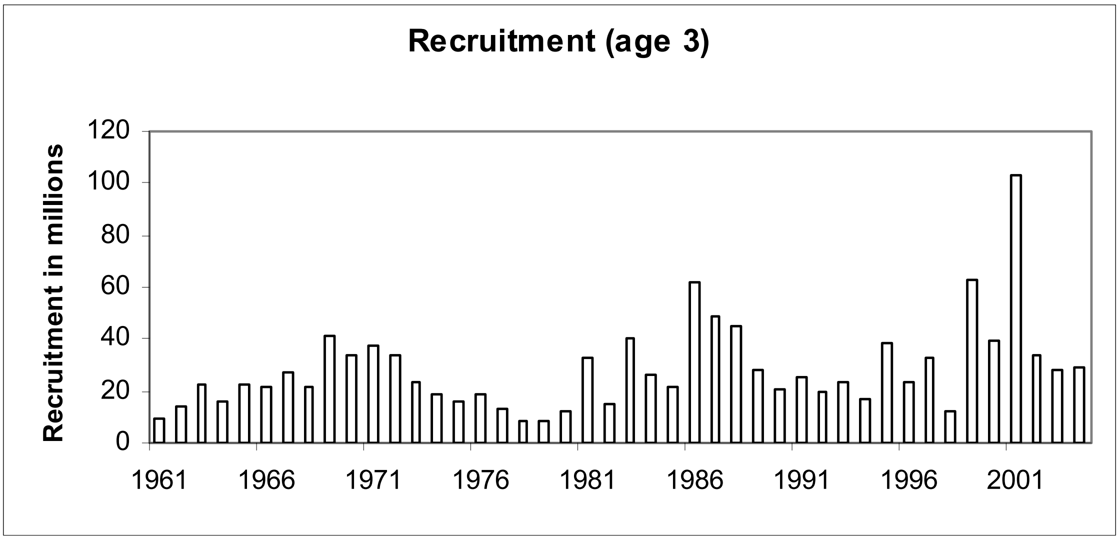


Figure 2.5.5.5. Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

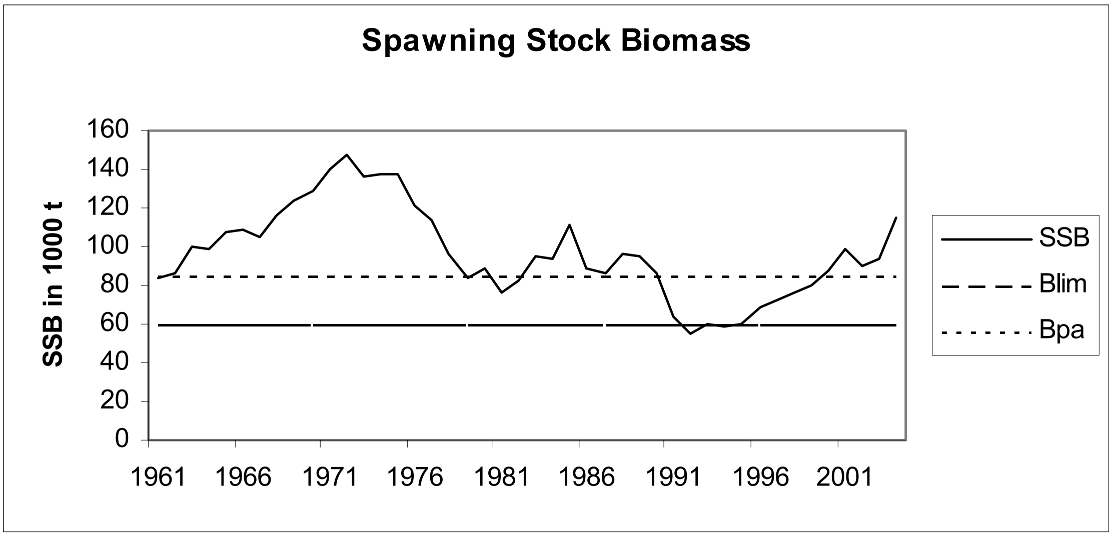


Figure 2.5.5.6 Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes).

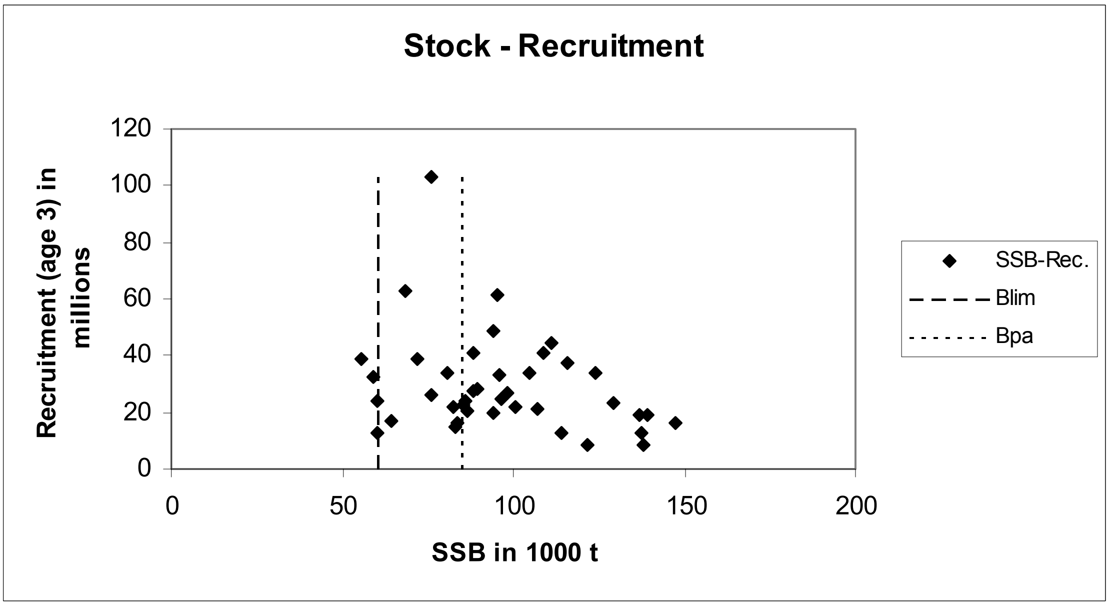


Figure 2.5.5.7 Saithe in the Faroes (Division Vb). Stock-Recruitment plot.

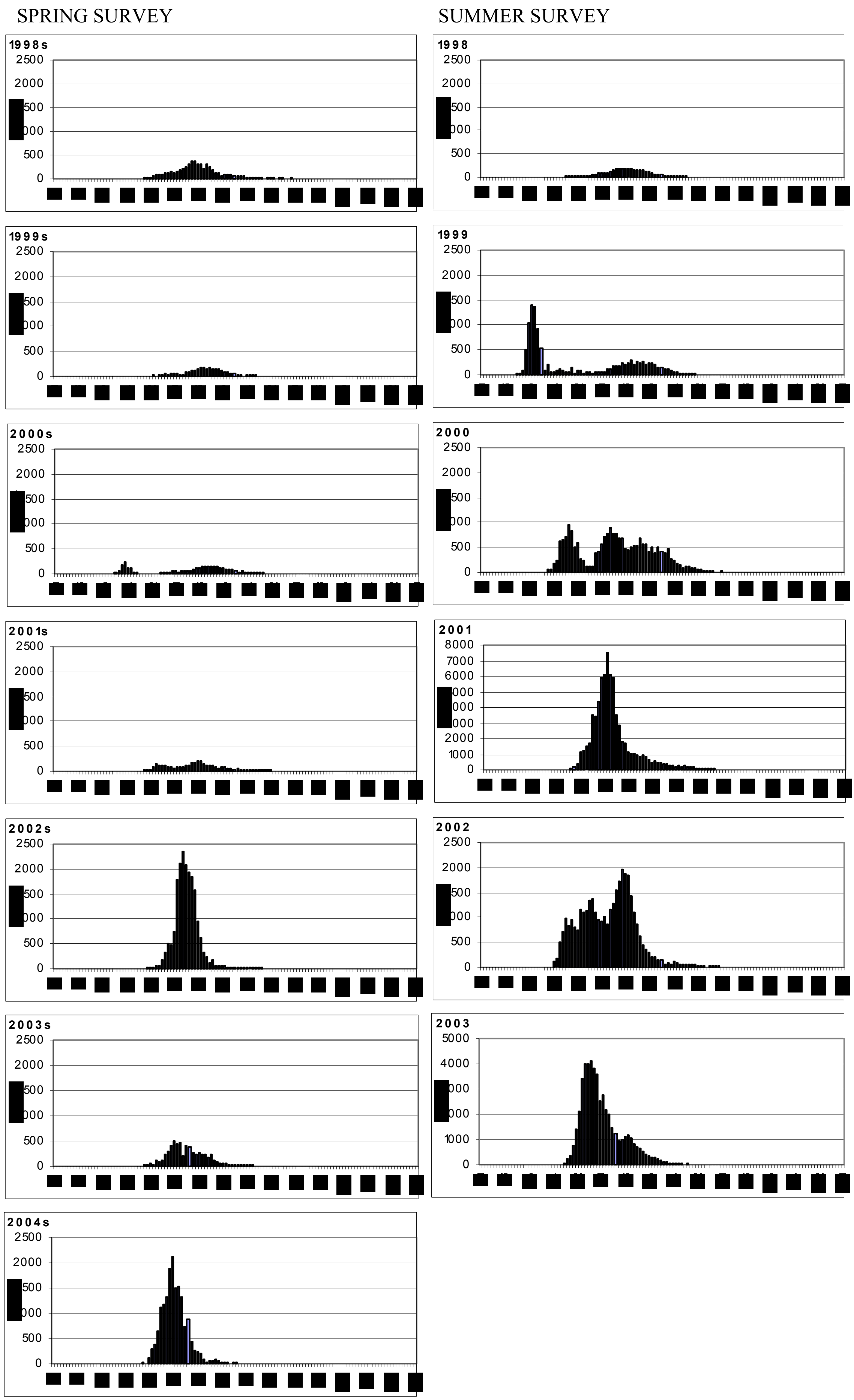


Figure 2.5.5.8. Saithe in the Faroes (Division Vb). Length distribution from spring (s) and summer survey 1996-2003. NB! Different scale for year 2001 and 2003 summer survey.

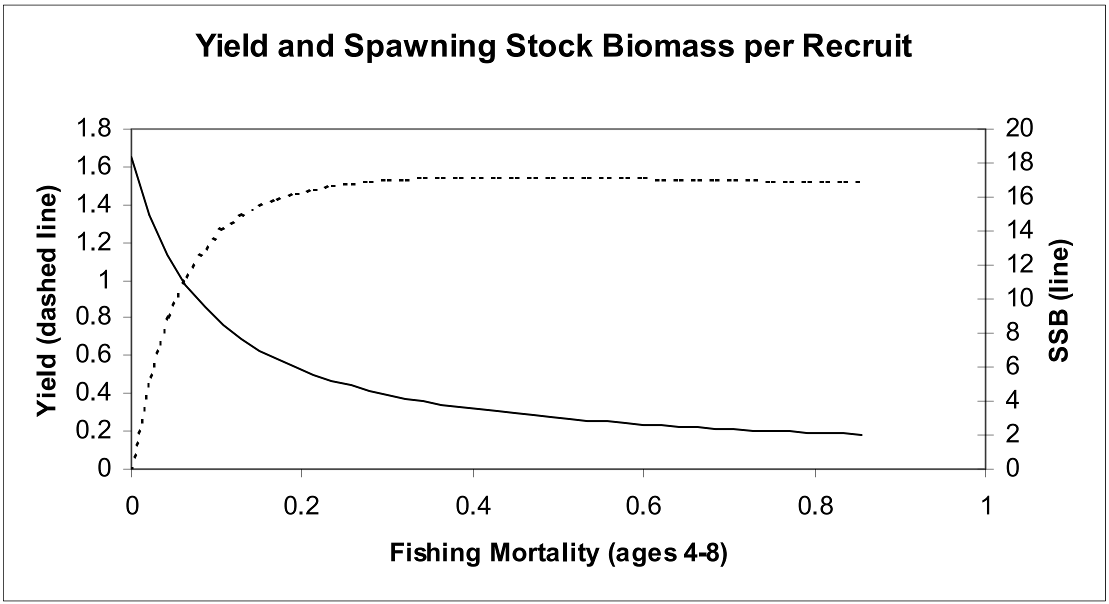


Figure 2.5.6.1 Saithe in the Faroes (Division Vb). Fish stock summary.

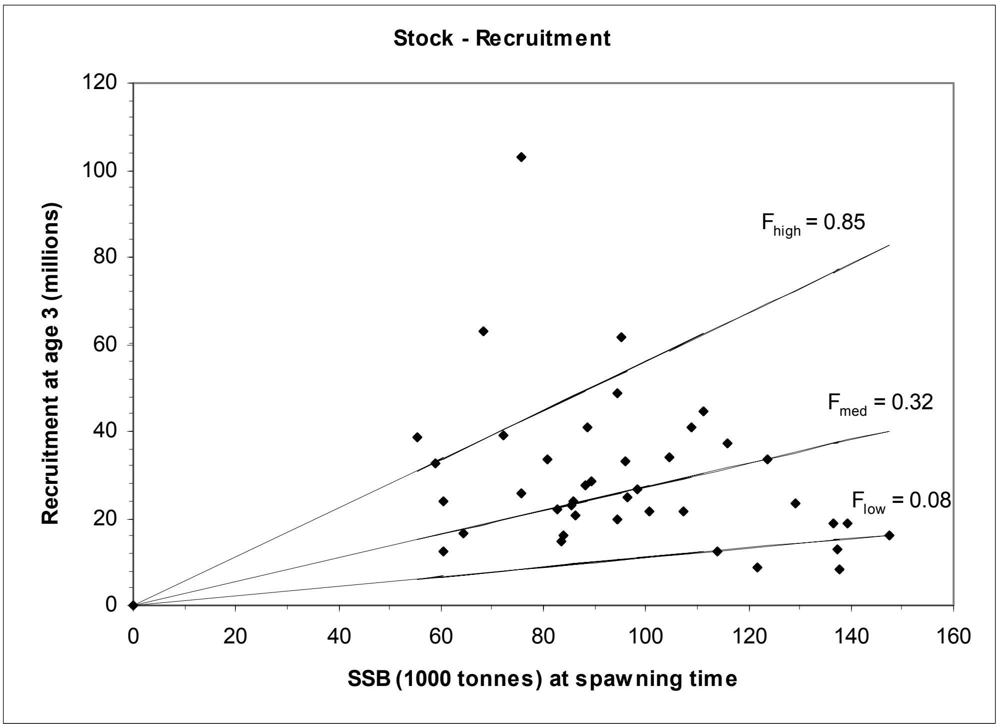


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

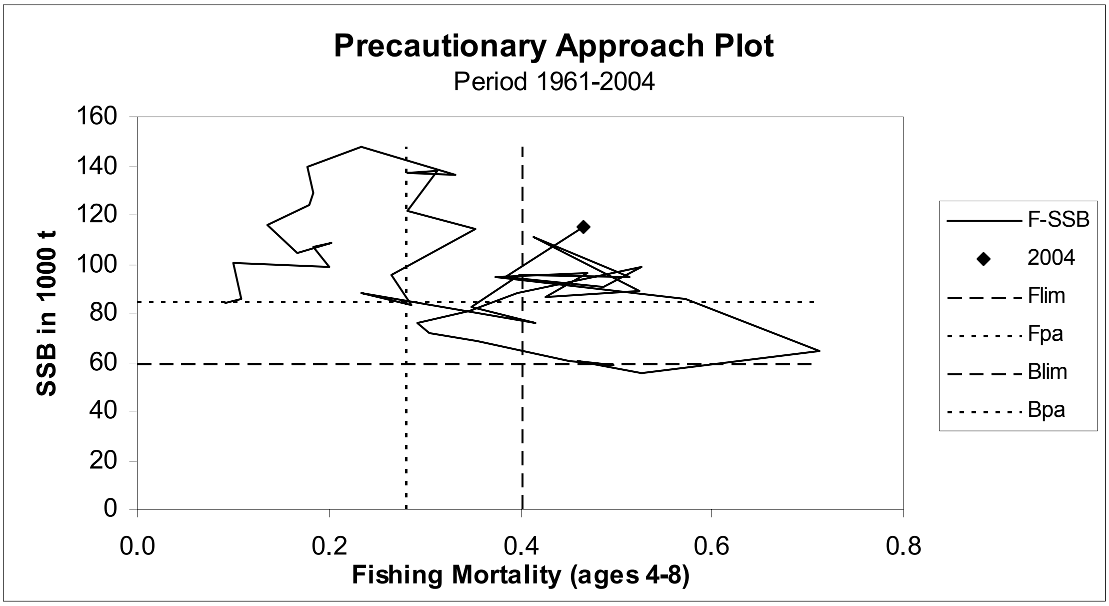
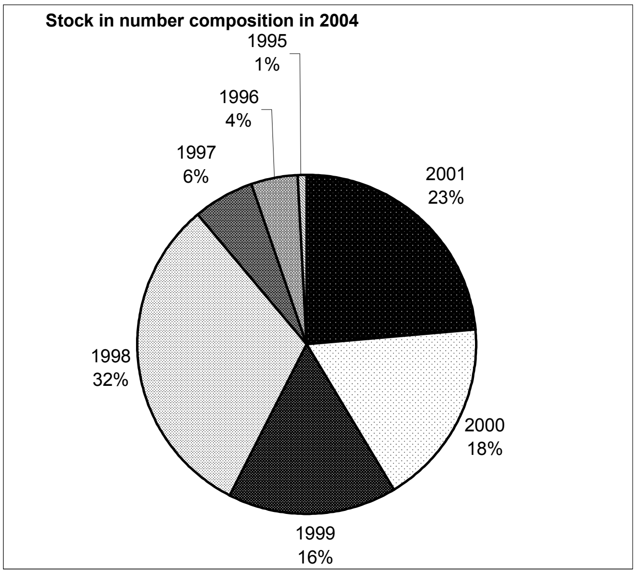


Figure 2.5.6.3. Saithe in the Faroes (Division Vb). The history of the stock/fishery in relation to the four reference points**.**



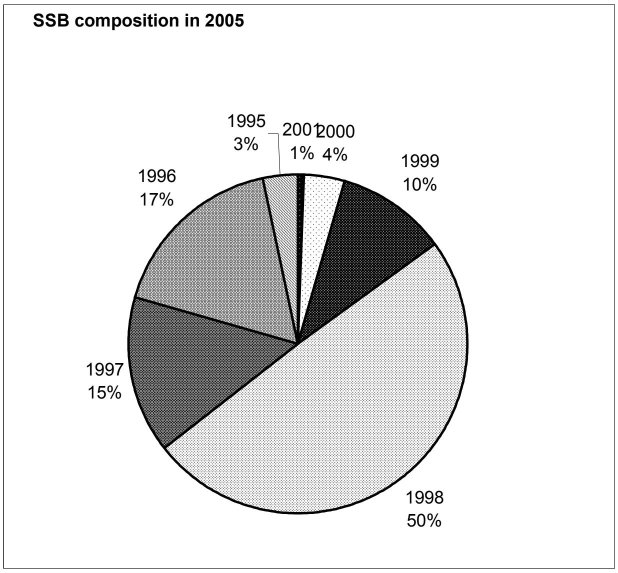


Figure 2.5.6.4. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2004 (left figure) and the composition in SSB in 2005 by year classes (right figure).

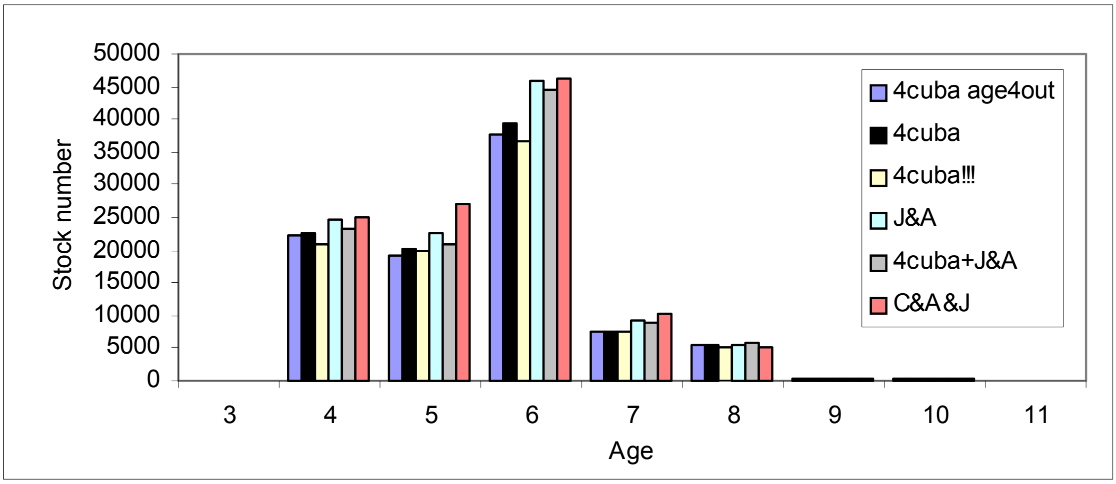


Figure 2.5.8.1. Saithe in the Faroes (Division Vb). Stock number at age in year 2004 a comparison between different XSA runs. Modified SPALY run in the black columns (4cuba). 4cuba age4out- SPALY XSA on the 4 Cubatrawlers left with age 4 out, 4cuba!!!- XSA with corrected 1996 catch at number, J&A- XSA on a new tuningfleet of two pairtrawlers, 4cuba+J&A- XSA on the two fleets combined and C&A&J- XSA on the 6 trawlers as one tuningfleet 1997-2003.

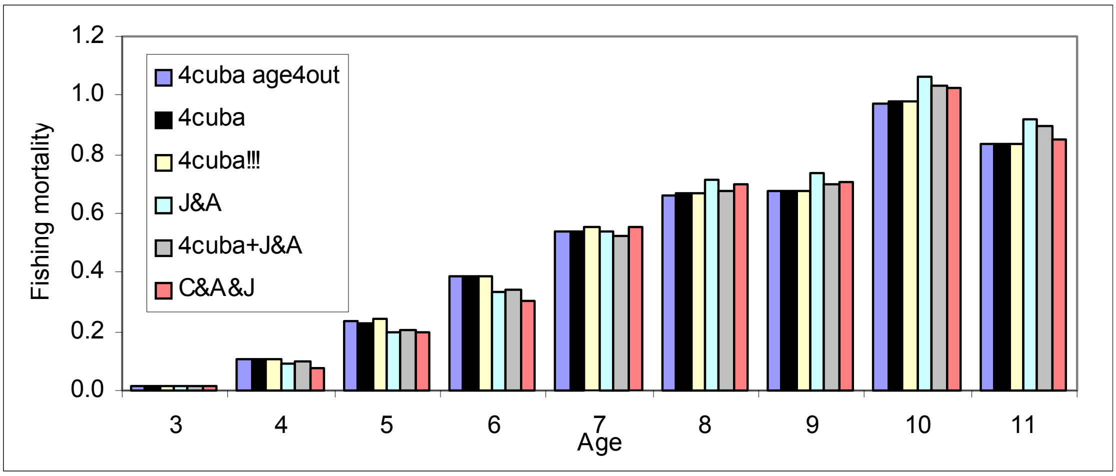


Figure 2.5.8.2. Saithe in the Faroes (Division Vb). Fishingmortality at age in year 2003. Comparison between different XSA runs. Modified SPALY run showed in the black columns. Legends are explained in the text in figure 2.5.8.1.

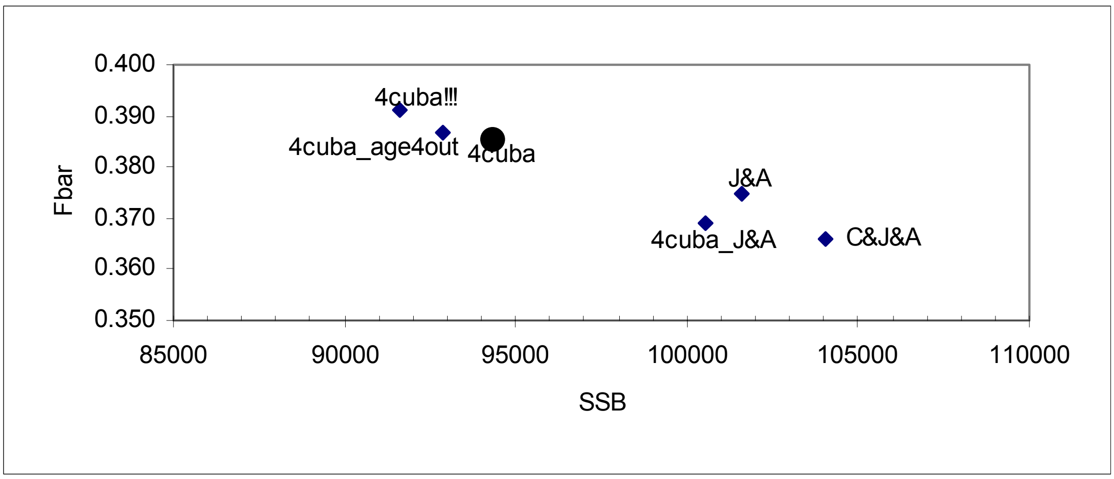
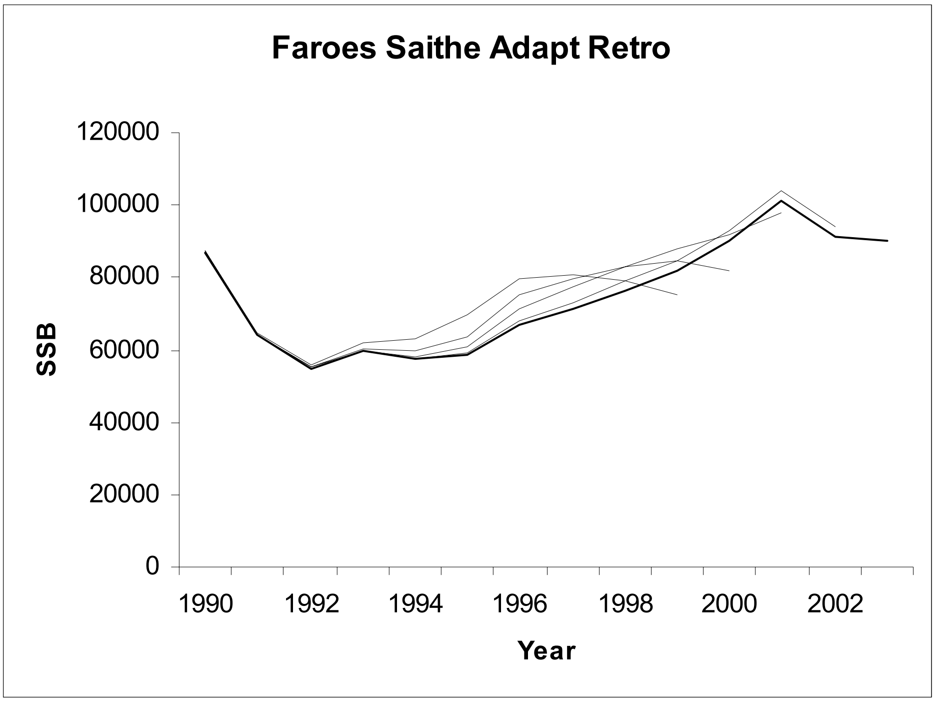


Figure 2.5.8.3. Saithe in the Faroes (Division Vb). Comparison between results from different XSA runs. The results from the modified SPALY run is showed as a black circle. Legends are explained in the text in figure 2.5.8.1.



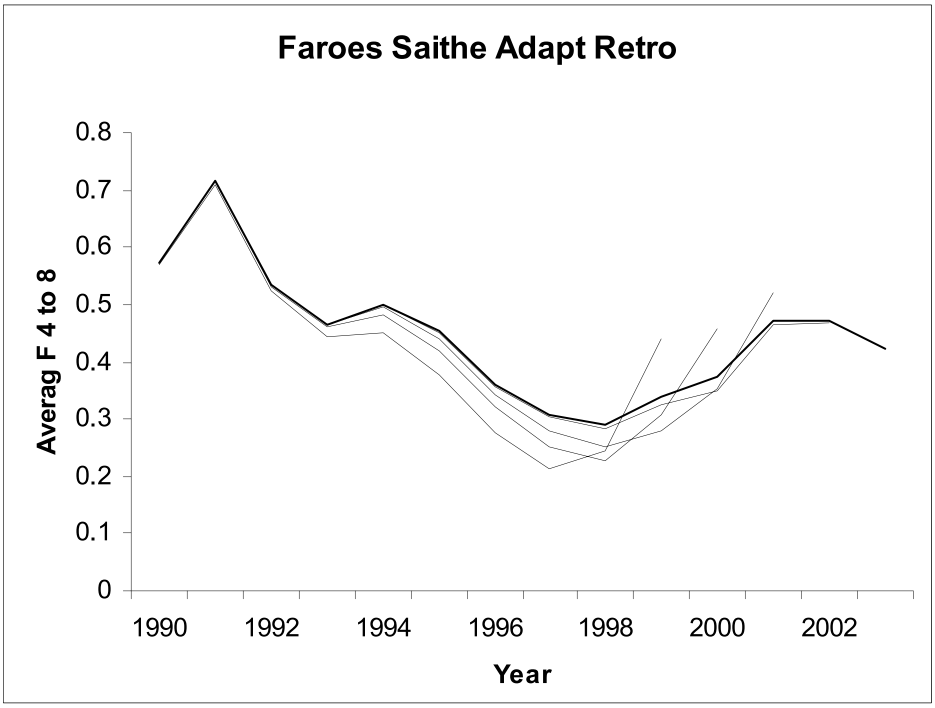


Figure 2.5.8.4. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from Adapt (upper figure) and retrospective analysis of average fishingmortality of age groups 4-8 from Adapt (lower figure).

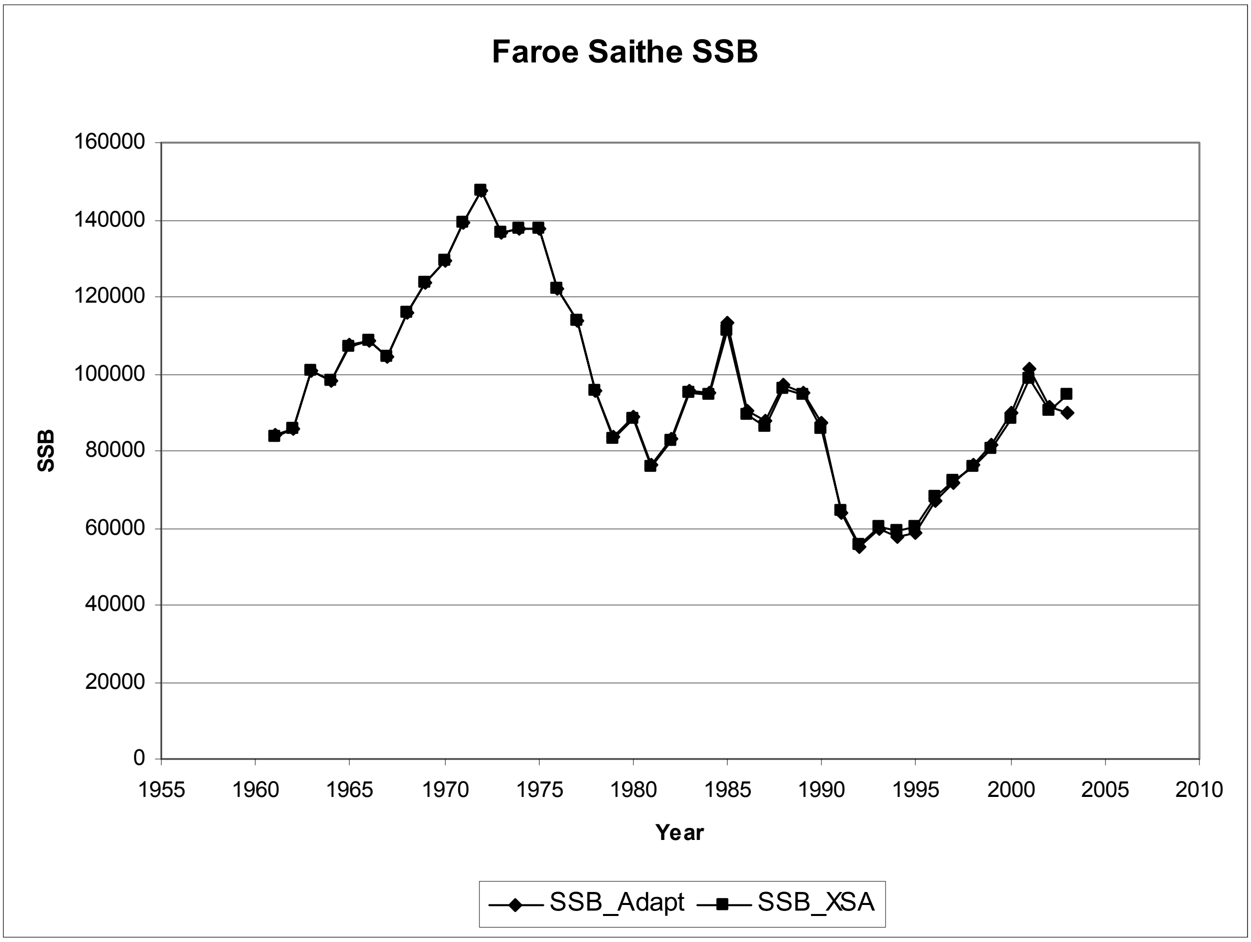


Figure 2.5.8.5. Saithe in the Faroes (Division Vb). Comparison between SSB from Adapt run and XSA run.

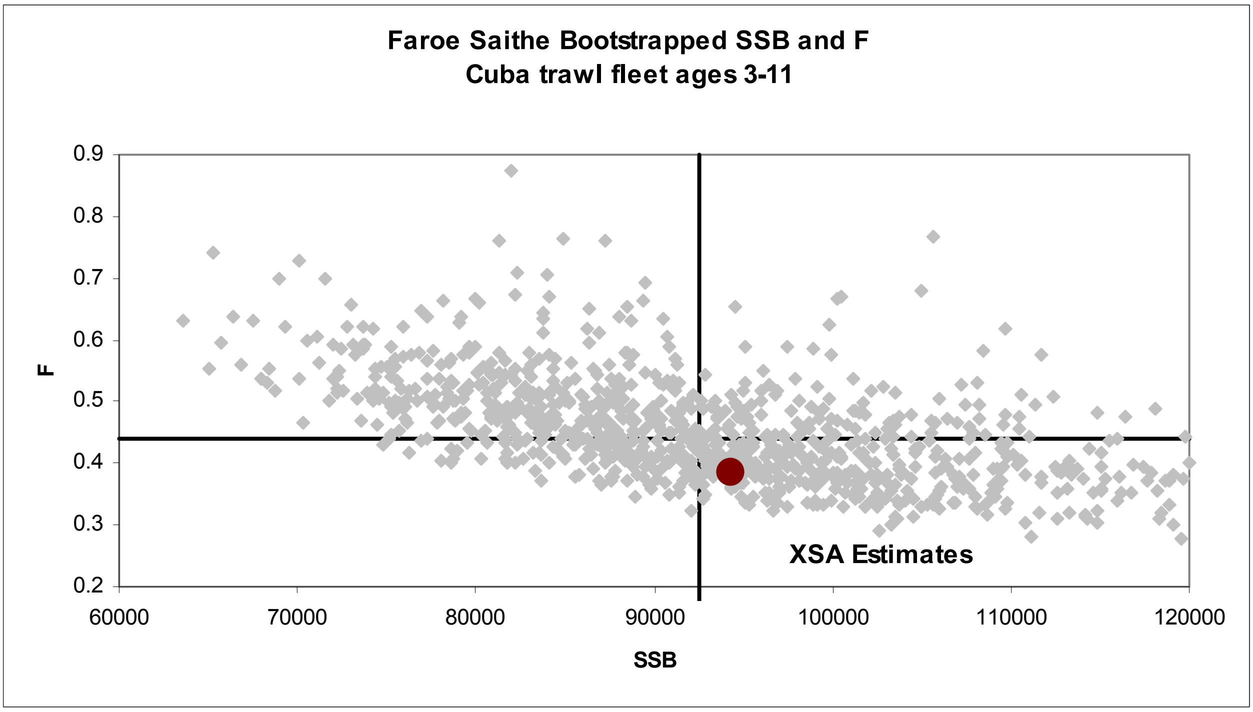


Figure 2.5.8.6. Saithe in the Faroes (Division Vb). Bootstrapped SSB and F on the cuba trawler fleet ages 3-11.

3 DEMERSAL STOCKS AT ICELAND (DIVISION VA)

3.1 Overview of the dynamics in the fishery in ICES division Va

This section gives a very broad and general overview of the fishery, fleet, species composition and some limited bycatch analysis of the commercially landed species as well as management measures in division Va. It should be considered as a first step towards a more thorough analysis that is a requisite to making a fishery based advice.

3.1.1 The fishery

Since the mid-seventies stocks in division Va have mainly been exploited by Icelandic vessels. However, vessels of other nationalities have also operated in the pelagic fishery on capelin, herring and blue whiting and few trawlers and longliners targeting for deep-sea redfish, tusk and ling have been operating in the region.

Fisheries in Icelandic waters are characterised by the most sophisticated technological equipment available in this field. This applies to navigational techniques and fish-detection instruments as well as the development of more effective fishing gear. The most significant development in recent years is the increasing size of pelagic trawls and with increasing engine power the the ability to fish deeper with them. There have also been substantial improvements with respect to technological aspects of other gears such as bottom trawl, longline and handline. Each fishery uses a variety of gears and some vessels frequently shift from one gear to another within each year. The most common demersal fishing gear are otter trawls, longlines, seines, gillnets and jiggers while the pelagic fisheries use pelagic trawls and purse seines. Following texttable gives the overview of the Icelandic fleet composition in 2003. Total number of vessels within each fleet category as of May 2004 is given, based on information from the Directory of Fishery. The definition of types may be very complicated as some vessels are operating both as large factory fishing for demersal species and as large purse seiners and pelagic trawlers fising for pelagic fishes. during different time of the year.

Type	No.vessels	Gear type used
Trawlers	79	(pelagic and bottom trawl)
Other large vessels within the TAC system	253	(Purse seine, longline, gillnet danish seine, pel. trawl)
Small vessels within the TAC system	884	(Jiggers, longline, gillnet, Purse seine)
Vessels within the effort system	308	(small jiggers)
Total	1.561	

The total catch in Icelandic waters in 2003 amounted to 1.7 million tonnes where pelagic fishes amounted to 1.2 million tonnes. Discard is banned in the Icelandic demersal fishery, but is allowed in the pelagic fishery where the catch exceeds the carrying capacity of the vessels. Overview of the catches in 2003 by species and gear type is given in **Table 3.1**. Overview of where catches of most important demersal species are taken in 2003 are given in **Figure 3.1**-**Figure 3.3**, divided by gear type and distribution of effort is shown in figures **Figure 3.4** and **Figure 3.5**. In the electronic logbook data total of 163.016 individual hauls/sets, divided by gear as follows:

Gear type	No. of hauls/sets
Pelagic trawl	6 647
Bottom trawl	58 201
Longline	21 029
Purse seine	3 965
Jiggers *	17 674
Danish seine	39 371

* number of fising days

3.1.1.1 Pelagic fishery

The fishery for the main pelagic species, Icelandic summer-spawning herring and capelin in the Iceland-East Greenland-Jan Mayen area, is almost exclusively carried out by vessels operating with both purse seine and pelagic trawl. The pelagic fisheries mainly target capelin, herring and blue whiting. Except for the summer fishery northwest of Iceland, the capelin fishery is mostly during the spawning migration,which goes clockwise around the country. The Herring fishery is conducted from autumn till February next year , both west and east of Iceland, using both purse seine and pelagic trawls. The blue whiting fishery has been developing rapidly in recent years and is conducted off the Southeast and the East Coast, using large pelagic trawls.

Most of the landings of these species are for fishmeal and fishoil production but an increasing part is used for human consumption. Bycatch of other than the targeted species is usually not a problem in this fishery but in some cases the target species have been mixed with juveniles of other species. In those cases the fishing areas have been closed for fishing, temporarily or permanently. Overview of where capelin, herring and blue whiting are caught with pelagic trawls and purse seiners are shown in **Figure 3.6**

3.1.1.2 Demersal fishery

Demersal fisheries usually target a mixture of roundfish species or a mixture of flatfish species with various amount of redfish as a bycatch. A fishery directed towards golden redfish and the deep-sea redfish exists along the shelf edge from Southeast to northwest of Iceland. The saithe fishery is also along the shelf edge, often in the same areas as the redfish fisheries, but the fleets are often targeting at redfish during daytime and saith during nights. Therefore the fishery for one of those species is relatively free of bycatch of the other species even though they take place in the same area. Directed Greenland halibut fishery exists also with very little bycatch. (Table 3.2 and Figure 3.7) Targeted fishery for deep-sea species (mainly tusk) takes place from the southeast to the southwest coast, often with cod and haddock as bycatch. **Table 3.1** gives the total landings of most of the species caught in Icelandic waters in 2003, divided by gear type and overview of the number of vessels in each fleet category is given in the textable above.

As seen in **Figure 3.1** gives overview where the most importand demersal species in Icelandic waters are caught with bottom trawl. **Figure 3.2** shows where the same species are caught using longline and **Figure 3.3** shows the distribution of the catches in 2003 caught with gillnets.

Demersal fisheries take place all around Iceland including variety of gears and boats of all sizes. The most important fleets targeting them are:

- Large and small trawlers using demersal trawl. This fleet is the most important one fishing cod, haddock, saithe, redfish as well as a number of other species. This fleet is operating year around; mostly outside 12 nautical miles from the shore.
- Boats (< 300 GRT) using gillnet. These boats are mostly targeting cod but cod haddock and a number of other species are included. This fleet is mostly operating close to the shore.
- Boats using longlines. These boats are both small boats (< 10 GRT) operating in shallow waters as well as much larger vessels operating in deeper waters. Cod and haddock are the main target species of this fleet but a number of less important species are also caught, some of them in directed fisheries.
- Boats using jiggers. These are small boats (<10 GRT), operating either within the TAC system or in an effort control system where each boat is allocated certain number of days for each year. Cod is the most important target species of this fleet with saithe following as the second most important species.
- Boats using danish seine. (20-300 GRT) The most important species for this fleet are cod and haddock but this fleet is the most important fleet fishing for a variety of flat fishes like plaice, dap and witch.

In addition to those fleets a number of other fleets targeting invertebrates and pelagic fishes can affect demersal fish stocks, both through discard and other hidden mortality. The spatial distribution of the trawlers and the longline fleets effort is shown in **Figure 3.4** - **Figure 3.5**. In general, the trawlers operate further away from the shore than the longliners.

3.1.2 Mixed fisheries

Some of the species caught in Icelandic waters are caught in fisheris targeting only one species, with very little bycatch. An exsample of this is directed Greenland halibut fishery (Table 3.2 and Figure 3.7) which is fished in waters deeper than 500 m west and southeast of Iceland. Within the narrowed areas drawn in **Figure 3.6** where it is fished, 17 600 t of the total landings of 20 300 t were caught in 2003. The bycatch in the greenland halibut fishery in these areas(**Table 3.2**) show that it is very clean fishery with Greenland halibut as over 90% of the total catches in the western area where over 16 thous. tonnes are caught with deep-sea redfish being the most importand bycatch species with less than 9% of the totla catch in that area. Other species such as plaice is more like an "bycatch species" in the bottom trawl fishery where 75 % of the plaice is caught in hauls where plaice is minority of the catches . Figure 3.8 indicates to what extent the catch of different species is bycatch. The x axis indicating how large proportion each species is of the total catch in the setting or haul and the y axis shows how large proportion of the annual catch of the species comes from hauls where the proportion of the species is less than the selected proportion.

Cumulative plot can also show how the fishery of a species evolves with time. **Figure 3.9** shows an example from the Icelandic bottom trawl fishery in few selected years. It can be seen that in 1995 largest proportion of cod was caught in mixed fisheries but 1995 is the year when fishing mortality of Icelandic cod was lowest.

The cumulative plot shown in **Figure 3.10** is showing haddock catch as proportion of haddock and cod catch in each haul, instead of as a proportion of the total catch as is shown in **Figure 3.8** and in **Figure 3.9**, The figure shows how much of haddock is caught in fisheries mixed with cod indicating that large proportion of haddock is caught as bycatch in cod fisheries.

3.1.3 Management

The Ministry of Fisheries is responsible for management of the Icelandic fisheries and implementation of the legislation. The Ministry issues regulations for commercial fishing for each fishing year, including an allocation of the TAC for each of the stocks subject to such limitations.

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

In 1990, an individual transferable quota (ITQ) system was established for the fisheries and they were subject to vessel catch quotas. The quotas represent shares in the national total allowable catch (TAC) for each species , and most of the Icelandic fleets operates under this system. Some of the smaller boats operate in an effort control system where the boats are assigned certain number of fishing days.

With the extension of the fisheries jurisdiction to 200 miles in 1975, Iceland introduced new measures to protect juvenile fish. The mesh size in trawls was increased from 120 mm to 155 mm in 1977. Mesh size of 135 mm was only allowed in the fisheries for redfish in certain areas. Since 1998 a mesh size of 135 is allowed in the codend in all trawl fisheries not using "Polish cover". A quick closure system has been in force since 1976 with the objective to protect juvenile fish. Fishing is prohibited for at least two weeks in areas where the number of small fish in the catches has been observed by inspectors to exceed certain percentage (25% or more of <55 cm cod and saithe, 25% or more of <45 cm haddock and 20% or more of <33 cm redfish). If, in a given area, there are several consecutive quick closures the Minister of Fisheries can with regulations close the area for longer time forcing the fleet to operate in other areas. Inspectors from the Directorate of Fisheries supervise these closures in collaboration with the Marine Research Institute. In 2003, 113 such closures took place.

In addition to allocating quotas on each species, there are other measures in place to protect fish stocks. Based on knowledge on the biology of various stocks, many areas have been closed temporarily or permanently aiming at protect juveniles. **Figure 3.11** shows map of such legislation that was in force in 2003. Some of them are temporarily, but others have been closed for fishery for decades.

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

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

Amendments adopted in June 2000:

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

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

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

At the time of the catch-rule amendment, because of time constrains, detailed alternative simulations were not possible. A working group was set up by the Ministry of Fisheries in 2001 with the objectives to analyse the experience of using the catch rule and try out alternative approaches taking into account obvious shortcomings of the current harvest control rule and use state of the art knowledge for further development. This working group delivered a final report to the Minister of Fisheries during the working group meeting.

3.1.4 Comments

The decision on the number of hours at sea for the effort fleet is set prior to the fishing season each year without taking into account the likely catch. For the Icelandic cod a figurative amount of catch (2000 tonnes in the current fishing year) is subtracted from the catch rule prior to the allocation of the catch to the boats operating in the qouta system. The realized catch of the effort fleet has however been around 10-15 kt higher than the figurative amount. That means that the catch rule is a priori not followed.

At present, ICES only assesses few stocks that are currently exploited in Icelandic waters. However, many of the species listed in **Table 3.1** are assessed domestically (MRI, Reykjavik) and advice given for them. For many of them a TAC is set by the management body. If a proper fishery based advice should be given for the Icelandic fishery ICES would also need to evaluate the status of these stocks.

3.1.5 References

Anon. 1994. Hagkvæm nýting fiskistofna (On Rational Utilization of fish stocks). In Icelandic. Reykjavik, 27pp.

Baldursson, F.M., Daníelsson, Á. and Stefánsson, G. 1996. On the rational utilization of the Icelandic cod stock. ICES Journal of Marine Science 53: 643-658.

Daníelsson, Á., Stefánsson, G., Baldursson, F.M. and Thórarinsson, K. 1997. Utilization of the Icelandic Cod Stock in a Multispecies Context. Marine Resource Economics 12: 329-244.

Stefánsson, G., Sigurjónsson, J. and Víkingsson, G.A. 1997. On Dynamic Interactions Between Some Fish Resources and Cetaceans off Iceland Based on a Simulation Model. Northw. Atl., Fish. Sci. 22: 357-370.

Stefánsson, G., Hauksson, E., Bogason, V., Sigurjónsson, J. and Víkingsson, G. 1997. Multispecies interactions in the C Atlantic. Working paper to NAMMCO SC SC/5/ME13 1380 (unpubl.).

Table 3.1. Overview of Icelandic fish (+ shrimp) catches in Icelandic waters by gear type in 2003. The fishery for capelin, blue whiting and herring are fished in both pelagic trawls and purse seine, but those gears are combined. Based on landing statistics from the Directorate of Fisheries. Landings are given in t.

spec	longline	gillnets	hooks	Danish seine	Bottom tr	Pel. trawl	Lobster tr.	Shrimp trawl	Other gears	Total
Capelin	0	0	0	0	0	0	0	0	682178	682178
blue whiting	0	0	0	0	0	0	0	0	390068	390068
Herring	0	4	0	0	1	0	0	0	132123	132128
Cod	44629	37527	15917	13333	87016	315	1065	33	492	200327
Redfish	895	190	193	316	57795	2844	503	1	28	62765
Haddock	17269	1565	74	4789	35768		464	12	36	59976
Saithe	842	2204	2606	1097	44783	188	122	0	16	51859
Deep water prawn						1		23235	0	23236
Greenland halibut	65	1383		0	18904		0	1	0	20352
Atlantic wolfish	8933	86	26	1398	5859	1	124	0	24	16451
Plaice	54	300	0	3579	1293		5	0	26	5257
Dab	7	22	0	4160	22		1		1	4213
tusk, cusk	3902	44	10	1	55		10		1	4024
ling	2208	456	7	63	582	3	265		1	3584
Long rough dab	9	11		2496	199	0	119	0	0	2835
greater argentine,					2617	23			40	2680
spotted wolffish, leopardfish	757	5	0	12	1614	4	2	0	2	2397
Witch	0	0		1690	30		228		0	1948
Monkfish	10	891	0	248	180	0	345	0	11	1685
Norway lobster							1666		0	1666
Lemon sole	0	9	0	770	446	0	17		1	1245
blue ling	197	6	0	11	869	5	10		0	1098
whiting	153	34	3	102	667	0	66		0	1026
Halibut	201	64	3	141	173	4	43	0	1	631
Dogfish	28	173	3	8	18		0		0	231
Others	0	119	0	8	14			0	0	141
skate	24	15	0	32	43	1	6		0	120
megrim		0		50	11	0	12		0	73
Greenland shark					61				0	61
roundnose grenadier,					57				0	57
Others species	0	40	0	3	6			0	5	55
roughhead grenadier					29	4			0	33
lumpsucker, lumpfish	1	17		2	1				4	25
shagreen ray	4	0		0	13		0		0	17
black scabbard fish					14				0	14
Other species.	7	8	0	1	3	0	0	0	0	20
Grand Total	80196	45172	18842	34313	259141	3395	5074	23284	1205058	1674475

Table 3.2. Catches of Greenland halibut (in kg) within the areas given in figure 1, as reported in the logbooks of the bottom trawlers. The data are also given as percentage.

Species	Western	Eastern	Grand Total	Western	Eastern	Grand Total
Greenland halibut	16282551	1226180	17508731	90.13	62.03	87.36
Saith	7736	7889	15625	0.04	0.40	0.08
S. marinus	141420	22270	163690	0.78	1.13	0.82
Cod	34298	530203	564501	0.19	26.82	2.82
Haddock	0	6500	6500	0.00	0.33	0.03
Catfish	1001	325	1326	0.01	0.02	0.01
Plaice	5559	0	5559	0.03	0.00	0.03
Halibut	500	0	500	0.00	0.00	0.00
ling	6513	0	6513	0.04	0.00	0.03
Blue ling	7897	0	7897	0.04	0.00	0.04
S.mentella	1578693	183328	1762021	8.74	9.27	8.79

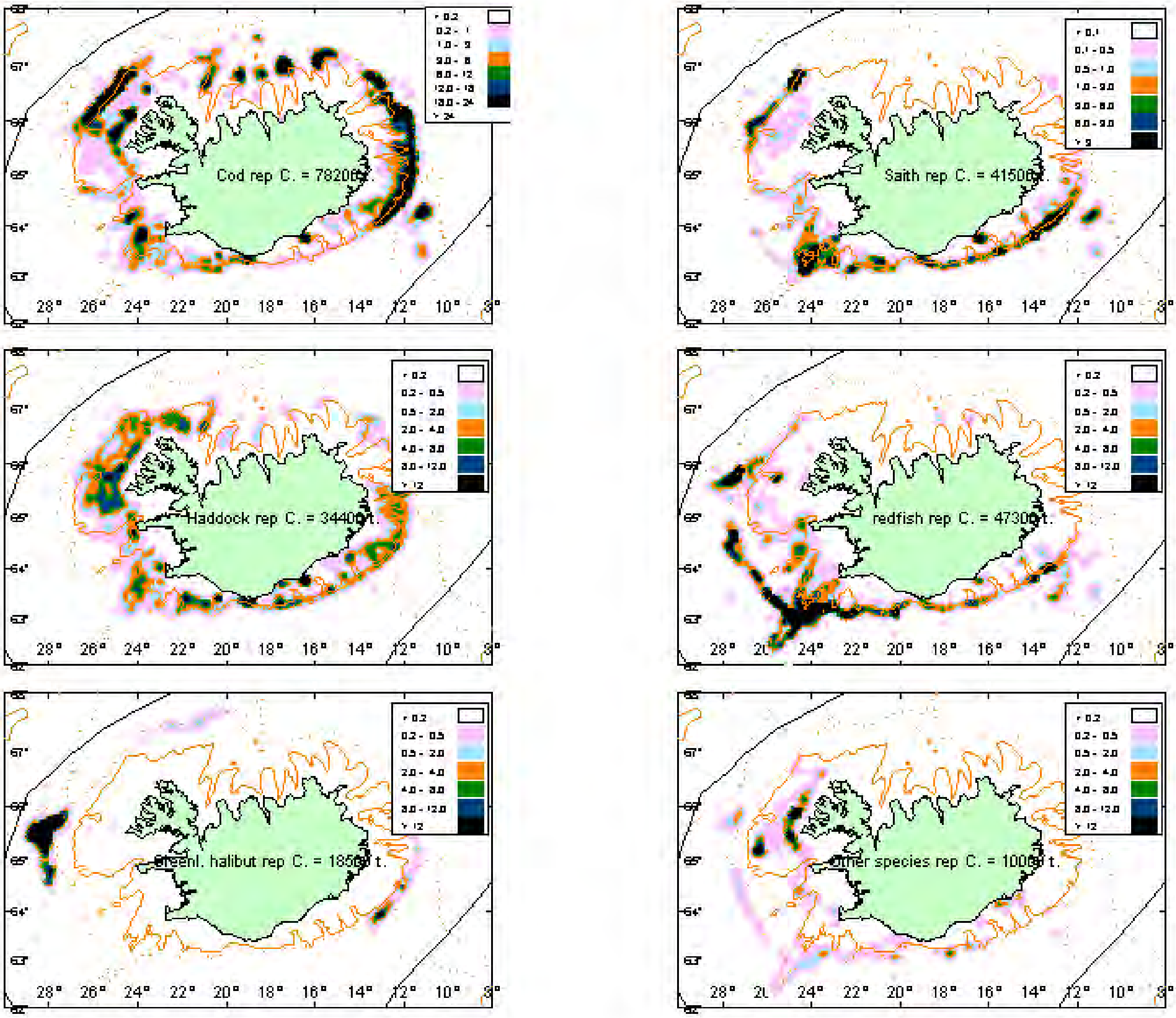


Figure 3.1. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with bottom trawl 2003.

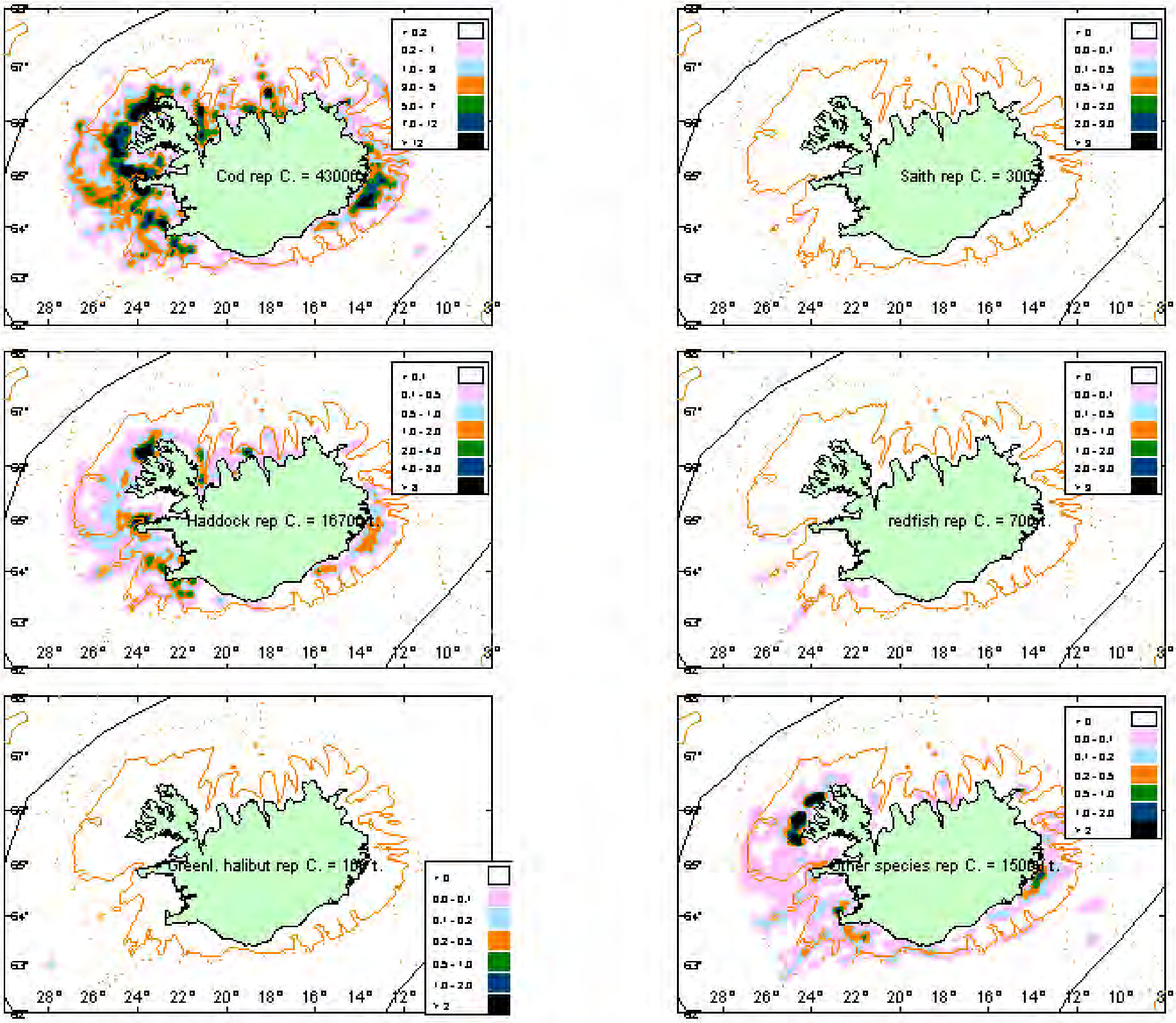


Figure 3.2. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with long-line in 2003.

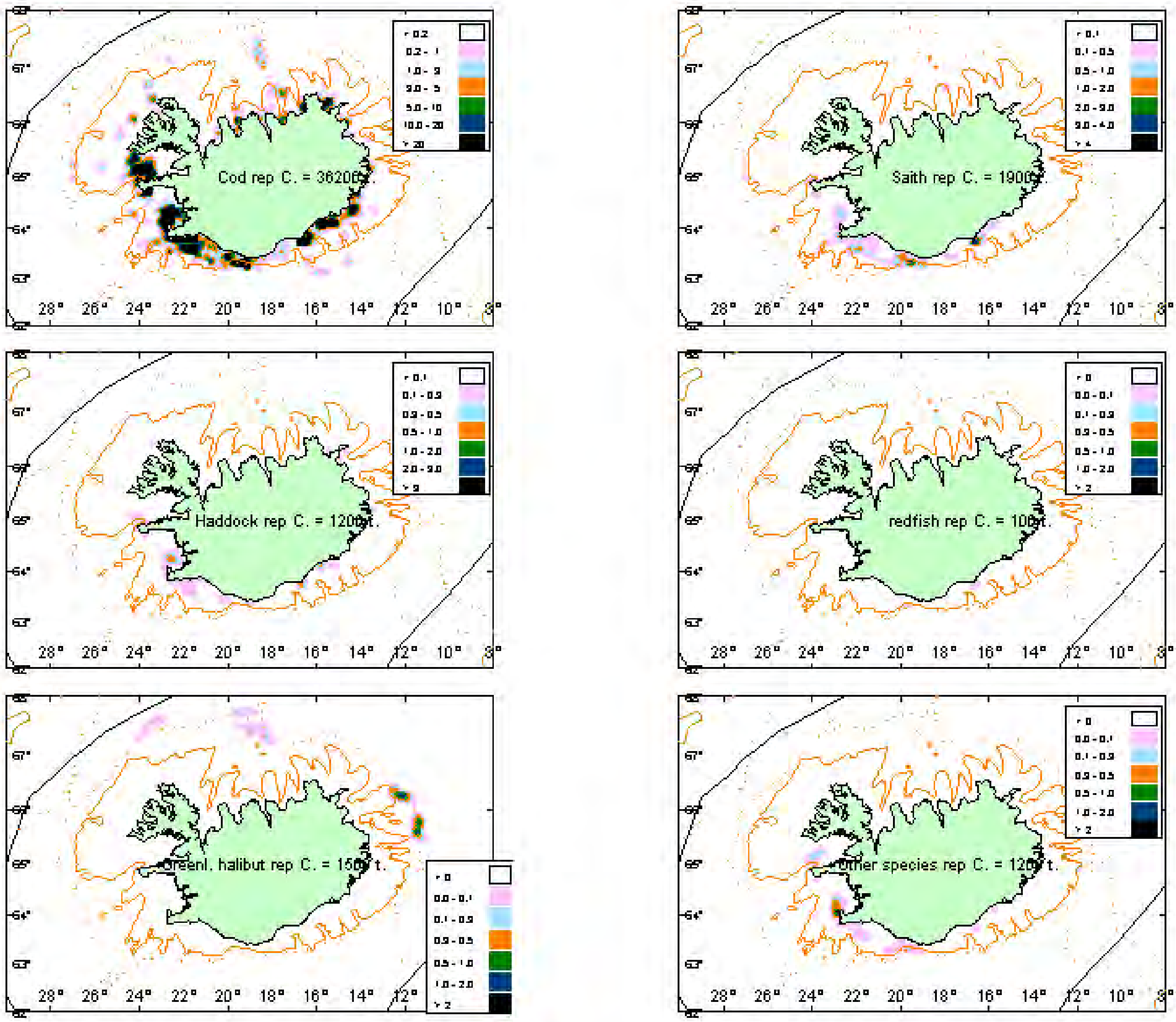


Figure 3.3. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with gillnets in 2003.

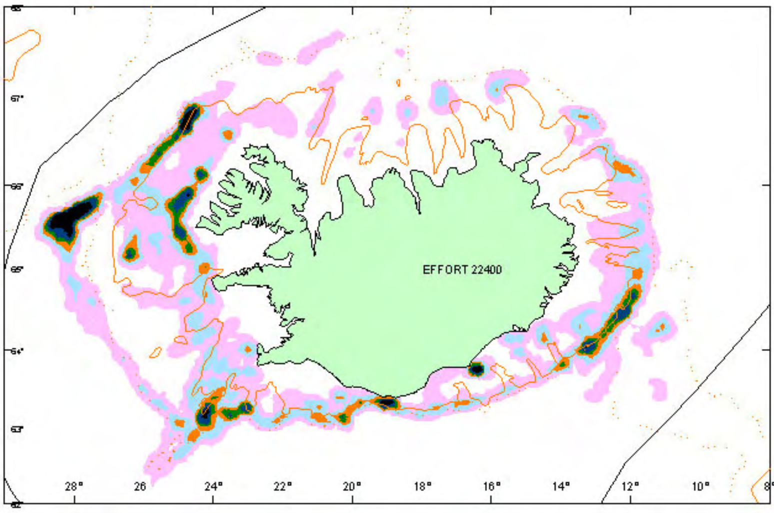


Figure 3.4. Effort of the trawler fleet in 2003. The dark colours show the areas of the greatest fishing effort to be off the southeast to the west coast and off Northwest Iceland.

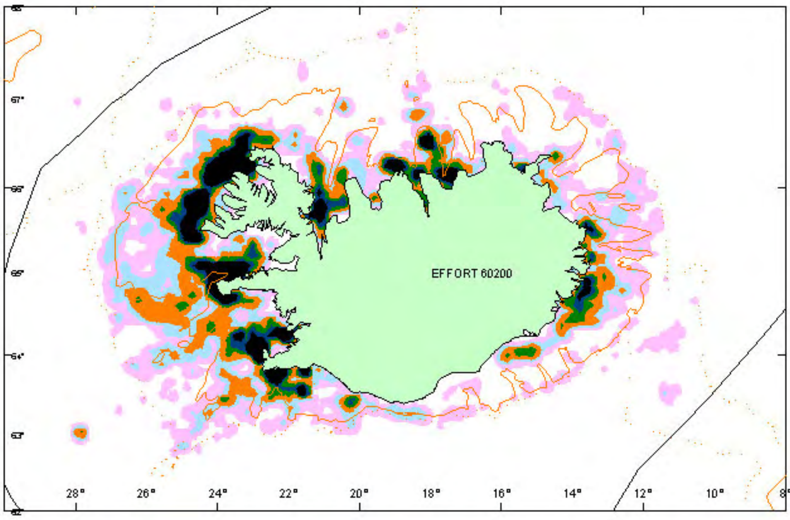


Figure 3.5. Effort in the longline fleet in 2003. The dark colours show the areas of the greatest fishing effort to be off the northwest and west coast but fishing is also concentrated along the entire southwest and south coast. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

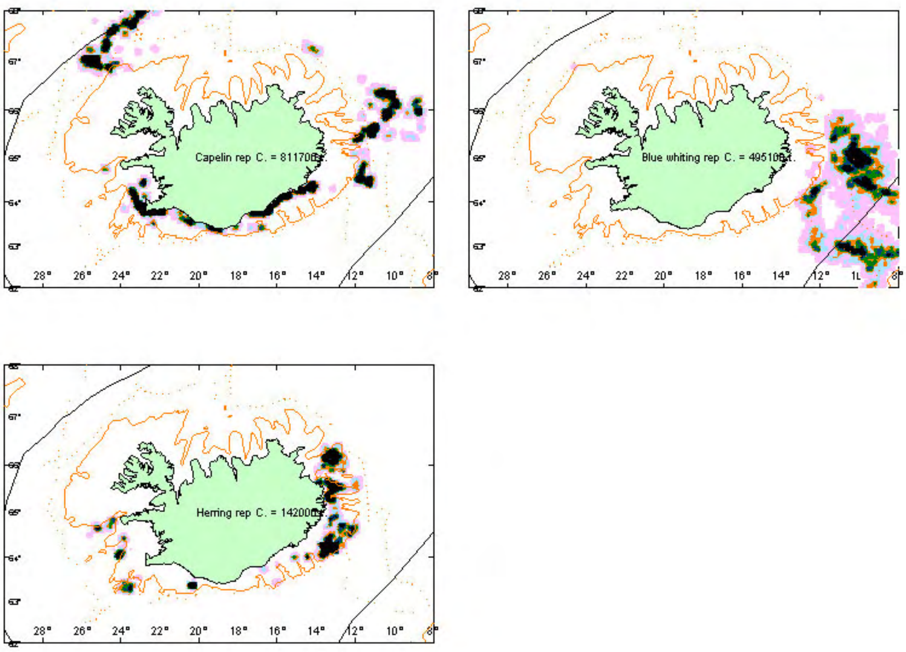


Figure 3.6. Location of catches of capelin, icelandic spring spawning herring and blue whiting with purse seine and pelagic trawls in 2003.

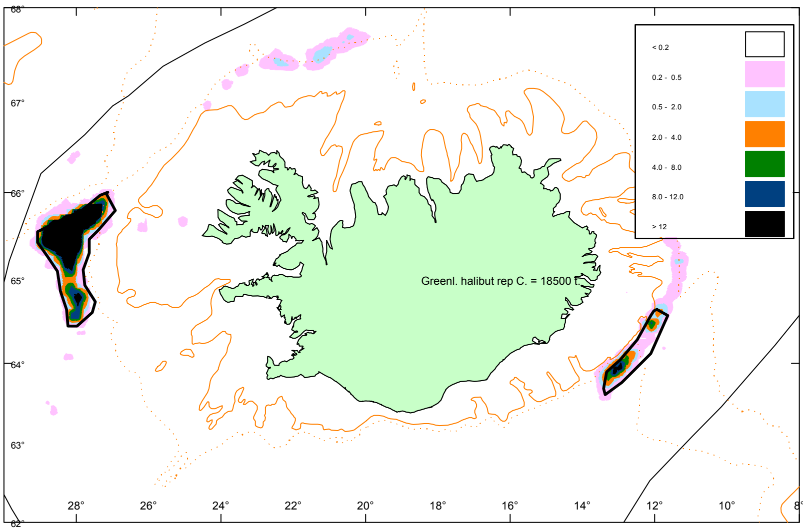


Figure 3.7. Greenland halibut Catches in 2003. The boxes drawn on the figure indicates the areas refereed to in table the textable.

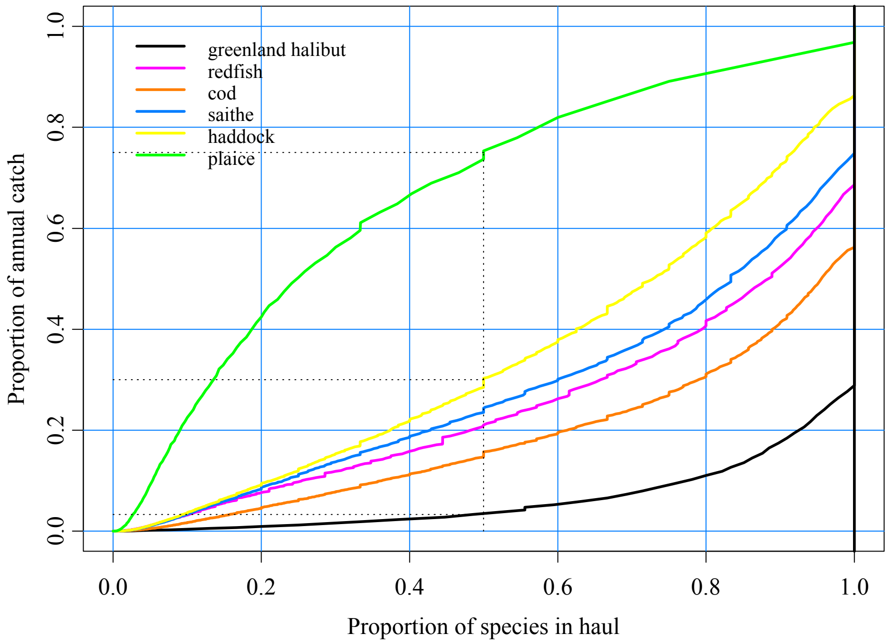


Figure 3.8. Cumulative plot for bottom trawl in 2003. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 50% of the total catch while only 4% of the catch of greenland halibut comes from hauls where it is less than 50% of the total catch. 75 % of the plaice is on the other hand caught in hauls where plaice is minority of the catches. The figures also shows that 70% of the catch of greenland halibut comes from hauls where nothing else is caught but only 15% of the haddock. Of the species shown in the figure plaice is the one with largest proportion as bycatch while greenland halibut is the one with largest proportion caught in mixed fisheries

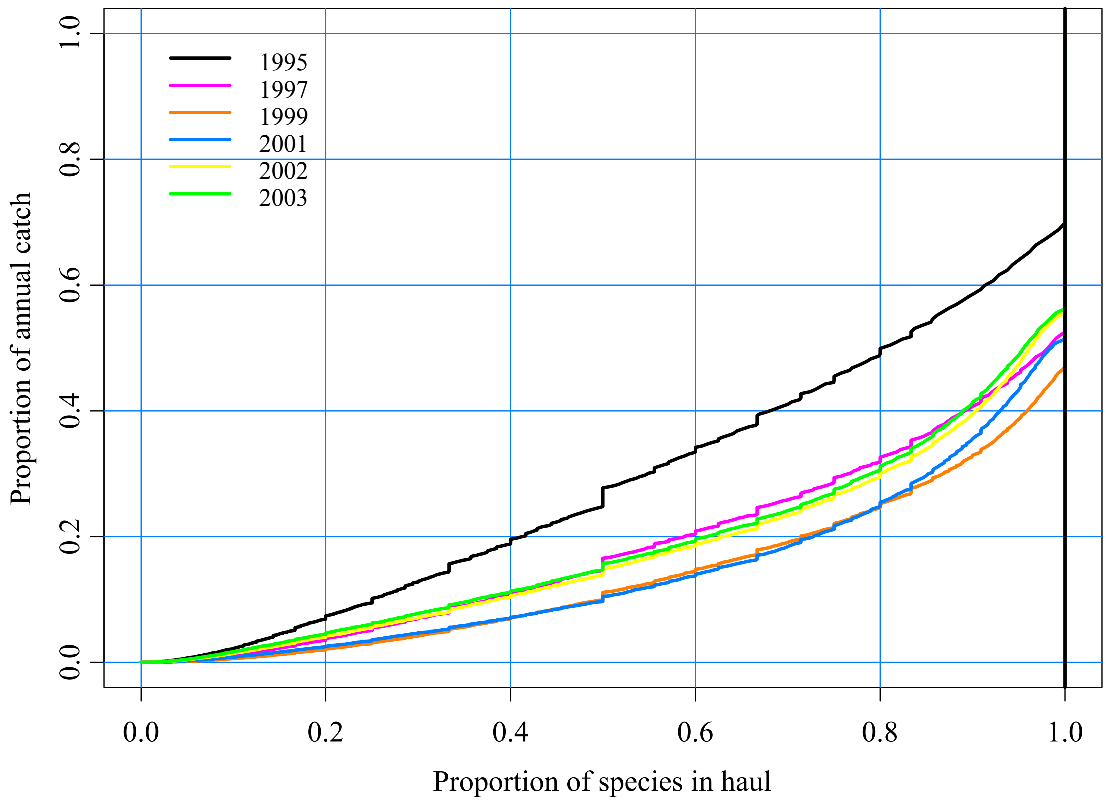


Figure 3.9. Cumulative plot for cod in the bottom trawl fishery.

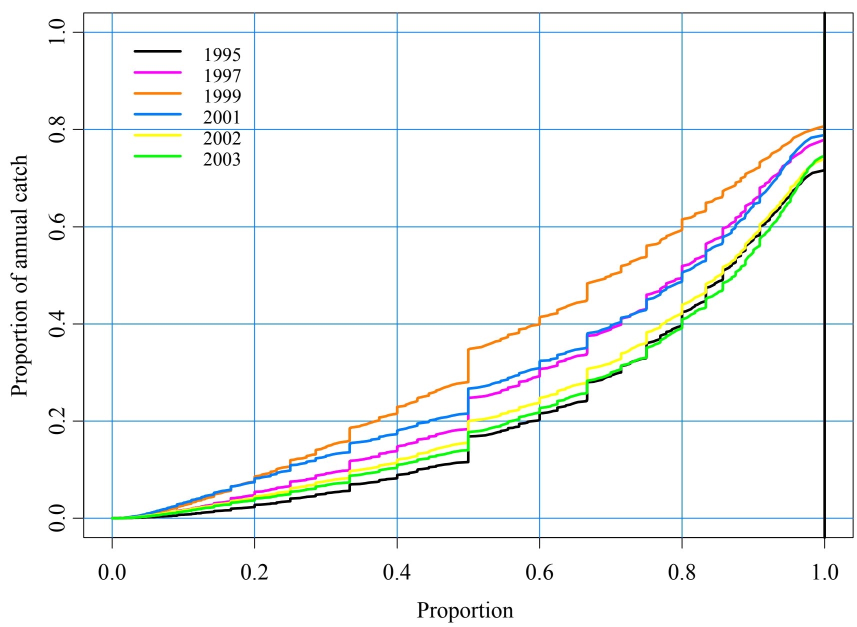


Figure 3.10. Cumulative plot showing haddock catch as proportion of haddock and cod catch in a haul instead as proportion of the total catch as in Figure 3.8-Figure 3.9.

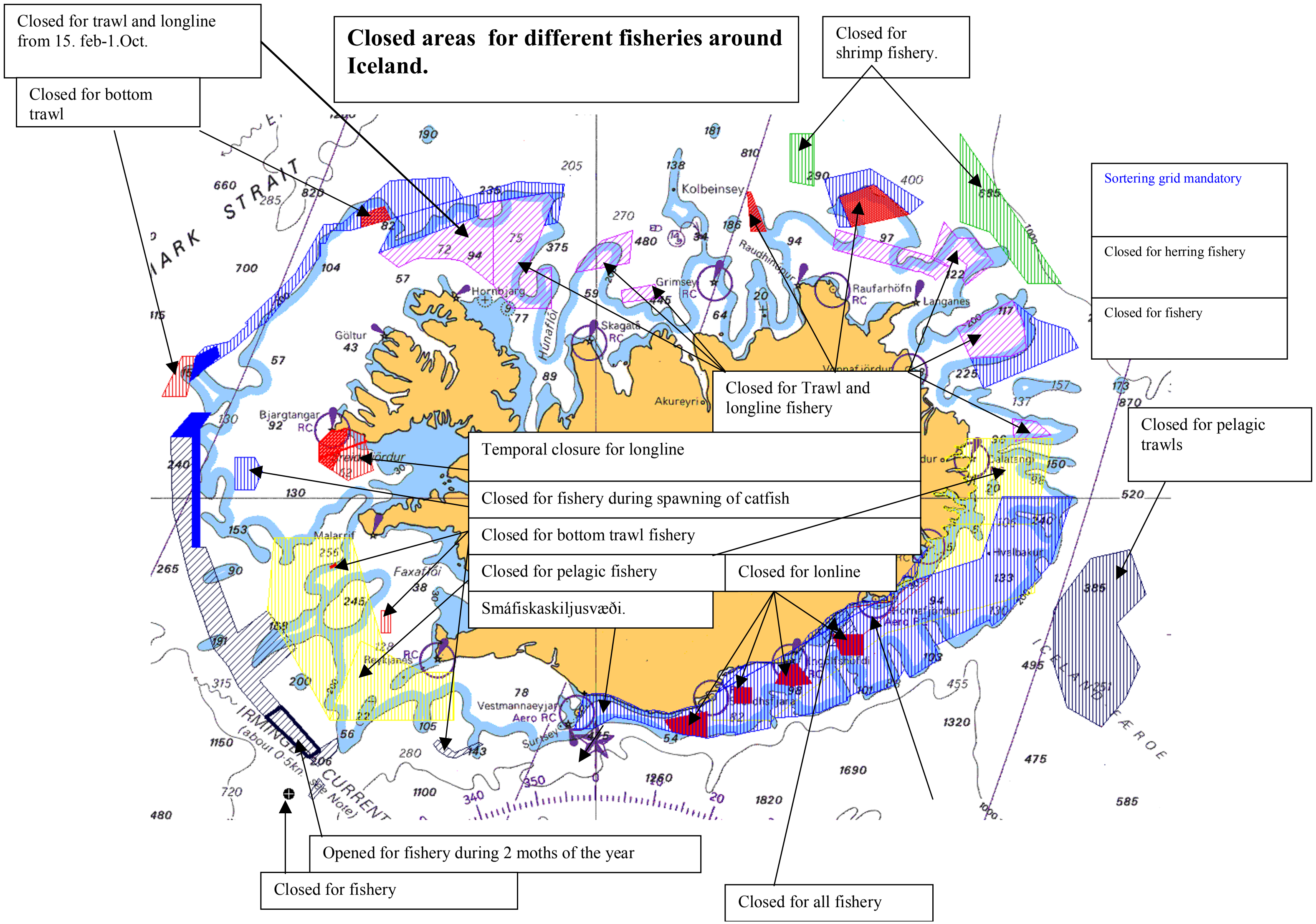


Figure 3.11. Overview of closed areas around Iceland in 2003. The boxes are of differnt nature and can be closed for differnt time period and gear type.

3.2 Saithe in Icelandic waters

This stock was not assessed by NWWG 2003 but an assessment was made at the Marine Research Institute. That assessment included time series analysis (TSA) which has been used in the assessment of this stock but a separable model was chosen for the final assessment run.

3.2.1 Trends in landings

Saithe landings from Icelandic waters (ICES division Va) have increased from a low of ~30 Kt in 1998-2001 to 42 Kt in 2002 and 52 Kt in 2003 (Table 3.2.1.1 and Figure 3.2.1.1). Icelandic landings in the quota year September 2002/August 2003 amounted to 47 467 t, slightly exeeding the national TAC of 45 Kt for the same period. The saithe TAC has increased from 30 Kt in 1997-2001 to 37, 45 and 50 Kt for fishing years 2001/2002, 2002/2003 and 2003/2004, respectively.

Landings of saithe in quota years 2001/2002 and 2003/2004 and in calendar years 2002 and 2003 show that the fishery proceeds at a steady rate, landings in 2004 have reached ~15 Kt, about the same as the remainder of a 50 Kt, which with landings of ~20 Kt in Sep-Des 2004 would lead to total landings close to 50-55 Kt in 2004, depending on TAC given after the 2004 assessment (Figure 3.2.1.2).

3.2.2 Fleets and fishing grounds

More than 85% of landings in 2003 were taken in bottom trawl, 5% in gillnets and on hooks and 2% in Danish seine (Figure 3.2.2.1). The proportion of the catch taken in gillnets has declined from almost a third of the total in 1994 and 1995, while the bottom trawl share has increased.

The main fishing grounds of the bottom trawl fishery are southwest of Reykjanes and off the south east coast and in recent years an area NW of Iceland has become increasingly important (Fig 3.2.2.2). The gillnet fishery is concentrated on spawning grounds south and southwest of Iceland.

Three simple CPUE indices: mean, sum of annual yield over sum of annual effort and median CPUE in trawl hauls where saithe was recorded and in hauls where saithe was more than 50% of the catch are shown in in Figure 3.2.2.3. GLM-indices (similar to those considered by NWWG 2002, not included in report, no WD yet) on the same data showed similar trends or a continuous increase in 1999-2003 for all hauls and a levelling off of the increase in 2002-2003 for indices based on hauls with saithe more than 50% of reported catch.

3.2.3 Catch at age

Compared to last years domestic prognosis (Fjölrit Hafró/MRI mimeo nr 97), considerably higher numbers were caught of age group 5 and lower for age group 6 than expected, their contribution to total catch in number 7% higher and 6% lower than their prognosticated proportion, respectively. For other age groups the difference between estimated numbers in catch-at-age and prognosis made in last years assessment is less, but higher numbers of age group 3 in the catch are worthy of note (Figure 3.2.3.1).

Data from samples from catch of most gear types, collected at a steady rate throughout the year (SÝNÓ-system), were used to calculate catch in numbers at age in total landings in 2003, with the sampling level indicated in the text table below, and used as input for the assessment (Table 3.2.3.1).

Gear/nation	Landings (t)	No. of otolith samples	No. of otoliths read	No. of length samples	No of length measurements
Gillnets	2207	9	450	13	1540
Jiggers	2606	6	278	7	722
Danish seine	1107	3	150	9	409
Bottom trawl	44778	132	6512	237	37158
Other gear	1159	1	50	1	118
Faroese jiggers	143	-	-	-	-
Total	52000	151	7440	267	39947

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. (Table 3.2.3.1 and Figures 3.2.3.2 and 3.2.3.3).

3.2.4 Mean weight at age

Mean weights at age in 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 two fleets used for derivation of catch at age and are then weighted together across the fleets, including Faroese and other foreign catches. Weight at age of the 1996 year class was lower than both the 1985-2002 and 2000-2002 average (Figure 3.2.4.1 and Table 3.2.4.1). Weight at age 3-6 is slightly lower than average for the same periods.

Weight at age in stock is computed based on weights at age from the Icelandic ground fish survey (IGFS), which are available for 2004 to NWWG. The data show similar trends as catch weight at age (Figure 3.2.4.2 and Table 3.2.4.2). A drop in weight-at-age 7 in 2003, corresponding to that in catch weight at age, is apparent, but does not show up again in stock weight at age 8 in 2004. Persistently lower weight at age for year classses 1976, 1984 and 1992 supported estimating migration for those year classes. Yearly estimates were used for age groups 3-8, 1985-2004 averages for age groups 2 and 9-14. A comparsion of SSB calculated on the basis of catch and stock weights is shown in Figure 3.2.5.3.

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 of has been used to describe maturity at age as a function of age and year class strength (NWWG2002, note on maturity modelling). In the domestic/MRI 2003 assessment maturity at age was based on survey data, available for 2004 at the time of assessment. This was used as maturity of age in this assessment (Figure 3.2.5.1). Using a constant ogive for maturity at age might be a more straightforward approach and is presented for comparison (Figure 3.2.5.3) (WD on predictions TO COME).

3.2.6 Migration of saithe

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

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

A tagging program was started in Icelandic waters in 2000 (650-700 of ~12500 tags released have been reported). Use of tag return data in assessment is under study. Number of returns from areas other than the Icelandic shelf has only reached 2. Both were tagged at the same locality off the south east coast, one in 2000 the other in 2001. The first was caught in Faroes waters in 2002, the other west of Scotland in 2004.

As previously estimated migrations have little effect on estimation of current state of the stock, no migration was estimated in the final run (section 3.2.7, compare TSA & ADCAM including migration to to AMCI, 'camera' and 'cadapt' without).

3.2.7 Stock Assessment

3.2.7.1 Tuning input

3.2.7.1.1 Commercial fleets

No commercial fleets were considered for tuning in this assessment. Recent trends CPUE are shown in Figure 2.3.7.1.

3.2.7.1.2 Survey

Survey indices for saithe around Iceland are variable but as they add independent information to data on catch-at-age in commercial they have been included in assessment of the stock since 2002.

In this assessment and the 2003 assessment age disaggregated indices of numbers in the IGFS have been used for tuning. The distribution area of saithe in the survey is similar to the major fishing grounds in 2001-2004 (Figure 3.2.7.1) as has been also observed for the whole time series (NWWG2002). A stratified mean index of survey biomass (Figure 3.2.7.2) shows high fluctuations in 1997-1992 but has in recent years been more stable and show trends not all that different from those in CPUE (Figure 3.2.7.1). Length distributions from the survey show distinct peaks for 2-4 year old saithe that can to some extent be tracked from one year to the next, and similarly in age the distribution of age measurements from the survey (Figures 3.2.7.2 and 3.2.7.3). Correspondence between index at age for the same year class from one year to the next is noisy but improves somewhat if only data from 1992-2004 are studied (Figures 3.2.7.4 and 3.2.7.5).

The stratified indices for saithe have been modified by setting the most extreme outlier equal to the second highest observation. 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. Stratified IGFS index-at-age is given in Table 3.2.7.1.

In the TSA an index based on indices for age groups 3-5 were used as a recruitment index. In ADAPT, separable and AD-CAM models of saithe population dynamics, an age disaggregated index of from the IGFS was used. (Section 3.2.7.2).

3.2.7.2 Estimates of fishing mortality

As has usually be done prior NWWG-meetings, time series analysis (TSA) (Gudmundsson 1994) was used in preliminary assessment runs. This year ADAPT ('cadapt' written in AD-ModelBuilder with R/S utility functions (WGMG2004, Appendix Table D3)), separable models (AMCI and 'camera' written in AD-ModelBuilder with R/S utility functions (WGMG2004, Appendix Table D4)) and AD-CAM (Sections 3.3 and 3.4 of this report) were run as well.

TSA

TSA was run by external expert Guðmundur Guðmundsson of National Bank of Iceland.

As in 2001 and 2002 (and 2003 domestic assessment) saithe migration was estimated. 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 in TSA.

The same migration events as in the NWWG2002 assessment were included and estimated again. The years and ages were selected by studying anomalies in length and weight at age data as well as by comparison of Icelandic catch at age data with catch-at-age for Faroese and Norwegian saithe (see also section 3.2.6). The years and age groups chosen were the ones for which the largest discrepancies in catch at age data had been detected in TSA runs. The strength of the migrations was estimated in TSA. The estimates of migrations were (in units of millions): $N_{10,86}$ = 2.3 , $N_{7,91}$=9.3, $N_{9,93}$=2.5, $N_{7,99}$=1.6, $N_{8,00}$=1.1.

A recruitment index for age group 4 based on IGFS indices of numbers at age 3-5 was used in the TSA . Results from the TSA are given in Table 3.2.7.2.

ADAPT-type model 'cadapt'

A simple ADAPT type model, using Pope's cohort approximation, with IGFS indices of numbers at age 2-8 in 1985-2004 was used in tuning catch-at-age 2-14 in 1985-2004 (with zero catches for age group 2). Estimated parameters were survivors at age 2-14 in 2004 and time-invariant, proportional catchabilities at age 2-6, catchabilities for age groups 7-8 were set the same as for age group 6. Cohorts were initiated on the assumption that catch-at-age-the-oldest-age fished them out. In optimization case weights were kept common for age group elements in the residual matrix, inverse variance weights were calculated in the fit. Estimated parameters and their standard deviations on log scale, as reported by AD-model builder, are given in Table 3.2.7.4. Mean square age group residuals residuals from the model fit, used as inverse age group case weights, are shown in Figure 3.2.7.1.

Separable models AMCI and 'camera'

The domestic assessment in 2003 was based on a separable model Two separable catch-at-age models (AMCI and 'camera') were applied to the data,run with model settings as close as possible. This was done as AMCI has been used in assessment working groups and received more scrutiny than camera which is still under development.

Strict, separable population dynamics (time-invariant commercial selectivity) were modelled with catch-at-age 3-14 in 1985-2003 and IGFS indices of numbers at age 2-8 in 1985-2004 as additional information. Survey catchability model was the same as in 'cadapt', selectivity in catches was estimated for age groups 3-8, set equal to that of age group 8 for age groups 9-14. *Ad hoc* age group case weights in optimization, set *a priori* at mean square age group residual from Shepherd-Nicolson models fit to catch-at-age and index-at-age, are shown in Figure 3.2.7.1. Estimated parameters for the two models with reported AD-ModelBuilder estimates of standard deviations on log-scale are given in Table 3.2.7.5.

In 'camera' the stock was brought forward through the assessment year with a TAC-constraint of 50 Kt but in AMCI a status-quo assumption on F2003-4 was made. Observed (landings) and predicted yields from 'camera', included in optimization, shown in Figure 3.2.7.8 indicate that the model does not follow the TAC-constraint very well (treatment in optimization needs further work), which must be kept in mind when bootstrap distribution of SSB2005 *vs.* F4-9,2004 is studied (Figure 3.2.7.18).

Residuals from AMCI and 'camera' are shown in Figures 3.2.7.9 and 3.2.7.10 and given for AMCI in Table 3.2.7.3.

Retrospective results

Retrospective plots of SSB and F4-9 from TSA, AMCI and 'camera' are shown in Figures 3.2.7.11 and 3.2.7.12, and recruitment at age 3 from AMCI and 'camera' are shown in Figures 3.2.7.13.As TSA includes migration estimation a comparison of SSB and F4-9 is difficult, and the age range assessed is also different. Inclusion of indices-at-age 2-3 in the separable models enables estimation of the incoming year classes.

Terminal estimates

Estimated SSB and F4-9 from TSA, 'cadapt' and 'camera' and of R3 from 'cadapt' AMCI and 'camera' since 1990 are shown in Figure 3.2.7.14 and terminal estimates in Figure 3.2.7.15. Terminal estimates from TSA deviate considerably from the results of ADAPT and separable models.

AD-CAM

Run by Höskuldur Björnsson. with settings as described below:

Settings for saithe

- Nonparametric fishing mortality. Random walk model of fishing mortality with light weight.
- Catch at age data from 1971 to 2003, survey data 1985 – 2004 age 1.
- Ricker SSB-recruitment relationship with linear trend on Rmax first recruitment guess.
- Correlation of residuals of age groups in survey estimated.
- CV of residual in catch and survey estimated.
- Linear relationship for all age groups.
- 5 Migrations estimated.

Prognosis were done using 50kt catch in 2004, 70 in 2005 and 75 after that. The values selected for 2005 and 2006 are the values corresponding to F=0.3 in deterministic projection (Figures 3.2.7.16 and 3.2.7.17).

Comparison of model results

Models, with a range of different assumptions about stock population dynamics, used in the assessment show the same general trends. Available measures of uncertainty from the models are given in a text table below

Summary of terminal estimates and measures of uncertainty from models run in the assessment

	N2004,3		N2004,4			SSB2004		F2003,4-9	
	estimate	cv	est.	cv	sd	est.	sd	est	sd
TSA			73.4		6.4	78.8	28.5	0.354	0.136
'cadapt'	7.3	0.64	76.2	0.39		83.2	17.0	0.345	
AMCI	9.3		79.7			83.2		0.320	
'camera'	9.0		79.6			85.8	14.1	0.317	0.063
AD-CAM	25.5		82.1			78.6		0.349	

Different measures of uncertainty and values missing from the table above are related to differences in model setup and which stock parameters are reported with associated errors in the different models. AD-CAM probability profiles for terminal numbers are shown in Figure 3.2.7.16.

TSA run with the same settings as in NWWG2002 and AD-CAM gave estimates of F_{4-9} in 2003 of 0.35 and spawning stock biomass (SSB) of 79 Kt at the start of 2004. The two separable models and ADAPT were in close agreement, F4-9, 2003 estimated at 0.32 and SSB2004 ~85 Kt.

The separable model 'camera' was used as 'final' run as it is the domestic SPALY, includes more information on incoming year classes and is run by the stock expert.

Fishing mortality and stock in numbers from final run are given in Tables 3.2.7.6 and 3.2.7.7 and stock summary in Table 3.2.7.8.

Estimation of uncertainty

Estimates of standard errors from different assessment models is shown text table above. In many cases the assessment model estimate the logarithms of the variables of interest and in those cases the confidence interval are not symmetric on ordinary scale but the standard error on log scale is a measure of the CV. In table the standard error on the youngest age groups is very high as expected for saithe. The models do though compare quite well and the difference between the models is well within given confidence intervals from the model. The exception is possibly the small 2001 year class that is estimated directly from the survey in 'cadapt' and 'camera' but ADCAM uses results from SSB – Recruitment relationship as a first guess estimating the weight of that initial guess compared to the survey (Figure 3.2.7.16).

A bootstrap of the separable model ('camera'), with 2000 replicates was run. Survey residuals from the model fit were chosen at random in *ad hoc* manner: year blocks of survey log residuals were sampled at random, modelled survey indices multiplied by the bootstrap sample in each replicate. Catch residuals were sampled at random for each age group. A scatter of >1950 pairs of SSB *vs.* F4-9 is shown in Figure 3.2.7.18. This figure is shown here as an example only since treatment of residual between observed and predicted yield needs further work.

3.2.7.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.7.20 and given in Table 3.2.7.8. After a decline from 1970-1977, the spawning stock biomass averaged between 85-110 Kt in 1978-1989 and increased to about 120 Kt in 1990. Since 1992 the spawning stock biomass has declined to a minimum in 1997-2001 of 55-60Kt , which is the lowest SSB recorded. Spawning stock biomass at the beginning of 2004 is estimated at 85Kt.

The 1983-1985 year classes are all well above the 1962-1998 long-term average of 41 million 3 year old recruits. The 1984 year class was among the highest on record at 94 million recruits. The year classes 1986-1997 are below the long term average. The average size of the 1986-1997 year classes is estimated at only 23 million recruits, close to the lower quartile of the historic series of recruitment. Recruitment has improved recently with the exception of year class 2001, year classes 1997-1999 are all estimated above 30 million 3 year old and the 2000 year class is estimated among the highest on record (Figure 3.2.7.20). The scatter of SSB and recruitment is shown in Figure 3.2.7.21.

3.2.8 Prediction of catch and biomass

3.2.8.1 Input data

Predicted catch in 2004 is 50 KT (Section 3.2.1). The input data for the catch projections is shown in Table 3.2.8.1.

For predictions of weight-at-age in stock in 2005-2006 a linear model with stock weight-at-age of the same year class in the previous year and year class strength was used for prediction. Predicted stock weight-at-age in 2005 where used to predict for 2006 and also as input in the weight predictor for catch-weight-at-age.

For predictions weight at age in catches 2004-2006, weight-at-age 4-9 was predicted using survey weight-at-age and catch weight at age of the same year class in the previous year

For short-term predictions, maturity at age was predicted as described in Section 3.2.5. The selection pattern was that estimated in the final separable model run. This average was scaled to the reference F of 2001. Geometric mean recruitment for year classes 1959-2000 (rounded value of 30 million) was used for 3 year olds in 2005-2006. Short term prediction based on these inputs is given in Table 3.2.8.2.

3.2.8.2 Biological reference points

The ACFM set $\mathbf{B}_{pa}$ at 150 Kt, $\mathbf{B}_{lim}$ tentatively at 90 Kt when SSB was calculated with catch-weight-at-age. With survey weights- and maturity-at-age, this corresponds to SSBs of ~100 and ~50 Kt, respectively. $\mathbf{F}_{pa}$ is set at 0.3, $\mathbf{F}_{lim}$ has not been set for this stock. The stock in 2004 is assessed close to or slightly below the proposed $\mathbf{B}_{pa}$ and is likely to have reached 100Kt in 2005. A PA-plot is shown in Figure 3.2.8.1. The scaling of $\mathbf{B}_{pa}$ to 100 Kt may seem *ad hoc* but it circumvents having to estimate hockey-stick/segmented regressions to the SSB/R data for which some rather unfortunate issues remain, maturity at age, whether or not to estimate migration and if they are what about migration events prior to those previously estimated and finally should autocorrelation be included in a SSB/R relationship.

3.2.8.3 Medium term projections

No medium term projections were made at NWWG 2004. Stochastic short term predictions were made in AD-CAM (Figure 3.2.7.17).

3.2.9 Management considerations

It is advisable not to increase fishing mortality above $\mathbf{F}_{pa}$. The probability that B2004 was less than $\mathbf{B}_{lim}$ is not negligible, but the models run agree that for B2005 that probability is much less.

3.2.10 Comments on the assessment

The stock was overestimated until in the 1997 assessment but has been more stable in more recent assessments. It has recovered from the lowest observed stock size in 1997-2001 and is now assessed as likely to have reached $\mathbf{B}_{pa}$ in 2005 The reference F4-9 values have shown a gradual decrease and are estimated close to $\mathbf{F}_{pa}$ in 2003-4b Recruitment in recent years has shown an increase (1998-2000 year classes all above average).

In 2002 the stock was assessed with TSA, using IGFS survey indices for age groups 3-5 as a recruitment index. ADAPT bootstrap bias corrected numbers at age 3 were used in projections. In 2003 the stock was only assessed domestically, with a separable model tuned with IGFS age-disaggregated indices. A SPALY of that assessment,. which corresponds closely with an AMCI run with similar settings, is presented here as a final run. Migration was included in TSA but not estimated in separable models as the contribution of the most recent migrating year class (1992) is now negligible.

Table 3.2.1.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2001, as officially reported to ICES with working group estimates where data are missing

SAITHE Va

Country	1997	1998	1999	2000	2001	2002	2003*
Faroe Islands	716	997	700	228**	128**	366**	143
Germany	-	3	2	1	14	6	56
Iceland	36,548	30,531	30,583	32,914	31,854	41,687	51,857
Norway	-	-	6	1	44*	3*	164
UK (E/W/NI)	-	-	1	2	23	7	...
UK (Scotland)	-	-	1	-	-	2	...
United Kingdom							35
Total	37,264	31,531	31,293				
WG estimate				33,146	32,063	42,071	52091

*Preliminary.
**WG estimate.

Table 3.2.3.1. Saithe in division Va. Catch in numbers (thousands) 1962--2001.

year\age	3	4	5	6	7	8	9	10	11	12	13	14
1962	1534	4999	3861	3744	1019	419	280	245	143	83	28	15
1963	6134	2314	2518	2902	1869	797	329	271	254	193	75	22
1964	3041	11712	3586	2301	1185	559	237	145	107	92	59	33
1965	2003	4825	7589	2158	1324	642	353	164	102	85	81	52
1966	940	2090	3283	4117	1285	739	390	235	133	69	102	73
1967	1116	3400	5591	4326	4931	1200	550	330	169	73	104	65
1968	836	2605	3563	6318	3207	3008	621	343	215	103	79	41
1969	1572	4395	5706	6518	9136	2796	1843	461	100	110	32	44
1970	287	5622	4999	6126	6178	5934	1689	1191	299	171	92	70
1971	476	3031	10221	6736	6694	5045	4272	959	887	349	96	63
1972	565	3786	6524	8646	4178	3320	2098	1421	361	328	79	68
1973	219	1768	5155	7077	7372	2616	1635	871	412	231	80	22
1974	1269	3404	2348	3164	3452	3384	1303	824	351	141	43	13
1975	526	2997	2479	1829	3496	2994	1434	710	325	176	100	36
1976	329	3234	3045	2530	2154	2367	1530	1064	295	191	94	68
1977	59	2099	2858	1801	1036	1068	1528	958	538	166	71	12
1978	548	1145	2435	1556	1275	961	537	575	476	279	139	91
1979	480	3764	1991	3616	1566	718	292	669	589	489	150	72
1980	275	2540	5214	2596	2169	1341	387	262	155	112	64	33
1981	203	1325	3503	5404	1457	1415	578	242	61	154	135	128
1982	508	1092	2804	4845	4293	1215	975	306	59	35	48	46
1983	107	1750	1065	2455	4454	2311	501	251	38	12	2	4
1984	53	657	800	1825	2184	3610	844	376	291	135	185	226
1985	376	4014	3366	1958	1536	1172	747	479	74	23	72	71
1986	3108	1400	4170	2665	1550	1116	628	1549	216	51	30	14
1987	956	5135	4428	5409	2915	1348	661	496	498	58	27	48
1988	1318	5067	6619	3678	2859	1775	845	226	270	107	24	1
1989	315	4313	8471	7309	1794	1928	848	270	191	135	76	10
1990	143	1692	5471	10112	6174	1816	1087	380	151	55	76	37
1991	198	874	3613	6844	10772	3223	858	838	228	40	6	5
1992	242	2928	3844	4355	3884	4046	1290	350	196	56	54	15
1993	657	1083	2841	2252	2247	2314	3671	830	223	188	81	12
1994	702	2955	1770	2603	1377	1243	1263	2009	454	158	188	82
1995	1573	1853	2661	1807	2370	905	574	482	521	106	35	13
1996	1102	2608	1868	1649	835	1233	385	267	210	232	141	74
1997	603	2960	2766	1651	1178	599	454	125	95	114	77	43
1998	183	1289	1767	1545	1114	658	351	265	120	81	85	85
1999	989	732	1564	2176	1934	669	324	140	72	25	28	22
2000	850	2383	896	1511	1612	1806	335	173	57	33	17	7
2001	1223	2619	2184	591	977	943	819	186	94	28	28	13
2002	1187	4190	3147	2970	519	820	570	309	101	27	15	11
2003	2262	4320	5973	2448	1924	282	434	287	195	27	29	15

Table 3.2.4.1A. Saithe in Division Va. Mean weight at age in the catches.

year\age	3	4	5	6	7	8	9	10	11	12	13	14
1962	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1963	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1964	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1965	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1966	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1967	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1968	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1969	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1970	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1971	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1972	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1973	1.12	1.96	3.05	4.34	5.38	6.55	7.64	8.63	9.52	10.29	10.97	11.55
1974	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1975	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1976	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1977	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1978	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1979	1.12	1.76	2.73	4.29	5.54	7.27	8.42	9.41	10.00	10.56	11.87	13.12
1980	1.43	1.98	2.67	3.69	5.41	6.32	7.21	8.57	9.15	9.62	10.07	11.04
1981	1.59	2.04	2.70	3.53	4.54	6.25	6.99	8.20	9.54	9.09	9.35	10.23
1982	1.55	2.19	3.02	3.18	5.11	6.20	7.26	7.92	8.92	10.13	9.45	10.54
1983	1.53	2.22	3.17	4.27	4.11	5.98	7.57	8.67	8.80	9.04	11.14	9.82
1984	1.65	2.43	3.33	4.68	5.47	4.97	7.41	8.18	8.77	8.83	11.01	11.13
1985	1.61	2.17	3.17	3.92	4.70	6.41	6.49	8.35	9.40	10.34	11.03	10.64
1986	1.45	2.19	2.96	4.40	5.49	6.41	7.57	6.49	9.62	10.46	11.75	11.90
1987	1.52	1.72	2.67	3.84	5.08	6.19	7.33	8.03	7.97	9.62	12.25	11.66
1988	1.26	2.02	2.51	3.48	4.72	5.93	7.52	8.44	8.75	9.56	10.82	14.10
1989	1.40	2.02	2.19	3.05	4.51	5.89	7.17	8.85	10.17	10.39	12.52	11.92
1990	1.65	1.98	2.57	3.02	4.08	5.74	7.04	7.56	8.85	10.65	11.67	11.43
1991	1.22	1.94	2.43	3.16	3.63	4.97	6.63	7.70	9.06	9.12	10.92	11.34
1992	1.27	1.91	2.58	3.29	4.15	4.87	6.17	7.93	8.35	9.03	11.57	9.47
1993	1.38	2.14	2.74	3.64	4.40	5.42	5.32	7.01	8.07	10.05	9.11	11.59
1994	1.44	1.84	2.65	3.51	4.91	5.54	6.82	6.37	8.34	9.77	10.53	11.26
1995	1.37	1.98	2.77	3.72	4.62	5.85	6.42	7.36	6.82	8.31	9.12	11.91
1996	1.23	1.76	2.67	3.80	4.90	5.68	7.18	7.73	9.26	8.32	10.50	11.89
1997	1.33	1.94	2.41	3.91	5.03	6.17	7.20	7.88	8.86	9.65	9.62	10.88
1998	1.35	1.97	2.94	3.42	4.85	5.96	6.93	7.78	8.70	9.56	10.16	10.38
1999	1.28	2.11	2.75	3.50	3.83	5.82	7.07	8.08	8.87	10.55	10.82	11.30
2000	1.37	1.93	2.75	3.27	4.17	4.45	6.79	8.22	9.37	9.82	10.93	12.20
2001	1.28	1.88	2.60	3.70	4.42	5.54	5.64	7.99	9.06	9.94	10.63	10.99
2002	1.31	1.95	2.57	3.27	4.87	5.37	6.83	7.07	9.24	9.66	10.09	11.63
2003	1.31	1.91	2.55	3.34	4.07	5.79	7.16	8.13	8.05	10.19	10.95	11.78
2004*	1.37	1.90	2.55	3.33	4.40	5.41	6.80	7.73	8.78	9.74	10.79	11.49
2005*	1.37	2.02	2.50	3.33	4.31	5.57	6.80	7.73	8.78	9.74	10.79	11.49

* Predicted

Table 3.2.4.1B. Saithe in Division Va. Mean weight at age in the stock.

year\age	2	3	4	5	6	7	8	9	10	11	12	13	14
1962	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1963	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1964	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1965	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1966	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1967	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1968	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1969	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1970	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1971	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1972	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1973	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1974	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1975	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1976	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1977	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1978	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1979	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1980	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1981	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1982	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1983	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1984	0.29	0.79	1.37	2.04	2.96	4.09	5.29	6.32	7.94	9.78	11.54	12.44	13.91
1985	0.27	0.97	1.69	2.15	3.10	3.99	4.98	6.32	7.94	9.78	11.54	12.44	13.91
1986	0.25	0.85	1.42	2.27	3.29	4.66	5.81	6.32	7.94	9.78	11.54	12.44	13.91
1987	0.19	0.88	1.17	1.72	3.39	4.20	5.92	6.32	7.94	9.78	11.54	12.44	13.91
1988	0.22	0.78	1.44	2.01	2.77	4.26	5.13	6.32	7.94	9.78	11.54	12.44	13.91
1989	0.24	0.65	1.41	1.80	2.81	3.66	5.01	6.32	7.94	9.78	11.54	12.44	13.91
1990	0.26	0.75	1.27	2.14	2.61	4.37	5.87	6.32	7.94	9.78	11.54	12.44	13.91
1991	0.34	0.80	1.37	1.88	2.65	2.92	4.57	6.32	7.94	9.78	11.54	12.44	13.91
1992	0.34	0.89	1.40	2.02	2.97	3.77	4.21	6.32	7.94	9.78	11.54	12.44	13.91
1993	0.32	0.77	1.48	2.07	2.93	3.73	4.79	6.32	7.94	9.78	11.54	12.44	13.91
1994	0.23	0.85	1.61	2.77	3.39	4.72	6.20	6.32	7.94	9.78	11.54	12.44	13.91
1995	0.36	0.74	1.22	2.33	3.64	4.27	6.08	6.32	7.94	9.78	11.54	12.44	13.91
1996	0.27	0.90	1.33	1.97	2.74	5.25	5.09	6.32	7.94	9.78	11.54	12.44	13.91
1997	0.39	0.74	1.30	1.78	2.73	4.23	5.75	6.32	7.94	9.78	11.54	12.44	13.91
1998	0.37	0.84	1.16	1.80	2.53	3.93	5.37	6.32	7.94	9.78	11.54	12.44	13.91
1999	0.28	0.77	1.47	2.13	2.87	3.55	5.52	6.32	7.94	9.78	11.54	12.44	13.91
2000	0.34	0.82	1.35	2.23	2.71	3.61	3.87	6.32	7.94	9.78	11.54	12.44	13.91
2001	0.35	0.77	1.52	2.12	3.39	4.22	5.12	6.32	7.94	9.78	11.54	12.44	13.91
2002	0.23	0.74	1.27	2.20	3.37	4.59	5.38	6.32	7.94	9.78	11.54	12.44	13.91
2003	0.26	0.60	1.18	1.89	2.68	3.67	5.30	6.32	7.94	9.78	11.54	12.44	13.91
2004	0.29	0.84	1.26	1.88	2.81	4.24	5.65	6.32	7.94	9.78	11.54	12.44	13.91
2005	0.29	0.71	1.50	1.77	2.78	3.97	5.38	6.32	7.94	9.78	11.54	12.44	13.91

* Predicted

Table 3.2.5.1B. Saithe in Division Va. Sexual maturity at age, mean values from IGFS survey.

year\age	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14
1985	0	0.01	0.05	0.23	0.51	0.71	0.78	0.76	1	1	1	1	1
1986	0	0	0.06	0.2	0.47	0.7	0.81	0.84	1	1	1	1	1
1987	0	0	0.03	0.22	0.42	0.66	0.8	0.87	1	1	1	1	1
1988	0	0.01	0.02	0.14	0.46	0.61	0.77	0.85	1	1	1	1	1
1989	0	0.01	0.04	0.08	0.32	0.65	0.73	0.83	1	1	1	1	1
1990	0	0.01	0.06	0.17	0.21	0.5	0.76	0.8	1	1	1	1	1
1991	0	0.01	0.07	0.23	0.38	0.36	0.64	0.83	1	1	1	1	1
1992	0	0.01	0.06	0.27	0.47	0.57	0.49	0.72	1	1	1	1	1
1993	0	0.01	0.08	0.23	0.52	0.66	0.7	0.59	1	1	1	1	1
1994	0	0.01	0.08	0.29	0.47	0.7	0.77	0.77	1	1	1	1	1
1995	0	0.01	0.08	0.28	0.55	0.66	0.8	0.83	1	1	1	1	1
1996	0	0.01	0.06	0.29	0.54	0.73	0.77	0.86	1	1	1	1	1
1997	0	0.01	0.07	0.23	0.54	0.71	0.82	0.83	1	1	1	1	1
1998	0	0.01	0.08	0.25	0.47	0.72	0.81	0.87	1	1	1	1	1
1999	0	0.01	0.09	0.29	0.5	0.66	0.82	0.87	1	1	1	1	1
2000	0	0.01	0.06	0.33	0.55	0.68	0.77	0.87	1	1	1	1	1
2001	0	0.01	0.06	0.25	0.59	0.72	0.79	0.83	1	1	1	1	1
2002	0	0.01	0.05	0.23	0.49	0.75	0.82	0.85	1	1	1	1	1
2003	0	0	0.04	0.19	0.47	0.68	0.84	0.87	1	1	1	1	1
2004	0	0.01	0.02	0.16	0.4	0.66	0.78	0.89	1	1	1	1	1
2005*	0	0.00	0.09	0.07	0.35	0.59	0.77	0.84	1	1	1	1	1
2006*	0	0.01	0.03	0.32	0.18	0.54	0.72	0.83	1	1	1	1	1

Table 3.2.5.1B. Saithe in Division Va. Sexual maturity at age, mean values from IGFS survey

age	3	4	5	6	7	8	9	10	11	12	13	14
maturity	0.01	0.06	0.23	0.47	0.66	0.76	0.82	0.9	0.93	0.96	1	1

Table 3.2.7.1. Saithe in Division Va. IGFS indices of numbers at age used for tuning in separable models.

year\age	2	3	4	5	6	7	8
1985	0.61	0.58	3.06	5.18	1.73	1.03	0.47
1986	2.33	2.44	2.1	2.1	1.41	0.6	0.26
1987	0.39	11.54	12.94	6.31	3.71	2.89	0.74
1988	0.31	0.48	2.69	2.72	1.62	0.88	0.35
1989	1.43	3.96	4.98	6.46	2.42	1.74	0.89
1990	0.35	1.69	4.83	6.2	11.95	3.17	1.13
1991	0.22	1.4	1.69	2.15	1.08	2.38	0.28
1992	0.14	0.89	5.68	5.45	2.76	2.62	1.86
1993	1.27	11.04	2	6.79	2.4	2.24	1.02
1994	0.82	0.73	1.89	1.73	1.94	0.52	0.83
1995	0.48	1.97	1.09	0.5	0.28	0.33	0.09
1996	0.13	0.51	3.71	1.11	0.99	0.57	0.94
1997	0.32	0.9	4.66	3.9	0.94	0.39	0.15
1998	0.11	1.64	2.3	2.5	1.23	0.69	0.29
1999	0.75	3.7	0.92	1.23	1.64	0.56	0.16
2000	0.38	2.01	2.51	0.6	0.84	0.52	0.44
2001	0.89	1.9	2.6	1.58	0.2	0.22	0.38
2002	1.05	2.22	2.93	3.04	2.14	0.41	0.46
2003	0.05	9.6	4.99	2.9	1.34	0.75	0.2
2004	0.91	1.38	8.98	5.8	4.19	1.44	0.8

Table 3.2.7.2. Saithe in Division Va. Output from TSA run with average IGFS index for year classess as 3, 4, and 5 year olds (3-4 for year class 2000 in 2004) as a index of recruitment as 4 year olds. Note maturity at age is from catches.

STANDARDIZED CATCH PREDICTION ERRORS

1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	-1.43	0.38	-0.04	0.05	0.70	-0.15	1.59	-0.65
1987	-0.11	2.98	2.34	1.41	1.57	1.06	1.30	-0.78
1988	0.30	-0.36	0.25	-1.04	0.76	2.29	-1.10	1.02
1989	1.29	0.62	0.64	-1.69	-0.13	0.12	-0.79	0.59
1990	-1.23	-0.31	2.01	1.75	1.99	0.66	-0.37	-0.30
1991	-1.31	0.24	1.06	0.56	0.03	0.80	2.13	0.42
1992	0.73	1.86	0.45	-0.90	-1.44	-0.86	-0.36	-0.91
1993	0.19	-2.67	-1.90	-0.61	0.66	1.01	0.83	0.83
1994	0.18	-0.29	-1.80	-1.66	-0.75	0.36	0.65	0.42
1995	1.14	-1.80	0.62	0.41	-0.24	-1.11	-1.20	-2.05
1996	-0.15	-0.84	-1.92	-1.90	-0.91	-1.06	-0.64	-0.77
1997	0.12	0.06	0.04	-1.06	-0.58	-2.04	-2.18	-1.51
1998	-0.56	-1.44	-1.12	-0.28	-0.80	0.32	-0.45	0.57
1999	-0.75	1.11	1.60	0.65	-0.44	-1.20	-1.19	-2.25
2000	-0.39	-0.12	1.04	0.29	1.06	-0.42	-0.03	-0.73
2001	-0.05	-0.60	-1.14	-0.45	-0.31	-0.06	0.22	0.48
2002	0.85	0.64	2.24	0.02	1.39	0.45	-1.33	0.10
2003	-0.05	1.68	-0.32	0.01	-0.76	1.16	0.32	-0.15
2004	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SKEWNESS AND KURTOSIS
0.079 -0.584

VARIANCE AT AGE

0.5958 1.7345 1.8666 1.0515 0.9089 1.0621 1.2294 0.9803

VARIANCE AT YEAR

0.7074 2.7799 1.1763 0.7924 1.6652 1.0716 1.0943 1.7500 0.9267 1.4984

VARIANCE AT YEAR

1.3740 1.5815 0.6229 1.6125 0.3957 0.2819 1.2603 0.6242

CORRELATION WITHIN COHORTS 0.03

CORRELATION WITHIN AGES AND YEARS 0.46 0.03

FINAL ESTIMATES

STOCK

	4	5	6	7	8	9	10	11	BIOM	SPAWN
1985	37582.	21450.	10162.	5636.	3858.	4704.	1511.	339.	270.9	167.7
1986	28457.	27283.	14270.	6473.	3357.	2171.	3705.	870.	309.1	206.6
1987	59831.	21261.	18753.	9112.	3789.	1811.	1176.	1942.	339.3	219.5
1988	53225.	44339.	13610.	10576.	4766.	1909.	896.	593.	369.3	200.5
1989	46834.	39354.	29752.	8082.	5781.	2354.	907.	455.	369.0	235.5
1990	25567.	34402.	25246.	17805.	4673.	3064.	1203.	469.	353.2	263.4
1991	17906.	19206.	22540.	15408.	8842.	2245.	1501.	595.	284.3	209.0
1992	23378.	13666.	12349.	12031.	3545.	4112.	1038.	644.	226.7	190.6
1993	11912.	16343.	7756.	6320.	5987.	9194.	2058.	517.	226.2	195.3
1994	15676.	8718.	10302.	4215.	3090.	2814.	4250.	959.	180.2	154.4
1995	14434.	10320.	5574.	6036.	2135.	1355.	1163.	1745.	147.4	131.0
1996	14059.	9822.	6060.	2996.	2815.	960.	625.	545.	121.4	95.6
1997	19819.	9454.	6336.	3524.	1613.	1225.	427.	276.	128.3	101.9
1998	13472.	13548.	5607.	3692.	1868.	824.	620.	225.	127.1	102.4
1999	6216.	9606.	9173.	5820.	1993.	907.	374.	265.	117.3	99.9
2000	21238.	4337.	6349.	5594.	4749.	1043.	479.	196.	131.0	105.8
2001	21934.	15136.	2788.	3845.	3066.	2381.	543.	249.	144.9	114.5
2002	36151.	15665.	10197.	1744.	2227.	1647.	1225.	282.	187.1	142.0
2003	36888.	25883.	9927.	5872.	934.	1143.	852.	652.	219.3	167.7
2004	73408.	26249.	16174.	5808.	3157.	491.	582.	442.	314.9	230.4

Table 3.2.7.2 (Cont'd)

STANDARD DEVIATION OF STOCK ESTIMATES

1985	1538.	917.	478.	159.	112.	91.	65.	41.	-1.0	-1.0
1986	1149.	1177.	653.	327.	128.	99.	78.	55.	-1.0	-1.0
1987	2257.	890.	841.	449.	213.	96.	77.	100.	-1.0	-1.0
1988	3386.	1781.	575.	515.	267.	132.	69.	53.	-1.0	-1.0
1989	1703.	2635.	1284.	380.	340.	176.	91.	48.	-1.0	-1.0
1990	957.	1284.	1825.	837.	255.	231.	126.	62.	-1.0	-1.0
1991	702.	760.	932.	1191.	485.	151.	146.	75.	-1.0	-1.0
1992	868.	559.	541.	587.	780.	315.	104.	88.	-1.0	-1.0
1993	486.	665.	338.	324.	372.	552.	222.	67.	-1.0	-1.0
1994	631.	378.	500.	238.	217.	252.	422.	144.	-1.0	-1.0
1995	616.	475.	267.	346.	166.	158.	190.	310.	-1.0	-1.0
1996	1121.	461.	348.	180.	230.	113.	109.	125.	-1.0	-1.0
1997	956.	860.	335.	249.	129.	167.	85.	76.	-1.0	-1.0
1998	735.	738.	621.	232.	170.	90.	119.	57.	-1.0	-1.0
1999	495.	548.	550.	454.	165.	122.	66.	83.	-1.0	-1.0
2000	1886.	383.	418.	406.	321.	114.	82.	43.	-1.0	-1.0
2001	2447.	1498.	301.	318.	291.	233.	77.	49.	-1.0	-1.0
2002	3932.	1935.	1150.	232.	246.	225.	187.	55.	-1.0	-1.0
2003	6443.	3207.	1555.	917.	180.	192.	168.	136.	22.3	16.9
2004	8687.	5216.	2522.	1182.	718.	141.	159.	130.	28.5	22.0

FISHING MORTALITY RATES

	4	5	6	7	8	9	10	11	FGBAR	FBAR
1985	0.117	0.207	0.249	0.319	0.376	0.052	0.356	0.283	0.183	0.220
1986	0.079	0.173	0.246	0.331	0.417	0.413	0.446	0.422	0.240	0.277
1987	0.099	0.246	0.373	0.446	0.480	0.503	0.485	0.460	0.315	0.358
1988	0.102	0.198	0.321	0.404	0.505	0.544	0.478	0.492	0.299	0.346
1989	0.107	0.245	0.308	0.343	0.434	0.471	0.459	0.463	0.288	0.318
1990	0.086	0.223	0.443	0.499	0.526	0.506	0.499	0.507	0.323	0.380
1991	0.070	0.240	0.429	0.907	0.565	0.570	0.646	0.634	0.358	0.464
1992	0.131	0.350	0.467	0.499	0.915	0.492	0.496	0.538	0.411	0.476
1993	0.109	0.241	0.389	0.502	0.550	0.568	0.559	0.560	0.342	0.393
1994	0.162	0.245	0.328	0.457	0.569	0.614	0.624	0.598	0.357	0.396
1995	0.177	0.272	0.393	0.518	0.556	0.530	0.515	0.499	0.377	0.408
1996	0.179	0.233	0.306	0.393	0.529	0.520	0.516	0.506	0.334	0.360
1997	0.179	0.294	0.333	0.404	0.449	0.431	0.412	0.427	0.333	0.348
1998	0.123	0.187	0.302	0.402	0.468	0.518	0.518	0.510	0.296	0.333
1999	0.159	0.212	0.295	0.418	0.443	0.432	0.435	0.422	0.304	0.326
2000	0.139	0.239	0.301	0.401	0.491	0.451	0.451	0.447	0.310	0.337
2001	0.136	0.192	0.269	0.344	0.422	0.463	0.454	0.451	0.279	0.304
2002	0.133	0.255	0.352	0.425	0.463	0.456	0.429	0.444	0.320	0.347
2003	0.140	0.270	0.336	0.421	0.442	0.474	0.457	0.447	0.322	0.347
2004	0.137	0.255	0.337	0.413	0.447	0.447	0.447	0.447	0.315	0.340

VPA - F

1985	0.125	0.199	0.245	0.332	0.353	0.176	0.485	0.283	0.238
1986	0.057	0.185	0.239	0.312	0.429	0.325	0.661	0.422	0.258
1987	0.103	0.258	0.386	0.445	0.492	0.490	0.461	0.460	0.362
1988	0.065	0.186	0.355	0.363	0.539	0.663	0.307	0.492	0.362
1989	0.113	0.147	0.322	0.293	0.447	0.539	0.459	0.463	0.310
1990	0.077	0.204	0.262	0.496	0.543	0.490	0.496	0.507	0.345
1991	0.056	0.233	0.423	0.491	0.526	0.538	0.895	0.634	0.378
1992	0.156	0.368	0.485	0.454	0.344	0.414	0.439	0.538	0.370
1993	0.106	0.224	0.383	0.500	0.541	0.604	0.515	0.560	0.393
1994	0.224	0.251	0.329	0.429	0.575	0.650	0.804	0.598	0.409
1995	0.157	0.322	0.438	0.564	0.560	0.577	0.557	0.499	0.436
1996	0.131	0.235	0.339	0.371	0.655	0.495	0.587	0.506	0.371
1997	0.185	0.200	0.335	0.432	0.499	0.539	0.294	0.427	0.365
1998	0.112	0.161	0.164	0.398	0.460	0.621	0.709	0.510	0.319
1999	0.146	0.193	0.303	0.317	0.443	0.433	0.544	0.422	0.306
2000	0.129	0.267	0.289	0.386	0.552	0.417	0.436	0.447	0.340
2001	0.147	0.168	0.283	0.308	0.410	0.525	0.432	0.451	0.307
2002	0.128	0.263	0.361	0.431	0.460	0.468	0.384	0.444	0.352
2003	0.140	0.270	0.336	0.421	0.442	0.474	0.457	0.447	0.347

Table 3.2.7.2 (Cont'd)

STANDARD DEVIATIONS OF LOG(F)

1985	0.09	0.08	0.07	0.07	0.08	0.09	0.10	0.11	-1.000
1986	0.07	0.08	0.07	0.07	0.08	0.08	0.10	0.11	-1.000
1987	0.09	0.09	0.08	0.07	0.08	0.08	0.10	0.11	-1.000
1988	0.11	0.07	0.07	0.07	0.08	0.09	0.10	0.12	-1.000
1989	0.11	0.09	0.07	0.06	0.08	0.09	0.11	0.12	-1.000
1990	0.06	0.07	0.08	0.07	0.08	0.09	0.10	0.12	-1.000
1991	0.06	0.07	0.07	0.07	0.08	0.09	0.11	0.12	-1.000
1992	0.09	0.07	0.06	0.06	0.08	0.10	0.11	0.12	-1.000
1993	0.09	0.04	0.05	0.06	0.08	0.09	0.11	0.12	-1.000
1994	0.07	0.06	0.05	0.06	0.07	0.09	0.10	0.12	-1.000
1995	0.11	0.04	0.06	0.06	0.07	0.08	0.10	0.11	-1.000
1996	0.08	0.06	0.05	0.06	0.07	0.08	0.11	0.12	-1.000
1997	0.08	0.08	0.07	0.06	0.07	0.08	0.10	0.11	-1.000
1998	0.07	0.07	0.08	0.07	0.08	0.09	0.11	0.12	-1.000
1999	0.06	0.11	0.10	0.08	0.08	0.09	0.10	0.12	-1.000
2000	0.10	0.10	0.10	0.09	0.09	0.10	0.12	0.13	-1.000
2001	0.12	0.12	0.11	0.12	0.12	0.13	0.15	0.15	-1.000
2002	0.17	0.14	0.15	0.15	0.16	0.17	0.17	0.18	-1.000
2003	0.19	0.16	0.16	0.19	0.23	0.24	0.24	0.24	0.136
2004	0.27	0.21	0.20	0.23	0.27	0.27	0.27	0.27	0.157

STATE VECTORS

1985	-1.42	-1.40	0.25
1986	-1.30	-1.50	0.13
1987	-1.28	-1.47	0.41
1988	-1.26	-1.36	0.07
1989	-1.20	-1.75	-0.21
1990	-1.13	-2.10	-0.24
1991	-1.07	-1.51	-0.11
1992	-1.11	-1.48	0.28
1993	-1.10	-1.16	0.91
1994	-1.10	-0.96	0.78
1995	-1.14	-0.84	1.00
1996	-1.18	-0.74	0.57
1997	-1.23	-1.13	0.91
1998	-1.25	-0.89	0.89
1999	-1.25	-0.99	0.72
2000	-1.27	-0.98	0.82
2001	-1.22	-1.05	0.33
2002	-1.20	-1.01	0.25
2003	-1.20	-1.01	0.25
2004	-1.20	-1.01	0.25

Table 3.2.7.3A. Saithe in Division Va. Log catch residuals from AMCI.

year\age	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	MeanSqLog
1985	-0.51	0.33	-0.02	-0.09	0.12	-0.06	-0.46	0.45	-0.01	-0.51	0.11	0.24	0.09
1986	0.89	-0.59	-0.04	-0.28	-0.17	0.16	-0.18	0.78	0.16	0.12	0.59	-0.85	0.25
1987	-0.90	-0.09	0.08	0.12	-0.10	0.01	0.10	0.05	0.11	-0.69	0.28	1.23	0.24
1988	0.27	-0.34	0.06	0.17	-0.04	0.11	0.40	-0.12	0.30	-0.58	-0.38	-1.88	0.37
1989	-0.72	0.17	-0.12	0.24	-0.28	0.05	0.00	-0.12	0.34	0.23	0.04	0.00	0.07
1990	-1.19	-0.45	-0.01	0.02	0.22	0.10	-0.01	-0.29	-0.18	-0.39	0.50	0.51	0.20
1991	-1.31	-0.77	-0.07	0.22	0.29	0.00	-0.07	0.31	-0.22	-0.94	-1.70	-1.24	0.66
1992	-0.29	0.14	0.48	0.27	0.01	-0.11	-0.18	-0.23	-0.41	-0.89	0.43	0.33	0.15
1993	0.39	-0.22	-0.30	-0.07	-0.21	-0.09	0.36	-0.06	-0.12	0.12	0.37	0.02	0.05
1994	0.40	0.45	-0.14	-0.39	-0.35	-0.34	-0.08	0.37	-0.05	0.15	1.05	1.60	0.38
1995	0.64	0.17	0.18	0.13	-0.01	-0.03	-0.22	-0.16	-0.09	-0.61	-0.14	-0.16	0.08
1996	0.54	-0.07	-0.01	-0.08	-0.20	0.02	-0.05	-0.15	-0.15	-0.06	0.84	1.93	0.40
1997	0.46	0.31	-0.21	0.07	-0.01	0.11	-0.18	-0.38	-0.39	0.04	-0.04	1.09	0.16
1998	0.10	0.07	-0.35	-0.55	0.12	0.08	0.40	0.10	0.40	0.28	0.90	1.52	0.33
1999	0.54	0.18	-0.04	-0.07	-0.05	0.09	0.00	0.11	-0.57	-0.53	0.18	0.55	0.11
2000	0.15	0.04	0.00	-0.07	-0.17	0.30	-0.03	-0.06	-0.22	-0.78	-0.02	-0.27	0.07
2001	0.36	0.12	-0.21	-0.19	-0.09	-0.06	0.30	0.17	0.12	-0.14	0.18	0.88	0.10
2002	-0.01	0.19	-0.10	0.07	-0.16	0.11	-0.04	-0.15	0.08	-0.60	0.09	0.36	0.05
2003	-0.07	-0.01	0.23	-0.20	0.01	-0.23	0.12	0.11	0.03	-0.83	0.75	1.23	0.25
MeanSqLog	0.39	0.10	0.04	0.05	0.03	0.02	0.05	0.08	0.07	0.28	0.39	1.07	0.21

Table 3.2.7.3B. Saithe in Division Va. Log survey residuals from AMCI.

year\age	a2	a3	a4	a5	a6	a7	a8	MeanSqLogRes
1985	-0.44	-1.36	-0.34	0.42	0.21	0.38	-0.20	0.37
1986	0.47	-0.54	-0.49	-0.63	-0.41	-0.37	-0.45	0.24
1987	-0.66	0.59	0.71	0.70	0.42	0.80	0.42	0.40
1988	-0.47	-1.94	-1.29	-0.75	-0.15	-0.48	-0.67	0.98
1989	1.49	0.59	-0.02	-0.32	-0.39	0.41	0.10	0.43
1990	-0.27	0.18	0.37	0.29	0.77	0.37	0.55	0.19
1991	0.03	-0.37	-0.24	-0.34	-0.96	-0.32	-1.44	0.49
1992	-0.61	-0.06	0.61	1.04	0.43	0.47	0.07	0.32
1993	1.71	2.27	0.34	0.90	0.73	0.76	0.16	1.45
1994	0.63	-0.33	0.10	0.32	0.19	-0.21	0.46	0.13
1995	0.27	0.02	-0.34	-1.09	-0.92	-0.94	-0.46	0.47
1996	-0.59	-1.15	0.24	-0.19	0.15	0.39	0.83	0.37
1997	1.00	-0.14	0.65	0.41	0.18	-0.20	-0.26	0.25
1998	-1.31	1.15	0.39	0.13	-0.23	0.42	0.15	0.49
1999	0.45	0.72	0.15	-0.15	0.20	-0.51	-0.45	0.18
2000	-0.53	-0.05	-0.09	-0.18	-0.04	-0.44	-0.15	0.08
2001	0.08	-0.41	-0.21	-0.45	-0.78	-0.85	-0.14	0.25
2002	-0.29	-0.49	-0.39	0.03	0.33	0.43	0.46	0.14
2003	-0.96	0.44	-0.10	-0.31	-0.29	-0.20	0.32	0.21
2004	0.00	0.87	-0.05	0.15	0.56	0.30	0.47	0.20
MeanSqLogRes	0.58	0.83	0.21	0.28	0.25	0.26	0.26	0.38

Table 3.2.7.4. Saithe in Division Va. Parameters and their standard errrors from 'cadapt'. Note estimated parameters are on log scale, SSB2004 in Kt.

Parameter	Estimate (log N and q, SSB in t)	CV on N&q, sd on SSB	N (thous)/q
N2004,2	11.252	0.77	77033.8
N2004,3	8.892	0.64	7272.8
N2004,4	11.241	0.39	76191.1
N2004,5	10.387	0.35	32435.2
N2004,6	9.644	0.36	15433.6
N2004,7	9.056	0.33	8565.5
N2004,8	8.266	0.38	3887.4
N2004,9	6.812	0.47	908.8
N2004,10	5.759	1.67	316.9
N2004,11	6.308	1.34	549.1
N2004,12	0.000	1.18	1.0
N2004,13	0.004	16.65	1.0
N2004,14	0.000	0.36	1.0
q2	-11.346	0.18	1.18E-05
q3	-9.661	0.21	6.38E-05
q4	-9.031	0.11	1.20E-04
q5	-8.811	0.13	1.49E-04
q6	-8.915	0.08	1.34E-04
SSB	83205	17035	

Table 3.2.7.5. Saithe in Division Va. Estimated initial numbers (millions) and recruits at age 2 from separable models 'camera' and AMCI.

Init number age 3 1985	36.2	34.4
Init number age 4 1985	36.3	36.0
Init number age 5 1985	23.1	22.1
Init number age 6 1985	10.4	10.0
Init number age 7 1985	5.3	5.1
Init number age 8 1985	4.3	4.1
Init number age 9 1985	4.1	3.8
Init number age10 1985	1.1	0.9
Init number age11 1985	0.3	0.2
Init number age12 1985	0.1	0.1
Init number age13 1985	0.3	0.2
Init number age14 1985	0.3	0.2
Recruits age 2 1985	82.4	79.6
Recruits age 2 1986	126.0	115.3
Recruits age 2 1987	65.4	61.5
Recruits age 2 1988	42.9	38.2
Recruits age 2 1989	27.9	25.4
Recruits age 2 1990	39.9	37.9
Recruits age 2 1991	18.6	18.6
Recruits age 2 1992	22.4	22.7
Recruits age 2 1993	20.0	20.8
Recruits age 2 1994	38.1	39.7
Recruits age 2 1995	31.7	31.6
Recruits age 2 1996	20.3	20.3
Recruits age 2 1997	10.2	9.7
Recruits age 2 1998	35.5	34.3
Recruits age 2 1999	41.5	39.3
Recruits age 2 2000	56.0	56.2
Recruits age 2 2001	71.3	68.9
Recruits age 2 2002	121.6	121.4
Recruits age 2 2003	11.3	11.0
Recruits age 2 2004	79.0	76.7

Table 3.2.7.6. Saithe in Division Va. Fishing mortality from final run, a separable model calibrated with IGFS survey.

year\age	3	4	5	6	7	8	9	10	11	12	13	14
1985	0.020	0.095	0.181	0.262	0.336	0.419	0.419	0.419	0.419	0.419	0.419	0.419
1986	0.022	0.106	0.203	0.294	0.377	0.471	0.471	0.471	0.471	0.471	0.471	0.471
1987	0.027	0.130	0.248	0.359	0.461	0.575	0.575	0.575	0.575	0.575	0.575	0.575
1988	0.022	0.106	0.202	0.293	0.376	0.469	0.469	0.469	0.469	0.469	0.469	0.469
1989	0.022	0.103	0.197	0.285	0.367	0.457	0.457	0.457	0.457	0.457	0.457	0.457
1990	0.024	0.111	0.213	0.308	0.396	0.493	0.493	0.493	0.493	0.493	0.493	0.493
1991	0.021	0.101	0.193	0.280	0.359	0.448	0.448	0.448	0.448	0.448	0.448	0.448
1992	0.023	0.107	0.205	0.296	0.381	0.475	0.475	0.475	0.475	0.475	0.475	0.475
1993	0.027	0.128	0.245	0.354	0.455	0.568	0.568	0.568	0.568	0.568	0.568	0.568
1994	0.035	0.167	0.320	0.463	0.595	0.741	0.741	0.741	0.741	0.741	0.741	0.741
1995	0.029	0.139	0.266	0.384	0.494	0.616	0.616	0.616	0.616	0.616	0.616	0.616
1996	0.028	0.134	0.257	0.371	0.477	0.595	0.595	0.595	0.595	0.595	0.595	0.595
1997	0.026	0.122	0.233	0.337	0.433	0.539	0.539	0.539	0.539	0.539	0.539	0.539
1998	0.026	0.124	0.236	0.342	0.440	0.548	0.548	0.548	0.548	0.548	0.548	0.548
1999	0.024	0.112	0.213	0.309	0.397	0.495	0.495	0.495	0.495	0.495	0.495	0.495
2000	0.025	0.117	0.224	0.324	0.416	0.519	0.519	0.519	0.519	0.519	0.519	0.519
2001	0.022	0.104	0.200	0.289	0.372	0.463	0.463	0.463	0.463	0.463	0.463	0.463
2002	0.023	0.111	0.211	0.306	0.393	0.491	0.491	0.491	0.491	0.491	0.491	0.491
2003	0.022	0.105	0.201	0.291	0.374	0.466	0.466	0.466	0.466	0.466	0.466	0.466
2004	0.015	0.069	0.133	0.192	0.247	0.308	0.308	0.308	0.308	0.308	0.308	0.308

Table 3.2.7.7. Saithe in Division Va. Stock in numbers (in thousands) from final run, a separable model calibrated with IGFS survey.

year\age	2	3	4	5	6	7	8	9	10	11	12	13	14
1985	79642	34435	36044	22130	9958	5103	4141	3794	924	206	128	170	228
1986	115276	65205	27635	26849	15123	6276	2985	2229	2043	497	111	69	92
1987	61501	94380	52201	20348	17945	9230	3523	1526	1140	1045	254	57	35
1988	38217	50352	75184	37545	13003	10264	4766	1624	703	525	481	117	26
1989	25430	31289	40313	55375	25108	7943	5768	2441	831	360	269	247	60
1990	37894	20821	25065	29772	37223	15452	4506	2989	1265	431	187	139	128
1991	18627	31025	16650	18361	19705	22400	8518	2253	1494	632	215	93	70
1992	22665	15251	24864	12323	12393	12198	12804	4456	1178	782	331	113	49
1993	20759	18557	12207	18292	8222	7546	6826	6523	2270	600	398	168	57
1994	39741	16996	14787	8794	11726	4724	3919	3168	3028	1054	279	185	78
1995	31580	32537	13432	10244	5230	6044	2134	1529	1236	1181	411	109	72
1996	20328	25856	25868	9571	6430	2915	3019	944	676	547	522	182	48
1997	9737	16643	20577	18520	6063	3632	1481	1364	426	305	247	236	82
1998	34271	7972	13280	14918	12017	3545	1929	707	651	203	146	118	113
1999	39310	28058	6358	9609	9643	6988	1870	913	335	308	96	69	56
2000	56187	32184	22437	4656	6356	5798	3848	934	456	167	154	48	34
2001	68927	46002	25706	16342	3048	3764	3131	1875	455	222	81	75	23
2002	121399	56432	36841	18959	10957	1869	2125	1613	966	234	114	42	39
2003	11010	99393	45135	27004	12563	6605	1032	1065	809	484	117	57	21
2004	76729	9014	79590	33270	18087	7691	3722	531	548	415	249	60	29
2005	34153	62820	7273	60792	23852	12219	4919	2240	319	329	250	150	36

Table 3.2.7.8. Saithe in Division Va. Summary table from final run, a separable model calibrated with IGFS survey.

	RECRUITS Age 3	fishableBIO (4+)	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 4- 8
1962	30	140	68	50	0.74	0.288
1963	77	152	71	48	0.68	0.351
1964	54	210	74	60	0.81	0.269
1965	84	257	94	60	0.64	0.249
1966	68	336	127	52	0.41	0.199
1967	67	404	173	76	0.44	0.258
1968	63	440	206	78	0.38	0.230
1969	88	467	235	116	0.50	0.268
1970	64	497	247	113	0.46	0.319
1971	52	478	241	134	0.56	0.429
1972	27	412	211	108	0.51	0.378
1973	18	347	192	111	0.58	0.336
1974	21	289	174	98	0.56	0.310
1975	26	242	151	88	0.58	0.320
1976	30	208	125	82	0.66	0.357
1977	20	184	100	62	0.62	0.302
1978	44	171	92	50	0.54	0.323
1979	54	184	87	64	0.73	0.370
1980	27	208	84	58	0.70	0.332
1981	19	210	91	59	0.65	0.333
1982	23	198	100	69	0.69	0.370
1983	31	180	96	58	0.61	0.228
1984	42	191	100	63	0.63	0.319
1985	34	220	95	57	0.60	0.285
1986	65	235	109	65	0.60	0.320
1987	94	250	109	81	0.74	0.391
1988	50	316	102	77	0.76	0.319
1989	31	317	103	82	0.80	0.311
1990	21	325	122	98	0.80	0.336
1991	31	251	113	102	0.91	0.305
1992	15	247	122	80	0.65	0.323
1993	19	213	120	72	0.60	0.386
1994	17	195	118	64	0.54	0.504
1995	33	136	83	49	0.59	0.419
1996	26	127	65	40	0.62	0.405
1997	17	122	57	37	0.66	0.367
1998	8	113	56	32	0.56	0.373
1999	28	107	59	31	0.53	0.337
2000	32	108	54	33	0.61	0.353
2001	46	136	59	32	0.54	0.315
2002	56	168	67	42	0.63	0.334
2003	99	188	68	52	0.76	0.317
2004	9		86			
Arith. Mean	42	242	115	69	0.62	0.33
0 Units	(Millions)	(KiloTonnes)	(KiloTonnes)	(KiloTonnes)		
1						

Table 3.2.8.1. Saithe in Va. Prediction with management option/short term prediction - input data.

Icelandic SAITHE. Division Va.

Prognosis - input parameters

Starting year = **2004**

Desired TAC:

	2004	*2005*	*2006*	*2007*	*2008*
Opt1	50	59	65	67	65
Opt2	50	63	67	69	66
Opt3	50	66	70	71	67
Opt4	50	70	73	72	67
Opt5	50	73	75	74	68
Opt6	50	76	77	75	68
Opt7	50	80	80	76	69
Opt8	50	83	82	77	69
Opt9	50	86	84	78	69
Opt10	50	89	85	79	69

F-factor:

	2004	*2005*	*2006*	*2007*	*2008*
Opt1	0.766623145	0.75	0.75	0.75	0.75
Opt2	0.766623145	0.8	0.8	0.8	0.8
Opt3	0.766623145	0.85	0.85	0.85	0.85
Opt4	0.766623145	0.9	0.9	0.9	0.9
Opt5	0.766623145	0.95	0.95	0.95	0.95
Opt6	0.766623145	1	1	1	1
Opt7	0.766623145	1.05	1.05	1.05	1.05
Opt8	0.766623145	1.1	1.1	1.1	1.1
Opt9	0.766623145	1.15	1.15	1.15	1.15
Opt10	0.766623145	1.2	1.2	1.2	1.2

Mean weight in the catches:

	age/year	**2004**	**2005**	**2006**	**2007**	**2008**
1.28	**3**	1.37	1.37	1.37	1.37	1.37
1.88	**4**	1.896	2.02	1.929	1.929	1.929
2.6	**5**	2.55	2.503	2.972	2.972	2.972
3.7	**6**	3.334	3.329	3.225	3.225	3.225
4.42	**7**	4.398	4.306	4.258	4.258	4.258
5.54	**8**	5.411	5.571	5.472	5.472	5.472
5.64	**9**	6.8	6.8	6.8	6.8	6.8
7.98	**10**	7.73	7.73	7.73	7.73	7.73
9.06	**11**	8.78	8.78	8.78	8.78	8.78
9.94	**12**	9.74	9.74	9.74	9.74	9.74
	13	10.79	10.79	10.79	10.79	10.79
	14	11.49	11.49	11.49	11.49	11.49

Table 3.2.8.1 (Cont'd)

Mean weight at spawning time:

age/year	2004	2005	2006	2007	2008
3	0.844	0.705	0.818	0.818	0.818
4	1.257	1.496	1.219	1.219	1.219
5	1.882	1.766	2.233	2.233	2.233
6	2.812	2.783	2.567	2.567	2.567
7	4.24	3.966	3.909	3.909	3.909
8	5.645	5.384	5.188	5.188	5.188
9	6.32	6.32	6.32	6.32	6.32
10	7.94	7.94	7.94	7.94	7.94
11	9.78	9.78	9.78	9.78	9.78
12	11.54	11.54	11.54	11.54	11.54
13	12.44	12.44	12.44	12.44	12.44
14	13.91	13.91	13.91	13.91	13.91

Sexual maturity:

age/year	2004	2005	2006	2007	2008
3	0.01	0.00	0.01	0.01	0.01
4	0.02	0.09	0.03	0.03	0.03
5	0.16	0.07	0.32	0.32	0.32
6	0.40	0.35	0.18	0.18	0.18
7	0.66	0.59	0.54	0.54	0.54
8	0.78	0.77	0.72	0.72	0.72
9	0.89	0.84	0.83	0.83	0.83
10	1	1	1	1	1
11	1	1	1	1	1
12	1	1	1	1	1
13	1	1	1	1	1
14	1	1	1	1	1

Natural mortality (M):

age/year	2004	2005	2006	2007	2008
3	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2
13	0.2	0.2	0.2	0.2	0.2
14	0.2	0.2	0.2	0.2	0.2

Table 3.2.8.1 (Cont'd)

Selection pattern:

age/year	2004	2005	2006	2007	2008
3	0.02	0.02	0.02	0.02	0.02
4	0.11	0.11	0.11	0.11	0.11
5	0.20	0.20	0.20	0.20	0.20
6	0.29	0.29	0.29	0.29	0.29
7	0.37	0.37	0.37	0.37	0.37
8	0.47	0.47	0.47	0.47	0.47
9	0.47	0.47	0.47	0.47	0.47
10	0.47	0.47	0.47	0.47	0.47
11	0.47	0.47	0.47	0.47	0.47
12	0.47	0.47	0.47	0.47	0.47
13	0.47	0.47	0.47	0.47	0.47
14	0.47	0.47	0.47	0.47	0.47
F4-9	**0.32**	**0.32**	**0.32**	**0.32**	**0.32**

Stock in numbers in starting year (millions):

age/year	2004	Recruitment =	30.000
3	9.01445		
4	79.5898		
5	33.2701		
6	18.0873		
7	7.69142		
8	3.72209		
9	0.530578		
10	0.547548		
11	0.415498		
12	0.248813		
13	0.0603699		
14	0.0294727		
Total=	**153.207**		

Table 3.2.8.2. Saithe in Va. Prediction with management/short term prediction. TAC-constraint of 50Kt in 2004, F-factors relative to F4-9,2003, stock numbers and selectivity-at-age from separable model..

Icelandic SAITHE. Division Va.

Projection of stock and spawning stock biomass (thousand tonnes)
in 2005-2007 for different management strategies.

2004				**2005**				**2006**				**2007**		
Stofn 4+	Hrygn-stofn				Stofn 4+	Hrygn-stofn			Stofn 4+	Hrygn-stofn		Stofn 4+	Hrygn-stofn	
Stock 4+	*SSB*	F	Afli *Catch*	Afli *Catch*	*Stock 4+*	*Spawn. stock*	F	Afli *Catch*	*Stock 4+*	*Spawn. stock*	F	*Stock 4+*	*Spawn. stock*	F-Factor
283	86	0.24	50	59	278	101	0.24	65	282	116	0.24	288	156	0.75
				63	278	101	0.25	67	279	114	0.25	281	151	0.8
				66	278	101	0.27	70	275	112	0.27	275	147	0.85
				70	278	101	0.29	73	272	110	0.29	268	142	0.9
			F_{pa}	73	278	101	0.30	75	268	108	0.30	262	138	0.95
				76	278	101	0.32	77	265	106	0.32	256	134	1
				80	278	101	0.33	80	262	105	0.33	250	130	1.05
				83	278	101	0.35	82	259	103	0.35	245	126	1.1
				86	278	101	0.36	84	255	101	0.36	239	123	1.15
				89	278	101	0.38	85	252	100	0.38	234	119	1.2

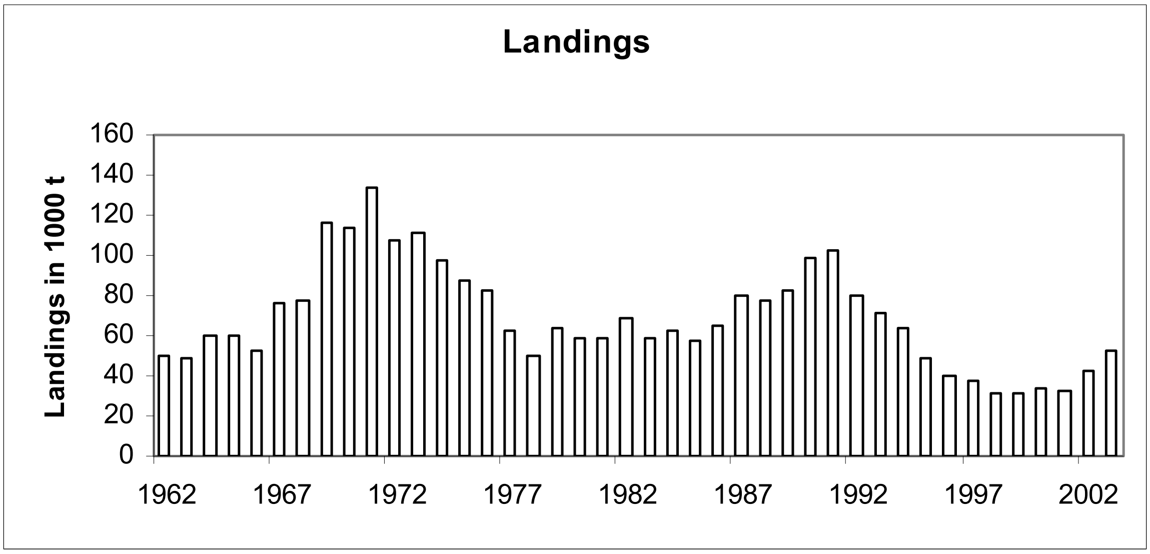


Figure 3.2.1.1. Saithe in Va. Nominal landings 1962-2003.

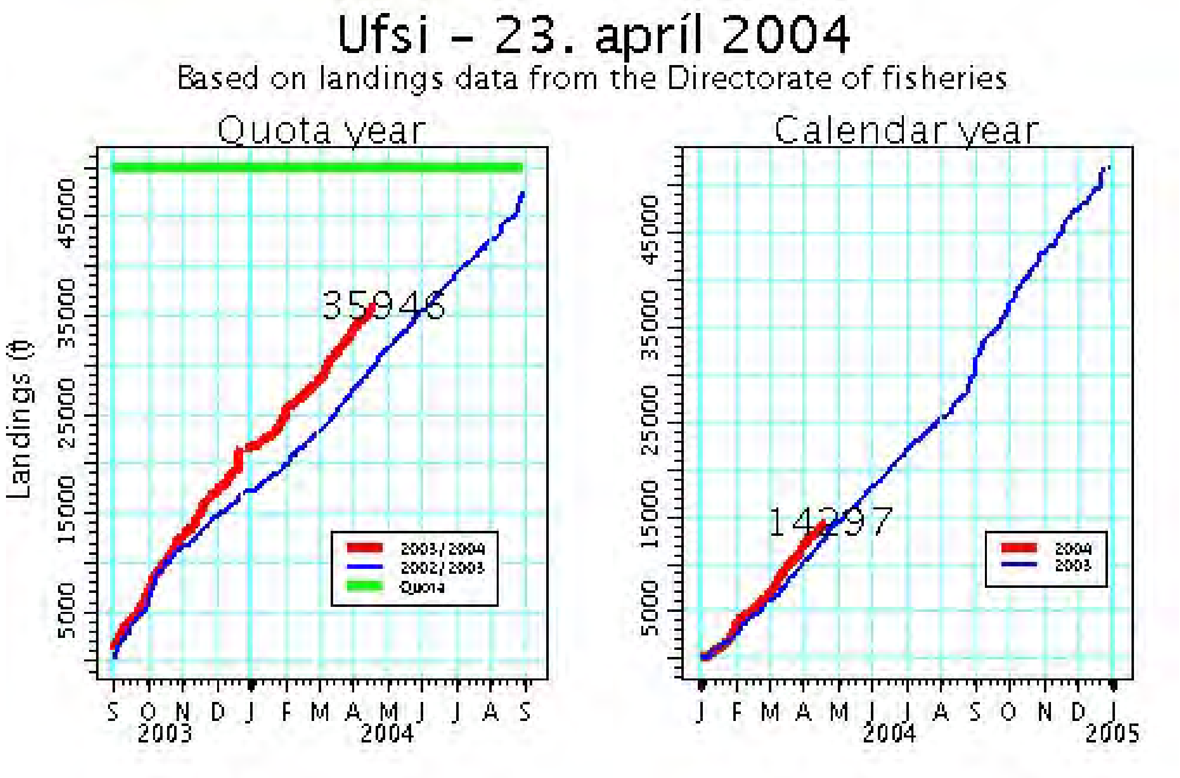


Figure 3.2.1.2. Saithe in Va. Landings in qouta years 2002/2003 (blue) and 2003/2004 and calendar years 2003 and 2004 (www.hafro.is/~sigurdur/Landings).

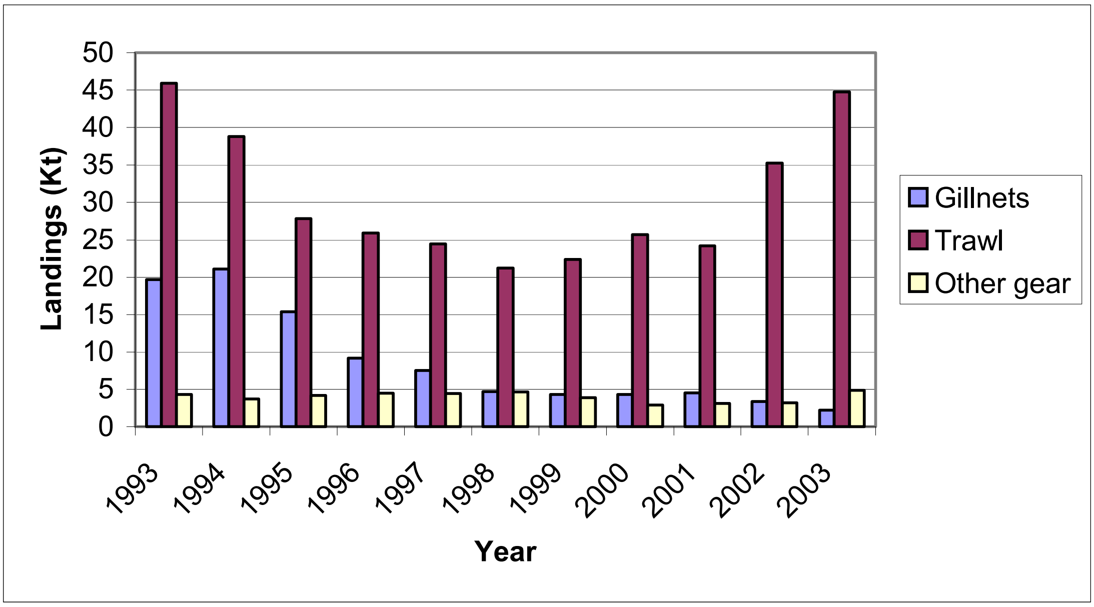


Figure 3.2.2.1. Saithe in Va. Landings in 1993-2001 by gear type.

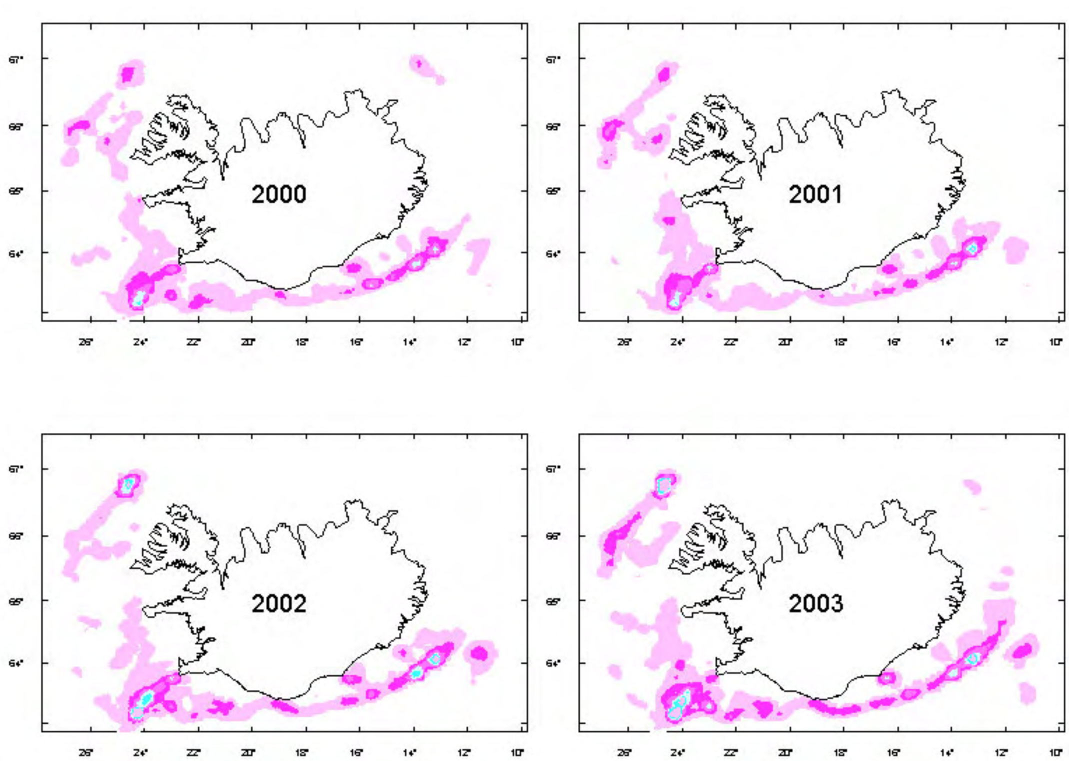


Figure 3.2.2.2. Saithe in Va. Geographical distribution of the trawler fishery 2000-2003.

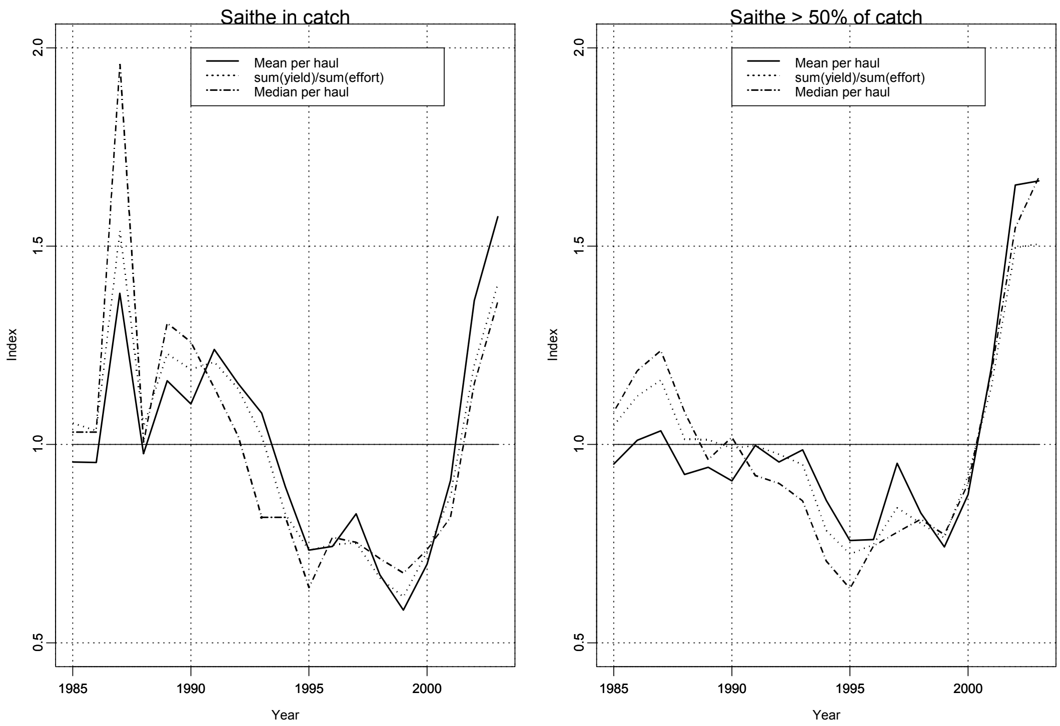


Figure 3.2.2.3. Saithe in Va. Simple CPUE indices from the trawler fleet for 1985-2003.

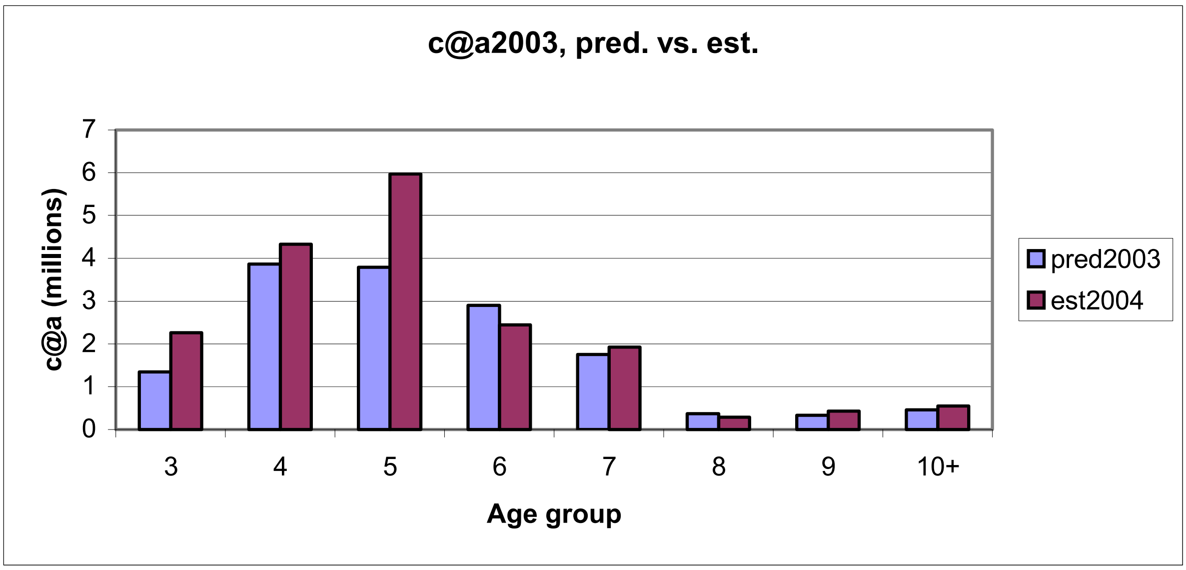


Figure 3.2.3.1. Saithe in Va. Prognosis in May 2003 and estimate in April 2004 of age distribution in catch-at-age.

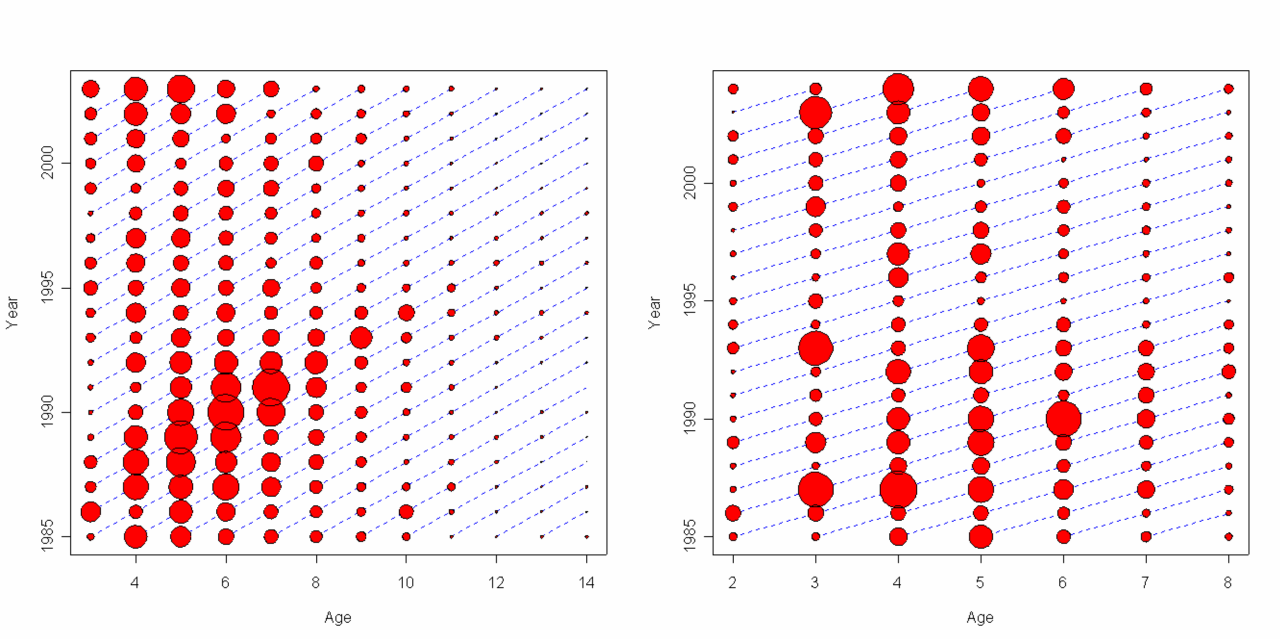


Figure 3.2.3.2. Saithe in Va. Bubbles of catch-at-age 3-14 in1985-2003 (right) and of index-at-age 2-8 in 1985-2004 for comparison.

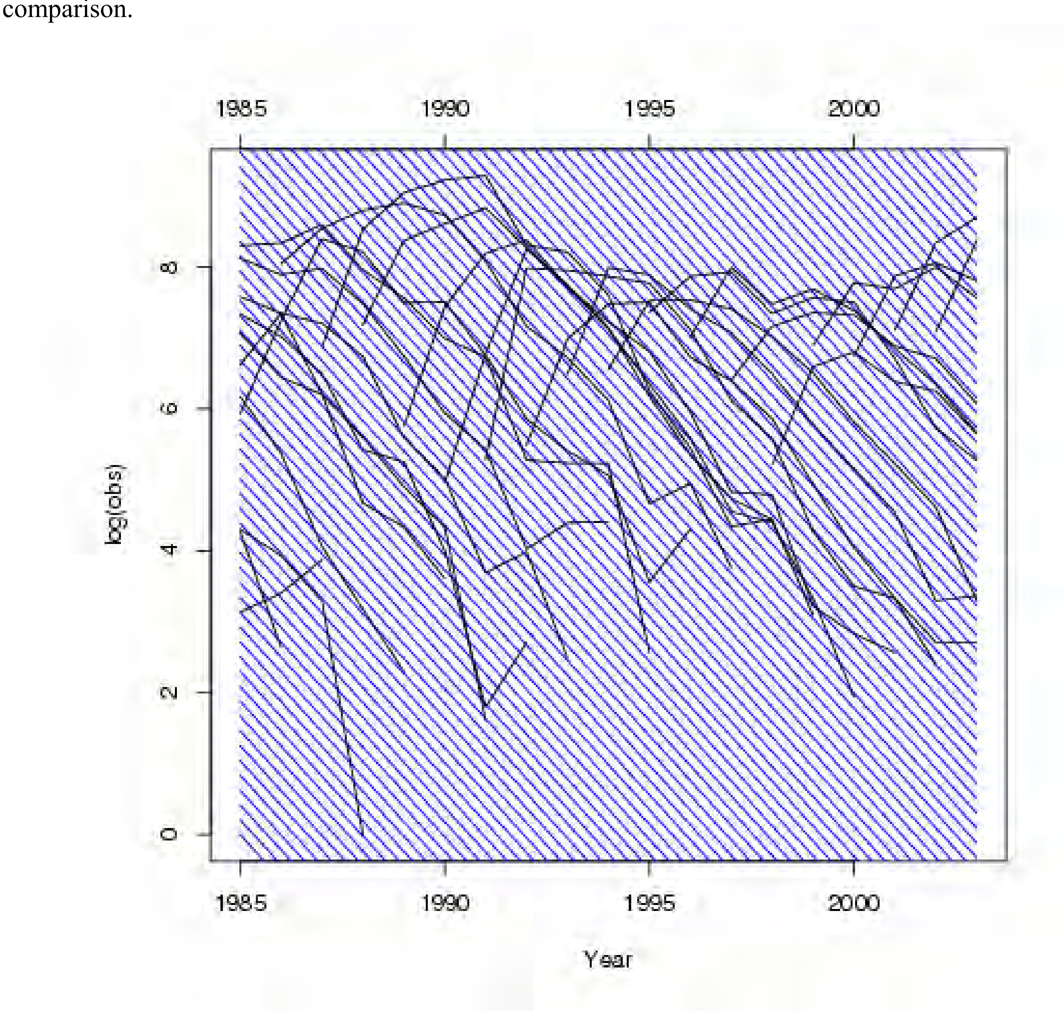


Figure 3.2.3.3. Saithe in Va. Catch curves for catch-at-age for age groups 3-14 in1985-2003.

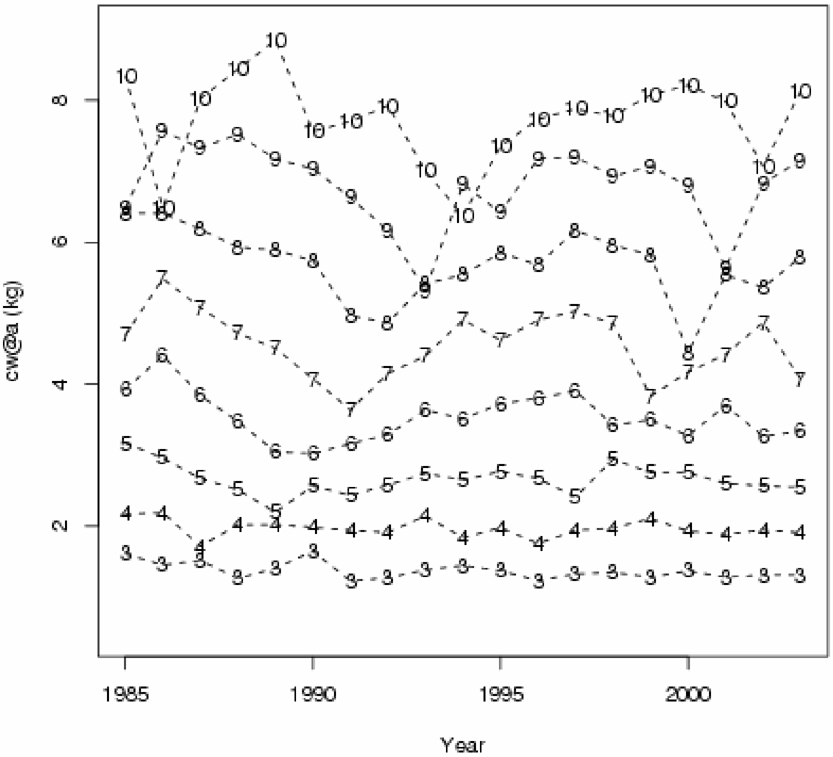


Figure 3.2.4.1. Saithe in Va. Mean weight at age in the catches 1985-2003 for age groups 3-10.

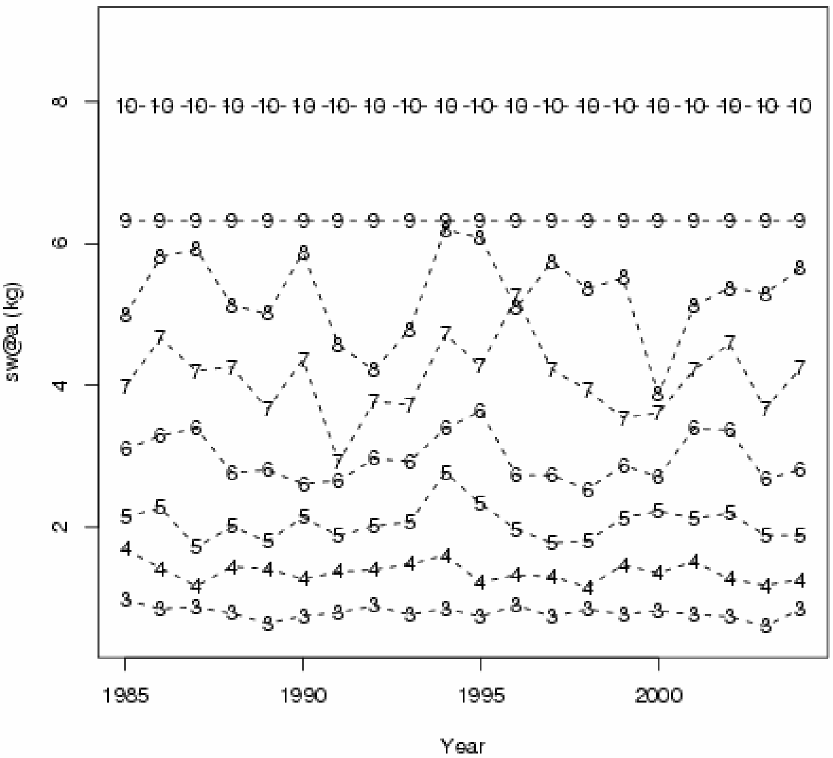


Figure 3.2.4.2. Saithe in Va. Mean weight at age 3-10 in the stock in 1985-2004, based on weights in IGFS. Long term average shown for age groups 9 and 10.

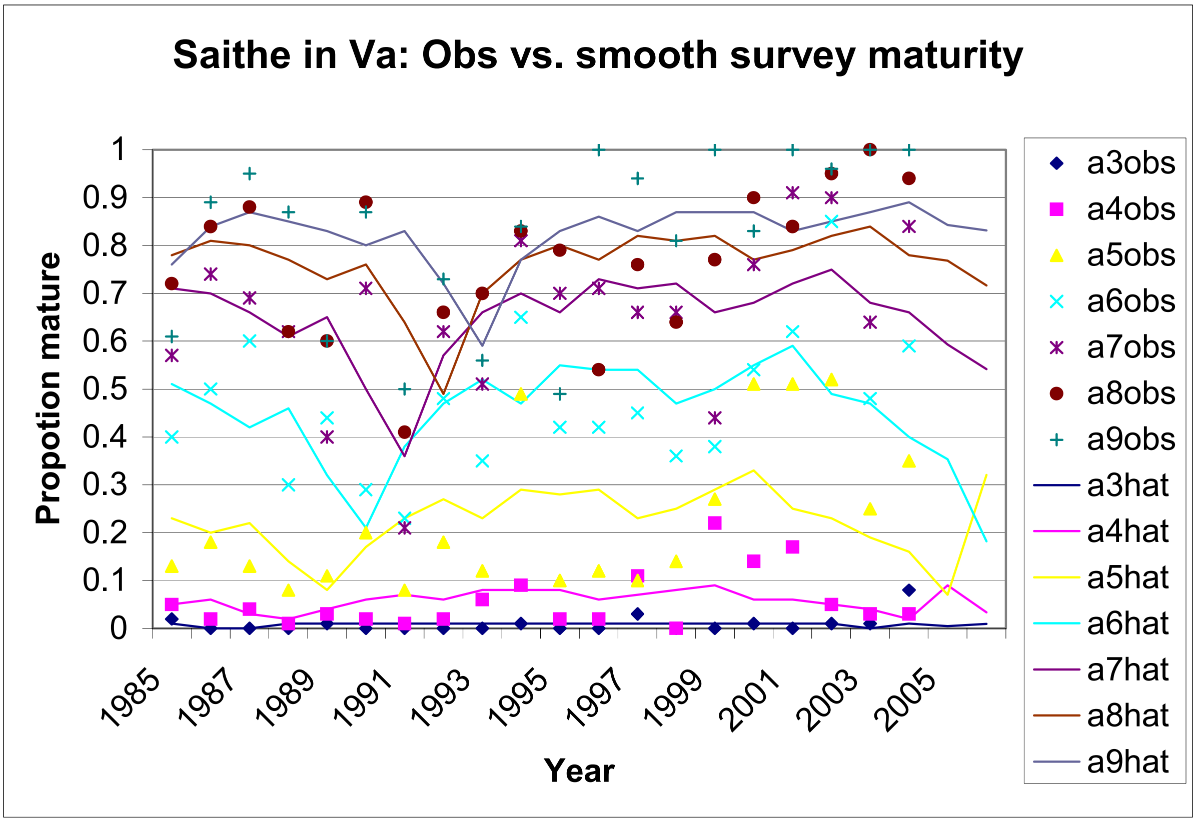


Figure 3.2.5.1. Saithe in Va. Observed and smoothed maturity at age from IGFS for age groups 3-9 in 1985-2004.

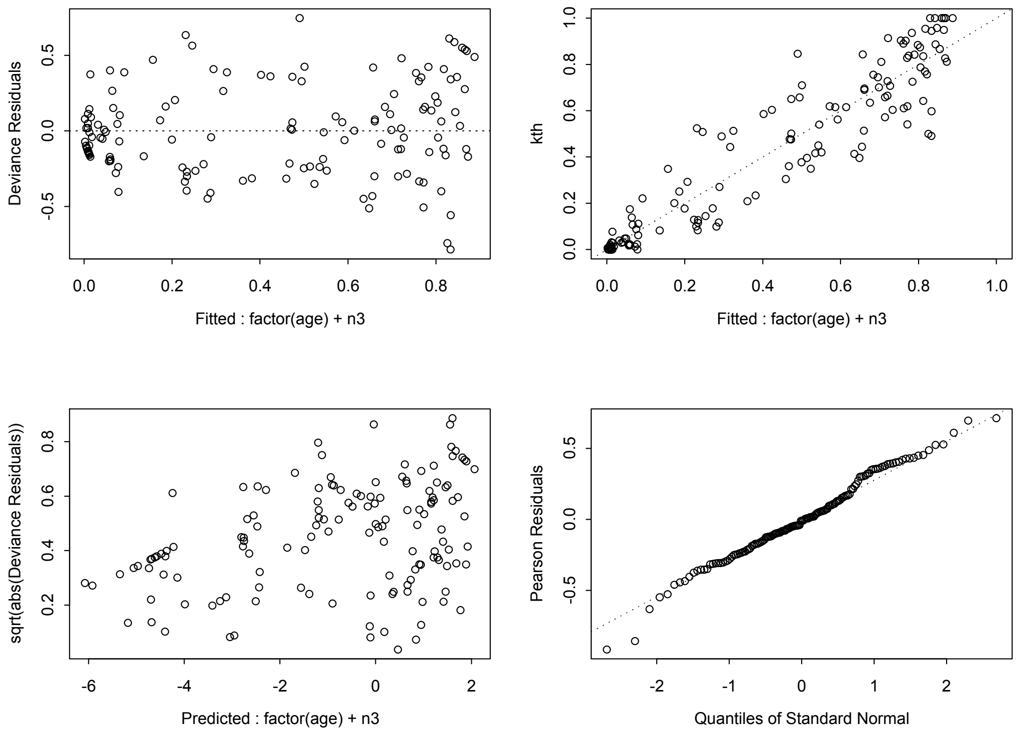


Figure 3.2.5.2. Saithe in Va.. Diagnostic plot of maturity smoother..

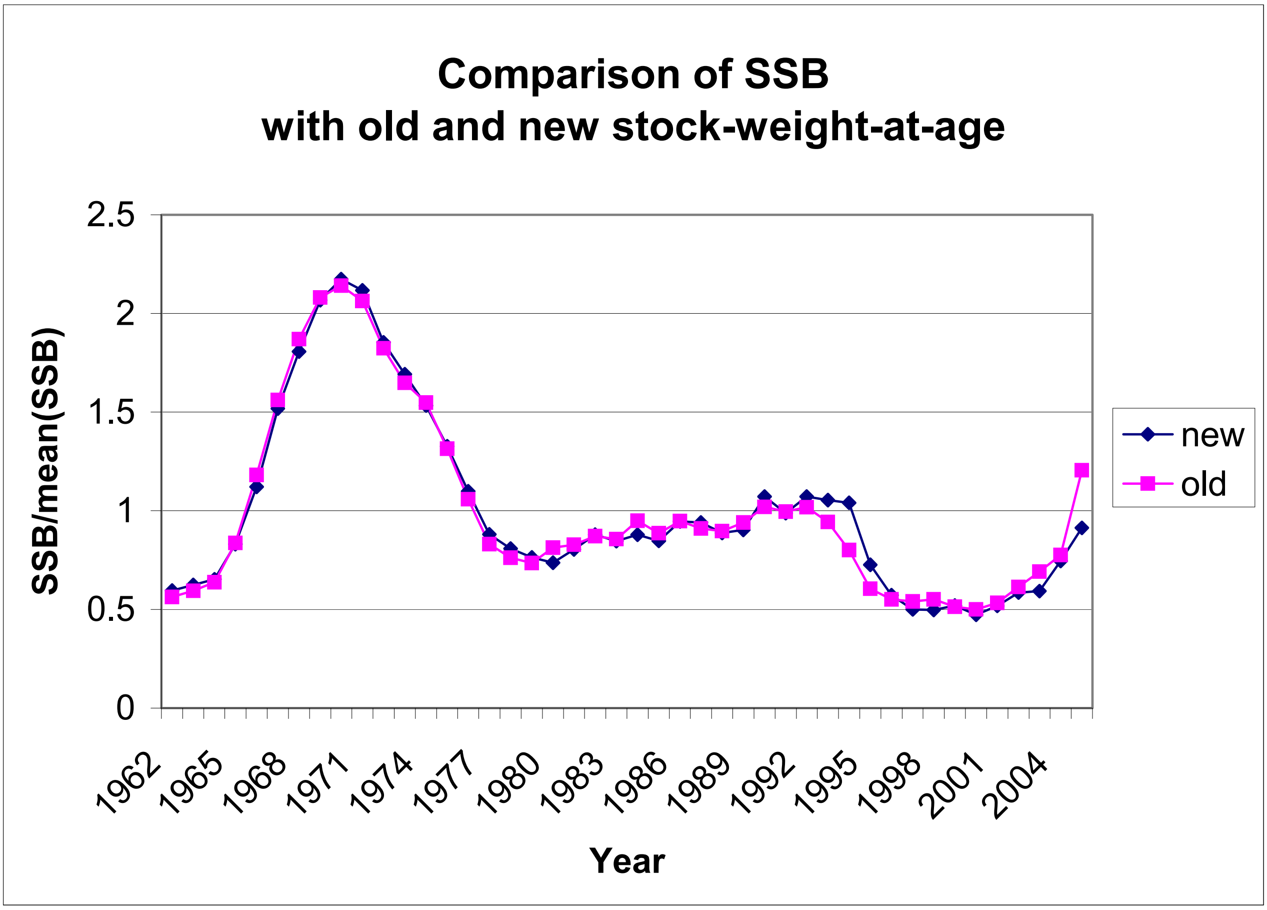


Figure 3.2.5.3. Saithe in Va.. SSB- trajectories 1962-2005 from 'camera' based on old and new weight-at-age-in-stock.

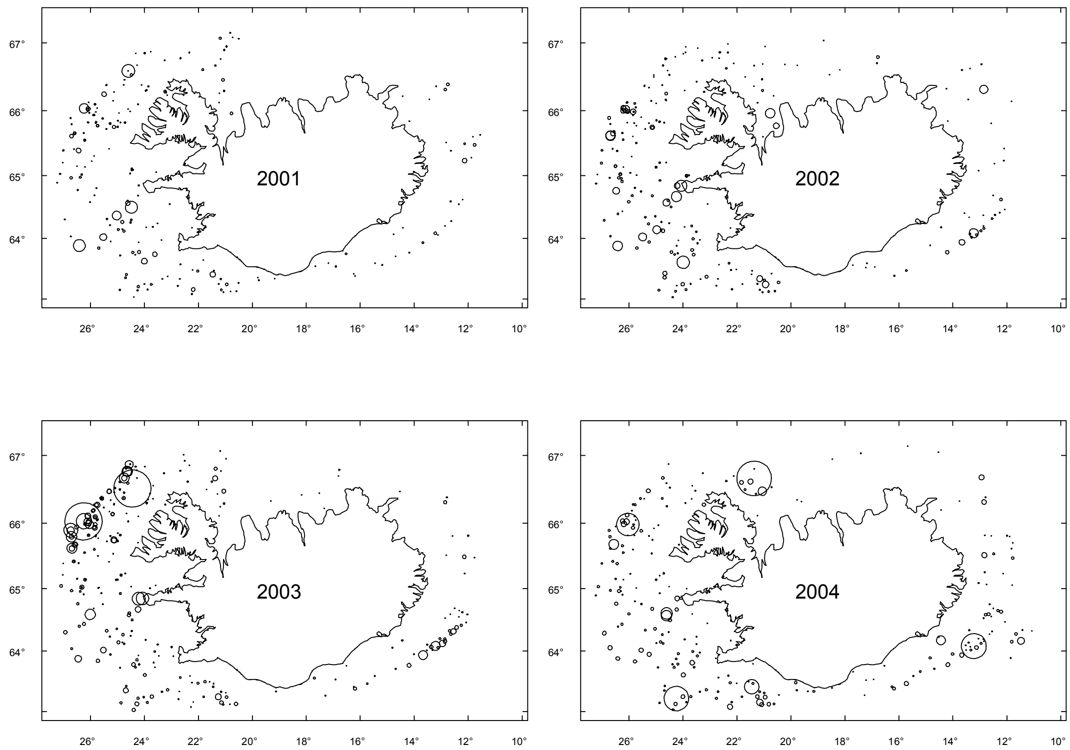


Figure 3.2.7.1. Saithe in Va. Geographic distribution of abundance in IGFS. Circle area propotional to abundance. Only stations where saitheon which saithe occurred are shown.

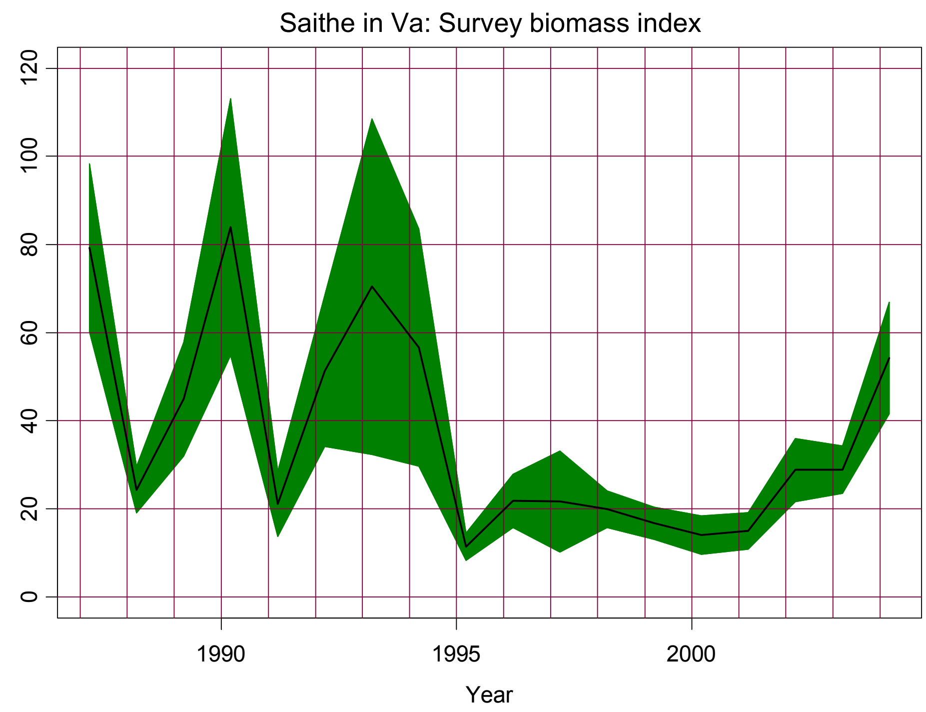


Figure 3.2.7.2. Saithe in Va. Stratified mean survey biomass index from IGFS 1987-2004.

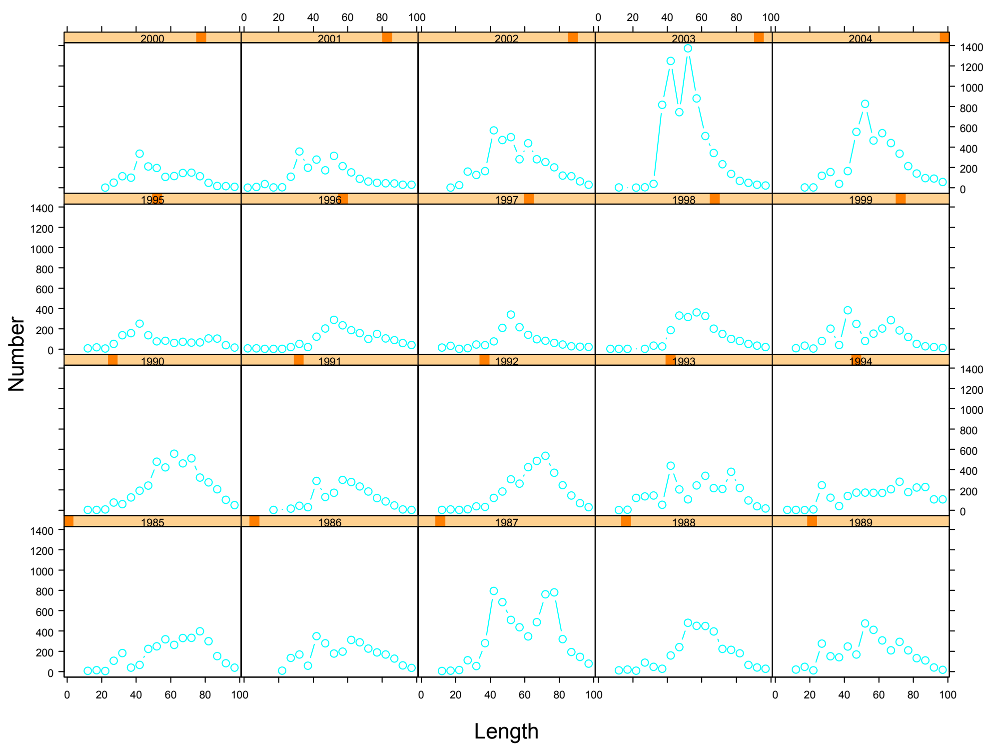


Figure 3.2.7.3. Saithe in Va. Length distributions in IGFS (in 5 cm length groups). Number measured per length group each year.

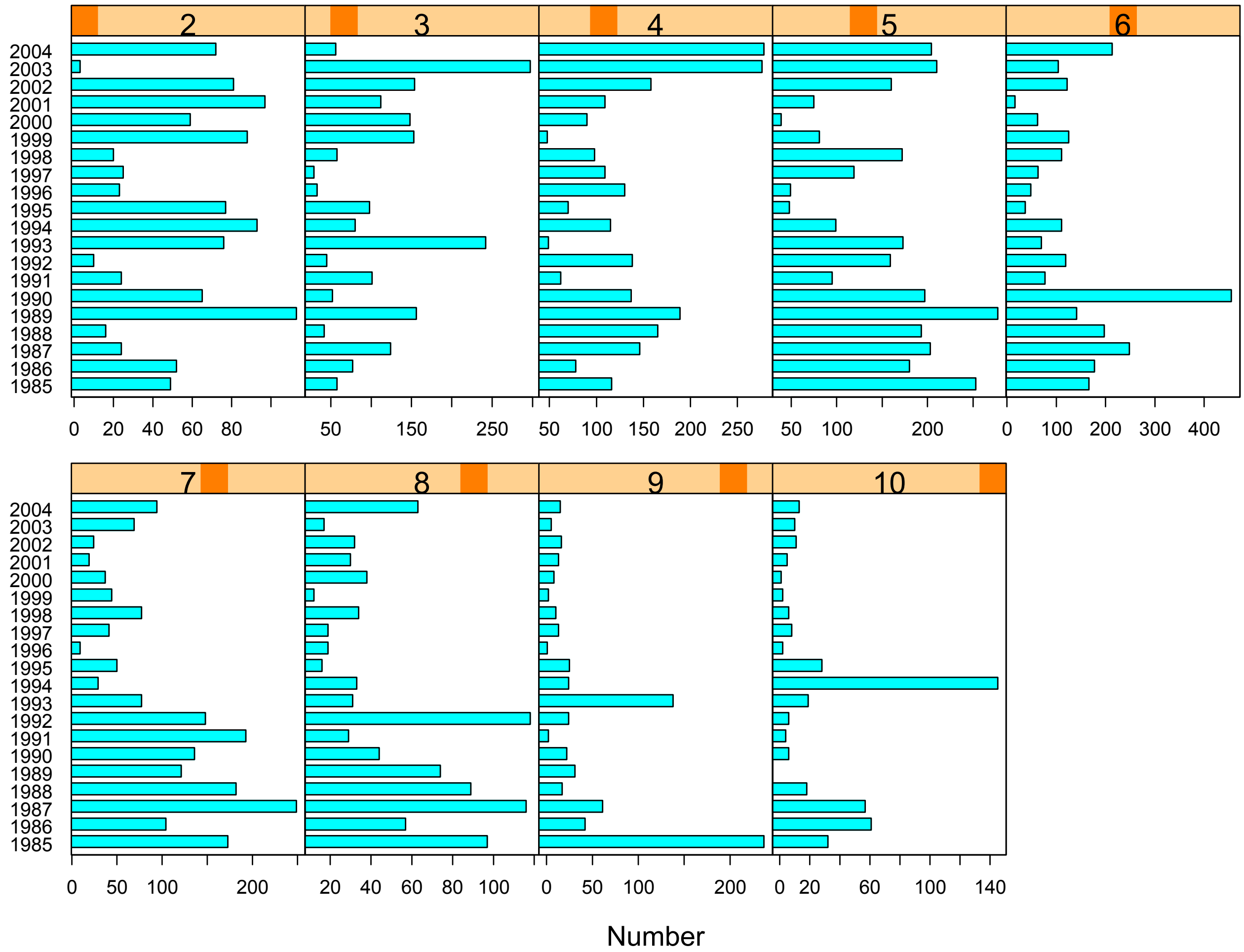


Figure 3.2.7.4. Saithe in Va. Age distributions in IGFS. Number per age group 1985-2004 is shown.

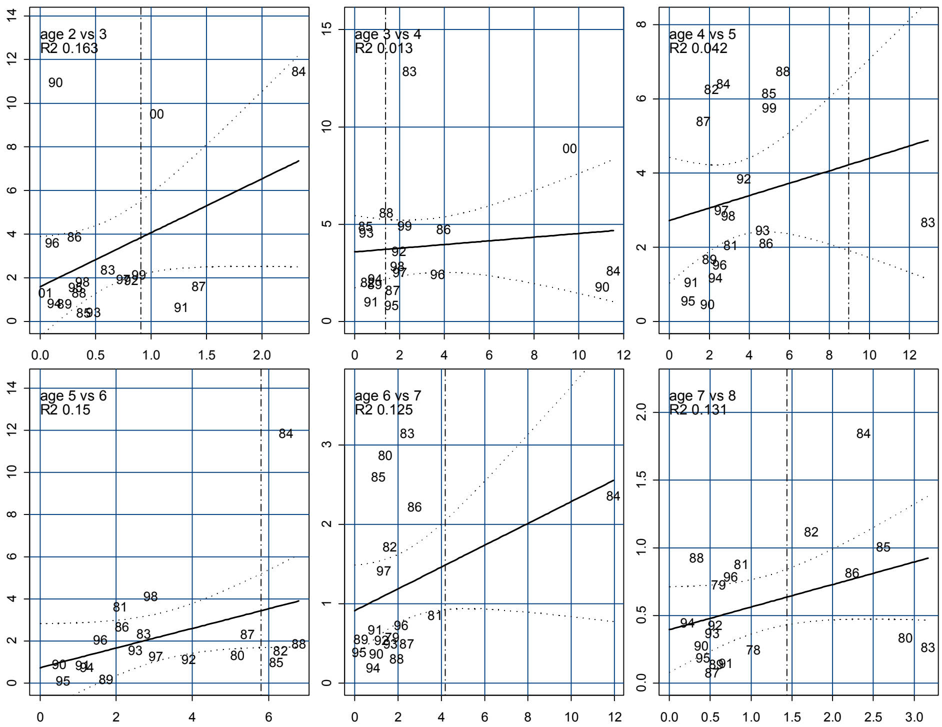


Figure 3.2.7.5. Saithe in Va. Between year and age correspondance for year classes in IGFS 1985-2004 with R^2 from linear fit. Dashed line shows prediction for next years survey.

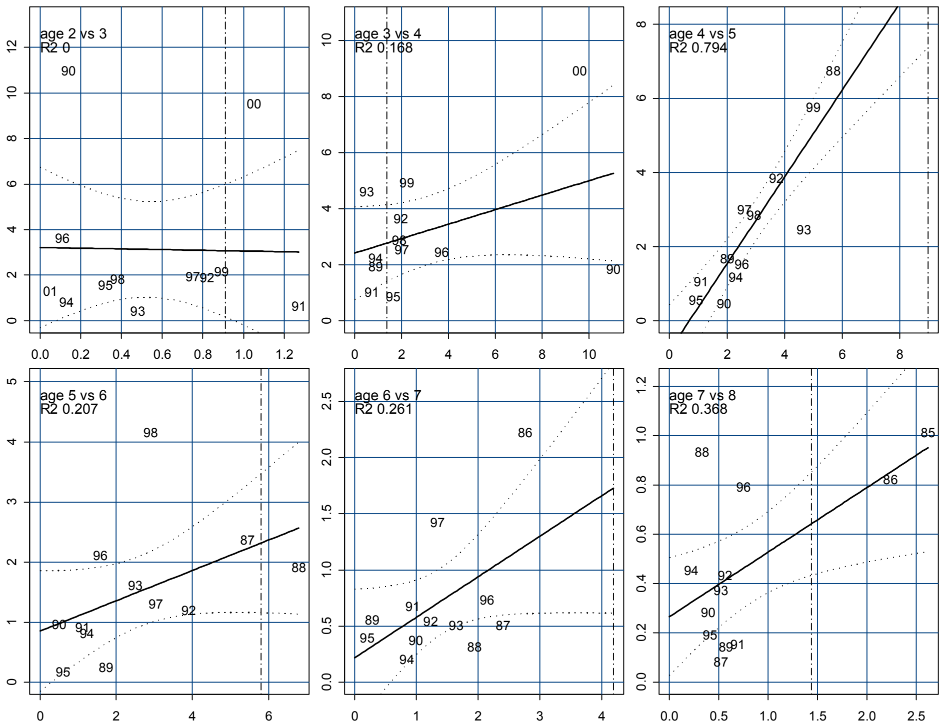


Figure 3.2.7.56. Saithe in Va. Between year and age correspondance for year classes in IGFS 1992-2004 with sR^2 from linear fit. Dashed line shows prediction for next years survey.

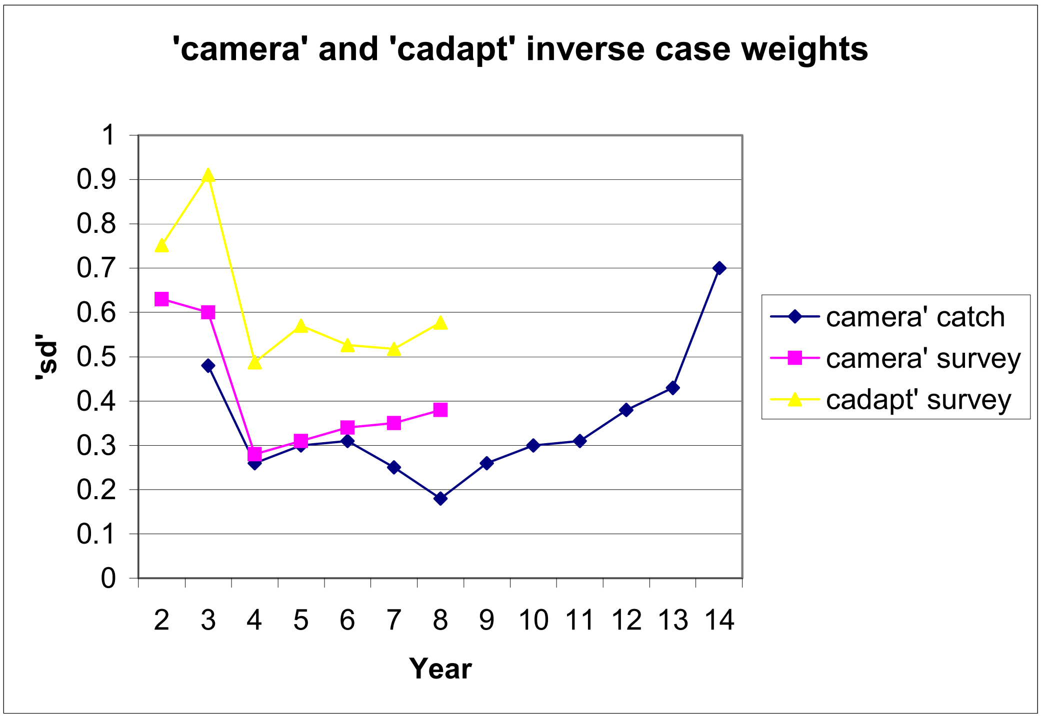


Figure 3.2.7.7. Saithe in Va. Inverse variance case weights used in 'camera' and 'cadapt' runs. Calculated in model fit in 'cadapt', set *ad hoc, a priori* in 'camera' with mean square age group residuals from Sheperd-Nicholson model fits to ccatch-at-age and index-at-age.

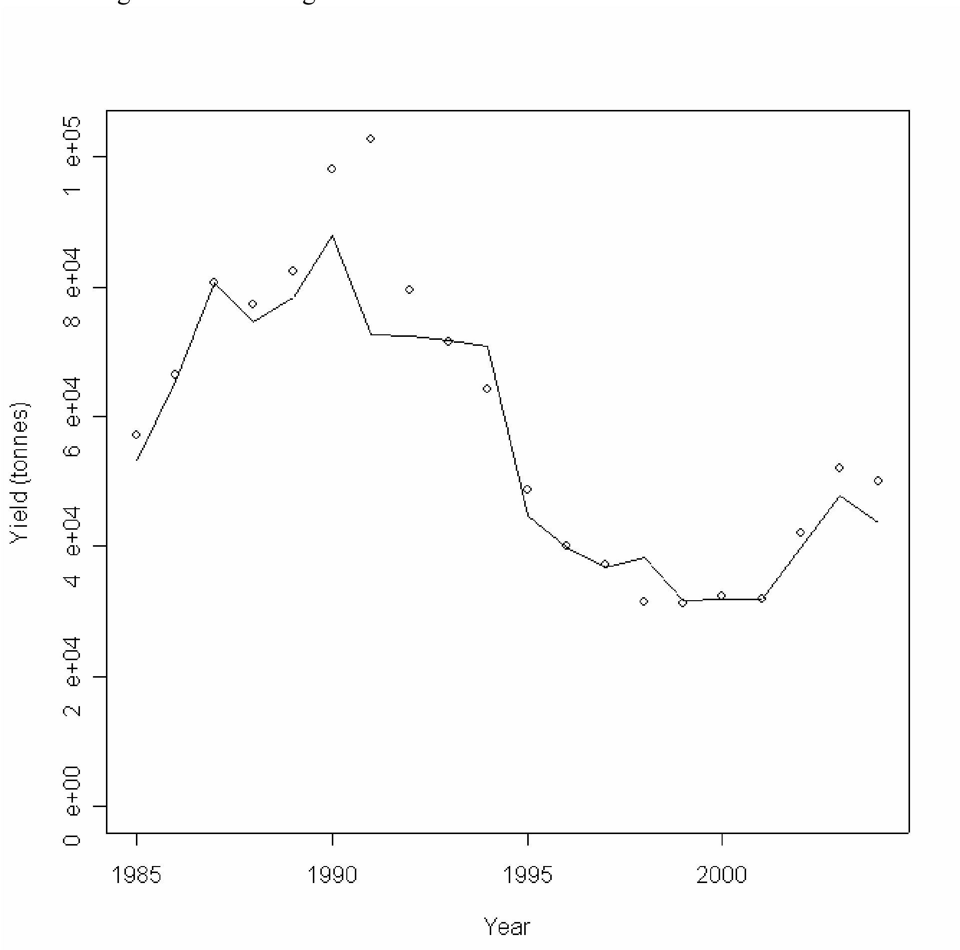


Figure 3.2.7.8. Saithe in Va. Observed and predicted yield from 'camera' run.

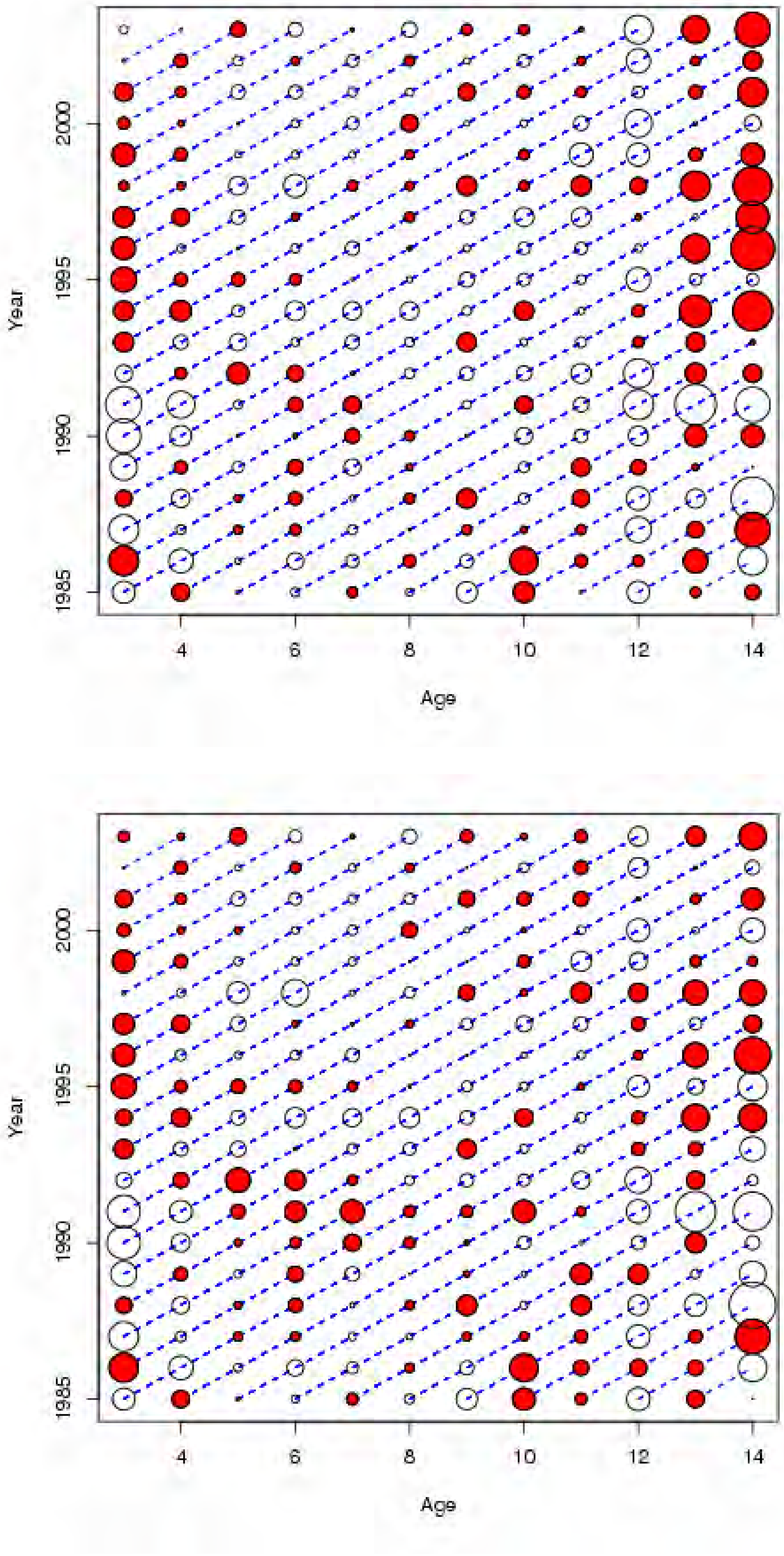
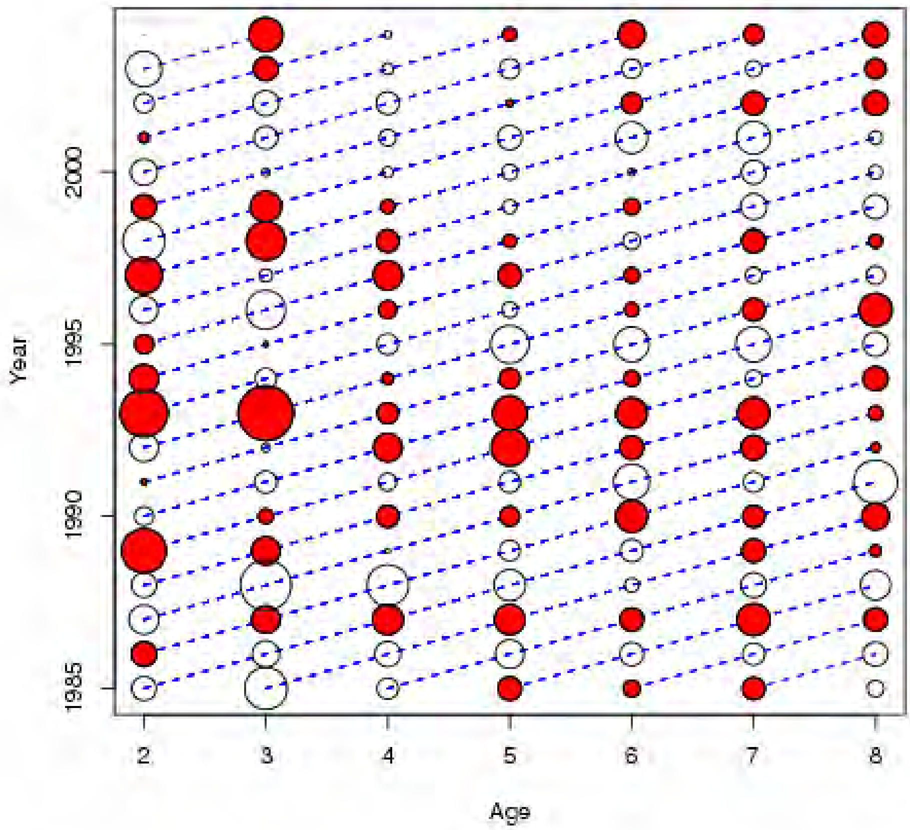


Figure 3.2.7.9. Saithe in Va. AMCI (upper) and 'camera' (lower) catch-log-residuals



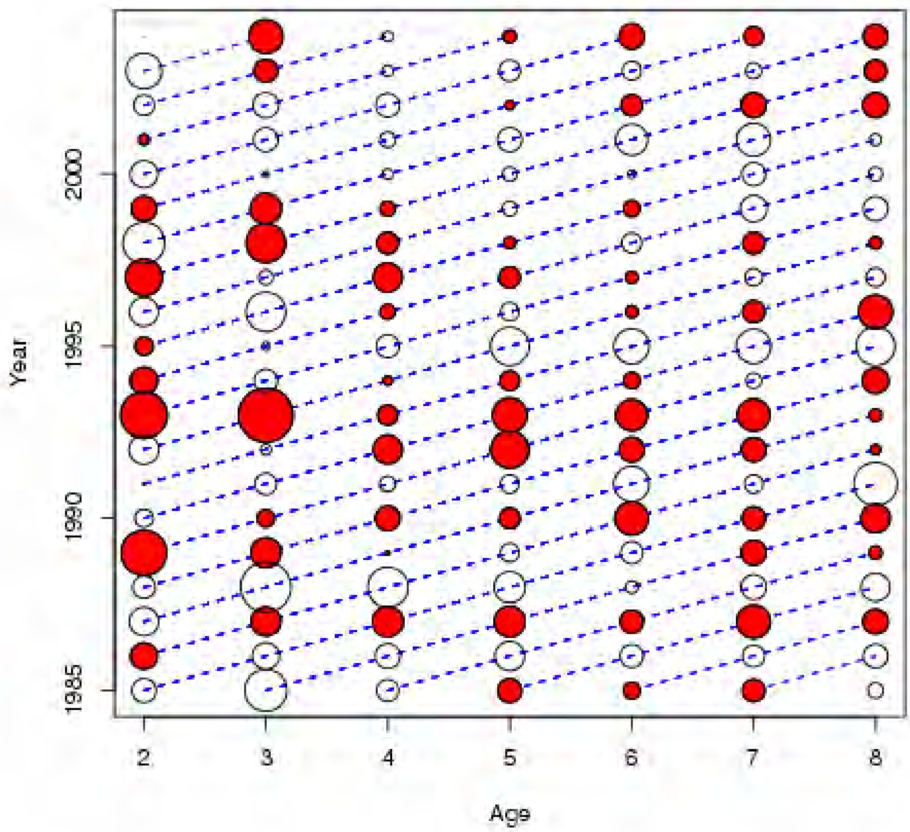
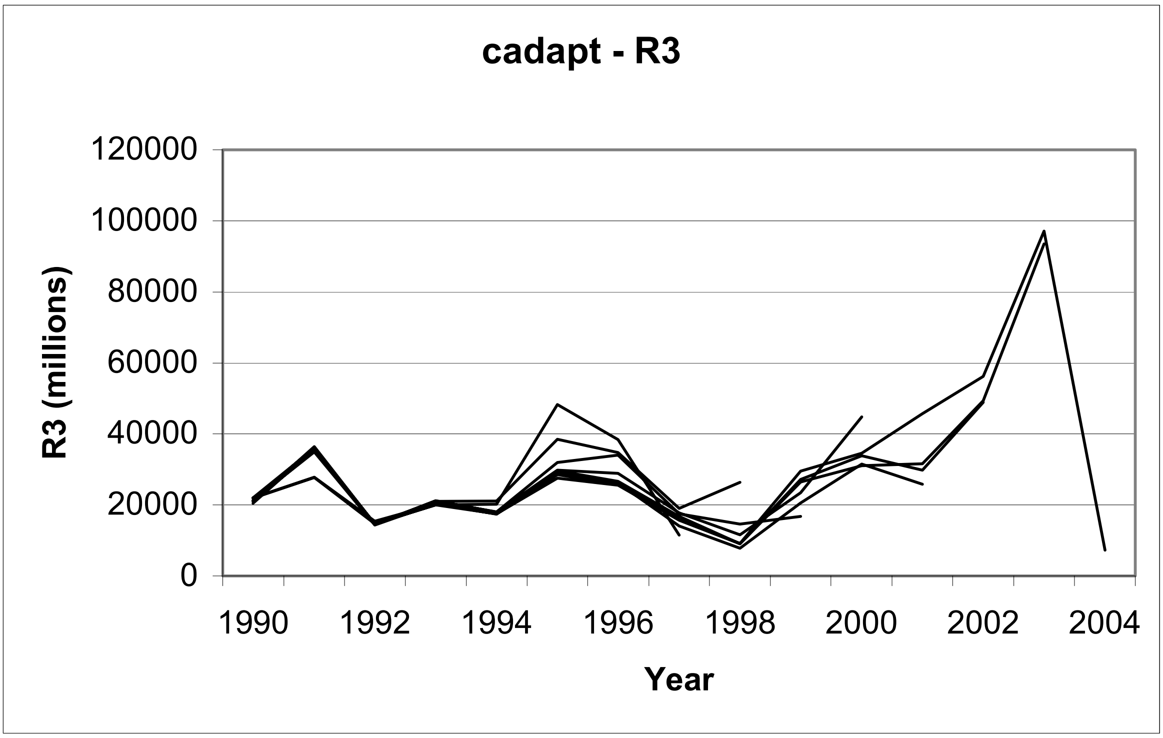


Figure 3.2.7.10. Saithe in Va. AMCI (upper) and 'camera' (lower) survey-log-residuals



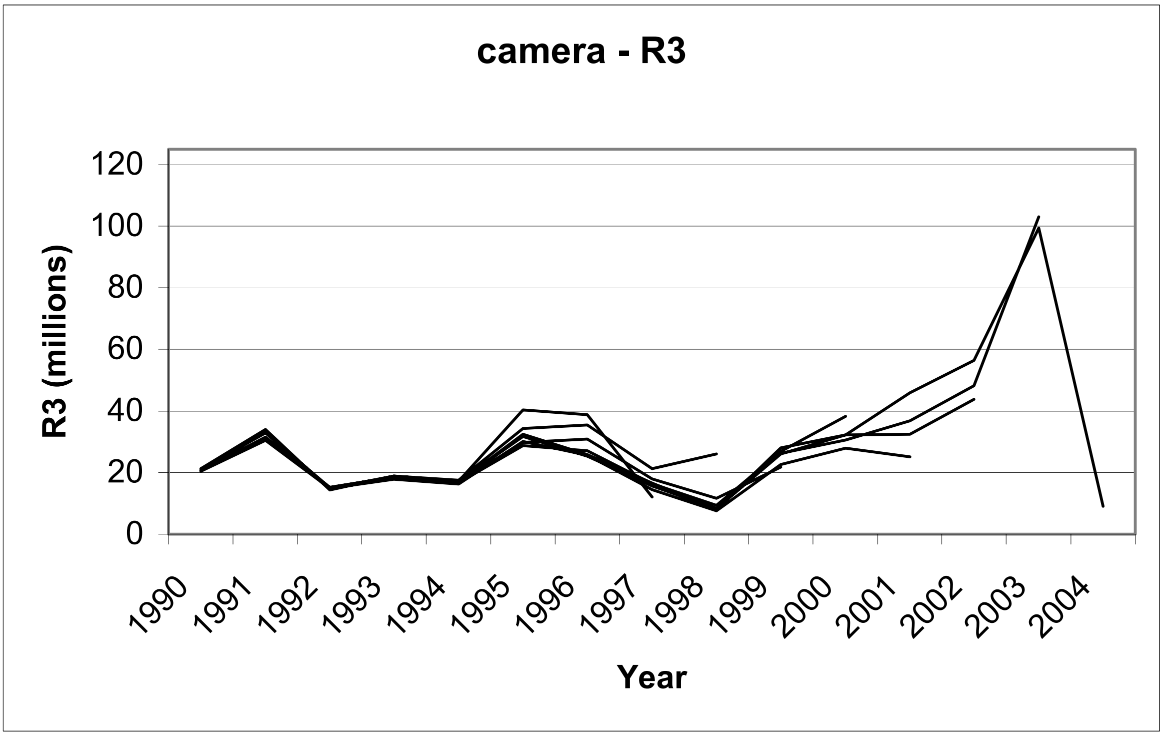
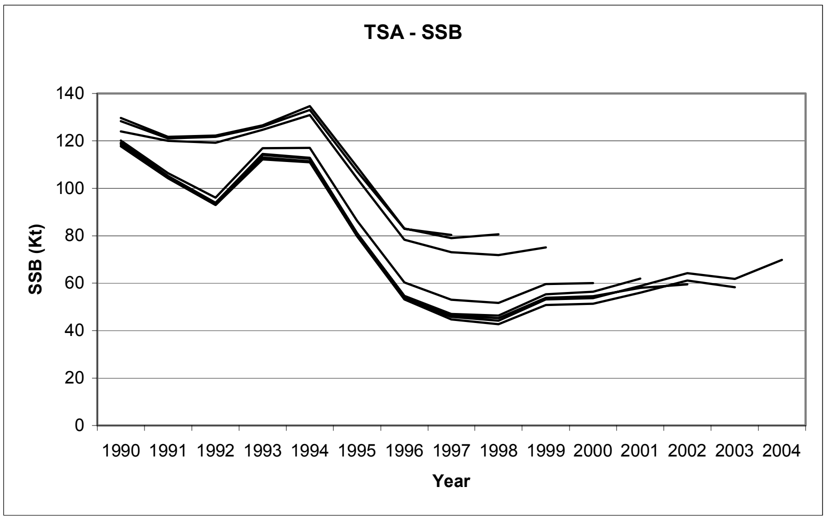
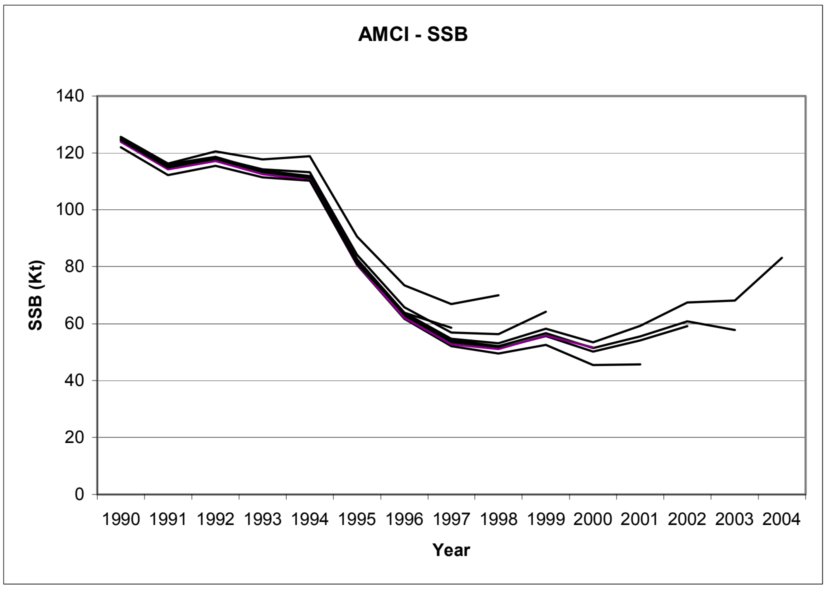


Figure 3.2.7.11. Saithe in Va. Retrospective analysis of 'cadapt' and 'camera' R3. AMCI left since age 2 was recruiting age in model setup.





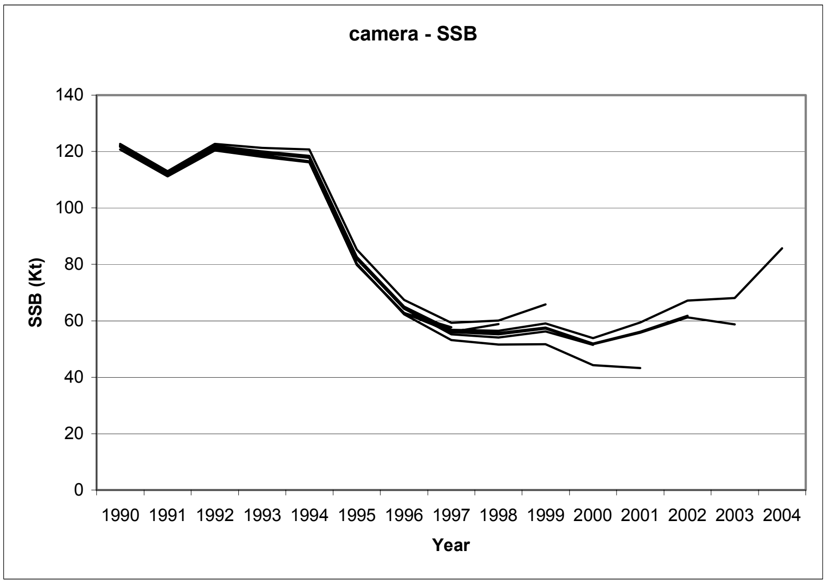


Figure 3.2.7.12. Retrospective analysis of TSA, AMCI and 'camera' SSB. Note that migration is estimated in TSA.

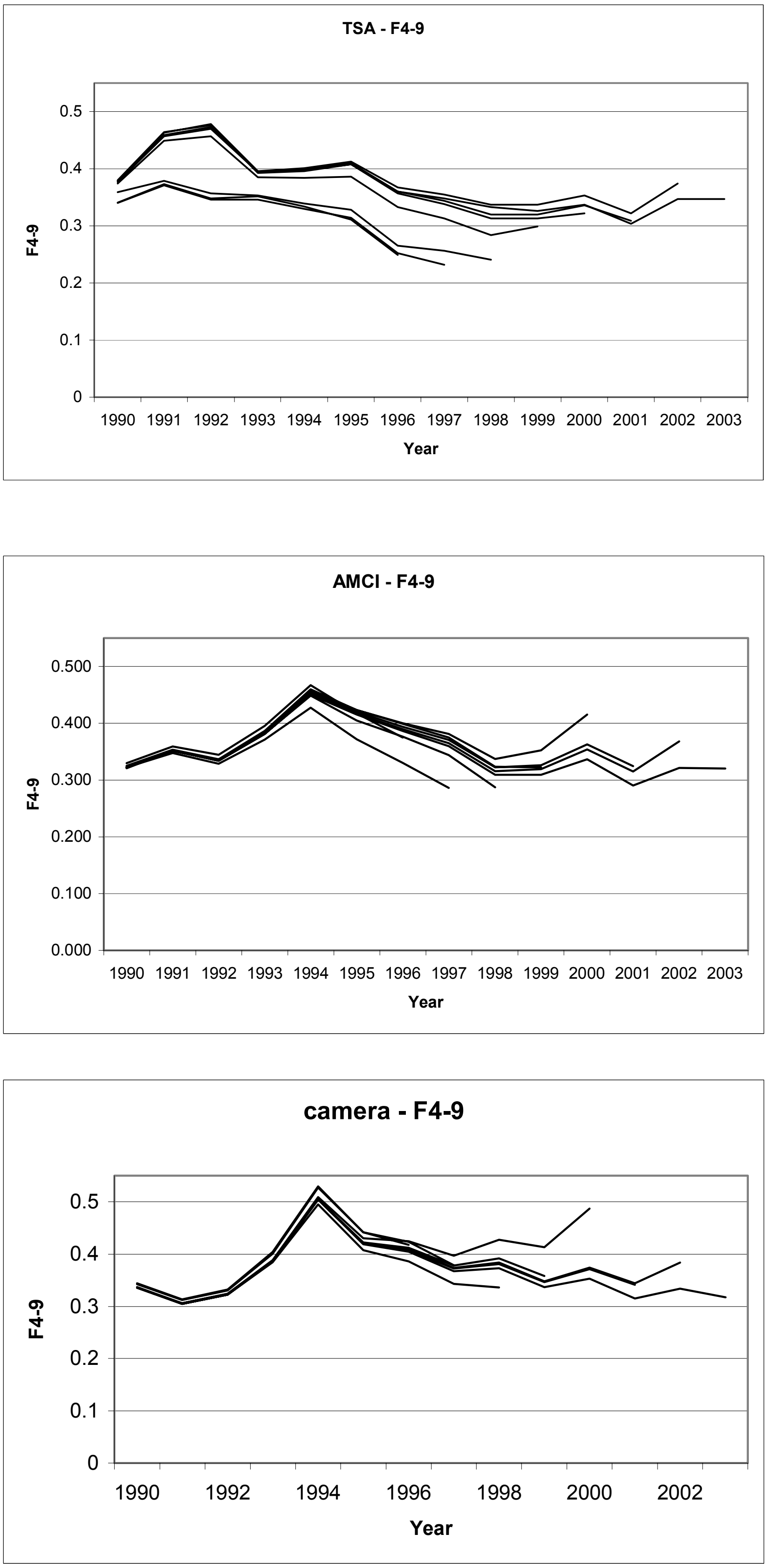
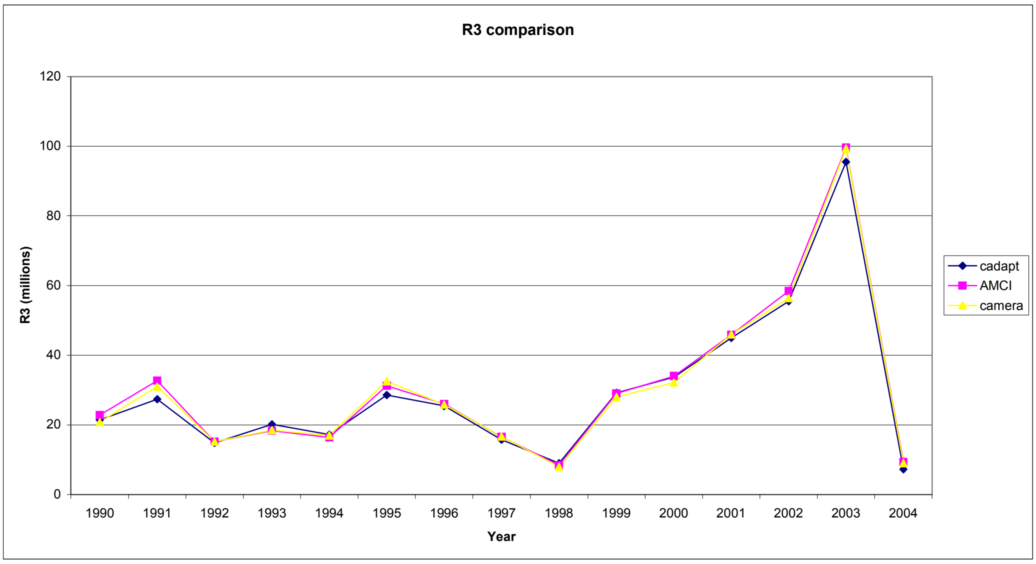
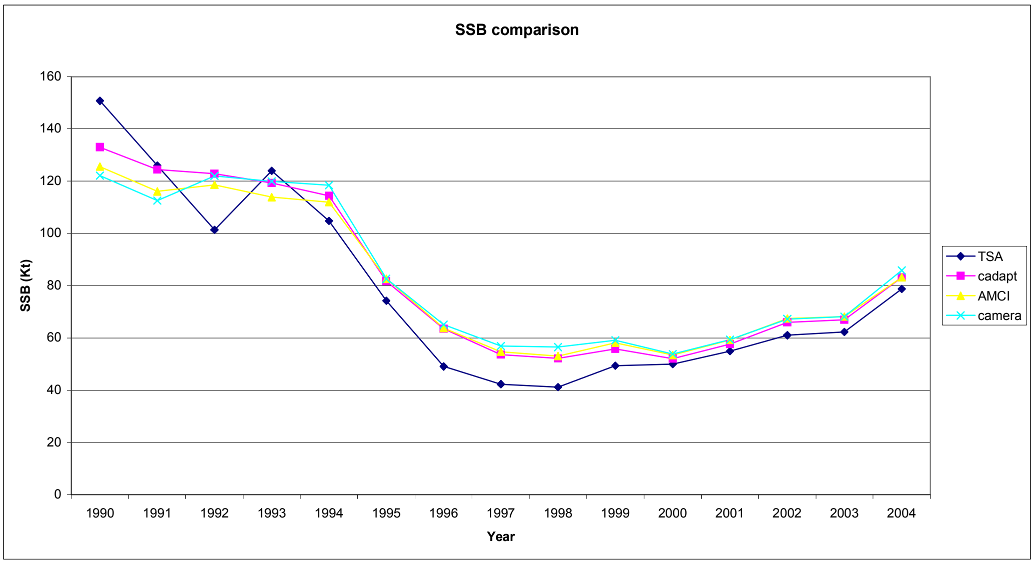


Figure 3.2.7.13. Saithe in Va. Retrospective analysis of TSA, AMCI and 'camera' F4-9. Note that migration is estimated in TSA.





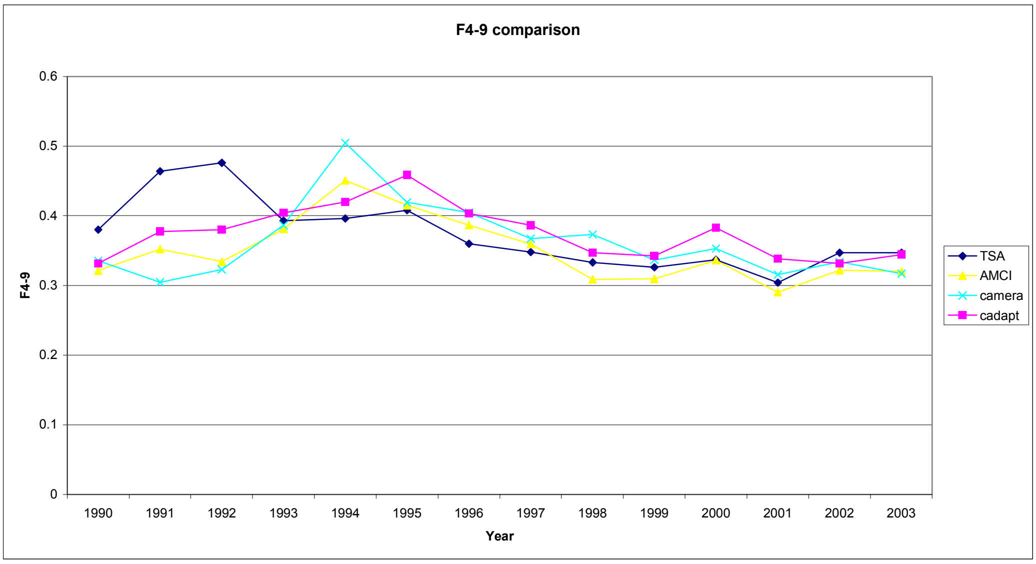


Figure 3.2.7.14. Saithe in Va. R3, SSB and F4-9 1990-2003 from AMCI and 'camera' and 'cadapt', SSB and F4-9 1990-2003 from TSA

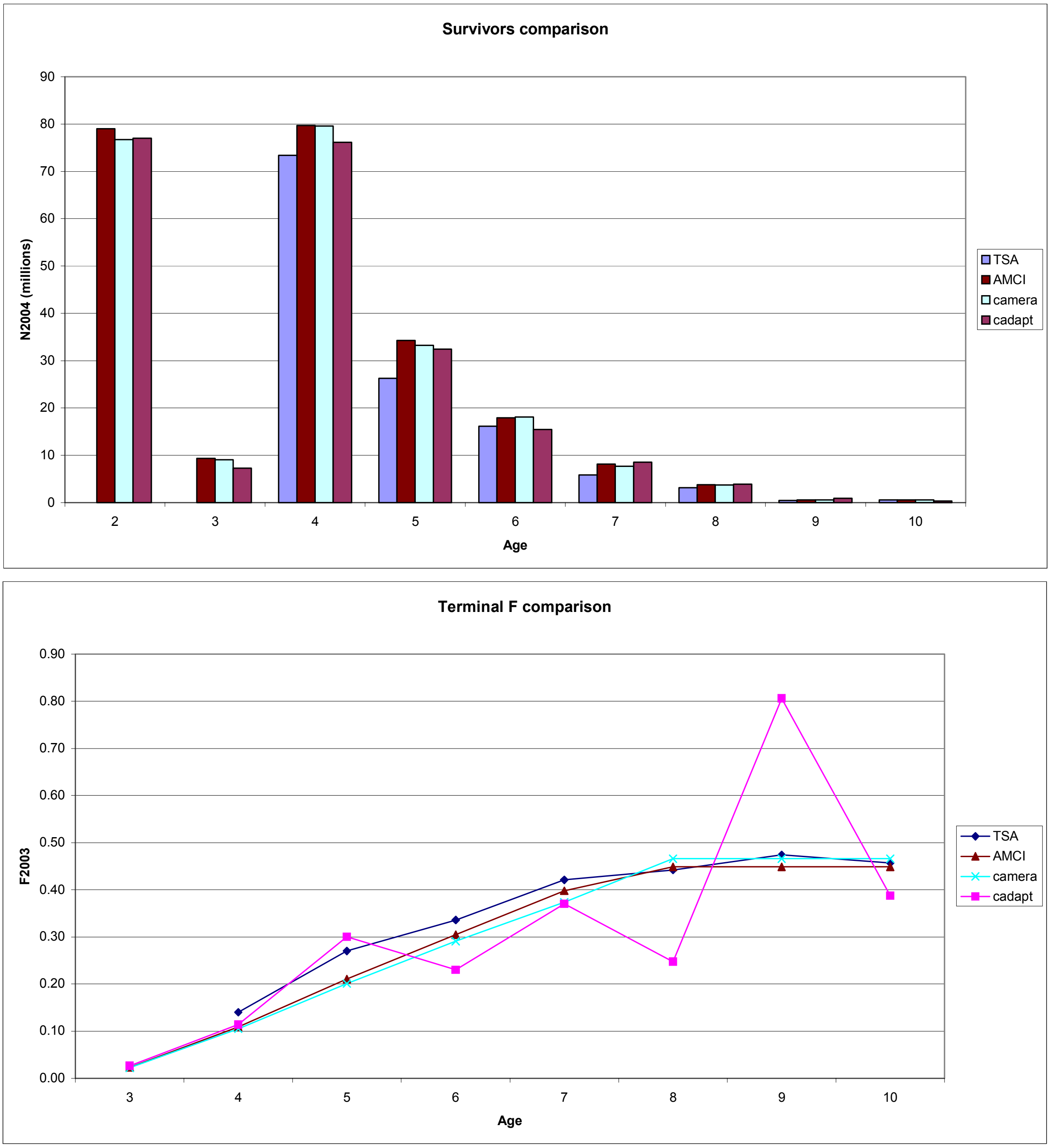


Figure 3.2.7.15. Saithe in Va. Comparison of terminal F4-9 and survivor estimates from TSA, AMCI, 'camera' and 'cadapt'.

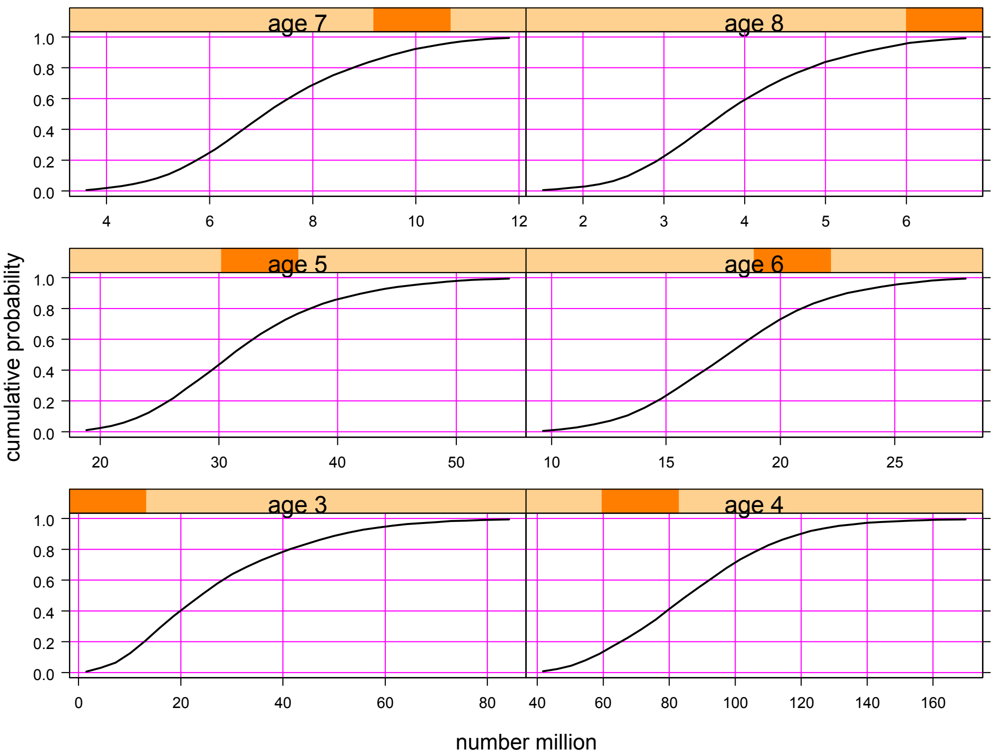


Figure 3.2.7.16. Saithe in Va. AD-CAM 'Probability' distribution of terminal numbers-at-age (at the start of 2004).

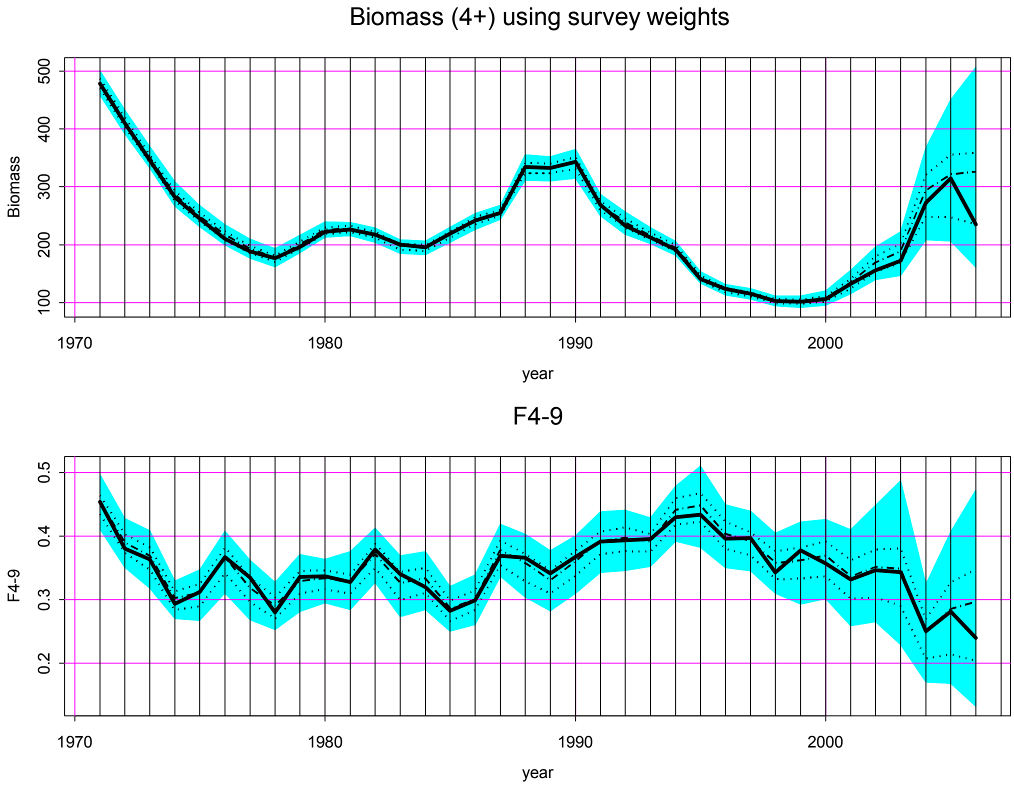


Figure 3.2.7.17. Saithe in Va. Results of AD-CAM prognosis. Shaded areas indicate 90% probability and dashed lines 50%.

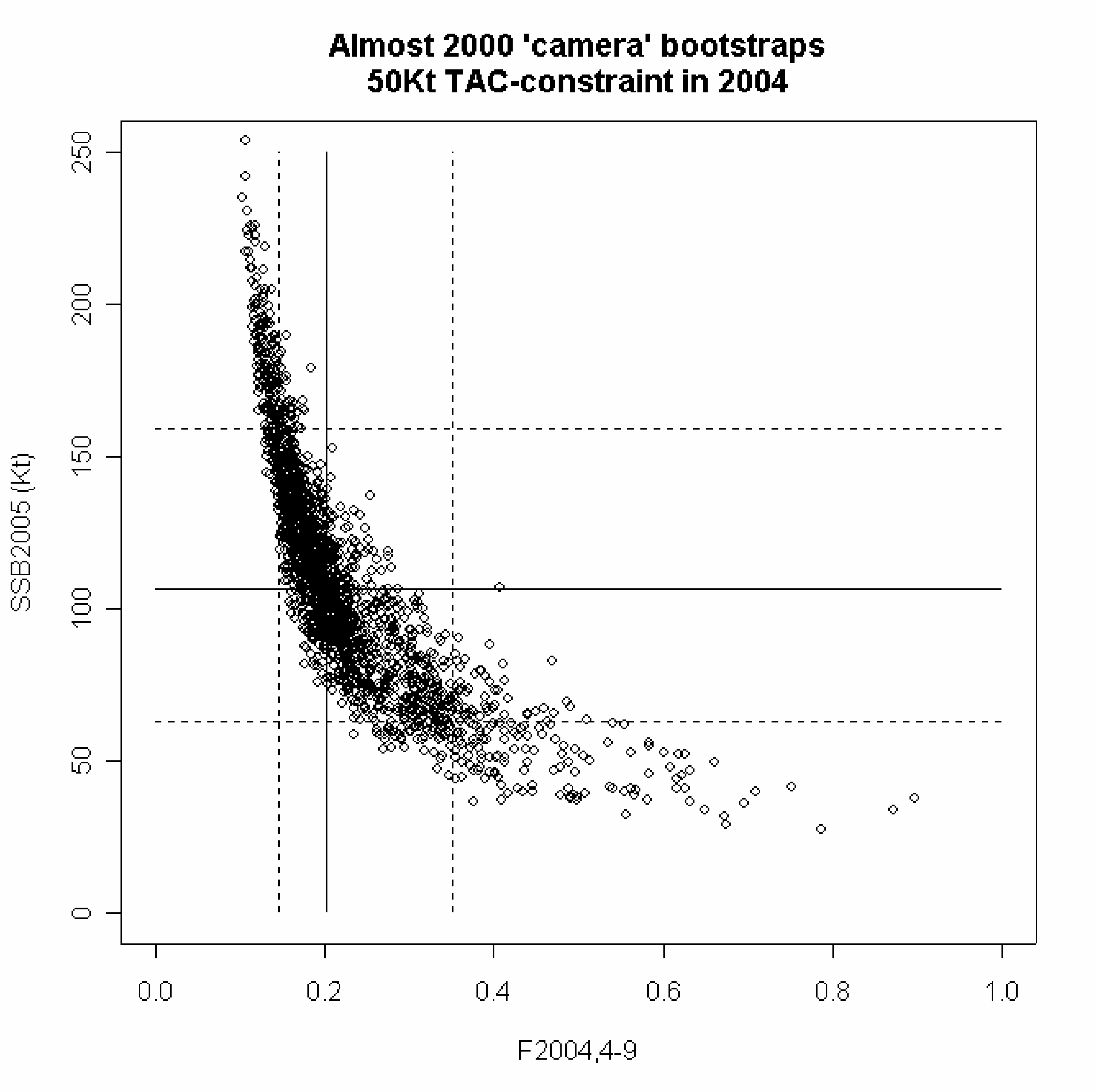


Figure 3.2.7.18. 'camera' boostrap distribution of SSB2005 vs F2004,4-9. Percentiles 10, 50 and 90 are drawn for each stock parameter. Note that a few bootstrap replicates (<50) gave results outside plotting range. Further note that treatment of log residual for observed over predicted yield needs further work and F2004 is underestimated by approx 10%.

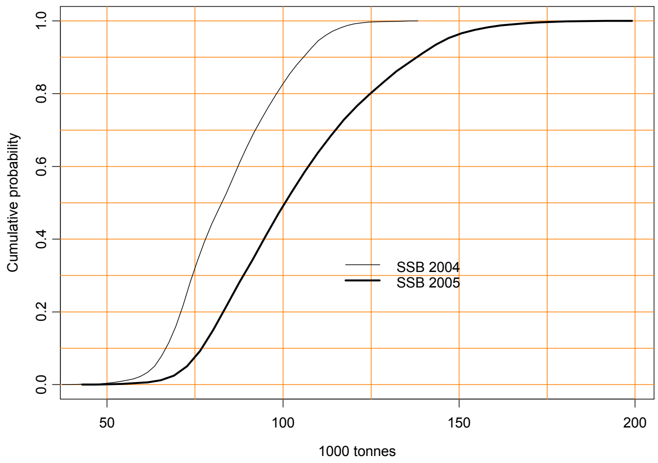
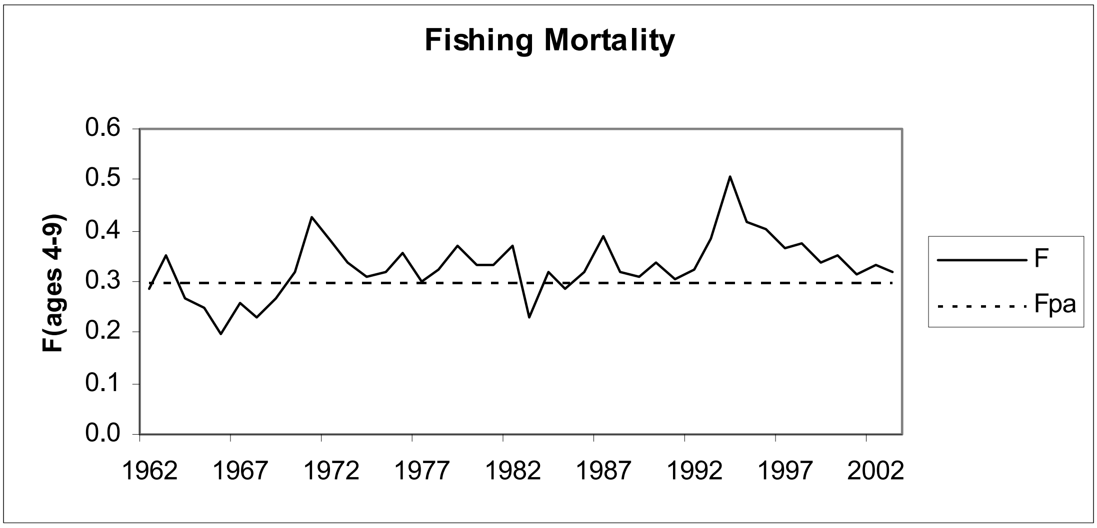
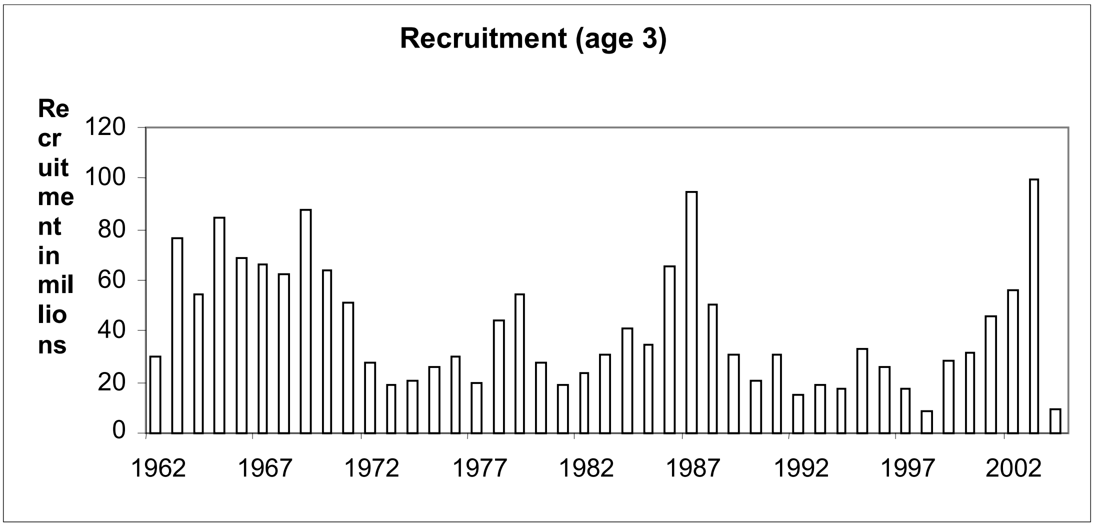


Figure 3.2.7.19. Saithe in Va. AD-CAM likelihood profiles of the spawning stock of saithe in 2004 and 2005.

Icelandic saithe (Division Va)





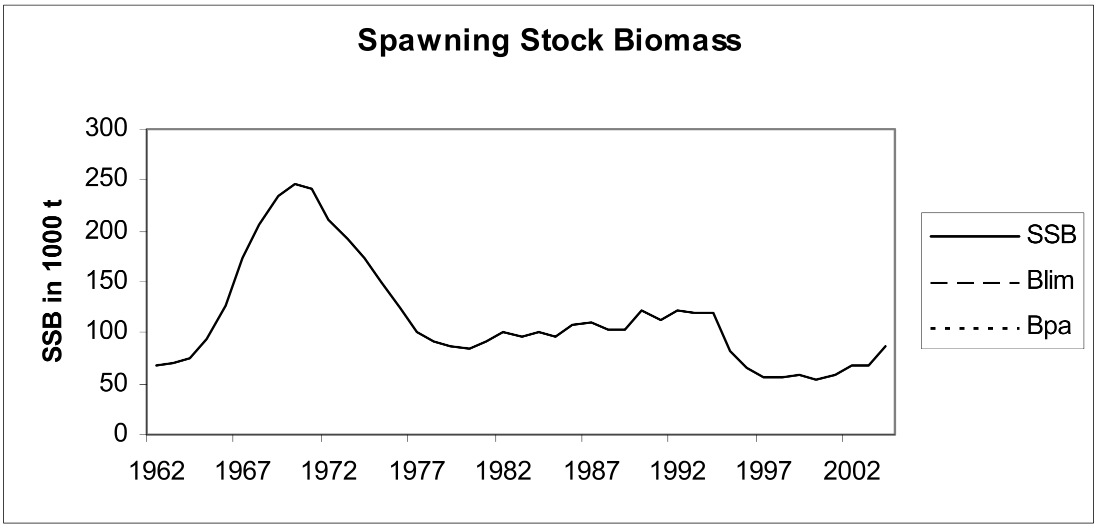
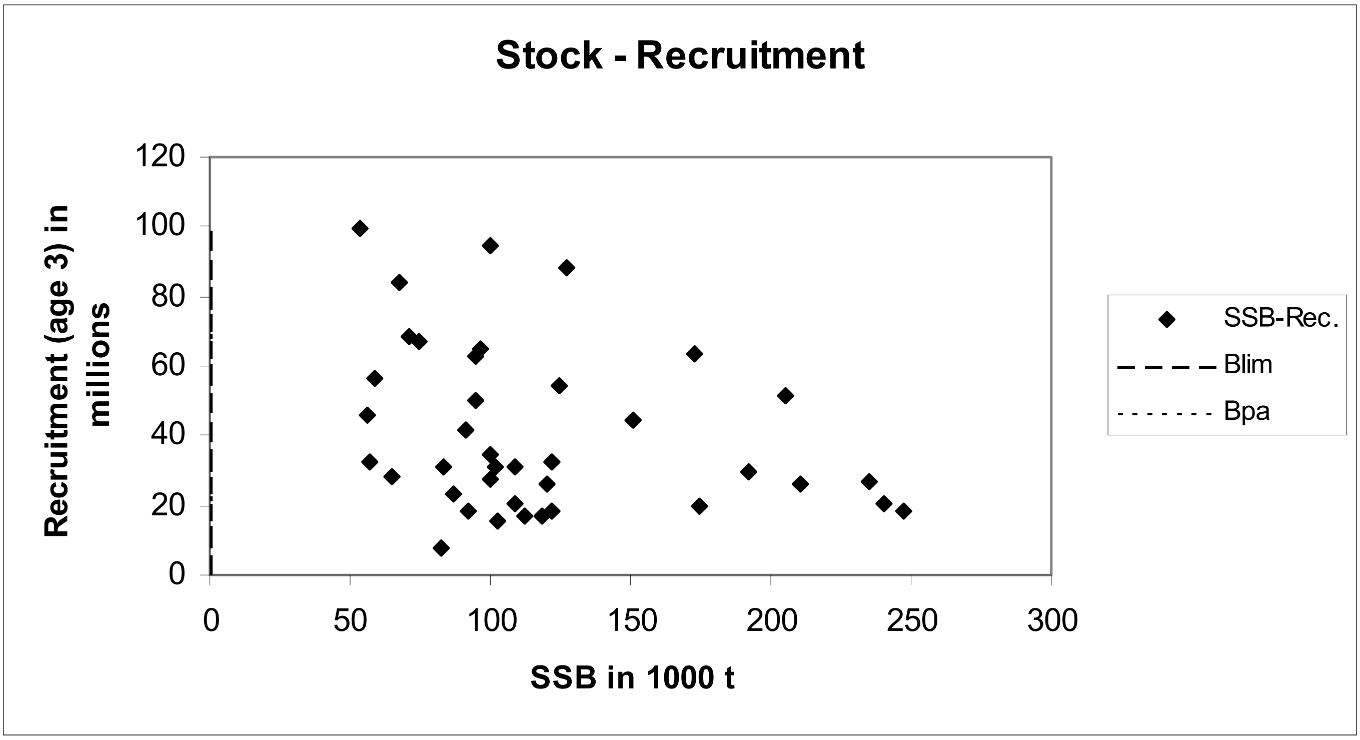


Figure 3.2.7.20 Saithe in Va. Stock summary plot.



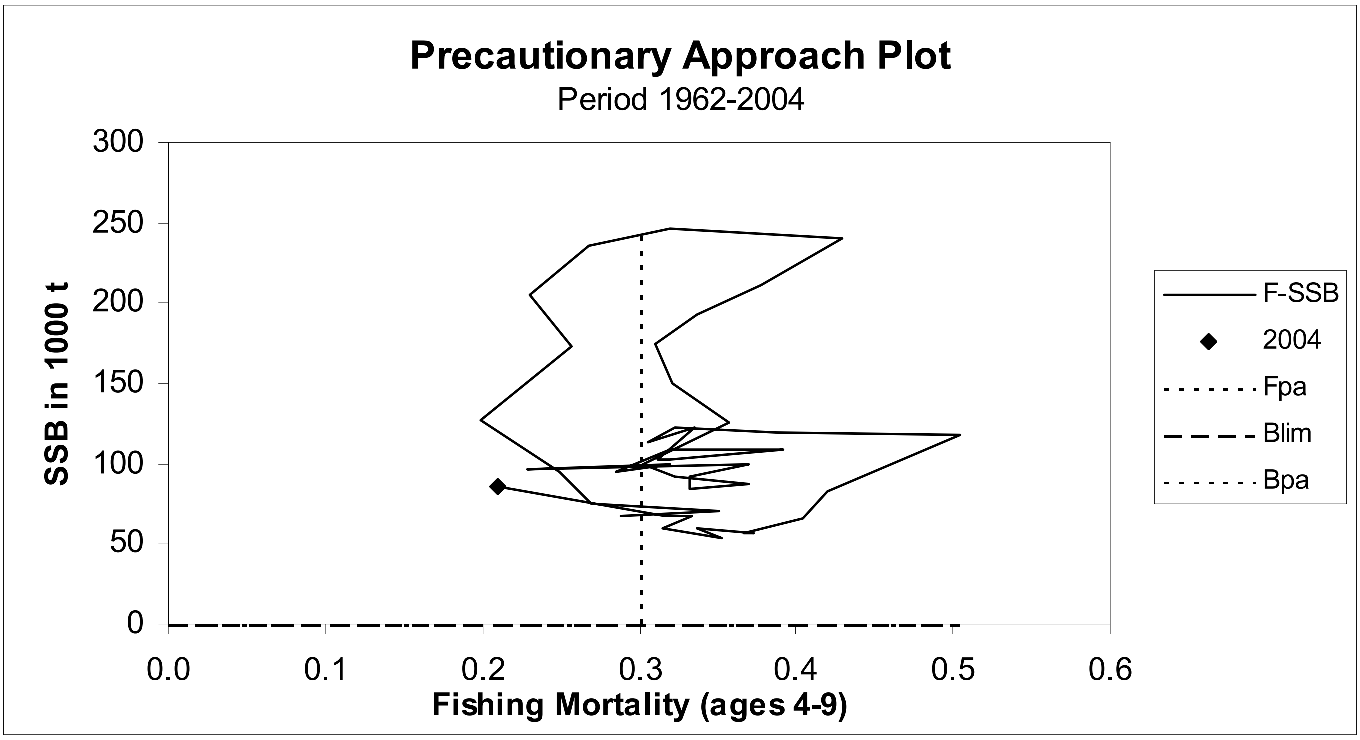


Figure 3.2.7.21. Saithe in Va. Scatter of stock and recruitment pairs.

3.3 Icelandic cod (Division Va)

3.3.1 Stock definition

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

3.3.2 Data

3.3.2.1 Fishery dependent data

3.3.2.1.1 Landings

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

During the period 1988-1996 all year classes entering the fishable stock were well below average, or even poor, resulting in a continuous decline in the landings. The 1995 catch of only 170 000 t is the lowest since 1942. From 1995 catches increased continuously to 1999 when the estimated landings were 260 000 tonnes but decreased to 235 000 tonnes in the years 2000 and 2001, declined to 209 000 tonnes in 2002 and the recorded landings in 2003 were 202 000 tonnes.

3.3.2.1.2 Sampling intensity

Gear	Area	Season	No. length samples	No. length measured	No. age samples	No. aged	Landings tonnes
Longline	South	Jan.-May	105	19593	22	1093	12870
Gillnet	South	Jan.-May	158	23356	11	541	26814
Handlines	South	Jan.-May	5	848	0	0	1877
Danish seine	South	Jan.-May	34	6599	7	348	3870
Bottom trawl	South	Jan.-May	44	8512	12	586	8955
Longline	North	Jan.-May	81	16910	13	697	7024
Gillnet	North	Jan.-May	11	1378	3	147	3365
Handlines	North	Jan.-May	3	581	2	100	1337
Danish seine	North	Jan.-May	4	577	1	50	1333
Bottom trawl	North	Jan.-May	220	45407	41	1990	27487
Longline	South	June-Dec.	86	17256	13	640	10539
Gillnet	South	June-Dec.	40	6247	3	144	6444
Handlines	South	June-Dec.	5	471	4	179	2702
Danish seine	South	June-Dec.	13	2035	1	50	3694
Bottom trawl	South	June-Dec.	28	3877	15	719	5647
Longline	North	June-Dec.	68	13186	15	745	15255
Gillnet	North	June-Dec.	9	1419	0	0	1223
Handlines	North	June-Dec.	23	4605	5	248	9996
Danish seine	North	June-Dec.	8	1584	0	0	4439
Bottom trawl	North	June-Dec.	280	54683	61	2998	46699
Total			**1225**	**229124**	**229**	**11275**	**201570**

The data samples comprising the age-length keys for 2003 are given in the following table:

In recent years emphasis has been put on relating the sampling scheme to the landings database automatically, calling for samples when certain amount has been landed in each cell, calculated daily ("real time proportional sampling scheme").

3.3.2.1.3 Catch in numbers at age

The Icelandic catch in number at age has since 1970 been calculated by splitting the landings by 5 fleets, 2 areas and 2 seasons. The gears are long lines, bottom trawl, gillnets, hand lines and Danish seine, seasons January-May (spawning season) and June-December and regions North and South. Historically, there have been some changes in fleet definitions and thus there does not currently exist a fully consistent set of catch-at-age data on a per-fleet basis. In some cases samples are not available for a cell or are to few to give reliable keys. In those cases otholith samples from "related" cells are used. Since these missing cell constitute a small proportion of the total catch it is not considered to affect the quality of the combined catch at age matrix.

The total catch-at-age data is given in Table 3.3.3 and Figure 3.3.4. The Shepherd Nicholson model gives a CV of 0.2 for age groups 4-10. It should be noted that much higher proportions of the older age groups are taken during the first part of the year and this fishing mortality affects estimation of the spawning stock at spawning time. Since the catch-at-age data have historically only been available for January to May, and not by shorter periods, it is assumed that 60% of those catches were taken during January to March, i.e., before spawning time (Table 3.3.4). Natural mortality before spawning is assumed to be one fourth of the annual natural mortality.

3.3.2.1.4 Mean weight at age in the landings

Mean weight at age in the landings is calculated with the catch in numbers. Before 1993 weighting of cod was relatively uncommon so length-weight relationships were based on little data. Since 1994 weighting has been much more extensive but currently all fishes sampled for otolith are weighted and length-weight relationships can be calculated from current data. The mean weights at age in the landings are shown in table 3.3.5 and figure 3.3.7.

The observed mean weights at age in 2003 were about 6% lower for age groups 3-7 compared to 2002. For age group 8 and older the observed decrease is around 20%.

Mean weight at age have been shown to correlate well with the size of the capelin stock and capelin stock size has been used as a predictor of weights in the landings since 1991. In 1981-1982 weights were low following collapse of the capelin stock and were also relatively low in 1990-1991 when the capelin stock was small. In recent years this relationship seems to be much weaker, most likely due to changes in the spatial distribution of capelin or uncertainties in the estimation of the capelin stock size.

The mean weight at age were high in 1994 to 1997 but have been around the long term average between 1998-2002. In 2003 the observed mean weights are below the last 20 years average for all age groups and for age groups 8 and older it is the lowest mean weight observed since 1981

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

Weights at age in the landings are used to calculate stock biomasses. with the exception of the spawning stock biomass (see section 3.3.3.2.2).

3.3.2.1.5 CPUE

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

The unstandardised CPUE indices and effort from the commercial fleets since 1991 is presented in Figures 3.3.9. A and Tables 3.3.2. In the years 1993 - 1995 a marked reduction in effort and increase in CPUE was observed with the adoption of the HCR. The largest reduction was by the trawlers who diverted their effort to other species and other areas. The effort increased and CPUE decreased in all gears in 1998 - 2001. In 2002-2003 a decrease in effort was observed for trawlers and gillnetters but an increase in 2003 by longliners. CPUE for gillnets has been decreasing since 1997 but an increase has been observed in bottom trawl since 2001 and a slight decrease in 2003 by longliners. The increase in effort in 1998-2001 can be explained by overestimation of the stock and the amendment of the HCR in the year 2000.

3.3.2.2 Fishery independent data

3.3.2.2.1 Survey abundance indices

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

A conventional stratified random type method was used for calculating survey indices. The strata used follow depth contours. The stratified indices were calculated separately for two areas: Northern and Southern area and combined. For all models used except for the TSA the indices were combined by simple summation (Table 3.3.8 and figure 3.3.11) but for the TSA tuning the two area indices a weighted geometric mean was calculated (Table3.3.9). The total biomass index from the survey is presented in figure 3.3.10. The Shepherd Nicholson model gives a CV of 0.24 for age groups 2-9 for the survey indices.

Figure 3.3.13 show plots of survey index for cod vs. the index of the same year class in the survey one year later. This type of plot should show good relationship if the survey is consistent, except when fishing effort varies much. The best relationship is between ages 3 and 4, age groups that are fully recruited to the survey but age 3 does usually have low fishing mortality.

3.3.2.2.2 Mean weight and maturity at age in survey

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

In previous assessments data from the commercial catch period January-May were used for estimation of mean weights at age in the spawning stock and maturity at age. Because of the selectivity of the commercial fishing gears only the largest individuals of the youngest age groups are represented in samples from landings leading to overestimation of both mean weight at age and proportion mature at age for the youngest fish. Using data collected in the Icelandic groundfish survey (IGS) is considered to provide a better estimates of mean weights at age in the spawning stock as well as maturity at age, at least for the youngest fish. The survey takes place near spawning time, sampling is performed with small meshes in the trawl codend and it covers the distribution of cod. As a consequence of the random otolith sampling scheme used in the survey and a relatively low abundance of age group 8 and older the mean weight and maturity at age for the older fish are poorly estimated from survey data. For these reasons the mean weights at age used to calculate the spawning stock biomass are taken from mature fish in the spring survey for age groups 4-7 and for age 8 and older the weights in the catches are used. The observed maturity at age from the spring survey for age groups 3-9 are now used for estimation of the spawning stock biomass while for age 10 and older, values from catches are used. The mean weight at age used for calculation of spawning stock biomass are shown in table 3.3.6. and figure 3.3.8. and the maturities in table 3.3.7. figure 3.3.6.

As the survey data are only available back to 1985 mean weights in the spawning stock prior 1985 were estimated using the relationship between the mean weight at age in the catches to the weights of mature fish in the survey in 1985-2004. The same procedure was used for maturity at age using the relationship between proportion mature in the survey and in samples taken from the catches January-May 1985-2004.

3.3.3 Stock Assessment

In the current report results from three different models are presented: **XSA**, **TSA** (Time Series analysis developed by G. Gðmundsson) and **AD-CAM**- an AD-Model builder statistical Catch at Age Model written and developed at the MRI (WD-33, NWWG-2002). The results from the AD-CAM model were adopted last year as point estimate for forward projections.

3.3.3.1 Estimates of fishing mortality

The three different assessment models were run all using the same datasets, catch in number at age, Table 3.3.3, and survey indices, Table 3.3.8, expect for TSA using weighted geometric mean of North and South areas indices, Table 3.3.9.

XSA tuning

XSA was run using the same settings as in last years assessment using age groups 1-9 from survey for tuning. To use the latest information available for tuning, the 2004 spring survey indices were moved three months back in time i.e. to end of December 2003. The resulting tuning diagnostic and terminal F's are presented in Table 3.3.10, resulting retrospective analysis in Figure 3.3.16 and Figure 3.3.17 and the log catchability residuals in Figure 3.3.18. The estimated terminal reference F (average of age groups 5-10) is **0.69.**

TSA

The results of the TSA run are presented in Table. 3.3.11. The test statistics from standardised residuals of prediction errors of catches and survey indices seem satisfactory. (Table 3.3.11 and Figure 3.3.18). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.64**.

AD-CAM

The input parameters settings, are presented in Table 3.3.12 along with the resulting residuals and the estimated fishing mortality rates and stock in numbers in Table 3.3.14-15. The residuals plot are shown in Figure 3.3.18 and the corresponding retrospective pattern in Figures 3.3.16-17. The terminal reference fishing mortality is estimated 0.70.

3.3.3.2 The selection of a final run

Comparison of the retrospective results from the three models (Figure 3.3.16-17) show that the most consistent patterns are observed using the AD-CAM model looking at both the reference fishing mortalities and the fishable biomass (4+). The retrospective pattern from the TSA also show reasonable consistency but the XSA model shows somewhat more inconsistent pattern.

In Table 3.3.13 and Figures 3.3.19-21 a summary of the resulting terminal fishing mortalities and estimated, biomass and stock in numbers in 2004 from the different models are presented. The estimated stock in weight (4+) in the beginning of 2004 from the three models used are very similar or in the range of 854-878 thous. tonnes. These models also show similar fishing mortality pattern but TSA estimate somewhat lower F values for the older age groups. Resulting terminal reference fishing mortalities are also very similar or in the range 0.64-0.70, the lowest value from the TSA which is reflecting the difference in the older ages. The estimated stock in numbers in the beginning of 2004 from TSA and XSA are well within one standard error of the AD-CAM results (Figure 3.3.24).

Last year the NWWG concluded that the AD-CAM modelling approach is the most appropriate since it provides stock and recruitment estimates within the same statistical framework including probability profiles. Medium term projection are also a natural extension of this type of model approach. Furthermore the AD-CAM model can handle migrations and survey indices in the assessment year and is designed and run by a member of the working group. For these reasons, and for convenience, the AD-CAM run was adopted as a point estimate for forward projections. Those arguments are still valid and the results from the AD-CAM run were also adopted this year as point estimate for forward projections.

The estimated biomass(4+) in 2004 from the AD-CAM model is 854 thous. tonnes with standard error of 41. The resulting fishing mortalities are given in Table 3.3.14 and in Figure 3.3.22B. The fishing mortality increased to a peak in 1988, decreased in 1989 but then rose to another peak in 1993. Due to restriction of the cod quota fishing mortality dropped markedly in 1995 and 1996 but has increased since then to 0.70-0.76 in 2000-2003.

3.3.3.3 Stock and recruitment estimates

The resulting stock size in numbers and stock in weight from the final run are given in Tables 3.3.15 & 3.3.17. The recruitment in the most recent years are estimated by the AD-CAM model. Parameters setting and assumptions made are described in table 3.3.12.

3.3.4 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 were used in 1991-2003 to predict the mean weight at age in the catches in the short-term predictions based on the results in Steinarsson and Stefánsson (1996). This year no estimates are available for capelin stock size.

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

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

A number of fleets operate in Division Va. The primary gears are described in Section 3.3.2. Earlier work by this group included the separation of catches into finer seasonal and areal splits, but this has not been taken further at this meeting.

A numerical description of interactions between fisheries and species requires data on landings as well as catches in numbers at age of each species by gear type, region and season.

3.3.5 Prediction of catch and biomass

3.3.5.1 Input data to the short-term prediction

Between 1991 and 2003, mean weights for age groups 4-9 in the catches have been predicted using a simple multiple regressions model based on mean weight of the year classes in the previous year and capelin stock biomass. For ages 10-14 an average of three previous years has been used due to low sample size of these year classes.

In recent years the relationship with capelin biomass and mean weights seem to be much weaker, most likely due to changes in the spatial distribution of capelin or uncertainties in the estimation of the capelin stock size. No prediction for the capelin biomass estimate has been made for 2005

Therefore a new approach had to be set. Different methods have been used for calculating the mean weights at age in 1) the catches and 2) the mature stock .

1) In the catches, a relationship between the mean weight at age in the survey and mean weight at age in the catches the same year were used for predicting catch weights in 2004, for age groups 3-8. In 2005 the weight prediction was made as a regression between the mean weight at age in the survey and the mean weight at age in the catches in the following year, for age groups 4-8.For age 9 and older the observed mean weights in the 2003 catches were used as face value for weight predictions in 2004 and 2005. Retrospective analysis shows that using mean weights at age from previous year are somewhat better predictor than using traditional three years average.

   2)To predict the mean weight at age in the spawning stock in 2005 different methods were used for separate age groups. For age groups 3-4 the mean weight in the survey was multiplied with 1.23 for scaling the weight with that in the spawning stock. For age group 5-7 the result of a regression of mean weight of year classes in previous year were used from mature cod in the spring groundfish survey. For age groups 8 and older mean weights in the catches were used and For 2006 and 2007 the estimated values for 2005 were used (Table 3.3.21.) For predicting the spawning stock in 2005-2007 the average from maturity at age in the spring survey between 2002–2004 was used.

The exploitation pattern used for the short-term predictions was taken as the average of the years 2001–2003.

Based on the reported landings in the first month of the 2003/2004 fishing year and an assumption of the use of harvest control rule for the coming fishing year the expected catch in 2004 will be a around 220000t corresponding to F=0.60. A TAC constraint is used for this stock since the TAC forecasts have historically been relatively good.

The results from the AD-CAM model were used for recruitment prediction. For comparison the RCT3 program was also run with same settings as last year. The combined Cochran survey indices, age groups 1-4 and recruitment estimates from the XSA for the year classes 1981-1998, were used as input for the RCT3 recruitment prediction. The input is given in Table 3.3.19. and the output in Table 3.3.20. The size of the year classes 1998–2002 as estimated by the various models give all very similar estimates, see Table 3.3.13.

3.3.5.2 Short term prediction results

Input data to the short term prediction and results from projections up to the year 2007 with different management options are presented in Table 3.3.21 and Figure 3.3.23A.

The resulting TAC according to the harvest control rule in the 2004/2005 fishing year will be 205 000t. The SSB will increase to about 260 000 t in 2005 and the resulting reference fishing mortality is about 0.50. The estimated age distribution of the catches and SSB in 2005 are shown in figure 3.3.23B.

3.3.5.3 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 for the last three years and mean weight at age and maturity at age over the years 1982–2003 has been used as input (Table 3.3.25).

3.3.5.4 Long-term prediction results and biological reference points

The biological reference values for $\mathbf{F}_{max}$ and $\mathbf{F}_{0.1}$ are 0.32 and 0.14 respectively. Yield per recruit at the $\mathbf{F}_{max}$- is 1.82 kg. (Figure 3.3.25 Table 3.3.26).

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.26. When using the period 1955–1998, the reference point $\mathbf{F}_{med}$ is estimated around 0.62.

The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested a candidate for $\mathbf{B}_{lim}$ "somewhere in the range of 400kt". Due to the the new method used to calculate the spawning stock biomass presented in this report this estimate needs to be revised.

The inclusion of the stock recruitment relationship has a major effect on long-term predictions. From Figure 3.3.26 it is seen that below-median recruitment occurs more frequently when the SSB is below-median than when the SSB is above the median. The increased probability of poor recruitment at low SSB is of major concern.

3.3.6 Medium term simulation.

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

- The amended Harvest Control law was followed.
- Assessment error was assumed to be lognormal with CV of 15% and autocorrelation 0.2.
- The SSB-recruitment relationship used are described in Table 3.3.12
- Deviations in weights at age were assumed to be lognormal with CV 0.1 and autocorrelation 0.35. The same deviations were applied to all age groups in the same year. The values are based on examination of weight at age

in the catches 1980-2003. Errors in weights at age and assessment errors were not correlated but it is likely that sudden reduction in weight at age will not be predicted and lead to too high catches.

The results of the simulations are shown in figure 3.3.27. The results indicate that the catchable biomass 4+ will most likely increase somewhat in coming years.

3.3.7 Management considerations

Catch quotas for the Icelandic cod stock have since 1994 been based on the 25% catch rule. This catch rule was based on extensive simulations and has been considered precautionary. Until year 2000 the Icelandic government followed the catch rule with minimal deviations although it has turned out that the TAC has exceeded the 25% rule due to overestimation of the stock. In 2000 the Icelandic government, after some limited studies by the MRI, changed the adopted 25% catch rule by limiting the allowed changes in TAC between consecutive years to 30 thousand tonnes. The catch control rule has been in a reviewing process since 2001 by a group scientists appointed by the Ministry of Fisheries. This group delivered a final report to the Minister during the working group meeting.

Since the implementation of the catch rule in 1995 realised reference fishing mortalities have been in the range of 0.56-0.70, in last four years about 0.7. The expected long-term fishing mortality by the application of catch rule was 0.4.

At present fishing mortality is high (F5-10 in the year 2004 about 0.6) and age 7 and younger fish account for 94% of the fishable biomass(4+). The age composition of the spawning stock is highly skewed. Spawners at age 8 and younger will constitute to about 94% of the spawning stock biomass in 2005. Given the relatively high proportions of younger fish in both the fishable as well as in the spawning stock biomass a lower fishing mortalities than resulting from the catch control rule should be considered.

The working group noticed that before The Ministry of Fisheries allocates the national TAC between vessels, catches of about 2000 tonnes are assumed to be taken by about 300 small jiggers operating in a effort control system. In recent years this amount has been exceeded considerable and in the fishing year 2002/2003 the catches of this fleet was about 11 000 t. This is taken into account by the working group estimate of the total annual catch in the assessment year.

3.3.8 Comments on the assessment

The current assessment and last two years assessments are more consistent with previous years assessments compared to the assessments in 1998-2000 were substantial overestimation was observed. As in two previous years assessment indices from commercial fleets were not used for the calibration of the assessment models used. This decision was based on retrospective patterns, the results from the working group on Icelandic cod in autumn 2000 and a study by Guðmundsson and Jónsson (WD-31, 2002) revealing marked trend in catchability in cpue series from commercial fleets. Indices from commercial fleets are still used even if they are not used directly in tuning and they are taken as an important source of information on the state of the stock. The commercial cpue series give the same main message as the survey and a situation where they would show opposite trends would demand thorough investigation of the survey and the cpue indices.

The fishable biomass 4+ in 2003 was estimated at 765 thous. tonnes in last years assessment compared to 739 000t in the current assessment. This difference of 26 000t, or less than 4% , is well within the error limits of last years point estimate.

Since 1991 relationship between capelin biomass and the mean weight at age in the catches have been used to predict the mean weight at age in the stock for the most important age groups. As no estimate for the capelin biomass are now available for 2004 and 2005 an alternative approach was used fro predicting the weights. The results from a capelin echosurvey conducted by the MRI in April this year could not be used for stock estimation as practically no capelin were found in conventional survey are. The indices from the o-group survey in 2003 were the lowest observed since the beginning of the series in 1982. Using the same relationship between mean weight at age and capelin biomass as in last years assesment assuming the capelin biomass being at same level as in the record low 1982 give somewhat lower weights than now predicted. The resulting estimated fishable biomass 4+ in the beginning of 2004 will be about 5% lower than presented in this report and the catches in 2005 according to the harvest control rule around 190 000t compared to 205 000t.

The year classes 1999-2002 were estimated 165, 205, 70 and 195 millions respectively in last years assessment compared to 160, 200, 70 and 170 in the current assessment.

The main causes of the 13-24% overestimation of this stock in the years 1998-2000 is now considered to be the use of combination of commercial cpue and survey indices for calibration of stock assessment models and high availability of cod in the years 1997 and 1998. The causes for the anticipated increase changes in availability in these years are still not quite understood. Many factors have been mentioned such as: hydrographical changes, capelin availability, increased availability with reduced effort (disturbance), increased natural mortality, emigration, increased discards etc.. Some of those theories have been analysed but no analytical results are available. As those effects still remain unexplained the point estimate in this years assessment is not corrected for possible changes in parameters of this kind.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1997- 2003 as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Faroe Islands	408	1,078	1,247				
Germany	-	9	21	15	11	15	88
Greenland	-	-*	25*	-*	-*	-*	
Iceland	202,745	241,545	258,658	234,362	233,875	206,987	199,965
Norway	-	-	85	60	129*	76*	278
UK (E/W/NI)	-	-	12	10	15	19	...
UK (Scotland)	-	-	4	+	5	13	...
United Kingdom							142
Total	203,153	242,632	260,052				
WG estimate				235,623	235,164	208,298	201,570

*Preliminary.

Table 3.3.2 Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-2003 (with 1991 as 100%). Data are based on logbooks which have been mandatory in the fisheries since 1991.

Bottom trawl

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	175142	234946	100	745	100
1992	131504	228196	97	576	77
1993	114587	182882	78	627	84
1994	66186	83975	36	788	106
1995	60580	71202	30	851	114
1996	66867	66867	28	1000	134
1997	81202	74841	32	1085	146
1998	109947	86098	37	1277	171
1999	124381	120408	51	1033	139
2000	103289	126270	54	818	110
2001	98067	109877	47	892	120
2002	88059	84340	36	1044	140
2003	88552	78170	33	1133	152

Gillnet

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	58948	1060	100	56	100
1992	59712	984	93	61	109
1993	56701	1008	95	56	101
1994	39192	718	68	55	98
1995	32309	437	41	74	133
1996	41764	492	46	85	153
1997	46742	483	46	97	174
1998	51554	721	68	72	129
1999	47648	781	74	61	110
2000	47989	842	79	57	102
2001	53943	1124	106	48	86
2002	44560	990	93	45	81
2003	37846	901	85	42	75

Long line

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	44711	2006	100	22	100
1992	42301	2016	100	21	94
1993	47263	2224	111	21	95
1994	36426	1652	82	22	99
1995	44588	1724	86	26	116
1996	39770	1478	74	27	121
1997	31276	824	41	38	170
1998	37243	972	48	38	172
1999	53380	1570	78	34	153
2000	50085	1727	86	29	130
2001	47092	1811	90	26	117
2002	42155	1405	70	30	135
2003	44662	1595	80	28	127

Table 3.3.3 Cod at Iceland. Catch in numbers by year and age (millions).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1983	3.554	10.910	24.305	18.944	17.382	8.381	2.054	2.733	0.514	0.215	0.064	0.037
1984	6.750	31.553	19.420	15.326	8.082	7.336	2.680	0.512	0.538	0.195	0.090	0.036
1985	6.457	24.552	35.392	18.267	8.711	4.201	2.264	1.063	0.217	0.233	0.102	0.038
1986	20.642	20.330	26.644	30.839	11.413	4.441	1.771	0.805	0.392	0.103	0.076	0.040
1987	11.002	62.130	27.192	15.127	15.695	4.159	1.463	0.592	0.253	0.142	0.046	0.058
1988	6.713	39.323	55.895	18.663	6.399	5.877	1.345	0.455	0.305	0.157	0.114	0.025
1989	2.605	27.983	50.059	31.455	6.010	1.915	0.881	0.225	0.107	0.086	0.038	0.005
1990	5.785	12.313	27.179	44.534	17.037	2.573	0.609	0.322	0.118	0.050	0.015	0.020
1991	8.554	25.131	15.491	21.514	25.038	6.364	0.903	0.243	0.125	0.063	0.011	0.012
1992	12.217	21.708	26.524	11.413	10.073	8.304	2.006	0.257	0.046	0.032	0.012	0.008
1993	20.500	33.078	15.195	13.281	3.583	2.785	2.707	1.181	0.180	0.034	0.011	0.013
1994	6.160	24.142	19.666	6.968	4.393	1.257	0.599	0.508	0.283	0.049	0.018	0.006
1995	10.770	9.103	16.829	13.066	4.115	1.596	0.313	0.184	0.156	0.141	0.029	0.008
1996	5.356	14.886	7.372	12.307	9.430	2.157	0.837	0.208	0.076	0.065	0.055	0.005
1997	1.722	16.442	17.298	6.711	7.379	5.958	1.147	0.493	0.126	0.028	0.037	0.021
1998	3.548	7.707	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.932	18.477	24.291	6.872	8.941	2.226	1.353	0.689	0.123	0.040	0.041	0.002
2003	3.839	15.710	21.281	17.598	4.902	4.325	1.093	0.394	0.169	0.033	0.019	0.015

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

F	M
0.085	0.250
0.180	0.250
0.248	0.250
0.296	0.250
0.382	0.250
0.437	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250
0.477	0.250

Table 3.3.5 Cod at Iceland. Division Va. Mean weight at age in the landings(g).

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	1006	1550	2246	3104	4258	5386	6682	9141	11963	14226	17287	16590
1983	1095	1599	2275	3021	4096	5481	7049	8128	11009	13972	15882	18498
1984	1288	1725	2596	3581	4371	5798	7456	9851	11052	14338	15273	16660
1985	1407	1971	2576	3650	4976	6372	8207	10320	12197	14683	16175	19050
1986	1459	1961	2844	3593	4635	6155	7503	9084	10356	15283	14540	15017
1987	1316	1956	2686	3894	4716	6257	7368	9243	10697	10622	15894	12592
1988	1438	1805	2576	3519	4930	6001	7144	8822	9977	11732	14156	13042
1989	1186	1813	2590	3915	5210	6892	8035	9831	11986	10003	12611	16045
1990	1290	1704	2383	3034	4624	6521	8888	10592	10993	14570	15732	17290
1991	1309	1899	2475	3159	3792	5680	7242	9804	9754	14344	14172	20200
1992	1289	1768	2469	3292	4394	5582	6830	8127	12679	13410	15715	11267
1993	1392	1887	2772	3762	4930	6054	7450	8641	10901	12517	14742	16874
1994	1443	2063	2562	3659	5117	6262	7719	8896	10847	12874	14742	17470
1995	1348	1959	2920	3625	5176	6416	7916	10273	11022	11407	13098	15182
1996	1457	1930	3132	4141	4922	6009	7406	9772	10539	13503	13689	16194
1997	1484	1877	2878	4028	5402	6386	7344	8537	10797	11533	10428	12788
1998	1230	1788	2477	3588	5013	7293	7843	9283	10976	15352	17718	16068
1999	1241	1716	2426	3443	4720	6352	8730	9946	11088	12535	14995	15151
2000	1308	1782	2330	3252	4690	5894	7809	9203	10240	11172	13172	17442
2001	1499	2050	2649	3413	4766	6508	7520	9055	8796	9526	11210	13874
2002	1294	1926	2656	3680	4720	6369	7808	9002	10422	13402	9008	16893
2003	1256	1786	2418	3503	4459	5038	5986	7852	8819	10834	12152	13805

Table 3.3.6. Cod at Iceland. Division Va. Mean weight at age in the spawning stock(g)

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1983	650	1472	2139	2918	4130	5481	7049	8128	11009	13972	15882	18498
1984	650	1479	2257	3476	4480	5798	7456	9851	11052	14338	15273	16660
1985	485	1377	1753	2713	3457	6372	8207	10320	12197	14683	16175	19050
1986	759	1600	2886	3250	4585	6155	7503	9084	10356	15283	14540	15017
1987	577	1586	2427	3526	4909	6257	7368	9243	10697	10622	15894	12592
1988	610	1477	2264	3281	4402	6001	7144	8822	9977	11732	14156	13042
1989	673	1496	2342	3433	4690	6892	8035	9831	11986	10003	12611	16045
1990	563	1036	2173	2802	4426	6521	8888	10592	10993	14570	15732	17290
1991	688	1285	2042	2750	3401	5680	7242	9804	9754	14344	14172	20200
1992	619	1339	2098	3033	3757	5582	6830	8127	12679	13410	15715	11267
1993	708	1363	2309	3235	4109	6054	7450	8641	10901	12517	14742	16874
1994	847	1728	2254	3340	4514	6262	7719	8896	10847	12874	14742	17470
1995	745	1635	2345	3186	4489	6416	7916	10273	11022	11407	13098	15182
1996	678	1753	2490	3531	4273	6009	7406	9772	10539	13503	13689	16194
1997	670	1347	2267	3746	5245	6386	7344	8537	10797	11533	10428	12788
1998	599	1516	2261	3263	4474	7737	7837	9304	10759	14903	16651	18666
1999	711	1467	1932	2996	3961	6352	8730	9946	11088	12535	14995	15151
2000	600	1355	1915	2881	4319	5894	7809	9203	10240	11172	13172	17442
2001	661	1550	2071	2694	4131	6508	7520	9055	8769	9526	11210	13874
2002	630	1590	2259	3120	3984	6369	7808	9002	10422	13402	9008	16893
2003	579	1338	2215	2988	4169	5038	5986	7852	8819	10834	12152	13804

Table 3.3.7a. Cod at Iceland. Division Va. Maturity at age from spring survey data.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1983	0.02	0.03	0.05	0.12	0.26	0.53	0.72	0.98	0.99	1.00	1.00	1.00
1984	0.02	0.02	0.05	0.17	0.44	0.62	0.72	0.95	0.97	0.95	1.00	1.00
1985	0.00	0.02	0.19	0.41	0.50	0.74	0.57	1.00	1.00	1.00	1.00	1.00
1986	0.00	0.02	0.15	0.40	0.68	0.73	0.94	0.96	0.99	1.00	1.00	1.00
1987	0.00	0.03	0.09	0.36	0.49	0.89	0.78	1.00	0.98	1.00	1.00	1.00
1988	0.01	0.03	0.23	0.51	0.45	0.68	0.94	0.95	0.97	0.82	1.00	1.00
1989	0.01	0.03	0.14	0.37	0.65	0.65	0.63	0.99	1.00	0.90	0.86	1.00
1990	0.01	0.01	0.16	0.44	0.58	0.80	0.81	0.99	1.00	1.00	1.00	1.00
1991	0.00	0.06	0.15	0.37	0.64	0.79	0.68	0.84	1.00	1.00	1.00	1.00
1992	0.00	0.06	0.27	0.40	0.81	0.92	0.89	1.00	1.00	1.00	1.00	1.00
1993	0.01	0.09	0.27	0.46	0.69	0.80	0.84	0.97	1.00	1.00	1.00	1.00
1994	0.01	0.11	0.34	0.59	0.70	0.92	0.70	0.85	0.99	1.00	1.00	1.00
1995	0.01	0.11	0.38	0.53	0.75	0.79	0.86	1.00	1.00	1.00	1.00	1.00
1996	0.00	0.03	0.19	0.50	0.65	0.73	0.81	1.00	1.00	0.99	0.97	1.00
1997	0.01	0.04	0.25	0.42	0.69	0.79	0.80	0.93	1.00	0.91	1.00	1.00
1998	0.00	0.06	0.21	0.49	0.78	0.81	0.81	0.93	1.00	1.00	1.00	1.00
1999	0.01	0.04	0.24	0.52	0.65	0.84	0.69	0.99	1.00	1.00	1.00	1.00
2000	0.00	0.07	0.25	0.51	0.61	0.87	1.00	0.98	1.00	1.00	1.00	1.00
2001	0.00	0.04	0.26	0.59	0.75	0.74	0.86	0.99	1.00	1.00	1.00	1.00
2002	0.01	0.09	0.32	0.66	0.76	0.92	0.55	0.98	1.00	1.00	1.00	1.00
2003	0.01	0.05	0.22	0.52	0.87	0.80	0.86	1.00	1.00	1.00	1.00	1.00
2004	0.00	0.04	0.25	0.55	0.63	0.84	0.82	1.00	1.00	1.00	1.00	1.00

Table 3.3.7b Cod at Iceland. Maturity at age estimated using samples from catches Jan.-May.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1982	0.02	0.05	0.13	0.23	0.54	0.85	0.96	0.97	1.00	1.00	1.00	1.00
1983	0.00	0.09	0.17	0.34	0.51	0.72	0.86	0.98	0.98	1.00	1.00	1.00
1984	0.00	0.04	0.19	0.42	0.66	0.78	0.86	0.95	0.97	0.95	1.00	1.00
1985	0.03	0.06	0.20	0.55	0.77	0.90	0.94	1.00	1.00	1.00	1.00	1.00
1986	0.01	0.05	0.24	0.54	0.76	0.89	0.98	0.96	0.99	1.00	1.00	1.00
1987	0.02	0.05	0.24	0.59	0.81	0.94	0.95	1.00	0.98	1.00	1.00	1.00
1988	0.04	0.02	0.21	0.48	0.69	0.83	0.93	0.95	0.97	0.82	1.00	1.00
1989	0.00	0.05	0.23	0.55	0.82	0.86	0.89	0.99	1.00	0.90	0.86	1.00
1990	0.00	0.08	0.30	0.63	0.82	0.91	0.95	0.99	1.00	1.00	1.00	1.00
1991	0.00	0.06	0.21	0.54	0.78	0.89	0.95	0.84	1.00	1.00	1.00	1.00
1992	0.07	0.23	0.56	0.71	0.91	0.96	0.98	1.00	1.00	1.00	1.00	1.00
1993	0.08	0.25	0.47	0.71	0.94	0.98	0.97	0.97	1.00	1.00	1.00	1.00
1994	0.10	0.28	0.57	0.80	0.90	0.92	1.00	0.85	0.99	1.00	1.00	1.00
1995	0.04	0.39	0.73	0.85	0.85	0.95	1.00	1.00	1.00	1.00	1.00	1.00
1996	0.08	0.10	0.51	0.74	0.86	0.91	0.84	1.00	1.00	0.99	0.97	1.00
1997	0.07	0.31	0.50	0.74	0.88	0.92	0.97	0.93	1.00	0.91	1.00	1.00
1998	0.03	0.26	0.48	0.65	0.83	0.94	0.99	0.93	1.00	1.00	1.00	1.00
1999	0.05	0.30	0.55	0.72	0.83	0.93	0.97	0.99	1.00	1.00	0.84	1.00
2000	0.04	0.18	0.44	0.64	0.80	0.92	0.98	0.98	1.00	1.00	1.00	1.00
2001	0.13	0.41	0.61	0.79	0.92	0.90	0.97	0.99	1.00	1.00	1.00	1.00
2002	0.12	0.41	0.59	0.84	0.85	0.99	0.99	0.98	1.00	1.00	1.00	1.00
2003	0.15	0.34	0.59	0.81	0.90	0.95	1.00	1.00	1.00	1.00	1.00	1.00

Table 3.3.8. CPUE from bottom trawl survey 1985-2004 as used in the XSA and AD-CAM tuning. Sum of North and South (stratified mean) areas indices.

Year/age	1	2	3	4	5	6	7	8	9	10	11	12	13
1985	16.54	111.07	34.85	48.09	64.3	22.57	14.86	4.85	3.21	1.52	0.3	0.3	0.1
1986	15.08	60.56	95.56	22.43	21.23	26.36	6.64	2.48	0.83	0.74	0.27	0.07	0.06
1987	3.65	28.86	103.10	82.03	21.08	12.22	12.02	2.57	0.90	0.40	0.45	0.23	0.15
1988	3.44	7.36	71.69	101.61	66.75	7.81	5.88	6.14	0.58	0.25	0.11	0.12	0.05
1989	4.04	16.45	21.97	77.70	67.59	34.20	4.20	1.45	1.14	0.24	0.17	0.06	0.01
1990	5.56	11.79	26.15	14.07	26.97	32.38	14.22	1.51	0.53	0.42	0.13	0.00	0.04
1991	3.95	16.27	17.93	30.17	15.24	18.09	20.93	4.23	0.80	0.32	0.24	0.00	0.11
1992	0.72	17.13	33.26	18.87	16.27	6.54	5.70	5.11	1.29	0.22	0.04	0.04	0.04
1993	3.57	4.82	30.76	36.41	13.24	9.93	2.13	1.75	1.17	0.34	0.11	0.03	0.03
1994	14.38	15.01	8.97	26.66	21.90	5.77	3.62	0.70	0.48	0.43	0.14	0.02	0.03
1995	1.18	29.03	24.78	8.99	23.88	17.69	3.78	1.76	0.35	0.17	0.21	0.12	0.02
1996	3.72	5.48	42.60	29.44	12.84	14.62	13.99	3.81	1.05	0.19	0.06	0.22	0.09
1997	1.21	22.39	13.57	56.18	29.05	9.48	8.71	6.59	0.56	0.36	0.15	0.04	0.12
1998	8.06	5.56	29.98	16.06	61.77	28.33	6.51	5.20	3.05	0.66	0.13	0.00	0.02
1999	7.39	32.98	7.01	42.27	13.02	23.66	11.12	2.35	1.32	0.66	0.15	0.06	0.00
2000	18.79	27.90	54.74	6.94	30.00	8.28	8.18	4.14	0.51	0.30	0.07	0.03	0.04
2001	12.16	21.72	36.78	37.60	4.91	15.24	3.33	1.97	0.79	0.23	0.10	0.09	0.04
2002	0.92	38.07	41.12	40.16	36.16	7.10	8.33	1.49	0.72	0.30	0.00	0.01	0.00
2003	11.17	4.44	46.36	38.55	31.51	19.09	4.11	4.71	1.08	0.23	0.09	0.02	0.06
2004	6.57	24.58	7.91	61.65	34.96	24.81	14.44	2.82	2.88	0.47	0.26	0.02	0.00

Table 3.3.9 CPUE from bottom trawl survey 1985-2004 as used in the TSA runs. Weighted geometric mean of North and South (stratified mean) areas indices.

Year/age	4	5	6	7	8	9
1985	16347	19217	9257	4147	1978	1338
1986	8202	8829	10057	2946	821	388
1987	27774	6912	5058	4007	1170	340
1988	34775	25312	3611	1982	1675	282
1989	26886	27478	16076	1988	635	376
1990	3391	11938	15953	6120	734	270
1991	10328	6214	8674	10241	2058	392
1992	7653	6497	2780	2840	2787	693
1993	15593	6196	4491	906	877	554
1994	12414	9372	2700	1305	302	246
1995	4181	10771	8032	1702	729	165
1996	13136	5669	6954	6089	1524	507
1997	18617	10904	3930	3563	2417	258
1998	5336	17804	9961	2398	1672	1184
1999	13306	5209	10909	4950	1186	470
2000	2808	12131	3736	3390	2074	256
2001	14671	2146	6222	1304	744	397
2002	17033	16837	3584	3076	720	315
2003	13088	12888	8388	2044	1128	341
2004	22253	15402	11316	5626	1290	650

Table 3.3.10 . XSA Tuning diagnostic**.**

Lowestoft VPA Version 3.1

19/04/2004 7:19

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1971-2003"

CPUE data from file codvarnt.dat

Catch data for 33 years. 1971 to 2003. Ages 0 to 14.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SMB. Tot ,	1984,	2003,	0,	8,	.990,	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 5

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

Catchability independent of age for ages >= 11

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 4 oldest ages.

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

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

Prior weighting not applied

Tuning converged after 14 iterations

1

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

Fishing mortalities

Age,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
1,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
2,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000,	.000
3,	.096,	.076,	.036,	.022,	.023,	.044,	.065,	.075,	.039,	.023
4,	.304,	.200,	.144,	.148,	.131,	.177,	.153,	.216,	.169,	.136
5,	.324,	.360,	.246,	.247,	.359,	.410,	.434,	.336,	.337,	.299
6,	.454,	.372,	.489,	.372,	.511,	.715,	.610,	.589,	.447,	.437
7,	.651,	.534,	.507,	.619,	.661,	.740,	.893,	.722,	.597,	.675
8,	.761,	.523,	.602,	.712,	.791,	.782,	.893,	.935,	.717,	.659
9,	.800,	.426,	.581,	.768,	.988,	.840,	.848,	.971,	1.053,	.992
10,	.823,	.615,	.564,	.836,	.956,	.738,	.948,	1.101,	1.155,	1.090
11,	.625,	.652,	.560,	.822,	1.007,	.794,	.821,	1.165,	1.100,	1.054
12,	.671,	.752,	.631,	.413,	1.138,	.689,	1.524,	.879,	.763,	1.071
13,	.702,	1.174,	.763,	.944,	1.329,	.636,	.866,	1.470,	.910,	1.092
14,	.710,	.805,	.636,	.763,	1.121,	.721,	1.054,	1.167,	.993,	1.088

Table 3.3.10 (Cont'd)

1

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1994	1.58E+05	2.49E+05	1.98E+05	7.47E+04	1.02E+05	7.85E+04	2.11E+04	1.01E+04	2.61E+03	1.20E+03
1995	3.03E+05	1.30E+05	2.04E+05	1.62E+05	5.56E+04	6.16E+04	4.65E+04	1.10E+04	4.33E+03	9.97E+02
1996	1.19E+05	2.48E+05	1.06E+05	1.67E+05	1.23E+05	3.73E+04	3.52E+04	2.62E+04	5.27E+03	2.10E+03
1997	3.38E+05	9.76E+04	2.03E+05	8.69E+04	1.32E+05	8.72E+04	2.39E+04	1.77E+04	1.29E+04	2.36E+03
1998	3.16E+05	2.77E+05	7.99E+04	1.66E+05	6.96E+04	9.31E+04	5.57E+04	1.35E+04	7.80E+03	5.20E+03
1999	3.16E+05	2.58E+05	2.27E+05	6.54E+04	1.33E+05	5.00E+04	5.32E+04	2.74E+04	5.70E+03	2.89E+03
2000	3.37E+05	2.59E+05	2.12E+05	1.85E+05	5.13E+04	9.12E+04	2.72E+04	2.13E+04	1.07E+04	2.13E+03
2001	1.37E+05	2.76E+05	2.12E+05	1.73E+05	1.42E+05	3.60E+04	4.84E+04	1.21E+04	7.15E+03	3.59E+03
2002	3.29E+05	1.12E+05	2.26E+05	1.73E+05	1.32E+05	9.39E+04	2.11E+04	2.20E+04	4.80E+03	2.30E+03
2003	2.91E+05	2.69E+05	9.15E+04	1.85E+05	1.37E+05	9.10E+04	5.49E+04	1.10E+04	9.90E+03	1.92E+03

Estimated population abundance at 1st Jan 2004

,	0.00E+00	2.38E+05	2.21E+05	7.49E+04	1.48E+05	9.76E+04	5.52E+04	2.90E+04	4.60E+03	4.19E+03

Taper weighted geometric mean of the VPA populations:

,	2.89E+05	2.42E+05	1.96E+05	1.65E+05	1.27E+05	8.34E+04	4.57E+04	2.17E+04	9.39E+03	3.58E+03

Standard error of the weighted Log(VPA populations) :

,	.4230	.4377	.4382	.4165	.4127	.4179	.4541	.5321	.6394	.7495

YEAR	AGE 10	11	12	13	14
1994	1.00E+03	6.73E+02	1.11E+02	3.94E+01	1.30E+01
1995	4.43E+02	3.60E+02	2.95E+02	4.64E+01	1.60E+01
1996	5.33E+02	1.96E+02	1.54E+02	1.14E+02	1.17E+01
1997	9.62E+02	2.49E+02	9.15E+01	6.69E+01	4.35E+01
1998	8.98E+02	3.41E+02	8.95E+01	4.96E+01	2.13E+01
1999	1.58E+03	2.82E+02	1.02E+02	2.35E+01	1.08E+01
2000	1.02E+03	6.19E+02	1.05E+02	4.20E+01	1.02E+01
2001	7.48E+02	3.24E+02	2.23E+02	1.87E+01	1.44E+01
2002	1.11E+03	2.04E+02	8.28E+01	7.58E+01	3.51E+00
2003	6.56E+02	2.87E+02	5.55E+01	3.16E+01	2.50E+01

Estimated population abundance at 1st Jan 2004

,	5.83E+02	1.81E+02	8.18E+01	1.56E+01	8.68E+00

Taper weighted geometric mean of the VPA populations:

,	1.40E+03	5.06E+02	1.86E+02	6.99E+01	2.34E+01

Standard error of the weighted Log(VPA populations) :

,	.8139	.7452	.7158	.7064	1.1228

1

Log catchability residuals.

Fleet : SMB. Tot

Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0	-.16	.31	.37	-.12	.21	-.18	-.16	-.26	-.30	.31
1	.11	-.03	.08	.07	.03	.12	-.25	-.05	-.04	-.21
2	.08	-.15	.08	.37	.35	-.01	.02	-.13	-.01	-.09
3	.29	-.23	-.25	.05	.39	.02	.05	.05	-.09	-.06
4	.15	-.03	-.12	-.10	.00	-.09	.20	-.15	.07	-.18
5	.28	.05	.08	-.54	.19	-.17	.11	-.18	.00	-.30
6	.63	-.28	.06	.23	-.22	.01	.13	-.18	-.31	-.13
7	.26	-.30	-.17	.54	-.04	-.34	-.24	-.15	-.08	-.44
8	.62	-.48	-.09	-.37	.54	.12	.13	-.35	-.31	.05

Table 3.3.10 (Cont'd)

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	-.19	-.31	.11	-.06	-.03	.39	.13	-.15	.11	-.01
1	.11	-.12	-.03	.17	.07	.05	-.08	.15	-.09	-.06
2	-.24	.07	.01	-.15	-.11	.11	-.06	.01	.01	-.17
3	-.11	-.15	.20	.06	.02	-.17	-.14	-.02	-.07	.15
4	.13	.24	-.04	.41	-.02	-.07	-.37	.02	-.03	-.02
5	.04	.12	.08	.33	.19	-.19	-.15	-.09	-.05	.20
6	-.17	.27	.19	.17	.00	-.06	-.39	-.07	-.09	.20
7	-.02	.55	.21	.47	-.01	-.07	-.41	-.29	.14	.39
8	-.08	.28	-.47	.44	.18	-.46	-.54	-.19	.39	.59

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	-7.9124	-7.8110	-7.7904	-7.8813
S.E(Log q)	.2110	.2423	.3142	.3903

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
0	.46	3.981	11.62	.75	20	.23	-10.66
1	.53	7.602	10.64	.94	20	.12	-9.20
2	.62	4.633	9.86	.89	20	.16	-8.48
3	.63	3.944	9.55	.86	20	.17	-8.16
4	.68	3.357	9.14	.86	20	.17	-7.99

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	.87	1.290	8.33	.85	20	.18	-7.91
6	.87	1.269	8.18	.83	20	.21	-7.81
7	.97	.175	7.84	.70	20	.31	-7.79
8	.98	.097	7.90	.61	20	.39	-7.88

1

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SMB. Tot	236423.	.300	.000	.00	1	.680	.000
P shrinkage mean	241680.	.44				.320	.000
F shrinkage mean	0.	.50				.000	.000

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
238091.	.25	.01	2	.050	.000

Table 3.3.10 (Cont'd)

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

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,    226624.,   .212,       .086,     .40,   2,  .810,     .000

   P shrinkage mean  ,    196202.,    .44,,,,                         .190,     .000

   F shrinkage mean  ,         0.,    .50,,,,                         .000,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    220507.,       .19,      .07,    3,    .369,   .000



1
 Age  2   Catchability dependent on age and year class strength

 Year class = 2001

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     65361.,   .173,       .025,     .14,   3,  .853,     .000

   P shrinkage mean  ,    164921.,    .42,,,,                         .147,     .000

   F shrinkage mean  ,         0.,    .50,,,,                         .000,     .000

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     74915.,       .16,      .21,    4,   1.288,   .000


 Age  3   Catchability dependent on age and year class strength

 Year class = 2000

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,    165292.,   .150,       .032,     .21,   4,  .815,     .021

   P shrinkage mean  ,    127118.,    .41,,,,                         .110,     .027

   F shrinkage mean  ,     56603.,    .50,,,,                         .075,     .060

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    148169.,       .14,      .14,    6,   1.023,   .023

1
 Age  4   Catchability dependent on age and year class strength

 Year class = 1999

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,    102067.,   .134,       .088,     .66,   5,  .829,     .130

   P shrinkage mean  ,     83357.,    .42,,,,                         .101,     .157

   F shrinkage mean  ,     72063.,    .50,,,,                         .070,     .180

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     97579.,       .12,      .08,    7,    .645,   .136
```

Table 3.3.10 (Cont'd)

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

 Year class = 1998

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     56632.,   .123,       .042,    .34,   6,  .911,     .293

   F shrinkage mean  ,     42788.,    .50,,,,                        .089,     .372

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     55239.,       .12,      .05,    7,    .417,   .299


1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     30118.,   .117,       .047,    .40,   7,  .889,     .424

   F shrinkage mean  ,     21554.,    .50,,,,                        .111,     .553

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     29016.,       .12,      .06,    8,    .500,   .437


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

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,      4717.,   .115,       .090,    .78,   8,  .845,     .663

   F shrinkage mean  ,      4013.,    .50,,,,                        .155,     .745

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4601.,       .12,      .08,    9,    .650,   .675


1
 Age  8   Catchability constant w.r.t. time and dependent on age

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,      4685.,   .133,       .104,    .78,   9,  .772,     .607

   F shrinkage mean  ,      2884.,    .50,,,,                        .228,     .857

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      4194.,       .15,      .12,   10,    .755,   .659
```

Table 3.3.10 (Cont'd)

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

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,       563.,   .136,       .100,    .73,   9,  .523,    1.014

   F shrinkage mean  ,       606.,    .50,,,,                        .477,     .968

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       583.,       .25,      .07,   10,    .283,   .992


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

 Year class = 1993

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,       170.,   .149,       .090,    .60,   9,  .191,    1.130

   F shrinkage mean  ,       183.,    .50,,,,                        .809,    1.081

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       181.,       .41,      .04,   10,    .106,  1.090


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

 Year class = 1992

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        68.,   .129,       .090,    .70,   9,  .102,    1.175

   F shrinkage mean  ,        83.,    .50,,,,                        .898,    1.041

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        82.,       .45,      .07,   10,    .153,  1.054


1
 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1991

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        14.,   .123,       .082,    .67,   9,  .053,    1.127

   F shrinkage mean  ,        16.,    .50,,,,                        .947,    1.068

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        16.,       .47,      .03,   10,    .072,  1.071
```

Table 3.3.10 (Cont'd)

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

 Year class = 1990

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,        10.,   .134,       .065,    .48,   9,  .023,     .982

   F shrinkage mean  ,         9.,    .50,,,,                        .977,    1.095

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
         9.,       .49,      .06,   10,    .120,  1.092


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

 Year class = 1989

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,         8.,   .124,       .084,    .68,   9,  .017,    1.017

   F shrinkage mean  ,         7.,    .50,,,,                        .983,    1.090

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
         7.,       .49,      .04,   10,    .077,  1.088


1
```

Table 3.3.11. Cod at Iceland. Division Va. TSA-results

Input data and estimated parameters:

Data: Catch at age 1971–2003 and spring trawl survey indices (weighted geometric of North and South) 1985–2004.

Estimated stock in numbers and total biomass:

Year/age	4	5	6	7	8	9	10	11	BIOM(4-11)
1984	183009.	76761.	40649.	18319.	13784.	4961.	988.	981.	878.1
1985	109943.	121475.	44814.	19789.	7815.	4712.	1691.	338.	901.7.5
1986	107570.	67824.	66370.	20893.	7993.	2911.	1664.	584.	831.3
1987	240933.	68885.	32034.	26466.	7078.	2525.	908.	524.	982.7
1988	225191.	145405.	32564.	11865.	8279.	2084.	747.	269.	1028.0
1989	136687.	144903.	71783.	11834.	3514.	1845.	486.	180.	1011.8
1990	64212.	85578.	102358.	31725.	4519.	1194.	640.	167.	819.3
1991	101761.	41543.	43925.	43820.	11788.	1579.	412.	220.	685.6
1992	77275.	60668.	19711.	16099.	14074.	3834.	500.	126.	532.4
1993	133316.	43396.	25874.	6591.	4523.	4257.	1308.	168.	573.9
1994	101643.	79320.	20819.	9900.	2208.	1252.	1108.	341.	576.8
1995	56390.	62306.	45994.	10651.	4338.	856.	484.	430.	558.6
1996	119995.	37702.	35699.	25076.	5222.	2056.	402.	223.	673.8
1997	132283.	84964.	23510.	18181.	12155.	2321.	916.	177.	790.1
1998	68737.	93149.	53826.	12973.	8050.	4923.	884.	347.	721.1
1999	125419.	48768.	53699.	26391.	5458.	2901.	1551.	283.	721.5
2000	50032.	85157.	26234.	21840.	10287.	2063.	1103.	593.	568.3
2001	146037.	34674.	45734.	11448.	7630.	3559.	731.	390.	688.4
2002	134112.	97892.	19598.	20626.	4468.	2634.	1174.	242.	749.9
2003	128447.	92611.	58155.	10166.	8935.	1740.	929.	408.	770.5
2004	146950.	90515.	56898.	30660.	4391.	3345.	593.	331.	864.8

Standard deviation of stock estimate:

2003	8489.	5473.	3303.	595.	618.	142.	118.	63.	33.1
2004	12154.	6837.	4284.	2611.	475.	501.	115.	74.	45.4

Estimated fishing mortality rates:

Year/age	4	5	6	7	8	9	10	11	FBAR(5-10)
1984	0.210	0.338	0.519	0.651	0.873	0.875	0.868	0.877	0.687
1985	0.282	0.404	0.563	0.705	0.787	0.840	0.863	0.868	0.694
1986	0.246	0.542	0.720	0.882	0.951	0.961	0.954	0.957	0.835
1987	0.302	0.548	0.785	0.960	1.022	1.018	1.013	1.021	0.891
1988	0.241	0.501	0.804	1.016	1.257	1.217	1.186	1.189	0.997
1989	0.261	0.462	0.605	0.744	0.877	0.856	0.863	0.883	0.734
1990	0.235	0.460	0.648	0.790	0.851	0.865	0.867	0.873	0.747
1991	0.317	0.544	0.777	0.917	0.917	0.945	0.970	0.953	0.845
1992	0.374	0.652	0.891	1.027	0.971	0.873	0.888	0.906	0.884
1993	0.319	0.532	0.760	0.894	1.049	1.106	1.117	1.111	0.910
1994	0.278	0.345	0.470	0.625	0.747	0.749	0.745	0.753	0.613
1995	0.202	0.344	0.407	0.513	0.545	0.551	0.571	0.576	0.488
1996	0.145	0.271	0.448	0.521	0.600	0.605	0.614	0.614	0.510
1997	0.149	0.257	0.393	0.578	0.693	0.747	0.756	0.757	0.571
1998	0.143	0.344	0.513	0.660	0.758	0.876	0.847	0.825	0.666
1999	0.187	0.420	0.684	0.740	0.764	0.740	0.735	0.744	0.680
2000	0.166	0.422	0.628	0.837	0.857	0.831	0.826	0.830	0.734
2001	0.200	0.359	0.592	0.723	0.863	0.909	0.907	0.894	0.725
2002	0.170	0.321	0.448	0.630	0.722	0.838	0.854	0.834	0.636
2003	0.150	0.287	0.440	0.639	0.780	0.873	0.827	0.822	0.641

Standard deviations of log(F):

2003	0.09	0.08	0.08	0.10	0.13	0.15	0.16	0.16	0.090

Table 3.3.11 (Continued)

Standardized catch prediction errors:

Year/age	4	5	6	7	8	9	10	11
1984	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1985	1.48	0.78	1.12	-0.64	0.55	-1.14	0.83	0.72
1986	-0.55	1.01	1.61	1.30	0.13	1.21	-0.56	0.62
1987	2.00	1.15	-1.14	0.73	0.21	0.22	0.87	-0.30
1988	-1.75	1.30	1.97	-1.18	0.61	0.18	0.24	1.95
1989	-0.88	-0.87	-0.10	0.38	-0.65	-2.36	-1.91	-0.88
1990	-0.16	-2.02	-0.62	1.56	1.82	0.03	-0.08	0.74
1991	1.26	1.38	-0.34	0.64	-0.02	0.54	0.37	0.22
1992	0.95	1.25	1.27	-0.71	-0.96	-0.91	-0.66	-1.40
1993	0.30	-1.58	-0.13	-0.58	-1.23	-0.52	1.80	1.64
1994	0.48	-0.50	-0.75	0.32	1.66	-0.93	-0.90	0.87
1995	-0.65	-1.55	-0.88	-0.56	-1.27	-1.35	-0.92	-0.73
1996	-0.35	-1.10	-1.14	0.37	-0.03	0.21	1.30	-0.22
1997	-0.79	0.50	-0.16	-1.13	0.88	0.08	0.87	1.54
1998	-0.34	1.07	2.10	0.93	-1.58	0.69	-0.02	0.07
1999	1.98	1.62	0.52	1.21	0.17	-1.73	-1.91	-1.58
2000	-0.11	1.05	0.62	-0.72	0.77	-0.02	-0.76	-0.52
2001	0.59	-0.23	-0.16	0.50	-1.06	0.11	0.32	-0.49
2002	-0.74	-1.48	0.07	-0.19	1.09	-0.03	0.43	-0.11
2003	-0.61	-0.81	-1.46	1.48	0.42	2.58	-0.45	-0.50

Skewness and kurtosis (Standardized normal distribution**):** 1.123 -1.580

Correlation between cohorts aages and years: 0.32 0.30 -0.07

Standardized prediction errors of cpue:

Year/age	4	5	6	7	8	9
1985	1.90	0.17	0.82	0.65	1.36	0.82
1986	-1.09	-0.34	-0.63	-0.56	-1.52	-0.30
1987	-0.29	-0.66	-0.98	-0.13	0.29	-0.13
1988	0.37	1.65	-0.89	-0.48	0.57	-0.29
1989	1.14	1.00	2.08	1.17	0.27	-0.27
1990	-1.18	-1.31	-0.66	1.93	1.01	0.87
1991	0.39	1.94	-0.46	1.45	0.31	1.18
1992	0.91	-0.57	-0.69	-1.03	-0.23	-0.07
1993	0.85	0.54	0.44	-0.90	-0.59	-1.02
1994	-0.58	-0.58	-0.99	-1.07	-0.65	-0.42
1995	-0.30	-0.48	0.11	-0.28	-0.02	0.28
1996	0.79	1.02	-1.05	1.78	2.17	1.26
1997	-0.04	0.06	-0.37	-1.26	-0.05	-1.70
1998	-0.32	0.09	-0.09	-0.29	-0.90	0.35
1999	0.69	-0.34	-0.83	0.21	0.26	-1.46
2000	0.15	0.43	-0.27	-1.36	0.30	-1.22
2001	-0.41	-0.82	-0.84	-1.01	-1.95	-1.14
2002	0.45	0.92	2.46	0.44	0.98	-0.39
2003	-0.43	-0.11	-0.86	2.03	-0.05	1.24
2004	1.34	0.91	0.33	0.59	1.97	0.79

Skewness and kurtosis (Standardized normal distribution)**:** 2.724 -0.690

Correlation within cohorts: 0.12

Correlation between ages and years: 0.35 -0.11

Table 3.3.12. AD Model Builder -Statistical Catch at Age Model- AD-CAM - diagnostic and results.

Input data and estimated parameters:

- The model used catchdata from 1955 to 2003 and survey data from 1985 – 2004. Age groups included are 1-10 in the survey and 3 – 14 in the catches.
 Parameter settings and assumptions used:
- Fishing mortality was estimated for every year and age.

- Recruitment was assumed to be lognormally distributed around a Ricker curve with the CV of the lognormal distribution estimated. Timetrend in R_{max} of the Ricker curve was allowed and CV of the residuals in the SSB-recruitment relationship depend on stock size. The SSB – recruitment relationship was based on spawning stock based on maturity at age from the survey, predicting the survey maturitity at age backwards in time from the observations from the catches.

- Migrations for specified years in specified ages are estimated.

- Catchability in the survey was dependent on stocksize for ages 1-5.

- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated seperately for each age in the survey (change from last year when it was also a 2nd order polynomial) Correlation of residuals of different agegroups in the survey was estimated as a 1st order AR model.

- Fishing mortality of each age group was random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variablility in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups.

- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error must be specified.

Some non-traditional of the assemssment model are.
- Rmax decrease by 0.9% per year from 1955 to 1995 so precdicted recruitment in 1995 is expected to be 67% of what it was in 1995 for the same spawing size of the spawing stock. At lesat part of this trend is considered to be due to different composition of the spawning stock with higher percentage of young fish in the spawing stock in recent years. Using catch maturity at age gives 1.5% trend per year.

- CV in recruitment. increases with reduced spawning stock as expected.

Age	M	Survey sigma	Survey lnQ	Survey Power	Meansel	Progsel	Sigma
1	0.2	0.396	-24.820	2.207	-1.000	-1.000	-1.000
2	0.2	0.153	-20.220	1.955	-1.000	-1.000	-1.000
3	0.2	0.204	-16.626	1.697	0.191	0.048	0.162
4	0.2	0.208	-14.646	1.572	0.624	0.177	0.129
5	0.2	0.178	-12.504	1.422	0.938	0.367	0.109
6	0.2	0.140	-7.701	1.000	1.112	0.568	0.098
7	0.2	0.167	-7.560	1.000	1.431	0.748	0.094
8	0.2	0.201	-7.507	1.000	1.669	0.811	0.095
9	0.2	0.225	-7.603	1.000	1.780	0.942	0.102
10	0.2	0.228	-7.566	1.000	1.907	0.942	0.116
11	0.2	-1.000	-1.000	-1.000	1.810	0.919	0.141
12	0.2	-1.000	-1.000	-1.000	1.528	0.874	0.181
13	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.247
14	0.2	-1.000	-1.000	-1.000	1.000	1.000	0.359

Table 3.3.12 (Continued)

Residuals:

Log(Cay-observed/Cay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	0.00	0.04	-0.02	-0.01	-0.05	-0.01	0.03	-0.02	0.06	-0.01
4	0.02	-0.02	0.03	-0.03	-0.03	-0.04	0.01	-0.03	0.03	0.02
5	-0.01	0.00	0.02	-0.01	0.03	-0.05	-0.03	0.04	-0.03	0.00
6	0.00	0.01	-0.02	0.07	-0.03	-0.01	0.00	0.04	0.03	-0.07
7	-0.03	0.04	0.02	-0.02	-0.02	0.00	0.03	0.03	-0.02	-0.04
8	-0.03	0.00	0.01	0.02	-0.07	0.02	0.00	0.02	0.00	-0.01
9	-0.04	0.04	0.02	0.08	-0.12	-0.02	0.05	-0.01	0.07	-0.07
10	0.02	-0.03	0.05	0.05	-0.10	-0.06	0.04	-0.04	0.17	-0.10
11	0.02	0.04	-0.08	0.18	-0.12	0.03	-0.05	-0.23	0.23	0.05
12	-0.12	0.06	-0.02	0.06	0.03	-0.07	0.14	-0.24	0.02	0.07
13	0.07	-0.23	0.08	0.24	-0.10	-0.24	-0.25	-0.24	-0.28	0.15
14	0.16	0.11	-0.02	0.19	-0.66	0.02	0.04	-0.01	0.31	-0.14

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0.07	-0.04	-0.05	-0.04	0.01	0.01	0.06	0.00	-0.06
4	0.00	0.02	-0.02	-0.02	0.03	-0.04	0.01	0.01	-0.01
5	0.02	-0.04	0.00	-0.03	0.03	0.04	0.00	0.00	0.00
6	-0.03	0.01	-0.06	0.03	0.00	0.01	0.02	0.00	-0.03
7	-0.02	0.02	-0.02	0.03	0.04	-0.03	0.00	-0.04	0.04
8	-0.08	0.00	0.06	-0.02	0.02	0.04	-0.04	0.00	0.01
9	-0.11	0.00	0.04	0.08	-0.05	0.02	0.02	-0.06	0.04
10	-0.12	0.05	0.08	0.06	-0.05	-0.02	0.07	0.05	-0.07
11	-0.14	-0.09	0.23	0.11	-0.04	0.02	0.01	0.03	-0.03
12	0.13	-0.14	-0.11	0.32	-0.04	0.14	0.07	-0.17	-0.01
13	0.24	0.11	-0.02	0.33	-0.01	0.06	-0.17	0.05	-0.08
14	0.23	-0.05	0.19	0.03	0.04	0.30	0.20	-0.46	0.13

Table 3.3.12 (Continued)

Log(Uay-observed/Uay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.12	0.23	0.31	-0.10	0.13	-0.16	-0.15	-0.28	-0.24	0.22
2	0.06	0.00	0.03	0.04	0.05	0.05	-0.18	-0.03	-0.04	-0.13
3	0.08	-0.13	0.07	0.21	0.23	0.01	-0.02	-0.08	0.01	-0.07
4	0.18	-0.13	-0.16	0.08	0.24	-0.02	0.06	0.00	-0.02	-0.01
5	0.09	-0.03	-0.03	-0.05	0.07	-0.07	0.12	-0.05	0.02	-0.10
6	0.13	0.02	0.01	-0.19	0.06	-0.07	0.06	-0.05	0.00	-0.18
7	0.24	-0.09	0.03	0.06	-0.10	0.00	0.08	-0.06	-0.15	-0.11
8	0.10	-0.14	-0.05	0.23	-0.08	-0.13	-0.10	-0.06	-0.06	-0.20
9	0.21	-0.18	-0.04	-0.12	0.11	0.02	0.10	-0.11	-0.13	-0.07
10	0.24	-0.01	-0.06	-0.13	-0.02	0.11	0.23	-0.04	-0.27	-0.09

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	-0.17	-0.27	0.12	-0.08	-0.03	0.40	0.03	-0.07	0.13	0.00
2	0.03	-0.07	0.01	0.18	0.05	0.05	-0.03	0.04	0.02	-0.02
3	-0.13	-0.01	0.03	-0.09	-0.04	0.07	-0.04	0.03	-0.07	-0.05
4	-0.10	-0.08	0.08	0.02	0.02	-0.12	-0.10	-0.01	-0.03	0.02
5	0.06	0.08	-0.03	0.20	-0.03	-0.04	-0.25	-0.01	-0.04	-0.01
6	0.00	0.01	0.00	0.15	0.05	-0.08	-0.07	-0.03	-0.05	0.07
7	-0.11	0.12	0.02	0.07	0.02	-0.07	-0.18	-0.05	0.00	0.07
8	-0.06	0.22	0.11	0.14	-0.01	-0.02	-0.25	-0.14	0.07	0.20
9	-0.03	0.12	-0.20	0.22	0.02	-0.19	-0.23	-0.17	0.20	0.30
10	-0.10	0.08	0.04	0.28	0.00	-0.17	-0.07	-0.16	-0.16	0.32

Table 3.3.13 Comparison of the results from the variuos methods.

Estimated fishing mortality rate in 2003:

Age	XSA	TSA	AD-CAM
3	0.02		0.02
4	0.14	0.15	0.15
5	0.30	0.29	0.31
6	0.44	0.44	0.47
7	0.68	0.64	0.71
8	0.66	0.78	0.74
9	0.99	0.87	0.99
10	1.09	0.83	0.95
11	1.05	0.82	0.93
12	1.07		0.85
13	1.09		0.99
14	1.09		0.99
F(5-10)	**0.69**	**0.64**	**0.70**

Estimated stock in numbers (millions) in 2004:

Age	XSA	TSA	AD-CAM
3	74.915	66.000	67.890
4	148.169	146.950	157.933
5	97.579	90.515	89.735
6	55.239	56.898	52.974
7	29.016	30.660	27.644
8	4.601	4.391	3.819
9	4.194	3.345	3.489
10	0.583	0.593	0.527
11	0.181	0.331	0.257
12	0.082		0.104
13	0.016		0.023
14	0.009		0.012

Recruitment:

Yearcl.	XSA	RCT3	TSA	AD-CAM
1999	173	175	158	162
2000	185	206	197	198
2001	75	69	70	68
2002	180	178	163	171
2003	160	160	150	153

Estimated stock in weight (4+, Thous. tonnes) in 1990-2004

Year	XSA	TSA	AD-CAM
1990	847	819	832
1991	711	686	677
1992	554	532	536
1993	588	574	572
1994	585	577	581
1995	562	559	555
1996	687	674	659
1997	803	790	786
1998	735	721	715
1999	744	722	718
2000	590	568	571
2001	696	688	681
2002	747	750	729
2003	776	771	739
2004	**878**	**865**	**854**

Table 3.3.14 Cod at Iceland. Division Va. Resulting fishing mortality using final F from AD-CAM using catch at age and spring trawl survey indices.

Year/age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	0.11	0.07	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.05
4	0.30	0.26	0.20	0.17	0.18	0.17	0.15	0.19	0.14	0.20
5	0.52	0.38	0.34	0.29	0.25	0.33	0.39	0.40	0.41	0.35
6	0.55	0.56	0.42	0.37	0.40	0.41	0.47	0.54	0.58	0.56
7	0.68	0.67	0.71	0.55	0.52	0.56	0.61	0.62	0.70	0.66
8	0.87	0.86	0.74	0.68	0.59	0.64	0.83	0.93	0.86	0.87
9	0.92	0.89	0.85	0.68	0.62	0.64	0.79	1.02	0.93	0.80
10	1.00	0.96	0.79	0.63	0.57	0.62	0.81	0.88	0.94	0.79
11	1.01	0.87	0.70	0.65	0.63	0.66	0.74	0.66	0.66	0.65
12	0.71	0.67	0.60	0.60	0.61	0.67	0.74	0.66	0.68	0.66
13	0.26	0.25	0.24	0.30	0.37	0.45	0.55	0.61	0.66	0.70
14	0.26	0.25	0.24	0.30	0.37	0.45	0.55	0.61	0.66	0.70
$F_{5\text{-}10}$	**0.76**	**0.72**	**0.64**	**0.54**	**0.49**	**0.53**	**0.65**	**0.73**	**0.74**	**0.67**

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	0.05	0.06	0.05	0.04	0.04	0.05	0.09	0.09	0.15	0.10
4	0.27	0.25	0.29	0.26	0.27	0.25	0.32	0.38	0.31	0.29
5	0.40	0.56	0.54	0.50	0.50	0.50	0.55	0.60	0.51	0.33
6	0.60	0.69	0.77	0.75	0.65	0.67	0.79	0.84	0.72	0.51
7	0.73	0.85	0.93	0.92	0.81	0.82	0.94	1.02	0.85	0.68
8	0.83	0.94	1.05	1.17	0.97	0.87	0.87	1.01	1.03	0.82
9	0.82	0.85	0.94	0.99	0.87	0.82	0.81	0.80	0.97	0.82
10	0.76	0.77	0.77	0.80	0.74	0.76	0.79	0.77	0.85	0.81
11	0.66	0.68	0.69	0.76	0.74	0.74	0.74	0.73	0.77	0.74
12	0.65	0.68	0.70	0.78	0.81	0.81	0.81	0.78	0.79	0.79
13	0.69	0.64	0.71	0.78	0.71	0.69	0.70	0.73	0.78	0.84
14	0.69	0.64	0.71	0.78	0.71	0.69	0.70	0.73	0.78	0.84
$F_{5\text{-}10}$	**0.69**	**0.78**	**0.83**	**0.86**	**0.76**	**0.74**	**0.79**	**0.84**	**0.82**	**0.66**

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003
3	0.07	0.04	0.03	0.03	0.04	0.06	0.07	0.04	0.02
4	0.19	0.15	0.15	0.14	0.17	0.17	0.21	0.17	0.15
5	0.34	0.27	0.26	0.37	0.40	0.41	0.36	0.34	0.31
6	0.42	0.46	0.44	0.52	0.67	0.61	0.57	0.50	0.47
7	0.57	0.54	0.61	0.66	0.74	0.86	0.74	0.68	0.71
8	0.65	0.65	0.69	0.77	0.80	0.86	0.89	0.76	0.74
9	0.67	0.67	0.75	0.87	0.87	0.88	0.95	1.00	0.99
10	0.77	0.78	0.83	0.86	0.85	0.92	0.98	1.00	0.95
11	0.73	0.77	0.84	0.88	0.87	0.90	0.94	0.94	0.93
12	0.80	0.78	0.80	0.85	0.87	0.90	0.89	0.85	0.85
13	0.91	0.96	0.98	1.01	1.00	1.00	0.99	1.00	0.99
14	0.91	0.96	0.98	1.01	1.00	1.00	0.99	1.00	0.99
$F_{5\text{-}10}$	**0.57**	**0.56**	**0.60**	**0.67**	**0.72**	**0.76**	**0.75**	**0.71**	**0.70**

Table 3.3.15 Cod at Iceland. Division Va. Resulting Stock in numbers using final F from AD-CAM using catch at age and spring trawl survey indices.

Year/age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	211.347	335.260	362.023	217.656	214.041	200.036	333.014	209.121	205.259	497.205
2	428.006	173.036	274.488	296.399	178.202	175.242	163.775	272.649	171.214	168.052
3	264.673	350.422	141.670	224.732	242.671	145.899	143.476	134.088	223.226	140.178
4	130.452	193.284	267.533	112.893	178.644	192.445	115.887	115.171	107.066	178.747
5	112.945	79.045	121.721	179.913	77.738	121.774	132.425	81.435	77.672	75.977
6	30.245	54.728	44.040	70.847	110.100	49.494	71.660	73.411	44.502	42.364
7	21.016	14.242	25.717	23.792	39.996	68.783	26.853	36.703	35.024	20.475
8	7.334	8.706	5.981	10.377	11.214	19.432	48.757	11.909	16.138	14.251
9	3.626	2.504	3.012	2.326	4.288	5.066	8.425	17.437	3.855	5.577
10	1.270	1.182	0.844	1.052	0.967	1.894	2.195	3.116	5.158	1.249
11	1.189	0.383	0.371	0.314	0.457	0.446	0.835	0.801	1.056	1.647
12	0.885	0.354	0.131	0.151	0.134	0.199	0.190	0.325	0.340	0.445
13	0.245	0.356	0.149	0.059	0.068	0.059	0.083	0.074	0.137	0.141
14	0.208	0.155	0.227	0.095	0.036	0.038	0.031	0.039	0.033	0.058

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	393.564	261.360	127.221	190.285	159.895	249.722	213.097	113.065	223.937	260.780
2	407.077	322.223	213.984	104.160	155.792	130.911	204.455	174.469	92.570	183.344
3	137.589	333.286	263.814	175.195	85.279	127.552	107.181	167.393	142.843	75.790
4	109.568	106.793	255.855	205.564	137.247	67.155	99.074	80.553	125.471	100.794
5	120.052	68.468	68.237	156.843	130.073	85.676	42.730	59.121	44.965	75.293
6	43.748	65.931	32.076	32.400	77.662	100.575	42.714	20.149	26.605	22.109
7	19.827	19.564	27.054	12.170	12.482	33.224	42.084	15.842	7.134	10.633
8	8.629	7.852	6.815	8.700	3.962	4.566	11.951	13.473	4.697	2.489
9	4.889	3.082	2.512	1.945	2.200	1.234	1.564	4.083	4.014	1.375
10	2.047	1.765	1.080	0.803	0.591	0.758	0.445	0.569	1.507	1.250
11	0.464	0.780	0.672	0.411	0.295	0.231	0.290	0.166	0.216	0.529
12	0.704	0.196	0.323	0.276	0.157	0.116	0.090	0.113	0.065	0.082
13	0.189	0.300	0.081	0.131	0.104	0.057	0.042	0.033	0.042	0.024
14	0.057	0.078	0.129	0.033	0.049	0.042	0.024	0.017	0.013	0.016

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	125.407	234.512	93.592	272.960	249.070	241.994	294.955	101.280	255.124	228.712
2	213.508	102.675	192.002	76.627	223.481	203.922	198.128	241.489	82.921	208.878
3	150.109	174.806	84.063	157.198	62.737	182.971	166.957	162.214	197.715	67.890
4	56.410	114.651	137.846	67.078	125.245	49.122	140.654	127.765	127.475	157.933
5	61.807	38.009	80.956	97.255	47.649	86.285	33.790	93.071	88.152	89.735
6	44.138	36.025	23.826	50.858	54.932	26.123	46.664	19.221	54.203	52.974
7	10.828	23.669	18.618	12.547	24.806	22.996	11.601	21.506	9.524	27.644
8	4.403	4.996	11.249	8.255	5.311	9.726	7.983	4.535	8.894	3.819
9	0.895	1.879	2.144	4.598	3.128	1.960	3.373	2.691	1.731	3.489
10	0.496	0.374	0.787	0.827	1.584	1.070	0.663	1.066	0.811	0.527
11	0.456	0.189	0.141	0.282	0.288	0.556	0.350	0.203	0.321	0.257
12	0.206	0.179	0.071	0.050	0.096	0.099	0.186	0.111	0.065	0.104
13	0.030	0.076	0.068	0.026	0.017	0.033	0.033	0.063	0.039	0.023
14	0.009	0.010	0.024	0.021	0.008	0.005	0.010	0.010	0.019	0.012

Table 3.3.16 Cod at Iceland. Division Va. Resulting SSB using final F from AD-CAM using catch at age and spring trawl survey indices.

Year/age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	3.241	5.385	1.660	3.465	2.843	2.339	1.683	1.737	2.617	1.640
4	7.632	7.314	10.157	4.348	5.687	6.259	3.570	4.301	4.383	5.824
5	36.644	14.788	17.420	23.704	9.323	13.584	7.208	5.579	6.716	7.923
6	29.196	48.945	58.128	45.437	105.783	36.341	17.220	11.629	12.081	20.061
7	64.930	23.046	82.517	80.720	112.103	187.510	40.925	35.481	27.810	30.061
8	25.763	30.485	22.281	40.859	43.889	75.944	141.179	28.676	30.588	33.319
9	14.118	10.819	12.350	12.103	21.082	23.845	34.429	55.581	11.879	19.315
10	6.440	6.843	5.358	8.037	5.987	14.056	12.873	17.197	24.915	7.619
11	6.150	2.777	2.959	2.854	4.225	3.819	6.263	6.659	7.935	12.308
12	5.862	2.798	1.348	1.293	1.272	2.292	1.621	3.212	3.261	4.212
13	2.082	4.220	2.195	0.922	0.734	0.677	0.762	0.913	1.517	1.466
14	1.931	2.123	4.625	1.668	0.568	0.562	0.431	0.463	0.425	0.663
Total	203.989	159.542	220.998	225.409	313.497	367.228	268.162	171.427	134.129	144.411

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	0.000	0.239	0.288	0.608	0.435	0.408	0.000	0.196	0.570	0.485
4	2.871	3.575	12.091	7.996	4.650	0.759	6.292	5.937	13.075	17.301
5	33.543	24.385	12.799	67.088	36.317	24.272	10.785	26.954	23.237	50.375
6	38.891	65.623	30.844	41.337	77.852	96.037	32.615	18.234	30.723	35.656
7	24.454	41.985	43.318	16.052	26.402	59.358	60.587	31.226	13.949	24.704
8	26.755	22.380	22.649	20.299	11.103	15.405	34.816	42.177	13.822	9.487
9	14.774	13.807	8.793	7.718	7.054	5.745	4.989	16.218	15.123	4.768
10	13.956	10.182	6.587	4.354	3.847	5.238	2.400	3.050	8.005	6.131
11	3.926	5.485	4.813	2.638	2.371	1.697	1.886	1.410	1.555	3.775
12	7.200	2.058	2.334	1.743	0.916	1.093	0.837	0.991	0.534	0.689
13	2.101	3.051	0.874	1.219	0.763	0.617	0.409	0.347	0.409	0.228
14	0.750	0.821	1.101	0.280	0.539	0.496	0.324	0.130	0.144	0.177
Total	169.220	193.591	146.492	171.332	172.250	211.124	155.940	146.870	121.146	153.773

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.529	0.225	0.321	0.000	0.507	0.104	0.418	0.775	0.543	0.000
4	9.233	5.771	6.362	5.752	7.455	3.988	8.582	16.114	7.263	8.091
5	48.663	15.672	40.215	39.871	18.947	35.170	15.873	59.181	37.500	41.052
6	62.313	52.692	31.589	66.490	66.233	30.583	59.417	32.253	70.173	74.163
7	27.929	50.803	50.340	32.454	45.786	41.593	25.777	47.655	25.017	49.470
8	15.909	15.784	39.698	35.314	18.916	32.478	24.882	18.110	24.662	13.637
9	4.199	7.809	8.412	18.372	11.767	9.530	13.207	6.826	5.290	11.413
10	3.367	2.401	4.019	4.503	9.887	5.926	3.527	5.550	3.843	2.767
11	3.370	1.310	0.969	1.892	2.006	3.535	1.861	1.285	1.731	1.530
12	1.527	1.568	0.489	0.470	0.753	0.683	1.104	0.947	0.445	0.773
13	0.245	0.606	0.419	0.258	0.154	0.255	0.218	0.334	0.281	0.181
14	0.080	0.097	0.181	0.227	0.070	0.054	0.081	0.099	0.155	0.107
Total	177.364	154.737	183.015	205.604	182.481	163.901	154.948	189.130	176.904	203.184

Table 3.3.17 Cod at Iceland. Division Va. Resulting stock weight using final F from AD-CAM using catch at age and spring trawl survey indices.

Year/age	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
3	291.140	473.070	178.363	289.680	341.681	203.091	169.302	134.893	244.432	180.549
4	230.900	344.046	511.256	206.933	349.428	358.333	191.329	178.515	171.199	308.339
5	313.987	209.470	347.635	526.965	205.385	332.808	299.281	182.902	176.703	197.236
6	113.720	224.384	179.199	280.200	440.290	186.493	235.976	227.867	134.440	151.707
7	114.535	72.208	148.564	136.232	221.896	361.730	120.383	156.280	143.459	89.497
8	49.067	58.589	39.690	70.625	75.737	135.653	283.816	64.143	88.452	82.624
9	27.447	20.656	23.148	21.032	35.586	40.712	65.203	116.514	27.176	41.579
10	10.896	11.358	8.208	11.433	9.001	20.324	20.685	28.480	41.925	12.307
11	10.476	4.424	4.347	4.098	6.000	5.489	9.492	9.582	11.620	18.202
12	8.656	4.046	1.890	1.806	1.791	3.442	2.424	4.630	4.745	6.384
13	2.473	4.999	2.593	1.120	0.921	0.882	1.043	1.282	2.184	2.148
14	2.293	2.515	5.465	2.026	0.713	0.732	0.590	0.650	0.612	0.971
4+	**884**	**957**	**1272**	**1262**	**1347**	**1447**	**1230**	**971**	**803**	**911**

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	193.588	486.264	347.179	251.930	101.141	164.542	140.300	215.770	198.837	109.365
4	215.959	209.421	500.452	371.043	248.829	114.432	188.142	142.418	236.764	207.938
5	309.254	194.723	183.285	404.028	336.889	204.166	105.756	145.970	124.643	192.900
6	159.680	236.891	124.902	114.015	304.046	305.145	134.932	66.331	100.089	80.895
7	98.661	90.680	127.586	59.999	65.029	153.627	159.583	69.611	35.172	54.411
8	54.986	48.327	42.641	52.209	27.309	29.777	67.881	75.209	28.435	15.584
9	40.122	23.127	18.510	13.895	17.677	10.970	11.325	27.886	29.906	10.612
10	21.126	16.036	9.980	7.087	5.809	8.026	4.364	4.623	13.025	11.122
11	5.658	8.082	7.185	4.100	3.541	2.537	2.829	2.100	2.358	5.735
12	10.341	2.996	3.429	3.233	1.567	1.688	1.296	1.512	0.817	1.058
13	3.063	4.358	1.289	1.855	1.308	0.901	0.600	0.516	0.623	0.359
14	1.093	1.173	1.625	0.425	0.793	0.725	0.475	0.194	0.219	0.278
4+	**920**	**836**	**1021**	**1032**	**1013**	**832**	**677**	**536**	**572**	**581**

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	202.347	254.692	124.749	193.354	77.856	239.326	250.269	209.905	248.330	87.646
4	110.508	221.276	258.737	117.386	214.920	87.535	288.341	246.075	227.670	279.383
5	180.476	119.043	232.990	239.053	115.596	201.044	89.509	247.197	213.150	223.620
6	160.000	149.179	95.972	181.004	189.132	84.952	159.263	70.735	189.872	182.706
7	56.047	116.500	100.577	65.407	117.082	107.850	55.288	101.509	42.470	116.877
8	28.250	30.019	71.838	63.868	33.733	57.323	51.956	28.882	44.808	22.427
9	7.082	13.917	15.746	36.033	27.303	15.307	25.362	21.010	10.363	20.888
10	5.099	3.654	6.720	7.698	15.756	9.847	6.001	9.597	6.371	4.140
11	5.028	1.992	1.522	3.038	3.191	5.695	3.070	2.118	2.835	2.265
12	2.356	2.421	0.824	0.741	1.198	1.104	1.772	1.494	0.702	1.126
13	0.398	1.036	0.704	0.439	0.261	0.432	0.368	0.565	0.474	0.276
14	0.130	0.162	0.304	0.386	0.119	0.091	0.137	0.168	0.262	0.163
4+	**555**	**659**	**786**	**715**	**718**	**571**	**681**	**729**	**739**	**854**

Table 3.3.18. 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) (OldSSB using maturity and mw@age in the catches), Harvest Ratio and total biomass ('000 tonnes).

Year	F5-10	SSB	OldSSB	Bio4+	Recruitment	HarvesRatio	Landings
1955	0.32	932	1217	2282	220	0.40	545
1956	0.31	796	1086	2003	301	0.40	487
1957	0.33	779	1021	1795	152	0.40	455
1958	0.35	893	1174	1819	197	0.44	517
1959	0.36	805	1014	1732	133	0.45	459
1960	0.37	716	857	1730	178	0.47	470
1961	0.37	477	737	1366	196	0.45	332
1962	0.40	594	792	1515	212	0.47	389
1963	0.45	571	724	1338	230	0.52	409
1964	0.51	510	625	1252	326	0.59	437
1965	0.56	376	467	1051	172	0.65	387
1966	0.57	322	405	1046	250	0.64	353
1967	0.60	289	393	1109	182	0.62	336
1968	0.65	265	398	1222	182	0.64	382
1969	0.59	378	582	1375	137	0.60	403
1970	0.60	399	601	1363	282	0.67	475
1971	0.65	339	531	1277	177	0.78	518
1972	0.68	308	492	1189	265	0.80	476
1973	0.70	298	436	839	350	0.87	369
1974	0.74	220	332	918	142	0.91	368
1975	0.76	204	337	884	225	0.88	365
1976	0.72	159	288	957	243	0.76	346
1977	0.64	221	330	1272	146	0.63	340
1978	0.54	225	383	1262	143	0.55	330
1979	0.49	313	468	1347	134	0.55	366
1980	0.53	367	515	1447	223	0.60	432
1981	0.65	268	370	1230	140	0.71	465
1982	0.73	171	266	971	138	0.78	380
1983	0.74	134	219	803	333	0.73	298
1984	0.67	144	225	911	264	0.70	282
1985	0.69	169	264	920	175	0.78	323
1986	0.78	193	262	836	85	0.89	365
1987	0.83	146	250	1021	128	0.91	390
1988	0.86	171	196	1032	107	0.89	378
1989	0.76	172	265	1013	167	0.89	363
1990	0.74	211	333	832	143	0.91	335
1991	0.79	156	219	677	76	1.01	308
1992	0.84	147	234	536	150	1.05	265
1993	0.82	121	220	572	175	0.98	251
1994	0.66	154	259	581	84	0.74	178
1995	0.57	177	326	555	157	0.63	169
1996	0.56	155	269	659	63	0.56	181
1997	0.60	183	350	786	183	0.56	203
1998	0.67	206	339	715	167	0.69	244
1999	0.72	182	322	718	162	0.79	260
2000	0.76	164	246	571	198	0.81	235
2001	0.75	155	339	681	68	0.75	234
2002	0.71	189	377	729	171	0.65	208
2003	0.70	177	412	739	153	0.60	202
Mean	0.62	321	465	1091	181	0.69	352

Table 3.3.19. Cod at Iceland. Division Va. Input file used for RCTR3

```
Iceland Cod: VPA and groundfish survey data,N+S
4 23 2
'Yearcl'  'VPAage3'  'Surv4'  'Surv3'  'Surv2'  'Surv1'
1981     141    4809      -11      -11      -11
1982     146    2243     3485      -11      -11
1983     339    8203     9556    11107      -11
1984     283   10161    10310     6056     1654
1985     170    7770     7169     2886     1508
1986      84    1407     2197      736      365
1987     133    3017     2615     1645      344
1988     102    1887     1793     1179      404
1989     175    3641     3326     1627      556
1990     147    2666     3076     1713      395
1991      75     899      897      482       72
1992     162    2944     2478     1501      357
1993     167    5618     4260     2903     1438
1994      87    1606     1357      548      118
1995     167    4227     2998     2239      372
1996      65     694      701      556      121
1997     185    3760     5474     3298      806
1998     173    4016     3378     2790      739
1999     -11    3855     4112     2172     1879
2000     -11    6165     4636     3807     1216
2001     -11     -11      791      444       92
2002     -11     -11      -11     2458     1117
2003     -11     -11      -11      -11      657
```

Table 3.3.20. Cod at Iceland. Division Va. Output from RCT3

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

in_2004.dat

Iceland Cod: VPA and groundfish survey data,N+S

Data for    4 surveys over   23 years :  1981 - 2003

Regression type = C
Tapered time weighting not applied
Survey weighting not applied

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

Forecast/Hindcast variance correction used.

Year class =   1999

         I-----------Regression----------I  I-----------Prediction---------I

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

Surv4      .63   -.08    .18   .852     18   8.26    5.11     .200     .276
Surv3      .64   -.13    .18   .870     17   8.32    5.17     .193     .277
Surv2      .54    .93    .13   .933     16   7.68    5.07     .139     .277
Surv1      .52   1.78    .27   .714     15   7.54    5.67     .319     .109

                                        VPA Mean =    4.97     .426     .061


Year class =   2000

         I-----------Regression----------I  I-----------Prediction---------I

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

Surv4      .63   -.08    .18   .852     18   8.73    5.41     .205     .265
Surv3      .64   -.13    .18   .870     17   8.44    5.25     .194     .278
Surv2      .54    .93    .13   .933     16   8.24    5.38     .142     .278
Surv1      .52   1.78    .27   .714     15   7.10    5.44     .307     .118

                                        VPA Mean =    4.97     .426     .061


Year class =   2001

         I-----------Regression----------I  I-----------Prediction---------I

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

Surv4
Surv3      .64   -.13    .18   .870     17   6.67    4.12     .209     .362
Surv2      .54    .93    .13   .933     16   6.10    4.22     .149     .397
Surv1      .52   1.78    .27   .714     15   4.53    4.12     .321     .154

                                        VPA Mean =    4.97     .426     .087
```

Table 3.3.20 (Cont'd)

Year class = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv4									
Surv3									
Surv2	.54	.93	.13	.933	16	7.81	5.14	.139	.607
Surv1	.52	1.78	.27	.714	15	7.02	5.40	.306	.260
					VPA Mean =		4.97	.426	.134

Year class = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv4									
Surv3									
Surv2									
Surv1	.52	1.78	.27	.714	15	6.49	5.13	.297	.673
					VPA Mean =		4.97	.426	.327

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1999	175	5.17	.11	.09	.74		
2000	206	5.33	.11	.06	.31		
2001	69	4.23	.13	.13	1.13		
2002	178	5.19	.16	.10	.40		
2003	160	5.08	.24	.07	.09		

Table 3.3.21. Short term prediction (Management option table)

Calculation were performed with the spreadsheet: codpr2004.xls

Input data:

Sexual maturity at spawning time:

age\year	2003	2004	2005	2006
3	0.01	0.00	0.00	0.00
4	0.05	0.04	0.04	0.04
5	0.22	0.25	0.25	0.25
6	0.52	0.55	0.55	0.55
7	0.87	0.63	0.63	0.63
8	0.80	0.84	0.84	0.84
9	0.86	0.82	0.82	0.82
10	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00

Mean weights in the SSB (in March survey)

age\year	2003	2004	2005	2006
3	0.579	0.59	0.650	0.650
4	1.338	1.453	1.370	1.370
5	2.215	2.099	2.240	2.240
6	2.988	3.057	3.084	3.084
7	4.169	3.757	4.219	4.219
8	5.038	5.873	5.947	5.947
9	5.986	5.986	5.986	5.986
10	7.852	7.852	7.852	7.852
11	8.819	8.819	8.819	8.819
12	10.834	10.834	10.834	10.834
13	12.152	12.152	12.152	12.152
14	13.804	13.805	13.805	13.805

Mean weights in the catch

age\year	2003	2004	2005	2006
3	1.256	1.291	1.256	1.256
4	1.786	1.769	1.792	1.792
5	2.418	2.492	2.453	2.453
6	3.503	3.449	3.391	3.391
7	4.459	4.228	4.660	4.660
8	5.038	5.873	5.947	5.947
9	5.986	5.986	5.986	5.986
10	7.852	7.852	7.852	7.852
11	8.819	8.819	8.819	8.819
12	10.834	10.834	10.834	10.834
13	12.152	12.152	12.152	12.152
14	13.805	13.805	13.805	13.805

Table 3.3.21 (Continued)

Selection pattern from a AD-CAM:

age\year	1998	1999	2000	2001	2002	2003	01-03	Used
3	0.040	0.062	0.083	0.090	0.057	0.035	0.062	0.062
4	0.211	0.240	0.230	0.284	0.240	0.217	0.248	0.248
5	0.551	0.556	0.547	0.486	0.477	0.445	0.470	0.470
6	0.769	0.931	0.808	0.766	0.703	0.681	0.718	0.718
7	0.980	1.022	1.133	0.986	0.956	1.027	0.989	0.989
8	1.144	1.105	1.134	1.184	1.068	1.058	1.105	1.105
9	1.285	1.211	1.168	1.269	1.398	1.422	1.361	1.361
10	1.271	1.175	1.211	1.309	1.398	1.367	1.357	1.357
11	1.312	1.205	1.182	1.259	1.321	1.337	1.305	1.316
12	1.263	1.205	1.191	1.183	1.190	1.220	1.197	1.316
13	1.500	1.392	1.319	1.325	1.395	1.428	1.381	1.316
14	1.500	1.392	1.319	1.325	1.395	1.428	1.381	1.316
Ave(5-10)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Natural Mortality

age\year	2003	2004	2005	2006	2007
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

Given stock numbers / ***Mortality proportions before spawning***

age\year	2004	2005	2006	2007	F	M
3	67.890	171.00	153.00	153.00	0.085	0.250
4	157.933				0.180	0.250
5	89.735				0.248	0.250
6	52.974				0.296	0.250
7	27.644				0.382	0.250
8	3.819				0.437	0.250
9	3.489				0.477	0.250
10	0.527				0.477	0.250
11	0.257				0.477	0.250
12	0.104				0.477	0.250
13	0.023				0.477	0.250
14	0.012				0.477	0.250

Table 3.3.21 (Continued)

Prognosis - Summary

Catch, '000 tonnes

	2000	2001	2002	2003	2004	2005	2006	2007
Opt1	235	234	208	202	220	170	170	170
Opt2	235	234	208	202	220	205	206	222
Opt3	235	234	208	202	220	180	180	180
Opt4	235	234	208	202	220	200	200	200
Opt5	235	234	208	202	220	220	220	220

Average fishing mortality of 5-10 years old

	2000	2001	2002	2003	2004	2005	2006	2007
Opt1	0.76	0.75	0.71	0.70	0.604	0.400	0.339	0.293
Opt2	0.76	0.75	0.71	0.70	0.604	0.498	0.455	0.458
Opt3	0.76	0.75	0.71	0.70	0.604	0.427	0.370	0.324
Opt4	0.76	0.75	0.71	0.70	0.604	0.484	0.435	0.396
Opt5	0.76	0.75	0.71	0.70	0.604	0.544	0.509	0.484

Fishable stock, 4+ in '000 tonnes at the beginniq of the year

	2000	2001	2002	2003	2004	2005	2006	2007
Opt1	571	681	729	739	854	785	901	997
Opt2	571	681	729	739	854	785	861	914
Opt3	571	681	729	739	854	785	890	973
Opt4	571	681	729	739	854	785	866	926
Opt5	571	681	729	739	854	785	843	879

Spawning stock in '000 at the time of spawning

	2000	2001	2002	2003	2004	2005	2006	2007
Opt1	164	155	189	177	202	265	312	352
Opt2	164	155	189	177	202	258	281	289
Opt3	164	155	189	177	202	263	303	335
Opt4	164	155	189	177	202	259	285	302
Opt5	164	155	189	177	202	254	267	269

Prognosis - Summary table (nwwg2004)

2004				2005				2006				2007			
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)*
220	854	202	0.604	170	785	265	0.400	170	901	312	0.339	170	997	352	0.293
				205	785	258	0.498	206	861	281	0.455	222	914	289	0.458
				180	785	263	0.427	180	890	303	0.370	180	973	335	0.324
				200	785	259	0.484	200	866	285	0.435	200	926	302	0.396
				220	785	254	0.544	220	843	267	0.509	220	879	269	0.484

The shaded option corresponds to the harvest control rule.

Table 3.3.22 Cod at Iceland. Division Va. Yield per recruit input data

```
"MFYPR version 1"
"Run: final "
"Cod Va (NWWG 2004)"
"Time and date: 11:55 02/05/2004"
"Fbar age range: 5-10"
""
""
"Age","M","Mat","PF","PM","SWt","Sel","CW"
3,0.2,0.01,0.085,0.25,0.652,0.062,1.320
4,0.2,0.05,0.18,0.25,1.446,0.248,1.842
5,0.2,0.21,0.248,0.25,2.224,0.470,2.588
6,0.2,0.45,0.296,0.25,3.151,0.718,3.539
7,0.2,0.64,0.382,0.25,4.281,0.989,4.724
8,0.2,0.78,0.437,0.25,6.179,1.105,6.123
9,0.2,0.79,0.477,0.25,7.583,1.361,7.543
10,0.2,0.97,0.477,0.25,9.252,1.357,9.246
11,0.2,0.99,0.477,0.25,10.710,1.305,10.778
12,0.2,0.98,0.477,0.25,12.722,1.197,12.811
13,0.2,0.99,0.477,0.25,14.002,1.381,14.200
14,0.2,1.00,0.477,0.25,15.905,1.381,15.818
""
"Weights in kilograms"
```

Table 3.3.23. Cod at Iceland. Division Va. Yield and spawning biomass per Recruit. F-reference points:

	Fish Mort Ages 5-10	Yield/R	SSB/R
Average last 3 years	0.720	1.721	1.282
$\mathbf{F}_{max}$	0.318	1.818	3.531
$\mathbf{F}_{0.1}$	0.139	1.641	7.944
$\mathbf{F}_{med}$	0.620	1.748	1.560

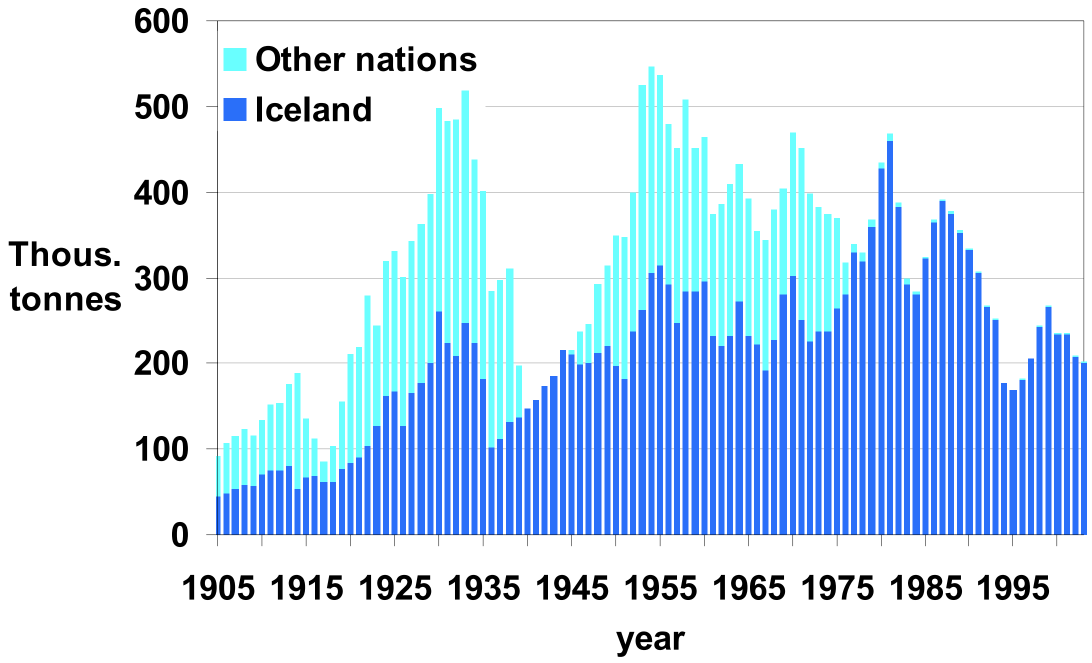


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.

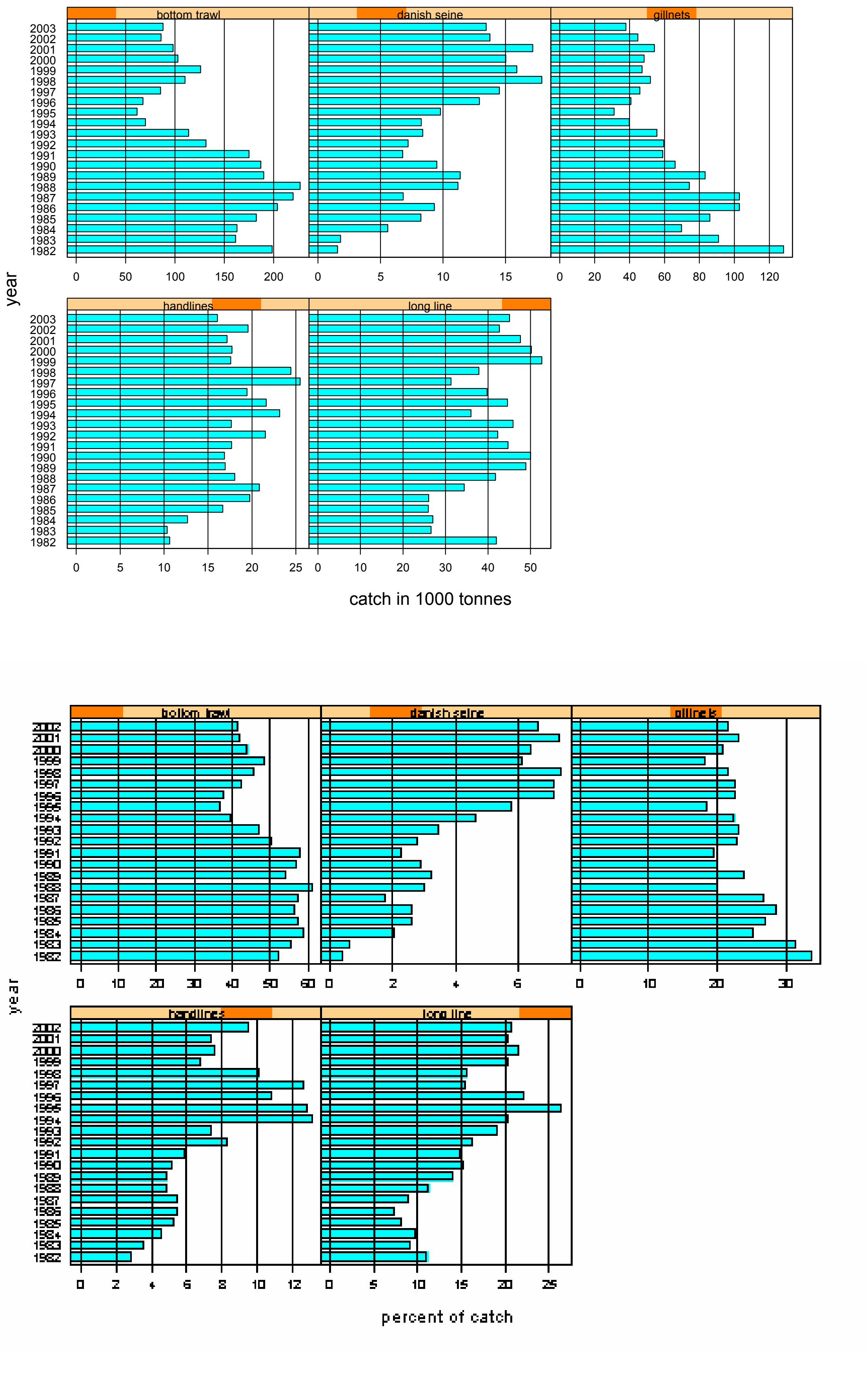


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes and lower in percentages.

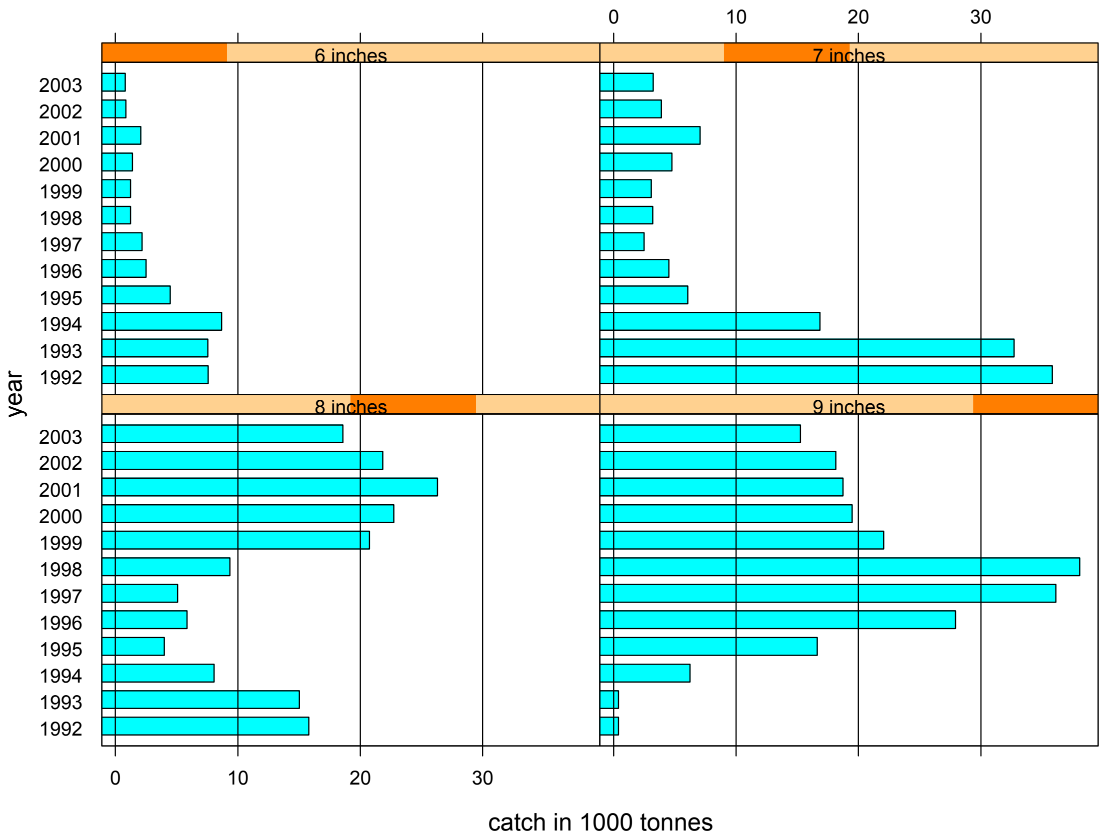


Figure 3.3.3.. Cod in division Va. Gillnet landings by mesh size and year.

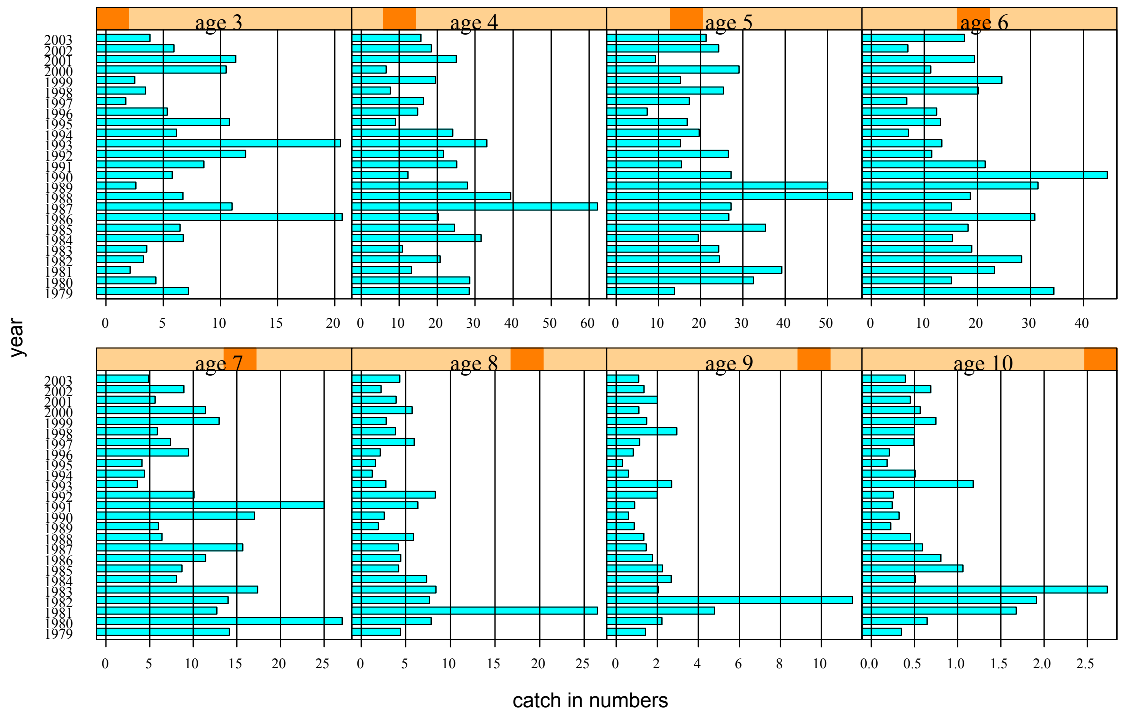


Figure 3.3.4 . Cod in division Va. Catch in numbers by year and age.

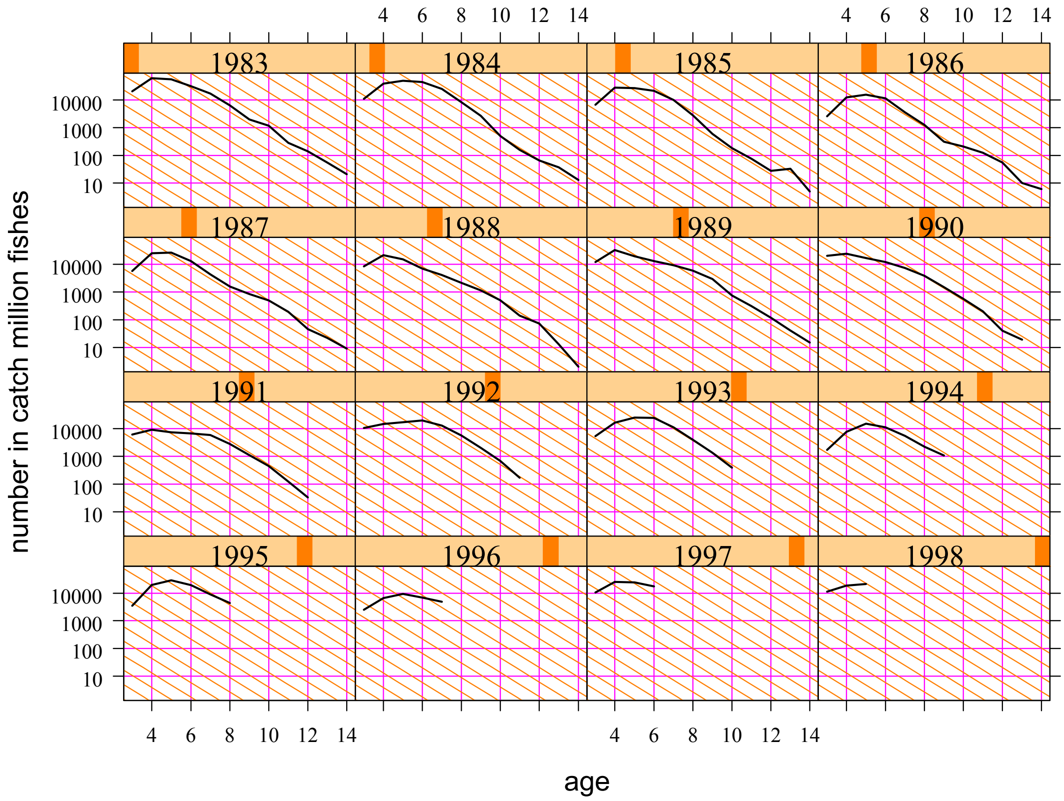


Figure 3.3.5. Icelandic cod. Catch curves. Grey lines show Z = 1.

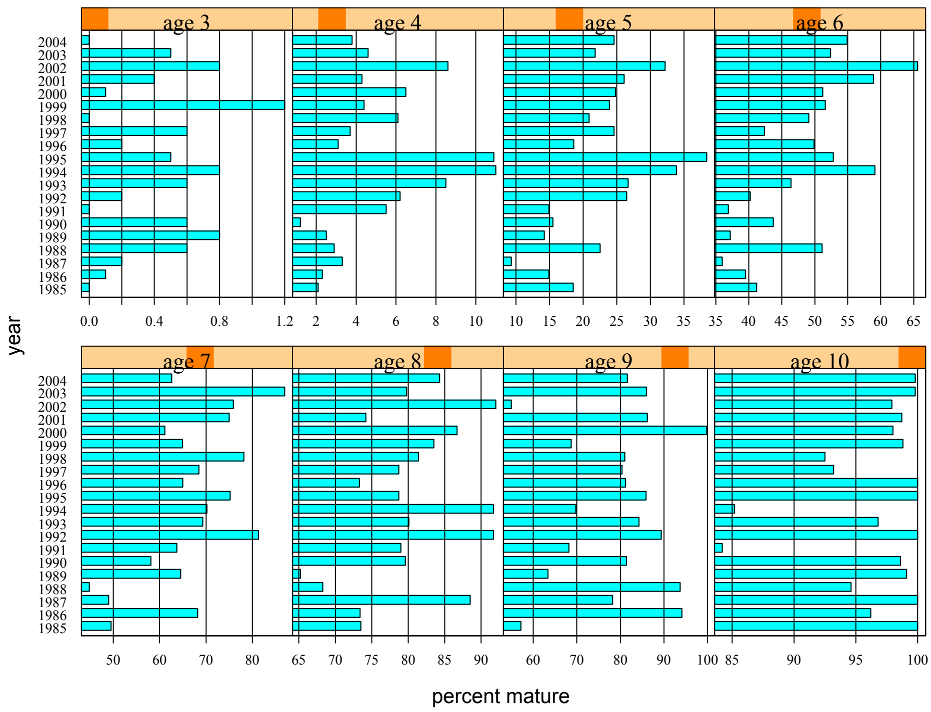


Figure 3.3.6. Cod. Sexual maturity at age in the spring survey.

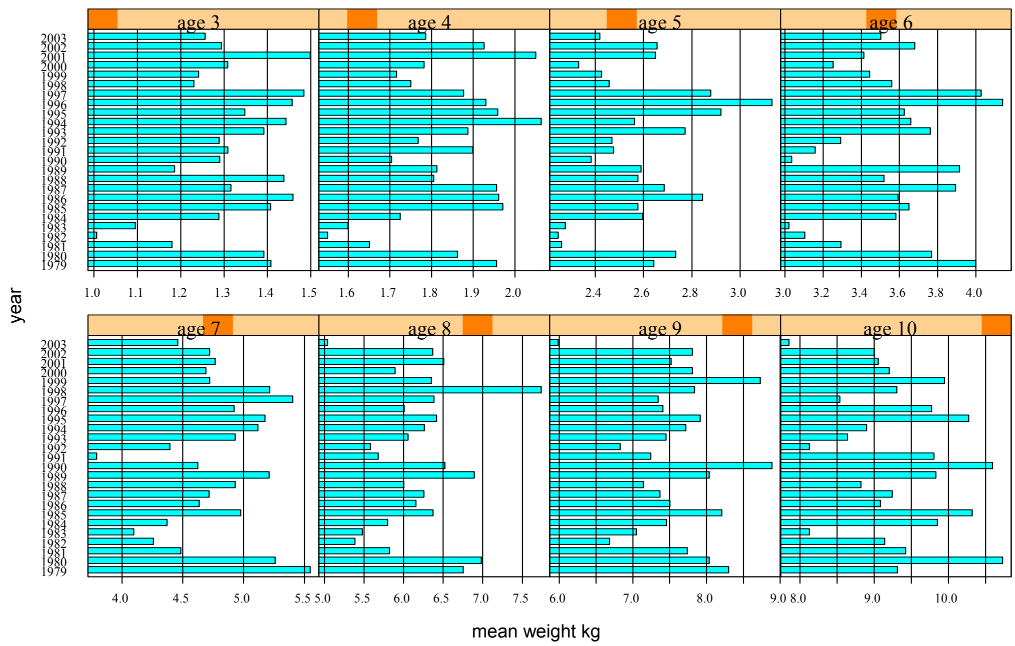


Figure 3.3.7 Cod in division Va. Mean weight at age in the catches.

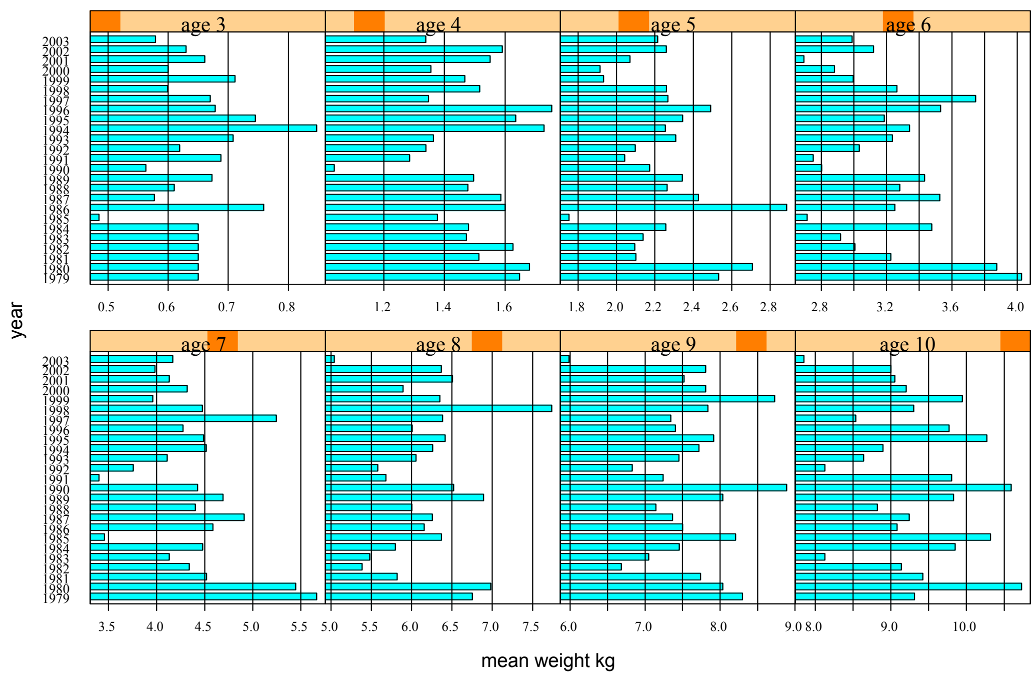


Figure 3.3.8 Cod in division Va. Mean weight at age in the SSB.

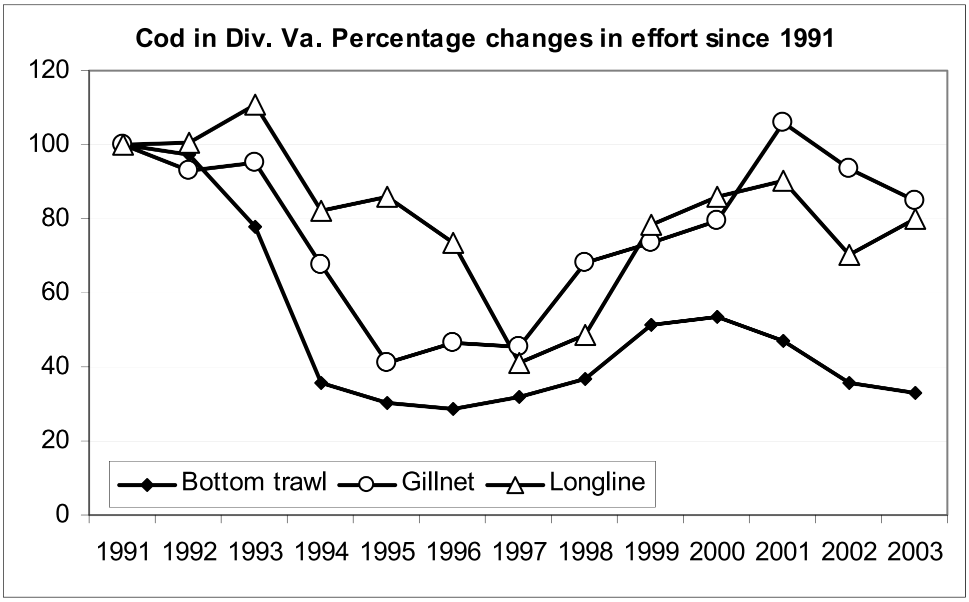


Figure 3.3.9.A. Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

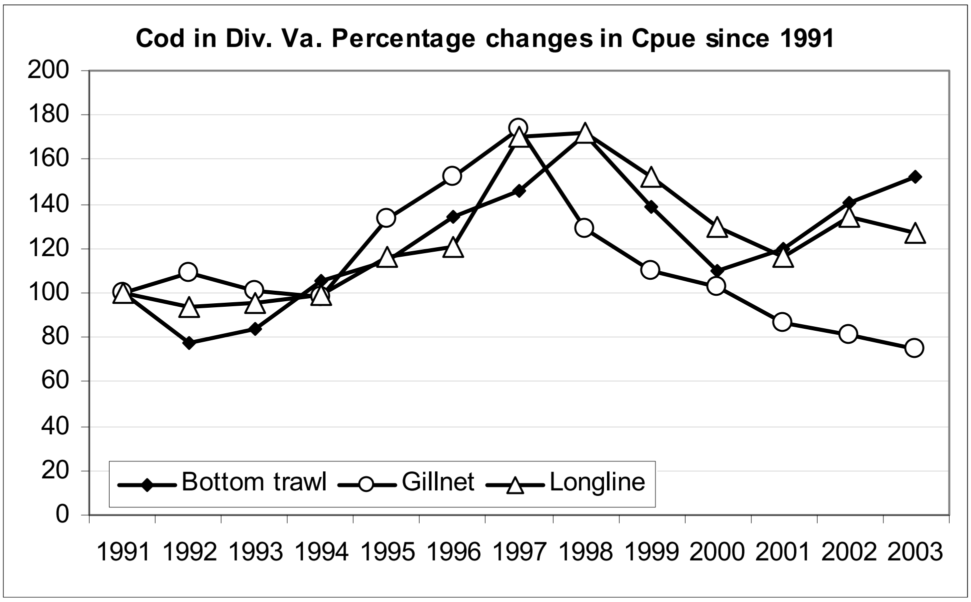


Figure 3.3.9.B. Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

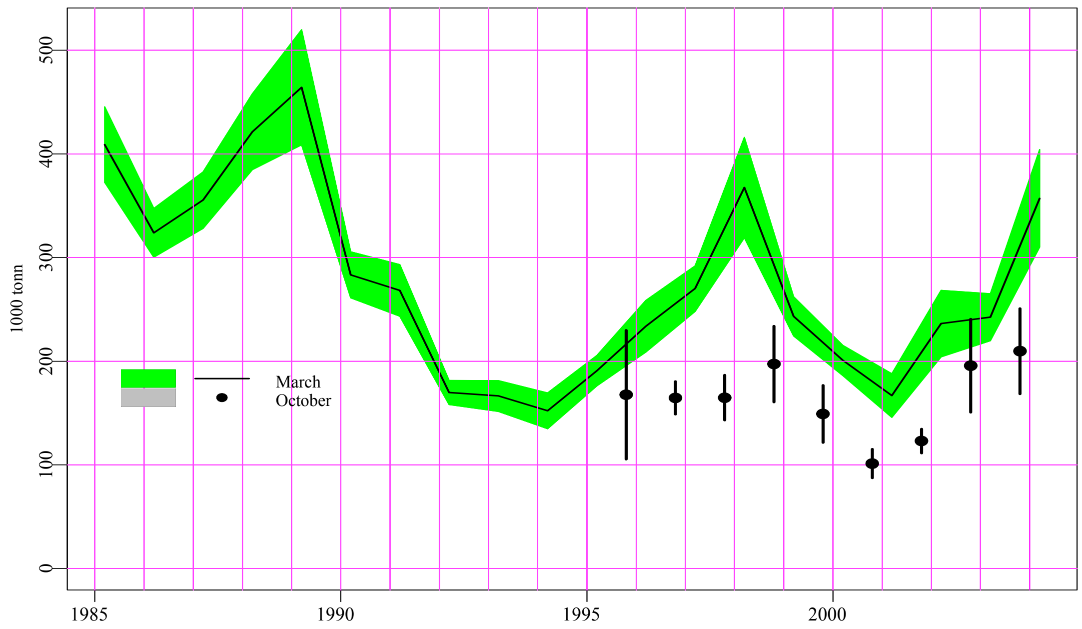


Figure 3.3.10. Cod in division Va. Total biomass index from the spring groundfish survey 1985-2004 and from the autumn survey 1996-2003.

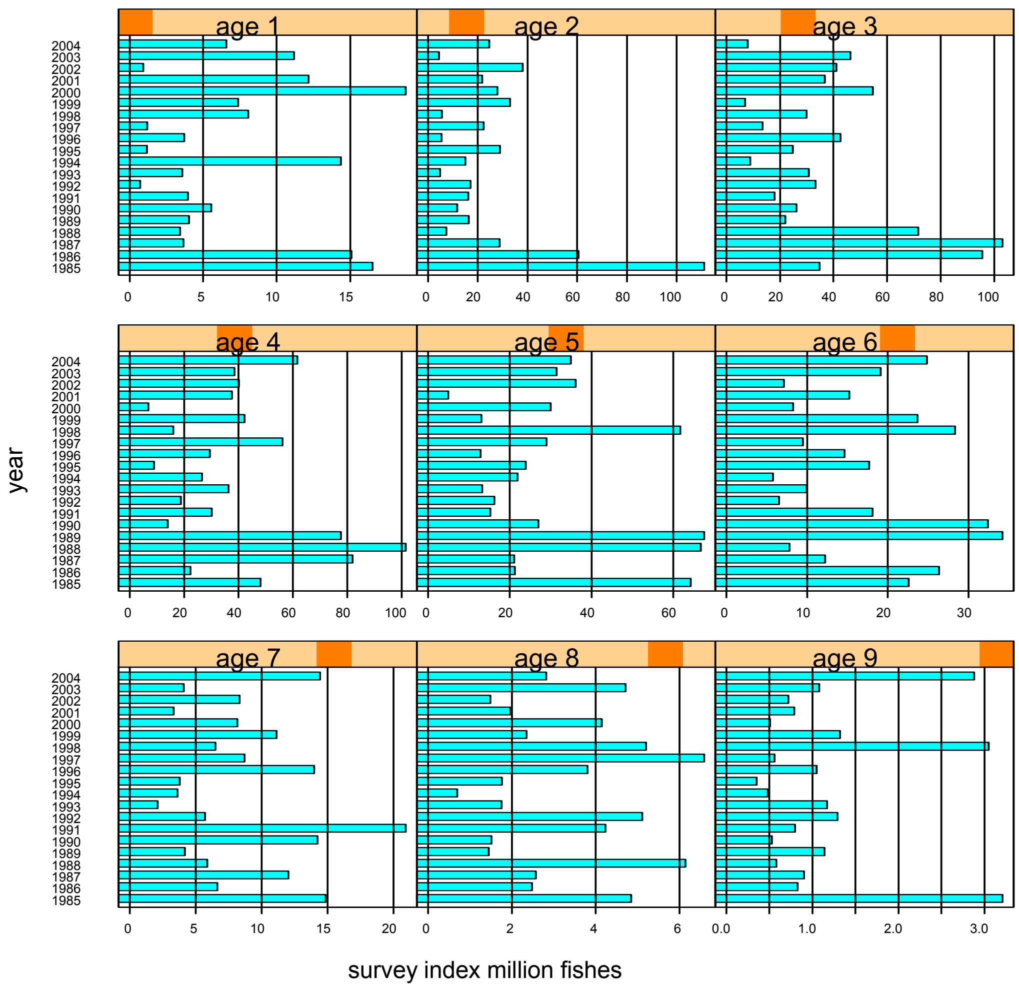


Fig 3.3.11. Cod in division Va. Survey indices from the March survey. Numbers by year and age.

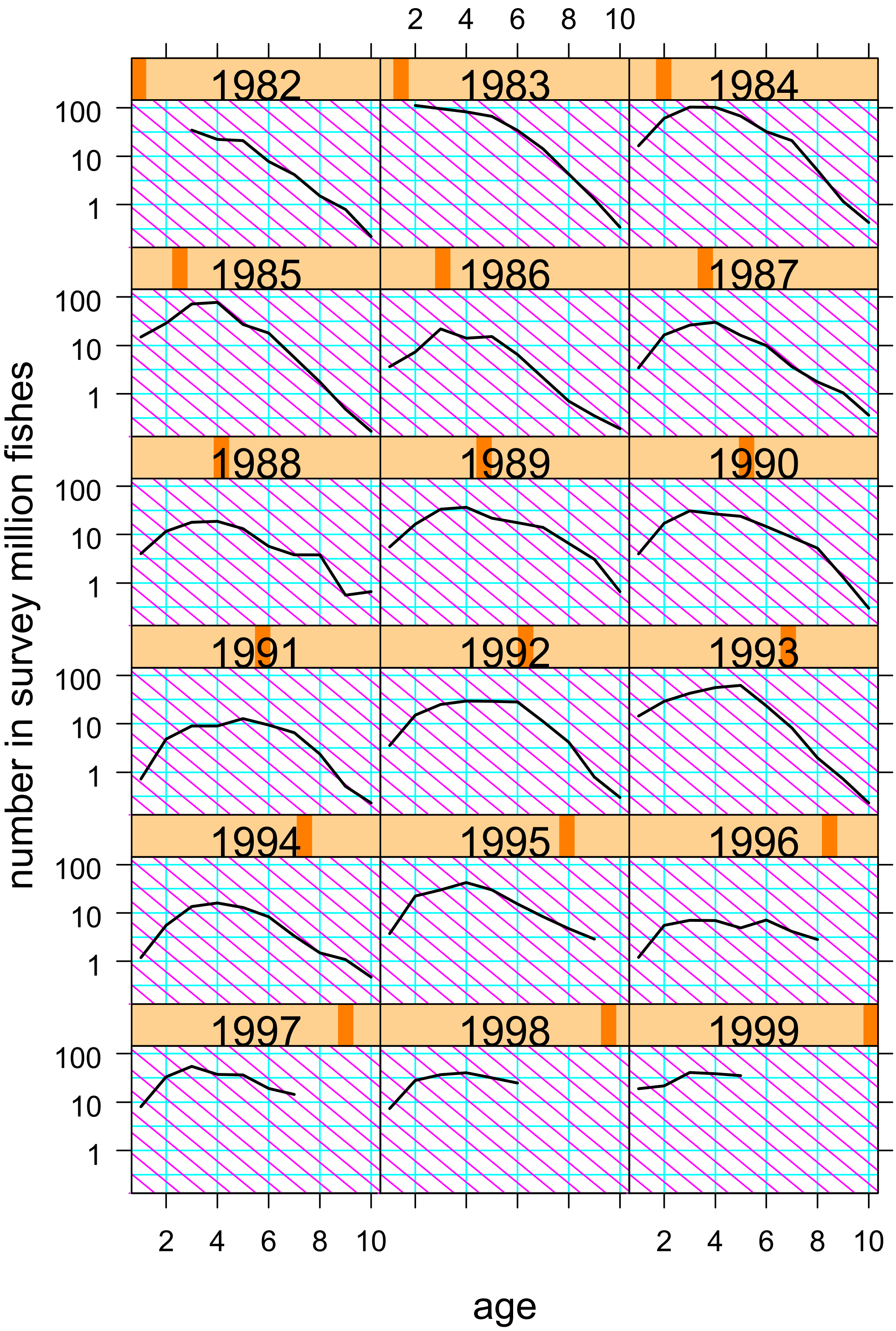


Figure 3.3.12. Cod in division Va. Catchcurves from the survey. The grey lines show Z=1

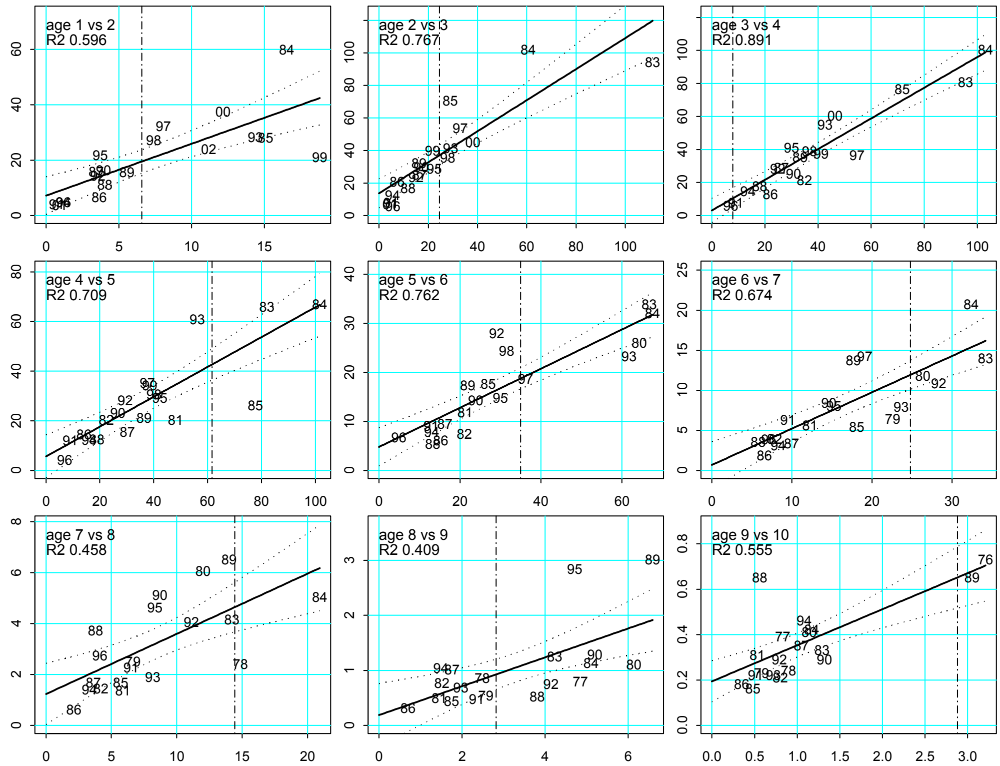


Figure 3.3.13. Cod in division Va. Indices from the groundfish survey vs. index of the same year class in survey a year later.

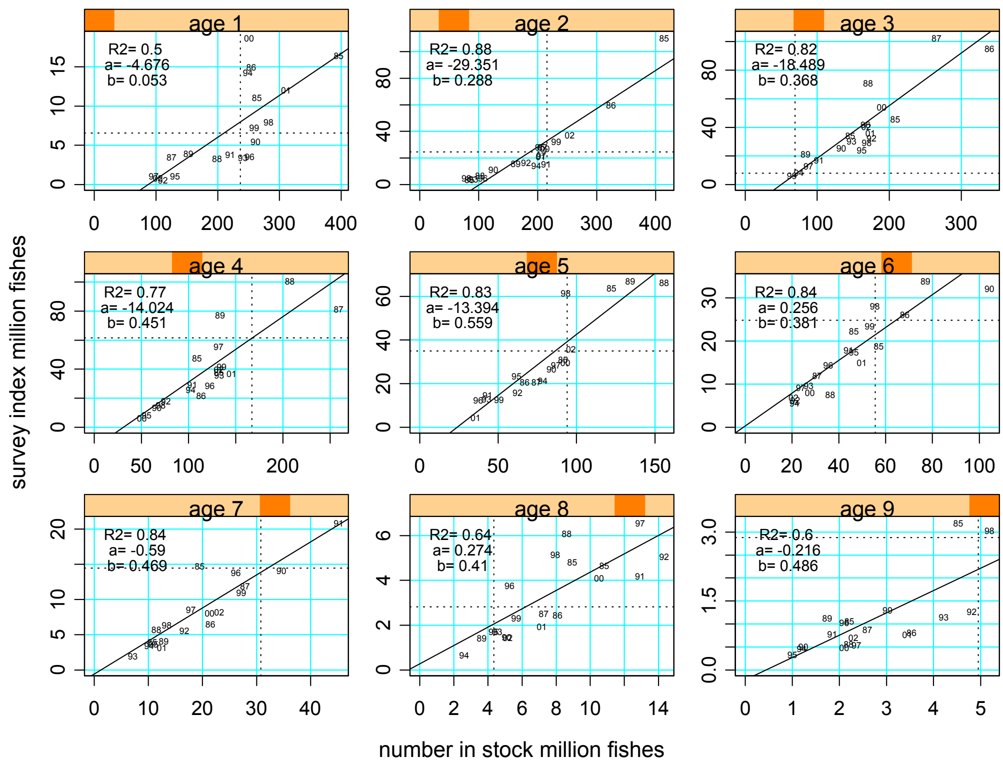


Figure 3.3.14. Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale using 1985-2000 data.

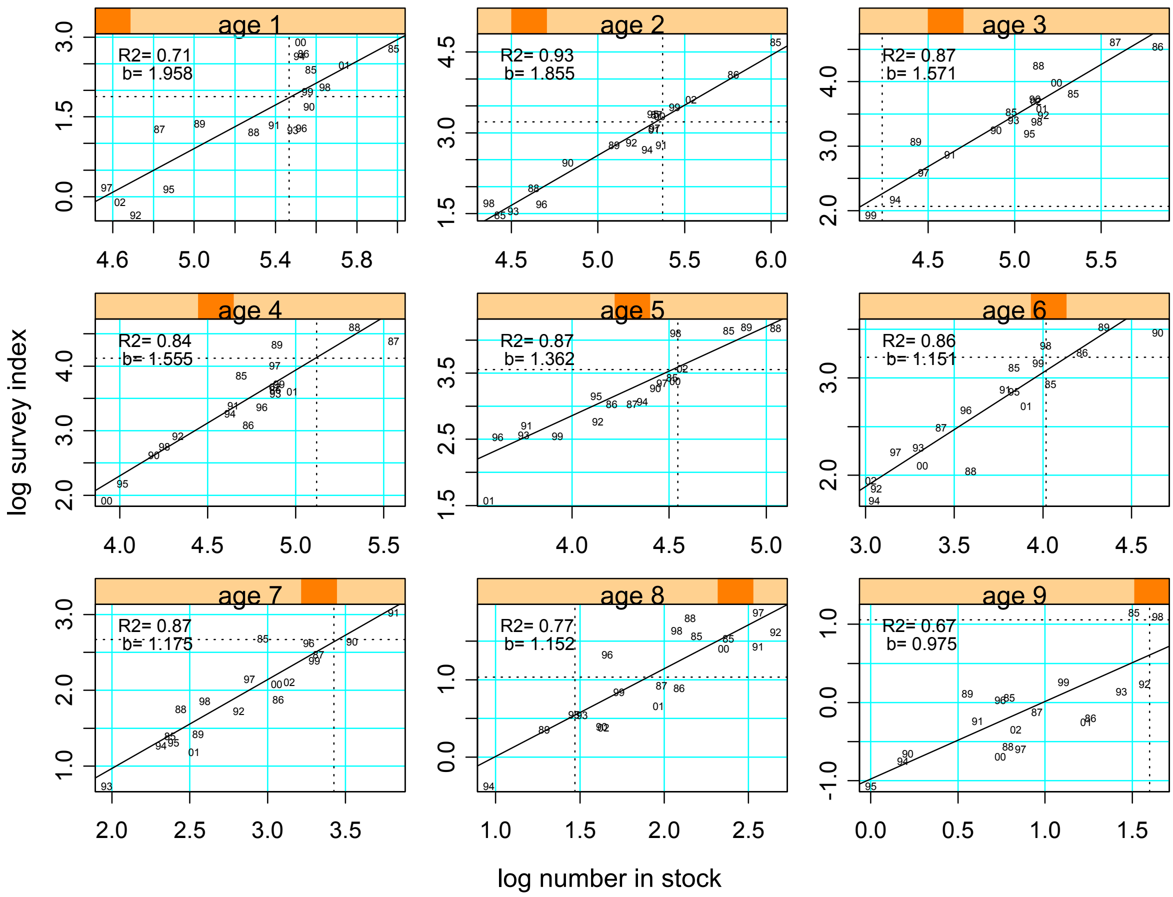


Figure 3.3.15. Cod in division Va. Survey indices vs. number in stock. Line fitted on logscale (power curve) using 1985-2000 data.

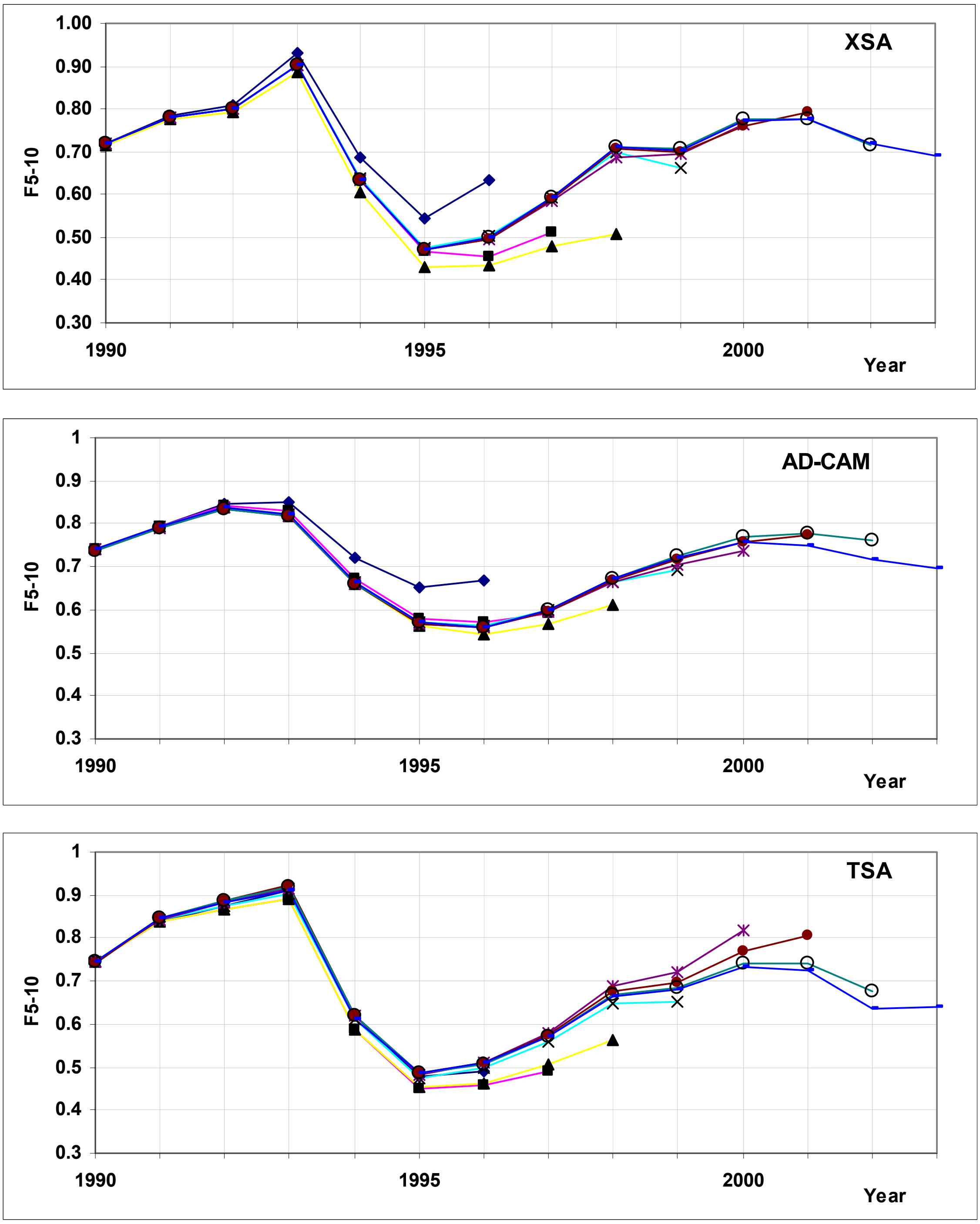
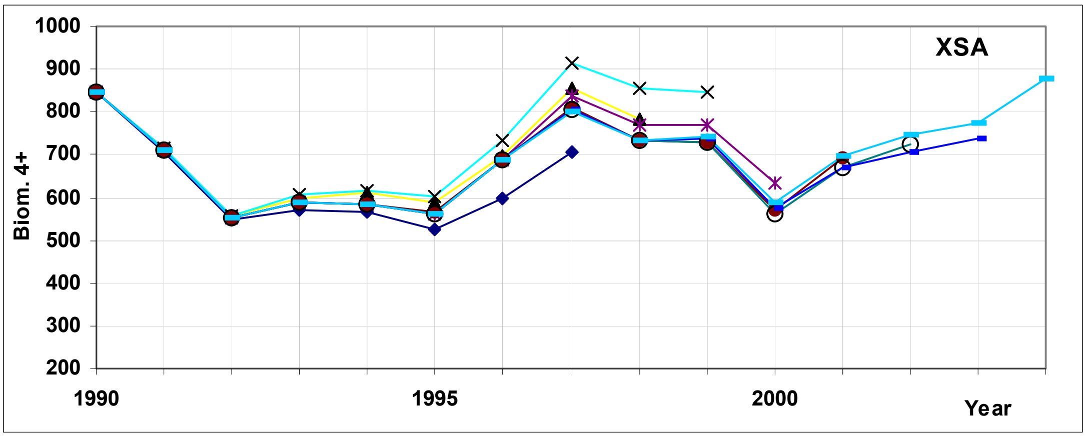
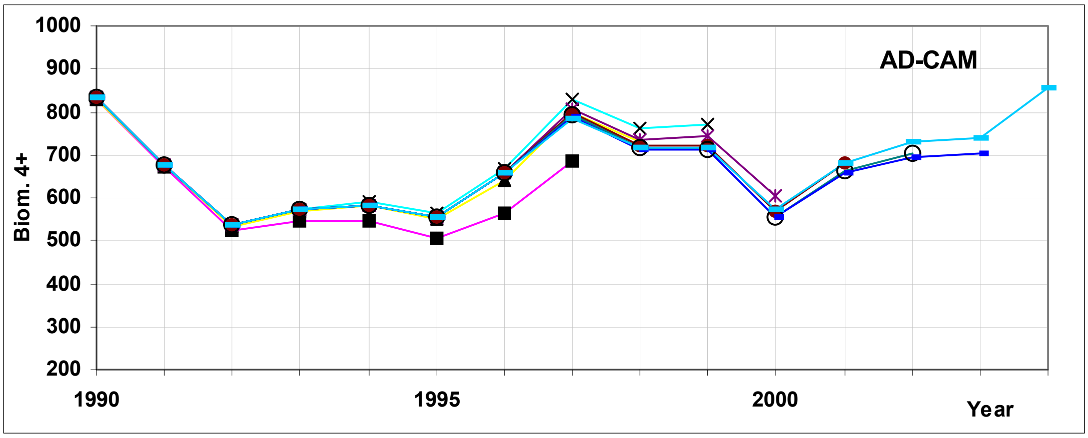


Figure 3.3.16. Retrospective pattern from assessment runs. The figures show mean fishing mortality of ages 5 to 10.





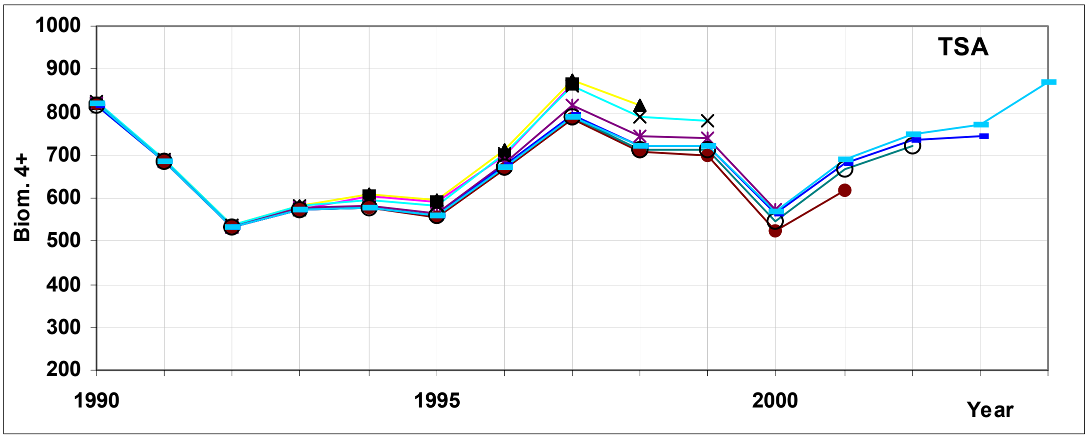
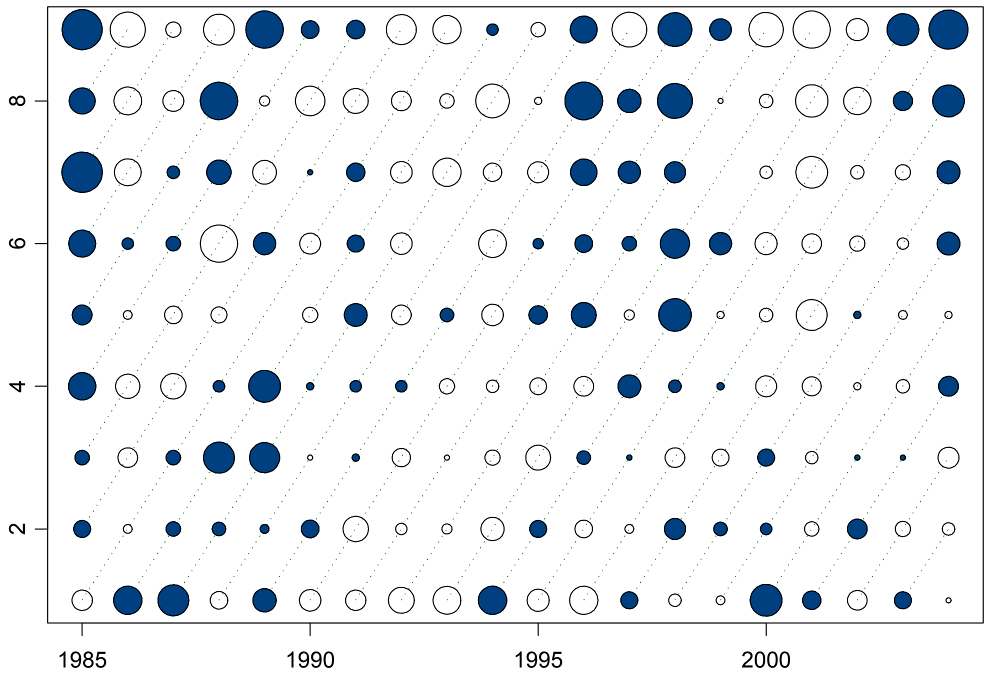


Figure 3.3.17. Retrospective patterns from assessment runs. The figures show number of age 4 and older multiplied by the weight in the catches.



XSA-Log catchability residuals

AD-CAM ln(CNay-observed/CNay-predicted)

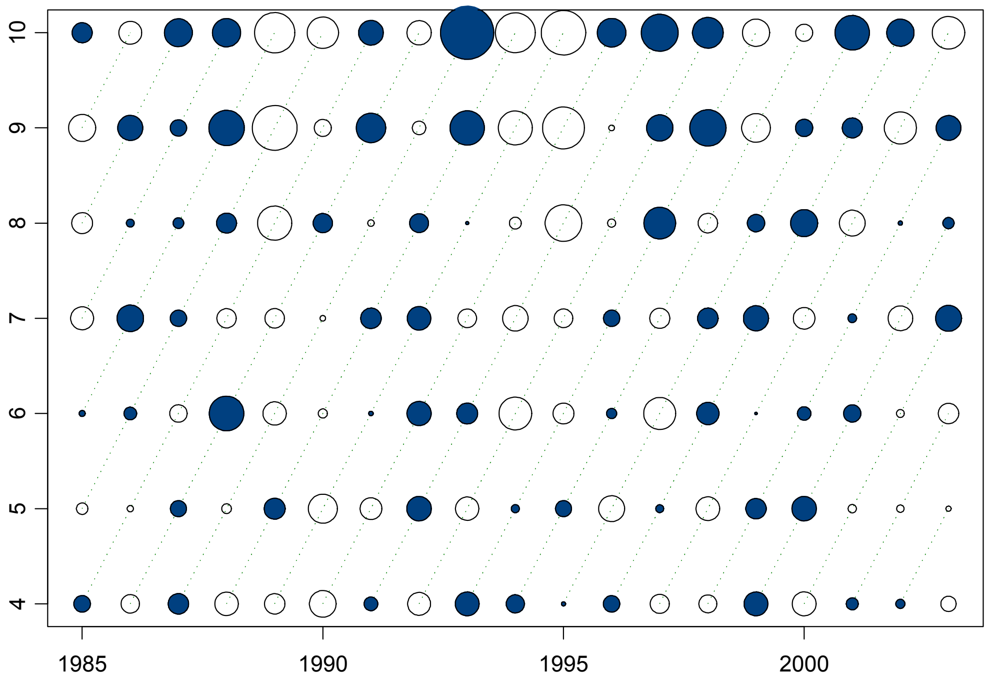


Figure 3.3.18. Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

AD-CAM ln(Uay-observed/Uay-predicted)

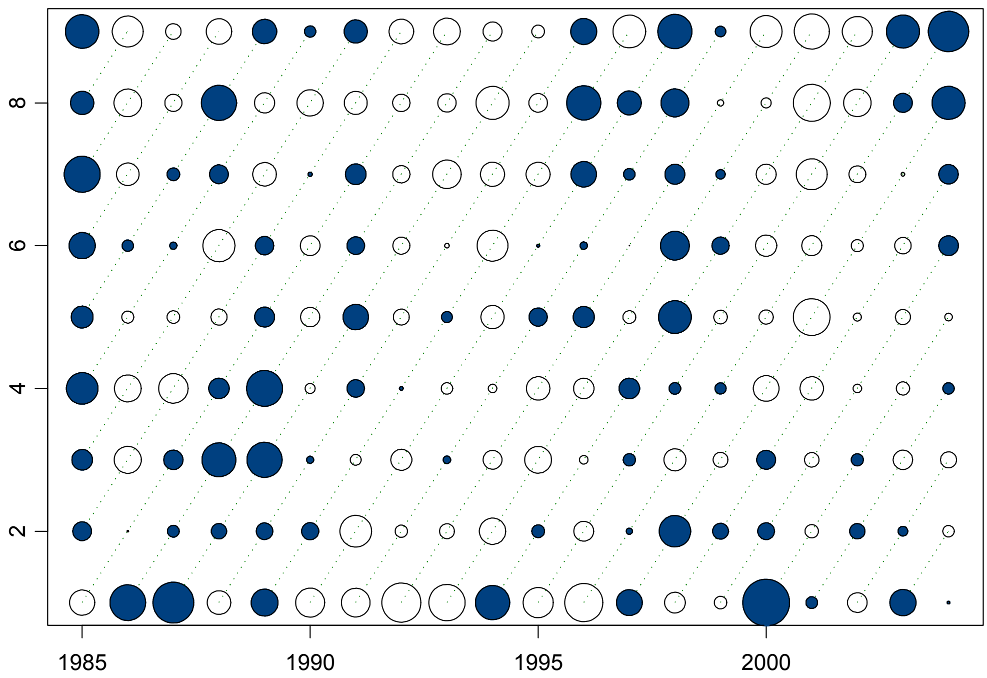
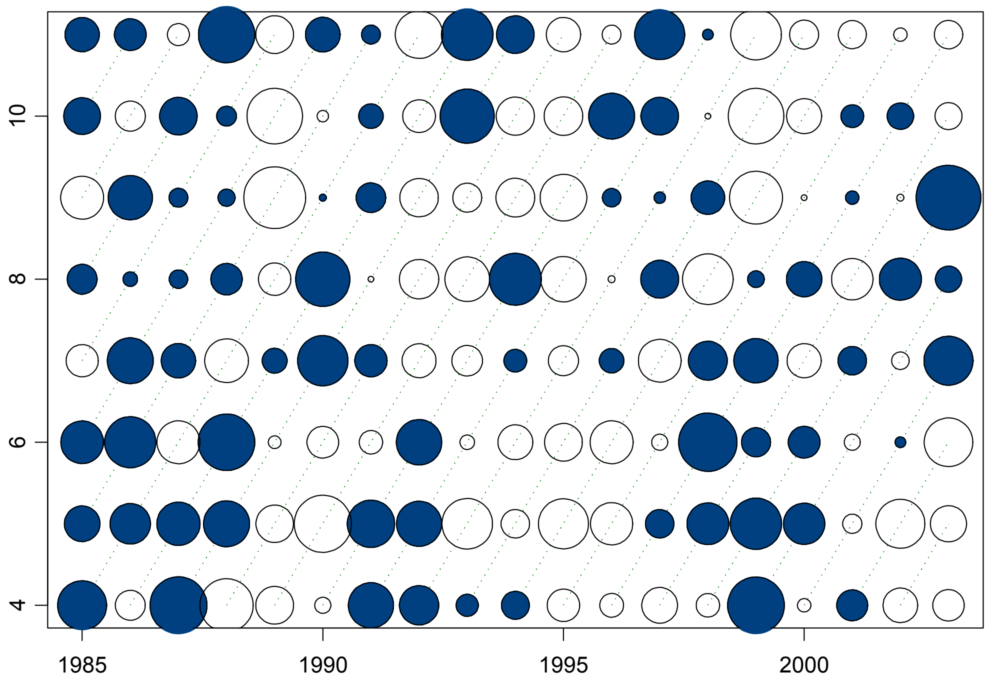


Figure 3.3.18 (Continued)



TSA - Standardized catch prediction errors

TSA - Standardized prediction errors of survey cpue

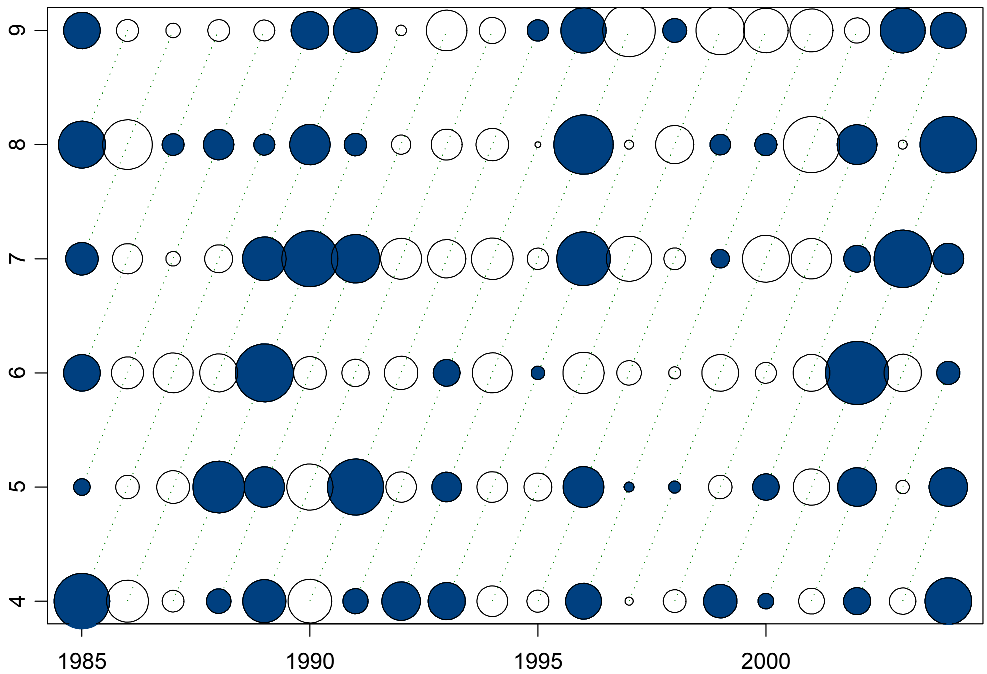


Figure 3.3.18. (Continued)

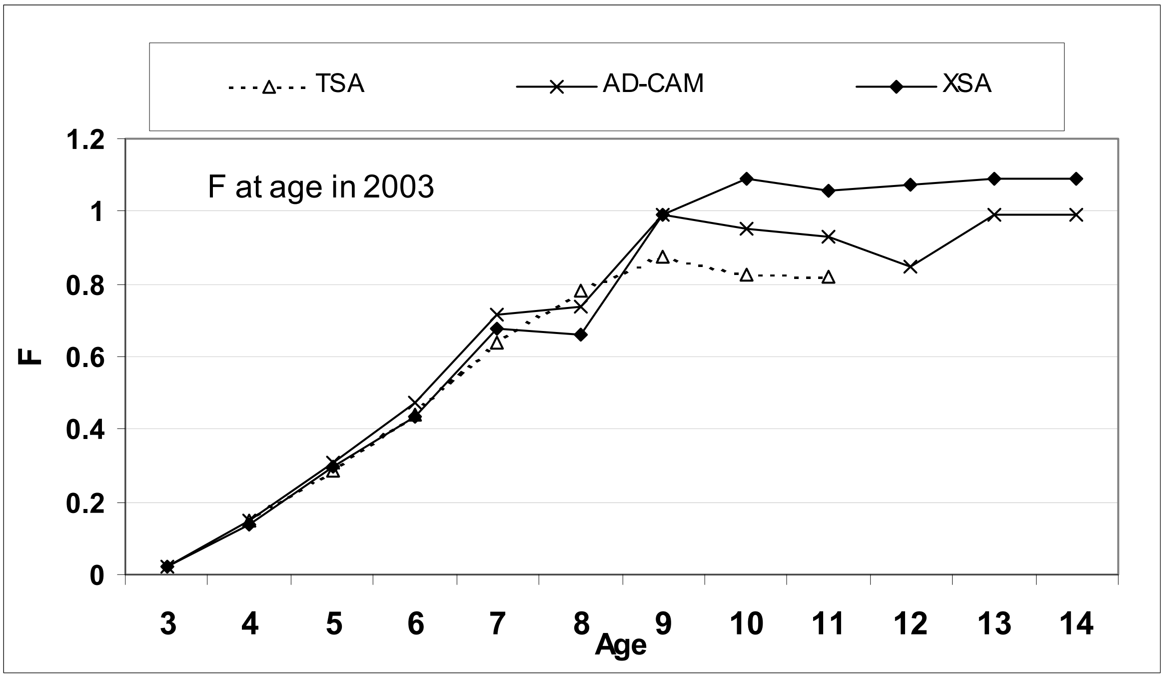


Figure 3.3.19. Comparison of estimated fishing mortalities in 2003 from different assessment runs.

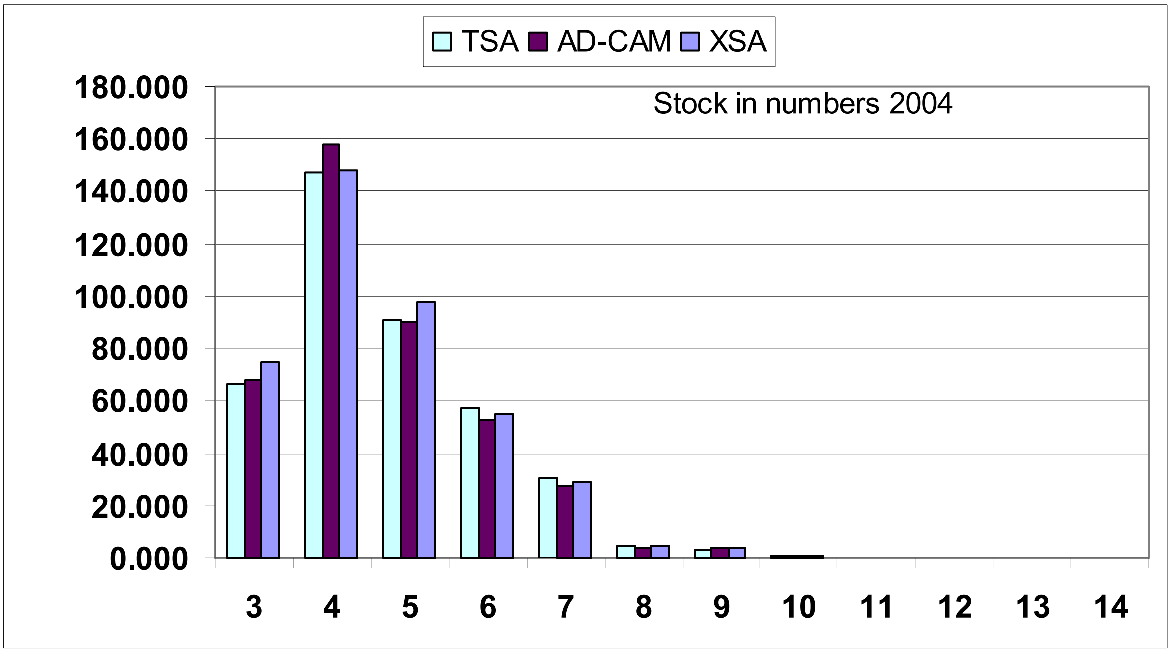


Figure 3.3.20. Comparison of estimated stock in numbers in 2004 from different assessment runs.

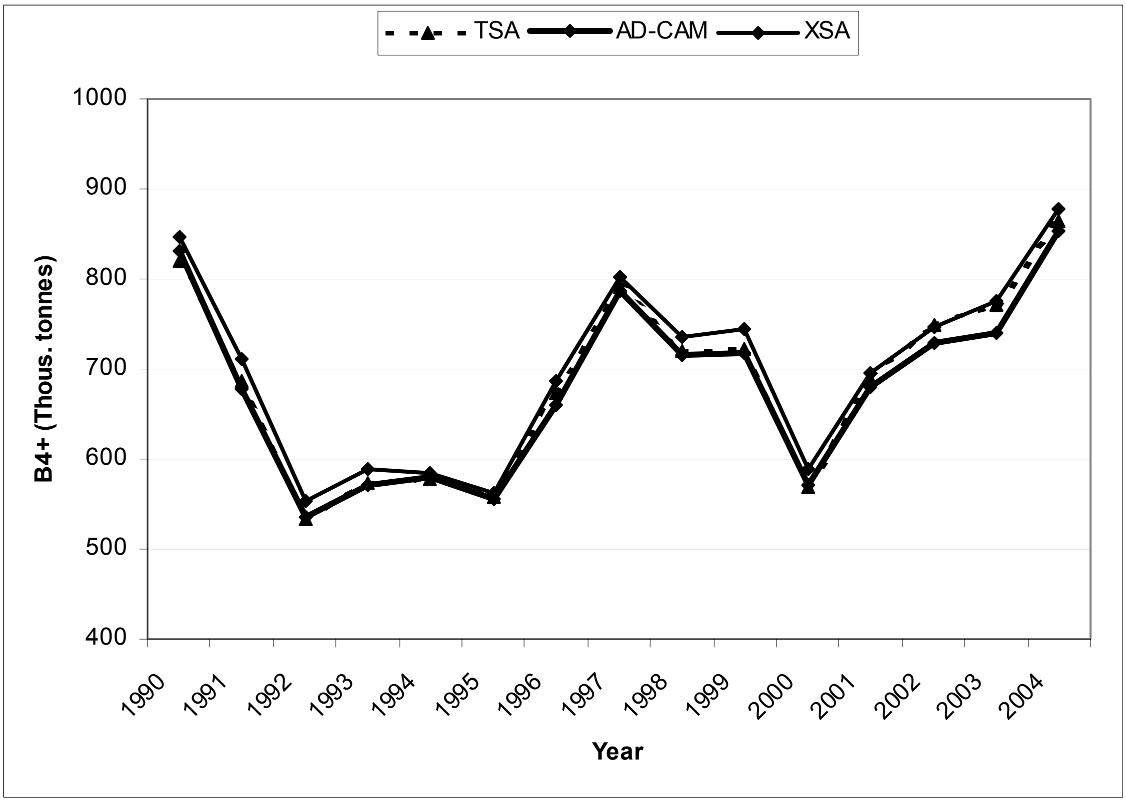


Figure 3.3.21. Estimated 4+ biomass from the various assessment models.

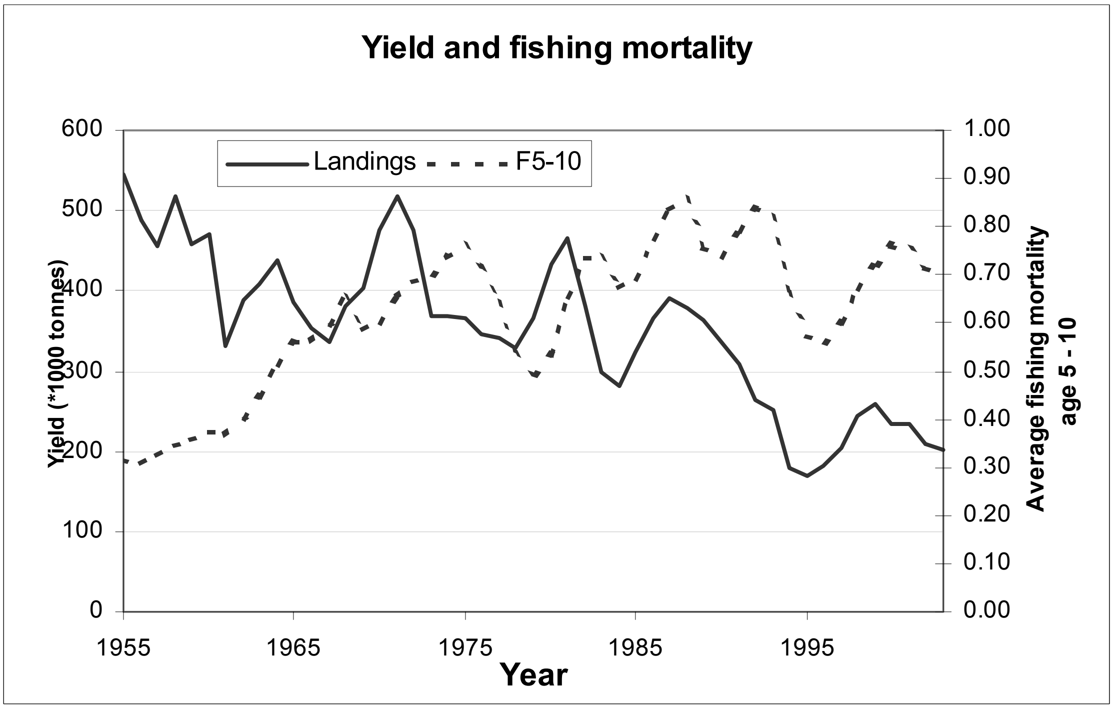


Figure 3.3.22A. Yield and fishing mortality

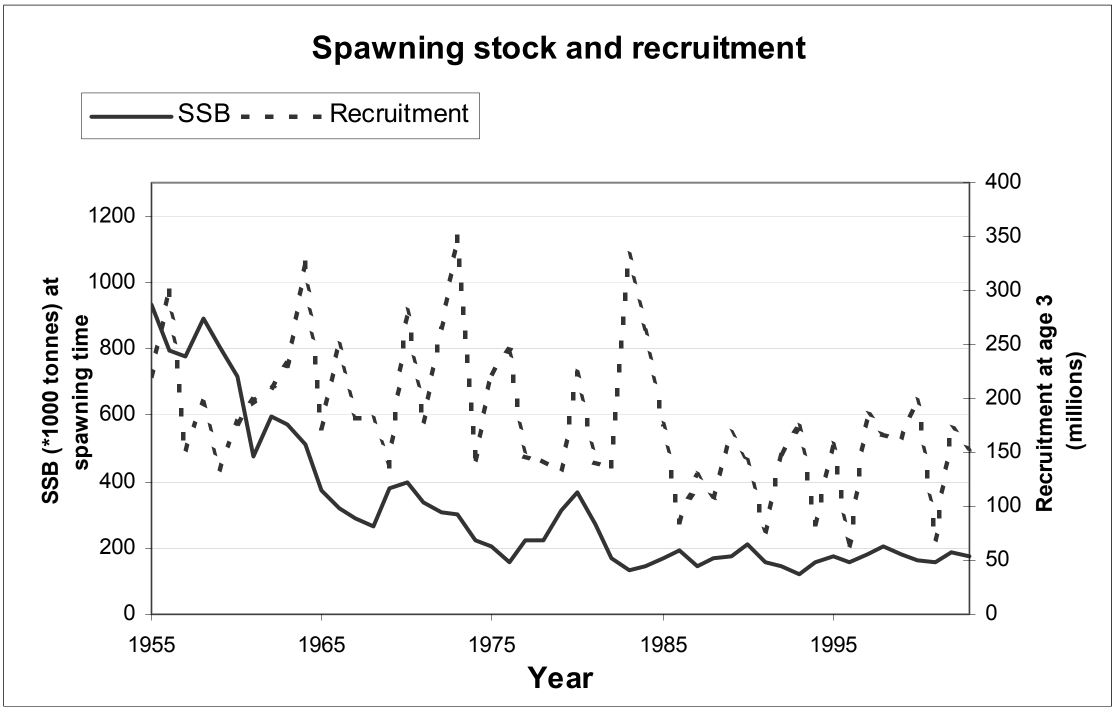


Figure 3.3.22B. Spawning stock and recruitment.

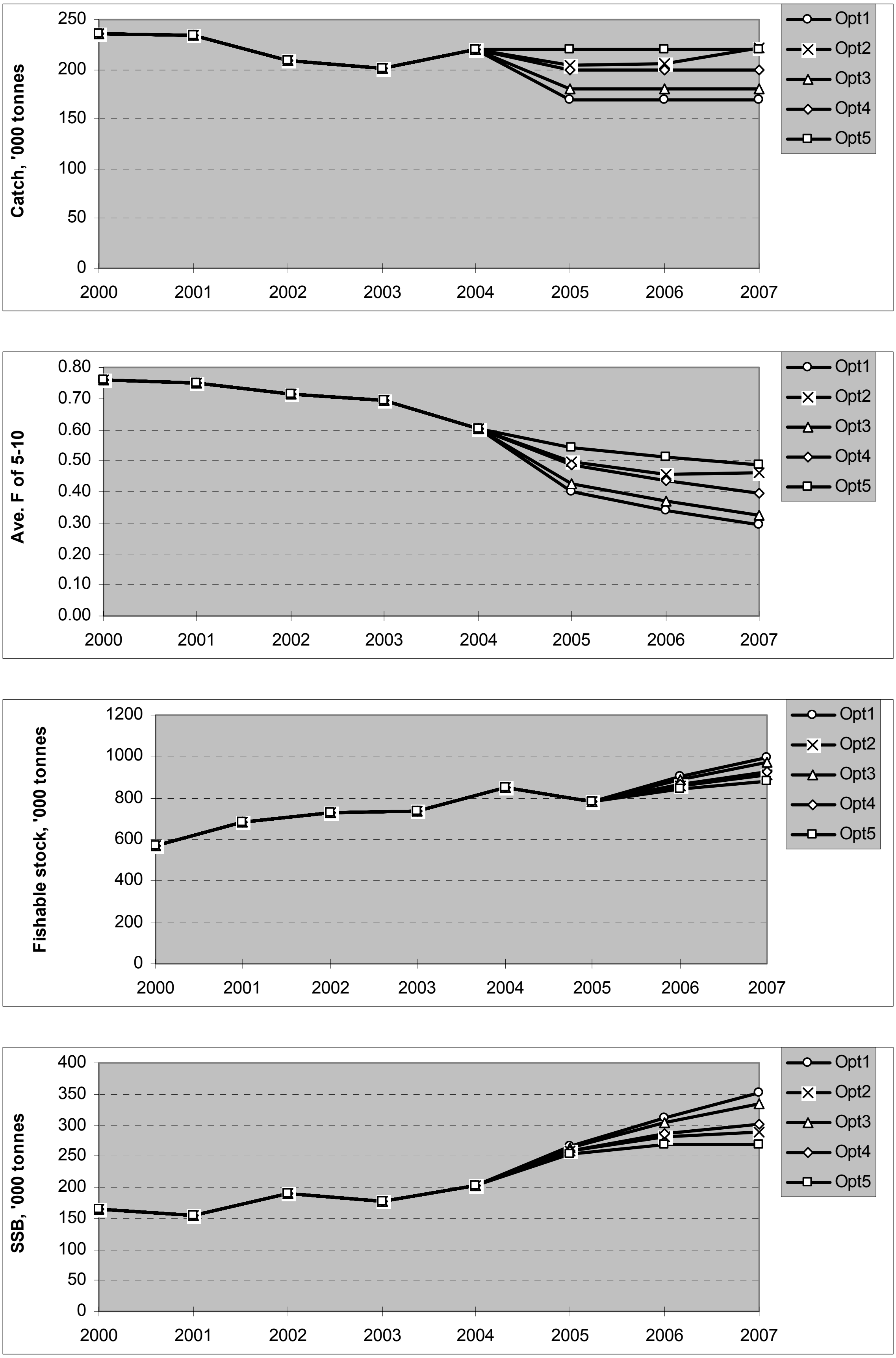
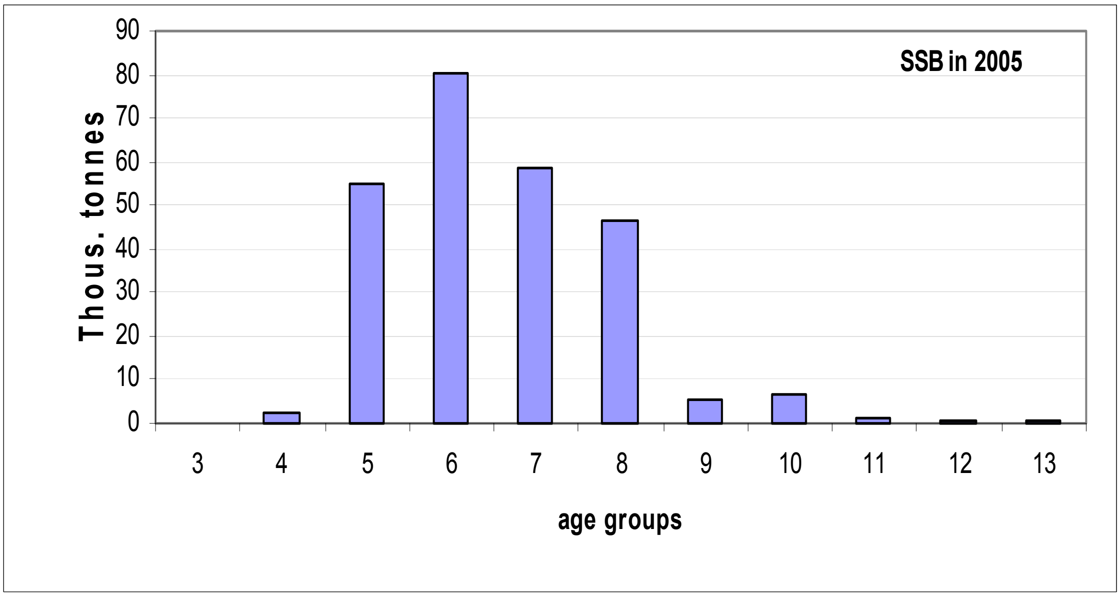


Figure 3.3.23A. Results of different management options.



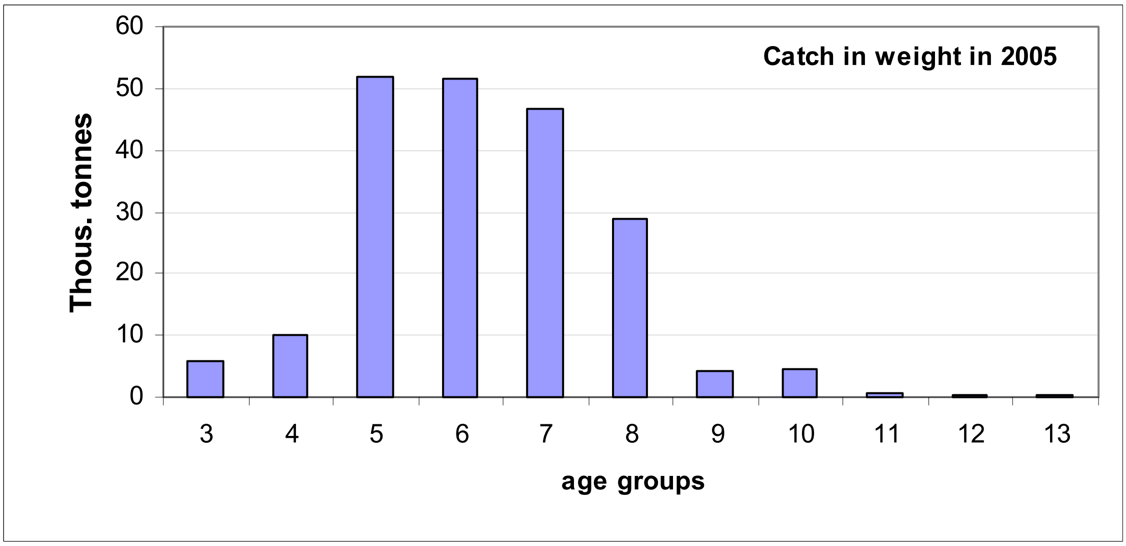


Figure 3.3.23B. Estimed age composition of the SSB and the catches in 2004.

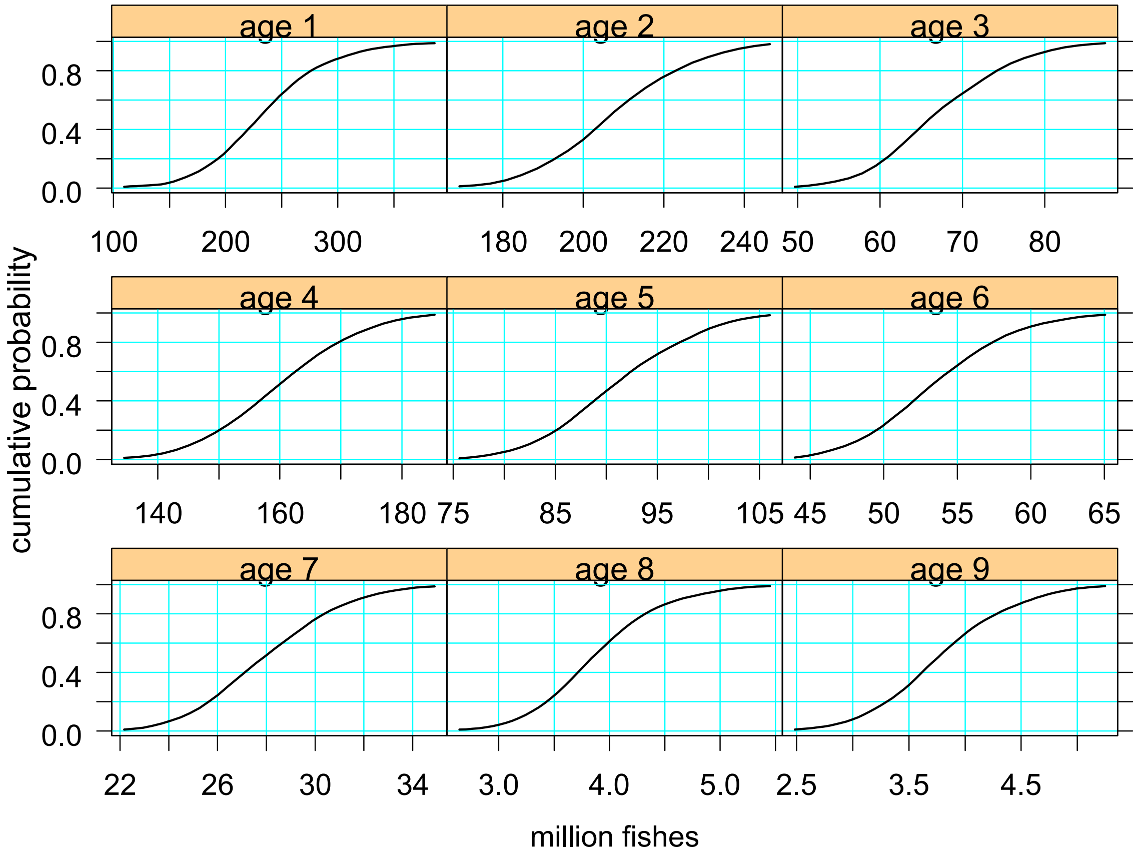


Figure 3.3.24.. Cod in division Va. Cumulative probability distribution of number in stock at the start of 2004.

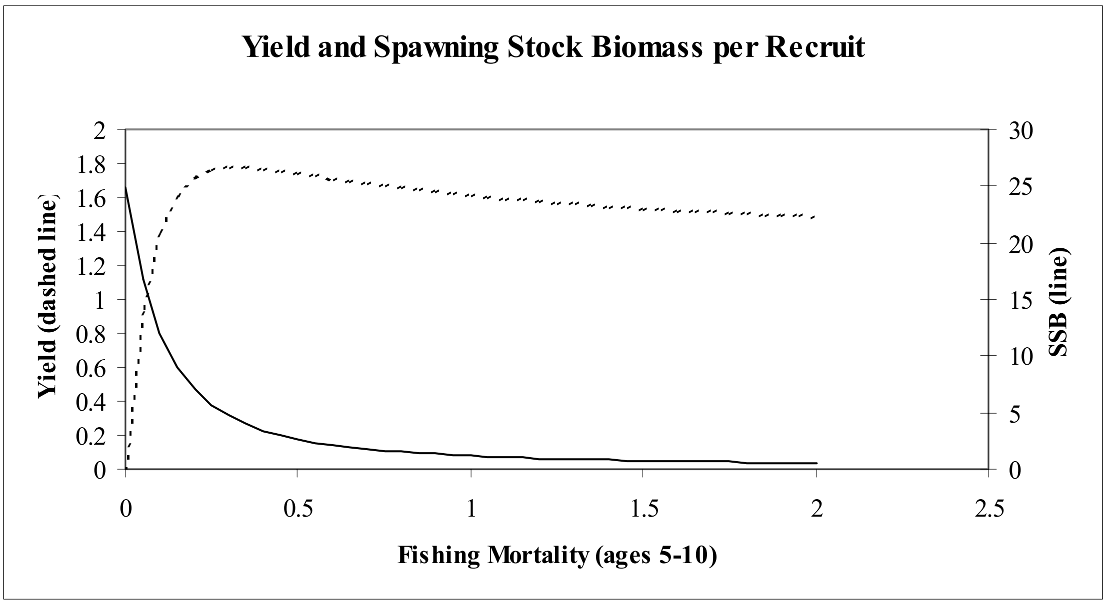


Figure 3.3.25 Yield per recruit

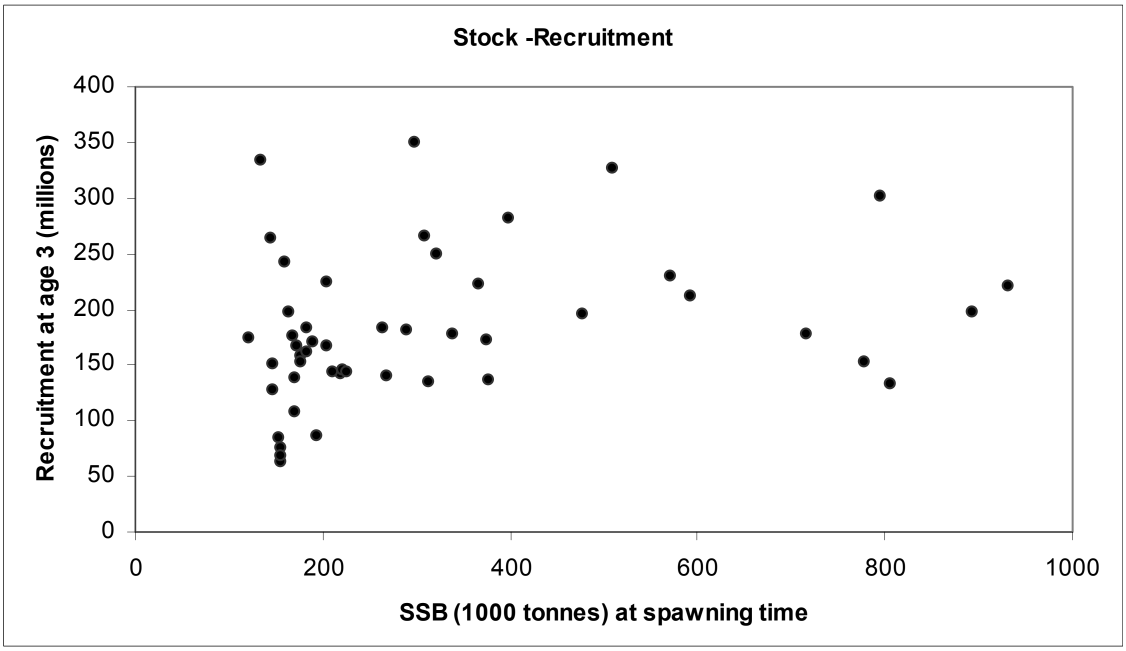


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

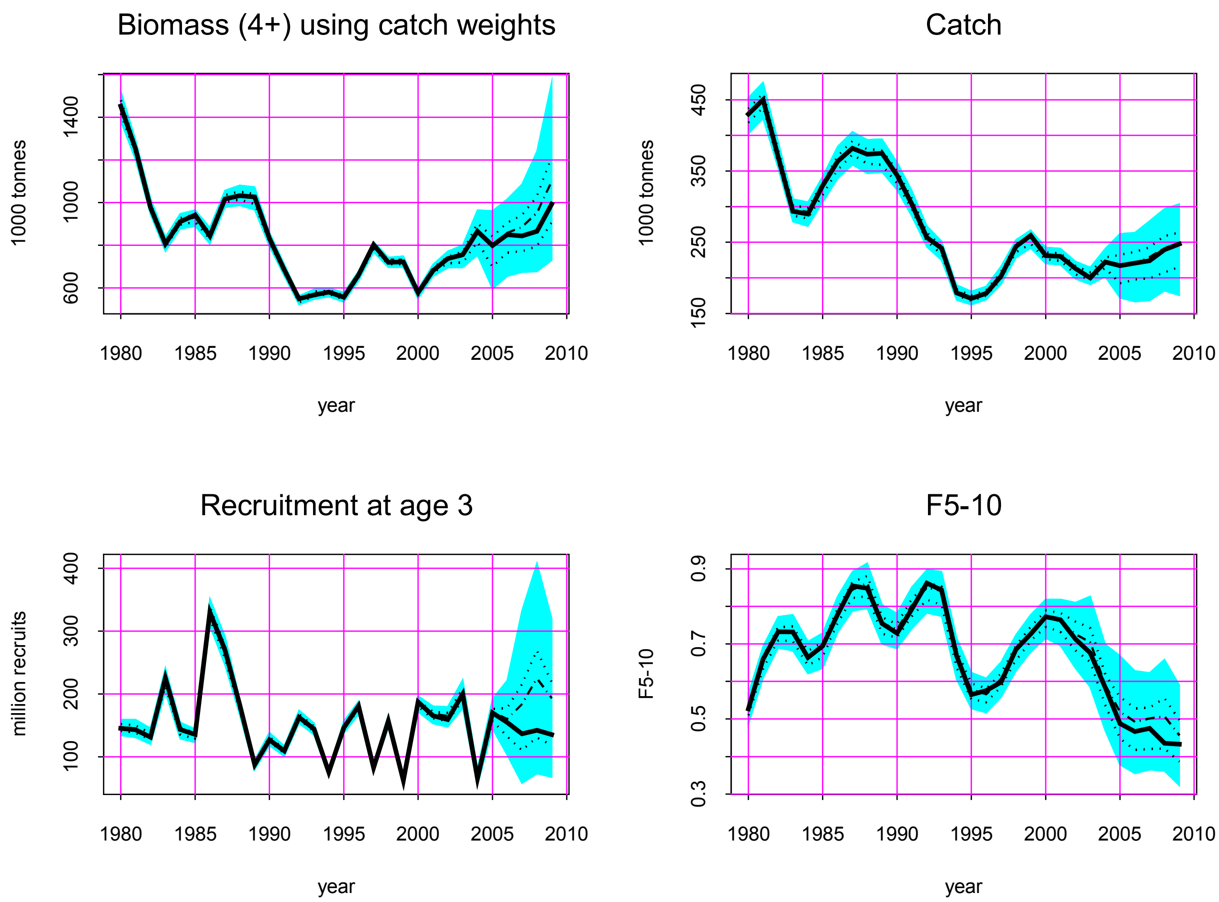


Figure 3.2.27. Cod in division Va. Stock estimate and medium term prognosis according to the ammended catchrule (errors inmw@age and assessment error included). Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

3.4 Icelandic haddock

3.4.1 Introductory comment

Haddock (*Melanogrammus aeglefinus*) in Icelandic waters is only connected with other haddock stocks due to 0-group and occasionally young fish found in E-Greenland waters originate from the Icelandic stock. The species is distributed all around the Icelandic coast, principally in the relatively warm waters off the west and south coast, in fairly shallow waters (50-200 m depth). Haddock is also found off the North coast and in warm periods a large part of the immature fish can be found in that area. In warm periods the area inhabited by the stock in considerably larger than in cold period. Recent years have been relatively warm and since 1998 recruitment has been exceptionally good with 4 of 5 most recent year classes being strong, something which has not been observed in 40 years. This is probably due to favourable environmental conditions for haddock north of Iceland.

Icelandic haddock was assessed at the North-Western Working Group in 1970 and 1976 but otherwise assessments were conducted by the Marine Research Institute in Iceland until in 1999 when it was again assessed by the North-Western Working Group.

3.4.2 Trends in landings and fisheries

During the early sixties haddock landings were around 100 000 tonnes for five years (Figure 3.4.2.1) After that, landings have been between 40 000 and 65 000 tonnes . Historically landings by foreign fleets accounted for up to half of the total landed catch. Since 1976 fisheries by foreign nations have been negligible except a small catch by the Faroese. Haddock landings are subject to fluctuations, reflecting variability in stock biomass and recruitment, which is very variable.

The landings in 2003 were 60 500 tonnes, increasing from 50 500 tonnes in 2002. In last year the forecasted landings for the year 2003 were 65 000 tonnes. The most likely explanation for less than expected landings in 2003 is low price of haddock.

In 2003, 60% of landings were by demersal trawl, 8% by Danish seine, 29% by long line and 3% by gillnets. The share of each gear is similar to what is was in 2002 (figure 3.4.2.2).

3.4.3 Catch at age

Catch at age for 2003 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 2003 are given in the table below.

Region	Season	Gear	Number length measured	Number. aged	No of length samples	Number of age samples	Number weighed
South	Jan-May	Long line	10999	1290	70	25	799
South	Jan-May	Gillnet	1151	146	10	3	150
South	Jan-May	Danish seine	2986	197	20	4	232
South	Jan-May	Bottom trawl	16377	1182	90	24	900
South	June-Dec	Long line	8579	943	61	19	998
South	June-Dec	Gillnet	790	197	9	4	199
South	June-Dec	Danish seine	1380	294	9	6	300
South	June-Dec	Bottom trawl	12765	1933	76	39	1749
North	Jan-May	Long line	2803	200	14	4	199
North	Jan-May	Gillnet	261	50	2	1	50
North	Jan-May	Danish seine	567	0	3	0	0
North	Jan-May	Bottom trawl	17300	1203	95	25	500
North	June-Dec	Long line	7878	992	58	20	950
North	June-Dec	Gillnet	763	47	5	1	0
North	June-Dec	Danish seine	1844	248	12	5	250
North	June-Dec	Bottom trawl	24300	2551	153	52	1199

For comparison, the calculations of catch in numbers by age were done by 3 gears, 2 regions (North and South) and 2 time intervals, giving identical results.

The table below shows catch at age in 2003 in percent of number compared to last years prediction. Some discrepancies may be seen, with less than predicted catch of age 3 but more of most other agegroups, especially ages 7 and 8.

Age	2	3	4	5	6	7	8	9
Forecast %	1	24.2	38.5	27.6	6.3	0.8	1.6	0.1
Catch %	0.7	15.7	40.1	31.1	7	1.9	3.2	0.2

Figure 3.4.3.1 shows the catch in number plotted on log scale. The curves indicate that total mortality was high or close to 1 for the oldest haddock but is decreasing in the most recent years. The big 1976 year class is shown for comparison but the fishing mortality was low around 1980. Figure 3.4.3.1 indicates that CV in these data is low. Shephard Nicholson model gives a CV of 23% for agegroups 3-8.

3.4.4 Weight and maturity at age

Mean weight at age in the catch is shown in table 3.4.4.1.

Mean weight at age in the stock for 1982–2004 is given in Table 3.4.4.2. Those data are calculated from the Icelandic groundfish survey. Weights for 1985–1992 were calculated using a length-weight relationship which is the mean from the years 1993–2003. Weights from 1993 onwards are based on weighting of fish in the groundfish survey each year. Stock weights prior to 1985 have been taken to be the mean of 1985-2002 weights.

Both stock and catch weights have been relatively low since 1990 compared to the eighties. Since 1990 the weights have not shown any apparent trend but it seems like the large year classes (1990 and 1995) grow slower. Four of the most recent year classes are large so drop in mean weights would not be unexpected in coming years. The weight at age of those age groups is though still well above what is was for the 1990 and 1995 year classes. Lower fishing mortality could also compensate for density dependent growth as the fishery tends to remove the largest individuals of each agegroup affecting mean weight at age of those left.

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 but maturity at age decreased from 2003 to 2004. Maturity at age data from 1985 onwards are taken from the groundfish survey but maturity at age in catches January - May is used 1980 to 1984.

3.4.5 Survey and cpue data.

Haddock is one of the most abundant fishes in the Icelandic groundfish survey in March, being caught in large number at age 1 and becoming fully recruited at age 2 or 3. Age disaggregated indices from the March survey are given in table 3.4.5.1 and indices from the autumn survey in table 3.4.5.2.

The index of total biomass from the Icelandic groundfish survey in March is shown in figure 3.4.5.1. It was at record low in 2000 but has increased since then due to good recruitment and was in the year 2003 the highest since the series started. The increase between 2002 and 2003 was much larger than predicted and the catch curves and Hjörleifsson Pálsson plot (figures 3.4.5.4 and 3.4.5.3) suggested the 2003 survey to be an outlier for year classes 1998 and 1999. The 2004 survey indicates a little lower biomass than the 2003 survey but the measurement error is much smaller (CV = 0.075 2004 but 0.16 in 2003) and the 2004 results confirm that the 1998 and 1999 year classes are outliers in the 2003 survey. The 2004 survey indicates that year classes 2002 and 2003 are large, especially the 2003 year class which is much larger than any year class in recent decades.

The median index shown in figure 3.4.5.1, calculated as the proportion of stations where haddock is found, times the median of the haddock catch at those stations shows even more increase than the traditional Cochran index and increases by 25% between 2003 and 2004.

Figure 3.4.5.2 shows the total index from the autumn survey. The autumn survey does not decrease as much in 2000 but shows a large increase in biomass between 2002 and 2003.

In figure 3.4.5.5 survey indices from the March survey are plotted against VPA estimates with regression lines based on all data until 2001 and r^2 in the fit of these lines included. The figure shows that the survey indices have been good measure of stock size and the relationship between survey index and number in stock is close to linear for all agegroups.

The figure do though indicate that ages 4 and 5 in 2003 are outliers although the final number in stock is not known yet. The most recent estimates are shown as intersection of dashed lines.

The survey indicates that in some of recent years unusually high proportion of the incoming year classes have been in the northern part of the survey area (figure 3.4.5.6) in areas where fishing effort has been relatively light. As described in WD#34 in 2003 the relatively little overlap of the recruiting year classes and the fishery in recent years can explain why discards have reduced in recent years and recent year classes have progressively become stronger in every new survey.

CPUE from the commercial fleet is shown in figure 3.4.5.7. The figure is calculated from records where more than 50% of the catch is haddock and shows increase from 2001 to 2002, specially for Danish seine and bottom trawl but remains stable or decreased between 2002 and 2003. As shown in figure 3.4.5.8 effort by the most important fleets increased or remained stable between 2002 and 2003. The effort shown is calculated by dividing the total catch in the gear by the CPUE based on the 50% criterion.

The discrepancy between CPUE from commercial fleets and survey indices from 2002 to 2003 is of interest and needs some clarification.

- Large part of the increase in the haddock indices in recent years is in the area north of Iceland where fishing effort is small

- Price of haddock was relatively low last year, leading to fishermen trying to avoid haddock . The surveys do though indicate that avoiding haddock might have been difficult except going to deep waters. The effects of the criterion of selecting tows where more than 50% of the catch is haddock is unclear in this case.

- The Danish seine fishery shows the most dramatic reduction in CPUE of haddock. This trend is most likely driven by difficulty of the fleet in catching cod which is the main targets species for this fleet.

The dynamics of the fleets fishing haddock are complicated and it seems like CPUE is as much a measure of price as of stock size.

3.4.6 Stock Assessment

Last years assessment was based on a number of different models and settings. This year the same procedure was used but the final result was based on slightly different premises. Most of the models were run on age disaggregated indices from the groundfish survey in March but few runs were made using indices from the autumn survey. As before an emphasis was put on letting more than one person do an assessment.

Many of the models explored have some kind of inertia terms both when estimating fishing mortality and recruitment. The inertia terms on fishing mortality are either some kind of random walk (TSA, ADCAM) or shrinkage to the mean of last years (XSA). Some of the models as EXCAM or Adapt do not have this inertia term and it can be relaxed in the other models if the person doing the assessment finds it appropriate.

Most recruitment models do have some kind of first guess, either long term mean or from a SSB-recruitment relationship and the weight of this term is often estimated. In XSA and RCT3 this term is referred to as P-shrinkage and similar term is included in many of the other models and its effect can be reduced in some of them.

In this year's assessment results from 3 different models TSA, XSA and ADCAM will be presented. In addition to the standard model settings different alternative configuration are tested, checking the effect of different inertia terms, weighting of survey age groups and correlation of residuals. Summary of the results is given in the tables below, the former table showing biomass and fishing mortality and the latter table recruitment

Summary of results from different assessment models.

	F4-7 2003	Biomass 3+ 200	Std. Err in 3+ bio	N9-2004	N6-2004	N5-2004
XSA survey 2-9	0.482	267		0.84	23.5	66.7
XSA survey 1-9	0.494	236		0.84	22.5	56.9
TSA	0.443	241	20.6	0.9	25.7	55.9
Adapt	0.496	242	34			
Last years spaly	0.55	211	22			
ADCAM	0.52	229	25	0.5	22.4	58.6
ADCAM Reduced Inertia	0.467	261	30			
ADCAM Skip survey correlation	0.502	255	20			
Adapt autum survey	0.51	228	32	0.86	27.2	57.2

Most signs indicate that recruitment of haddock has been far above average since 1998 and that fishing mortality is being reduced in last two years. In those cases the use of the inertia terms can be questioned but it can also be argued that including the inertia terms might be suitable for management purposes even though it will most likely lead to underestimation of the stock. One argument for including inertia terms is that the assessment is based on data which are outside historical range and the assessment as such could be considered as an extrapolation. Features like stock size dependent catchability could be affecting the results even though it has not been noticed so far.

Last year the different models and settings gave widely different results with models using the March survey for tuning giving biomass (3+) in 2003 ranging from 190 to 260 thousand tonnes and 140 to 180 thousand tonnes if the autumn data was used for tuning. As seen in the table above the difference between different models is a little less than last year with models using data from the groundfish survey in March giving biomass (3+) in 2004 ranging from 211 to 261 tonnes. Much discrepancy between different model last year was partly caused by outliers in the survey 2003.

The highest value in the table is 261 tonnes but taking results from the survey in 2004 directly gives a biomass (3+) exceeding 300 tonnes and that could well the correct estimate. All the models shown here have some kind of inertia terms and even when the ADCAM model (script) is run with much reduced effect of inertia terms the models freedom to follow the most recent survey is limited by data from older surveys.

In the model using the autumn survey no inertia terms were included as the goal was to look at what the data from the autumn survey told directly about the state of the stock.

Last year ADCAM (WD 38 from 2002) run was used as the basis for advice, but XSA run using the same agegroups for tuning gave similar results This year the SPALY from last year gives the lowest results of all the methods. The settings from last year were selected in a situation where the most recent survey showed much higher stock abundance than earlier surveys and the age distribution from the survey showed apparent outliers. This years survey confirms the high abundance seen in the survey in March 2003 as does the autumn survey 2003. The age distribution in the 2004 survey is also more in line with what is to be expected and the measurement error in the survey is low.(Figure 3.5.4.1) These facts combined with signs of reduced fishing mortality indicate that the inertia terms should be relaxed, the question is how much. In the current setting weight of the random walk term in the fishing mortlity was reduced to 25% of what it was last year and in addition correlation of survey residuals between ages 1 and 2 and older age groups was set to 0. (see later chapter on recruitment). With these changes the results from ADCAM were more in line with some of the other models (TSA,XSA) so even though the ADCAM model was used for prognosis the other models were used as much for selection of final run. It must also be born in mind that both XSA and TSA have parameters that can be adjusted to it is probably not correct to talk about the outcome from XSA.

The ADCAM is a statistical catch at age model written in AD-model builder (described in working paper 33 in 2002 and also in last years report. was used. The settings used in the final run are described in last years report but repeated here below:

- Fishing mortality was estimated for every year and age.

- Recruitment was assumed to be lognormally distributed around a fixed mean with the CV of the lognormal distribution estimated. This term can be looked at as the P-shrinkage in the model. The estimate was of the CV was 0.8 to be compared with estimated CV of the survey shown in figure 3.4.6.2.

- CV of commercial catch data and of survey indices as function of age are estimated. The CV of the commercial catch is a parabola but estimated separately for each age in the survey (change from last year when it was also a 2nd

order polynomial (figure 3.4.6.2). Correlation of residuals of different agegroups in the survey was estimated as a 1^{st} order AR model.

- Catchability in survey was independent of stock size for all ages.

- Fishing mortality of each age group was random walk with standard deviation specified as proportion of the estimated CV in the catch at age data. In the input file the process error (variability in F) is specified to be larger than the measurement error for the younger ages but the measurement error is specified to be larger for the older age groups

- The model estimates standard deviation on survey and age disaggregated catches. The division of the standard deviation in catches between process (random walk of F) and measurement error can not be estimated.

- Correlation of the residuals of different age groups in the survey is estimated and the residuals assumed to follow a multivariate normal distribution. The correlation between different ages **i** and **j** is $\rho^{|i-j|}$. where ρ is the estimated correlation coefficient.

It is repeated that the changes from last years assessment is reduced effect of random walk term in fishing mortality and no correlation of the residuals of the youngest 2 age groups and older haddock in the survey.

The results from the selected ADCAM runs are shown in figures 3.4.6.1 to 3.4.6.6 Figure 3.4.6.4 showing the survey residuals show large year blocks in the survey. These blocks can also be seen in the XSA output in table 3.4.6.2. There are 2 possible explanations for this year factor

- Large abundance of haddock in a survey leads to sub-sampling for the length measurement in number of stations. Getting representative length sample is difficult and a common belief is that larger haddock tend rather to be selected for length sample.

- Abundance dependent catchability at each station.

In TSA a common year factor is estimated for all age groups but in ADCAM the correlation between residuals of different agegroups is estimated to be high or 0.6 between adjacent age groups. This high correlation works in a way like a year factor and the model does not follow the most recent surveys as well. In the table above results from a run identical to the selected base run but not including the correlation of residuals in the survey is shown.

Figure 3.4.6.6 shows the residuals in catch at age from the model. The residuals are small as the selection pattern of the model is quite flexible and the catch at age for this stock does usually not contain major surprises.

The standard error of the Biomass (3+) by some of the models is given in the table above. It is smaller than the largest difference between different models and it is probably an underestimate of the real uncertainty in the assessment.

3.4.7 Recruitment estimates

The discussion about recruitment estimates has been treated in last section under stock assessment. Many of the models used for stock assessment also give recruitment estimates but in addition to those model 2 recruitment models, RTC3 and a time series model from Guðmundur Guðmundsson (Gudmundsson 2004) were used. The table below shows results of the various models. The agreement between different models is quite good and considerably better than last year. The most notable exception to this is with the 2002 year class where the models ADCAM and ADAPT estimate the year class smaller than the other models. This has to do with the correlation between residuals of different age groups in the survey which is estimated to be quite high so positive residuals of older age groups is smeared on younger age groups. If sub-sampling for length distribution is causing the correlation it should not be smeared on the youngest agegroups. Therefore the residuals for age groups 1 and 2 were excluded from the correlation of survey residuals in this years base run.

years base run.

Recruitment (million 2 year old.)									
Yearclass	RTC3	Adapt autumn survey	XSA Age 1-9	TSA REC	ADCAM Last years settings	ADAPT	ADCAM much reduced inertia	ADCAM settings used this year	Last years estimate
2000	180	138	174		166	173	187	165	156
2001	53	57	50	40	43	44	48	49	40
2002	180	142	174	165	143	144	172	185	113
2003	301		333	357	345	335	457	388	52*

* Geometric mean

Input to the RTC3 model is shown in table 3.4.7.1 and output from the model in table 3.4.7.2

3.4.8 Prediction of catch and biomass

3.4.8.1 Input data

The input data for the prediction are shown in Table 3.4.8.1

For the short-term catch prediction and stock biomass calculations, the mean weight at age 3–8 in the catches in 2004 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 2004 the mean of 2001-2003 was then used.

For the stock weights, survey weights for the year 2004 were used for that year but for the year 2005 mean weight at age was predicted from the mean weight of the same year class in the survey in 2004

The exploitation pattern was taken as the mean exploitation pattern from 1999–2003.

Maturity was taken to be the mean of the 2002-2004 values.

Stock in number in the year 2005 and recruitment in 2005 – 2006 was obtained from the ADCAM model and the prognosis were done by the ADCAM model and the MFDP program at ICES.

A TAC constraint of 80 000 tonnes was applied to the prediction for the year 2000. The estimate was the sum of the TAC for the fishing year starting September 1st 2002 that was remaining in the beginning of 2003 and 41% of the estimated TAC for the fishing year 2003-2004 but 41% of the TAC for the fishing year 2003-2004 was taken in the year 2003. In the prognosis last year a TAC constraint of 65 000 was used for the year 2003 while the landings are now estimated to be 61 000 tonnes

The short term prognosis were done using the ADCAM model and also the MFDP program at Ices. In the ADCAM prognosis the proposed $\mathbf{F}_{pa}$ of 0.47 was used for the years 2005 and 2006. Assessment error was assumed to be lognormal with 15% CV and no autocorrelation. Variations in stock and catch weights were assumed to be lognormal with 13% CV and an autocorrelation of 0.35 between years The same deviations in weights were applied to all age groups the same year. Errors in weight at age and assessment errors were not correlated which they probably should be. The ADCAM model was also used for deterministic prognosis to see if if the results were identical to MFDP.

For the long-term yield and spawning stock biomass per recruit, the exploitation pattern was taken as the mean relative fishing mortality from 1980-2003. Mean weight at age in the stock and the maturity ogive are means from 1980-2003. Mean weight at age in the catch is the mean from 1980-2003. Input data for long term yield per recruit are given in Table 3.4.8.2 .

3.4.8.2 Biological reference points

The yield per recruit is shown in table 3.4.8.3. and figure 3.4.8.1

Compared to the estimated fishing mortality of $F_{4\text{–}7}$=0.52 for 2003, $\mathbf{F}_{max}$=0.44 and $\mathbf{F}_{0.1}$=0.16.

Yield per recruit at $\mathbf{F}_{max}$ corresponds to 0.88kg. (Table 3.4.8.3). Mean weights as in the most recent years would give lower yield per recruit.

A plot of spawning stock biomass and recruitment from 1981-2003 is shown in Figure 3.4.6.1 and a plot of recruitment vs. spawning stock in figure 3.4.8.3.

In the year 2000 the working group proposed provisional $\mathbf{F}_{pa}$ set to the $\mathbf{F}_{med}$ value of 0.47 and this value has been used nearly as F_{target} since then. Since 1986 $F_{4\text{–}7}$ has exceeded $\mathbf{F}_{max}$ and for only 4 years since 1960 has $F_{4\text{–}7}$ been lower than $\mathbf{F}_{pa}$.

The SGPRP proposed $\mathbf{B}_{loss}$ as candidate for $\mathbf{B}_{pa}$ at its meeting in February 2003. The working group did not discuss this matter further.

TAC for Icelandic fish stock is given for fishery years which are from September 1st. each year to August 3rd the following year. 1/3rd of the fishing year 2004/2005 falls withing the calendar year 2004 and 2/3rd within the calendar year 2005. The TAC for the next fishing year will therefore be 1/3rd of the landings in 2004 plus 2/3rd of the advice for 2005.

3.4.8.3 Projection of catch and biomass

At the beginning of 2004, the biomass of age 3+ is predicted to be 228 000 t with a spawning stock of 163 000 t. (Tables 3.4.8.4)

With a catch of 80 000 t in 2004, fishing mortality is estimated to be 0.44, the biomass of age 3+ is predicted to be 267 000 t in the beginning of the year 2003 and the spawning stock biomass 195 000 t

The predictions indicate that the annual catches could be around or above 100 000 tonnes for at least the next 2-4 years if the F=0.47 will be used as HCR. F=0.47 leads to 97 000 for the calendar year 2005 increasing to 115 000 tonnes in 2006.

Figures 3.4.8.4 and 3.4.8.5 show the output of the short term prognosis including errors in mean weight at age and assessment errors. The figures indicate that catches will probably increase considerable when the 2003 year class will recruit to the fishery.

3.4.9 Management considerations

For more than a decade fishing mortality on haddock was high with $F_{4\text{–}7}$ between 0.6 and 0.8 since 1986. The advice for 2003 was based on provisional F_{med}.

The short term predictions do not show much advantage in reducing fishing mortality. It must though be born in mind that a number of factors, like discard, hidden mortality due to mesh penetration and reduction of mean weight at age by removal of the largest individuals of each age group are not included in these predictions.

As described in working paper 34 in 2003 discard and other hidden mortality, most likely caused by the fisheries might be a potential problem for this stock. A model described in that paper indicated that reduction in hidden mortality might explain how incoming year classes became progressively larger in each assessment. .The finding in the paper were that commercial fishing fleets, both those targeting haddock and the *nephrops* fishery might account for a large part of the hidden mortality of age 1 and age 2 haddock. Reducing hidden mortality by the fisheries is an important point for getting optimal yield from the stock.

3.4.10 Comments on the assessment

The current assessment was done using only groundfish survey indices for tuning. .

Fishing mortality on haddock increased after 1985 (Figure 3.4.6.2.) The high fishing mortality was at least partly due to an overestimation of the stock biomass through the use of catch weights that are 20–25% higher than survey weights which have been used in the assessment since 1999.

The assessment presented here gives $F_{4\text{–}7}$=0.52 in 2003 which is an reduction from 2002 when $F_{4\text{–}7}$ is now estimated to have been 0.56 (last years estimate for 2002 was 0.63)

This years assessment gives a more optimistic view of the stock than last years assessment with the changes driven by the results of the 2003 and 2004 March survey. The biomass of age 3+ at the start of 2004 is now predicted to be 228 000 t (SSB 163 000 t) but was predicted to be 204 000 t (SSB 148 000 t) in last years assessment

In this years assessment a number of different models were used and the range of results investigated. The point estimates selected for prognosis come from a model called ADCAM . Those estimates are close to estimates done by many other models (XSA, TSA) but the results from the most recent surveys indicate that the stock could be considerably larger.

The assessment this year and last year is based on survey data well outside previously known range and the tuning can therefore be considered as an extrapolation. Similar considerations apply to predictions of year class 2003 which seems to be much larger than any year class seem in recent decades.

Table 3.4.2.1 Haddock in Division Va Landings by nation.

Table 1.1. Icelandic haddock. Landings by nation.

Country	1979	1980	1981	1982	1983	1984	1985	1986
Belgium	1010	1144	673	377	268	359	391	257
Faroe Islands	2161	2029	1839	1982	1783	707	987	1289
Iceland	52152	47916	61033	67038	63889	47216	49553	47317
Norway	11	23	15	28	3	3	+	
€UK								
Total	55334	51112	63560	69425	65943	48285	50933	48863

HADDOCK Va

Country	1987	1988	1989	1990	1991	1992	1993	1994
Belgium	238	352	483	595	485	361	458	248
Faroe Islands	1043	797	606	603	773	757	754	911
Iceland	39479	53085	61792	66004	53516	46098	46932	58408
Norway	1	+						1
UK								
Total	40761	54234	62881	67202	53774	47216	48144	59567

HADDOCK Va

Country	1995	1996	1997	1998	1999	2000	2001	2002
Belgium								
Faroe Islands	758	664	340	639	624	968	609	878
Iceland	60061	56223	43245	40795	44557	41199	39038	49591
Norway	+	4						
UK								
Total	60819	56891	43585	41434	45481	42167	39647	50469

Country	2003
Belgium	833
Faroe Islands	
Iceland	59970
Norway	30
UK	51
Total	60884

Table 3.4.3.1 Haddock in division Va. Catch in number by year and age.

Year/age	2	3	4	5	6	7	8	9
1979	161	2066	4074	6559	9769	1887	474	61
1980	595	1384	11476	4296	3796	3730	544	91
1981	10	516	4929	16961	6021	2835	1810	169
1982	50	286	2698	10703	14115	2288	1167	816
1983	10	705	1498	4645	10301	8808	874	241
1984	60	755	4970	1176	4875	3772	4446	171
1985	427	1773	4981	6058	837	1564	2475	2212
1986	196	3681	3822	4933	5761	493	852	898
1987	2237	7559	7500	2696	2249	1194	151	208
1988	133	10068	15927	5598	1260	1009	577	58
1989	78	2603	23077	9703	3118	541	507	144
1990	446	2603	7994	23803	6654	857	167	71
1991	2461	1282	3942	6711	13650	2956	398	52
1992	2726	7343	4181	4158	3989	5936	1314	132
1993	218	11617	12642	3167	1786	1504	2263	379
1994	280	3030	27025	10722	1550	756	404	700
1995	2357	6327	5667	23357	5605	610	263	210
1996	1467	8982	7076	4751	13963	2446	228	87
1997	1375	3690	11127	4885	2540	4981	692	52
1998	207	8109	5984	8390	2420	1502	1884	207
1999	1077	1455	16897	4844	4982	942	588	514
2000	2351	6496	2335	13817	2052	1789	364	197
2001	2212	11298	7124	1497	6212	698	484	104
2002	1020	10603	16192	5128	1126	3126	245	175
2003	279	6396	16355	12695	2866	766	1314	85

year/age	2	3	4	5	6	7	8	9
1981	0	0.5	4.9	17	6	2.8	1.81	0.17
1982	0	0.3	2.7	10.7	14.1	2.3	1.17	0.82
1983	0	0.7	1.5	4.6	10.3	8.8	0.87	0.24
1984	0.1	0.8	5	1.2	4.9	3.8	4.45	0.17
1985	0.4	1.8	5	6.1	0.8	1.6	2.48	2.21
1986	0.2	3.7	3.8	4.9	5.8	0.5	0.85	0.9
1987	2.2	7.6	7.5	2.7	2.2	1.2	0.15	0.21
1988	0.1	10.1	15.9	5.6	1.3	1	0.58	0.06
1989	0.1	2.6	23.1	9.7	3.1	0.5	0.51	0.14
1990	0.4	2.6	8	23.8	6.7	0.9	0.17	0.07
1991	2.5	1.3	3.9	6.7	13.6	3	0.4	0.05
1992	2.7	7.3	4.2	4.2	4	5.9	1.31	0.13
1993	0.2	11.6	12.6	3.2	1.8	1.5	2.26	0.38
1994	0.3	3	27	10.7	1.6	0.8	0.4	0.7
1995	2.4	6.3	5.7	23.4	5.6	0.6	0.26	0.21
1996	1.5	9	7.1	4.8	14	2.4	0.23	0.09
1997	1.4	3.7	11.1	4.9	2.5	5	0.69	0.05
1998	0.2	8.1	6	8.4	2.4	1.5	1.88	0.21
1999	1.1	1.5	16.9	4.8	5	0.9	0.59	0.51
2000	2.4	6.5	2.3	13.8	2.1	1.8	0.36	0.2
2001	2.2	11.3	7.1	1.5	6.2	0.7	0.48	0.1
2002	1	10.6	16.2	5.1	1.1	3.1	0.24	0.18
2003	0.3	6.4	16.4	12.7	2.9	0.8	1.3	0.1

Table 3.4.4.1 Haddock in division Va Weight at age in the catches.

Year/ age	2	3	4	5	6	7	8	9
1982	330	819	1365	1649	2329	3012	3384	3965
1983	655	958	1436	1827	2355	2834	3569	4308
1984	980	1041	1476	2105	2460	3028	3014	3807
1985	599	1002	1783	2201	2727	3431	3783	4070
1986	867	1187	1755	2377	2710	3591	3760	4135
1987	446	1048	1629	2373	2984	3550	4483	4667
1988	468	808	1474	2230	2934	3545	3769	4574
1989	745	856	1170	2010	2879	4109	4035	4706
1990	357	716	1039	1542	2403	3458	4186	4969
1991	409	868	1111	1546	2035	2849	3464	4642
1992	320	856	1253	1597	2088	2529	3133	4022
1993	420	756	1372	1870	2360	2888	2975	3442
1994	568	720	1058	1742	2380	2785	3447	3156
1995	457	874	1145	1366	2079	2853	3251	3899
1996	387	841	1189	1528	1816	2641	3499	3526
1997	450	829	1192	1663	1934	2360	3059	3010
1998	689	777	1166	1692	2312	2379	2882	3417
1999	616	866	1096	1638	2205	2681	2863	3229
2000	518	951	1314	1461	2096	2679	3181	3438
2001	542	933	1451	1759	1836	2309	2966	3123
2002	573	918	1256	1741	2192	2224	2844	3392
2003	559	908	1266	1700	2297	2699	2626	2897

Table 3.4.4.2 Haddock in division Va Weight at age in the stock

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	35	244	567	1187	1673	2372	2768	3199	3334	3718
1986	35	239	671	1134	1944	2400	3192	3295	3731	3675
1987	31	162	550	1216	1825	2605	3031	3644	3838	4099
1988	37	176	456	974	1831	2697	3104	3483	3321	4357
1989	26	182	440	886	1510	2382	3011	3502	3198	3681
1990	29	184	456	839	1234	1966	2677	3055	3269	
1991	31	176	500	1002	1406	1885	2498	3757	3656	5458
1992	28	157	503	894	1365	1892	2326	2938	3684	5120
1993	41	169	384	879	1487	1766	2548	2538	3227	
1994	33	179	401	696	1242	1683	1641	2693	1991	
1995	37	164	444	763	1071	1856	2667	5312	1313	
1996	41	174	447	806	1072	1474	2160	2407	4803	2186
1997	50	173	423	818	1224	1426	1917	2397	3694	3573
1998	41	202	404	742	1232	1738	2015	2333	3081	
1999	34	205	479	719	1198	1967	2381	2798	2929	5313
2000	29	179	552	888	1167	1777	2620	2924	3155	3668
2001	36	188	487	1052	1433	1502	2165	2758		3900
2002	63	172	474	891	1465	1955	2143	1998	3662	4981
2003	40	230	412	801	1268	1873	3139	2343	3301	4191
2004	34	176	556	807	1282	1690	2454	3236	2942	

Table 3.4.4.3 Haddock in division Va Sexual maturity at age in the stock and the survey.

Year/ age	1	2	3	4	5	6	7	8	9
1985	0	1.6	14.4	53.6	57.8	76.5	76.6	96.1	93.4
1986	0	2.1	20.5	41.3	67.3	84.5	88.4	95.2	98.6
1987	0	2.2	13.7	42.6	53.5	77.8	77.6	100	96.9
1988	0	1.3	22.1	39.4	76.7	79.4	92.8	91.4	100
1989	0	4.1	20.2	53.2	72.7	81.8	99.8	100	100
1990	0	11.4	33.4	63.4	81.5	84.3	91.8	88.2	100
1991	0	6.3	22.4	59.3	73.9	81.7	89.4	49.5	100
1992	0	5	22.7	42	79.9	90.1	90.1	85.8	100
1993	0.5	12.4	36.4	48.8	67.4	90.6	97.7	91	86.8
1994	3.5	25.6	31.7	59.9	78.5	85.9	100	87.8	100
1995	0	12.9	48	39.2	75.3	75.4	61.3	98.5	100
1996	0	19.8	37.9	59.7	65.1	78.8	74	94.7	89.7
1997	1.5	9.3	43.4	58.4	68.2	75	78.4	87.9	100
1998	0	3.1	48.5	68	77.5	73.6	85.2	89.9	100
1999	0	5	39.5	67.9	72.3	75	89.6	76.3	92
2000	0	10.6	25.6	62.7	80.5	86.7	87.3	100	77.7
2001	0.2	10	37.8	52	75.2	89.7	92.1	91.7	
2002	0	4.7	28.4	63	80	93.5	92.8	100	100
2003	0.5	6.2	34.7	68.5	86.7	92.2	94.6	100	100
2004	0	3.7	36.1	57	83.1	91	100	100	100

Table 3.4.5.1 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in March

Year/ age	1	2	3	4	5	6	7	8	9	10
1985	28.15	32.72	18.34	23.65	26.54	3.73	10.98	4.88	5.64	0.51
1986	123.95	108.51	59.07	12.8	16.38	13.2	0.98	2.77	1.26	2.32
1987	22.22	296.28	163.63	57.08	13.17	11.17	8.09	0.58	1.28	0.84
1988	15.77	40.71	184.77	88.86	22.86	1.36	2.25	1.87	0.18	0.28
1989	10.58	23.35	41.53	146.71	44.9	12.74	0.85	0.84	0.41	0.28
1990	70.48	31.86	27.25	39.06	91.79	30.87	3.44	0.9	0.23	0
1991	89.73	145.95	41.55	17.83	20.27	32.55	7.67	0.3	0.1	0.11
1992	18.15	211.43	138.4	35.54	16.56	13.14	15.93	2.21	0.18	0.07
1993	29.99	37.65	245.06	87.3	11.15	3.86	1.66	4.46	0.88	0
1994	58.54	61.34	39.83	142.62	42.41	6.93	2.89	1.42	4.07	0
1995	35.89	82.53	48.09	19.74	68.41	7.66	1.31	0.11	0.34	0
1996	95.25	66.3	121	36.93	19.11	39.77	5.84	0.62	0.13	0.12
1997	8.57	119.13	50.88	52.99	10.86	7.28	10.58	1.37	0.06	0.03
1998	23.12	18.07	108.27	28.25	23.32	4.64	3.47	4.57	0.33	0
1999	80.73	86.21	25.8	98.18	12.9	9.6	1.42	1.7	1.03	0.03
2000	60.58	90.44	45.03	8.54	24.63	2.94	1.62	0.41	0.15	0.45
2001	81.33	148.06	115.04	22.16	4.09	10.56	0.93	0.57	0	0.1
2002	21.14	298.28	201	112.78	23.25	3.52	7	0.31	0.34	0.11
2003	111.96	97.85	282.83	244.83	112.28	18.05	2.58	4.43	0.48	0.85
2004	325.9	291.97	70.85	208.84	109.26	33.86	6.88	1.08	0.86	0

Table 3.4.5.2 Icelandic haddock. Age disaggregated survey indices from the groundfish survey in October.

Year/age	0	1	2	3	4	5	6	7	8	9	10
1995	93.95	162.64	184.92	51.4	24.27	42.47	5.74	0.56	0	0.07	0
1996	12.45	347.52	93.69	77.33	16.52	6.35	15.27	1.28	0	0	0
1997	49.84	29.63	200.21	59.25	39.34	7.12	5.79	6.35	0.29	0	0
1998	183.18	79.7	33.41	138.33	19.47	13.6	4.52	4.36	1.68	0	0
1999	204.63	343.81	57.78	26.55	96.25	10.51	8.97	0.45	1.49	0.31	0
2000	56.59	157.27	240.32	41.42	7.05	26.77	1.8	2.73	0.07	0.21	0.28
2001	50.18	331.24	253.85	155.73	31.35	3.53	12.14	0.64	0.95	0	0.2
2002	137.95	76.53	213.48	171.33	84.46	16.88	2.49	2.14	0.85	0.09	0
2003	313.57	337.83	139.25	223.58	144.16	48.03	8.24	1.89	0.55	0	0.05

Table 3.4.6.1 Haddock in division Va. Input data for tuning.

ICE HADDOCK Catch at age
101
SUR CPU
1984 2003
1 1 0.99 1
0 8

0.1	28.2	32.7	18.3	23.6	26.5	3.7	11.0	4.9	5.6
0.1	124.0	108.5	59.1	12.8	16.4	13.2	1.0	2.8	1.3
0.1	22.2	296.3	163.6	57.1	13.2	11.2	8.1	0.6	1.3
0.1	15.8	40.7	184.8	88.9	22.9	1.4	2.2	1.9	0.2
0.1	10.9	23.6	41.6	146.8	44.9	12.7	0.8	0.8	0.4
0.1	70.5	31.9	27.3	39.1	91.8	30.9	3.4	0.9	0.2
0.1	89.7	146.0	41.6	17.8	20.3	32.5	7.7	0.3	0.1
0.1	18.2	211.4	138.7	35.6	16.6	13.2	15.9	2.2	0.2
0.1	30.0	37.7	252.9	88.8	11.3	3.9	1.7	4.5	0.9
0.1	58.5	61.3	40.6	162.8	46.1	7.2	2.9	1.4	4.1
0.1	35.9	82.5	48.8	20.7	68.4	8.1	1.4	0.1	0.4
0.1	95.3	66.3	118.4	34.3	18.7	40.4	6.2	0.6	0.1
0.1	8.6	119.1	49.6	54.6	10.4	7.0	11.2	1.4	0.1
0.1	23.1	18.1	110.4	28.4	23.4	4.6	3.5	4.6	0.3
0.1	80.7	86.2	25.8	98.2	12.9	9.6	1.4	1.7	1.0
0.1	60.6	90.4	45.5	8.6	24.7	2.9	1.6	0.4	0.2
0.1	81.3	148.1	115.2	22.2	4.1	10.6	0.9	0.6	0.0
0.1	21.1	298.3	202.3	113.0	23.7	3.6	7.1	0.3	0.4
0.1	112.0	97.9	282.8	244.8	112.3	18.1	2.6	4.4	0.5
0.1	325.9	291.9	70.9	208.8	109.3	33.9	6.9	1.1	0.9

Table 3.4.6.2 Haddock Va. Output from XSA.

Lowestoft VPA Version 3.1

Mon May 3 12:31:15

Extended Survivors Analysis

Icelandic Haddock. Run 3.

CPUE data from file glm.dat

Catch data for 21 years. 1983 to 2003. Ages 0 to 9.

Fleet,	First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SUR CPU ,	1984,	2003,	0,	8,	0.990,	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 2

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

Catchability independent of age for ages >= 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 21 iterations

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

Fishing mortalities

Age,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000
1,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000,	0.000
2,	0.008,	0.037,	0.047,	0.015,	0.014,	0.024,	0.022,	0.017,	0.006,	0.006
3,	0.116,	0.234,	0.196,	0.162,	0.116,	0.134,	0.200,	0.138,	0.104,	0.051
4,	0.348,	0.331,	0.446,	0.396,	0.427,	0.377,	0.329,	0.353,	0.301,	0.230
5,	0.619,	0.578,	0.513,	0.642,	0.594,	0.749,	0.612,	0.363,	0.465,	0.409
6,	0.810,	0.793,	0.848,	0.576,	0.787,	0.889,	0.859,	0.623,	0.515,	0.517
7,	0.911,	0.916,	1.036,	0.872,	0.828,	0.842,	0.990,	0.833,	0.758,	0.821
8,	0.690,	0.998,	1.152,	0.989,	1.029,	0.957,	0.977,	0.819,	0.815,	0.872
9,	0.701,	0.998,	1.177,	0.925,	0.958,	0.915,	1.070,	0.863,	0.820,	0.763

XSA population numbers (Thousands)

	AGE									
YEAR ,	0,	1,	2,	3,	4,	5,	6,	7,	8,	9,
1994 ,	5.22E+04,	8.64E+04,	4.13E+04,	3.05E+04,	1.02E+05,	2.57E+04,	3.09E+03,	1.40E+03,	8.95E+02,	1.54E+03,
1995 ,	1.51E+05,	4.27E+04,	7.08E+04,	3.35E+04,	2.22E+04,	5.88E+04,	1.13E+04,	1.12E+03,	4.60E+02,	3.68E+02,
1996 ,	2.38E+04,	1.23E+05,	3.50E+04,	5.58E+04,	2.17E+04,	1.31E+04,	2.70E+04,	4.19E+03,	3.68E+02,	1.39E+02,
1997 ,	7.38E+04,	1.95E+04,	1.01E+05,	2.73E+04,	3.76E+04,	1.14E+04,	6.41E+03,	9.46E+03,	1.22E+03,	9.52E+01,
1998 ,	1.80E+05,	6.04E+04,	1.59E+04,	8.15E+04,	1.90E+04,	2.07E+04,	4.91E+03,	2.95E+03,	3.24E+03,	3.71E+02,
1999 ,	2.21E+05,	1.47E+05,	4.95E+04,	1.29E+04,	5.94E+04,	1.02E+04,	9.35E+03,	1.83E+03,	1.05E+03,	9.48E+02,
2000 ,	2.60E+05,	1.81E+05,	1.21E+05,	3.95E+04,	9.21E+03,	3.34E+04,	3.93E+03,	3.15E+03,	6.45E+02,	3.31E+02,
2001 ,	7.47E+04,	2.13E+05,	1.48E+05,	9.66E+04,	2.65E+04,	5.43E+03,	1.48E+04,	1.36E+03,	9.57E+02,	1.99E+02,
2002 ,	2.60E+05,	6.12E+04,	1.74E+05,	1.19E+05,	6.89E+04,	1.52E+04,	3.09E+03,	6.50E+03,	4.86E+02,	3.46E+02,
2003 ,	4.96E+05,	2.13E+05,	5.01E+04,	1.42E+05,	8.79E+04,	4.18E+04,	7.84E+03,	1.51E+03,	2.50E+03,	1.76E+02,

Table 3.4.6.2 (Cont'd)

Estimated population abundance at 1st Jan 2004

,	0.00E+00,	4.06E+05,	1.74E+05,	4.07E+04,	1.10E+05,	5.71E+04,	2.27E+04,	3.83E+03,	5.44E+02,	8.54E+02,

Taper weighted geometric mean of the VPA populations:

,	1.05E+05,	7.54E+04,	5.68E+04,	4.54E+04,	2.88E+04,	1.56E+04,	7.35E+03,	3.08E+03,	1.16E+03,	3.57E+02,

Standard error of the weighted Log(VPA populations) :

,	0.8043,	0.7667,	0.7433,	0.7439,	0.7829,	0.7510,	0.7706,	0.8936,	0.9566,	1.0064,

Log catchability residuals.

Fleet : SUR CPU

Age ,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993
0 ,	-0.61,	0.14,	-0.21,	0.05,	-0.12,	0.35,	-0.18,	-0.15,	0.22,	0.30
1 ,	-0.43,	-0.06,	0.25,	-0.36,	-0.29,	0.17,	0.32,	-0.08,	-0.19,	0.17
2 ,	-0.35,	0.09,	0.34,	-0.16,	-0.40,	-0.24,	0.37,	0.31,	0.14,	-0.19
3 ,	-0.22,	-0.32,	0.45,	0.11,	-0.04,	-0.12,	-0.27,	0.56,	0.27,	0.06
4 ,	0.03,	0.01,	0.42,	0.21,	0.09,	0.04,	-0.17,	0.25,	0.09,	0.24
5 ,	0.35,	0.09,	0.56,	-0.87,	0.55,	0.48,	-0.16,	0.28,	-0.20,	0.59
6 ,	0.90,	-0.13,	0.97,	-0.13,	-0.42,	0.39,	0.01,	0.06,	-0.71,	0.50
7 ,	-0.08,	0.49,	0.58,	0.60,	-0.04,	0.95,	-1.02,	-0.18,	-0.10,	0.32
8 ,	0.08,	-0.32,	0.89,	0.51,	0.42,	0.22,	-0.12,	-0.31,	0.10,	0.85

Age ,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003
0 ,	0.55,	0.40,	0.00,	-0.21,	0.07,	-0.40,	-0.29,	-0.30,	0.01,	0.36
1 ,	-0.09,	0.41,	-0.10,	-0.03,	0.31,	-0.54,	-0.28,	0.22,	0.42,	0.20
2 ,	-0.10,	0.28,	0.13,	-0.17,	0.22,	-0.33,	-0.30,	0.06,	0.22,	0.08
3 ,	-0.48,	0.05,	-0.03,	-0.01,	0.10,	-0.48,	-0.58,	0.09,	0.62,	0.23
4 ,	-0.20,	0.01,	-0.44,	-0.23,	-0.11,	-0.65,	-0.63,	0.09,	0.64,	0.30
5 ,	-0.59,	0.15,	-0.17,	-0.32,	-0.23,	-0.56,	-0.59,	-0.10,	0.58,	0.15
6 ,	-0.01,	0.17,	-0.06,	-0.05,	-0.49,	-0.90,	-0.64,	-0.14,	0.32,	0.37
7 ,	-1.66,	0.36,	0.01,	0.22,	0.35,	-0.61,	-0.60,	-0.61,	0.44,	0.58
8 ,	-0.04,	-0.46,	-0.08,	-0.34,	-0.08,	-0.63,	99.99,	0.02,	0.92,	-0.08

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,	-4.1349,	-4.2004,	-4.2592,	-4.3547,	-4.3845,	-4.4822,	-4.4822,
S.E(Log q),	0.2537,	0.3318,	0.3251,	0.4473,	0.4935,	0.6358,	0.4608,

Regression statistics :

Ages with q dependent on year class strength

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Log q
0,	0.94,	0.736,	5.72,	0.88,	20,	0.31,	-5.32,
1,	0.94,	0.649,	4.77,	0.87,	20,	0.30,	-4.36,

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

Age,	Slope ,	t-value ,	Intercept,	RSquare,	No Pts,	Reg s.e,	Mean Q
2,	0.97,	0.394,	4.34,	0.90,	20,	0.25,	-4.13,
3,	0.84,	1.973,	5.22,	0.90,	20,	0.26,	-4.20,
4,	0.95,	0.535,	4.59,	0.85,	20,	0.31,	-4.26,
5,	1.02,	-0.120,	4.27,	0.74,	20,	0.47,	-4.35,
6,	0.93,	0.489,	4.70,	0.73,	20,	0.47,	-4.38,
7,	0.98,	0.085,	4.54,	0.61,	20,	0.64,	-4.48,
8,	0.99,	0.094,	4.43,	0.83,	19,	0.46,	-4.40,

Terminal year survivor and F summaries :

Age 0 Catchability dependent on age and year class strength

Year class = 2003

Fleet,		Estimated,	Int,	Ext,	Var,	N,	Scaled,	Estimated
,		Survivors,	s.e,	s.e,	Ratio,	,	Weights,	F
SUR CPU	,	583674.,	0.355,	0.000,	0.00,	1,	0.823,	0.000
P shrinkage mean	,	75420.,	0.77,,,,				0.177,	0.000
F shrinkage mean	,	0.,	0.50,,,,				0.000,	0.000

Table 3.4.6.2 (Cont’d)

```
Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   406418.,      0.32,     0.86,    2,   2.669,  0.000

Age  1   Catchability dependent on age and year class strength

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUR CPU              ,   193691.,  0.229,      0.094,   0.41,   2, 0.913,    0.000

  P shrinkage mean  ,     56802.,   0.74,,,,                       0.087,    0.000

  F shrinkage mean  ,         0.,   0.50,,,,                       0.000,    0.000

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   174159.,      0.22,     0.26,    3,   1.202,  0.000

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

Year class = 2001

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUR CPU              ,    44176.,  0.178,      0.205,   1.15,   3, 0.887,    0.006

  F shrinkage mean  ,     21631.,   0.50,,,,                       0.113,    0.012

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    40738.,      0.17,     0.21,    4,   1.249,  0.006

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

Year class = 2000

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUR CPU              ,   121537.,  0.160,      0.127,   0.80,   4, 0.902,    0.047

  F shrinkage mean  ,     44839.,   0.50,,,,                       0.098,    0.121

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
   110254.,      0.15,     0.19,    5,   1.232,  0.051

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

Year class = 1999

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUR CPU              ,    59831.,  0.143,      0.181,   1.26,   5, 0.899,    0.221

  F shrinkage mean  ,     38032.,   0.50,,,,                       0.101,    0.329

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    57147.,      0.14,     0.17,    6,   1.204,  0.230

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

Year class = 1998

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUR CPU              ,    22792.,  0.138,      0.173,   1.25,   6, 0.860,    0.408

  F shrinkage mean  ,     22198.,   0.50,,,,                       0.140,    0.417
```

Table 3.4.6.2 (Cont'd)

```
 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     22708.,      0.14,     0.15,    7,   1.063,  0.409

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

 Year class = 1997

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUR CPU             ,      3966.,  0.141,      0.153,   1.09,   7, 0.789,    0.503

   F shrinkage mean  ,      3345.,   0.50,,,,                       0.211,    0.574

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3826.,      0.15,     0.13,    8,   0.844,  0.517

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

 Year class = 1996

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUR CPU             ,       536.,  0.147,      0.144,   0.98,   8, 0.677,    0.830

   F shrinkage mean  ,       562.,   0.50,,,,                       0.323,    0.803

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       544.,      0.19,     0.11,    9,   0.585,  0.821

 Age  8   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1995

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUR CPU             ,       797.,  0.210,      0.102,   0.49,   9, 0.542,    0.913

   F shrinkage mean  ,       927.,   0.50,,,,                       0.458,    0.825

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       854.,      0.26,     0.08,   10,   0.308,  0.872

 Age  9   Catchability constant w.r.t. time and age (fixed at the value for age)  7

 Year class = 1994

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUR CPU             ,        96.,  0.253,      0.224,   0.89,   9, 0.318,    0.588

   F shrinkage mean  ,        57.,   0.50,,,,                       0.682,    0.855

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        67.,      0.35,     0.19,   10,   0.535,  0.763
1
    Run title : Icelandic Haddock. Run 3.

    At Mon May  3 12:32:27

                   Terminal Fs derived using XSA (With F shrinkage)
```

Table 3.4.6.2 (Cont'd)

Table 8 Fishing mortality (F) at age

YEAR,	1983,
AGE	
0,	0.0000,
1,	0.0000,
2,	0.0000,
3,	0.0228,
4,	0.3063,
5,	0.3582,
6,	0.6653,
7,	0.5655,
8,	1.0574,
9,	0.8198,
0 FBAR 4- 7,	0.4738,

Table 8 Fishing mortality (F) at age

YEAR,	1984,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,
AGE										
0,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
1,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
2,	0.0033,	0.0114,	0.0024,	0.0148,	0.0031,	0.0032,	0.0223,	0.0345,	0.0178,	0.0064,
3,	0.0344,	0.1284,	0.1283,	0.1218,	0.0857,	0.0768,	0.1418,	0.0824,	0.1368,	0.0984,
4,	0.2217,	0.3310,	0.4474,	0.4163,	0.4056,	0.2883,	0.3561,	0.3310,	0.4190,	0.3686,
5,	0.4210,	0.4613,	0.6438,	0.6657,	0.6363,	0.4655,	0.5464,	0.5772,	0.7041,	0.6568,
6,	0.8034,	0.6071,	1.1421,	0.6996,	0.7763,	0.9292,	0.6862,	0.7117,	0.8371,	0.7683,
7,	0.5494,	0.6600,	0.9184,	0.7766,	0.8097,	0.9554,	0.7226,	0.7658,	0.8007,	0.9241,
8,	0.6325,	0.8840,	0.9729,	0.8281,	1.1810,	1.4504,	0.9242,	0.9191,	0.9802,	0.8473,
9,	0.5961,	0.7681,	0.9929,	0.6747,	0.9281,	1.1655,	0.8174,	0.8628,	0.9429,	0.8832,
0 FBAR 4- 7,	0.4989,	0.5149,	0.7879,	0.6395,	0.6570,	0.6596,	0.5778,	0.5964,	0.6902,	0.6794,

1

Run title : Icelandic Haddock. Run 3.

At Mon May 3 12:32:27

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR,	1994,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	FBAR **-**
AGE											
0,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
1,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,	0.0000,
2,	0.0075,	0.0375,	0.0475,	0.0151,	0.0145,	0.0243,	0.0218,	0.0167,	0.0065,	0.0062,	0.0098,
3,	0.1163,	0.2338,	0.1958,	0.1617,	0.1164,	0.1336,	0.2004,	0.1383,	0.1036,	0.0512,	0.0977,
4,	0.3479,	0.3308,	0.4459,	0.3965,	0.4272,	0.3773,	0.3287,	0.3527,	0.3007,	0.2303,	0.2945,
5,	0.6193,	0.5783,	0.5133,	0.6421,	0.5945,	0.7486,	0.6121,	0.3634,	0.4649,	0.4094,	0.4126,
6,	0.8099,	0.7930,	0.8481,	0.5764,	0.7872,	0.8891,	0.8589,	0.6229,	0.5152,	0.5175,	0.5519,
7,	0.9106,	0.9157,	1.0357,	0.8718,	0.8279,	0.8420,	0.9902,	0.8330,	0.7577,	0.8211,	0.8039,
8,	0.6903,	0.9977,	1.1525,	0.9885,	1.0291,	0.9575,	0.9769,	0.8187,	0.8151,	0.8720,	0.8353,
9,	0.7006,	0.9978,	1.1769,	0.9248,	0.9583,	0.9146,	1.0696,	0.8626,	0.8204,	0.7629,	0.8153,
0 FBAR 4- 7,	0.6719,	0.6545,	0.7108,	0.6217,	0.6592,	0.7143,	0.6975,	0.5430,	0.5096,	0.4946,	

1

Run title : Icelandic Haddock. Run 3.

At Mon May 3 12:32:27

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1983,
AGE	
0,	62287,
1,	24343,
2,	30159,
3,	34515,
4,	6275,
5,	17051,
6,	23429,
7,	22539,
8,	1480,
9,	476,
0 TOTAL,	222554,

Table 3.4.6.2 (Cont'd)

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

AGE	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
0,	133045,	250599,	71097,	39780,	33360,	119711,	254132,	55948,	61579,	105584,
1,	50996,	108928,	205173,	58209,	32569,	27313,	98011,	208066,	45806,	50417,
2,	19930,	41752,	89183,	167981,	47658,	26665,	22362,	80245,	170350,	37503,
3,	24692,	16263,	33797,	72839,	135507,	38898,	21761,	17905,	63472,	137004,
4,	27621,	19533,	11711,	24340,	52796,	101834,	29492,	15461,	13499,	45322,
5,	3782,	18117,	11485,	6130,	13142,	28814,	62494,	16913,	9092,	7269,
6,	9757,	2033,	9351,	4939,	2579,	5694,	14812,	29628,	7775,	3681,
7,	9862,	3577,	907,	2443,	2009,	972,	1841,	6106,	11906,	2756,
8,	10483,	4661,	1514,	296,	920,	732,	306,	732,	2324,	4377,
9,	421,	4560,	1577,	468,	106,	231,	141,	99,	239,	714,
0 TOTAL,	290589,	470023,	435794,	377427,	320647,	350865,	505351,	431102,	386042,	394628,

1

Run title : Icelandic Haddock. Run 3.

At Mon May 3 12:32:27

Terminal Fs derived using XSA (With F shrinkage)

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

AGE	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	GMST 83-**	AMST 83-**
0,	52183,	150829,	23773,	73817,	179983,	220572,	259938,	74690,	259815,	496398,	0,	92574,	116995,
1,	86445,	42724,	123489,	19464,	60436,	147358,	180589,	212819,	61151,	212719,	406418,	72207,	93850,
2,	41278,	70775,	34980,	101104,	15936,	49481,	120647,	147854,	174242,	50066,	174159,	53905,	69255,
3,	30508,	33542,	55813,	27311,	81533,	12860,	39537,	96650,	119051,	141734,	40738,	40692,	51285,
4,	101658,	22236,	21737,	37569,	19022,	59416,	9212,	26492,	68907,	87877,	110254,	25946,	33959,
5,	25668,	58777,	13077,	11394,	20691,	10159,	33357,	5429,	15244,	41765,	57148,	14863,	19623,
6,	3086,	11313,	26988,	6408,	4909,	9348,	3935,	14808,	3091,	7841,	22708,	7665,	10235,
7,	1398,	1124,	4191,	9462,	2948,	1829,	3146,	1365,	6503,	1512,	3826,	3073,	4757,
8,	895,	460,	368,	1218,	3240,	1055,	645,	957,	486,	2496,	544,	1169,	1930,
9,	1536,	368,	139,	95,	371,	948,	331,	199,	346,	176,	854,	372,	685,
0 TOTAL,	344655,	392149,	304556,	287842,	389068,	513026,	651337,	581263,	708835,	1042583,	816649,		

1

Run title : Icelandic Haddock. Run 3. ,

At Mon May 3 12:32:27

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 7,
1983,	62287,	161864,	101887,	65943,	0.6472,	0.4738,
1984,	133045,	125034,	79754,	48285,	0.6054,	0.4989,
1985,	250599,	115981,	59917,	50933,	0.8501,	0.5149,
1986,	71097,	114862,	56371,	48863,	0.8668,	0.7879,
1987,	39780,	131183,	41626,	40801,	0.9802,	0.6395,
1988,	33360,	161582,	65955,	54236,	0.8223,	0.6570,
1989,	119711,	175063,	99582,	62979,	0.6324,	0.6596,
1990,	254132,	151053,	110544,	67200,	0.6079,	0.5778,
1991,	55948,	135850,	91415,	54732,	0.5987,	0.5964,
1992,	61579,	133861,	63419,	47212,	0.7444,	0.6902,
1993,	105584,	137338,	69497,	48844,	0.7028,	0.6794,
1994,	52183,	135755,	83253,	59345,	0.7128,	0.6719,
1995,	150829,	131838,	86974,	61131,	0.7029,	0.6545,
1996,	23773,	113646,	68517,	56958,	0.8313,	0.7108,
1997,	73817,	103421,	61704,	44053,	0.7139,	0.6217,
1998,	179984,	98565,	63911,	41434,	0.6483,	0.6592,
1999,	220572,	99685,	63505,	45481,	0.7162,	0.7143,
2000,	259938,	108655,	59973,	42167,	0.7031,	0.6975,
2001,	74690,	139785,	62099,	39647,	0.6384,	0.5430,
2002,	259815,	192367,	94103,	50496,	0.5366,	0.5096,
2003,	496398,	219868,	144235,	60803,	0.4216,	0.4946,
Arith. Mean ,	141863,	137488,	77535,	51978,	0.6992,	0.6215,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 3.4.6.3 Haddock in division Va Summary table from the selected final run.
.

	RECRUITS	TOTALBIO (3+)	TOTSBIO	LANDINGS	YIELD/SSB	FBAR4-7	
	Age 2						
1979	78996	162902	95835	59190	0.618	0.538	
1980	37049	191639	115951	50902	0.439	0.442	
1981	9681	204071	138987	63491	0.457	0.488	
1982	42269	179033	135784	68533	0.505	0.457	
1983	30272	144316	109297	64698	0.592	0.491	
1984	18788	110998	80977	48121	0.594	0.507	
1985	42389	98664	63293	50261	0.794	0.565	
1986	87489	91869	55314	47272	0.855	0.709	
1987	166250	104387	44026	40132	0.912	0.66	
1988	44019	153176	66846	53871	0.806	0.663	
1989	24927	168808	100099	62712	0.626	0.632	
1990	23468	142669	109655	67038	0.611	0.613	
1991	80790	117897	86960	54694	0.629	0.626	
1992	167314	102894	64854	47026	0.725	0.698	
1993	36041	128197	69290	48737	0.703	0.694	
1994	39406	123915	80171	59007	0.736	0.687	
1995	70639	118057	80473	60111	0.747	0.677	
1996	35940	104829	67483	56716	0.84	0.699	
1997	97893	85858	57387	44006	0.767	0.657	
1998	15446	94310	62109	41374	0.666	0.682	
1999	48270	85457	60445	45231	0.748	0.734	
2000	118766	83084	57608	41870	0.727	0.705	
2001	148040	108377	64320	39530	0.615	0.605	
2002	164513	158049	91229	50294	0.551	0.554	
2003	49050	201019	135236	60598	0.448	0.528	
2004	185472		163867				
Arith.							
Mean	67108	130579	83745	53017	0.668	0.612	
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 3.4.7.1 Haddock in division Va. Input file for RCT3.
Iceland Haddock: VPA and groundfish survey data
Iceland Haddock: VPA and groundfish survey data
3 20 2

'Yearcl'	'VPAage2'	'Surv3'	'Surv2'	'Surv1'
1984	89	1636	1085	282
1985	166	1848	2963	1240
1986	47	416	407	222
1987	26	273	234	158
1988	22	416	319	106
1989	79	1387	1460	705
1990	169	2451	2114	897
1991	37	398	377	181
1992	41	481	613	300
1993	70	1210	825	585
1994	35	509	663	359
1995	98	1083	1191	953
1996	14	258	182	86
1997	48	450	862	231
1998	117	1150	901	807
1999	138	2010	1481	606
2000	161	2828	2983	813
2001	-11	710	979	211
2002	-11	-11	2920	1120
2003	-11	-11	-11	3259

Table 3.4.7.2 Haddock in division Va. Output from the RTC3 model.
Analysis by RCT3 ver3.1 of data from file :

Analysis by RCT3 ver3.1 of data from file :

Recrun04.dat

Iceland Haddock: VPA and groundfish survey data

Data for 3 surveys over 20 years : 1984 - 2003

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

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

Forecast/Hindcast variance correction used.

Year class = 1997

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
Surv3	1.04	-2.84	.27	.892	13	6.11	3.50	.320	.308
Surv2	.94	-2.15	.24	.913	13	6.76	4.19	.282	.397
Surv1	.92	-1.43	.31	.864	13	5.45	3.61	.364	.239
						VPA Mean =	3.95	.747	.057

Year class = 1998

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
Surv3	1.04	-2.81	.29	.873	14	7.05	4.50	.335	.294
Surv2	.95	-2.23	.25	.899	14	6.80	4.21	.289	.395
Surv1	.92	-1.37	.30	.858	14	6.69	4.77	.367	.245
						VPA Mean =	3.94	.712	.065

Year class = 1999

Survey/ Series	Regression: Slope	Inter- cept	Std Error	Rsquare	No. Pts	Prediction: Index Value	Predicted Value	Std Error	WAP Weights
Surv3	1.08	-3.09	.29	.870	15	7.61	5.15	.366	.292
Surv2	1.04	-2.77	.31	.854	15	7.30	4.79	.374	.280
Surv1	.92	-1.37	.29	.875	15	6.41	4.50	.333	.353
						VPA Mean =	4.00	.721	.075

Table 3.4.7.2 (Cont'd)

Year class = 2000

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv3	1.06	-2.94	.28	.887	16	7.95	5.47	.356	.344
Surv2	1.07	-3.00	.31	.862	16	8.00	5.58	.405	.266
Surv1	.98	-1.70	.32	.858	16	6.70	4.84	.376	.310
					VPA Mean =		4.07	.740	.080

Year class = 2001

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv3	1.01	-2.63	.27	.899	17	6.57	3.99	.309	.385
Surv2	1.02	-2.67	.31	.871	17	6.89	4.34	.354	.292
Surv1	1.02	-1.93	.32	.863	17	5.36	3.52	.376	.260
					VPA Mean =		4.16	.768	.062

Year class = 2002

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv3									
Surv2	1.03	-2.74	.32	.869	17	7.98	5.46	.404	.437
Surv1	1.02	-1.98	.32	.863	17	7.02	5.21	.401	.444
					VPA Mean =		4.17	.774	.119

Year class = 2003

Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
	I-----------Regression----------I					I-----------Prediction---------I			
Surv3									
Surv2									
Surv1	1.03	-2.04	.33	.863	17	8.09	6.33	.496	.712
					VPA Mean =		4.18	.781	.288

Table 3.4.7.2 (Cont'd)

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1997	45	3.83	.18	.18	1.06	48	3.89
1998	82	4.41	.18	.15	.65	118	4.77
1999	113	4.73	.20	.19	.96	139	4.93
2000	180	5.19	.21	.26	1.57	162	5.09
2001	53	3.98	.19	.18	.86		
2002	180	5.20	.27	.28	1.09		
2003	301	5.71	.42	.97	5.38		

Table 3.4.8.1 Haddock Va. Input data for short term prediction.
MFDP version 1a
Run: Ice-haddock3
Time and date: 19:26 04/05/2004
Fbar age range: 4-7

Year:	2004	F multiplier:	0.8430	Fbar:	0.4450				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0103	1723	962	185472	32643	6862	1208	6862	1208
3	0.0880	3051	2691	39906	22188	14406	8010	14406	8010
4	0.2313	19474	25160	103650	83646	59081	47678	59081	47678
5	0.3784	16495	27843	57410	73600	47708	61161	47708	61161
6	0.4995	7924	17409	22054	37271	20069	33917	20069	33917
7	0.6709	1654	4557	3693	9063	3693	9063	3693	9063
8	0.7919	202	630	403	1304	403	1304	403	1304
9	0.7919	260	748	518	1524	518	1524	518	1524
Total		50783	80000	413106	261238	152740	163864	152740	163864
Year:	2005	F multiplier:	1.0000	Fbar:	0.5279				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0122	4275	2385	388266	74935	19025	3672	19025	3672
3	0.1044	13524	12438	150295	67182	49748	22237	49748	22237
4	0.2744	6537	8657	29920	30519	18820	19196	18820	19196
5	0.4488	22235	38540	67338	83027	56092	69162	56092	69162
6	0.5925	13174	27776	32196	56666	29685	52246	29685	52246
7	0.7958	5522	13311	10957	25179	10497	24122	10497	24122
8	0.9394	867	2437	1546	4443	1546	4443	1546	4443
9	0.9394	84	263	149	506	149	506	149	506
Total		66217	105807	680668	342457	185562	195583	185562	195583
Year:	2006	F multiplier:	1.0000	Fbar:	0.5279				
Age	F	CatchNos	Yield	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
2	0.0122	641	358	58226	11238	2853	551	2853	551
3	0.1044	28257	25987	314024	140369	103942	46462	103942	46462
4	0.2744	24219	32074	110856	113073	69728	71123	69728	71123
5	0.4488	6148	10656	18619	22957	15509	19123	15509	19123
6	0.5925	14401	30362	35195	61943	32450	57111	32450	57111
7	0.7958	7345	17706	14575	33494	13963	32088	13963	32088
8	0.9394	2269	6381	4048	11633	4048	11633	4048	11633
9	0.9394	277	870	495	1673	495	1673	495	1673
Total		83557	124395	556038	396381	242988	239765	242988	239765

Input units are thousands and kg - output in tonnes

Table 3.4.8.2 Haddock in division Va. Input to yield per recruit.

MFYPR version 1
Run: final
Haddock Va (NWWG 2004)
Time and date: 11:50 03/05/2004
Fbar age range: 4-7

Age	M	Mat	PF	PM	SWt	Sel	CW
2	0.2	0.079	0	0	0.188	0.02045	0.552
3	0.2	0.304	0	0	0.477	0.16242	0.878
4	0.2	0.546	0	0	0.904	0.51375	1.31
5	0.2	0.73	0	0	1.402	0.85986	1.819
6	0.2	0.826	0	0	1.963	1.22308	2.371
7	0.2	0.872	0	0	2.53	1.4033	2.99
8	0.2	0.909	0	0	3.039	1.67562	3.441
9	0.2	0.967	0	0	3.3	1.67562	3.927

Weights in kilograms

Table 3.4.8.3 Haddock in division Va. Output from yield per recruit.

F-reference points:

	Fish Mort Ages 4-7	Yield/R	SSB/R
Average last 3 years	0.562	0.882	1.406
$\mathbf{F}_{max}$	0.441	0.887	1.684
$\mathbf{F}_{0.1}$	0.161	0.779	3.282
$\mathbf{F}_{med}$	0.617	0.879	1.311

Table 3.4.8.4a Haddock in division Va. Output from short term prediction using MFDP. Tac constraint of 80 000 tonnes for 2004.
MFDP version 1a
Run: Ice-haddock3
Index file 4/5/2004
Time and date: 19:26 04/05/2004
Fbar age range: 4-7

2004						
Biomass	SSB	FMult	FBar	Landings		
261238	163864	0.8430	0.4450	80000		
2005					2006	
Biomass	SSB	FMult	FBar	Landings	Biomass	SSB
342457	195583	0.0000	0.0000	0	496720	329250
.	195583	0.1000	0.0528	12928	484326	318071
.	195583	0.2000	0.1056	25254	472541	307468
.	195583	0.3000	0.1584	37011	461329	297408
.	195583	0.4000	0.2112	48231	450658	287860
.	195583	0.5000	0.2639	58943	440496	278793
.	195583	0.6000	0.3167	69175	430815	270179
.	195583	0.7000	0.3695	78954	421588	261994
.	195583	0.8000	0.4223	88303	412789	254211
.	195583	0.9000	0.4751	97247	404394	246809
.	195583	1.0000	0.5279	105807	396381	239765
.	195583	1.1000	0.5807	114003	388728	233059
.	195583	1.2000	0.6335	121854	381417	226674
.	195583	1.3000	0.6862	129380	374428	220589
.	195583	1.4000	0.7390	136596	367744	214790
.	195583	1.5000	0.7918	143519	361348	209260
.	195583	1.6000	0.8446	150164	355225	203985
.	195583	1.7000	0.8974	156546	349360	198950
.	195583	1.8000	0.9502	162677	343740	194142
.	195583	1.9000	1.0030	168570	338352	189550
.	195583	2.0000	1.0558	174239	333183	185161

Input units are thousands and kg - output in tonnes

Table 3.4.8.4b Haddock in division Va. Output from short term prediction using ADCAM. Tac constraint of 80 000 tonnes for 2004 but $F_{4-7} = 0.47$ after that.

Year	Landings 1000 tonnes	SSB 1000 tonnes	Biomass 3+ 1000 tonnes	Fishing mortality 4-7
2004	79.9	163.9	228.6	0.441
2005	97.2	195.7	267.6	0.47
2006	117.5	247	393.2	0.47
2007	142.6	310.6	430.5	0.47

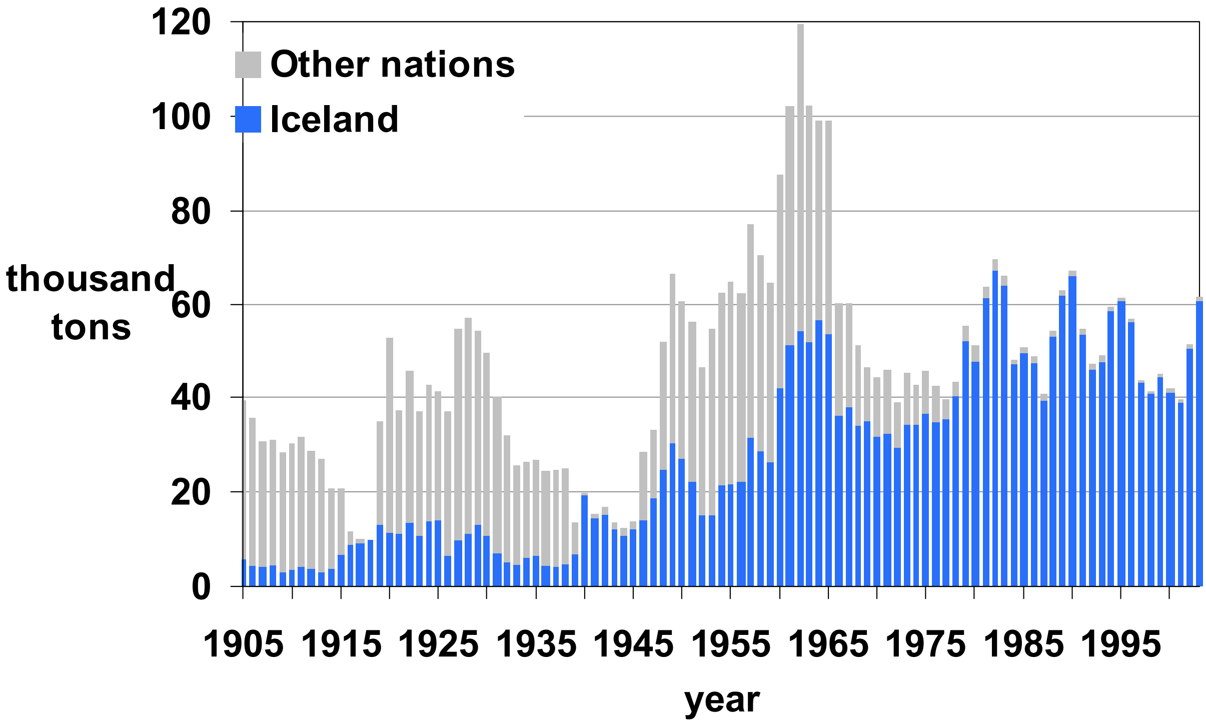


Figure 3.4.2.1 Haddock Division VA. Nominal landings (tonnes) 1905 – 2003.

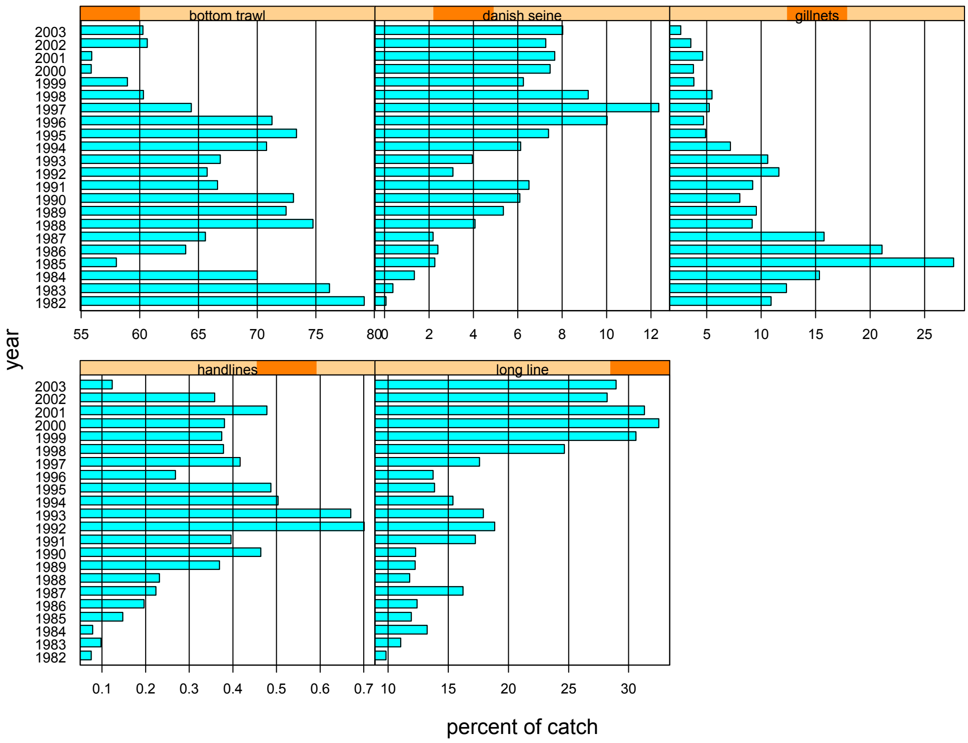


Figure 3.4.2.2 Haddock Division VA. Landings in percent of total by gear and year.

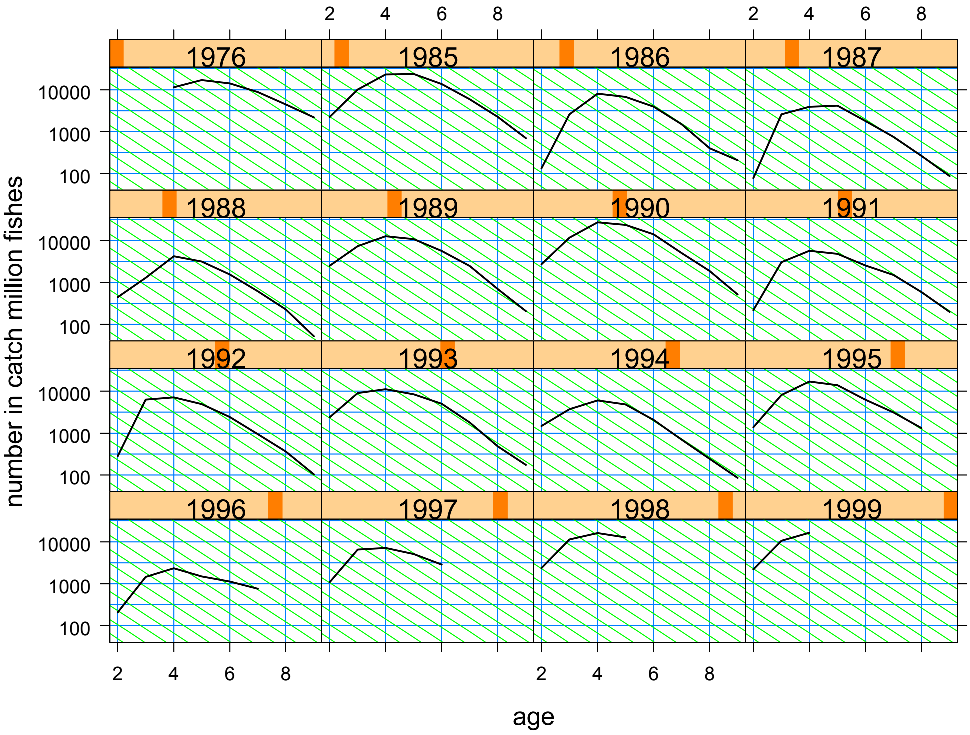


Figure 3.4.3.1 Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

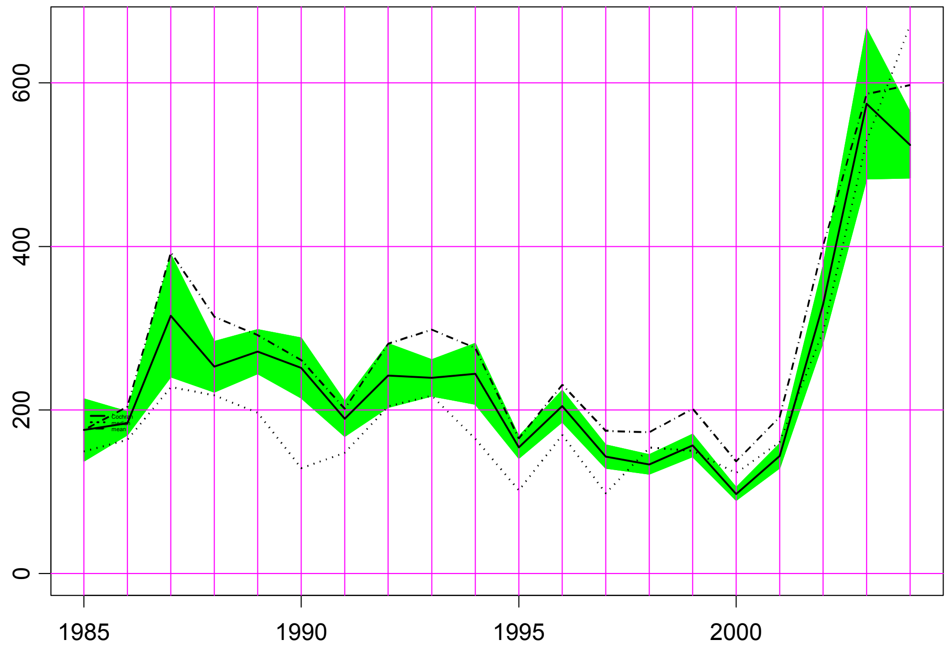


Figure 3.4.5.1. Haddock in division va. Total biomass index from the groundfish survey. 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices. Indices based on unweighed mean of all stations and number of stations with haddock times median of the haddock catch at those stations are shown for comparison.

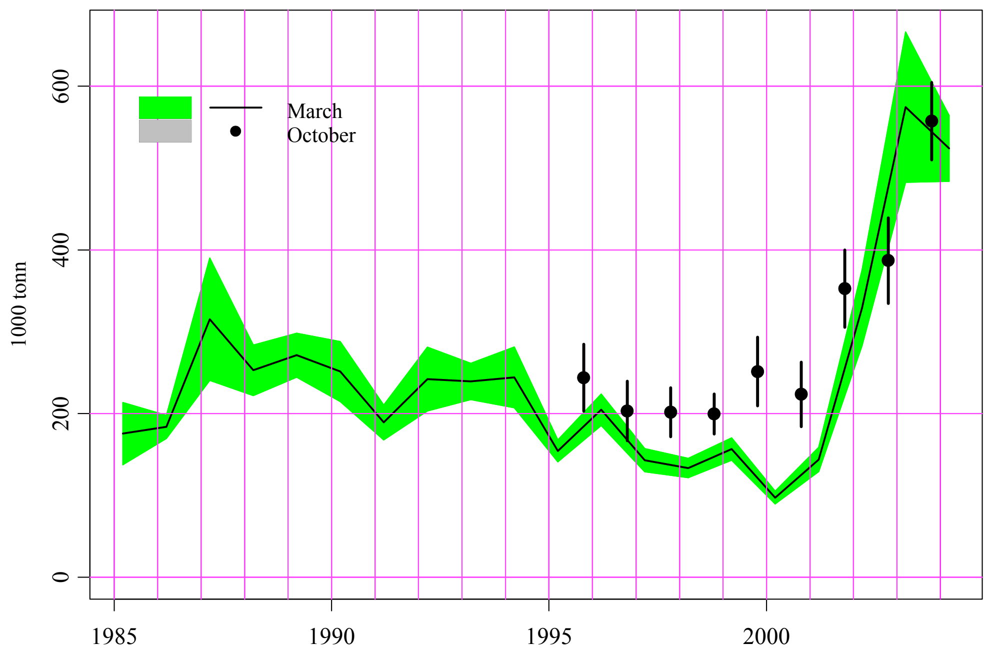


Figure 3.4.5.2 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

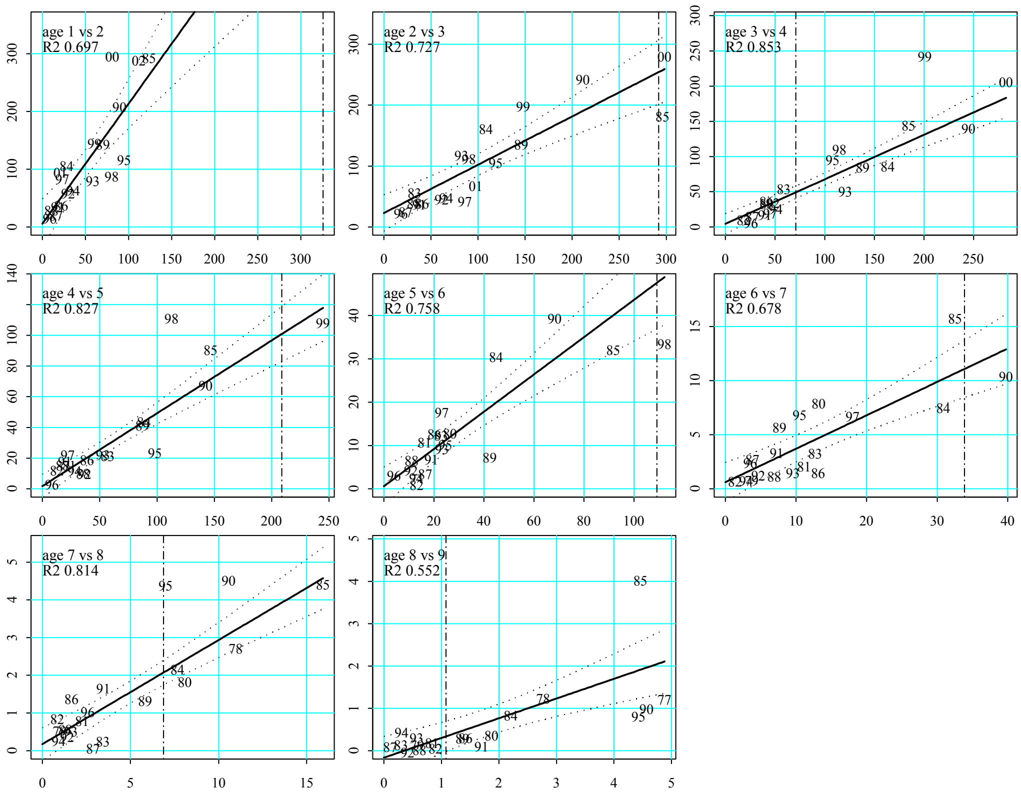


Figure 3.4.5.3 Haddock in division Va. Survey indices plotted against survey indices of the same year class one year arlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.

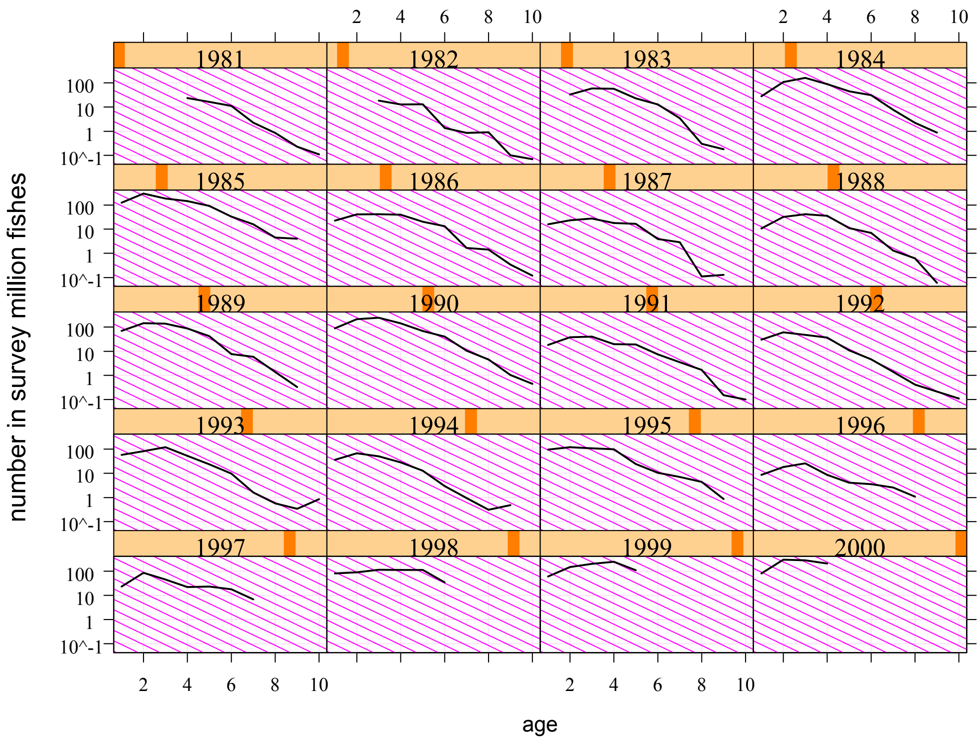


Figure 3.4.5.4 Catchcurves from the groundfish survey. Grey lines show Z=1.

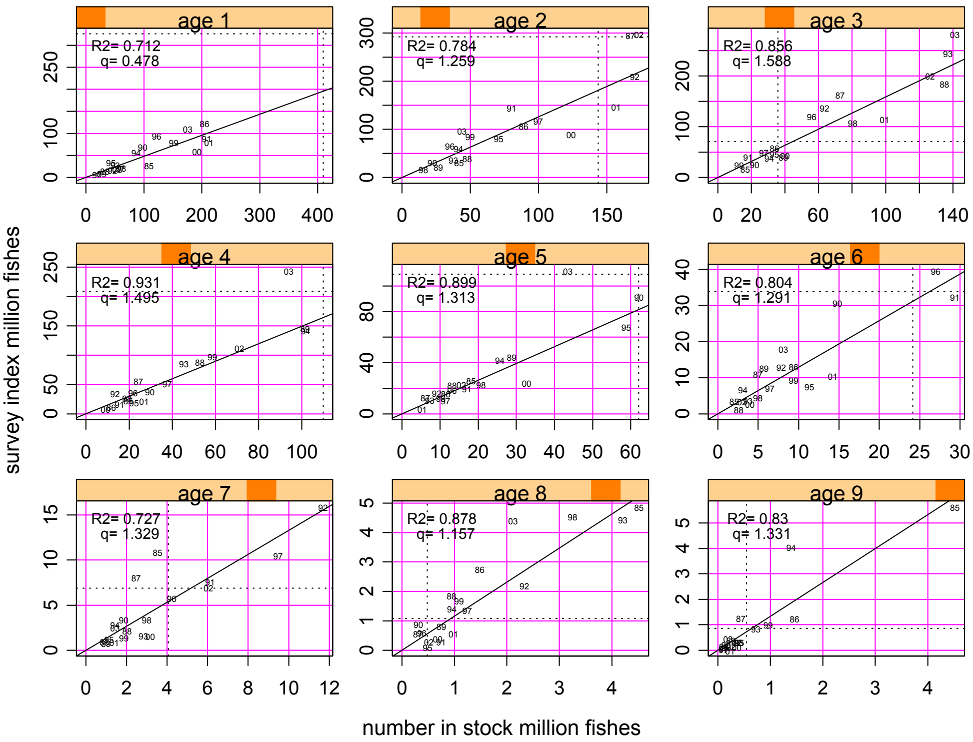


Figure 3.4.5.5 Icelandic haddock. Survey indices vs. number in stock. Line fitted through origin on original scale. . The fitted line uses the data until 1999. Dashed lines show most recent estimates.

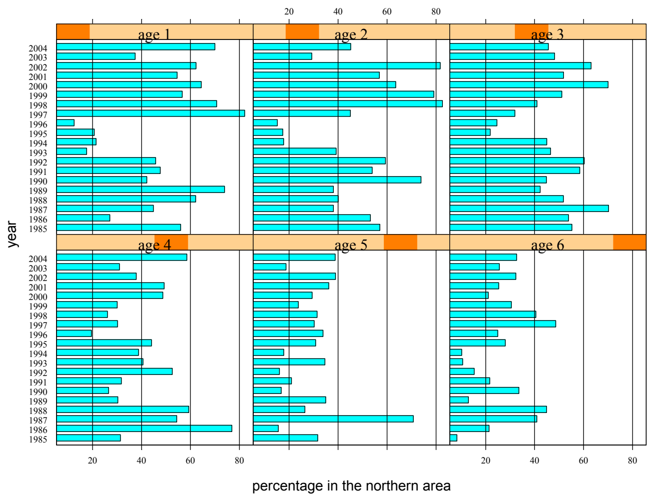


Figure 3.4.5.6. Percentage of survey index in the northern area

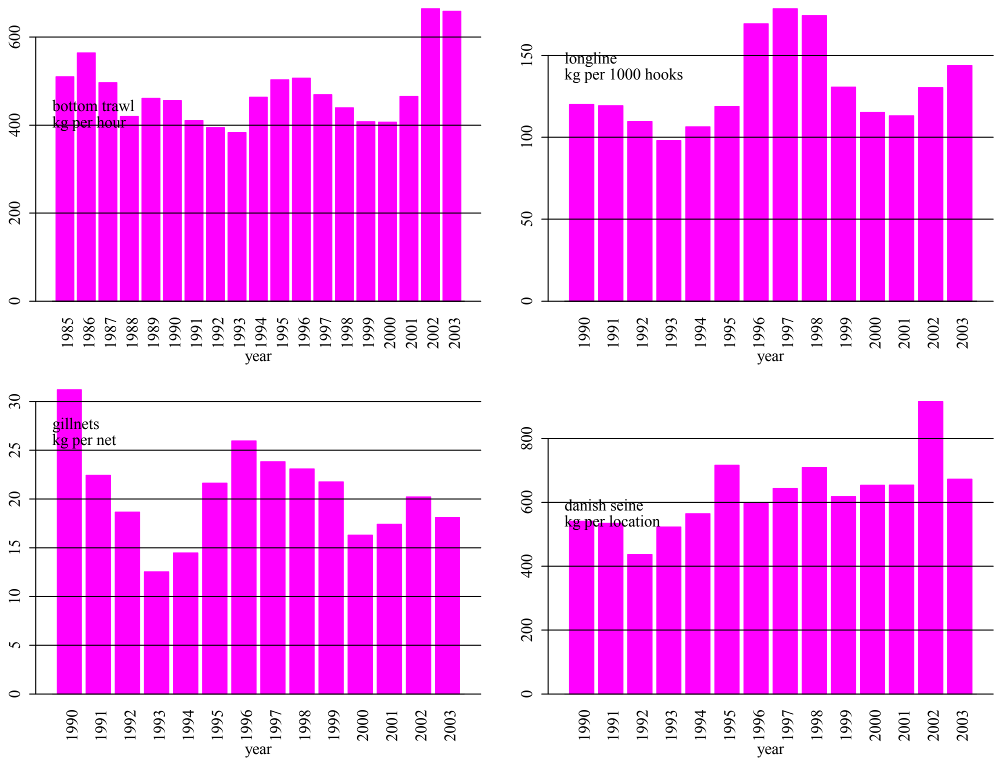


Figure 3.4.5.7. Catch per unit effort in the most important gear types. The figure is based on locations where more than 50% of the catch is haddock. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks.

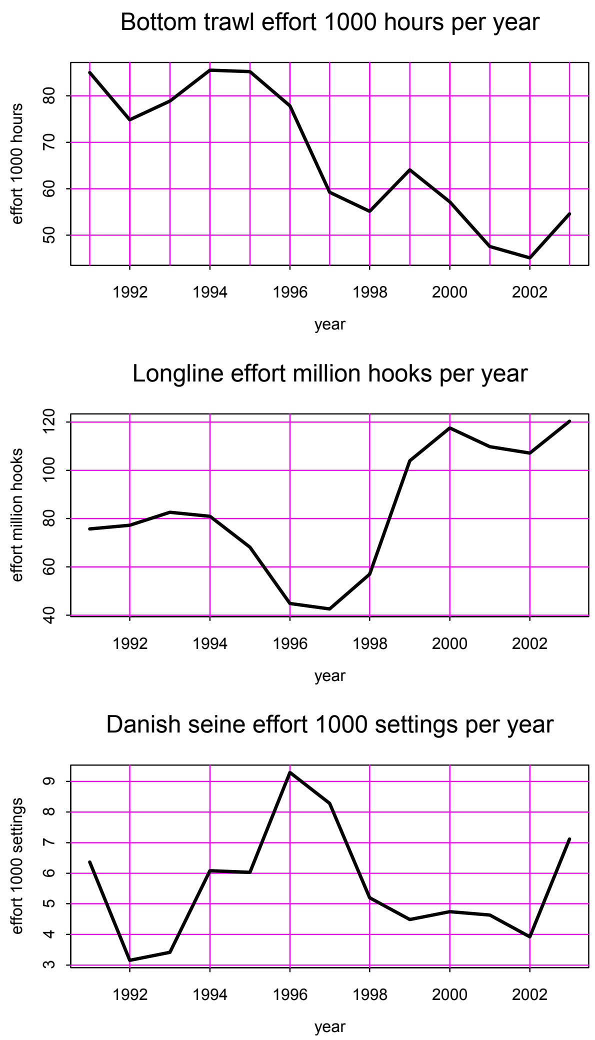


Figure 3.4.5.8. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch.

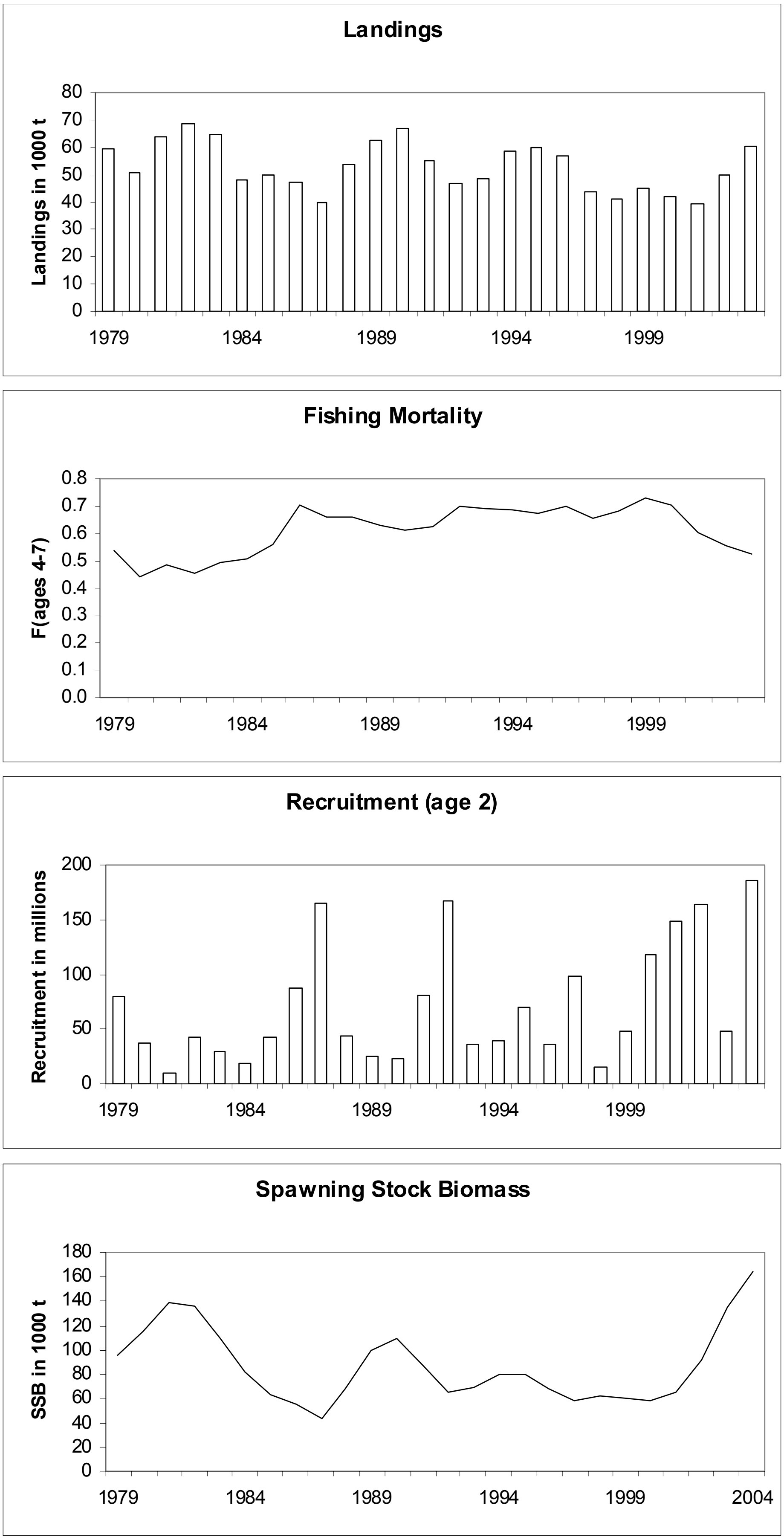


Figure 3.4.6.1. Haddock in division Va. Summary plots.

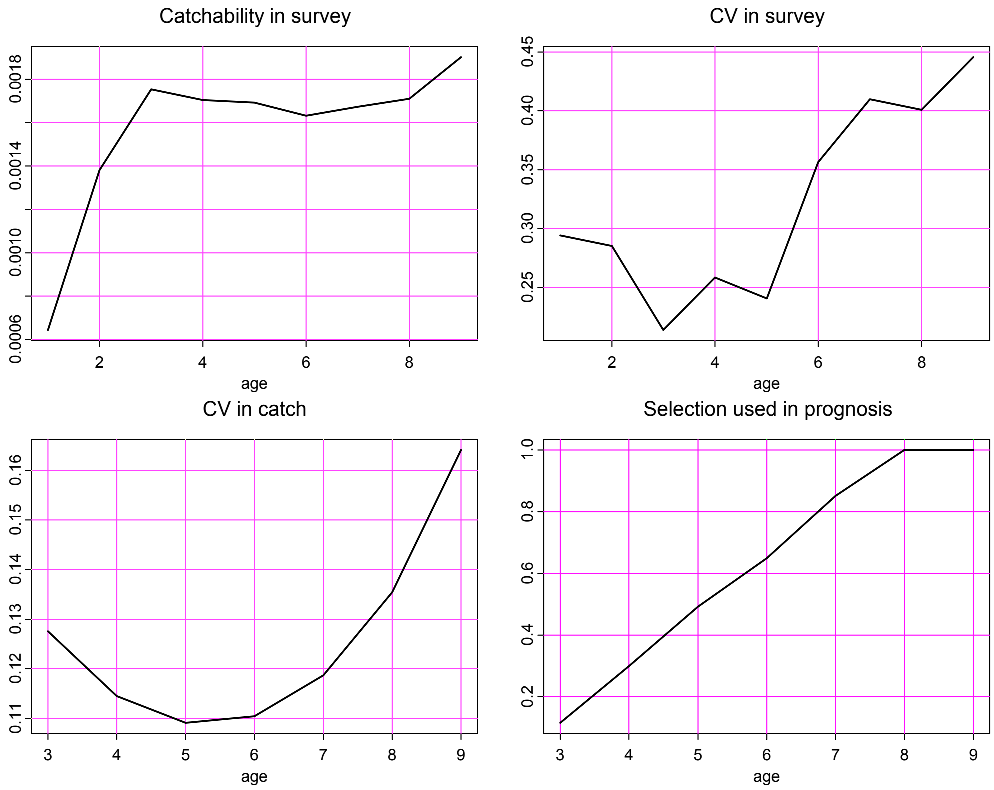


Figure 3.4.6.2. Haddock in division Va. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

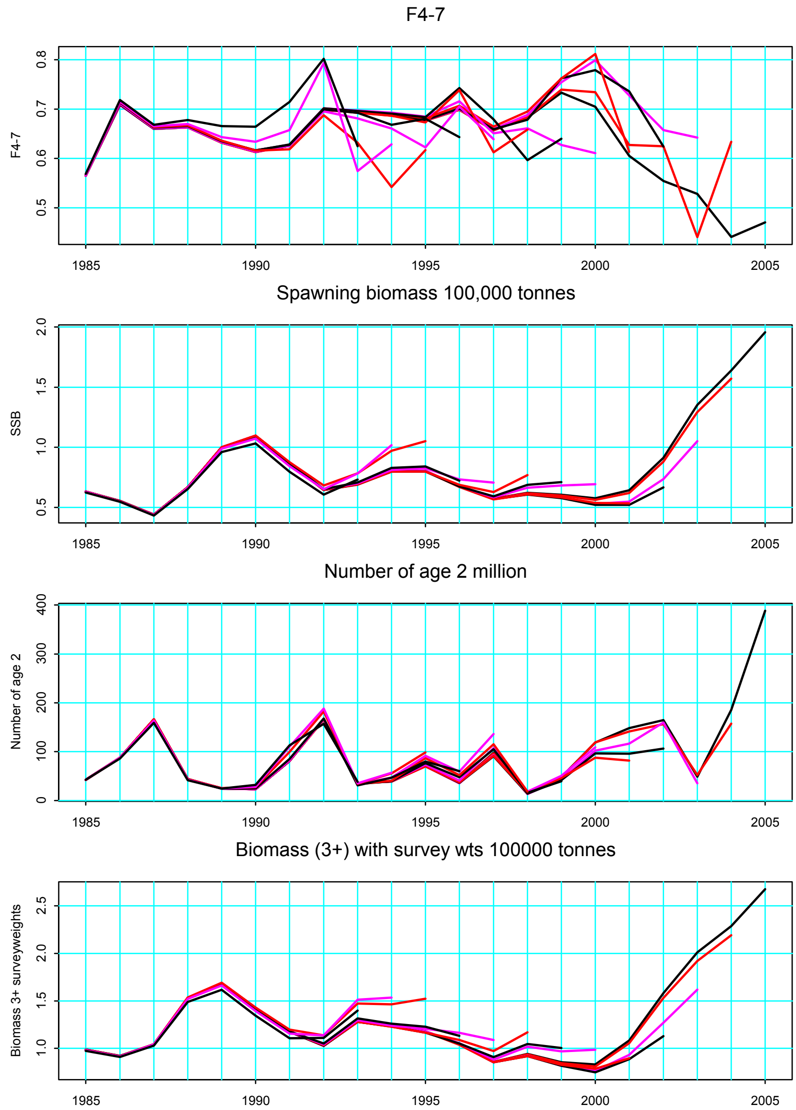


Figure 3.4.6.3 Haddock in division Va. Retrospective pattern from the ADCAM run using indices from age 1 to 9.

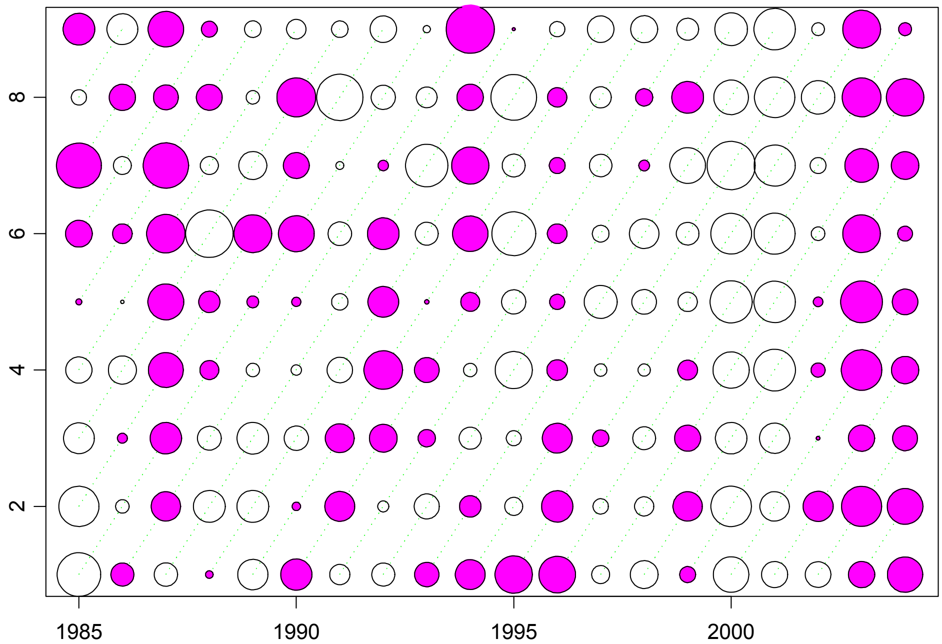


Figure 3.4.6.4 Residuals from the fit to survey data . $\frac{\log(I_{ay}+\varepsilon_{age})}{\log(I_{ay}+\varepsilon_{age})}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles

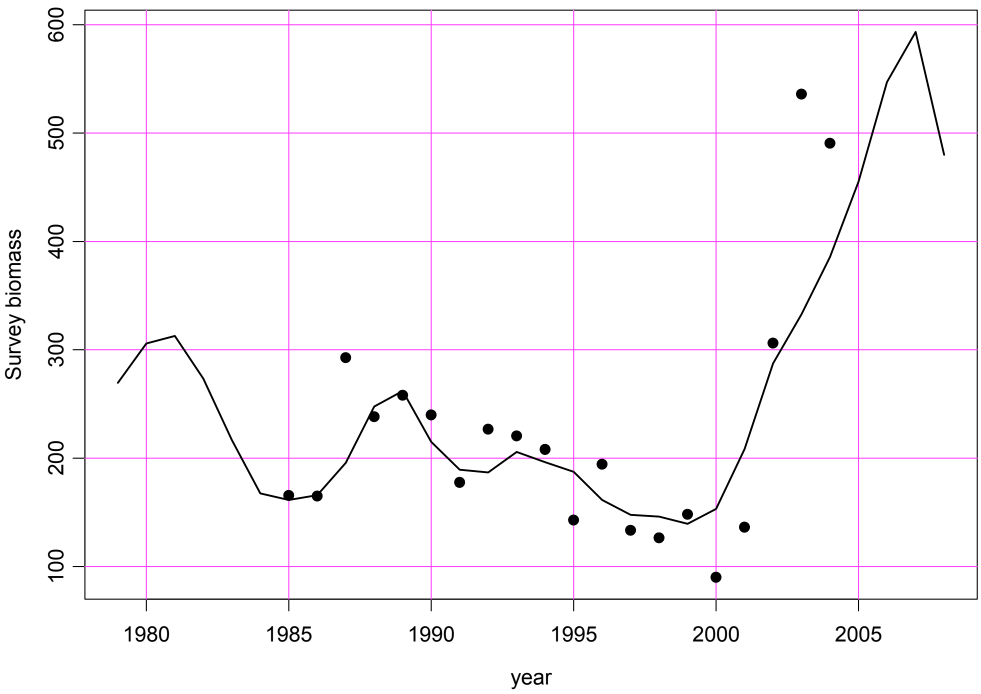


Figure 3.4.6.5 Haddock in division Va. Observed (points) and modelled (lines) survey biomass.

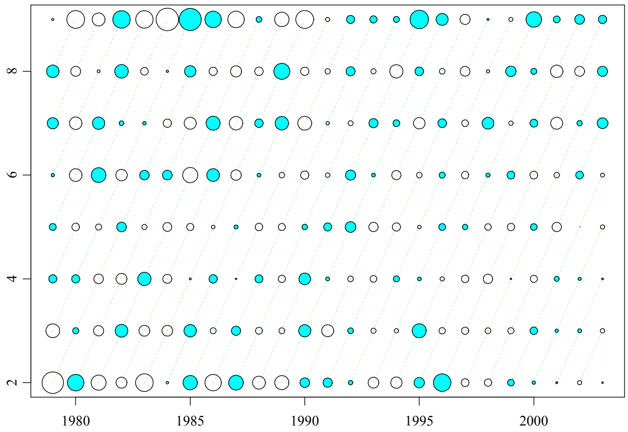


Figure 3.4.6.6 Haddock in division Va. Residuals from the model fit to catch at age data using the selected AD-cam model. .

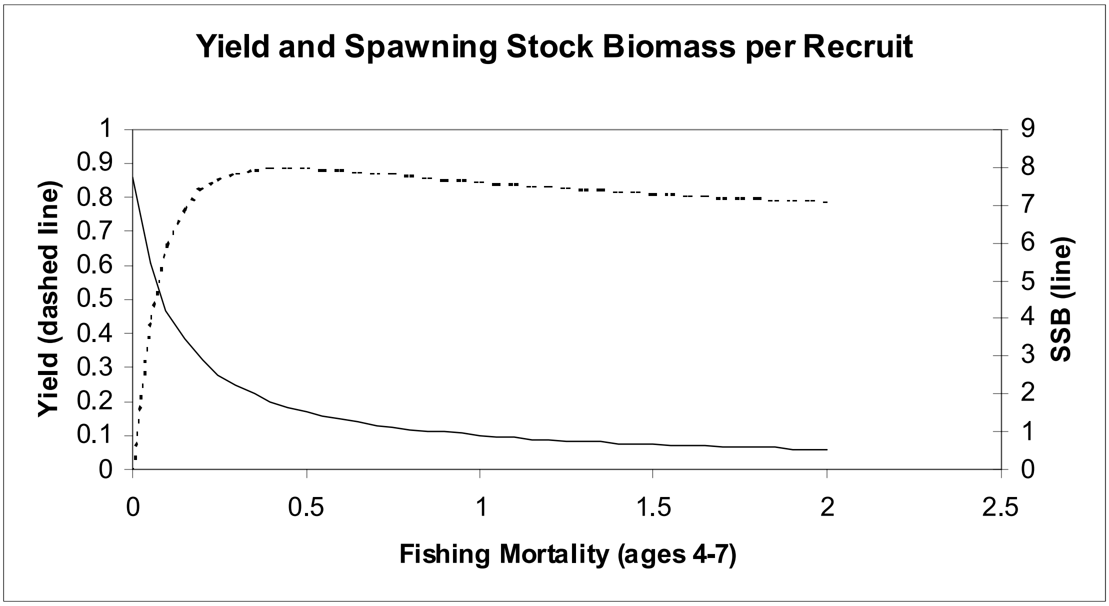


Figure 3.4.8.1 Haddock in division Va. Yield per recruit.

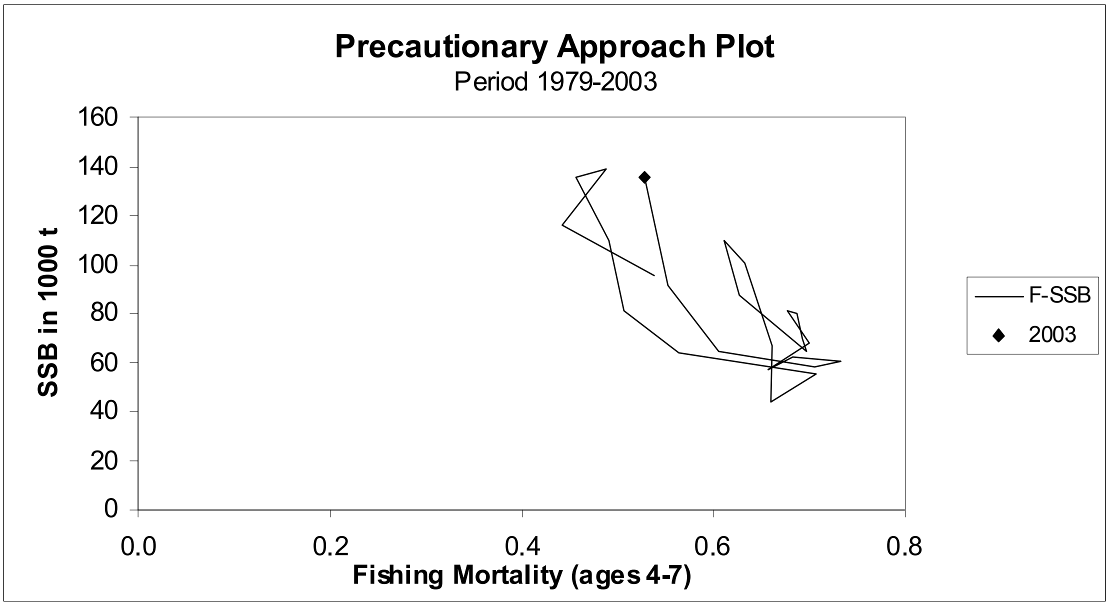


Figure 3.4.8.2 Haddock in division Va. Spawning stock vs. fishing mortality. .

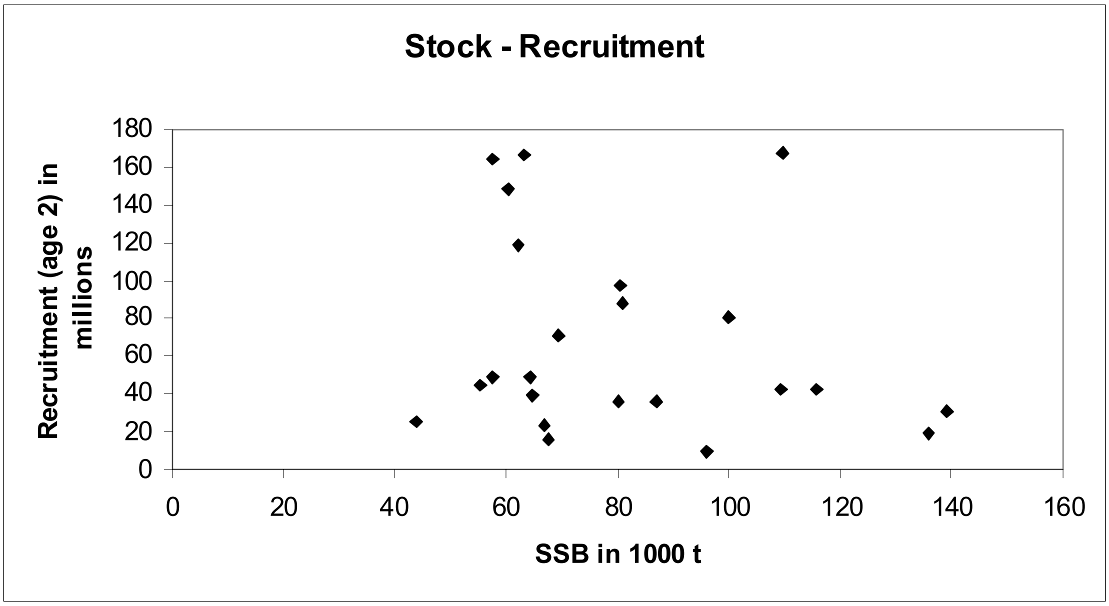


Figure 3.4.8.3 Haddock in division Va. Spawning stock vs. recruitment. . The labels in the figure show year classes.

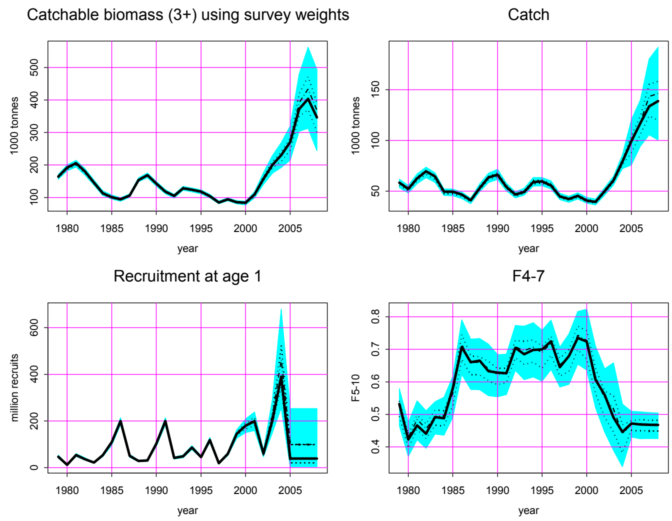


Figure 3.4.8.4 Haddock in division Va. Results from short term simulations assuming fishing at F=0.47 after 2003.

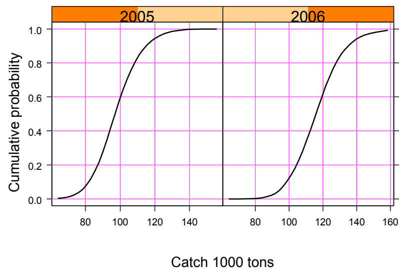


Figure 3.4.8.5 Haddock in division Va. Cumulative probability profiles of the catch in 2004 and 2005 assuming F=0.47.

4 OVERVIEW ON FISHERIES AND THEIR MANAGEMENT IN GREENLAND WATERS

4.1 Description of the fisheries

Fisheries targeting living marine resources off Greenland can be divided into inshore and offshore fleets. The Greenland fleet has been built up through the 60s and is today comprised of 450 ships with an inside motor and a large fleet of small boats. It is estimated that around 5000 small boats are dissipating in some sort of artisinal fishery mainly for private use or in the pound net fishery.

Active fishing fleet reported to Greenland statistic in 1996 – no later number are available.

All fleet (N)	<5	6-10	11-20	21-80	>80
441	31%	34%	2%	9%	6%

There is a large different between the fleet in the northern and southern part of Greenland. In south, were the cod fishery was a major recourse the average age is 22 years, in north only 9 years.

4.1.1 Inshore fleets;

The fleet are constituted by a variety of different platforms from dog sledges used for ice fishing, to small multi purpose boats engaged in whaling or deploying mainly passive gears like gill nets, pound nets, traps, dredges and long lines. West Greenland water is ice free all years up to Sisimiut at 67 ºN.

In the northern areas from the Disko Bay at 72ºN and north to Upernavik at 74º30N, dog sledge are the platforms in winter and small open vessels the units in summer, both fishing with longlines to target Greenland halibut in the icefjords. The main by-catch from this fishery is redfish, Greenland shark and roughhead grenadier.

The inshore shrimp fisheries are departed along most of the West coast from 61-72ºN. The main by-catch with the inshore shrimp trawlers is juvenile redfish, cod and Greenland halibut. An inshore shrimp fishery is conducted mainly in Disko Bay but also occasional in fjords at southwest Greenland. Most of the small inshore shrimp trawlers have dispensation for using sorting grid, which is mandatory in the shrimp fishery.

Cod is targeted all year, but with a peak time in June – July, and pound net and gill net are main gear types. By-catches are mainly the Greenland cod (*Gadus ogac*) and wolffish. There is also some directed fishery for Greenland cod in the fjords.

In the recent years there has been an increasing exploitation rate for lumpfish. Fishing season is rather short, around April and along most of the West coast the roe is landed. By-catch is mainly comprised of eiders.

The scallop fishery is conducted with dredges at the West coast from 64-72 ºN, with the main landings at 66ºN. By-catch in this fishery is considered insignificant.

Fishery for snow crab is presently the third largest fishery in Greenland waters measured by economic value. The snow crabs are caught in traps in areas 62-70ºN. Problems with by-catch are at present unknown.

A small salmon fishery with drifting nets and gillnets are conducted in August to October, regulated by a TAC.

Management of the inshore fleets is regulated by licenses, TAC and closed areas for the snow crab, scallops, salmon and shrimp. Fishery for Greenland cod, Atlantic cod and lumpfish are unregulated.

4.1.2 Offshore fleets

Apart from the Greenland fleet, Greenland living resources are exploited by several nations mainly EU, Iceland and Norway, depending on the status of various resources including exploratory fisheries and other criteria. Recently, Greenland halibut and redfish were target using demersal otter board trawls with a minimum mesh size of 130 mm.

Cod fishing has ceased since 1992 in the West Greenland offshore water but a very reduced fishery is still ongoing at the East coast. The Greenland offshore shrimp fleet consist of 15 freezer trawlers. They exclusively target shrimp stocks off West and East Greenland landing around 135 000 and 13 500 t, respectively. The shrimp fleet is close to or above 80 BT and 75% of the fleet process the shrimps onboard. They deploy shrimp trawls are acquired with a minimum mesh size of 44 mm and a mandatory sorting grid (26 mm) to avoid by-catch of juvenile fish. Even though, juveniles of redfish, Greenland halibut and cod are believed to be caught as by-catch.

The main part of the longliners are operating on the East coast with Greenland halibut as targeted species. By-catches for these longliners are roundnose grenadier, roughhead grenadier, tusk and Atlantic halibut, and Greenland shark (Gordon et al. 2003).

At the East coast an offshore pelagic fleet, are conducting a fishery on capelin (106 000t landed in 2003 by EU, Norway and Iceland). The capelin fishery is considered a rather clean fishery, without any significant by-catches. Also the pelagic red fish fishery is a clean fishery conducted in the Irminger Sea and extending south of Greenland into NAFO area. The demersal and pelagic offshore fishing is managed by TAC, minimum landing sizes, gear specifications and irregularly closed areas.

4.2 Overview of resources

In the last century the main target species of the various fisheries in Greenland waters have changed. A large international fleet landed in the 50s and 60s, large catches of cod reaching historic high in 1962 with about 450 000t. The offshore stock collapsed in the late 60s early 70s due to heavy exploitation and possible due to environmental condition. Since then the stock remained depended on occasional Icelandic larval cod transported. Since 1992 the biomass of offshore cod at West Greenland have been negligible. The TAC for cod is given to the East and West Greenland waters combined. The quota has through a longer period not been fully utilized. In 1969 the offshore shrimp fishery started and has been increasing ever since reaching a historic high of close to 150 000t in 2003.

4.3 Description of the most important commercial fishery resources - except mammals

4.3.1 Shrimp

The shrimp *Pandalus borealis* stock in Greenland water is considered in good condition. The 2003 biomass is estimated as the highest in the time series in West Greenland and stable in East Greenland. The landings in East Greenland estimated to 13 500t. and the CPUE values have been increasing since 1993. In West Greenland landings in 2003 are estimated to 135 000t.

4.3.2 Snow crab

The biomass of snow crab is believed to be decreasing in Greenland water. It has been exploited since the mid 90s in West Greenland inshore water and since 1999 at the offshore area. Total landings have been reported to amount to 12400t in 2002 the main part caught inshore. TAC for 2003 was 27 000t. CPUE have been decreasing from all offshore areas with 65% from 1999-2003.

4.3.3 Scallops

The status of scallops in Greenland is unknown. From the mid 80s to the start 90s landings were between 4-600t yearly. Since then landings have increased to around 2000t a year in 2002 the reported landings were 2240t. The fishery is based on license and is exclusively at the west coast between 20-60m. The growth rate is considered very low reaching the minimum landing size on 65mm on 10 years.

4.3.4 Squids

The status of squids in Greenland water is unknown.

4.3.5 Cod

In 2003, total landings of cod was reported as 5515t where only 300t were reported from the offshore areas. Although the landings are the highest in a 10-years period it is still only a fraction (5.5%) of the landings caught in 1990. Recruitment has been failing ever since the 1984 and 1985 year-class was observed, and no spawning takes at the moment place in the offshore waters. The present observations confirm the depleted status of the stock. The inshore fishery is not regulated and the offshore fishery is managed with license and minimum size. As a response to the favourable environmental conditions (large shrimp stock and high temperatures) cod could re-colonise the offshore areas and therefore a recovery plan is urgently required to rebuild the stock.

4.3.6 Redfish

4.3.7 Greenland halibut

Greenland halibut in the Greenland area consist of at least two stocks and more components; the status of the inshore component is not known but the component have sustained catches of 15.-20 000 t annually. The offshore stock component in NAFO SA 0+1 has remained stable in the last decade, sustaining a fishery of about 10 000 t annually. The East Greenland stock is a part of a complex distributed to Iceland and Faroe Islands. The recent status of this stock of is unknown, but in a longer time perspective the stock is at a low level.

4.3.8 Lump sucker

The status of the lumpfish is unknown. The landing of lumpfish has increased the last couple of years reaching close to 10 000t in 2003, which is more than a doubling compared to last year. Local depletion will likely occur due to a heavy exploitation.

4.3.9 Capelin

Deep sea species

Advice on demersal stocks under mixed fisheries consideration

4.4 Advice on demersal fisheries

ICES recommends a zero catch for cod in Greenland for all offshore areas. A recovery plan is recommended to ensure a sustainable increase in SSB and recruitment. Such plan must include appropriate measures to avoid any cod by-catch in other fisheries deploying mobile gears capable of catching cod. Observers must monitor functionalism of measures.

Reference

Gordon, J.D.M., Bergstad, O.A., Figueiredo, I. And G. Menezes. 2003. Deep-water Fisheries of the Northeast Atlantic: I Description and current Trends. J. Northw. Atl. Fish. Sci. Vol: 31; 37-150.

East Greenland

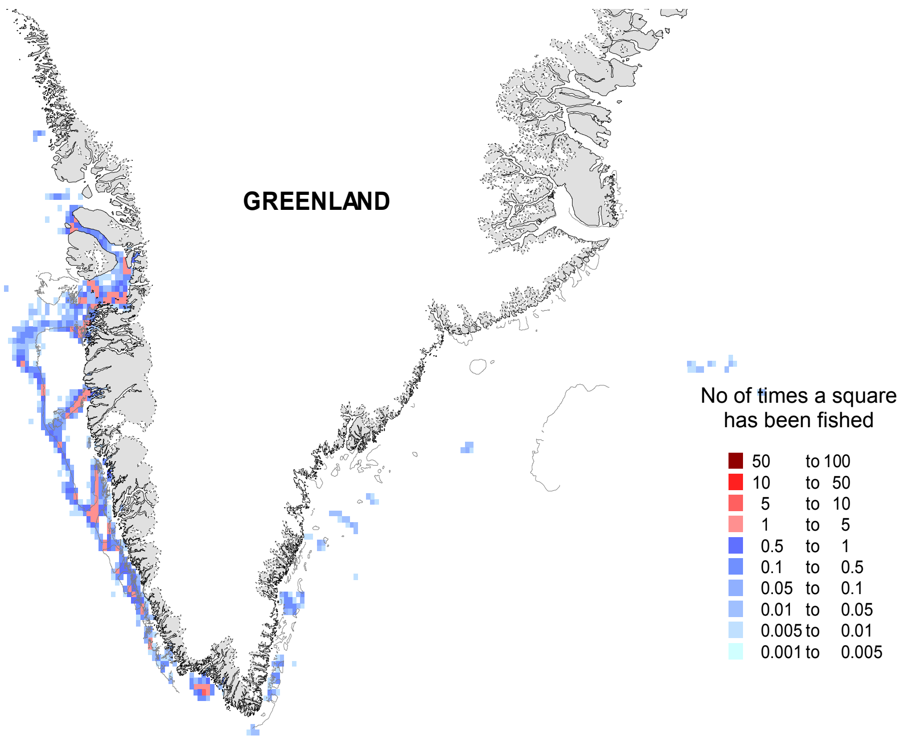
Offshore:	Vessels	tonnes	dicard
Capelin	70	117838	0
G.halibut	26	8026	10
A.Halibut	10	248	0
Shrimp	28	7349	11
S. mentella Pel.	35	10680	11
Redfish sp.	2	106	0
S.Marinus	19	366	0
Roundn. grenadier	19	104	6
Wolffish	3	10	0
Mixed quota	3	485	1

West Greenland

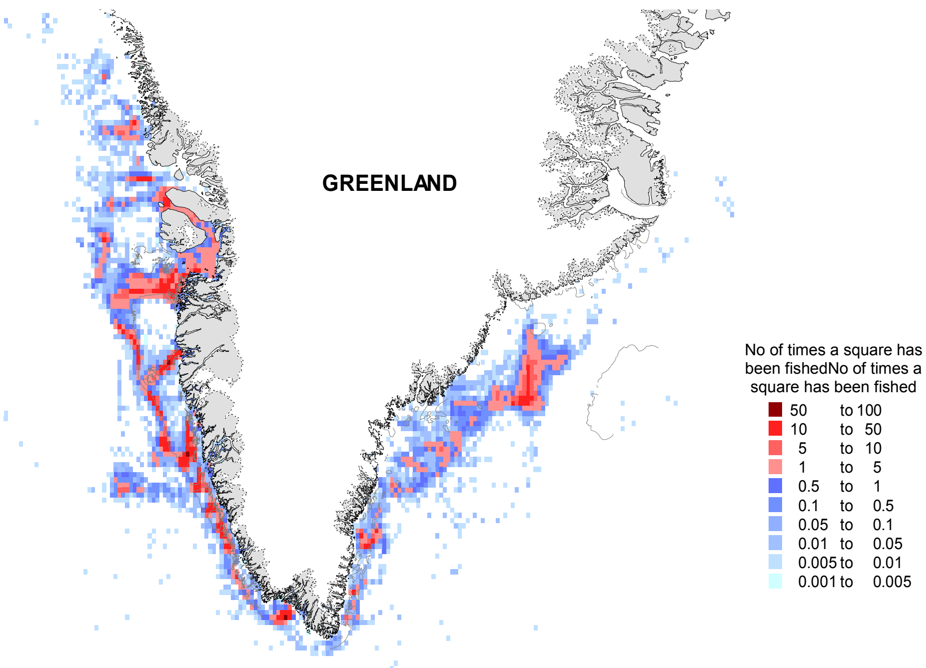
Offshore:	Vessels	tonnes	dicard
G.halibut	17	9502	18
A.halibut	1	20	0
Shrimp	20	58623	9
Redfish sp.	14	2349	0
Roundn. grenadier	7	46	30
Cod	10	728	0
Inshore:			
Snow crab	12	2802	41
Scallops	4	2215	0

*vessels number included vessels from EU, Norway and Iceland

Impact of shrimp fishery in 2002



Disturbance by fishing gear during the history of logbooks (~ 20 years)



5 COD STOCKS IN THE GREENLAND AREA (NAFO AREA 1 AND ICES SUBDIVISION XIVB)

5.1 Stock definition

Cod is described a common species in the Greenland fauna, although reaching here its ecological northern boundary. Given suitable environmental conditions, cod in the offshore areas of Greenland are considered to be self-sustaining. Stock parameters, slow growth and poor conditions (Lloret and Rätz 2000), late maturation, and highly variable recruitment strongly affected by environmental conditions, suggest that to be sustainable in long term, exploitation rates would need to be low, particularly in periods of cold water. In productive periods, higher exploitation rates could be sustainable, but it would be advisable to maintain a spawning stock biomass sufficiently large to buffer for brief periods of cold water. In resent years temperature have increased significant in Greenland water, with historic high temperatures registered in 2003 (50 years time series). Recently increased growth rates and earlier maturation as indicated from the surveys might be a response of the stock to such favourable environmental conditions.

For assessment purposes Atlantic cod in Greenland waters is separated into three components: The offshore cod in East and West Greenland waters, West Greenland inshore cod and occasionally Icelandic offspring that are transported with the Irminger current to Greenland water. Historically spawning have occurred in East Greenland offshore water between approximately 62 and 66°N (Jónsson 1959; Meyer 1963), and eggs and larvae are transported towards Southeast and West Greenland (Wieland and Hovgård 2002). In addition, migration of immature cod from East to West Greenland has been seen in some years (Rätz 1994). In west Greenland offshore waters spawning has been observed at the offshore slope of Fylla Bank at 64 °N but more frequently at the various fishing banks further south including the northern part of Julianehåb Bight at 61 °N (Jónsson 1959; Meyer 1963; Diaz 1969). Eggs and larvae are transported along the coast towards Store Hellefisk Bank at about 67 - 68 °N. Spawning have been documented for inshore areas between 64 and 67 °N, were a number of local populations exist.

5.1.1 Cod off Greenland (offshore component)

Prior to 1996, the cod stocks off Greenland have been divided into West and East Greenland or treated as one stock unit for assessment purposes to avoid migration effects. Fjord populations (inshore) have always been included. In 1996, the offshore component off West and East Greenland, the so called Bank Cod, was assessed separately as one stock unit and distinguished from the inshore populations for the first time. The completion of a re-evaluation of available German sampling data for the offshore catches back to 1955 enabled such an analysis given in the 1996 North-Western Working Group report (ICES 1996/Assess:15). Due to the severely depleted status of the offshore stock component, the directed cod fishery was given up in 1992, the final year in the VPA. Since then, no adequate data were available to update the assessment. Information on the historic VPA is available in ICES 2001/Assess:20. Therefore, the present report only includes updated survey results and catch information.

5.1.1.1 Trends in landings and fisheries (offshore component)

Officially reported landings are given in Tables 5.1.1 and 5.1.2 for West and East Greenland respectively and includes the inshore landings. Landings as used by the working group are listed in Table 5.1.3 by inshore areas for West Greenland and offshore areas for both West and East Greenland, their trends being illustrated in Figure 5.1.1.

In 1924 the offshore fishery at West Greenland took off and until 1929 the landings increased from 200t to 22000t and exceeded the level of 120 000t in 1931. The next 10 years landings were fluctuating in the range of 60 000 –130 000t (Horsted 2000). During World War II landings decreased by 1/3 as only Greenland and Portugal participated in the fishery. Less is known about cod fisheries at East Greenland waters, but since 1954 landing statistics have been available. In the next 15 years the East Greenland landings were only contributing between 2-10 % of the total offshore landings (Figure 5.1.1.). During a period from the mid 1950s to 1960 the total annual landings taken offshore averaged about 270 000t. In 1962 the offshore landings culminated with landings of 440 000t. After this historic high, landings decreased sharply by 90% to 46 000t in 1974 and even further down in 1977. The level of 40 000t was only exceeded during the periods 1982–83 and 1988–1990. A large changes in effort started in 1970, which increased during exploitation of the strong year classes born in 1973 and 1984. The offshore fishery was closed in 1986 and for the first 10 months in 1987. During 1989–91, the total landings decreased from 125 000t by more than 65% to 41 000t, in West Greenland waters the landings decreased 97% in these three years. Since 1992 no directed cod fishery has taken place offshore at West Greenland, while high quota have been available. In 2003, the officially reported landings amounted to 294t all caught in East Greenland. From total offshore landings, 2t or less than 1% was reported as by-catch in other fisheries. No reports on discards have been available.

Age-1 cod is believed to be caught as by-catch in the shrimp fishery mainly at West Greenland, however no official registrations are available on this subject.

Logbook information about commercial catches and effort has been available from 1990-2003 from the offshore fishery in East Greenland. High landings occurred in the early 1990s reaching close to 35 000t. Since 1994 landings have fluctuated at low levels between 100- 500t. A weighted mean of the CPUE and a GLM model were estimated in the time period to analyse any trends in the stock size. It shows that CPUE decreased dramatically in the early 1990s (5.1.11.). The trend in weighted mean shows a small increase in 1997, but this is probably doe to increased fishing power, as the GLM model does not mirror this increase. Both the GLM model and the weighted mean show a small increase in CPUE in 2003. The result of the model should not be interpreted as an indicatior of biomass trends as it comprises 1260 factors and only 221 observations, hence only 17% of the cells were accounted for and specially in the last years few ships were accounting for the catches. In 2003, 6 vessels had cod as main target, 1 German, 2 Greenlandic and 3 from the Faroe Island, all used demersal otter board trawls equipped with a mesh size in the codend between 140-145mm.

Miscellaneous gears, mainly long lines and gill nets, contributed 30–40% until 1977 but have disappeared since then (Horsted 2000). At the moment otter trawl board catches (OTB) are the only operating fishing gear and have been the most important throughout the time series for offshore fisheries.

5.1.2 Surveys (offshore component)

5.1.2.1 Results of the German groundfish survey off West and East Greenland

Annual abundance and biomass indices have been derived using stratified random groundfish surveys covering shelf areas and the continental slope off West and East Greenland. Surveys commenced in 1982 and were primarily designed for the assessment of cod (*Gadus morhua* L.). A detailed description of the survey design and determination of these estimates was given in the report ICES 1993/Assess:18 and Working Doc. 12/2004. Figure 5.1.2 indicate names of the 14 strata, their geographic boundaries, depth ranges and areas in nautical square miles (nm^2). All strata were limited at the 3 mile line offshore except for some inshore regions off East Greenland where there is a lack of adequate bathymetric measurements. In 1984, 1992, and 1994 the survey coverage was incomplete off East Greenland and in 1995 and 2002 in West Greenland partly due to technical problems (Working Doc. 12/2004).

5.1.2.1.1 Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–2003. Trends of the biomass estimates for West and East Greenland are shown in Figure 5.1.3, including the spawning stock. The figure illustrate the pronounced increase in stock abundance and biomass indices from 23 million individuals and 45 000t in 1984 to 828 million individuals and 690 000t in 1987. This trend was the result of the recruitment of the predominating year classes 1984 and 1985, which were mainly distributed in the northern and the shallow strata off West Greenland during 1987–89. Such high indices were never observed in strata off East Greenland, although their abundance and biomass estimates increased during the period 1989–91 suggesting an eastward migration. During the period 1987–89, which were years with high abundance, the precision of survey indices was extremely low due to enormous variation in catch per tow data. Since 1988, stock abundance and biomass indices decreased dramatically by 99% to only 5 million fish and 6 000t in 1993. The 2003 survey results confirmed the severely depleted status of the stock, although they represent the highest stock size in 13 years (less than 5% of the abundance in 1987) and indicates a significant recovery signal. The total abundance and biomass indices amounted to 25 million individuals and 53 000t, respectively, were 77% of the stock in numbers were distributed off East Greenland.

5.1.2.1.2 Age composition

Age disaggregated abundance indices for West, East Greenland and total are listed in Tables 5.1.5–7, respectively, and are based on 1 242 individual age determinations. The recruiting year classes 1998-2002 are considered weak as compared to the strong 1984- and 1985-year classes. The year class 2002 at age 1 however is estimated as the third strongest year class in West Greenland since 1982 and thus to provide some recovery potential in the next few years. The 1999 year class which has earlier been considered relatively strong, are still as age group 4 the third strongest at the East coast, but nearly absent from the west coast. The 0- group indices are considered unrepresentative of year class strength due to gear specifications while the age groups 1 and 2 seem to be quantitatively estimated and to represent a reasonable recruitment index (Figure 5.1.5), the latter being more precise. With this in mind the 0-group index in 2003 from East Greenland waters is by far the largest in the time series (Table 5.1.6.) but there is no basis to predict its size at age 3.

5.1.2.1.3 Mean length at age

The trends of the mean length of the age groups 1–10 years for West and East Greenland are illustrated in Figure 5.1.6 and 5.1.7 respectively for the period 1982–2003. They reveal pronounced area and temperature effects. Age groups 3–10 years off East Greenland were found to be significant longer than those off West Greenland. Driven by the high abundance of cod off West Greenland, weighted mean length and weight for the age groups 1–5 displayed a decrease during 1986–87 and remained at low levels until 1991. Since then, the length at age at ages 3 to 8 years increased significantly and remained at that high level until 2000, when low values were recorded. The 2003 values for East Greenland indicate a small increase in length for the youngest age classes and a stable length for the older age classes. In West Greenland waters a small increase have been registered for all age groups. Mean weight at age can be obtained from regression $f(x)= 0.00895x^{3.00589}$, X=length in cm, the equation has been determined on the basis of historic measurements.

5.1.2.2 Results of the Greenland groundfish survey off West Greenland

Since 1988, the Greenland Institute of Natural Resources has annually conducted a stratified-random trawl survey off West Greenland from July to September (Working Doc. 3/2004). The main purpose of the survey is to evaluate the biomass and abundance of Northern shrimp (*Pandalus borealis*), but since 1992 data on most fish spices have been recorded. The survey covers the offshore areas at West Greenland between 59°00'N and 72°30'N from the 3-mile limit to the 600m (Figure 5.1.8). The survey area is divided into 6 NAFO Divisions, and further subdivided into three depth strata (0-200, 201-400 and 401-600m) on basis of depth contour lines. A minimum of two hauls per stratum is always planned. In 2002 and 2003 the stratification of the survey area changed due to reanalysed depth information, with more detailed information on the isobaths in the area north from 69°30’N and the Julianehåb Bay. The trawl is an Skjervoy 3000/20 with bobbin gear and double bag. The mesh size in the codend is 20 mm. and standard trawling time offshore is 15-30 minutes at a mean towing speed of 2.5 knots. Cod smaller than approximately 20 cm are caught insufficiently due to the distance between the fishing line and the bottom. Stratified abundance and biomass estimates were calculated from catch-per-tow data using the stratum areas as weighting factor (Cochran, 1953). The coefficient of catchability was set at 1.0, implying that estimates are merely indices of abundance and biomass. Confidence intervals (CI) were set at the 95% level of significance of the stratified mean.

5.1.2.2.1 Stock abundance indices

The biomass indices for cod were estimated to be between 4-7000t in the period 1988-1990. In 1992 the biomass decreased with more than 95% to only 217t and remained at this low level until recent years. In 2001 and 2002 a slight increase was detected in the biomass index but in 2003 the biomass level was estimated to be close to 1250t a reduction of 35% compared to last year. Abundance was estimated to be 3.1 millions which is the second highest number in the time series (1992-2003), but a reduction at 25% compared to 2002 (Table 5.1.8 and 5.1.9).

5.1.2.2.2 Age composition

Age disaggregated abundance indices are listed in Table 5.1.10. In 2001, the recruiting year classes 1997, 1998 and 1999 dominated the stock by 94% with equal shares. In 2002, year class 1998 and 1999 contributed to nearly 80% of the total abundance. Their abundance at ages 3 and 4 represent highest values of the time series. Age disaggregated abundance indices for West Greenland indicates occurrence of few year-classes and a dominance of year-class 1998 and 1999. a dominance of year-class 2001 contributing to more than 45% of the total abundance. In 2002, age length keys were determined on the basis of 582 otoliths.

5.1.3 Biological sampling of commercial catches

No commercial sampling data were available to assess recent catch in numbers, weight and maturity at age for the offshore areas.

The working group strongly recommends to conduct sampling of commercial catches from the East Greenland offshore areas with the purpose to update the assessment from 1996.

5.1.4 State of the stock

A historic XSA tuning was run in 1996 with the final year as 1992 and the output is illustrated in figure 5.1.8. and 5.1.9. The plots indicate the very high and fluctuating fishing mortality as well as periodic good year classes.

The two surveys, the German survey off West and East Greenland and the Greenland shrimp survey off West Greenland, do confirm that the offshore component of the cod off Greenland remains at a very low level.

Both surveys indicate increased recruitment of the year classes 1997, 1998, 1999, 2000 and 2002, the year class 1999 being the third strongest at age 2 since 1982 in the German survey. However, the recruiting year classes were estimated to be less than 10 % of the most recent strong year class of 1984. Although rebuilding to previous high stock sizes cannot be expected to occur based on these year classes, they suggest that the process of rebuilding may have begun.

The age composition of the stock off West Greenland indicates high mortality rates of juvenile cod during the past decade.

The former VPA assessment of the offshore cod stocks off Greenland revealed that over-fishing was an important cause for the collapse of this unit in the beginning of the 70s. Since that time, the spawning stock has remained below 100 000 t and has not been able to produce adequate recruitment. Relatively strong year class were produced in 1973 and 1984 despite the low SSBs, but these are believed to have emigrated from Iceland as larvae. The migration back to Iceland as mature fish further diminished the contribution of those year classes to local egg production. Recruitment pulses from Iceland could contribute to a substantial recovery of the offshore component in the short term. However, strong recruitment pulses are rare events (2 known occurrences in the last 30 years). The links between the cod stocks off Iceland, Greenland and along the Canadian Atlantic shelves through egg and larval drifts were currently investigated by an ICES/GLOBEC project (Wieland and Hovgård, 2002).

5.1.5 Management considerations

As a response to the favourable climate and biological conditions (large shrimp stock and high temperatures) cod could re-colonises the offshore areas and therefore a recovery plan is urgently required to protect the remaining biomass of offshore cod. No fishing should take place until a substantial increase in stock size is evident.

Effective technical measures should be maintained to avoid the by-catch of juvenile cod that are essential to enhance the recovery potential of the stock.

5.1.6 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 for all other years. 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.

An XSA was attempted in 2004 but not accepted due to incomplete catch at age numbers. Therefore, no XSA tuning has been applied since 1997 when low levels in landings, effort and stock abundance were observed. In 1984, 1992 and 1994 the age disaggregated survey indices were derived from incomplete coverage of the survey area.

References:

Buch, E., Horsted, S.A., and Hovgård, H. 1994. Fluctuations in the occurrence of cod in Greenland waters and their possible causes. ICES Mar. Sci. Symp. 198: 158-174.
Diaz, M.L. 1969. Portuguese research report, 1968. ICNAF Redbook 1969 Part II: 76-88.
ICES 1993 Report of the North Western Working Group. ICES CM 1993/Assess:18.
ICES 1996 Report of the North Western Working Group. ICES CM 1996/Assess:15.
ICES 2000 Report of the North Western Working Group. ICES CM 2000/ACFM:19.
ICES 2001 Report of the North Western Working Group. ICES CM 2001/ACFM:20
ICES 2002 Report of the North Western Working Group. ICES CM 2002/ACFM:20
ICES 2003 Report of the North Western Working Group. ICES CM 2003/ACFM:24
Hansen, P.M. 1949. Studies on the biology of the cod in Greenland waters. Rapp. P.-v. Réun. Cons. int. Explor. Mer 123: 1-77.

Hjørleifsson, E. 2003. Excel Statistical Catch at Age Model (EXCAM) analysis of Greenland cod. Working document 32, ICES North Western Working Group 2003.

Horsted, Sv. A. 1994. A Review with some Proposals for Amendments of the Catch Statistics for the Cod Fisheries in Greenland Waters since 1911. NAFO SCR Doc. 94/38, Ser. No. N2407

Horsted, S.A. 2000. A review of the cod fisheries at Greenland, 1910-1995. J.Northw.Atl.Fish.Sci. 28: 1-112.

Hovgård, H. and Christensen, S. 1990. Population structure and migration patterns of Atlantic cod at West Greenland waters based on tagging experiments from 1946 to 1964. NAFO Sci. Coun. Studies 14: 45-50.

Jónsson, J. 1959. Icelandic cod investigations in Southwest and Southeast Greenland waters, 1957. Annls. Biol. 14: 115-118.

Lewy,P., Nielsen, J.R. and Hovgård, H. 2004. Survey gear calibration independent of spatial fish distribbution. Can. J. Of Fish. And Aqu. Sci. In press.

Lloret, J. and H.-J. Rätz. 2000. Condition of cod (Gadus morhua) off Greenland during 1982-1998. Fisheries Research, 48 (1) (2000) pp. 79-86

Meyer, A. 1963. Greenland cod, German investigations, 1961. Annls. Biol. 18: 114-118.

Rätz, H.-J. 2003. Groundfish survey results for cod off Greenland (offshore component) 1982-2002. Working document 3, ICES North Western Working Group 2003.

Rätz, H.-J. 1994. Assessment of migration of Atlantic cod (*Gadus morhua*) between the stocks of West and East Greenland in 1984-86 by means of otolith typing. NAFO Sci. Coun. Studies 16: 7-18.

Smidt, E. 1979. Annual cycles of primary production and of zooplankton at Southwest Greenland. Meddelser om Grønland, Bioscience 1: 1-53.

Storr-Paulsen, M. 2003. Cod stock investigations off West Greenland. Working document 16, ICES North Western Working Group 2003.

Wieland, K. and H. Hovgård, 2002. Distribution and of Atlantic cod (*Gadus morhua*) eggs and larvae in Greenland offshore waters. J. Northw. Atl. Fish. Sci. 30: 61-76.

Table 5.1.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2003 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	-	-	51	1	-	-	-	-
Germany	6.574	12.892	7.515	96	-	-	-	-
Greenland	52.135	92.152	58.816	20.238	5.723	1.924	2.115	1.710
Japan	10	-	-	-	-	-	-	-
Norway	7	2	948	-	-	-	-	-
UK	927	3780	1.631	-	-	-	-	-
Total	59.653	108.826	68.961	20.335	5.723	1.924	2.115	1.710
WG estimate	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-	-	-

Country	1996	1997	1998	1999	2000	2001	2002[1]	2003[1]
Faroe Islands	-	-						
Germany	-	-						
Greenland	948	904	319	622	764	1680	3698	3989
Japan	-	-						
Norway	-	-						693 [5]
UK	-	-						
Togo								533 [5]
Total	948	904	319	622	764	1680	3698	5215
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
[5]) Transshipment from local inshore fishers

Table 5.1.2 Nominal catch (t) of cod in ICES Sub-area XIV, 1988-2003 as officially reported to ICES.

Country	1988	1989	1990	1991	1992	1993	1994	1995
Faroe Islands	12	40	-	-	-	-	1	-
Germany	12.049	10.613	26.419	8.434	5.893	164	24	22
Greenland	345	3.715	4.442	6.677	1.283	241	73	29
Iceland	9	-	-	-	22	-	-	1
Norway	-	-	17	828	1.032	122	14	+
Portugal								
Russia		-	-	-	126		-	-
UK (Engl. and Wales)	-	1.158	2.365	5.333	2.532	-	-	232
UK (Scotland)	-	135	93	528	463	163	-	-
United Kingdom	-	-	-	-	-	46	296	
Total	12.415	15.661	33.336	21.800	11.351	-	408	284
WG estimate	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-	736	-	-

Country	1996	1997	1998	1999	2000	2001	2002[5]	2003[5]
Faroe Islands	-	-	-	6				
Germany	5	39	128	13	3	92	5	1
Greenland	5	32	37 [5]	+ [5]		4	232	78
Iceland	-	-		-	-	210		
Norway	1	-	+	2	- [5]	43	13	
Portugal			31	-	-	278		
Russia	-	-						
UK (E/W/NI)	181	284	149	95	149	129		
UK (Scotland)	-	-						
United Kingdom							34	
Total	192	355	345	116	152	756	284	79
WG estimate	-	-	-	-	-		448[6]	294[7]

[1]) Excluding 3,000t assumed to be from NAFO Division 1F and including 42t taken by Japan
[2]) Excluding 2,74 t assumed to be from NAFO Division 1F and including 1,500t reported from other areas assumed to be from Sub-area XIV and including 94t by Japan and 155t by Greenland (Horsted, 1994)
[3]) Includes 129t by Japan and 48 t additional catches by Greenland (Horsted, 1994)
[4]) Includes 18t by Japan
[5]) Provisional data
[6]) Includes 164t from Faroe Islands
[7]) Includes 215t from Faroe Islands

Table 5.1.3 Cod off Greenland (offshore component). Catches (t) from 1924 – 2003 as used by the Working Group, inshore and offshore by NAFO div 1Band 1D offshore divided into East and West Greenland. Based on Horsted (1994, 2000).

Cod	**Inshore**			**Offshore**			Total
Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1924	131	221	843		200	200	1043
1925	122	318	1024		1871	1871	2895
1926	97	673	2224		4452	4452	6676
1927	282	982	3570		4427	4427	7997
1928	426	1153	4163		5871	5871	10034
1929	1479	1335	7080		22304	22304	29384
1930	2208	1681	9658		94722	94722	104380
1931	1905	1520	9054		120858	120858	129912
1932	1713	1042	9232		87273	87273	96505
1933	1799	1148	8238		54351	54351	62589
1934	2080	952	9468		88122	88122	97590
1935	1870	769	7526		65846	65846	73372
1936	2039	705	7174		125972	125972	133146
1937	1982	854	6961		90296	90296	97257
1938	1743	703	5492		90042	90042	95534
1939	2256	896	7161		89807	89807	96968
1940	2478	1061	8026		43122	43122	51148
1941	3229	823	8622		35000	35000	43622
1942	3831	1332	12027		40814	40814	52841
1943	5056	1240	13026		47400	47400	60426
1944	4322	1547	13385		51627	51627	65012
1945	4987	1207	14289		45800	45800	60089
1946	5210	1438	15262		44395	44395	59657
1947	5261	2096	18029		63458	63458	81487
1948	5660	1657	18675		109058	109058	127733
1949	4580	2110	17050		156015	156015	173065
1950	6358	2357	21173		179398	179398	200571
1951	5322	2571	18200		222340	222340	240540
1952	4443	2437	16726		317545	317545	334271
1953	5030	5513	22651		225017	225017	247668
1954	6164	3275	18698	4321	286120	290441	309139
1955	5523	4061	19787	5135	247931	253066	272853
1956	5373	5127	21028	12887	302617	315504	336532
1957	6146	5257	24593	10453	246042	256495	281088
1958	6178	5456	25802	10915	294119	305034	330836
1959	6404	5009	27577	19178	207665	226843	254420
1960	6741	3614	27099	23914	215737	239651	266750
1961	6569	4178	33965	19690	313626	333316	367281
1962	7809	3824	35380	17315	425278	442593	477973
1963	4877	2804	23269	23057	405441	428498	451767
1964	3311	8766	21986	35577	327752	363329	385315
1965	5209	6046	24322	17497	342395	359892	384214
1966	8738	7022	29076	12870	339130	352000	381076
1967	5658	6747	27524	24732	401955	426687	454211
1968	1669	6123	20587	15701	373013	388714	409301
1969	1767	7540	21492	17771	193163	210934	232426

Table 5.1.3 Cod off Greenland (offshore component). Continued.

Year	Nafo 1 B	Nafo 1D	Total inshore	East	West	Total offshore	Greenland
1970	1469	3661	15613	20907	97891	118798	134411
1971	1807	3802	13506	32616	107674	140290	153796
1972	1855	3973	14645	26629	95974	122603	137248
1973	1362	3682	9622	11752	53320	65072	74694
1974	926	2588	8638	6553	39396	45949	54587
1975	1038	1269	6557	5925	41352	47277	53834
1976	644	904	5174	13027	28114	41141	46315
1977	580	2946	13999	8775	23997	32772	46771
1978	1587	2614	19679	7827	18852	26679	46358
1979	1768	6378	35590	8974	12315	21289	56879
1980	2303	7781	38571	11244	8291	19535	58106
1981	2810	6119	39703	10381	13753	24134	63837
1982	2448	7186	26664	20929	30342	51271	77935
1983	2803	7330	28652	13378	27825	41203	69855
1984	3908	5414	19958	8914	13458	22372	42330
1985	2936	1976	8441	2112	6437	8549	16990
1986	1038	1209	5302	4755	1301	6056	11358
1987	2995	8110	18486	6909	3937	10846	29332
1988	6294	2992	18791	12457	36824	49281	68072
1989	8491	8212	38529	15910	70295	86205	124734
1990	9857	9826	28799	33508	40162	73670	102469
1991	8641	2782	18311	21596	2024	23620	41931
1992	2710	1070	5723	11349	4	11353	17076
1993	323	968	1924	1135	0	1135	3059
1994	332	914	2115	437	0	437	2552
1995	521	332	1710	284	0	284	1994
1996	211	164	948	192	0	192	1140
1997	446	99	1186	370	0	370	1556
1998	118	78	323	346	0	346	669
1999	142	336	622	112	0	112	734
2000	266	332	764	100	0	100	864
2001	1183	54	1680	221	0	221	1901
2002	1803	214	3698*	448	0	448	4146*
2003	1522	274	5215*	286	7	293	5515*

Table 5.1.4 Cod off Greenland (offshore component), German survey. Abundance (1000) and biomass indices (t) for West, East Greenland and total by stratum, 1982-2003. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

YEAR	Abundance WEST	Abundance EAST	Abundance TOTAL	Abundance CI	Abundance Spawn. St.	Biomass WEST	Biomass EAST	Biomass TOTAL	Biomass CI	Biomass Spawn. St.
1982	92276	8090	100366	28	33793	128491	23617	152107	25	79511
1983	50204	7991	58195	25	23889	82374	34157	116531	25	57223
1984	16684	(6603)	(23286)	32	17653	25566	(19744)	(45309)	34	36162
1985	59343	12404	71747	33	17349	35672	33565	69236	39	45630
1986	145682	15234	160915	32	14350	86719	41185	127902	26	48976
1987	786392	41635	828026	59	25467	638588	51592	690181	63	65584
1988	626493	23588	650080	48	128578	607988	52946	660935	46	155556
1989	358725	91732	450459	59	332589	333850	239546	573395	46	514773
1990	34525	25254	59777	43	46355	34431	65964	100395	34	77064
1991	4805	10407	15213	29	6404	5150	32751	37901	36	17756
1992	2043	(658)	(2700)	50	560	607	(1216)	(1823)	69	1091
1993	1437	3301	4738	36	2327	359	5600	5959	41	4024
1994	574	(801)	(1375)	36	457	140	(2792)	(2930)	68	1732
1995	278	7187	7463	93	2340	57	15525	15581	155	10445
1996	811	1447	2257	38	592	373	3599	3973	56	2017
1997	315	4153	4469	75	3411	284	13722	14007	90	10416
1998	1723	1671	3394	54	1133	130	4348	4479	91	3820
1999	912	2769	3681	34	809	240	3917	4157	62	3004
2000	1926	4816	6742	36	3556	570	4778	5349	40	4176
2001	8160	7604	15764	39	8252	2666	15271	17937	42	13381
2002	4121	9691	13812	41	11689	2110	19726	21836	51	21299
2003	5632	19904	25537	45	19520	2264	50867	53131	73	50967

Table 5.1.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2003. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5).

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	884	33470	11368	32504	9528	2622	578	939	91	90	92250
*1983	0	0	1469	2815	26619	4960	10969	1882	992	317	168	13	50204
1984	159	5	38	2070	1531	9848	842	1873	87	186	27	0	16666
1985	831	38016	1481	948	6403	2833	7682	467	646	27	35	0	59369
1986	0	14148	112532	4089	903	6823	2095	4271	133	616	34	39	145683
1987	0	317	45473	692567	24230	5929	11813	1637	4006	0	366	30	786368
1988	0	257	3332	102767	510980	5425	613	1122	654	1274	32	35	626491
1989	12	204	2461	3565	93687	254002	3934	0	535	114	228	0	358742
1990	159	47	1007	3005	1244	21724	7221	47	0	0	0	19	34473
1991	0	293	224	476	1397	164	1894	317	6	0	0	0	4771
1992	0	263	1427	220	36	77	0	28	0	0	0	0	2051
1993	0	10	832	544	20	28	6	0	0	0	0	0	1440
1994	0	283	45	199	38	5	0	5	0	0	0	0	575
1995	0	0	241	16	22	0	0	0	0	0	0	0	279
1996	0	147	11	638	10	0	10	0	0	0	0	0	816
1997	0	12	27	15	263	0	0	0	0	0	0	0	317
1998	48	1642	0	0	5	25	0	0	0	0	0	0	1720
1999	29	401	392	87	7	0	6	0	0	0	0	0	922
2000	0	165	1015	615	116	0	0	0	0	0	0	0	1911
2001	0	620	6202	1100	159	51	0	0	0	0	0	0	8132
2002	12	13	1061	2972	64	0	0	0	0	0	0	0	4122
2003	68	3225	392	1090	743	93	25	0	0	0	0	0	5636

Table 5.1.6 Cod off East Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2003. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	0	239	841	1764	1999	1227	379	130	1392	73	72	8116
*1983	0	0	411	605	1008	1187	2125	1287	302	265	703	101	7994
(1984)	0	18	74	1342	657	1397	855	1617	407	103	36	95	6601
1985	230	1932	556	118	2494	2034	1852	785	2000	295	56	36	12388
1986	0	1397	3351	1693	551	2417	1120	2191	566	1627	116	139	15168
1987	0	13	13785	17788	3890	1027	1770	457	1571	187	1093	36	41617
1988	11	25	163	6982	11094	2016	480	1435	152	674	98	469	23599
1989	0	7	179	489	17396	63216	3021	294	4870	406	1795	42	91715
1990	0	38	80	551	462	5128	18012	265	72	251	0	349	25208
1991	0	106	377	394	685	147	3512	5035	81	37	11	9	10394
(1992)	15	44	77	74	69	54	47	143	52	0	0	6	581
1993	0	17	44	1857	370	279	278	88	272	95	0	0	3300
(1994)	0	87	0	29	261	143	87	145	0	29	0	0	781
1995	0	7	2523	1125	370	1730	450	141	460	36	217	125	7184
1996	0	0	0	502	258	295	255	60	77	0	0	0	1447
1997	0	0	37	28	1508	1611	566	236	140	0	0	19	4145
1998	63	240	192	21	45	462	435	156	43	0	0	0	1657
1999	191	632	665	417	138	302	179	200	0	35	24	0	2783
2000	0	808	1074	1341	787	157	291	75	141	115	31	0	4820
2001	0	309	944	1468	2244	1349	705	211	191	73	36	9	7539
2002	96	8	415	1824	2026	2080	1952	889	235	83	36	30	9674
2003	1102	585	141	1067	4530	4285	4486	2374	1074	188	0	25	19857

Table 5.1.7 Cod off Greenland (total offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2003. *) calculated proportionally using age compositions reported by the ICES Working Group on Cod Stocks off East Greenland (ICES 1984/Assess:5). () incomplete sampling.

YEAR	0	1	2	3	4	5	6	7	8	9	10	11+	TOTAL
1982	0	176	1123	34311	13132	34503	10755	3001	708	2331	164	162	100366
*1983	0	0	1880	3420	27627	6147	13094	3169	1294	582	871	1140	58198
(1984)	159	23	112	3412	2188	11245	1697	3490	494	289	63	95	23267
1985	1061	39948	2037	1066	8897	4867	9534	1252	2646	322	91	36	71757
1986	0	15545	115883	5782	1454	9240	3215	6462	699	2243	150	178	160851
1987	0	330	59258	710355	28120	6956	13583	2094	5577	187	1459	66	827985
1988	11	282	3495	109749	522074	7441	1093	2557	806	1948	130	504	650090
1989	12	211	2640	4054	111083	317218	6955	294	5405	520	2023	42	450457
1990	159	85	1087	3556	1706	26852	25233	312	72	251	0	368	59681
1991	0	399	601	870	2082	311	5406	5352	87	37	11	9	15165
(1992)	15	307	1504	294	105	131	47	171	52	0	0	6	2632
1993	0	27	876	2401	390	307	284	88	272	95	0	0	4740
(1994)	0	370	45	228	299	148	87	150	0	29	0	0	1356
1995	0	7	2764	1141	392	1730	450	141	460	36	217	125	7463
1996	0	147	11	1140	268	295	265	60	77	0	0	0	2263
1997	0	12	64	43	1771	1611	566	236	140	0	0	19	4462
1998	111	1882	192	21	50	487	435	156	43	0	0	0	3377
1999	220	1033	1057	504	145	302	185	200	0	35	24	0	3705
2000	0	973	2089	1956	903	157	291	75	141	115	31	0	6731
2001	0	929	7146	2568	2403	1400	705	211	191	73	36	9	15671
2002	108	21	1476	4796	2090	2080	1952	889	235	83	36	30	13796
2003	1170	3810	533	2157	5273	4378	4511	2374	1074	188	0	25	25493

Table 5.1.8 Cod off Greenland (offshore component), Greenland survey. Abundance indices (1000) for West Greenland by stratum, 1991-2003. Confidence intervals (CI) are given in percent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	West.	CI
1991	*	0	11	7	32	429	78	*	*	(528)	73
1992	0	0	4	16	33	242	242	0	9	547	45
1993	0	0	0	0	0	54	36	205	12	308	67
1994	9	0	0	0	54	98	0	7	0	167	43
1995	0	0	0	33	17	504	42	20	46	662	58
1996	0	0	0	0	0	47	78	66	108	298	40
1997	0	0	0	2	8	35	0	0	0	45	64
1998	0	0	0	5	0	0	25	28	4	62	44
1999	0	10	18	141	52	17	18	8	0	261	41
2000	0	188	273	311	201	86	47	9	205	1321	19
2001	0	0	15	249	86	140	498	210	373	1570	23
2002	0	0	9	75	172	99	3595	102	202	4254	52
2003	0	122	128	1419	39	351	727	214	139	3139	23

Table 5.1.9 Cod off Greenland (offshore component), Greenland survey. Biomass indices (t) for West Greenland by stratum, 1988-2003. Confidence intervals (CI) are given in per cent of the stratified mean at 95% level of significance. () incorrect due to incomplete sampling.

Year	1AN	1AS	1AX	1BN	1BS	1C	1D	1E	1F	West.	CI
1988	0	0	*	35	0	1230	2613	*	*	(3879)	81
1989	44	0	*	73	0	41	1002	*	*	(1217)	51
1990	4	13	*	7	7	118	6825	*	*	(7004)	45
1991	*	0	7	1	2	188	53	*	*	(250)	58
1992	0	0	3	22	31	74	85	0	2	217	44
1993	0	0	0	0	0	24	8	87	4	122	69
1994	0	3	0	0	12	41	0	1	0	58	43
1995	0	0	0	3	2	158	22	2	5	190	67
1996	0	0	0	0	0	16	26	21	49	112	41
1997	0	0	0	2	2	60	0	0	0	64	65
1998	0	0	0	<1	0	0	55	57	4	117	43
1999	0	1	4	38	5	<1	13	1	0	64	31
2000	0	63	65	80	60	27	6	2	56	360	20
2001	0	0	9	126	38	72	186	67	110	609	26
2002	0	0	9	59	96	52	1629	38	87	1967	48
2003	0	20	27	341	8	264	453	118	29	1260	27

Table 5.1.10 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2003.

YEAR	1	2	3	4	5	6	7	8+	TOTAL
1992	0	221	126	123	63	10	3	1	547
1993	0	39	170	73	16	7	1	2	308
1994	0	10	126	22	8	1	0	0	167
1995	19	345	101	157	40	0	0	0	662
1996	0	14	203	78	3	0	0	0	298
1997	0	0	10	3	24	8	1	0	46
1998	0	17	25	20	0	0	0	0	62
1999	7	144	66	23	6	1	1	1	249
2000	90	711	363	92	13	52	0	0	1321
2001	97	540	546	376	0	0	0	0	1559
2002	0	603	2323	1078	245	0	4	0	4253
2003	81	1416	1037	433	135	18	0	0	3120

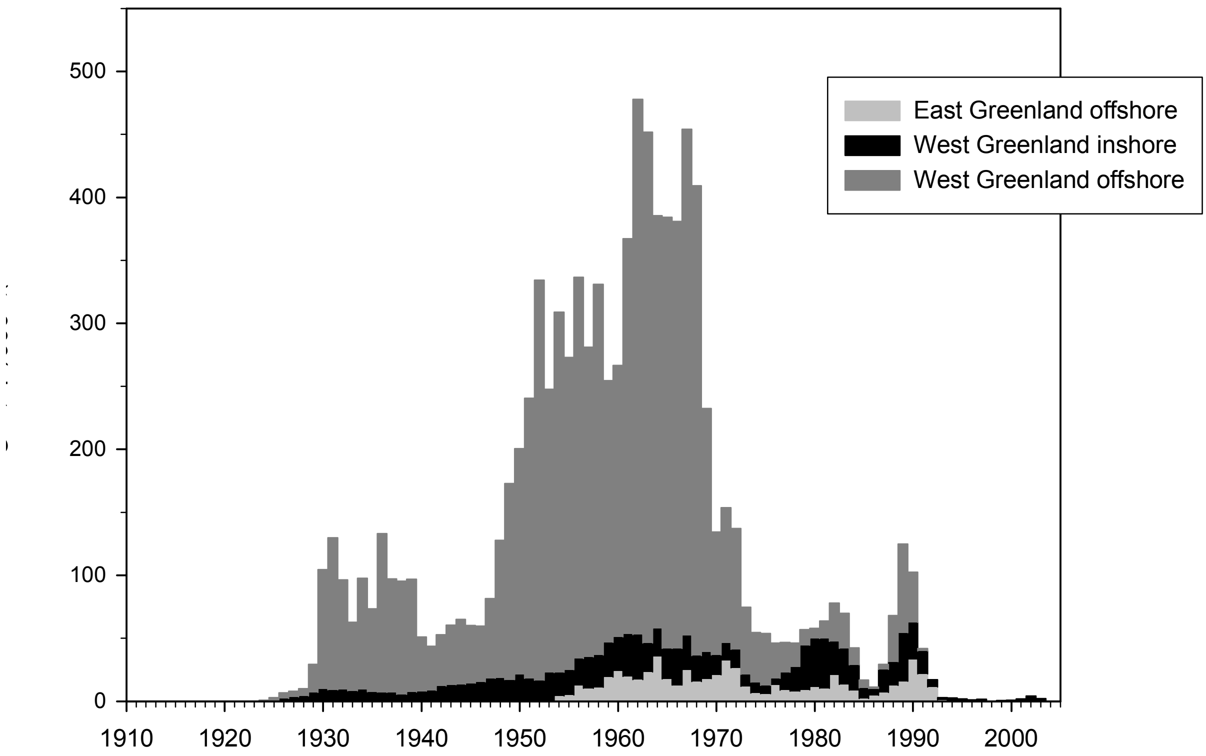


Figure 5.1.1 Cod off Greenland. Catches 1911-2003 as used by the Working Group, inshore and offshore by West and East greenland (Horsted 1994,2000).

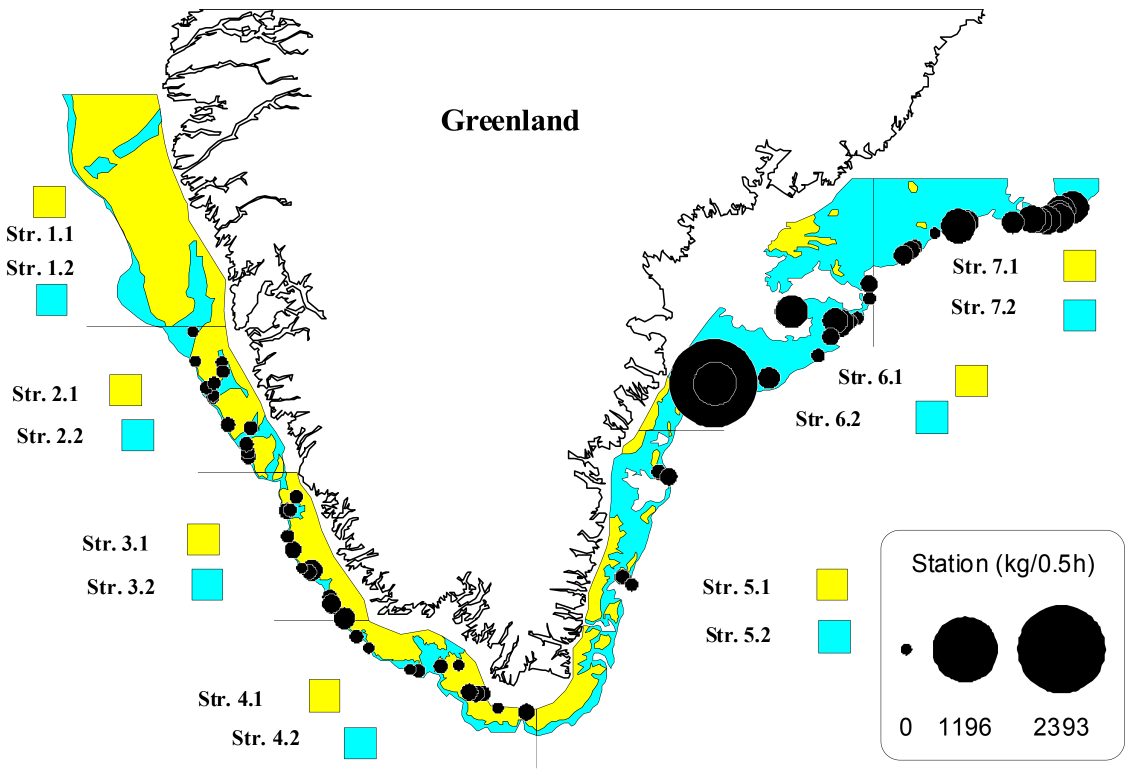


Figure 5.1.2 Cod off Greenland (offshore component), German survey. Survey area, stratification and position of hauls carried out in 2003.

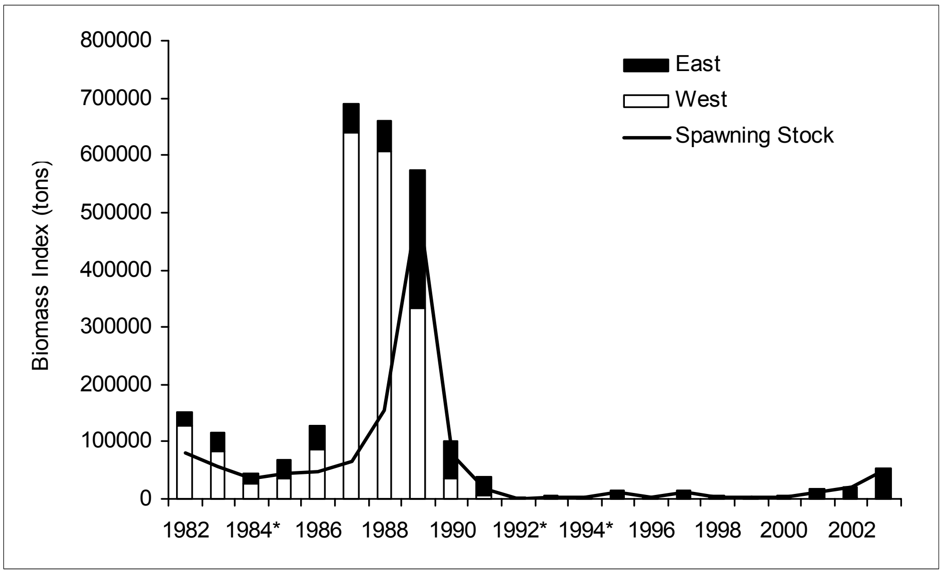


Figure 5.1.3 Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-2003. *)incomplete survey coverage.

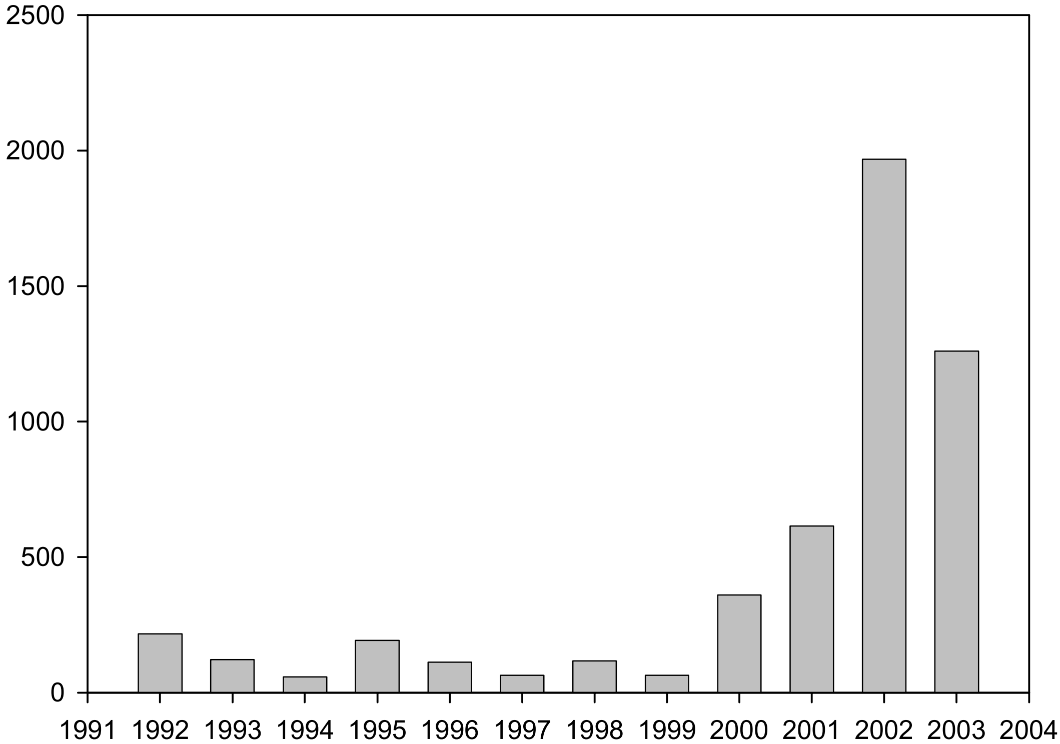


Figure 5.1.4 Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2003.

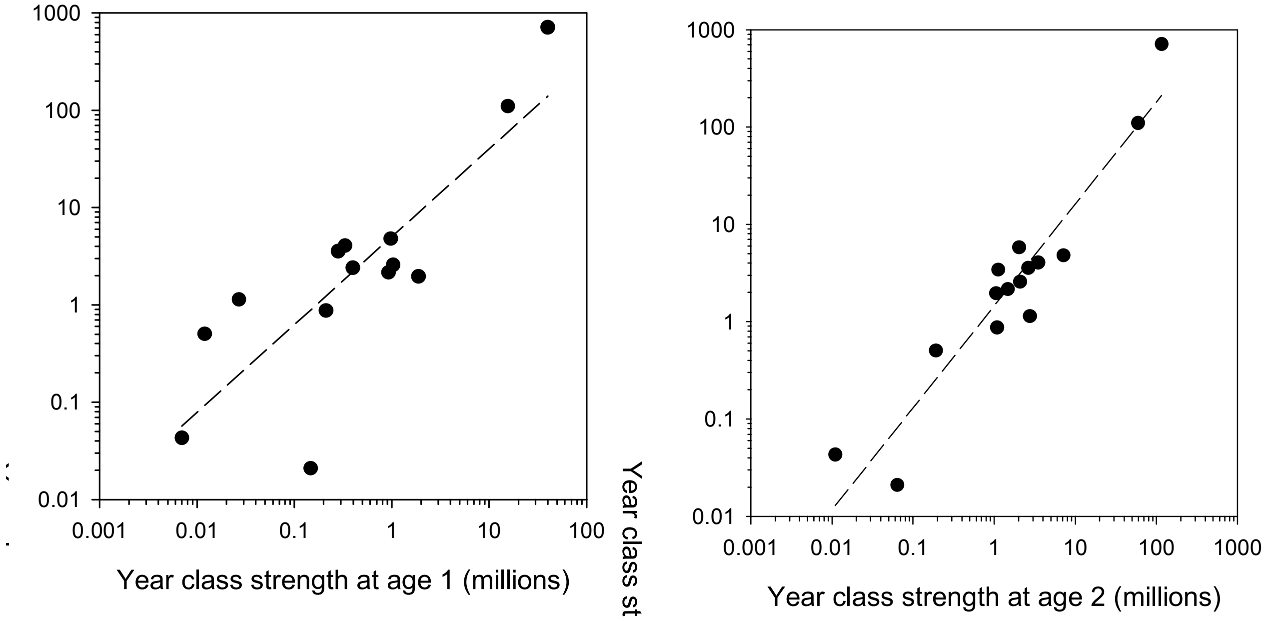


Figure 5.1.5 Comparison of survey estimates of abundance at age 3 in a given year with age 1 two years earlier (r^2= 0.69) and with age 2 one year earlier (r^2= 0.90) for East and West Greenland offshore cod. Years with incomplete coverage off East Greenland omitted. Data derived from the German survey.

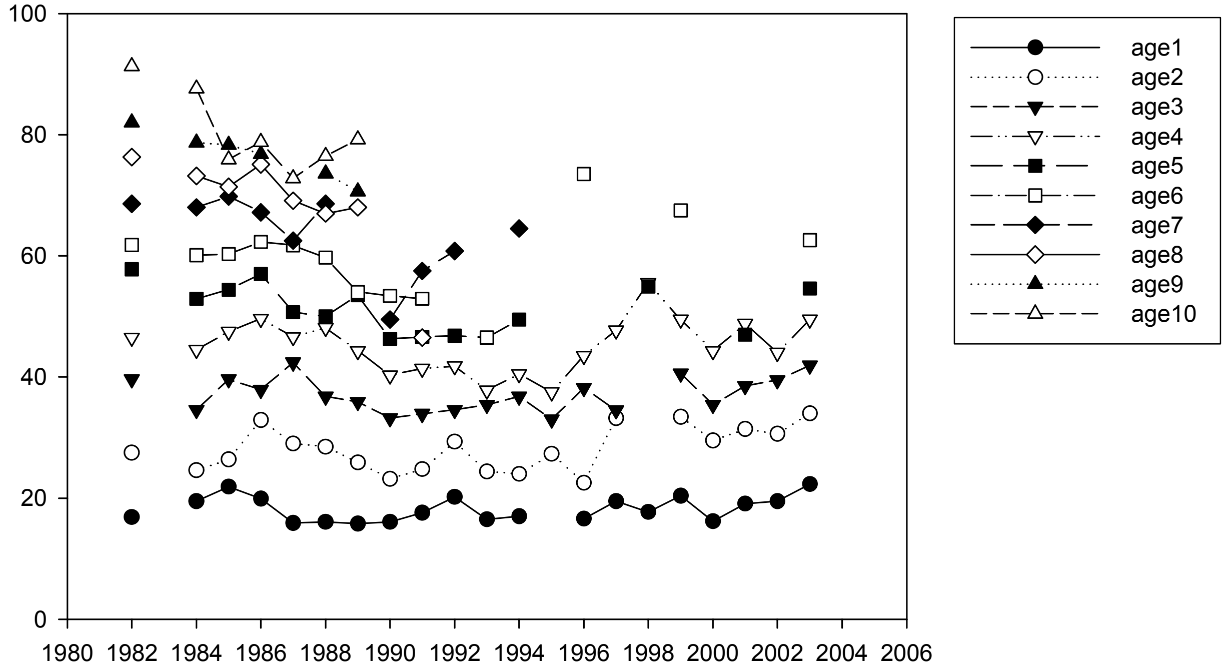


Figure 5.1.6 Weighted mean length at age 1-10 years 1982, 1984-2003 sampled in West Greenland. Data derived from German survey.

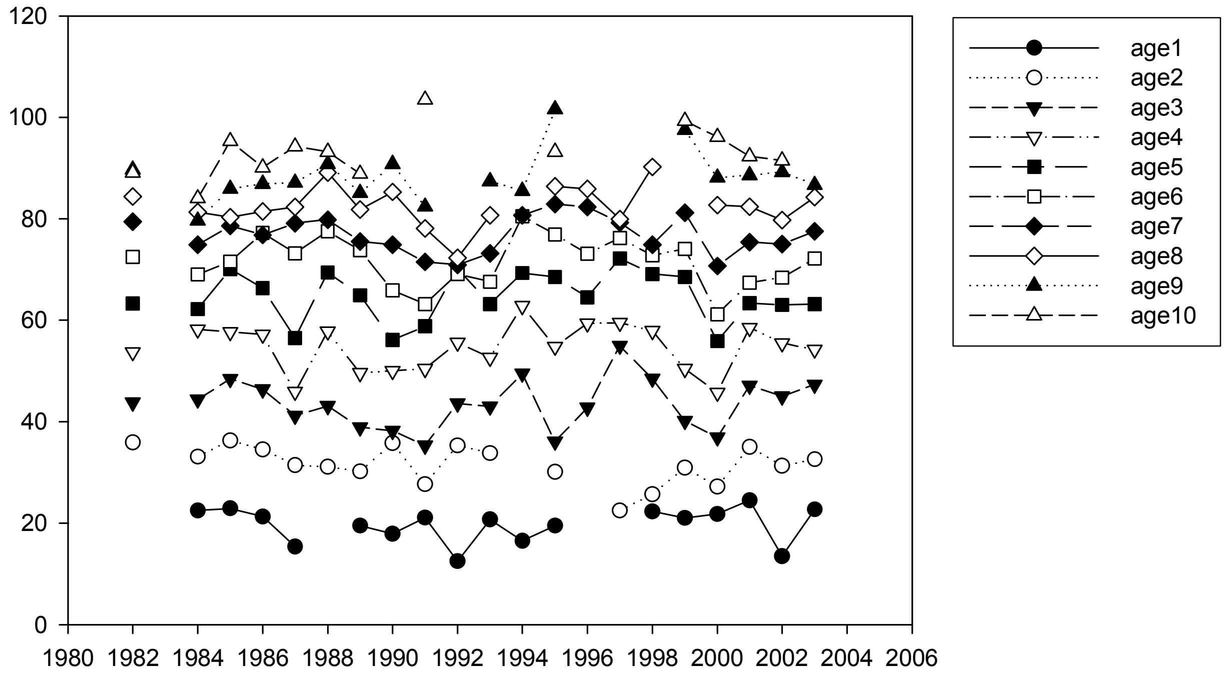


Figure 5.1.7 Weighted mean length at age 1-10 years 1982, 1984-2003 sampled in East Greenland. Data derived from German survey.

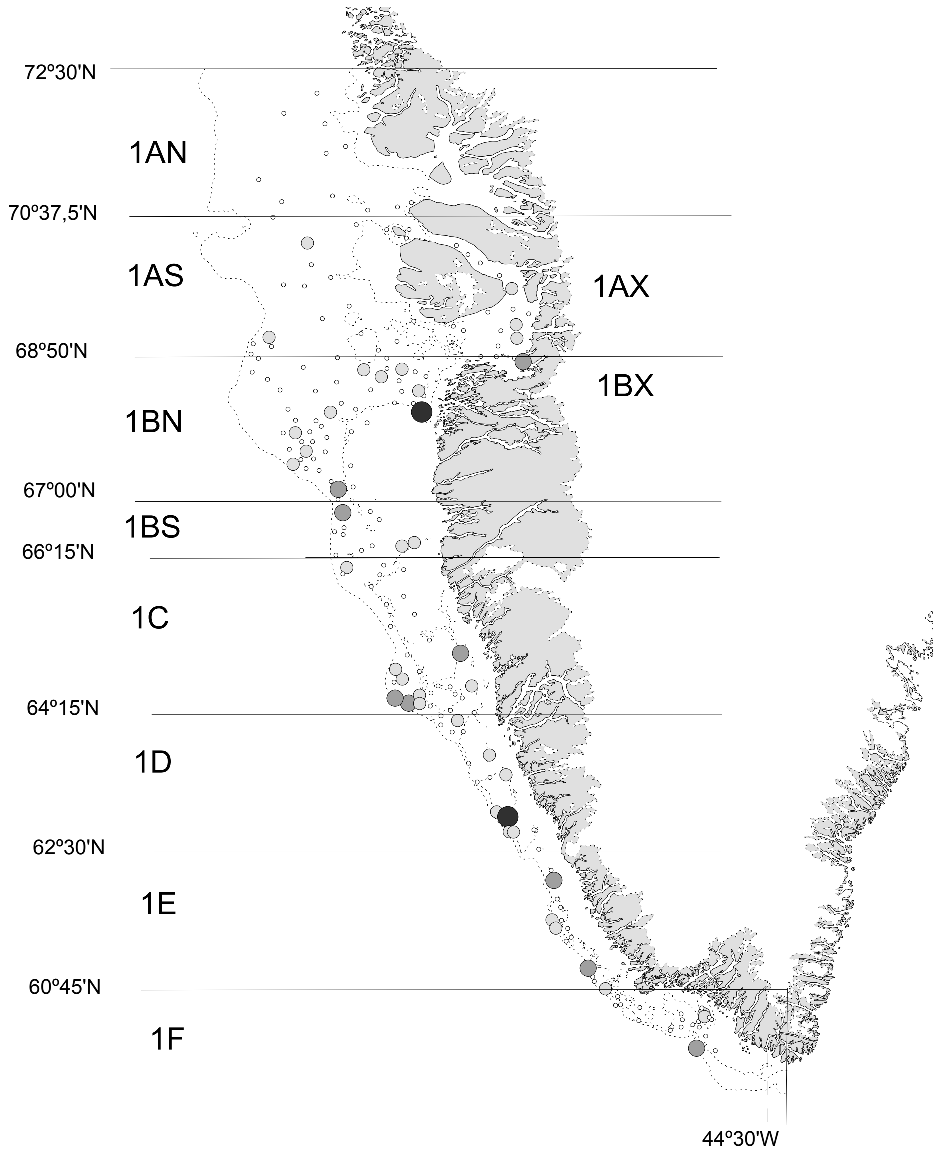


Figure 5.1.8 Number of cod /hour trawl off Greenland (offshore component), Greenland survey. Survey area, stratification and position of hauls carried out in 2003.

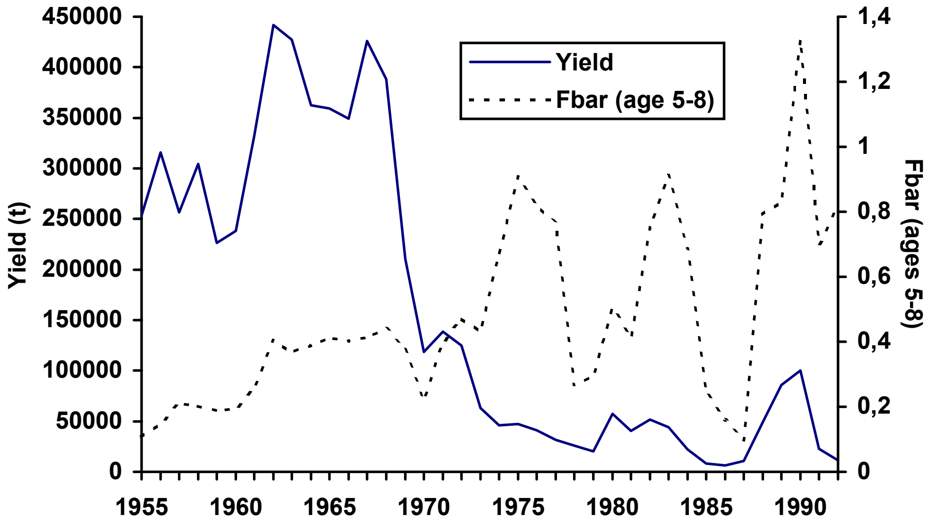


Figure 5.1.9 Greenland cod (offshore component). Trends in yield and fishing mortality.

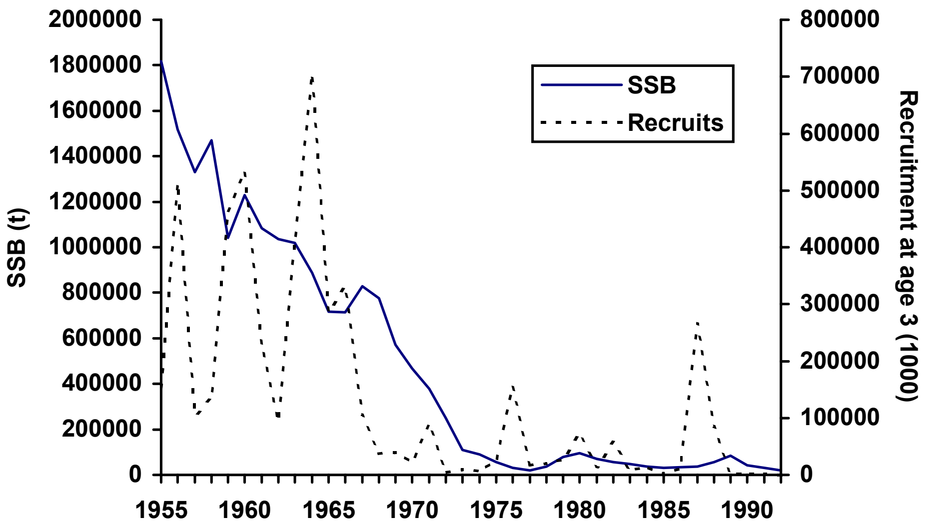


Figure 5.1.10 Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.

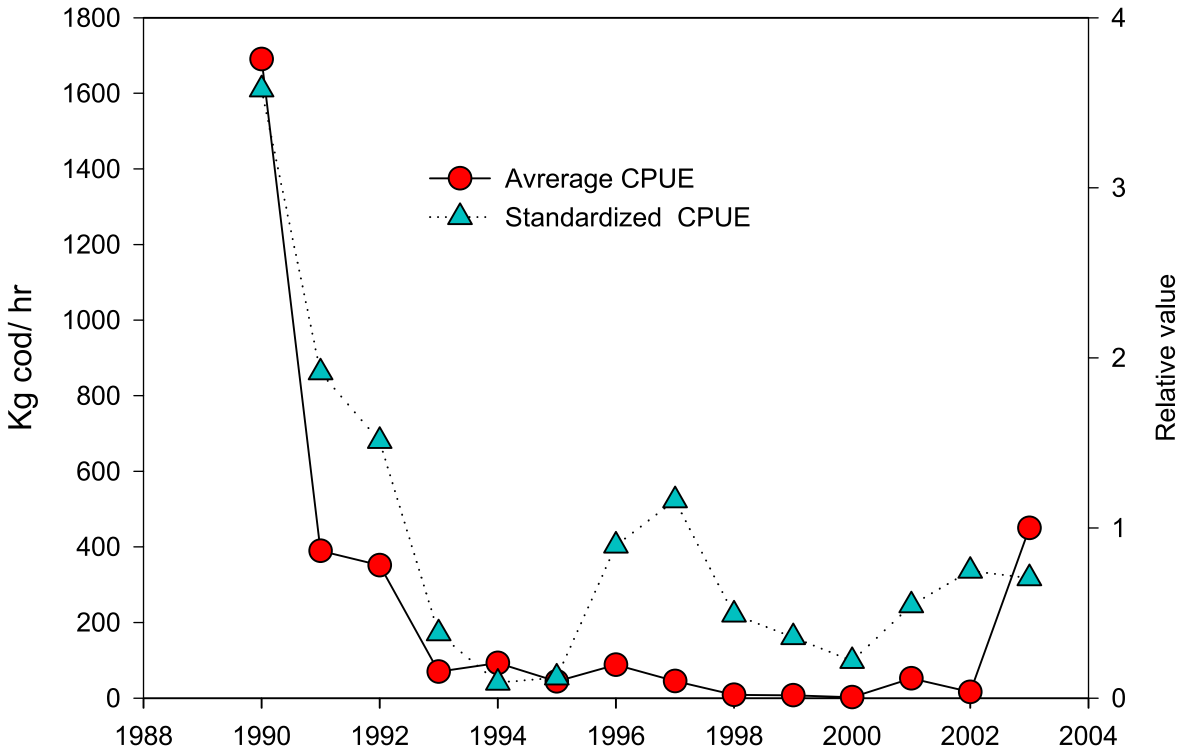


Figure 5.1.11. Average CPUE and standardized CPUE from the East Greenland offshore fishing fleet. 7 ships are used in standardized (GLM) model and in the period 1990 – 2003. 17% of the cells were accounted for.

5.2 Inshore cod stock off Greenland

Spawning cod is documented for several fjords and costal areas between 64 and 67°N in West Greenland (Hansen 1949, Smidt 1979, Buch *et al*., 1994). The inshore cod populations are believed to be relatively stationary, as most (82-86%) of the cod recaptured were found in the same area as they were tagged (Hovgård and Christensen 1990). Some interactions between the offshore and inshore cod stocks probably exist as the strong 1984- and partly 1985 year-class was registered in the inshore gillnet survey as well as in the inshore landings. These strong year-classes are believed to be Icelandic cod spawned off South-western Iceland. Some year's larvae are carried by the Irminger current to settle in South and West Greenland and contribute to the local fjord populations (Wieland and Hovgaard 2002).

5.2.1 Trends in Landings and Effort

The Greenland commercial cod fishery started locally in West Greenland in 1911 at some localities where cod seemed to occur regularly during summer and autumn. It took 15 years to reach 1 000t (Hansen 1949). In 1924 an offshore fishery started and until 1974 the inshore landings have been of limited importance accounting for only 5-15% of the total fishery in Greenland water. Annual catches above 20 000t have been taken inshore during the period 1955-1969 and in 1980 and 1989 catches of approximately 40 000t were landed, partly driven by a few strong year classes entering from the offshore stock (Horsted 2000). Due to the very low offshore landings the importance of the inshore landings has increased accounting for between 50-90% landings in the period 1993 –2003. In the same period the inshore landings have been fluctuating between 500-4 000t.

A historic low was reached in 1998 with a total inshore catch at 326t, the lowest catch registered since 1918. Since 1998, slight improvements have been registered with catches increasing to approximately 4000t in 2002. Preliminary catch statistics for 2003 are at 4000t where the two Northern NAFO division are accounting for approximately 2/3 of the total inshore landings (table 5.2.1). Besides 1250t have been transshipped from local inshore areas to foreign vessels (Table 5.1.1.)

Pound nets are used to take about 50% of the inshore catch, handline, longline and set gillnets are accounting for 30%. Peak fishing time is June and July where more than 50% of the catches are taken.

A commercial pound net CPUE series is available between 1992-1999. The mean catch per pound net setting decreased from 804 t in 1994 to 284 in 1999. No commercial effort data from 2000 to 2002 and catch at age data in 1997-1998 and 2000-2001 have been available to the working group. The catch at age sampling from 2003 is not considered representative as weight at age has increased unrealistic since 2002 (Table 5.2.3). Therefore, the weight at age from 2002 was used in the CAM-model.

Commercial samples 2003			
Samples	Length	Otolith	Weight
8	4372	132	132

5.2.2 West Greenland young cod survey

A survey using gangs of gill nets with different mesh-sizes has been conducted since 1985 with the objective to assess the abundance and distribution of pre-recruit cod in inshore areas of Greenland. The survey has usually been carried out in three inshore areas off West Greenland: Qaqortoq (NAFO 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 Greenland and Iceland shows up here. Technical problems caused that only Division 1D was covered in 1999, and again in 2000 only Div. 1D and Div. 1F was covered. A more detailed description of the survey is provided in the 2001 report and WD 3/2004. No survey took place in 2001, in 2003 Div. 1B and 1D were covered.

The recruitment index of 2-year old cod is shown in Figure 5.2.1 and reveals a strong 1984 -year class. Between 1996 and 2000 the recruitment index was very low. An increase in 2-year recruits was observed in 2002 Div 1B, reaching the levels from 1986-87 suggesting a strong 2000 year-class in this division however as this area has not been covered during the three previous years, the size of the year class remains uncertain. The overall survey results for 2003 indicate a decrease of the recruitment index in division 1B compared to the relative large value from last year and slightly below average (1985-2003). The recruitment index for division 1D is still at a very low level.

5.2.3 Assessment of the stocks

Previously an Schaefer general production model was fitted to the Greenland inshore cod landing data using the commercial pound net CPUE results for 1993 to 1997 as an index of stock biomass. Lack of contrast in data impeded the model to run satisfactory.

Catch-at-age and weight-at-age data for the period 1985-1996 and for 1999 and 2002-2003 were available to the working group (Table 5.2.2 and 5.2.3). A statistical age structured model implemented MS Excel on the inshore cod stock was used by the working group in 2003 as an exploratory tool to estimate the likely historical stock and exploitation dynamics. The model has been updated this year but due to insufficient data it was not accepted by the working group for assessment purpose (ICES CM 2003/ACFM:24, WD XX).

5.2.4 Status of the stock

The exploitation rate of the stock is unknown as no logbook information is available. The survey data presented indicate that the stock has undergone a series of poor recruitment in recent years, but recovery potential was observed in Div. 1B in 2002.

5.2.5 Biological reference points

No specific values can be put forward as reference points due to the depleted state of the stocks.

5.2.6 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 regulated. The data from the commercial fishery are considered insufficient to provide advice. If advice is required, additional information from the commercial fishery would be required. In particular logbook information would be very valuable. A recovery plan should be developed for this stock.

Table 5.2.1 Cod catches divided to NAFO -divisions, caught inshore from vessels < 50 GRT (Horsted 2000, Statistic Greenland 2003). [1]Including 1258t transshipped from local inshore fishers to foreign vessels.

Year\Div	Nafo 1A	Nafo 1B	Nafo 1C	Nafo 1D	Nafo 1E	Nafo 1F	Total
1984	175	3908	1889	5414	1149	1333	19958
1985	149	2936	957	1976	1178	1245	8441
1986	76	1038	255	1209	1456	1268	5302
1987	97	2995	536	8110	4560	1678	8402
1988	333	6294	1342	2992	3346	4484	22829
1989	634	8491	5671	8212	10845	4676	28529
1990	476	9857	1482	9826	1917	5241	29026
1991	876	8641	917	2782	1089	4007	18311
1992	695	2710	563	1070	239	450	5723
1993	333	323	173	968	18	109	1924
1994	209	332	589	914	11	62	2115
1995	53	521	710	332	4	81	1710
1996	41	211	471	164	11	46	948
1997	18	446	198	99	13	130	1186
1998	9	118	79	78	0	38	319
1999	68	142	55	336	8	4	622
2000	154	266	0	332	0	12	764
2001	117	1183	245	54	0	81	1680
2002	263	1803	505	214	24	813	3622
2003	1109	1522	334	274	3	479	5215 [1]

Table 5.2.2 Catch at age (abundance in millions) 1985-2003, missing values in 1997, 1998, 2000 and 2001.

Year\Age	1	2	3	4	5	6	7	8	9
1985				0.742	0.588	2.464	0.154	0.604	0.016
1986				0.172	0.170	1.245	0.117	0.565	0.014
1987		0.043	0.594	7.638	4.153	0.320	0.877	0.229	0.415
1988		0.052	0.214	7.533	6.446	0.421	0.452	0.088	0.184
1989		0.006	0.218	11.813	12.619	1.318	1.369	0.172	0.276
1990		0.002	0.154	10.169	9.340	2.632	0.742	0.137	0.116
1991		0.004	0.125	7.177	8.562	2.499	0.288	0.012	0.003
1992		0.001	0.051	1.767	2.634	0.730	0.126	0.008	0.005
1993		0.000	0.029	0.647	0.706	0.208	0.044	0.006	0.006
1994		0.001	0.053	1.152	0.727	0.079	0.053	0.012	0.003
1995			0.008	0.593	0.729	0.140	0.036	0.001	0.001
1996			0.002	0.148	0.262	0.119	0.056	0.009	0.007
1997									
1998									
1999			0.082	0.396	0.238	0.037	0.004		
2000									
2001									
2002		0.001	0.565	1.952	1.282	0.333	0.091	0.000	0.000
2003			0.0665	0.2871	0.4081	0.1068	0.0496	0.0069	0.0073

Table 5.2.3 Weight at age in landing 1985-2003, missing values in 1997, 1998, 2000 and 2001.

Year\Age	1	2	3	4	5	6	7	8	9
1985				0.84	1.29	1.82	2.25	2.97	3.55
1986				0.86	1.44	2.05	2.39	2.94	3.30
1987		0.46	0.69	0.88	1.17	2.30	2.91	4.37	4.15
1988		0.32	0.65	1.05	1.17	1.66	2.51	4.35	4.14
1989		0.57	0.75	1.19	1.34	1.80	2.21	3.61	3.63
1990		0.72	0.64	1.08	1.28	1.33	1.78	3.26	3.34
1991		0.72	0.60	0.84	1.07	1.04	1.42	1.77	2.75
1992		0.71	0.54	0.84	1.17	1.16	1.61	2.39	4.03
1993		0.72	0.53	0.76	1.25	1.23	1.97	3.57	3.97
1994		0.72	0.43	0.83	1.13	1.64	2.32	3.35	3.68
1995			0.45	0.87	1.28	1.67	1.78	3.17	6.18
1996			0.39	0.94	1.39	2.03	2.71	3.40	1.97
1997									
1998									
1999		0.31	0.56	0.71	1.02	1.25	1.58		
2000									
2001									
2002		0.32	0.52	0.69	1.09	1.51	1.70	3.36	0.31
2003		0.58	1.06	1.41	2.11	2.76	3.18	5.02	6.14

Table 5.2.4 CPUE (number of age 1,2,3 and 4 cod caught per 100 hours net setting) in the Greenland Gill net cod survey covering West Greenland 1987-2003.

Age	1	2	3	4
1985	107.51	45.36	0.37	2.53
1986	6.22	124.04	11.77	1.26
1987	0.34	75.04	119.82	6.73
1988	0.03	15.27	72.32	34.32
1989	0.11	58.47	37.33	21.67
1990	0.00	24.12	34.95	12.22
1991	63.63	2.40	29.00	12.16
1992	0.10	38.22	13.14	7.69
1993	0.00	6.89	33.20	10.45
1994	0.65	1.40	6.37	4.32
1995	0.23	18.95	3.76	3.16
1996	0.00	7.45	10.32	1.66
1997	1.92	5.88	2.71	0.82
1998	0.32	7.66	13.46	1.28
1999	0.00	0.40	1.20	2.70
2000	0.12	6.96	4.14	0.40
2001	no	survey		
2002	6.60	53.70	19.10	6.70
2003	0.45	20.16	19.09	6.72

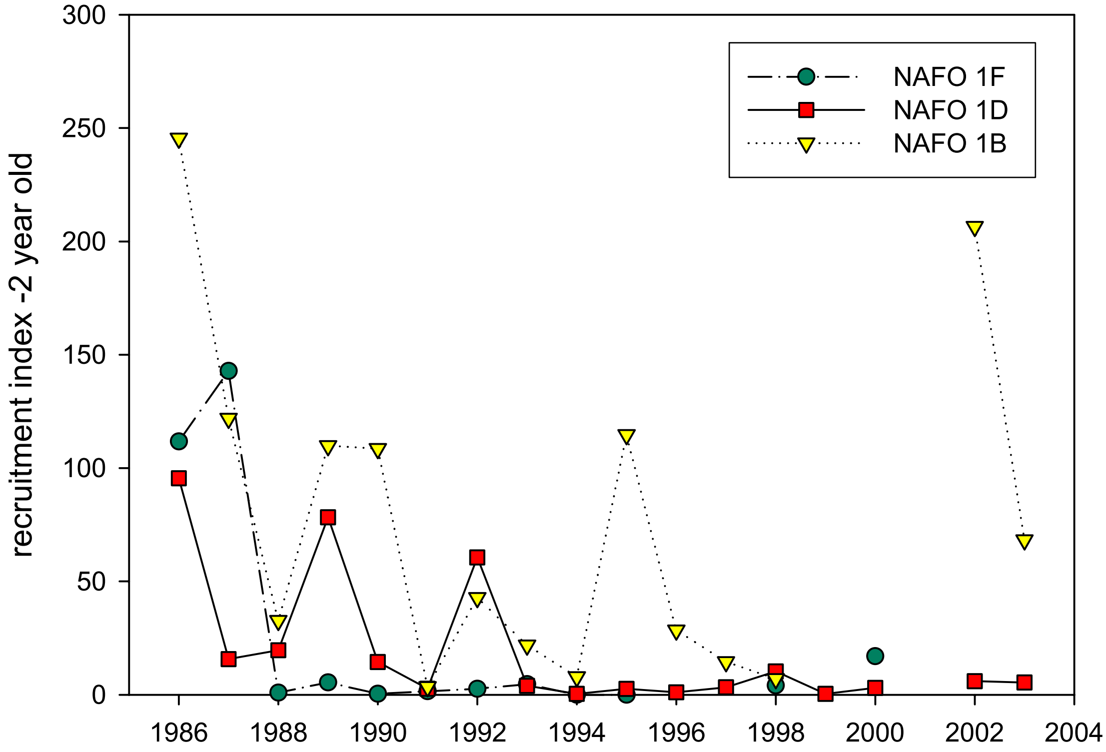

300
250
200
150
100
50
0
recruitment index -2 year old
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
NAFO 1F
NAFO 1D
NAFO 1B

Figure 5.2.1

6 GREENLAND HALIBUT IN SUBAREAS V AND XIV

6.1 Landings, Fisheries, Fleet and Stock Perception

Landings

Total annual landings in Divisions Va, Vb, and Subareas XII and XIV are presented for the years 1981–2003 in Tables 6.1.1–6.1.5 and since 1961 in Figure 6.1.1. Landings during the decade prior to the extension of the EEZ to 200 nm by coastal nations in 1976 were in the order of 20-35 000 t. From 1976 landings increased from a low of 5 000 t to above 30 000 t after 1982. In the years 1987–1989, landings increased further to a record high of about 61 000 t. Since 1989 catches have decreased to 20 000 t in 1998-99, followed by an increase in the past 5 years to about 30 000 t in 2003. Landings not officially reported to ICES have been included in the assessment.

Catches in Icelandic waters have historically predominated the total catches in areas V+XIV. In the year 1989 with record high catches Iceland took 97% of the total catch. Since then fisheries developed in Div. XIVb and Vb and these areas have increased their share of the total catches and have in the past decade varied from about 20% to 50%.

Fisheries and fleets

In the Greenland EEZ, the Greenland fleet was only capable of catching about 60% of the quota, while the foreign fleets nearly fulfilled their quotas. In Iceland EEZ the fleets caught the quota and in Faroese EEZ only by-catch regulations is limiting the individual trawlers.

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 comes partly from a redfish fishery and south of Iceland No major changes were observed in 2003. Table 6.1.6 describes the Working Group's best landing estimates for the year 2003 with respect to area and gear.

The major fishing grounds in Icelandic waters are located west of Iceland (64º30-66ºN, 27º-29ºW), where approximately 75% of the annual trawl catch in Icelandic waters has been taken in recent years. The Icelandic trawlers moved to deeper waters around 1988, but the average depth of fishing on the western grounds has remained at approximately 900 meters since 1990. A fishery also occurs north of Iceland (67º-68ºN, 19º-24ºW, at approximately 500 m), and along the narrow continental slope northeast and east of Iceland (63º30-66ºN, 11º–16ºW, between 400 and 700 meter depth). The main fishing season in Division Va formerly occurred during the spawning season in spring, but in recent years, the fishing season has expanded and the present fishery is conducted in late winter to early summer, with the bulk of the catches taken in April through June.

The trawlers (single trawlers > 1000 Hp) fishing in Division Vb operate on relatively shallow parts of the continental slope, mainly in summer. The gillnet fishery in Division Vb started in 1993, and since then the fishing grounds have expanded. This fishery is carried out during the whole year with a peak activity in the spring.

The fishing grounds in Division XIVb are found on the continental slopes (61ºN-65ºN, 36º-41ºW). Trawling was formerly concentrated in a narrow belt of the continental slope at depths of 500−1000 meters in the north-easternmost area of XIVb, but has in 1997 expanded to a southerly area between 61°40-62°30N, 40°00-40°30W at depths of 1000−1400 meters, where longliners are also fishing. The main fishing season is from April to November for both longliners and trawlers with the bulk of the catches taken in July. Both freezer trawlers and fresh fish trawlers operate in the area.

Since 1994 a longline fishery developed on new fishing grounds along the western slope of the Reykjanes Ridge (60ºN-62ºN, 27º-29ºW), both inside and outside the 200 mile EEZ (XIVb and XII). This fishery has ceased since 2000. The same fleet has continued as a gillnet fleet since, only accounting for small catches.

Bycatch and discard

Bycatches in the Greenland halibut trawl fisheries is mainly redfish, sharks and cod. Southeast of Iceland the cod fishery and Greenland halibut fishery are coinciding spatially.

Previous reports based on measurements from a Greenlandic shrimp trawler operating in Denmark Strait (XIVb), indicated that Greenland halibut, mainly pre recruits below 40 cm, did constitute a significant bycatch. (0.48 kg and 0.81 individuals of Greenland halibut were caught per 1 kg shrimp).

Only little information is presently available on discard in the fisheries. Discard records from logbooks that suggest discard less than 1% of the catches are considered incomplete.

Stock perception

The current definition of the Greenland halibut in East Greenland, Iceland, and Faroe waters as one stock, specified by ICES in 1976 was "based on a strong probability that the spawning grounds [for Greenland halibut in these waters] are the same". A summary of the current state of knowledge on Greenland halibut in the above-mentioned waters shows that key information on the life cycle is lacking (Woll 2000). Information on the spawning location and spawning time of the stock is very limited. It is hypothesised, based on information from one scientific bottom trawl cruise in 1977, that the major spawning grounds are located on the continental slopes west of Iceland at depths around and below 1000 m (Magnusson 1977; Sigurdsson 1977; Sigurdsson and Magnusson 1980). In recent years (1995 and 2000), some spawning has been observed in East Greenland waters (62°N and 64°N) in August (Gundersen *et al*. 1997; Fossen and Gundersen 2000).

Standard 0-group fish surveys have been carried out annually in late summer (mainly in August) in Icelandic and in East Greenland waters since 1970. Larvae are mainly observed along the shelf region off East Greenland and are in some years abundant all over the shelf area south to 60° N, which is the southernmost limit of the survey area. Highest abundance is observed on the continental shelf north of 64° N and just east off the continental shelf south of 64° N. 0-group larvae are only occasionally observed on the Icelandic shelf in very limited numbers. Nursery grounds for young Greenland halibut (ages 1-3, fish less than 45 cm long) are well known in West Greenland waters, where they are most abundant from Store Hellefiske Bank to Disko and in Disko Bay between 66^{o}-69^{o} latitude at depths of about 200 m (Riget and Boje, 1988). When it comes to knowledge on young fish in East Greenland and Icelandic waters, information is very sparse. A gillnet survey targeting young Greenland halibut, modelling of advection of eggs and larvae with currents from assumed spawning areas in Icelandic and East Greenland waters (Woll 2000), and results of historic Greenland ichtyoplankton surveys (Boje 1997), indicated that larvae were transported to Southwest Greenland waters before settling, mixing with specimens from the Greenland-Canadian stock complex. Analyses of shrimp surveys in Icelandic and Greenland waters (Boje and Hjørleifsson 2000) concluded that nursery grounds were neither to be found in Icelandic nor in East Greenland waters.

The highest aggregation of commercial-sized Greenland halibut is found just south of the Greenland-Iceland ridge. In this area the major portion of the annual catch in the past 10 to 15 years has been taken mainly at depths between 500 and 1000 meters. Other locations of Greenland halibut in exploitable densities (for trawl fisheries) are found along the north and east coast of Iceland, mainly at depths between 500 to 700 meters, in waters of Faroe Islands, as well as along the continental slope off East Greenland. The sizes of the Greenland halibut in the trawl fisheries depend largely on location and depth, and to some extent on the season. In Icelandic waters, smaller fish are found along the east and north coast, with somewhat larger fish in the deeper waters south of the Faroe-Iceland ridge. The largest fish are, however, always found on the main fishing grounds between Iceland and Greenland.

6.2 Trends in Effort and CPUE

Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2003 (Table 6.2.1, Fig. 6.2.1) were estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month, and year effects. All hauls with Greenland halibut exceeding 50% of the total catch were included in the CPUE estimation. The CPUE indices from the trawling fleets in Divisions Va, Vb and XIVb were used to estimate the total effort for each year (y) for each of the divisions according to:

$$E_{y,div} = Y_{y,div} / CPUE_{y,div}$$

where E is the total effort and Y is the total reported landings (Table 6.2.1).

Catch rates of Icelandic bottom trawlers decreased for all fishing grounds during 1990–1995, but stabilised in 1995–1997. In 1998, an increase of 60% in CPUE was observed for all fishing grounds coinciding with a drastic (60%) reduction in effort (Table 6.2.1, Figure 6.2.1). In 1999 to 2001 CPUE increases annually between 4 – 15% until 2002 and 2003 when CPUE decreased by 24% and 30%, respectively. The total effort increased up to 1995, decreased significantly until 2001, but increased again in 2002 and 2003 by 54 % and 47%, respectively. Since 1994 CPUE's have been stable and effort has thus followed the development of the catches (Fig. 6.2.1). CPUE trends are equal for the areas west, north, east and south of Iceland, but recent development into 2003 differs; but for the most important fishing grounds west of Iceland, where over 75% of the Va catch is taken, CPUE decreased markedly (Fig. 6.2.2).

Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2003 (Table 6.2.1). It is a rather new fishery and the location of the bulk of fishery has changed from the eastern side of the islands in 1995-1998, to the western side since 2000. Therefore, the fishery is assumed to have been in the process of learning. Only hauls where G.halibut consisted of more than 50% of the catches and conducted on depths more than 450 meters were selected for the analyses. The logbooks were standardised in the same way (GLM) as the Va fleet. Also effort is estimated as described for the Va fleet. The fishery has increased from about 1500 t in 1991 to more than 6000 t mostly mainly due to gillnetters. CPUE decreased in the early period by about 10% coinciding with a significant increase in effort.

Division XIVb

For Division XIVb, logbook data was available from German, Norwegian, Faroese, Russian, Japanese, U.K., Spanish and Greenland fleets. Hauls where targeted species was G.halibut and where catch weight exceeds 100 kg were selected, as no information on other species caught was available. CPUE from logbooks in the years 1991–2003 were standardised in the same way as described for fleets in Va and so was effort (Table 6.2.1, Fig.6.2.1). CPUE increased significantly from 1992 to 1993, where after it remains relatively stable. Effort has thus since 1993 followed the development in catches. However, the fishery in XIVb is relatively new and catches have increased from below 500 tons annually before 1991 to about 7000 t in the past three years. The fishery was therefore assumed to be in the process of learning in the beginning of the CPUE series. A breakdown of the CPUE series into fleet components, shows various signals for the fleets, but for the German fleet, CPUE is decreasing in 2003 after a stable period since 1997 (Fig. 6.2.3). The German fleet comprised about 40% of the catches in that Division and is the only series in the entire year span. The Greenland fleet, also being one of the major components in the fishery, do have status quo CPUE in 2003.

The CPUE series from Divisions Va, Vb and XIVb show contradictory trends in the period 1991 to 2003 (Fig.6.2.1). CPUE's in Vb and XIVb are stable for the period 1994 to 2002, while those series shows contradicting trends prior to 1994; in XIVb CPUE's increased from 1993 to 1994, while CPUE's decreased for Div. Vb in the same period. The Icelandic CPUE's (Va) have decreased since the late 1980'ies until 1996. From 1996 to 2001 CPUE's increased somewhat, but decline again after 2001. This might indicate different stock developments in the areas, but could also be artefacts, i.e. due to different behaviour of the fleets, fish migration between areas or difference in availability.

6.3 Catch-at-age

Otoliths have been sampled from the Icelandic fishery in 2003 but due to changes in the age-reading staff at MRI no readings were available at the time the WG met. The only available aged otoliths were from the Greenland survey in East Greenland. As this survey mainly catches younger fish than the commercial fishery, i.e. below age 8-9 and as length composition by age in the survey is expected to differ from the commercial fishery, attempts were not made to establish catch-at-age for the total catches. Since 2000 no age-disaggregated assessment have been conducted for Greenland halibut and the lack of a catch-at-age matrix do thus not prevent an update of stock assessment. When the otoliths sampled by Iceland is age-read, the catch-at-age matrix will be updated accordingly.

Length compositions of catches from the commercial trawl fishery in Div. Va are incredibly stable from year to year. In Fig. 6.3 is shown length distributions since 1985 from the western area of Iceland, comprising the most important fishing grounds. For all the years catches were in the range 40 – 100 cm with a mode at about 60 cm. The 2003 distribution do obviously not differ form the long-term average. A similar pattern has been observed for other areas within SA V and XIV although more noisy.

6.4 Weight-at-age

Due to lack of age-readings as described in Section 6.3 no weight-at-age is provided.

6.5 Maturity-at-age

Due to lack of age-readings as described in Sec. 6.3 no maturity-at-age is provided.

6.6 Survey information

Division Va

An October groundfish survey in Icelandic waters, covering the distributional area of Greenland halibut within the Icelandic EEZ, was started in 1996. The survey is a fixed station stratified random survey consisting of 300 stations on the continental shelf and slope down to a depth of 1300 m. An increase in the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) is observed from 1996 to 2001 (Figure 6.6.1b). Abundance indices of smaller fish (<50 cm) indicate signs of improved recruitment in 1998 and 1999 that may account for the increase in the estimated fishable biomass over the period. Since 2002 abundance fish between 40 and 60 cm decreased significantly below that observed in 2001. In the same period biomass indices decreased markedly for 40-60 cm fish Figure 6.6.1a.

Division Vb

Since 1995, a Faroese Greenland halibut survey has been carried out on the southern and eastern slope on the Faroe Plateau at depths of 400-600 m. In 1995, the survey was conducted in the first week of July and since then it has been conducted during the first two weeks in June. Usually the total number of hauls has been around 40, except in 1995 and 2003 when only about 24 stations were taken. The stations are not fixed; the skipper decides where and when the hauls are going to be taken and for how long time. Usually the whole area has been covered, except in 1995 and 1996 when only the southern and eastern part, respectively, were covered. Occasionally a few tows in shallower depths are taken. The majority of the catch consists of immature females (about 80 %). From that survey are selected hauls deeper than 450 m (all stations in 2003) to cover the areas where the commercial fishery takes place. Catch rates have generally been low in the survey, but the tendency since the start of the series is a gradual decline in catch rates (Fig. 6.6.3).

Division XIVb

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. No survey took place in 2001. In 2003 a total of 40 of the planned 70 stations were hauled. Total estimated biomass in 2003 was estimated at 14 000 t, which is a 7% decrease (not significant at the 95% level) from the 2002 biomass estimate (Fig. 6.6.2). Compared to the period 1999-2001, biomass estimates for the period 2002-2003 is somewhat lower, although not significant at the 5% level.

Also other indices have been made available from surveys not aimed at Greenland halibut. These surveys cover only very limited range of the total distribution of the Greenland halibut. The Icelandic groundfish spring survey has been conducted since 1985 mainly for cod, but has occasional catches of Greenland halibut in the deeper stations. Catch rates vary considerably, but generally decreases until recent years, where the index seems stable at very low values (Fig. 6.6.4). A shrimp survey has been conducted in northern waters of Iceland since 1987 and catch rates from this survey coincide with the trend from the spring groundfish survey, i.e. a decline throughout the time series to a minimum in recent years (Fig. 6.6.4).

Survey	No hauls in 2003	Depth range (m)	Coverage (km^2)
Va	150 (150)	500-1300	130 000
Vb	24 (40)	450-550	3 300
XIVb	40 (70)	400-1500	43 000

6.7 Stock Assessment

6.7.1 Age-based assessement

Age-disaggregated CPUE values for age groups 7–12 from the Icelandic trawling fleet operating in Division Va have previously been used in the XSA tuning assessments. Since 2000 the XSA assessment has been considered unreliable due to poor diagnostics mainly caused by inconsistent sampling and age readings (see section 6.9), and was thus rejected as a basis for advice. No attempt was made this year to run an age-based assessment due to lack of age readings. In the 2002 NWWG report is given the historic trends in log(q) residuals and the retrospective pattern of F. Based on those plots the Working Group in 2002 decided that an XSA model was not a reliable estimator of recent stock history.

6.7.2 Stock production model

A stock-production model approach, ASPIC, have been performed since 2000, when the age-disaggregated assessment was considered unreliable. ASPIC requires series of catch data and indices of stock biomass, either corresponding effort, CPUE, or survey catch rates. Corresponding catch and effort data is available for Div. Va, (formerly used as a tuning fleet in the XSA), Vb and XIVb, and in addition several survey series (Figure 6.2.1 and Figure 6.6.4) were available:

Fleet and index	Period	Division
Icelandic trawler CPUE from GLIM	1973-2003	Va
Icelandic fall groundfish survey	1996-2003	Va
Icelandic shrimp fishery	1986-1994	Va
Icelandic shrimp survey	1987-2003	Va
Greenland trawler CPUE from GLIM	1991-2003	XIVb
Greenland spring deepwater bottom-trawl survey	1997-2000, 2002-3	XIVb
Faroese trawler CPUE from GLIM	1991-2003	Vb
Faroese deep-water survey	1995-2003	Vb

The Icelandic shrimp fishery no longer exploits Greenland halibut, because of implementation of sorting grids in recent years. It does thus not provide indices of recent stock trends and was thus not included in the model. Since the shrimp survey covers a relatively limited area, the index was also excluded as an input candidate into the model. The Greenland deepwater survey only consist of a short time series with lack of a 2001 survey and was therefore not used. A run using the remaining four indices failed due to conflicting trends for the CPUE series in Divs. XIVb and Vb in the early 1990'ies. For the two remaining indices — Icelandic trawler standardized CPUE and Icelandic groundfish survey — ASPIC was run with a reduced commercial time-series from 1985-2003, the fall groundfish survey from 1996-2003. The decision of using only a reduced time series is because the CPUE index from 1973 to 1985 may not be reliable as it is based on limited logbook material and may cover a learning period at the beginning of the fishery.

ASPIC was run fitting a logistic model conditioned on catch as in previous years. Initially ASPIC was run with different starting guesses of MSY, B ratio and r to explore stability of parameter estimation. For an appropriate range of input values, ASPIC results were stable. However, when comparing the estimates to previous years estimates, the perception of stock productivity, and biomass and fishery related to MSY are changing over the time (text table below).

Parameter\Year of assessment	2000	2001	2002	2003	2004
B85/K	0.67	0.72	0.71	0.75	0.51
K	179	210	204	228	272
MSY	38	36	36	35	36
Bmsy	89	105	102	114	136
Fmsy	0.42	0.34	0.36	0.3	0.26

Observed and estimated CPUE's are provided in Fig. 6.7.2.1 and Table 6.7.2.1. For both indices the modelled CPUE do not entirely reflect the short-term dynamics in the observed CPUE's each year. The low of the commercial CPUE's in 1996 is hardly detected and similar with the observed increase until 2001 followed by the decrease to 2003. For the survey indices the decrease in observed values since 2001 is only moderately reflected by the model. The state of the stock relative to F_{msy} and B_{msy} is given in Fig 6.7.2.2 and Table 6.7.2.1. Compared to the 2003 assessment, the perception of the stock and fishery is changed considerably. Biomass has since the start of the period decreased, and was already in 1989 below Bmsy. For the past 5-7 years the biomass has been stable at about 40% of B_{msy}. F has in nearly the entire time series been above Fmsy and in the last decade increased dramatically being in 2003 about twice Fmsy.

Retrospective analyses were carried out in the 2002 NWWG report for both B/Bmsy and F/Fmsy in order to exploit the consistency of ASPIC with the currently used CPUE series. ASPIC then behaved consistent when contrasting data were available, e.g. back to about 1997. However, with the addition of this year's observation, ASPIC changes the modelled indices and CPUE's substantially compared to previous years. This is illustrated in the historic performance of ASPIC as given in Fig. 6.7.2.3. From the upper figures in Fig. 6.7.2.3. It is obvious that ASPIC reacts relatively strong to the decrease from 2002 to 2003 although the decrease already began a year before. This change in modelled indices results in a different historical perception of F and B in relation to MSY as seen from the lower part of Fig. 6.7.2.3. Therefore ASPIC most be considered a poor performer of the recent biomass dynamics that the CPUE and survey indices are considered to reflect.

6.7.3 Summary of the various observation data

A number of indices from the commercial fishery and from surveys are available as indicators for the biomass development. Although the indices are of different quality and are of different time length they indicate that stock dynamics may have been different in different areas in the most recent years:

- **Div. Va:** Icelandic trawl cpue (1985-2003) show that catch rates in 1993-2003 are less than half that observed in 1985-1989. In recent years catch rates increased from 1999 to 2001 but they have declined in the last three years and are currently 1/3 of that in 1985. The fall groundfish survey in Va (1996-2003) also indicate a decline in biomass in 2003 compared with previous years. A shrimp survey in the northern waters off Iceland (1987-2003), covering a limited area of whole distributional range of Greenland halibut indicate that the biomass in that area has been relatively low in recent years.

- **Div. Vb and XIVb:** The time series of the commercial indices as well as surveys from both Div. XIVb and Vb are relative short (approximately the last ten years) compared to the Icelandic trawler fleet and the Icelandic shrimp survey. None of these fleets show any clear trends over this period.

6.7.4 State of the stock

The present state of the stock is not known. Indices from Div. Va suggest a low biomass in recent years compared to the mid 1980'ies and a declining trend in the past two years. For the remaining areas, Divisions Vb and XIVb, the state of the stock in relation to a longer time perspective is unknown, but indices for the past decade point to stable stock components.

6.7.5 Stock projection

From calculated stock parameters and considered 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 2004 would be maintained at 30 000 t. This is based on a TAC in Icelandic waters that is maintained at 20 000 t and expected to be caught. Given that the landings in Vb and XIV will be the same as in recent years and that the Icelandic fleet will catch all its quota, it is anticipated that total landings in the year 2004 also will be in the order of 30 000 t. Three different trajectories were produced using the following options:

1) F(2004-13)=2/3$\mathbf{F}_{MSY}$~$\mathbf{F}_{pa}$,
2) F(2004-13)=$\mathbf{F}_{sq}$,
3) Catch(2004-2013)=30 000 t.

Plots of B-ratios (B/$\mathbf{B}_{MSY}$) are given in Figure 6.7.5 and biomass trajectory for option 1 only is given in Table 6.7.5. By fishing at $\mathbf{F}_{pa}$ (2/3$\mathbf{F}_{MSY}$) it is expected that the biomass will increase slowly above $\mathbf{B}_{MSY}$ by 2012 with a risk being below. Fishing at $\mathbf{F}_{sq}$ will result in a stock collapse within the next 5-6 years. Fishing at 30 000 t annually will also likely result in a stock collapse with a probability that stock biomass will remain very low. Landings in 2005 associated with the trajectories are 8 000 t at $\mathbf{F}_{pa}$ and 37 000 t at $\mathbf{F}_{sq}$. Compared to previous assessments, none of the projections in 2003 did result in a stock collapse.

6.7.6 Biological reference points

Defined reference points for Greenland halibut have previously been defined on the basis of an age-based analytical assessment. The Working Group considers it appropriate to define $\mathbf{F}_{pa}$ as 2/3 of $\mathbf{F}_{MSY}$ estimated from the stock-production model. Using 2/3 as $\mathbf{F}_{pa}$, $\mathbf{F}_{lim}$ could be calculated using $\mathbf{F}_{lim}=\mathbf{F}_{pa}*e^{1.645\sigma}$, where σ could be 0.30.

6.8 Management Considerations

No formal agreement on the management of the Greenland halibut exists among the three coastal states, Greenland, Iceland, and the Faroe Islands. The regulation schemes of those states have previously resulted in catches well in excess of TAC's advised by ICES.

Although the overall status of Greenland halibut in the assessment area is unknown, there are clear decreases in the CPUE from the Icelandic fishery from 1985. Normally, if a reduction in abundance of this magnitude is caused by high fishing mortality, larger fish would be expected to become progressively less abundant over time. In the Greenland halibut case, however, the size composition of the Icelandic catch on the principal fishing ground off the west coast have remained stable from 1985-2003 suggesting that fishing mortality is not affecting markedly the size composition of Greenland halibut in the area of the fishery. Such a discrepancy could be explained if the Icelandic fishing ground were regularly re-supplied by fish from neighbouring areas that are more lightly fished. Under this hypothesis, the decrease in abundance could be the result of the removal rate on the Icelandic ground being in excess of the re-supplying rate. If this hypothesis were true, the decrease in the survey index and in the CPUE would not necessarily cause concern for the conservation of the resource, but from a management perspective, however, there could be advantages in reducing fishing mortality to better match it with the hypothesised re-supplying rates from neighbouring areas. Given the uncertainties about overall stock size, stock structure, and abundance in the area of the fishery, a better mean to reduce fishing mortality could be through effort reductions rather than through TAC reductions.

6.9 Comments on the Assessment

It is noteworthy that even though there has been a substantial fluctuation in the commercial CPUE from Icelandic waters, the catch distribution from that area has kept relatively stable. This could be due to a limited availability of Greenland halibut to the fishery in combination with slow growth of the species, i.e. harvest occur on a relatively limited number of age groups in relation to the age range in the stock

The stock production model used to assess the status of the stock relies on the same trawler CPUE series as previously used in the XSA. This years output estimates of biomass and fishing mortality of the production model differs significantly from previous years ASPIC output and it is doubtful whether they represents the state of the stock in relation to MSY parameters. The lower biomass and higher exploitation as indicated by the model is driven by the most recent data points observed in 2003. Given the inertia of the ASPIC model it is not able to respond to the dynamics in observation data in recent year. This means that the observed biomass index decrease in recent years is not only considered due to fishing mortality but also other factors such as availability to fishery, migration etc.

Therefore, applying ASPIC bootstrap to the point estimates for catch projections as a basis for advice, will inevitability result in a considerable year to year variation in perception of stock production and thus also in expected catch for the forthcoming year. A stabilizer is therefore required …..

Use of other indices than the currently Icelandic (Va) CPUE series and survey series in the stock production model (ASPIC) should have been explored. CPUE series from XIVb and Vb are presently available, but due to 0 different trends than the Icelandic series it impedes inclusion in the ASPIC. Neither did they perform alone with catch related to their area, due to too short time series or to little contrast in data.

Table 6.1.1 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-areas V, XII and XIV 1981-2003, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	767	1,532	1,146	2,502	1,052	853	1,096	1,378	2,319
France	8	27	236	489	845	52	19	25	-
Germany	3,007	2,581	1,142	936	863	858	565	637	493
Greenland	+	1	5	15	81	177	154	37	11
Iceland	15,457	28,300	28,360	30,080	29,231	31,044	44,780	49,040	58,330
Norway	-	-	2	2	3	+	2	1	3
Russia	-	-	-	-	-	-	-	-	-
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	19,239	32,441	30,891	34,024	32,075	32,984	46,622	51,118	61,156
Working Group estimate	-	-	-	-	-	-	-	-	61,396

Country	1990	1991	1992	1993	1994	1995	1996 [1]	1997 [1]	1998 [1]
Denmark	-	-	-	-	-	-	1	-	
Faroe Islands	1,803	1,566	2,128	4,405	6,241	3,763	6,148	4,971	3,817
France	-	-	3	2	-	-	29	11	8
Germany	336	303	382	415	648	811	3,368	3,342	3,056
Greenland	40	66	437	288	867	533	1,162	1,129	747
Iceland	36,557	34,883	31,955	33,987	27,778	27,383	22,055	18,569	10,728
Norway	50	34	221	846	1,173 [1]	1,810	2,164	1,939	1,367
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	109	811	513	1,436	386	218	190
UK (Scotland)	-	-	19	26	84	232	25	26	43
United Kingdom									
Total	38,813	36,890	35,259	40,780	37,305	36,006	35,762	30,242	20,360
Working Group estimate	39,326	37,950	35,423	40,817	36,958	36,300	35,825	30,267	-

Country	1999 [1]	2000 [1]	2001 [1]	2002 [1]	2003 [1]
Denmark		-	0	0	0
Faroe Islands	3,884	-	0	0	0
France	-	21	25	20	33
Germany	3,082	3,271	2,807	2,148	2,948
Greenland	200	1,740	1,553		
Iceland	11,180	14,537	16,590	2,277	20,371
Ireland		-	7		
Norway	1,187	1,272	1,483	1,328	1,114
Portugal			6		
Russia	138	183	186	44	
Spain		8	10		
UK (Engl. and Wales)	261	370	227		
UK (Scotland)	69	121	130		
United Kingdom	-	-		239	1,205
Total	20,001	21,523	23,024	6,284	25,671
Working Group estimate	20,371	26,839	28,021	29,260	30,858

Table 6.1.2 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Va 1981-2002, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	325	669	33	46			15	379	719
Germany									
Greenland									
Iceland	15,455	28,300	28,359	30,078	29,195	31,027	44,644	49,000	58,330
Norway			+	+	2				
Total	15,780	28,969	28,392	30,124	29,197	31,027	44,659	49,379	59,049
Working Group estimate									59,272 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Faroe Islands	739	273	23	166	910	13	14	26	6
Germany					1	2	4		9
Greenland					1				[1]
Iceland	36,557	34,883	31,955	33,968	27,696	27,376	22,055	16,766	10,580
Norway								[1]	[1]
Total	37,296	35,156	31,978	34,134	28,608	27,391	22,073	16,792	10,595
Working Group estimate	37,308 [2]	35,413 [2]							

Country	1999	2000	2001	2002	2003 [1]
Faroe Islands	9				
Germany	13	22	50	31	23
Greenland	[1]				
Iceland	11,087	14,507	2,310 [4]	2,277	20,371
Norway			6		
UK (E/W/I)	26	73	50	21	
UK Scottland	3	5	12	16	
UK				37	21
Total	11,138	14,607	2,428	2,382	20,415
Working Group estimate		14,519 [3]	16,752	19,714	

1) Provisional data

2) Includes 223 t catch by Norway.

3) Includes 12 t catch by Norway.

4) 14280 t fished in Icelandic EEZ, previously reported in Va, are in 2002 moved to ICES XIV b.

Table 6.1.3 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Division Vb 1981-2003 as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Denmark	-	-	-	-	-	-	6	+	-
Faroe Islands	442	863	1,112	2,456	1,052	775	907	901	1,513
France	8	27	236	489	845	52	19	25	...
Germany	114	142	86	118	227	113	109	42	73
Greenland	-	-	-	-	-	-	-	-	-
Norway	2	+	2	2	2	+	2	1	3
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	566	1,032	1,436	3,065	2,126	940	1,043	969	1,589
Working Group estimate	-	-	-	-	-	-	-	-	1,606 [2]

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	-	-	
Faroe Islands	1,064	1,293	2,105	4,058	5,163	3,603	6,004	4750	3660
France [6]	...	...	3 [1]	2	1	28	29	11	8 [1]
Germany	43	24	71	24	8	1	21	41	
Greenland	-	-	-	-	-	-	-	-	
Norway	42	16	25	335	53	142	281	42 [1]	114 [1]
UK (Engl. and Wales)	-	-	1	15	-	31	122		
UK (Scotland)	-	-	1	-	-	27	12	26	43
United Kingdom	-	-	-	-	-				
Total	1,149	1,333	2,206	4,434	5,225	3,832	6,469	4,870	3825
Working Group estimate	1,282 [2]	1,662 [2]	2,269 [2]	-	-		-	-	0

Country	1999	2000 [1]	2001 [1]	2002 [1]	2003 [1]
Denmark					
Faroe Islands	3873				
France		21	25 [1]	20	33
Germany	22	6	7		
Iceland					
Ireland			+		
Norway	87	110 [1]	53 [1]	48	2
UK (Engl. and Wales)	9	35	77	50	
UK (Scotland)	66	116	118	141	
United Kingdom					197
Total	4057	288	280 2	259	232
Working Group estimate	2694 [2]	5092 [3]	3,951	2,694	2,426

1) Provisional data
2) WG estimate includes additional catches as described in Working Group reports for each year and in the report from 2001.

Table 6.1.4 GREENLAND HALIBUT. Nominal catches (tonnes) by countries, in Sub-area XIV 1981-2002, as officially reported to ICES.

Country	1981	1982	1983	1984	1985	1986	1987	1988	1989
Faroe Islands	-	-	-	-	-	78	74	98	87
Germany	2,893	2,439	1,054	818	636	745	456	595	420
Greenland	+	1	5	15	81	177	154	37	11
Iceland	-	-	1	2	36	17	136	40	+
Norway	-	-	-	+	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	+
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-
UK (Scotland)	-	-	-	-	-	-	-	-	-
United Kingdom	-	-	-	-	-	-	-	-	-
Total	2,893	2,440	1,060	835	753	1,017	820	770	518
Working Group estimate	-	-	-	-	-	-	-	-	-

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	-	-	-	-	-	-	1	+	+
Faroe Islands	-	-	-	181	168	147	130	148	151
Germany	293	279	311	391	639	808	3,343	3,301	3,399
Greenland	40	66	437	288	866	533	1,162	1,129	747 [1,7]
Iceland	-	-	-	19	82	7	-	1,803	148
Norway	8	18	196	511	1,120	1,668	1,881	1,897 [1]	1,253 [1]
Russia	-	-	5	-	-	10	424	37	52
UK (Engl. and Wales)	27	38	108	796	513	1405	264	218	190
UK (Scotland)	-	-	18	26	84	205	13		
United Kingdom	-	-	-	-	-	-	-		
Total	368	401	1,075	2,212	3,472	4,783	7,218	8,533	5940
Working Group estimate	736 [2]	875 [3]	1,176 [4]	2,249 [5]	3,125 [6]	5,077 [7]	7,283 [8]	8,558 [9]	

Country	1999	2000	2001 [1]	2002 [1]	2003 [1]
Denmark					
Faroe Islands	2				
Germany	3047	3243	2,750	2,117	2,925
Greenland	200 [1,4]	1740 [8]	1,553 [9]		
Iceland	93	30	14,280		
Ireland			7		
Norway	1100	1162 [1]	1,424	1,280	1,112
Portugal			6		
Russia	138	183	186	44	
Spain		8	10		
UK (Engl. and Wales)	226	262	100		
UK (Scotland)					
United Kingdom				202	987
Total	4806	6628	20,316	3,643 0	5,024
Working Group estimate	5376 [11]	6588 [5]	6,588 [6]	6,750 #	8,017 [10]

1) Provisional data
2)WG estimate includes additional catches as described in working Group reports for each year and in the report from 2001.
3) Includes 125 t by Faroe Islands and 206 t by Greenland.
4) Excluding 4732 t reported as area unknown.
5) Includes 1523 t by Norway, 102 t by Faroe Islands, 3343 t by Germany, 1910 t by Greenland, 180 t by Russia, as reported to Greenland authorities.
6) Includes 2849 t by Greenland, 142 t by Norway, 2750 t by Germany. Does not include 14280 t by Iceland as those are included in WG estimate of Va.
7) Excluding 138 t reported as area unknown.
8) Excluding 16 t reported as area unknown.
9) Excluding 20 t reported as area unknown
10) Includes 3370 t by Greenland, 3552 t as total for Germany and 959 t for Norway.

Table 6.1.5 GREENLAND HALIBUT. Nominal catches (tonnes) by countries in Sub-area XII, as officially reported to the ICES.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]
Faroe Islands		47						
Norway	2							
Total	2	47	-	-	-			
WG estimate							102 [1]	

[1] 102t by Faroe Islands as reported to Faroe Island authorities

Table 6.1.6. 2003 Catch statistics for Greenland halibut in V and XIV.
Working Groups best estimates.

Va	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands					0	
Germany, Fed. Rep.		23			23	23
Greenland					0	
Iceland	65	18,905	1,383		20,353	20371
Norway					0	
UK (E/W/NI)					0	
UK (Scotland)					0	
UK					21	21
Total	65	18,928	1,383	0	20,376	20,415

Vb	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands				2,194	2,194	
France					33	33
Germany Fed. Rep.					0	
Norway					2	2
UK (England & Wales)					0	
UK (Scotland)					0	
United Kingdom					197	197
Total	0	0	0	2,194	2,194	232

XII	Long line	Trawl	Gill Net	Unknown	SUM	SUM
Faroe Islands					0	
Total	0	0	0	0	0	0

XIV	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Denmark					0	
Faroe Islands		136			136	
EU (GER)		3,552			3,552	2,925
Greenland		3,370			3,370	
Iceland (outside 200 EEZ)					0	
Norway (inside 200 EEZ)	423	536			959	1,112
Norway (outside 200 EEZ)					0	
Russia					0	
Ireland					0	
UK (England & Wales)					0	
UK (Scotland)					0	
United Kingdom					0	987
Total	423	7,594	0	0	8,017	5,024

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM	SUM
	488	26,522	1,383	2,194	**30,587**	25,671

Table 6.2.1. CPUE indices oftrawl fleets in Div Va, Vb and XIVb as derived from GLM multiplicative models.

area	year	cpue	% change in CPUE between years	landings	effort	% change in effort between years
Iceland Va	1985	1.00		29,197	29	
	1986	0.91	-9	31,027	34	16
	1987	0.88	-3	44,659	51	49
	1988	0.96	9	49,379	51	2
	1989	0.91	-5	59,049	65	26
	1990	0.74	-19	37,308	50	-22
	1991	0.76	2	35,413	47	-7
	1992	0.65	-14	31,978	49	5
	1993	0.51	-23	34,134	68	38
	1994	0.41	-19	28,608	70	3
	1995	0.31	-24	27,391	88	26
	1996	0.26	-17	22,073	85	-3
	1997	0.29	11	16,792	58	-32
	1998	0.47	62	10,595	23	-61
	1999	0.54	15	11,138	21	-8
	2000	0.59	10	14,607	25	19
	2001	0.61	4	16,755	27	11
	2002	0.47	-24	19,714	42	54
	2003	0.33	-30	20,415	62	47
Greenland, XIVb	1991	1.00		875	1	
	1992	0.99	-1	1,176	1	36
	1993	1.18	19	2,249	2	60
	1994	1.27	7	3,125	2	30
	1995	1.23	-3	5,077	4	68
	1996	1.24	1	7,283	6	42
	1997	1.27	3	8,558	7	14
	1998	1.29	1	5,940	5	-31
	1999	1.24	-4	5,376	4	-6
	2000	1.26	1	6,958	6	28
	2001	1.23	-2	7,216	6	6
	2002	1.23	0	6,750	5	-7
	2003	1.25	1	8,017	6	17
Faroe Islands, Vb	1991	1.00		1,662	2	
	1992	1.01	1	2,269	2	35
	1993	0.95	-6	4,434	5	108
	1994	0.90	-6	5,225	6	25
	1995	0.88	-1	3,832	4	-26
	1996	0.88	0	6,469	7	70
	1997	0.86	-2	4,870	6	-23
	1998	0.88	3	3,825	4	-23
	1999	0.87	-1	4,265	5	13
	2000	0.87	0	5,079	6	20
	2001	0.88	1	3,245	4	-37
	2002	0.89	1	2,694	3	-18
	2003	0.92	4	2,426	3	-28

Table 6.7.2.1. Output from ASPIC model on CPUE series in Div. Va, total catches in Va, Vb and XIV and Icelandic fall survey indices.

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

CONTROL PARAMETERS USED (FROM INPUT FILE)
----------------------------------------------------------------------------------------------------
--------------------
Number of years analyzed:                     19           Number of bootstrap trials:
0
Number of data series:                         2           Lower bound on MSY:
2.000E+04
Objective function computed:           in effort           Upper bound on MSY:
1.800E+07
Relative conv. criterion (simplex):    1.000E-08           Lower bound on r:
2.000E-02
Relative conv. criterion (restart):    3.000E-08           Upper bound on r:
1.000E+01
Relative conv. criterion (effort):     1.000E-04           Random number seed:
5930561
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  cc va                             |   1.000
                                      |      19
                                      |
 2  survey va                         |   0.675   1.000
                                      |       8       8
                                      --------------------------------------------------
                                              1       2


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

Loss(-1)  SSE in yield                             0.000E+00
Loss( 0)  Penalty for B1R > 2                      0.000E+00    1            N/A    0.000E+00
N/A
Loss( 1)  cc va                                    1.089E+00   19      6.404E-02    1.000E+00
9.760E-01        0.772
Loss( 2)  survey va                                3.548E-01    8      5.913E-02    1.000E+00
1.057E+00        0.273
TOTAL OBJECTIVE FUNCTION:                     1.44352199E+00

Number of restarts required for convergence:              51
Est. B-ratio coverage index (0 worst, 2 best):        0.7494             < 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       1.130E+00          1.000E+00            1            1
MSY       Maximum sustainable yield               3.606E+04          6.000E+05            1            1
r         Intrinsic rate of increase              5.298E-01          6.000E-01            1            1
........  Catchability coefficients by fishery:
q( 1)     cc va                                   6.377E-03          5.000E-03            1            1
q( 2)     survey va                               6.575E-03          5.000E-03            1            1
```

Table 6.7.2.1 (Cont'd)

MANAGEMENT PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

Parameter	quantity	Estimate	Formula	Related
MSY	Maximum sustainable yield	3.606E+04	Kr/4	
K	Maximum stock biomass	2.722E+05		
Bmsy	Stock biomass at MSY	1.361E+05	K/2	
Fmsy	Fishing mortality at MSY	2.649E-01	r/2	
F(0.1)	Management benchmark	2.384E-01	0.9*Fmsy	
Y(0.1)	Equilibrium yield at F(0.1)	3.570E+04	0.99*MSY	
B-ratio	Ratio of B(2004) to Bmsy	4.109E-01		
F-ratio	Ratio of F(2003) to Fmsy	1.974E+00		
F01-mult	Ratio of F(0.1) to F(2003)	4.559E-01		
Y-ratio	Proportion of MSY avail in 2004	6.529E-01	2*Br-Br^2	Ye(2004) = 2.355E+04
....	Fishing effort at MSY in units of each fishery:			
fmsy(1)	cc va	4.154E+01	r/2q(1)	f(0.1) = 3.739E+01

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 Fmsy	Ratio of biomass to Bmsy
1	1985	0.206	1.539E+05	1.556E+05	3.208E+04	3.208E+04	3.532E+04	7.782E-01	1.130E+00
2	1986	0.208	1.571E+05	1.582E+05	3.298E+04	3.298E+04	3.511E+04	7.868E-01	1.154E+00
3	1987	0.304	1.593E+05	1.533E+05	4.662E+04	4.662E+04	3.546E+04	1.148E+00	1.170E+00
4	1988	0.365	1.481E+05	1.401E+05	5.112E+04	5.112E+04	3.599E+04	1.378E+00	1.088E+00
5	1989	0.516	1.330E+05	1.190E+05	6.140E+04	6.140E+04	3.538E+04	1.948E+00	9.768E-01
6	1990	0.377	1.070E+05	1.042E+05	3.933E+04	3.933E+04	3.408E+04	1.424E+00	7.857E-01
7	1991	0.382	1.017E+05	9.936E+04	3.795E+04	3.795E+04	3.343E+04	1.442E+00	7.472E-01
8	1992	0.369	9.719E+04	9.589E+04	3.542E+04	3.542E+04	3.291E+04	1.394E+00	7.140E-01
9	1993	0.453	9.467E+04	9.002E+04	4.082E+04	4.082E+04	3.191E+04	1.712E+00	6.955E-01
10	1994	0.449	8.577E+04	8.237E+04	3.696E+04	3.696E+04	3.043E+04	1.694E+00	6.301E-01
11	1995	0.482	7.924E+04	7.537E+04	3.630E+04	3.630E+04	2.887E+04	1.818E+00	5.821E-01
12	1996	0.534	7.181E+04	6.708E+04	3.583E+04	3.583E+04	2.677E+04	2.016E+00	5.276E-01
13	1997	0.505	6.276E+04	5.990E+04	3.027E+04	3.027E+04	2.475E+04	1.907E+00	4.610E-01
14	1998	0.343	5.724E+04	5.938E+04	2.036E+04	2.036E+04	2.460E+04	1.294E+00	4.205E-01
15	1999	0.317	6.148E+04	6.432E+04	2.037E+04	2.037E+04	2.602E+04	1.195E+00	4.516E-01
16	2000	0.400	6.713E+04	6.711E+04	2.684E+04	2.684E+04	2.679E+04	1.510E+00	4.932E-01
17	2001	0.422	6.708E+04	6.635E+04	2.802E+04	2.802E+04	2.659E+04	1.594E+00	4.928E-01
18	2002	0.458	6.565E+04	6.393E+04	2.926E+04	2.926E+04	2.592E+04	1.728E+00	4.823E-01
19	2003	0.523	6.231E+04	5.900E+04	3.086E+04	3.086E+04	2.448E+04	1.974E+00	4.577E-01
20	2004		5.593E+04						4.109E-01

RESULTS FOR DATA SERIES # 1 (NON-BOOTSTRAPPED) cc va

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	9.922E+02	0.2062	3.208E+04	3.208E+04	-0.00781	0.000E+00
2	1986	9.140E+02	1.009E+03	0.2084	3.298E+04	3.298E+04	0.09907	0.000E+00
3	1987	8.820E+02	9.779E+02	0.3041	4.662E+04	4.662E+04	0.10317	0.000E+00
4	1988	9.600E+02	8.932E+02	0.3650	5.112E+04	5.112E+04	-0.07212	0.000E+00
5	1989	9.130E+02	7.589E+02	0.5160	6.140E+04	6.140E+04	-0.18488	0.000E+00
6	1990	7.440E+02	6.647E+02	0.3773	3.933E+04	3.933E+04	-0.11272	0.000E+00
7	1991	7.570E+02	6.337E+02	0.3820	3.795E+04	3.795E+04	-0.17786	0.000E+00
8	1992	6.530E+02	6.115E+02	0.3694	3.542E+04	3.542E+04	-0.06564	0.000E+00
9	1993	5.060E+02	5.741E+02	0.4534	4.082E+04	4.082E+04	0.12623	0.000E+00
10	1994	4.110E+02	5.253E+02	0.4487	3.696E+04	3.696E+04	0.24544	0.000E+00
11	1995	3.130E+02	4.807E+02	0.4816	3.630E+04	3.630E+04	0.42903	0.000E+00
12	1996	2.590E+02	4.278E+02	0.5340	3.583E+04	3.583E+04	0.50190	0.000E+00
13	1997	2.880E+02	3.820E+02	0.5053	3.027E+04	3.027E+04	0.28256	0.000E+00
14	1998	4.660E+02	3.787E+02	0.3429	2.036E+04	2.036E+04	-0.20752	0.000E+00
15	1999	5.350E+02	4.102E+02	0.3167	2.037E+04	2.037E+04	-0.26557	0.000E+00
16	2000	5.890E+02	4.280E+02	0.3999	2.684E+04	2.684E+04	-0.31935	0.000E+00
17	2001	6.120E+02	4.231E+02	0.4223	2.802E+04	2.802E+04	-0.36901	0.000E+00
18	2002	4.670E+02	4.077E+02	0.4577	2.926E+04	2.926E+04	-0.13577	0.000E+00
19	2003	3.290E+02	3.763E+02	0.5230	3.086E+04	3.086E+04	0.13423	0.000E+00

Table 6.7.2.1.cont'd

```
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    -0.0078                                            |
1986     0.0991                                            |====
1987     0.1032                                            |====
1988    -0.0721                                         ===|
1989    -0.1849                                     =======|
1990    -0.1127                                       =====|
1991    -0.1779                                     =======|
1992    -0.0656                                         ===|
1993     0.1262                                            |=====
1994     0.2454                                            |==========
1995     0.4290                                            |=================
1996     0.5019                                            |====================
1997     0.2826                                            |===========
1998    -0.2075                                    ========|
1999    -0.2656                                 ===========|
2000    -0.3194                               =============|
2001    -0.3690                             ===============|
2002    -0.1358                                       =====|
2003     0.1342                                            |=====
                   ---------------------------------------------------------------------------------
RESULTS FOR DATA SERIES # 2 (NON-BOOTSTRAPPED)                                    survey va
----------------------------------------------------------------------------------------------------
--------------------
Data type I2: End-of-year biomass index                                           Series weight:  1.000
```

Obs	Year	Observed effort	Estimated effort	Estim F	Observed index	Model index	Resid in log index	Resid in index
1	1985	0.000E+00	0.000E+00	0.0	*	1.033E+03	0.00000	0.0
2	1986	0.000E+00	0.000E+00	0.0	*	1.047E+03	0.00000	0.0
3	1987	0.000E+00	0.000E+00	0.0	*	9.737E+02	0.00000	0.0
4	1988	0.000E+00	0.000E+00	0.0	*	8.743E+02	0.00000	0.0
5	1989	0.000E+00	0.000E+00	0.0	*	7.032E+02	0.00000	0.0
6	1990	0.000E+00	0.000E+00	0.0	*	6.687E+02	0.00000	0.0
7	1991	0.000E+00	0.000E+00	0.0	*	6.390E+02	0.00000	0.0
8	1992	0.000E+00	0.000E+00	0.0	*	6.225E+02	0.00000	0.0
9	1993	0.000E+00	0.000E+00	0.0	*	5.639E+02	0.00000	0.0
10	1994	0.000E+00	0.000E+00	0.0	*	5.210E+02	0.00000	0.0
11	1995	0.000E+00	0.000E+00	0.0	*	4.721E+02	0.00000	0.0
12	1996	1.000E+00	1.000E+00	0.0	3.440E+02	4.126E+02	-0.18190	-6.863E+01
13	1997	1.000E+00	1.000E+00	0.0	4.200E+02	3.764E+02	0.10971	4.364E+01
14	1998	1.000E+00	1.000E+00	0.0	4.200E+02	4.042E+02	0.03832	1.579E+01
15	1999	1.000E+00	1.000E+00	0.0	5.240E+02	4.414E+02	0.17160	8.263E+01
16	2000	1.000E+00	1.000E+00	0.0	3.960E+02	4.411E+02	-0.10778	-4.506E+01
17	2001	1.000E+00	1.000E+00	0.0	5.570E+02	4.316E+02	0.25498	1.254E+02
18	2002	1.000E+00	1.000E+00	0.0	4.720E+02	4.097E+02	0.14166	6.234E+01
19	2003	1.000E+00	1.000E+00	0.0	2.400E+02	3.677E+02	-0.42667	-1.277E+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    -0.1819                                     =======|
1997     0.1097                                            |====
1998     0.0383                                            |==
1999     0.1716                                            |=======
2000    -0.1078                                        ====|
2001     0.2550                                            |==========
2002     0.1417                                            |======
2003    -0.4267                           =================|
```

Table 6.7.5. Trajectories from ASPIC assuming Catch = 30,000 t in 2004 and F2005-2013 =Fpa (~2/3Fmsy).

USER CONTROL INFORMATION (FROM INPUT FILE)

Name of biomass (BIO) file	ghl8503.bio
Name of output file (this file)	ghlboot_catc
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
2004	3.000E+04	TAC
2005	3.050E-01	F/F(2003)
2006	3.050E-01	F/F(2003)
2007	3.050E-01	F/F(2003)
2008	3.050E-01	F/F(2003)
2009	3.050E-01	F/F(2003)
2010	3.050E-01	F/F(2003)
2011	3.050E-01	F/F(2003)
2012	3.050E-01	F/F(2003)
2013	3.050E-01	F/F(2003)

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	9.440E-01	1.058E+00	12.10%	3.807E-01	2.081E+00	6.046E-01	1.426E+00	8.210E-01	0.870
1986	1.004E+00	1.097E+00	9.24%	4.033E-01	1.848E+00	6.480E-01	1.382E+00	7.341E-01	0.731
1987	1.039E+00	1.127E+00	8.40%	4.518E-01	1.684E+00	7.111E-01	1.352E+00	6.406E-01	0.616
1988	9.827E-01	1.053E+00	7.17%	4.504E-01	1.503E+00	6.940E-01	1.225E+00	5.312E-01	0.541
1989	8.929E-01	9.468E-01	6.04%	4.260E-01	1.303E+00	6.405E-01	1.078E+00	4.376E-01	0.490
1990	7.191E-01	7.536E-01	4.81%	3.867E-01	1.146E+00	5.571E-01	8.912E-01	3.341E-01	0.465
1991	6.857E-01	7.181E-01	4.73%	3.714E-01	1.072E+00	5.322E-01	8.409E-01	3.087E-01	0.450
1992	6.565E-01	6.880E-01	4.79%	3.598E-01	1.006E+00	5.119E-01	7.945E-01	2.826E-01	0.430
1993	6.412E-01	6.733E-01	5.01%	3.430E-01	9.258E-01	4.823E-01	7.574E-01	2.751E-01	0.429
1994	5.811E-01	6.092E-01	4.83%	3.197E-01	8.529E-01	4.529E-01	6.883E-01	2.355E-01	0.405
1995	5.369E-01	5.625E-01	4.77%	2.994E-01	8.009E-01	4.239E-01	6.355E-01	2.116E-01	0.394
1996	4.870E-01	5.081E-01	4.33%	2.734E-01	7.449E-01	3.841E-01	5.758E-01	1.916E-01	0.393
1997	4.206E-01	4.396E-01	4.51%	2.549E-01	7.266E-01	3.410E-01	5.263E-01	1.853E-01	0.441
1998	3.871E-01	3.963E-01	2.40%	2.273E-01	7.244E-01	3.075E-01	5.136E-01	2.061E-01	0.532
1999	4.143E-01	4.277E-01	3.23%	2.461E-01	7.472E-01	3.292E-01	5.398E-01	2.105E-01	0.508
2000	4.550E-01	4.712E-01	3.55%	2.679E-01	7.559E-01	3.622E-01	5.560E-01	1.938E-01	0.426
2001	4.557E-01	4.717E-01	3.50%	2.704E-01	7.427E-01	3.652E-01	5.635E-01	1.983E-01	0.435
2002	4.463E-01	4.616E-01	3.45%	2.653E-01	7.327E-01	3.581E-01	5.614E-01	2.033E-01	0.456
2003	4.258E-01	4.365E-01	2.50%	2.444E-01	7.067E-01	3.269E-01	5.429E-01	2.161E-01	0.507
2004	3.600E-01	3.719E-01	3.30%	1.877E-01	6.842E-01	2.620E-01	5.086E-01	2.467E-01	0.685
2005	2.814E-01	3.010E-01	6.98%	6.061E-02	6.322E-01	1.476E-01	4.493E-01	3.017E-01	1.072
2006	3.838E-01	4.005E-01	4.36%	8.638E-02	7.602E-01	2.117E-01	5.848E-01	3.731E-01	0.972
2007	5.096E-01	5.166E-01	1.37%	1.312E-01	9.165E-01	2.977E-01	7.401E-01	4.424E-01	0.868
2008	6.429E-01	6.433E-01	0.07%	1.862E-01	1.041E+00	3.986E-01	8.688E-01	4.702E-01	0.731
2009	7.905E-01	7.721E-01	-2.32%	2.726E-01	1.181E+00	5.386E-01	1.022E+00	4.836E-01	0.612
2010	9.270E-01	8.938E-01	-3.59%	3.845E-01	1.300E+00	6.751E-01	1.161E+00	4.854E-01	0.524
2011	1.052E+00	1.001E+00	-4.82%	5.009E-01	1.383E+00	8.114E-01	1.259E+00	4.477E-01	0.426
2012	1.140E+00	1.090E+00	-4.44%	5.796E-01	1.434E+00	9.063E-01	1.323E+00	4.166E-01	0.365
2013	1.210E+00	1.160E+00	-4.13%	6.627E-01	1.464E+00	9.785E-01	1.370E+00	3.917E-01	0.324
2014	1.259E+00	1.213E+00	-3.70%	7.475E-01	1.491E+00	1.048E+00	1.404E+00	3.558E-01	0.283

NOTE: Printed BC confidence intervals are always approximate.
At least 500 trials are recommended when estimating confidence intervals.

Table 6.7.5 cont'd

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	8.154E-01	7.965E-01	-2.33%	5.544E-01	1.192E+00	6.549E-01	1.004E+00	3.495E-01	0.429
1986	8.032E-01	7.939E-01	-1.15%	6.134E-01	1.099E+00	6.909E-01	9.427E-01	2.518E-01	0.313
1987	1.156E+00	1.148E+00	-0.72%	9.526E-01	1.492E+00	1.030E+00	1.315E+00	2.846E-01	0.246
1988	1.382E+00	1.374E+00	-0.58%	1.191E+00	1.726E+00	1.262E+00	1.532E+00	2.700E-01	0.195
1989	1.967E+00	1.951E+00	-0.81%	1.720E+00	2.378E+00	1.816E+00	2.167E+00	3.501E-01	0.178
1990	1.442E+00	1.433E+00	-0.63%	1.260E+00	1.723E+00	1.344E+00	1.571E+00	2.266E-01	0.157
1991	1.456E+00	1.447E+00	-0.61%	1.294E+00	1.715E+00	1.361E+00	1.577E+00	2.163E-01	0.149
1992	1.403E+00	1.394E+00	-0.62%	1.270E+00	1.646E+00	1.321E+00	1.512E+00	1.910E-01	0.136
1993	1.716E+00	1.709E+00	-0.42%	1.565E+00	1.974E+00	1.622E+00	1.825E+00	2.034E-01	0.119
1994	1.704E+00	1.692E+00	-0.71%	1.560E+00	1.965E+00	1.620E+00	1.822E+00	2.026E-01	0.119
1995	1.838E+00	1.820E+00	-0.96%	1.688E+00	2.131E+00	1.753E+00	1.962E+00	2.095E-01	0.114
1996	2.048E+00	2.032E+00	-0.79%	1.740E+00	2.320E+00	1.904E+00	2.162E+00	2.030E-01	0.099
1997	1.929E+00	1.943E+00	0.72%	1.506E+00	2.160E+00	1.747E+00	2.052E+00	3.051E-01	0.158
1998	1.311E+00	1.323E+00	0.89%	9.953E-01	1.490E+00	1.168E+00	1.409E+00	2.414E-01	0.184
1999	1.201E+00	1.214E+00	1.08%	9.294E-01	1.361E+00	1.087E+00	1.281E+00	1.946E-01	0.162
2000	1.515E+00	1.525E+00	0.63%	1.237E+00	1.742E+00	1.397E+00	1.622E+00	2.253E-01	0.149
2001	1.594E+00	1.609E+00	0.89%	1.272E+00	1.870E+00	1.436E+00	1.715E+00	2.788E-01	0.175
2002	1.728E+00	1.747E+00	1.08%	1.338E+00	2.109E+00	1.532E+00	1.914E+00	3.826E-01	0.221
2003	2.124E+00	2.154E+00	1.41%	1.512E+00	3.374E+00	1.794E+00	2.602E+00	6.871E-01	0.323
2004	2.382E+00	2.401E+00	0.78%	1.485E+00	4.659E+00	1.868E+00	3.196E+00	1.328E+00	0.558
2005	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2006	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2007	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2008	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2009	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2010	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2011	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2012	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323
2013	6.480E-01	6.571E-01	1.41%	4.610E-01	8.678E-01	5.471E-01	7.567E-01	2.096E-01	0.323

TABLE OF PROJECTED YIELDS

2004	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
2005	**8.323E+03**	8.569E+03	2.95%	3.070E+03	1.013E+04	6.093E+03	9.501E+03	3.408E+03	0.409
2006	1.203E+04	1.122E+04	-6.74%	9.113E+03	1.572E+04	1.050E+04	1.389E+04	3.384E+03	0.281
2007	1.598E+04	1.422E+04	-11.03%	1.154E+04	2.117E+04	1.352E+04	1.907E+04	5.556E+03	0.348
2008	2.011E+04	1.737E+04	-13.61%	1.358E+04	2.629E+04	1.641E+04	2.372E+04	7.314E+03	0.364
2009	2.392E+04	2.046E+04	-14.47%	1.575E+04	3.117E+04	1.961E+04	2.760E+04	7.987E+03	0.334
2010	2.721E+04	2.328E+04	-14.46%	1.740E+04	3.591E+04	2.229E+04	3.133E+04	9.036E+03	0.332
2011	2.983E+04	2.569E+04	-13.88%	1.812E+04	4.004E+04	2.378E+04	3.339E+04	9.606E+03	0.322
2012	3.187E+04	2.763E+04	-13.30%	1.976E+04	4.321E+04	2.577E+04	3.578E+04	1.001E+04	0.314
2013	3.364E+04	2.914E+04	-13.39%	2.133E+04	4.717E+04	2.763E+04	3.866E+04	1.103E+04	0.328

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	1.196E+05	1.375E+05	14.94%	7.210E+04	3.284E+05	8.826E+04	1.976E+05	1.093E+05	0.914
1986	1.309E+05	1.425E+05	8.85%	8.195E+04	3.141E+05	9.952E+04	1.996E+05	1.001E+05	0.764
1987	1.388E+05	1.464E+05	5.48%	9.662E+04	3.083E+05	1.106E+05	2.084E+05	9.775E+04	0.704
1988	1.309E+05	1.368E+05	4.56%	9.451E+04	2.809E+05	1.060E+05	1.919E+05	8.590E+04	0.656
1989	1.182E+05	1.230E+05	4.07%	8.767E+04	2.504E+05	9.668E+04	1.713E+05	7.464E+04	0.632
1990	9.359E+04	9.791E+04	4.62%	6.641E+04	2.168E+05	7.465E+04	1.426E+05	6.791E+04	0.726
1991	8.893E+04	9.330E+04	4.91%	6.389E+04	2.052E+05	7.190E+04	1.341E+05	6.224E+04	0.700
1992	8.506E+04	8.938E+04	5.08%	6.194E+04	1.922E+05	6.940E+04	1.270E+05	5.759E+04	0.677
1993	8.345E+04	8.749E+04	4.84%	6.206E+04	1.810E+05	6.924E+04	1.211E+05	5.190E+04	0.622
1994	7.544E+04	7.915E+04	4.91%	5.587E+04	1.660E+05	6.240E+04	1.086E+05	4.615E+04	0.612
1995	6.954E+04	7.309E+04	5.11%	5.191E+04	1.549E+05	5.789E+04	1.011E+05	4.316E+04	0.621
1996	6.268E+04	6.602E+04	5.32%	4.642E+04	1.441E+05	5.196E+04	9.163E+04	3.967E+04	0.633
1997	5.382E+04	5.711E+04	6.12%	3.846E+04	1.334E+05	4.373E+04	8.298E+04	3.926E+04	0.729
1998	4.807E+04	5.150E+04	7.12%	3.257E+04	1.273E+05	3.782E+04	7.782E+04	3.999E+04	0.832
1999	5.211E+04	5.557E+04	6.64%	3.594E+04	1.319E+05	4.151E+04	8.253E+04	4.102E+04	0.787
2000	5.792E+04	6.122E+04	5.69%	4.146E+04	1.379E+05	4.744E+04	8.805E+04	4.061E+04	0.701
2001	5.836E+04	6.129E+04	5.02%	4.223E+04	1.352E+05	4.797E+04	8.702E+04	3.905E+04	0.669
2002	5.709E+04	5.998E+04	5.05%	4.172E+04	1.307E+05	4.684E+04	8.397E+04	3.713E+04	0.650
2003	5.377E+04	5.671E+04	5.46%	3.886E+04	1.287E+05	4.400E+04	8.210E+04	3.810E+04	0.709
2004	4.485E+04	4.832E+04	7.74%	2.806E+04	1.160E+05	3.343E+04	7.120E+04	3.777E+04	0.842
2005	3.357E+04	3.911E+04	16.52%	6.034E+03	9.802E+04	1.711E+04	5.673E+04	3.963E+04	1.181
2006	4.463E+04	5.204E+04	16.61%	6.421E+03	1.079E+05	2.264E+04	6.872E+04	4.608E+04	1.033
2007	5.848E+04	6.712E+04	14.78%	7.188E+03	1.169E+05	2.861E+04	8.320E+04	5.459E+04	0.933
2008	7.506E+04	8.359E+04	11.37%	9.805E+03	1.324E+05	3.950E+04	1.008E+05	6.127E+04	0.816
2009	9.215E+04	1.003E+05	8.87%	2.023E+04	1.528E+05	5.641E+04	1.208E+05	6.439E+04	0.699
2010	1.097E+05	1.161E+05	5.83%	3.445E+04	1.694E+05	7.335E+04	1.377E+05	6.435E+04	0.586
2011	1.263E+05	1.301E+05	2.97%	5.448E+04	1.894E+05	9.475E+04	1.567E+05	6.192E+04	0.490
2012	1.394E+05	1.416E+05	1.57%	7.524E+04	2.072E+05	1.115E+05	1.715E+05	5.996E+04	0.430
2013	1.492E+05	1.507E+05	0.99%	8.995E+04	2.198E+05	1.223E+05	1.821E+05	5.989E+04	0.401
2014	1.562E+05	1.576E+05	0.87%	1.052E+05	2.307E+05	1.304E+05	1.909E+05	6.053E+04	0.387

Table 6.7.5 cont'd

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	2.511E-01	2.289E-01	-8.85%	1.001E-01	4.157E-01	1.599E-01	3.408E-01	1.809E-01	0.720
1986	2.420E-01	2.282E-01	-5.73%	1.061E-01	3.690E-01	1.600E-01	3.136E-01	1.536E-01	0.635
1987	3.443E-01	3.299E-01	-4.18%	1.577E-01	4.881E-01	2.331E-01	4.320E-01	1.989E-01	0.578
1988	4.094E-01	3.948E-01	-3.55%	1.939E-01	5.607E-01	2.856E-01	5.064E-01	2.208E-01	0.539
1989	5.832E-01	5.608E-01	-3.85%	2.649E-01	8.066E-01	3.954E-01	7.250E-01	3.296E-01	0.565
1990	4.303E-01	4.117E-01	-4.30%	1.898E-01	6.049E-01	2.886E-01	5.365E-01	2.479E-01	0.576
1991	4.344E-01	4.158E-01	-4.27%	1.933E-01	6.041E-01	2.918E-01	5.369E-01	2.451E-01	0.564
1992	4.175E-01	4.007E-01	-4.03%	1.905E-01	5.711E-01	2.860E-01	5.107E-01	2.247E-01	0.538
1993	5.132E-01	4.911E-01	-4.31%	2.366E-01	6.943E-01	3.595E-01	6.223E-01	2.629E-01	0.512
1994	5.079E-01	4.863E-01	-4.24%	2.313E-01	6.867E-01	3.539E-01	6.154E-01	2.615E-01	0.515
1995	5.483E-01	5.231E-01	-4.61%	2.431E-01	7.408E-01	3.783E-01	6.624E-01	2.841E-01	0.518
1996	6.146E-01	5.839E-01	-5.00%	2.597E-01	8.491E-01	4.136E-01	7.524E-01	3.388E-01	0.551
1997	5.904E-01	5.584E-01	-5.42%	2.319E-01	8.540E-01	3.768E-01	7.435E-01	3.667E-01	0.621
1998	4.031E-01	3.802E-01	-5.67%	1.570E-01	5.964E-01	2.551E-01	5.132E-01	2.581E-01	0.640
1999	3.680E-01	3.488E-01	-5.24%	1.504E-01	5.237E-01	2.375E-01	4.565E-01	2.190E-01	0.595
2000	4.599E-01	4.382E-01	-4.73%	1.958E-01	6.413E-01	3.082E-01	5.608E-01	2.526E-01	0.549
2001	4.822E-01	4.623E-01	-4.12%	2.108E-01	6.669E-01	3.302E-01	5.886E-01	2.584E-01	0.536
2002	5.249E-01	5.019E-01	-4.37%	2.220E-01	7.215E-01	3.446E-01	6.364E-01	2.918E-01	0.556
2003	6.528E-01	6.191E-01	-5.15%	2.652E-01	1.324E+00	4.290E-01	9.281E-01	4.202E-01	0.644
2004	7.505E-01	6.900E-01	-8.07%	2.845E-01	2.014E+00	4.776E-01	1.224E+00	7.466E-01	0.995
2005	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2006	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2007	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2008	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2009	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2010	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2011	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2012	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644
2013	1.991E-01	1.888E-01	-5.15%	8.087E-02	2.970E-01	1.308E-01	2.590E-01	1.282E-01	0.644

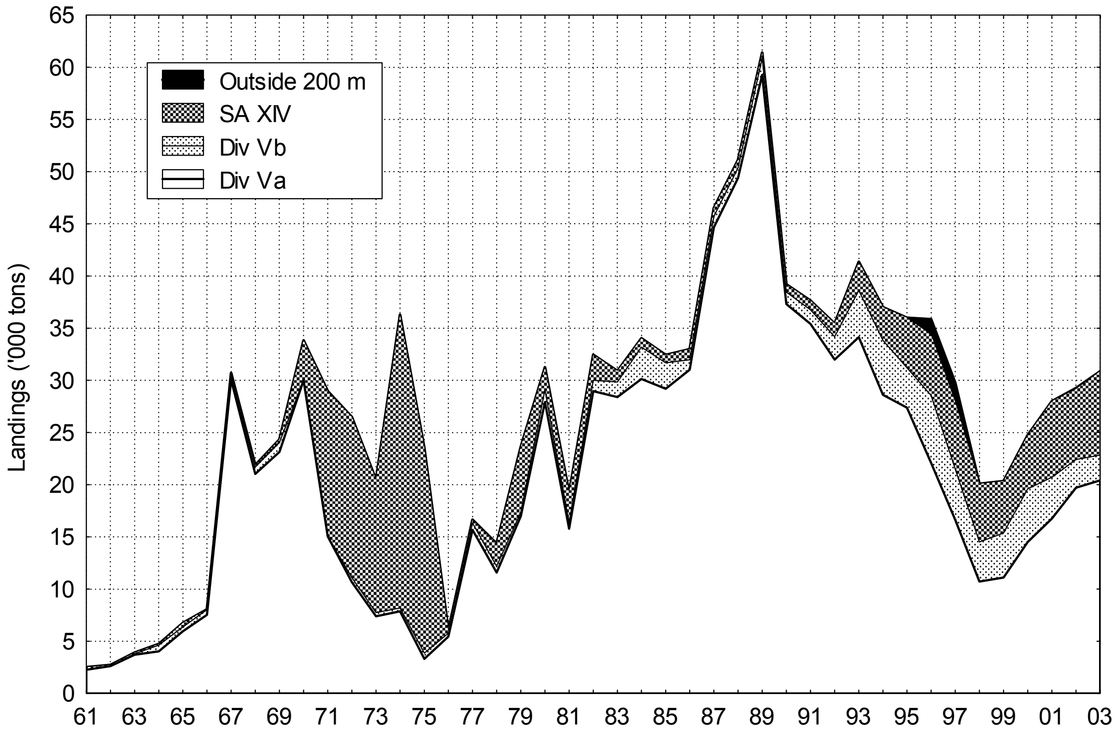


Figure 6.1.1 Landings of Greenland halibut in Divisions Va, Vb, and Subarea XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.

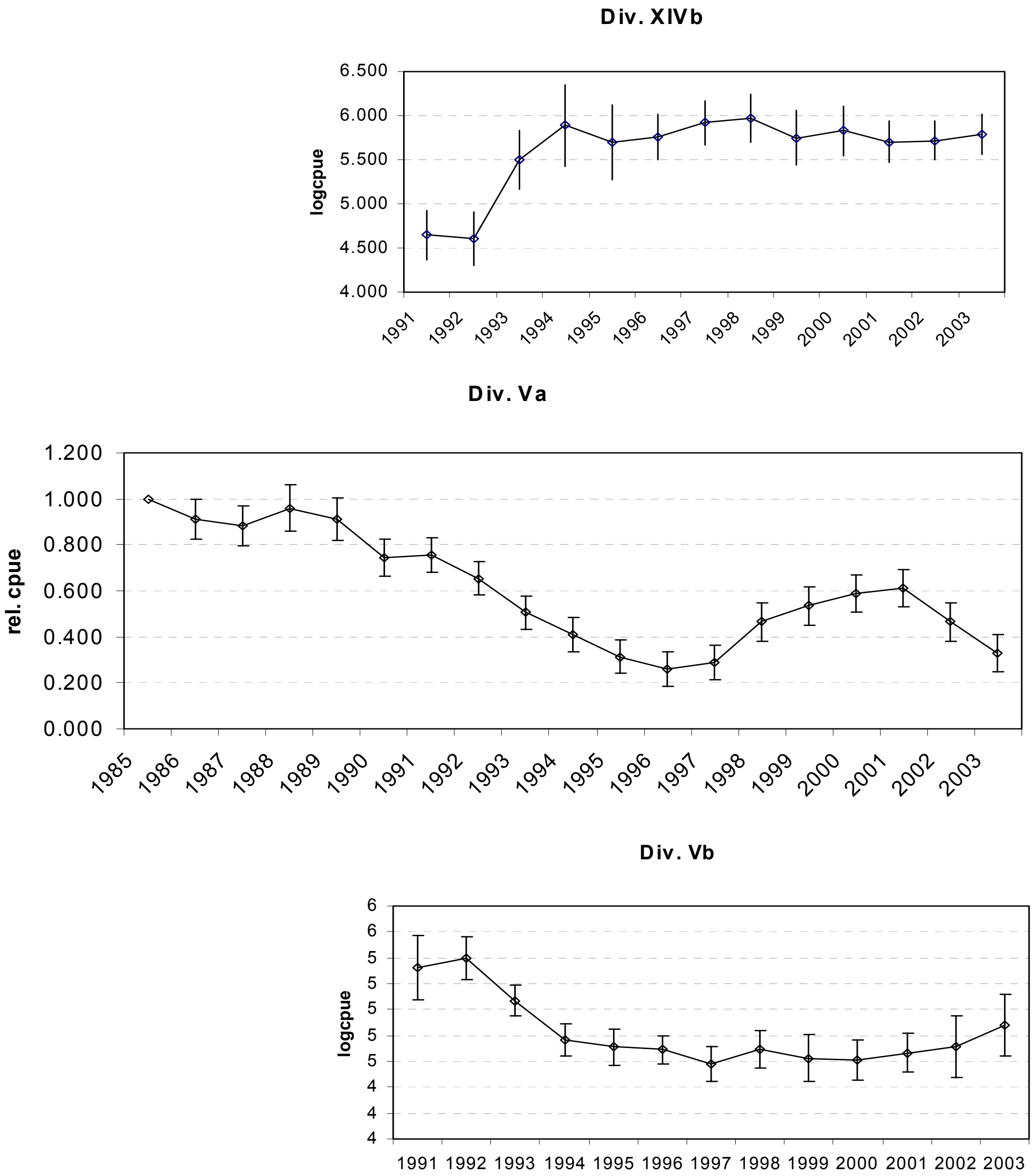


Figure 6.2.1. Standardised CPUE series from fleets in Divisions XIVb, Va and Vb with indication of 95% CI.

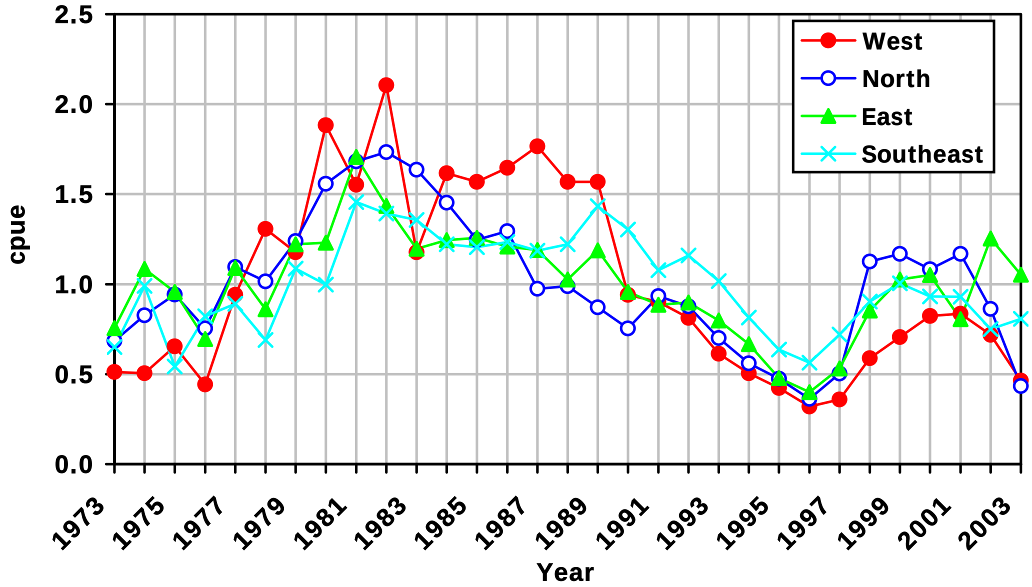


Figure. 6.2.2. Standardised CPUE from Icelandic trawlers from four areas around Iceland.

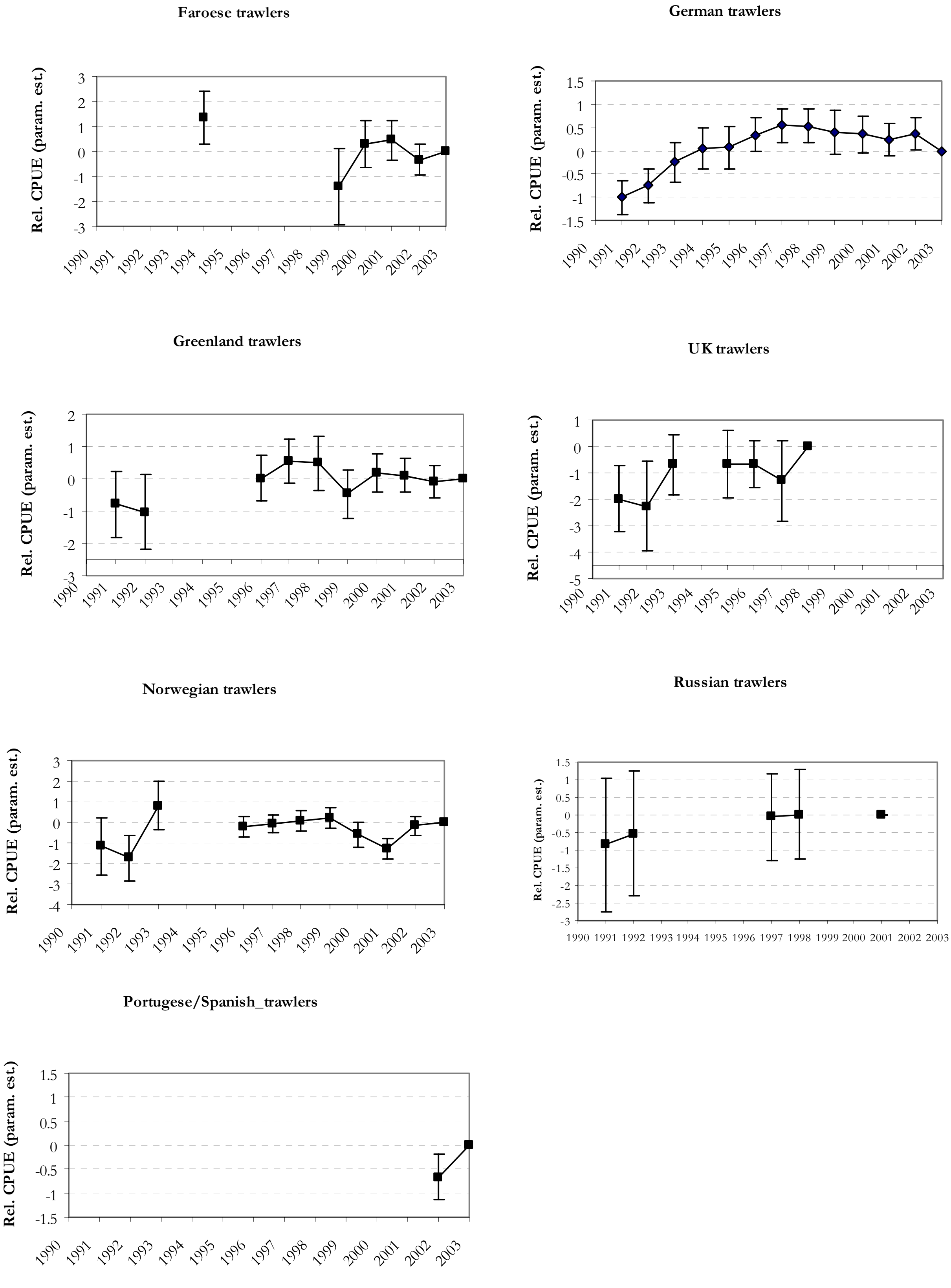


Figure. 6.2.3. Standardised CPUE series from individual fleets in Div. XIVb.

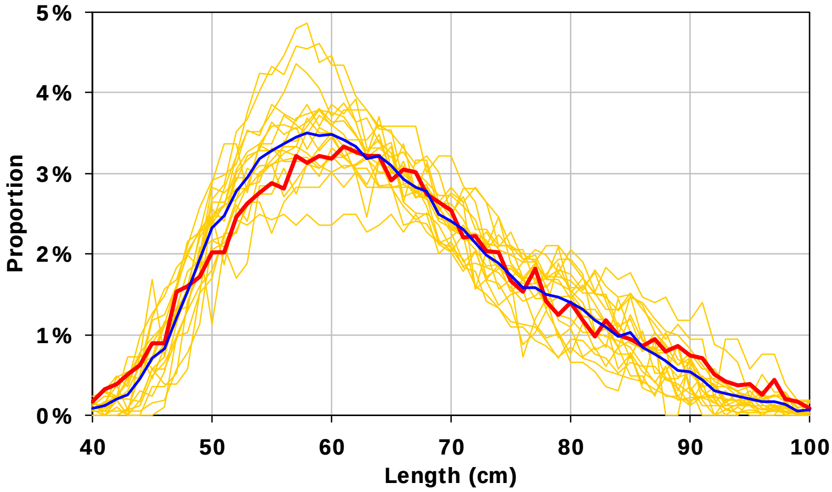
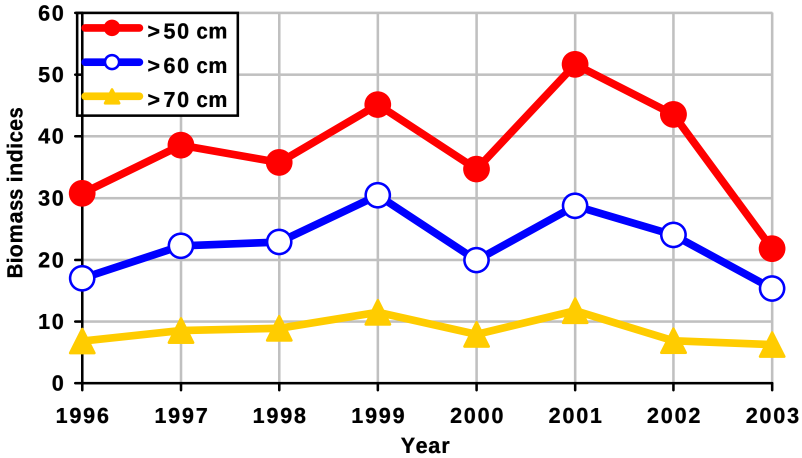


Figure 6.3 Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 – 2003. The thin solid line is average of 1985-2003 and the thick solid line is 2003 distribution.



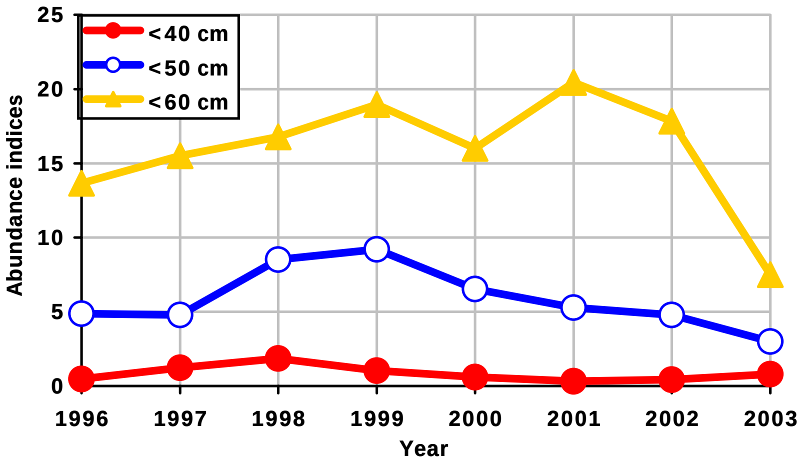


Figure 6.6.1. Greenland halibut in Icelandic fall groundfish survey; a) upper: biomass indices of lengths larger than indicated and b) lower: abundance indices by lengths smaller than indicated.

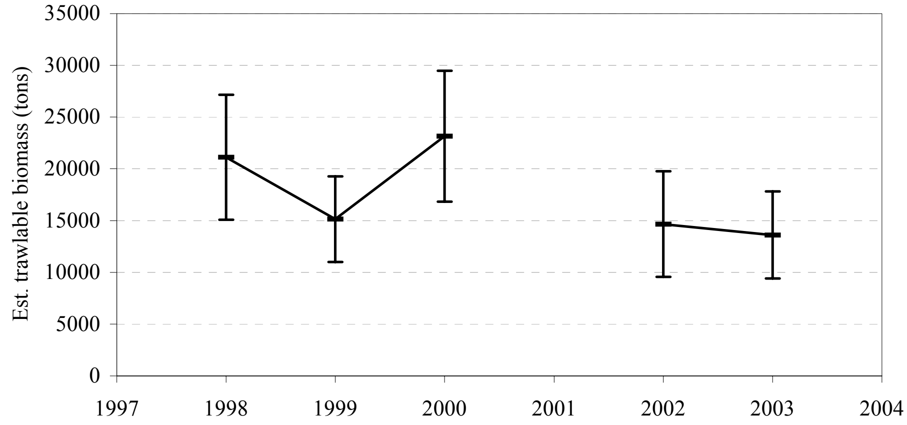


Figure 6.6.2. Estimated trawlable biomass in Div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.

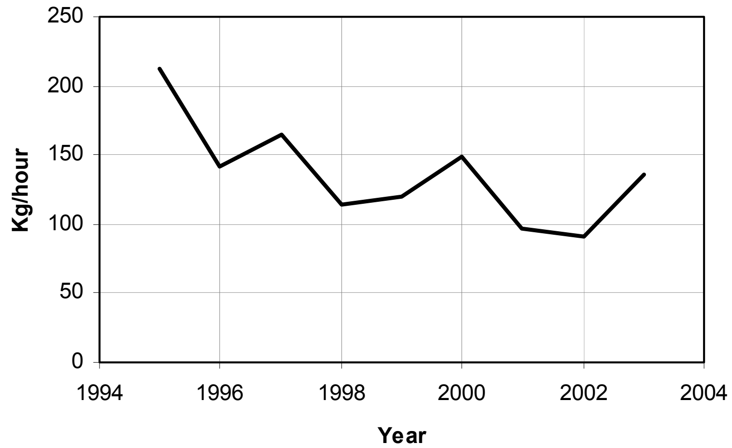


Figure 6.6.3. Catch rates from a Faroese deep-water survey in Div. Vb.

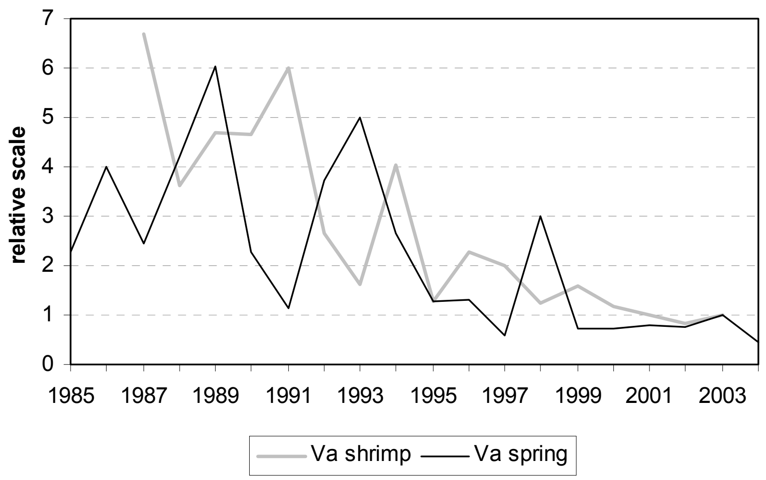
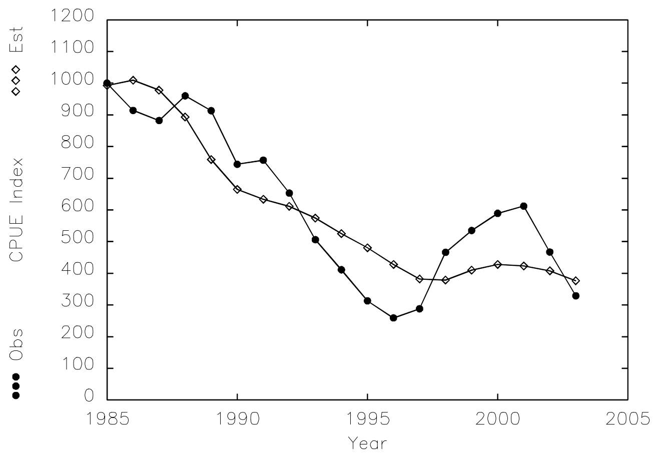


Figure 6.6.4. Comparison of catch rates from various surveys in Divisions Va, Vb and XIVb. Catch rates are scaled relative to the values of 2003.



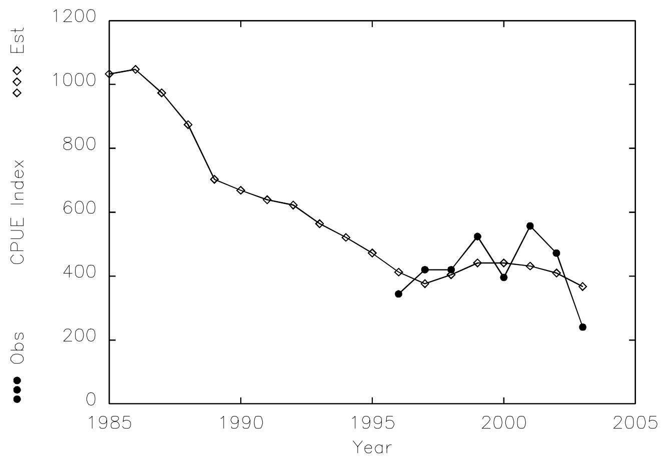


Figure 6.7.2.1. Observed and predicted CPUE's from ASPIC. Upper: Icelandic trawler CPUE, Lower: Icelandic groundfish survey.

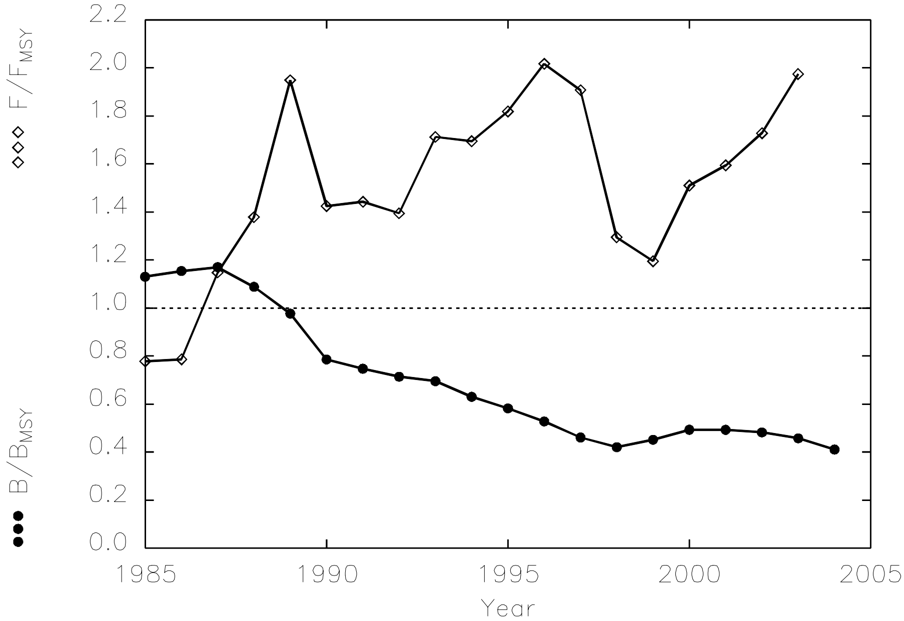


Figure 6.7.2.2 Greenland halibut V+XIV**.** Relative state of biomass and fishing mortality from ASPIC (Table 6.7.2.1).

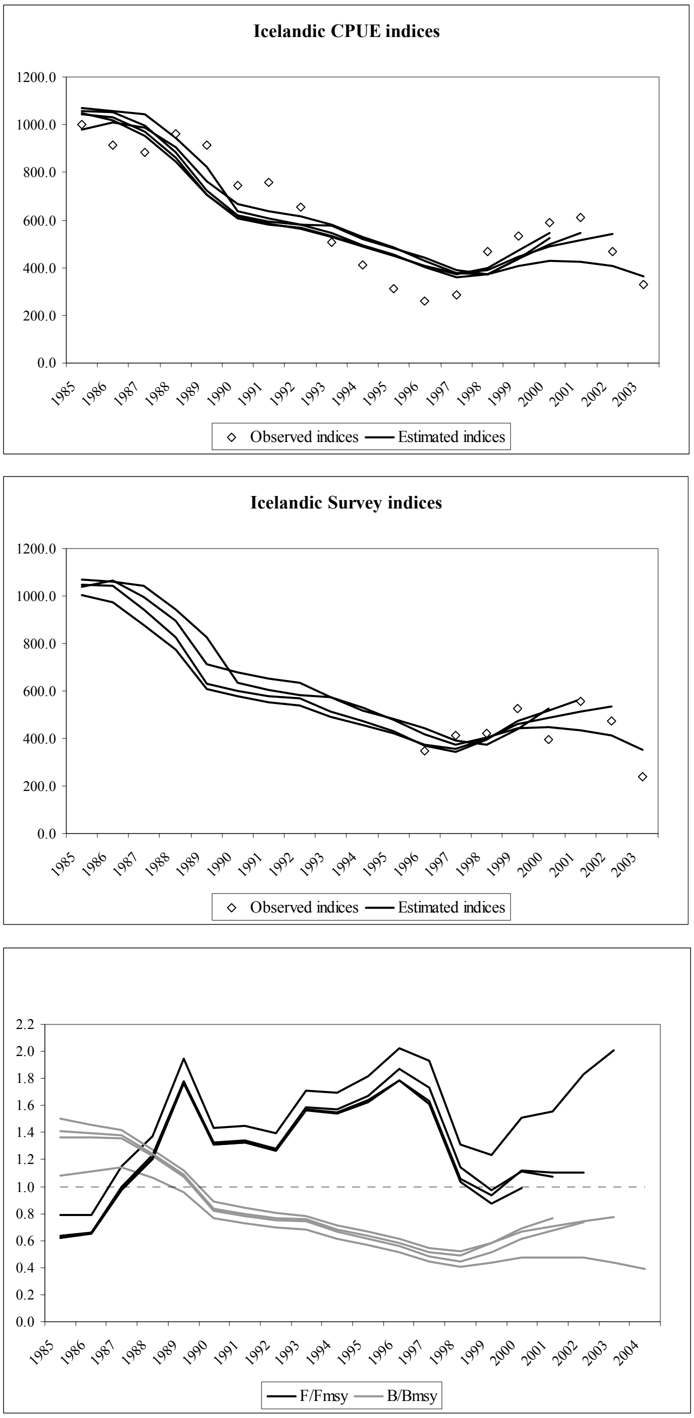
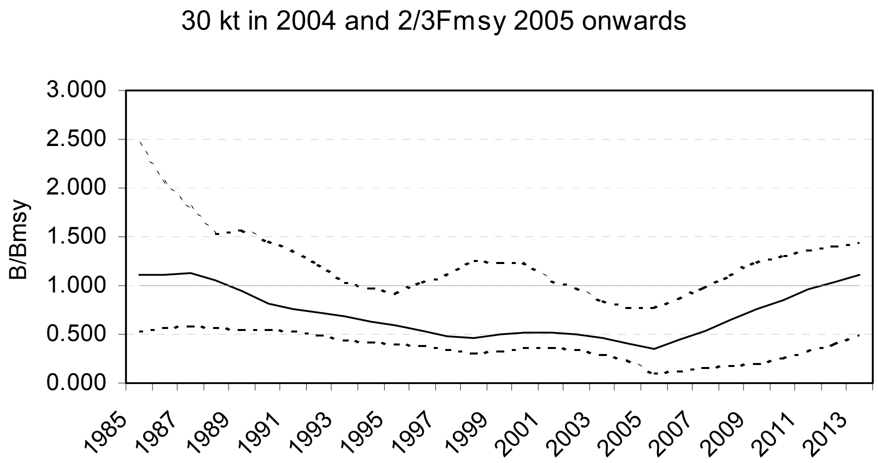
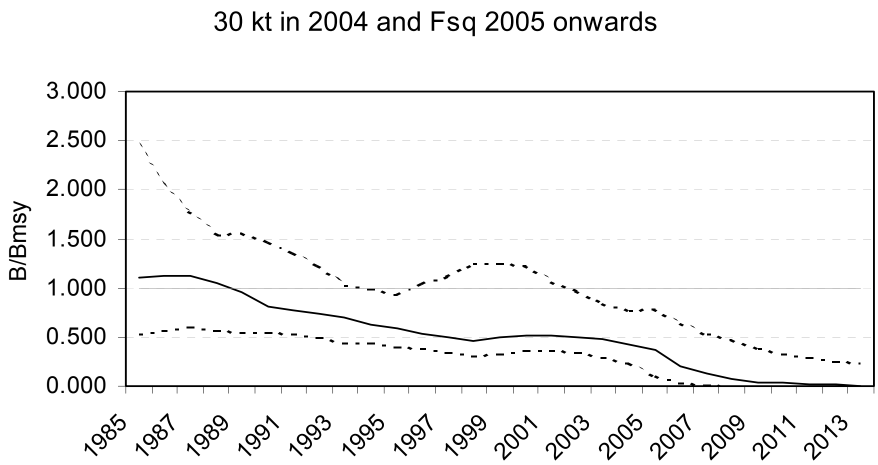


Figure 6.7.2.3. Historical plots of observed versus modelled indices from ASPIC (upper two) and relative state of biomass and fishing mortality (lower).





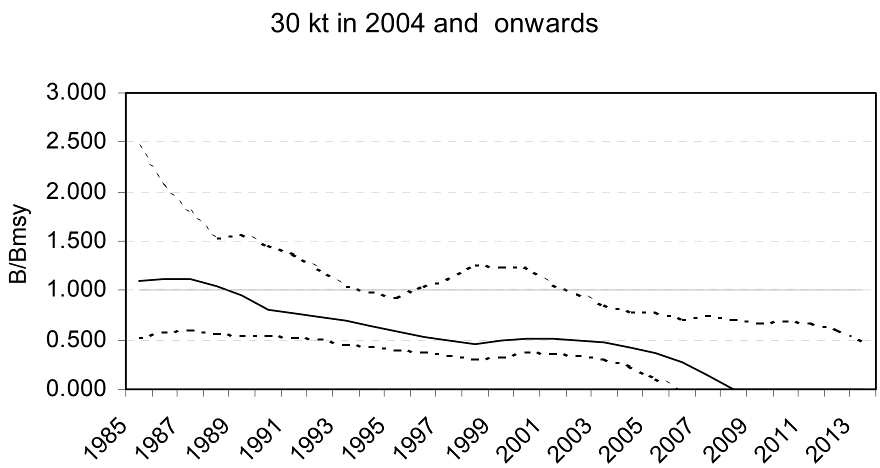


Figure 6.7.5. Biomass (B/Bmsy) trajectories under different options as derived from ASPIC-P.

7 REDFISH IN SUBAREAS V, VI, XII AND XIV

Species of the genus *Sebastes* are common and widely distributed in the North Atlantic. They are found off the coast of Great Britain, along Norway and Spitzbergen, in the Barents Sea, off the Faroe Islands, Iceland, East and West Greenland, and along the east coast of North America from Baffin Island to Cape Cod. All *Sebastes* species are viviparous. The extrusion of the larvae takes place in late winter–late spring/early summer, but copulation occurs in autumn–early winter.

There are three species of redfish commercially exploited in ICES Subareas V, VI, XII, and XIV, *S. marinus*, *S. mentella,* and *S. viviparus*. The last one has only been of a minor commercial value in Icelandic waters and is exploited in 2 small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1,160 t in 1994 to 3 t in 2003.

7.1 Problems regarding stock identity of *S. mentella*

The WG recommended in 2003 that a separate ICES group with the appropriate expertise would review both existing and pending scientific material. As a response to that, it was decided at the ICES ASC that "A Study Group on Stock Identity and Management Units of Redfishes [**SGSIMUR**] (Chair: Kjell Nedreaas, Norway) will be established and will meet in Bergen, Norway, from 31 August to 3 September 2004 to a) review all reported material on the stock identity of the various redfish units (S. mentella) in the Irminger Sea and adjacent waters; b) identify the most likely definition of biological stocks of S. mentella as well as suggest practical management units. SGSIMUR will report by 8 September 2004 for the attention of RMC and ACFM." It has further been decided that there will be a 5 days meeting of the NWWG right after the SGSIMUR meeting to complete the assessment of the *S. mentella* stock(s) based on the outcome of SGSIMUR. This Sub-Group of NWWG will also meet in Bergen; the dates have been set for 6 to 10 September.

Due to this decisions mentioned above, the WG did not discuss further the problems of stock identity, but focused on updating information which will form the basis for the advice. Furthermore, the group focused on dividing the available data in such a way that the outcome of the SGSIMUR could be used on the available data

The existence of more than one stock of *S. mentella* in the area has been discussed in recent years. Historically, *S. mentella* was fished on the continental shelves and slopes of the Faroe Islands, Iceland, and East Greenland and been considered as one stock. A new pelagic fishery started in the open Irminger Sea in 1982, primarily fishing in waters shallower than 500 m. In 1992, the Study Group on Redfish Stocks distinguished between these types as deep-sea *S. mentella* (shelf redfish) and oceanic *S. mentella* (Irminger Sea redfish). In the early 1990's, the pelagic fishery in the open Irminger Sea moved to layers deeper than 500 m. Some researchers considered that the fish caught pelagically deeper than 500 m differed from the fish caught shallower than 500 m and resembled more to the deep-sea *S. mentella* living on the continental shelves and slopes. *S. mentella* living deeper than 500 m has been called "pelagic deep-sea *S. mentella*". Recently, the distribution of the pelagic *S. mentella* in the upper 500 m has extended significantly more southwest and into the NAFO Convention Areas compared to the early 1990's.

It is not known whether these types represent one stock or several biologically different stocks and different hypotheses have been put forward based on comprehensive studies on growth, maturity, morphometrics, parasites as natural tags, and genetic and fatty acid differentiation of the species:

- **Single-stock hypothesis:** All *S. mentella* from the Faroe Islands to the Grand Banks is one stock and is segregated according to age/size.

- **Two-stock hypothesis:** The *S. mentella* living on the shelves (deep-sea *S. mentella*) and those living in deeper pelagic waters of the Irminger Sea (pelagic deep-sea *S. mentella*) is one stock unit, which is separated from the oceanic *S. mentella* living in the upper layers of the Irminger Sea.

- **Three-stock hypothesis:** The three described components are biologically different stocks.

Despite a lot of effort by the WG, there is not a consensus within the WG regarding which hypothesis is the most likely one. Although the uncertainty regarding stock structure of *S. mentella* is great, extensive research have been done. Currently, several studies are ongoing to answer important questions regarding the biology, population structure, and abundance and demography of this highly migratory and straddling species.

7.2 Nominal landings and splitting of the landings into stocks

The official statistics reported to ICES do not divide catch by species/stocks (Tables 7.2.1-7.2.5). Information from various sources, are used to split demersal landings into species (see WD 30). In Div, Va if no direct information are available on the catches for a given vessel, the landings are allocated based on logbooks and samples from the fishery. According to the proportion of biological samples from each cell (one fourth of ICES statistical square) the unknown catches within that cell is split accordingly and raised to the landings of a given vessel. For other areas, samples from the landings are used as basis for dividing the demersal redfish catches between *S. marinus* and *S. mentella*. Furthermore, according to Icelandic legislation fishing vessels are obligated to divide their *S. mentella* catches into pelagic *S. mentella* or shelf deep-sea *S. mentella* depending whether they are fishing west or east of the redfish line (see WD 30 for further details). All *S. mentella* caught outside the Icelandic EEZ is reported as pelagic type.

7.3 Abundance and distribution of 0-group and juvenile redfish

Available data on the distribution of juvenile *S. marinus* indicate that the nursery grounds are located in Icelandic and Greenland waters. No nursery grounds have been found in Faroese waters. Studies indicate that considerable amounts of juvenile *S. marinus* of East Greenland is mixed with juvenile *S. mentella* (Magnússon et al. 1988; 1990, ICES CM 1998/G:3). The 1983 Redfish Study Group report (ICES CM 1983/G:3) and in Magnússon and Jóhannesson (1997) describes the distribution of 0-group *S. marinus* off East Greenland. The nursery areas for *S. marinus* in Icelandic waters are found all around Iceland, but are mainly located west and north of the island at depths between 50 and 350 m (ICES C.M.1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). The migration of juveniles is along the north coast towards the most important fishing areas off the west coast.

Indices for 0-group redfish in the Irminger Sea and at East Greenland areas were available from the Icelandic 0-group surveys from 1970–1995. Thereafter, the survey was discontinued. Above or average year-class strengths were observed in 1972, 1973–74, 1985–91, and in 1995.

Abundance and biomass indices of juvenile (<17 cm) redfish (juveniles were only classified to the genus *Sebastes* spp. due to difficult identification) from the German annual groundfish survey, conducted on the continental shelf and slope of West and East Greenland down to 400 m, shows that juveniles were abundant in 1993 and 1995-1998 (Figure 7.3.1). The 1999-2003 survey results indicate low abundance and are similar to those observed in the late 1980s.

7.4 Discards and by-catch of small redfish

An offshore shrimp fishery with small meshed trawl (44 mm in the codend) began in the early 1970s off the west coast of Greenland. This fishery expanded to the east coast in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is bycatch in the shrimp fishery off Greenland. No information was available in recent years to quantify the bycatch and about the length distribution of the fish caught. Since the 1st October 2000, sorting grids have been mandatory to reduce bycatch, but the effect has not been documented. Such documentation is needed in order to estimate the bycatch of young redfish in the shrimp fishery.

In late 1980's, Iceland introduced a sorting grid in the shrimp fishery to reduce the bycatch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a bycatch in the fishery, but also juveniles of other species. Since the large yearclasses of *S. marinus* disapeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrip fishery.

7.5 Special Requests

There are several questions regarding stock structure, distribution, and fishery information of *S. mentella* in the area in the ToR for the Working Group. The following paragraphs deals with ToR *c* and *f* and special requests from NEAFC.The other special request will be adresseed during the September session of the WG.

Detailed descriptions of the fishery of different nations are given in Sections 8 for *S. marinus*, 9 for deep-sea *S. mentella*, and 10 for oceanic *S. mentella*, based on various working documents.

The fishery for pelagic *S. mentella* in ICES Sub-areas Va, XII, and XIV and in NAFO areas shows a persistent seasonal pattern in terms of geographical and depth distribution for the past five years (Figures 7.5.1-7.5.3). The main fishing occurs in the second and third quarter of the year. In the second quarter, the fishery takes place in the area east of 32°W and north of 61°N at depths deeper than 500 m. In the third quarter, the fleet moves towards the southwest to ICES Subarea XII and NAFO Convention areas and the depth of the hauls are in waters shallower than 500 m. There has traditionally been very little fishing activity from November until late March, and in November 2003 until late March 2004 no activity was reported. The size of the fish caught in the southwest areas in the third quarter of the year is smaller than the fish caught in the northeast area in the second quarter (Figure 7.5.4). Usually, over 95% of the fish caught in all seasons are sexually mature.

Based on the geographical and seasonal distribution of the oceanic *S. mentella*, logbook catches in the Irminger Sea and adjacent waters (Figures 7.5.1-7.5.4) it was concluded that the fishing pattern in 2003 was similar as it was in the past five years. The only new feature in the fishery was that the Icelandic fleet continued its fishery further north in 2003 than previously. The pelagic fishery extended to the shelf area, overlapping with the fishing areas for *S.mentella* on the shelf (see section 10.2.1.).

As has been reported in earlier reports of the Working Group, Iceland has classified its pelagic catches between oceanic and pelagic deep-sea redfish. Based on the samples, the results indicated that at depths shallower than 500-600 m, the proportion “oceanic” is between 85-100%, and the proportion deeper than 600 m between 0-20%. Based on the same samples, divided by areas instead of depth, the results shows that since 1997, more than 90% of the catches in the northeastern fishing area are classified as "deep sea type" and above 90% of the catches in the southwestern fishing area during the same period is classified as "oceanic type" (Table 7.2.6).

The WG acknowledge information on trawling depth as provided by some nations, but recommends that all nations provide depth information in accordance with the NEAFC logbook format.

Table 7.2.1 REDFISH. Nominal landings (tonnes) by countries, in Division Va 1996-2003, as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Faroe Islands	242	280	255				
Germany	-	284	428	513	844	467	1,105
Greenland	-	-*	-*	-*	-*	3,341*	
Iceland	73,976	108,380	81,430	95,118	48,970	63,247	67,997[1]
Norway	-	-	18	36	26*	16*	19
UK (E/W/NI)	-	-	542	734	1,037	432	...
UK (Scotland)	-	-	149	70	114	272	...
United Kingdom						704	1,081
Total	74,218	108,944	82,822				

*Preliminary. [1]Includes 41,231 t Golden redfish; 21,431 t Beaked redfish and 5,335 t Oceanic redfish.

Table 7.2.2 REDFISH. Nominal landings (tonnes) by countries, in Division Vb 1996-2003, as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Faroe Islands	7,199	6,484	6,191				
France	98	110*		250	189	221	262
Germany	36	-	207	79	88	2	19
Greenland	-	-*	-*	-*	-*	13*	
Iceland	-	-	-	-	54	35	-
Ireland	-	-	-	-	1	-	
Norway	25	39	37	41	24*	30*	31
Russia	-	-	-	12	-	-	-
UK (E/W/NI)	+	4	15	111	92	120	...
UK (Scotland)	36	27	46	142	116	89	...
United Kingdom						409	89
Total	7,394	6,664					

*Preliminary.

Table 7.2.3 REDFISH. Nominal landings (tonnes) by countries, in Division VI 1996-2003, as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Estonia	-	-	-	-	+	-	-
Faroe Islands	12	-	44				
France	395	297*		269	188	97	113
Germany	1	1	+	+	1	-	-
Ireland	10	10	34	54	47	26	
Norway	6	3	8	11	5*	9*	7
Portugal	-	1	-	-	-	-	-
Russia	-	-	243	461	88	19	94[1]
Spain	-	-	38	16	4	784	
UK (E/W/NI)	19	12	4	20	44	7	...
UK (Scotland)	518	364	762	405	485	376	...
United Kingdom							950
Total	961	688					

*Preliminary. [1]Reported as *S. mentella.*

Table 7.2.4 REDFISH. Nominal landings (tonnes) by countries, in Sub-area XII 1996-2003, as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Estonia	3,720	3,968	2,108	4,000	-	-	-
Faroe Islands	3,822	1,793	528				
France	-	3*	-*	+	+	-	1
Germany	8,866	9,746	8,204	1,128	3,833	3,032	565
Greenland	…	1,180*	1,188*	124*	740*	-*	
Iceland	3,856	1,311	5,072	3,121	11,679	5,745	-
Latvia	-	-	-	-	-	1,061	371
Lithuania	-	-	-	-	-	-	14,321
Norway	31	602	2,040	2,200	878*	1,094*	3,111
Poland	662	-	-	-	-	1	-
Portugal	-	-	-	-	387	878	504[1]
Russia	-	89	7,698	9,243	4,509	6,090	2,430[2]
Spain	1,155	2,231	1,723	576	1,332	854	
UK (E/W/NI)	-	+	187	-	-	+	...
UK (Scotland)	-	-	1	+	-	4	...
United Kingdom							1
Total	22,112	20,923	28,749				

*Preliminary. [1]Reported as V/XII/XIVGRN. [2]Reported as *S. mentella.*

Table 7.2.5 REDFISH. Nominal landings (tonnes) by countries, in Sub-area XIV 1996-2002, as officially reported to ICES.

Country	1997	1998	1999	2000	2001	2002	2003*
Estonia	-	-	-	3,811	599	-	-
Faroe Islands	123	47	2				
Germany	11,610	9,709	8,935	7,840	6,758	9,576	7,050
Greenland	193	296*	3,152*	3,545*	2,587*	1,171*	
Iceland	33,820	6,441	23,770[1]	17,999	31,786	41,805	43,063[2]
Norway	3,187	525	3,253	3,699	4,258*	4,215*	5,073
Poland	114	-	-	-	-	-	141[4]
Portugal	3,674	4,133	4,302	4,154	2,116	2,208	2,116[3]
Russia	36,930	25,748	16,652	14,851	23,851	25,309	28,687[4]
Spain	7,552	4,660	4,175	2,657	4,982	-	
UK (E/W/NI)	28	43	68	45	179	16	...
UK (Scotland)	-	-	-	-	-	17	...
United Kingdom							378
Total	97,231	51,602	64,309				

*Preliminary. [1]Note Excluding 58 t reported as area unknown . [2]Oceanic redfish. [3]Reported as V/XII/XIV. [4]Reported as *S. mentella.*

Table 7.2.6 Icelandic pelagic redfish catch between possible stocks. Iceland has divided samples collected from the fishery between "oceanic"and "deep sea" type since 1995. The table gives the Icelandic landings of these groups based on the sampling and. For definition of northeastern and southwestern areas, see Figure 10.2.5.

Northeastern area

Year	prop unclassified	prop. deep sea	Prop. oceanic	Total catch
1995	0%	71%	29%	7711
1996	4%	36%	61%	58320
1997	0%	31%	69%	39179
1998	0%	8%	92%	46647
1999	0%	6%	94%	38050
2000	0%	5%	95%	44568
2001	1%	4%	95%	28728
2002	2%	4%	94%	38079
2003	3%	5%	91%	43320

Southwestern area

Year	prop unclassified	prop. deep sea	Prop. oceanic	Total catch
1995	0%	69%	31%	26919
1996	74%	25%	0%	4583
1997	22%	67%	11%	2097
1998	100%			1872
1999	1%	98%	1%	5873
2000	100%			664
2001	0%	91%	8%	13744
2002	5%	95%	0%	5373
2003	0%	100%	0%	5078

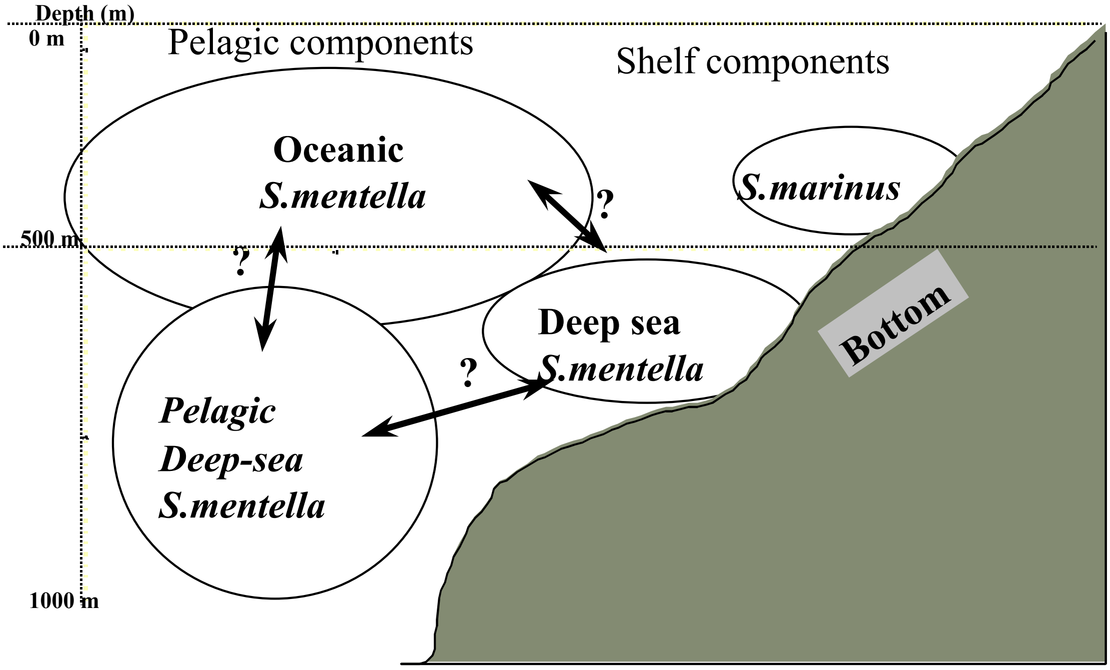


Figure 7.1.1 Possible relationship between different stocks and species *of S. marinus* and *S. mentella* in the Irminger Sea and adjacent waters.

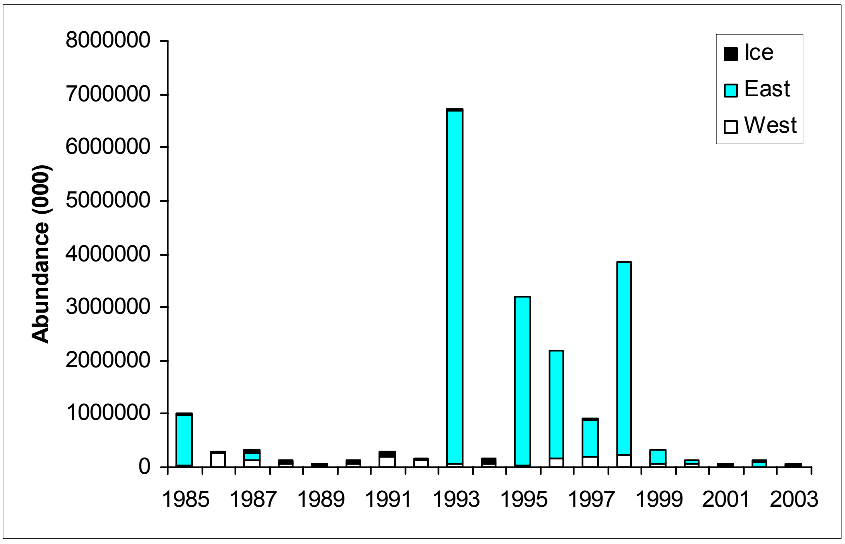


Figure 7.3.1 Survey abundance indices of *Sebastes* spp. (<17 cm) from the German and Icelandic groundfish surveys conducted on the continental shelves of East and West Greenland and Iceland 1985-2003.

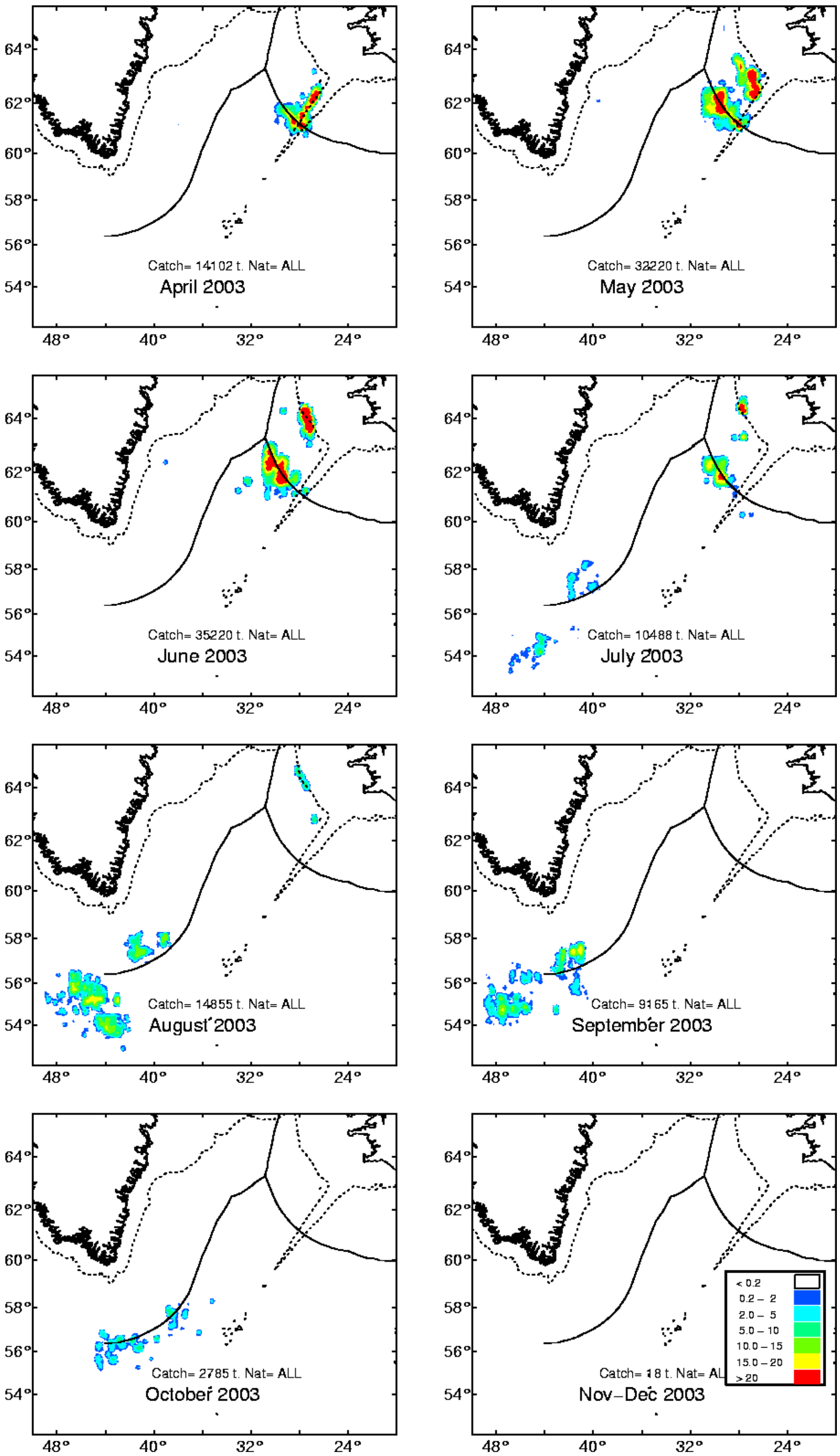


Figure 7.5.1 Fishing areas and total catch of the pelagic redfish (*S. mentella*) by month in 2003, derived from catch statistics provided by Faroes, Germany, Greenland, Norway, Iceland and Russia. The scale for the catch is in tonnes per squared nautical mile. Total catch for each period is also given.

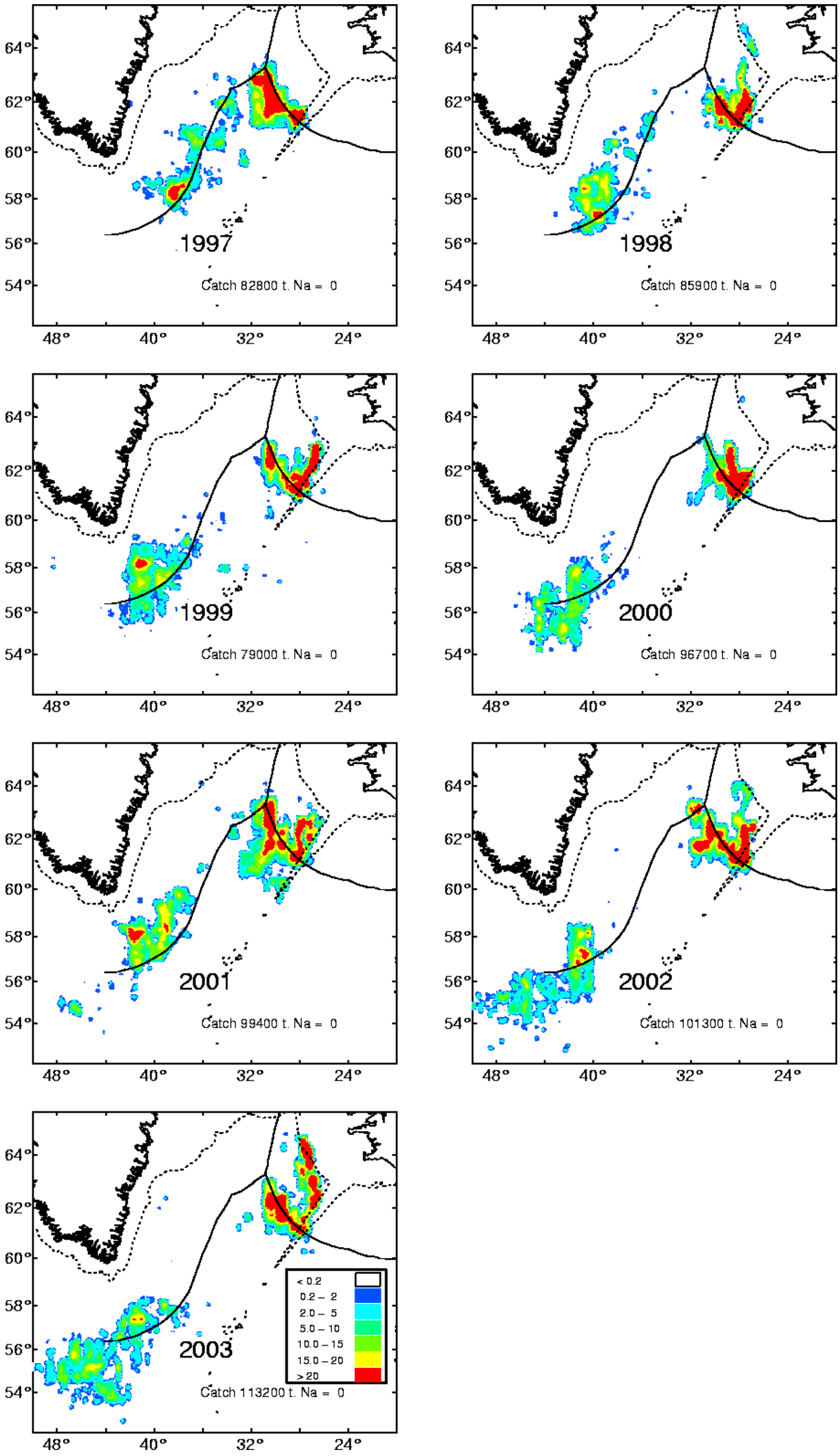


Figure 7.5.2 Fishing areas and total catch of the pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1995-2003. Data are from Germany (1995-2003), Norway (1995-2003) Greenland (1999-2003), Russia (1997-2003), Faroese (1995-2003), and Iceland (1995-2003). The scale given is tonnes per square nautical mile.

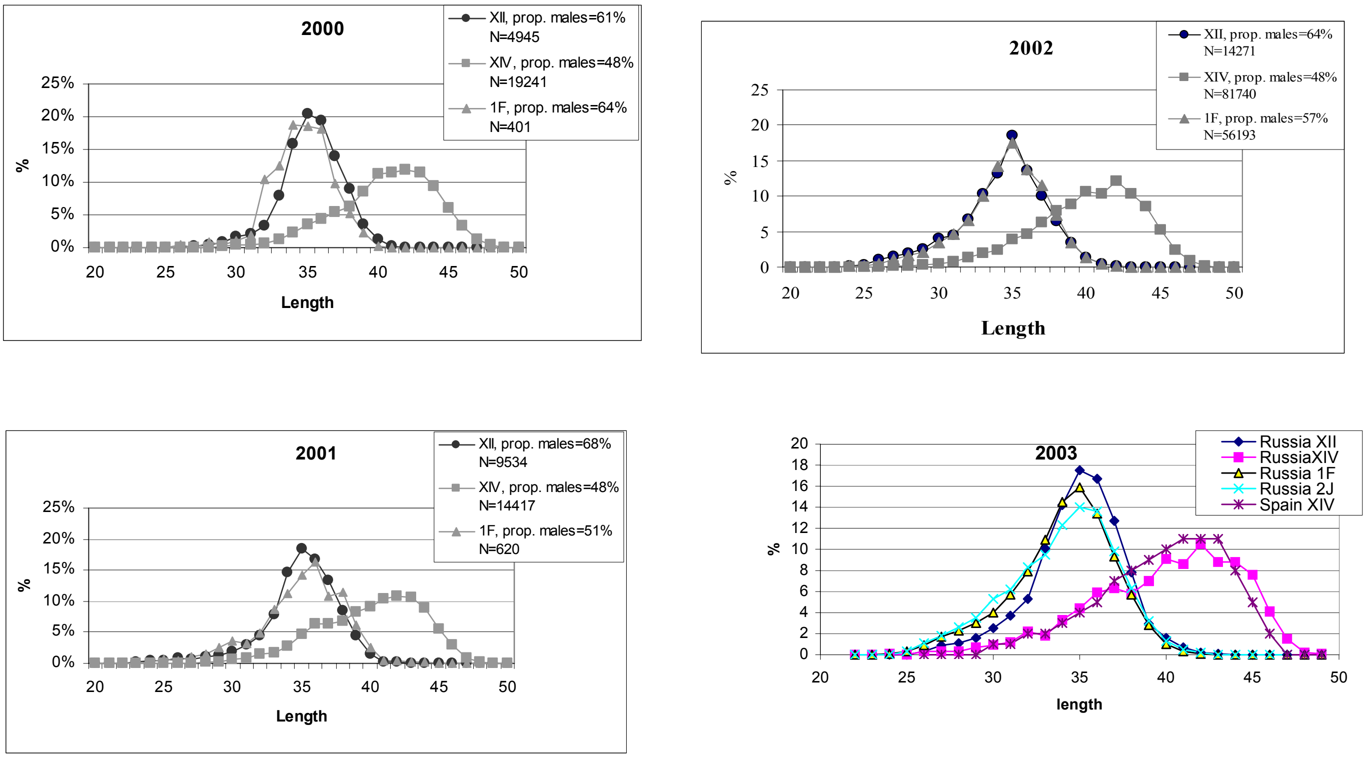


Figure. 7.5.5 Length distribution of the oceanic redfish fishery in ICES Div. XII, XIV and in NAFO Div. 1F by year from 2000-2003. Data from Spain (2000 -2003) and Russia (2002-2003). The proportion of males is also given.

8 SEBASTES MARINUS

Sebastes marinus in ICES Divisions V and XIV have been considered as one management unit. Catches in VI have traditionally been included in this report and the group continues to do so.

8.1 Trends in landings

Since the early 1980s total landings has decreased by more than 70% or from about 130 000 t in 1982 to 37 000 t in 2001 (Table 8.1.1 and Figure 8.1.1). In 2002 the total landings increased to 50 000 t due to increased landings from Division Va, but decreased again in 2003 to 39 000 t. The majority of the *S. marinus* catch is taken in ICES sub-Division Va and contributes between 90-95% of the total landings.

Landings of *S. marinus* in sub-Division Va declined from about 63 000 t in 1990 to 34 000 t in 1996. Since then landings have varied between 35 000 and 49 000 t, with the lowest landings in 2001 and the highest in 2002. The landings decreased in 2003 by about 12 000 t from the previous year and to 36 500 t. Between 90-95% of the annual *S. marinus* catch in Division Va have, in recent years, been taken by bottom trawlers targeting redfish (both fresh fish and factory trawlers; vessel length 48-65 m). The remains are partly caught as by-catch in gillnet and longline fishery. In 2003, as in previous years, most of the catches were taken along the shelf W, SW, and SE of Iceland, mostly between 12ºW and 27ºW (Figure 8.1.2). Although no direct measurements are available on discard, it is believed that there is no significant discard of *S. marinus* in the redfish fishery due to area closures of important nursery grounds west of Iceland.

In Subdivision Vb, landings dropped gradually from 1985 to 1999 or from 9 000 t to 1 500 t and has, since then, remained at that level (Table 8.1.1). Majority of the *S. marinus* caught in sub-Division Vb is caught by pair- and single trawlers (vessels smaller than 1000 HP).

Annual landings from Division VI increased from 1978 to 1987 followed by a gradual decrease to 1992 (Table 8.1.1). In the 1995-2003 period, annual landings have ranged between 400 and 800 t.

Annual landings from Division XIV have been more variable than in the other areas. After the landings reached a record high of 31 000 t in 1982 the *S. marinus* fishery collapsed within the next three years (the landings from XIV was about 2 000 t in 1985). During the period 1985-1994 the annual landings from Division XIV varied between 600 and 4 200 t but since 1995 there has been little or no directed fishery for *S. marinus*. In recent year landings have been 150 t or less and is mainly taken as by-catch in the shrimp fishery.

8.1.1 Biological data form the fishery

The length distribution from the Icelandic commercial trawler fleet in 1989-2003 is shown in Figure 8.1.2. The numbers of measured fish by statistical square are given in Figure 8.1.3.

Length distribution from the Faroes catches for 2001-2003 is shown on Figure 8.1.4. No length data from the catches have been available for several years in Divisions XIV and VI.

The table below shows the fishery related sampling by gear type and Divisions.

Area	Nation	Gear	Landings	Samples	Fish measured
Va	Iceland	Bottom trawl	36,579	260	44,830
Va	Germany/UK	Bottom trawl	22	0	
Va	Faeroe	Line/hooks	93	0	
Vb	Faeroe	Bottom trawl/gillnets	1,466	31	830
XIV	Germany	Bottom trawl	1	0	
VI	UK	Bottom trawl	689	0	

Catch-at-age data from the Icelandic fishery in Division Va shows that the 1985-year class dominated the catches from 1995-2002 (Figure 8.2.6 and Table 8.1.2) and in 2002 this year class contributed 25% of the total catch in weight. The 1990-year class is also strong and this year-class dominated the catch in 2003 contributing about 27% of the total catch in weight. The average Z, estimated from this 9-year series of catch-at-age data (Figure 8.1.7) is around 0.23 for age groups 15+, and about 0.20 for age groups 20+. This estimation is based on Icelandic age readings, but the ageing can vary between readers. Age reading comparison between four age readers revealed that there were significant difference in between readers and between methods, especially fish older than 20 years (Björnsson and Sigurdsson 2003, Stransky et al 2001, 2003). A fairly good agreement (about 60%) between readers was, however, obtained for ages 11-20 years when allowing for ±1 year tolerance.

8.2 Assessment data

8.2.1 CPUE

CPUE indices for the Icelandic trawl fleet for the period 1985-2003 were estimated from a GLM multiplicative model using summarised data (for each ICES statistical square, vessel, month and year). The model takes into account changes in the Icelandic trawl catches due to vessel, statistical square, month, and year effect. All hauls at depths above 500 m with redfish exceeding 10% of the total catch, were included in the CPUE estimation (Figure 8.2.1). A considerable increase in the CPUE was observed in 2001 and CPUE continued to increase in 2002 and 2003. The index is now 90% of the 1986 value.

Un-standardised CPUE from the Fareoese pair-trawler fleet gradually decreased from 1985 to a record low in 2002, but increased again in 2003 (Figure 8.2.2).

8.2.2 Survey data

Figure 8.3.2 shows total biomass index from the Icelandic groundfish surveys in March and October with ±1 standard deviation in the estimate (68% confidence interval) indicated. The figure shows a large measurement error in some years most notably in recent years in the March survey. This large measurement error is caused by relatively few tows accounting for a large part of the total amount caught and is also reflected in rapid changes of the indices from one year to another.

To get a more stable index the index of fishable biomass for area from 0–400 m depth based on an ogive rising sharply from 34-36 cm (L_{50} = 35 cm) was calculated. The survey extends down to 500 m depth and the stations between 400 and 500 m are few and show the largest CV. Figure 8.2.3 shows this index of fishable biomass with 95% confidence intervals. The index indicates a decrease in the fishable biomass from 1985-1995, but an increasing trend since then. The lowest index was in 1995, only about 30% of the maximum in 1987, but the value in 2004 is about 65% of the highest observed value. This index has been used in the assessment in recent year. The total indices were on the other hand used in the BORMICON model. The difference in indices presented, that is an increase in biomass from 2003 to 2004 shown in Figure 8.2.3 compared to a decrease shown in Figure 8.2.4, is because of a sharp increase in biomass at depth stratum 400-500 m caused by one haul exceeding 15 t (Table 8.2.1).

Length distributions from the Icelandic groundfish survey show that the peak (Figure 8.2.5), which has been followed during the last years (first in 1987) has now reached the fishable stock. The increase in the survey index since 1995, therefore, reflects the recruitment of a relatively strong year classes (1985-year class and the 1990-year class). This has been confirmed by age readings (Figure 8.1.5). There is no indication of recruitment after 1990-year class.

In Division Vb, CPUE of *S. marinus* were available from the Faroes groundfish survey 1994-2004 (Figure 8.2.6). After an increase in the period 1995-1998, CPUE decreased drastically and has been for the last five years at the lowest level in the time series. The Faeroes summer survey that has been conducted since 1996 (see Section 2) shows similar trend as the CPUE in the Faeroes spring survey. From 1996 to 1999 the index decreased to record low and has, since then, been relatively stable. In 2003, CPUE was only about 30% of what it was in 1996 (Figure 8.2.7).

For the period 1985-2003, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm are illustrated in Figures 8.2.8 and 8.2.9. From 1986 to 1995, an almost continuous reduction in survey biomass occurred. After a severe depletion of the *S. marinus* stock on the traditional fishing grounds around East Greenland in the early 1990's, the survey estimates showed a significant increase in abundance in 2002. The estimates in 2002 were the highest recorded since 1990 and this increase indicates a possible recovery. The estimates were though considerable lower compared to the years prior 1990. Between 2002 and 2003 there was a considerable decrease in abundance, whereas the biomass was stable. This could indicate increased number of adults in the stock of East-Greenland. The length frequencies from the German groundfish survey are illustrated in Figures 8.2.10, along with the length distributions from the Icelandic groundfish survey. Although adults seem to be severely depleted in East Greenland waters there is a sign of increased number of larger fish.

8.2.3 Assessment by use of BORMICON model

Since 1999 the working group has discussed an alternative model (BORMICON (BOReal MIgration and CONsumption model) that has been applied to the stock in Va. The model, where *S. marinus* is used as an example, was described in details by Björnsson and Sigurdsson (2003) (in Scientia Marina 2003, 67 (Suppl. 1): 301-314). The BORMICON model is an age- and length based cohort model, where all the selection curves depend on the length of the fish and information on age is not a prerequisite but can be utilized if available. The commercial catch is modelled as one fleet with a fixed selection pattern described by a logistic function and total catch in tonnes specified for each time period.

The BORMICON model was run using the same settings as last year's base case. The simulation period is from 1970 to 2004. Two time steps are used each year. Natural mortality is set to 0.15 for the youngest age, decreasing gradually to 0.05 for age 5 and older. The ages used were 1 to 30 years, where the oldest age is treated as a plus group (fish 30 years and older). Recruitment was set at age 1. Length at recruitment was estimated separately prior to and after 1989.

An alternative configuration was also investigated. There the L_{50} in the selection pattern of the commercial fleet was allowed to vary annually after 1998 and the length at recruitment was estimated separately for the 1990-year class. The former change was to check the effects of the area closures to preserve the 1990-year class and the second change to look at problem that the model has in distinguishing between the 1990- and 1991-year classes.

Estimated parameters are:

- Number of fishes when the simulation starts (8 parameters).
- Recruitment each year (32 parameters).
- Length at recruitment (2 parameters).
- Parameters in the growth equation; (2 parameters).
- Parameter β of the beta-binomial distribution controlling the spread of the length distribution.
- Selection pattern of the commercial fleet (2 parameters).

Results for 2004 run is shown in Figure 8.2.11.

Data used for tuning are:

- Length disaggregated survey indices from the Icelandic ground fish survey in March. The total indices 0-500 m were used in the model.
- Length distribution from the Icelandic commercial catch.
- Age length keys and mean length at age from the Icelandic autumn survey.
- Age length keys and mean length at age from the Icelandic catch.

Estimated model parameters were used in simulations to determine the value of $\mathbf{F_{max}}$ and $\mathbf{F_{0.1}}$. A year class was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The simulation was done for 40 years. The total yield from the year class was then calculated as function of fishing mortality. The results gave $\mathbf{F_{max}}$=0.165, $\mathbf{F_{0.1}}$=0.09 and maximum yield was estimated to be 250 g/recruit. Here, F is not fishing mortality, but close to it when small time steps are used, or mortality is small. It is also the mortality of a fish where the selection is 1. The estimated values of $\mathbf{F_{max}}$ and $\mathbf{F_{0.1}}$ are more conservative than corresponding estimate from catch at age model and $\mathbf{F}_{max}$ could be a candidate for $\mathbf{F_{target}}$.

Results from the assessment are shown in Figures 8.2.11 - 8.2.16 and compared to the results from two previous years in Figure 8.2.17. As may be seen the estimate on catchable biomass for 2004 is similar to the ones estimated in 2002 and 2003, although a little higher, with the difference probably driven by the high survey index in 2004 (Figure 8.2.17). Furthermore, the results for 2004 are similar to the one presented in Björnsson and Sigurdsson (2003), where they used data until 2000.

Figure 8.2.16 shows residuals from the model fit to the survey data, demonstrating large positive residuals in some years, most notably 1993, 1999, 2003, and 2004. The large positive residuals for 24-37 cm fish observed in 2003 and 2004 indicate that survey results exceeded model prediction .

The indices from the groundfish survey are the main indicators of recruitment in the model. As described in section 8.2.2 the groundfish survey has indicated bad recruitment of redfish since the 1991-year class and the model mimics those results. The estimated average year class size in 1992-2001 is now estimated 80 million (at age 0) which is only enough to sustain an annual catch of 20 000 tonnes using estimated maximum yield per recruit of 250 g.

According to the predictions here, the stock is going to be stable for the next few years with an annual catch of 30 000-35 000 t (Figure 8.2.12). This value might though have to be reduced every new year with no sign of good recruitment. From the above-mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new large year class will recruit to the fishable stock in the next 10 years.

Different catch options were tested in the simulations for a fixed catch. As may be seen in Figures 8.2.12, the catchable biomass will decrease in next 6 years for all catch options exceeding 37 000 t and the total biomass decrease for annual catch above 33 000 t.

8.2.4 State of the stock

S. marinus is mainly caught in ICES Division Va, contributing 90-95% of the total landings from Va, Vb, and XIV. All available survey information and CPUE data from Division Va show that the *S. marinus* stock decreased considerably from 1985 to the lowest recorded biomass in 1995. An improvement in the fishable biomass has, however, been seen in the most recent years due to improved recruitment. During the last few years, the 1985-year class has contributed significantly to the fishable stock, and the 1990-year class has also contributed significantly to the fishable biomass in the last 4 years. It is expected that those year classes will dominate the catches in the next few years. However, there is no indication of new, strong year classes since the 1990-year class. In Vb, survey indices as well as CPUE from the fleet do not indicate improved situation in the area. In sub-Division XIV, the adult fish is severely depleted, but there are signs of improved recruitment (Figure 8.2.10). The BORMICON model estimated the exploitation rate to amount to F=0.16 (exploratory XSA (WD 15) and catch curve confirm the BORMICON estimate).

In summary, the Icelandic groundfish survey, as well as the CPUE series, show a considerable decline in the fishable biomass of *S. marinus* during the period from 1986 to 1994. The stock has since the mid 1990s increased, and is now inside defined safe biological limits (U_{pa}). A large proportion of the catches in Va in recent years are caught from only two year-classes. The fishable stock situation remains bad for Division XIV and Vb.

8.2.5 Catch projections and management considerations

Two methods are used for projection of stock and catch. The one that has been the basis for advise by the ACFM is a short term catch projection, whereas the other one is a median projection is derived from the BORMICON model.

8.2.5.1 Short term projection

The Icelandic groundfish survey indices (U) can be related to overall biomass (B) by a simple linear relationship (U=kB). If catches are assumed to be proportional to stock size and effort (Y=cEB), then it follows that catch over survey index is proportional to effort (Y/U=aE, see Table 8.2.2) and this allows a one-year prediction of catch, assuming a status-quo effort level. Although calculated confidence limits in the groundfish survey are quite low, year-to-year variation in catchability/availability will affect the results drastically while using only the last observation value as a basis for extrapolation of catches in the coming year, based on a constant effort. By using a running average over a few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions.

By assuming same effort in 2005 as in 2003 (see Section 8.2.1) the predicted catch in Va will be around 41 000 tonnes, using the formula, $Catch_{2005}$ = Average Survey $index_{2002\text{-}2004}$ * $Effort_{2003}$. By applying the same method for Vb, using commercial CPUE data (both series combined) instead of survey index, a predicted catch in Vb would be around 1 750 tonnes by assuming the same effort in 2005 as it was in 2003.

The ACFM formulation for advice in last 3 years was to reduce the effort by 25% based on the approach given above. That corresponded to 32 300 tonnes in Division V for 2003. By applying the same method for 2005, the catches would be about 31 000 in Division Va and around 1 300 t in Vb.

8.2.5.2 Medium term projection

Based on the BORMICON model, a decrease in the fishable biomass is expected for all catch options above about 37 000 t and in total biomass for all options exceeding about 33 000 t. This is due to the poor recruitment after the 1990-year class. The estimated average year class since 1992 is about 80 millions (at age 0) and maximum yield-per-recruit is estimated to about 250 gr. Based on the model results, a TAC below 35 000 t in the next 5 years would provide a fishable stock size above current biomass level at the end of that period and total biomass similar to current level. A large proportion of the catch will be from the 1985- and 1990-year classes. Therefore, after these two strong year classes have passed the fishery, higher yield than about 20 000 t cannot be expected after 2010. The approximate **F** from the model would decrease from the current level and be close to $\mathbf{F_{max}}$.

8.3 Biological reference points

S. marinus is mainly caught in Division Va, and the relative state of the stock can be assessed through survey index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max}/5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been close to Upa during the last years. The survey index series is only available from 1985.

Simulations from the BORMICON model give $\mathbf{F_{max}}$ of 0.16, which could be a candidate for $\mathbf{F_{target}}$. The model indicates that catches in the range 30 000 to 35 000 tonnes in the next year will increase the catchable biomass a little and lead to fishing mortality close to $\mathbf{F_{max}}$.

8.4 Comment on the assessment

The working group has for a number of years used the two catch projection approaches described in Section 8.2.3 to provide a basis for advice. ACFM has for a number of years used the method described in the short term projection. The working group is of the opinion that the projection derived from the analytical model is equally suitable as a basis for the short term advise.

There are only available data on nursery grounds of *S. marinus* in Icelandic and Greenland waters but no nursery grounds are known in the Faeroe Islands waters. In Icelandic waters, nursery areas are found mostly West and North of Iceland at depths between 50 and approximately 350 m, but also in the South and East (ICES C.M. 1983/G:3; Einarsson, 1960; Magnússon and Magnússon 1975; Pálsson *et al.* 1997). As length (age) increases, migration of young *S. marinus* is anticlockwise from the North coast to the West coast and further to the Southeast fishing areas and to Faeroese fishing grounds in Vb. The largest specimens are found in Subdivision Vb and therefore the yearclasses from 1985 and 1990 might still not have entered into that area. This might explain the inconsistency between different indicators on the status of the stock.

Table 8.1.1 Official landings (in tonnes) of *S. marinus*, by area, 1978-2003 as officially reported to ICES.

	Area					
Year	Va	Vb	VI	XII	XIV	Total
1978	31,300	2,039	313	0	15,477	49,129
1979	56,616	4,805	6	0	15,787	77,214
1980	62,052	4,920	2	0	22,203	89,177
1981	75,828	2,538	3	0	23,608	101,977
1982	97,899	1,810	28	0	30,692	130,429
1983	87,412	3,394	60	0	15,636	106,502
1984	84,766	6,228	86	0	5,040	96,120
1985	67,312	9,194	245	0	2,117	78,868
1986	67,772	6,300	288	0	2,988	77,348
1987	69,212	6,143	576	0	1,196	77,127
1988	80,472	5,020	533	0	3,964	89,989
1989	51,852	4,140	373	0	685	57,050
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,460	40	0	746	55,710
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,274	129	0	1,443	42,515
1995	41,516	2,581	606	0	62	44,765
1996	33,558	2,316	664	0	59	36,597
1997	36,342	2,839	542	0	37	39,761
1998	36,771	2,565	379	0	109	39,825
1999	39,824	1,436	773	0	7	42,040
2000	41,187	1,498	776	0	89	43,550
2001	34,895	1,489	535	0	93	37,012
2002	48,560	1,559	392	0	189	50,700
2003[1)]	36,576	1,466	698	0	213	38,953

1) Provisional

Table 8.1.2 *S. marinus*. Landings in Va in weight (tonnes) by age 1995-2003. Highlighted are the 1985- and 1990-year classes. It should be noted that the catch-at-age results for 1996 are only based on three samples, which explains that there are no specimen older than 23 years

Year/ Age	1995	1996	1997	1998	1999	2000	2001	2002	2003
7	62	0	**33**	24	7	40	122	130	201
8	374	355	230	**285**	367	64	137	911	211
9	1,596	814	481	598	**1,643**	852	393	768	1,366
10	**9,436**	3,652	1,037	1,214	1,247	**4,308**	1,615	842	1,121
11	2,719	**9,007**	2,698	1,135	1,840	1,894	**7,725**	3,191	1,196
12	1,319	2,074	**11,559**	3,258	2,643	2,277	1,799	**11,076**	3,950
13	3,534	1,302	2,822	**12,552**	2,309	1,703	1,973	3,098	**9,764**
14	5,671	1,458	1,369	2,086	**15,583**	2,375	1,246	2,633	2,358
15	5,971	4,374	3,134	2,039	1,143	**14,878**	835	1,857	1,976
16	1,730	5,599	3,662	2,410	1,309	1,777	**11,629**	3,030	1,216
17	852	923	3,033	3,408	1,849	1,184	520	**12,049**	2,264
18	368	383	900	2,046	2,699	1,624	783	2,098	**6,419**
19	1,134	264	644	1,015	2,272	2,427	1,063	1,173	760
20	1,144	336	945	726	1,205	2,191	1,792	662	409
21	503	1,200	450	521	482	544	965	1,410	603
22	677	1,022	524	390	222	447	418	1,027	790
23	1,427	795	689	425	345	270	435	741	754
24	664	0	590	662	223	64	168	362	379
25	762	0	752	515	936	393	130	294	303
26	365	0	271	399	279	340	125	185	74
27	350	0	136	425	650	193	291	83	83
28	725	0	204	359	230	528	203	297	27
29	0	0	150	54	107	371	153	500	106
30	133	0	30	225	231	441	374	174	197
Total	41,516	33,558	36,343	36,771	39,821	41,186	34,894	48,591	36,527

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey 1985-2004 divided by depth intervals.

	Depth Intervals					
Year	< 100m	100-200m	200-400m	400-500m	0 - 400m	Total
1985	7	91	140	24	237	261
1986	2	86	180	12	268	280
1987	2	124	150	10	276	286
1988	1	95	110	4	206	210
1989	1	101	118	11	220	231
1990	2	68	81	22	151	173
1991	2	76	53	8	130	139
1992	1	62	59	9	122	132
1993	1	48	50	17	98	115
1994	1	58	51	1	110	111
1995	0	36	45	11	81	92
1996	1	44	76	21	122	143
1997	1	60	71	34	133	166
1998	2	57	71	3	130	132
1999	1	56	107	44	164	208
2000	2	47	69	8	117	125
2001	2	33	67	6	101	107
2002	2	64	74	11	140	151
2003	9	60	107	29	176	205
2004	8	57	92	102	157	259

Table 8.2.2 *S. marinus*. Survey index from the Icelandic groundfish survey in Va 1985-2004, total landings in Va and effort towards *S. marinus*.

Year	Survey index	Landings (Va)	Effort
1985	1000	67,312	67
1986	1129	67,772	60
1987	1163	69,212	60
1988	867	80,472	93
1989	928	51,852	56
1990	637	63,156	99
1991	549	49,677	91
1992	513	51,464	100
1993	415	45,890	111
1994	462	38,669	84
1995	341	41,516	122
1996	512	33,558	65
1997	559	36,342	64
1998	546	36,771	66
1999	689	39,824	58
2000	494	41,110	83
2001	426	34,986	82
2002	590	48,560	82
2003	743	36,576	49
2004	660		

Table 8.2.3 Results of the BORMICON model. BASE CASE, estimated value of L_{50}.

Year	<1998	1998	1999	2000	2001	2002	2003
L_{50}	34.90	34.54	34.33	33.95	33.65	33.41	33.41

Table 8.2.4 Index in thousands of total biomass of *S. marinus* from the groundfish survey in March 1985-2004 and CV of the estimates.

Year	Index	CV
1985	332	0.094
1986	373	0.134
1987	349	0.114
1988	283	0.103
1989	337	0.152
1990	311	0.313
1991	203	0.105
1992	173	0.093
1993	203	0.143
1994	189	0.125
1995	163	0.138
1996	228	0.211
1997	279	0.311
1998	228	0.159
1999	377	0.206
2000	261	0.203
2001	221	0.154
2002	255	0.122
2003	402	0.191
2004	459	0.309

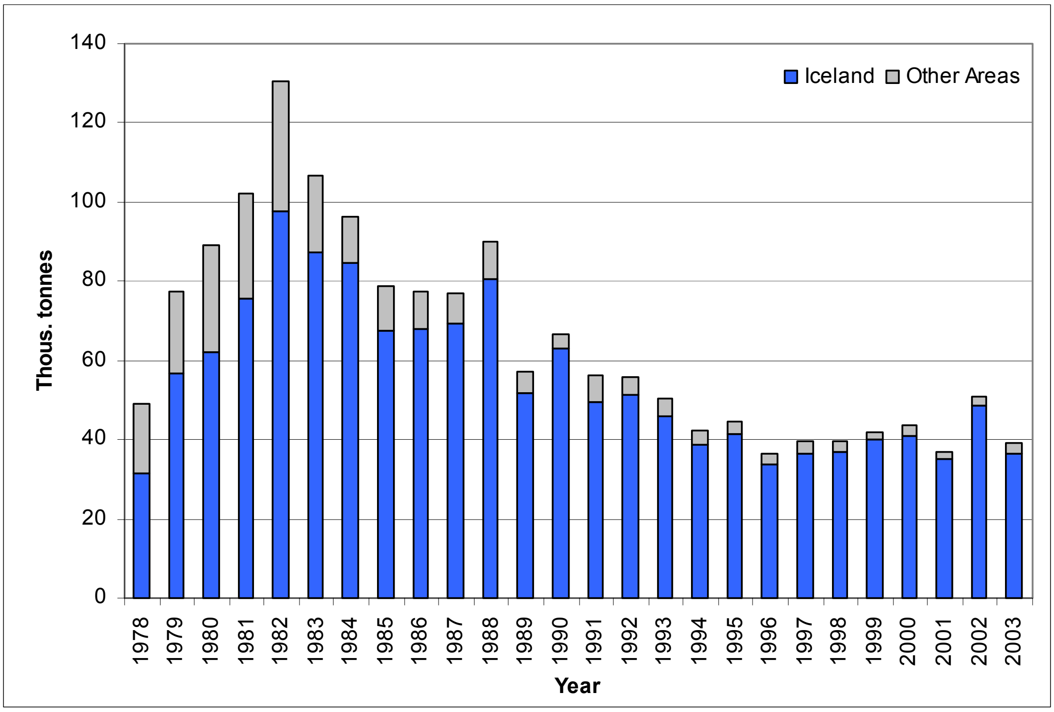


Figure 8.1.1 *Sebastes marinus*. Nominal landings in tonnes in ICES Division Va and in other areas (landing statistics for ICES Divisions Vb, VI and XIV combined) 1978-2003.

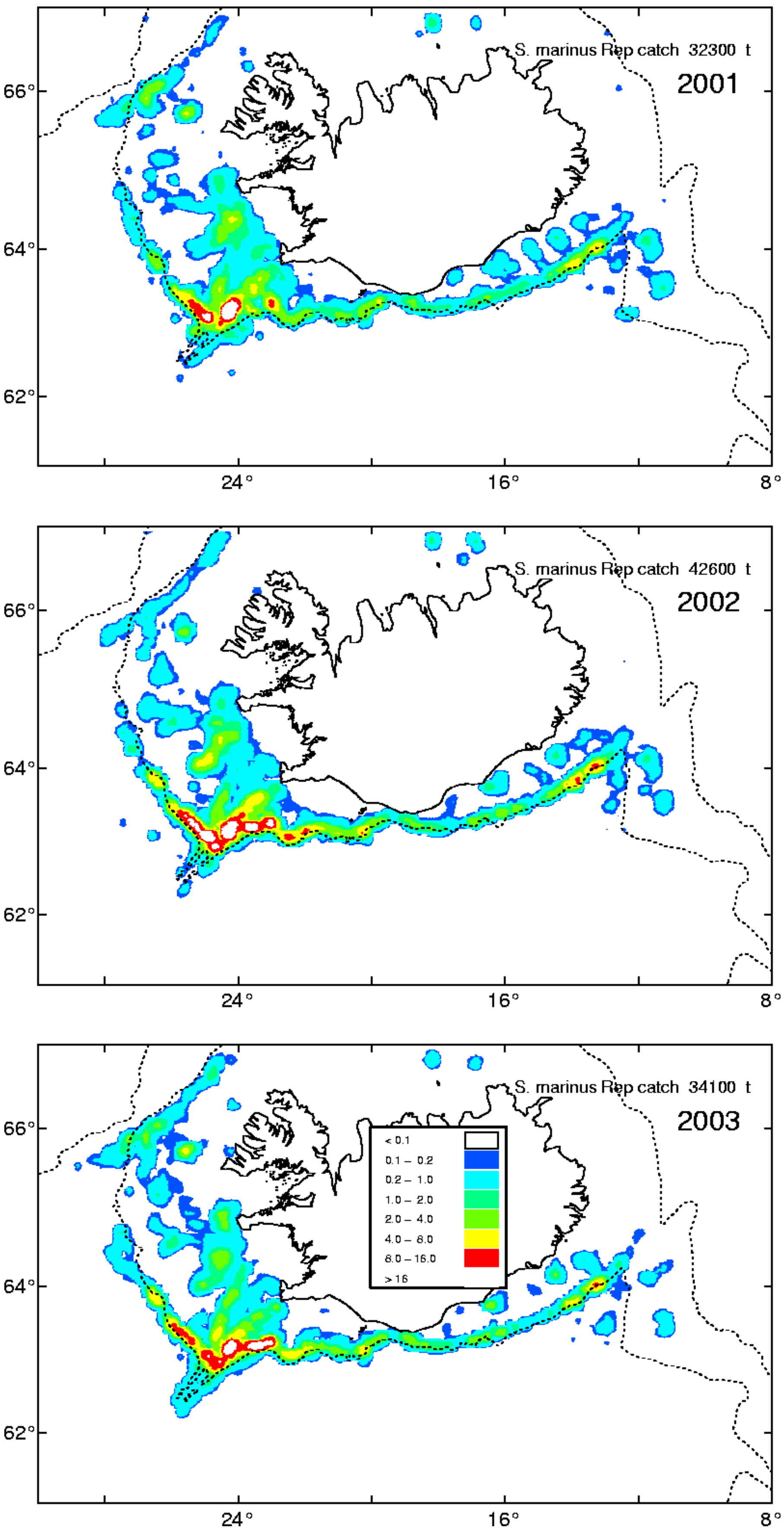


Figure 8.1.2 Geographical distribution of *S. marinus* catches in Division Va 2001-2003.

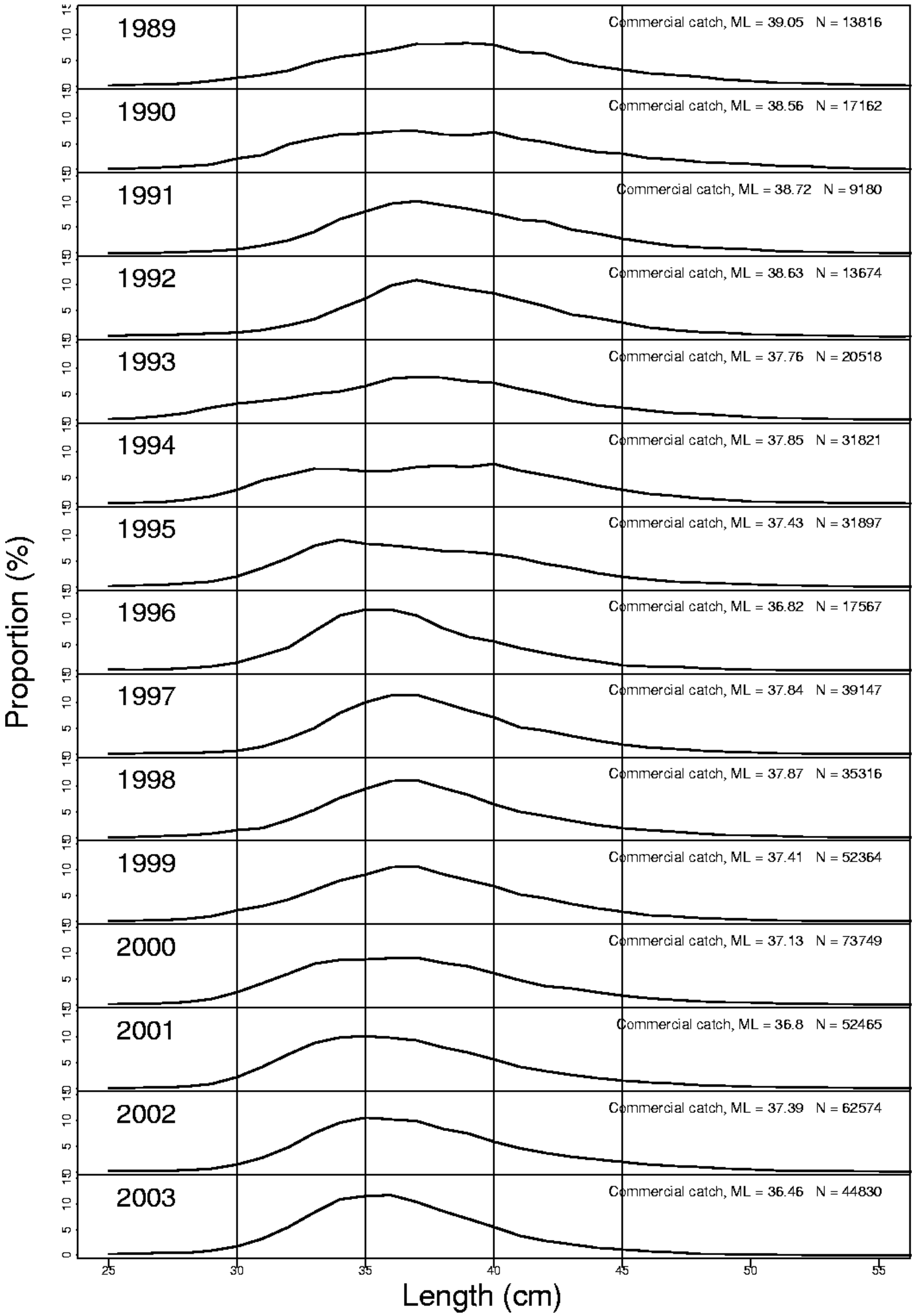


Figure 8.1.3 Length distribution of *S. marinus* in the commercial landings of the Icelandic bottom trawl fleet 1990-2003.

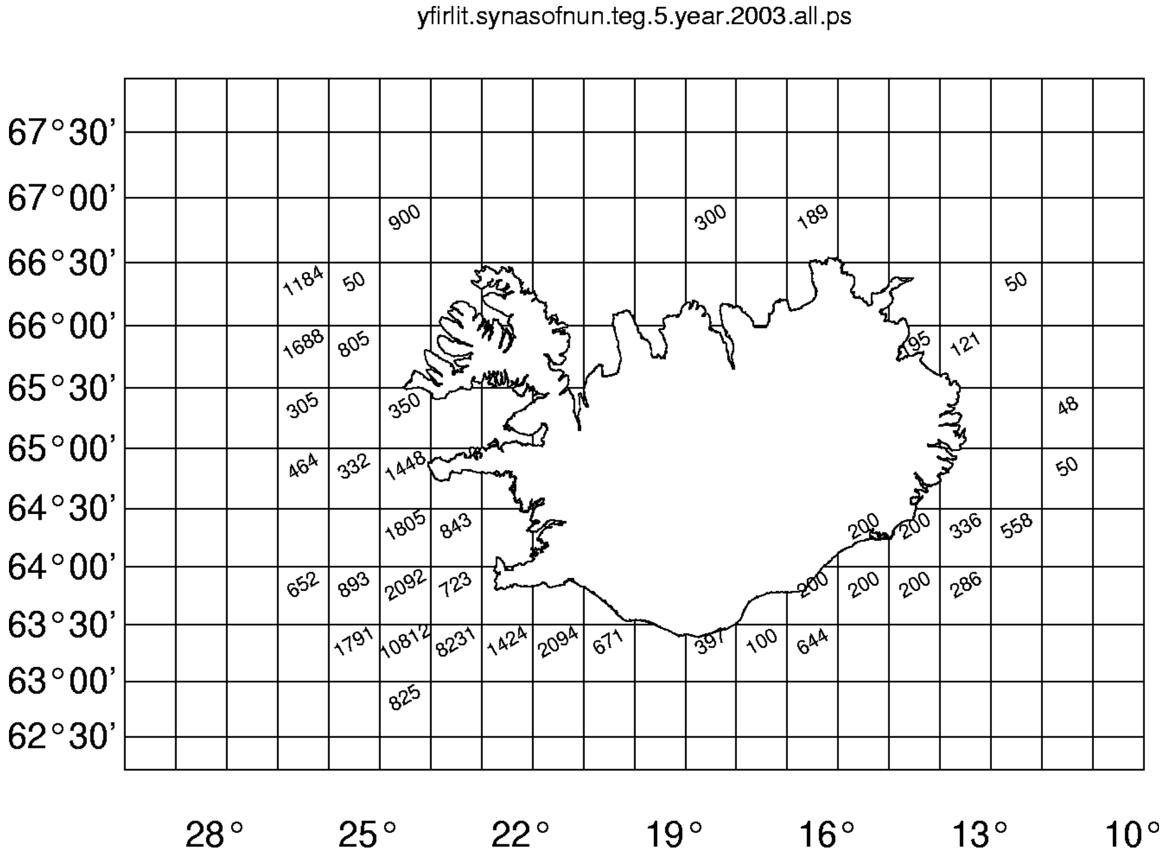


Figure 8.1.4 Number of length measured *S. marinus* in 2003 divided by statistical square.

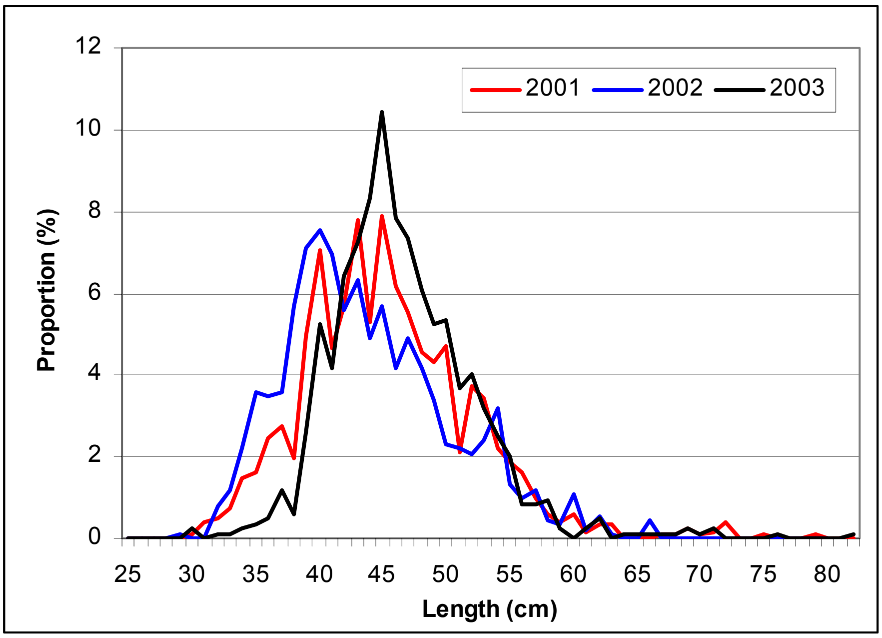


Figure 8.1.5 *S. marinus*. Length distribution from Faroese catches in 2001-2003.

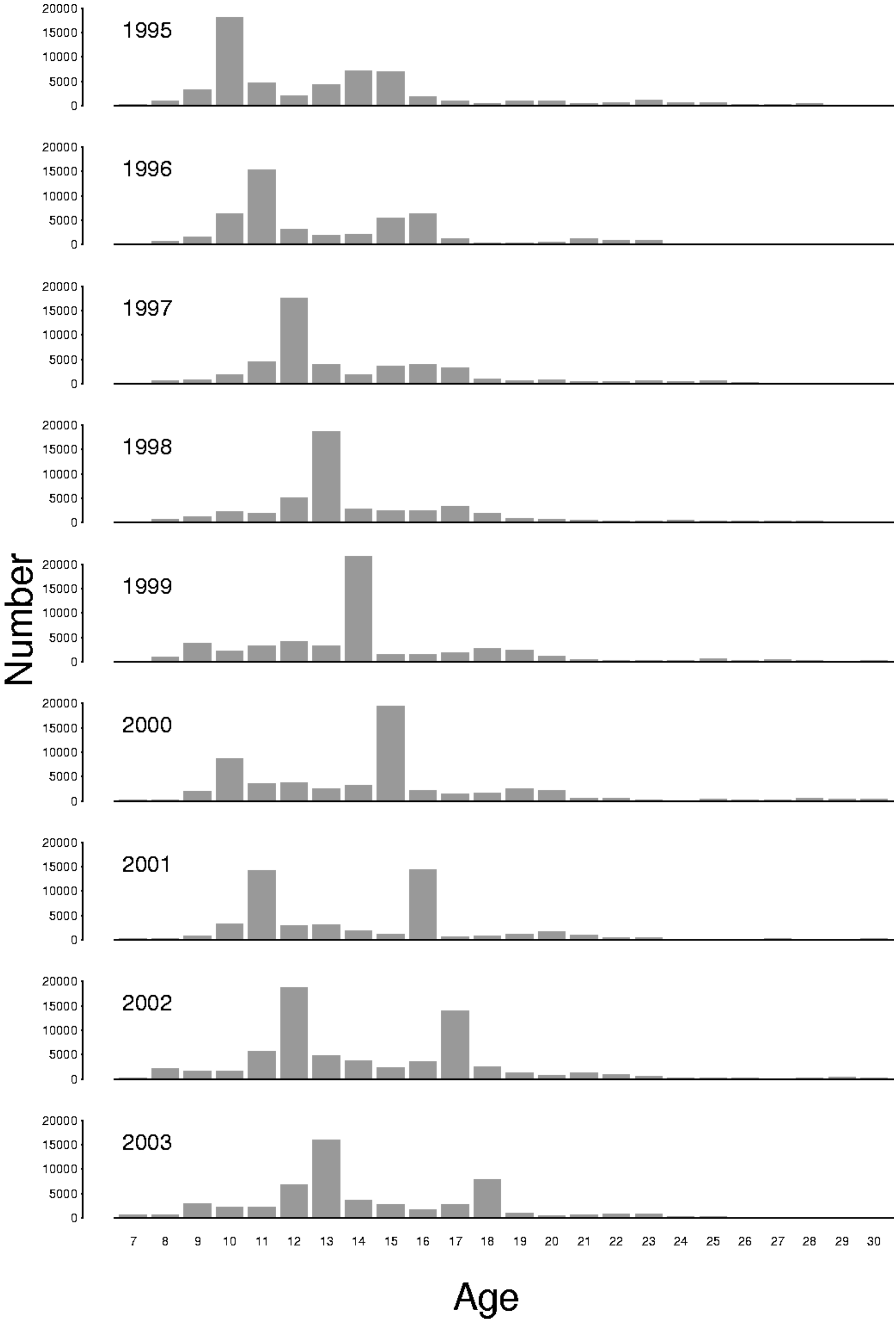


Figure 8.1.6 *S. marinus.* Catch-at-age in numbers in ICES Subdivision Va 1995-2003.

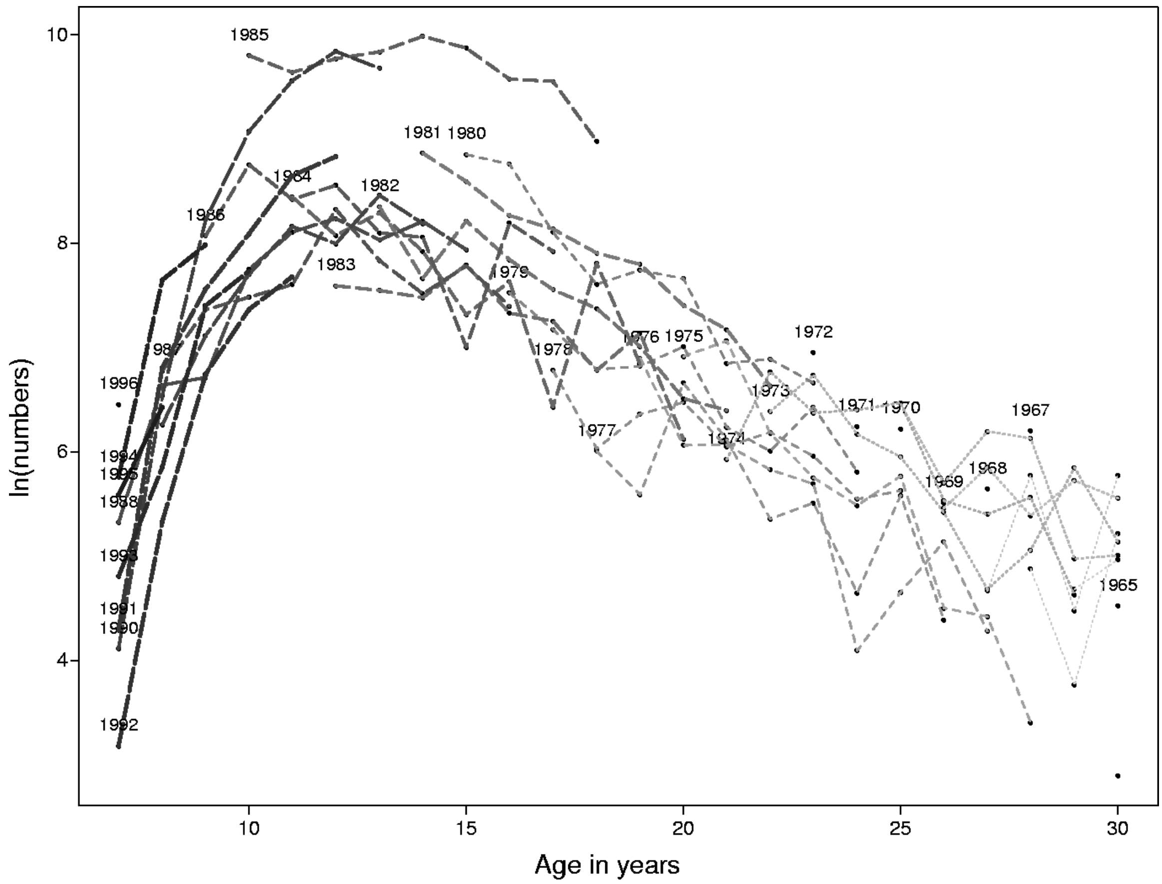


Figure 8.1.7 *S. marinus.* Catch curve based on the catch-at-age data in ICES Division Va 1995-2003.

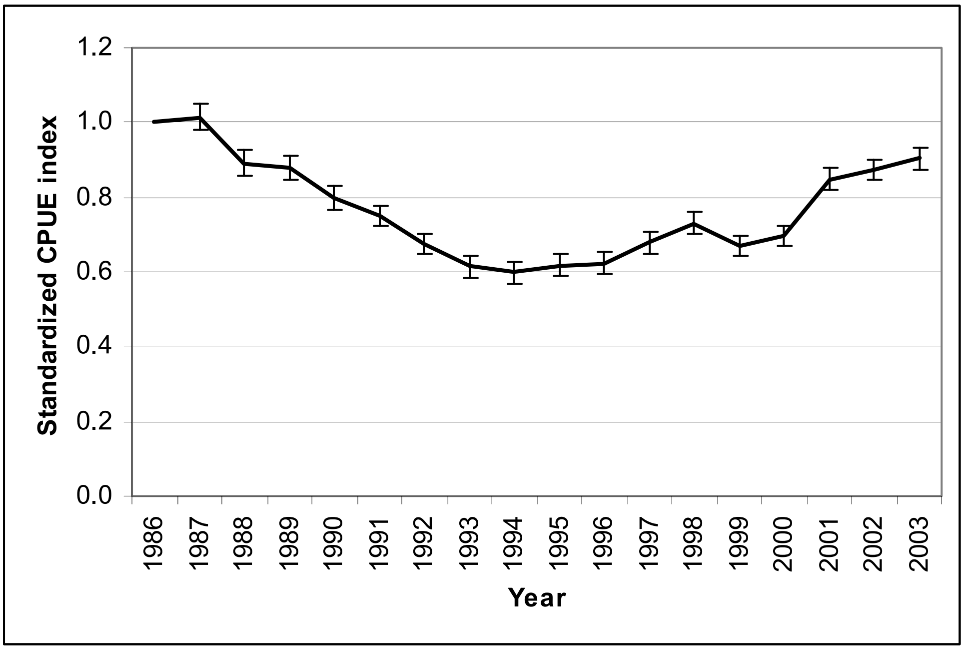


Figure 8.2.1 CPUE of *S. marinus* from Icelandic trawlers based on results from the GLM model 1985-2003 where the *S. marinus* catch composed at least 10% of the total catch in each haul.

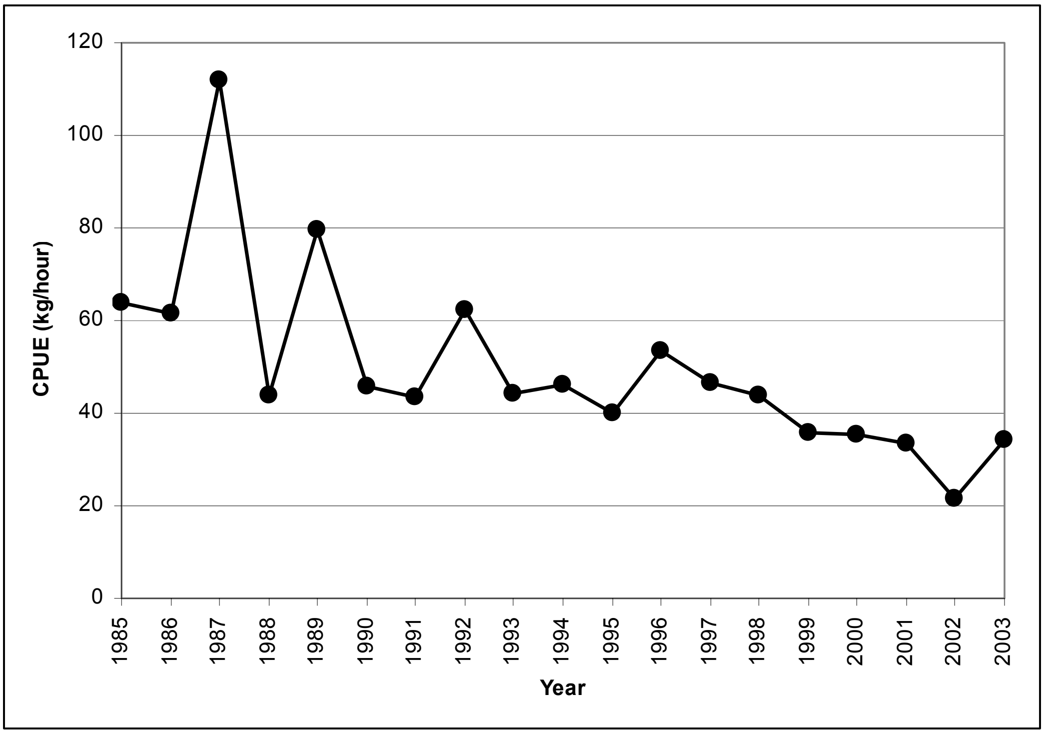


Figure 8.2.2 CPUE from the Faroese pair-trawlers in ICES Division Vb 1985-2003.

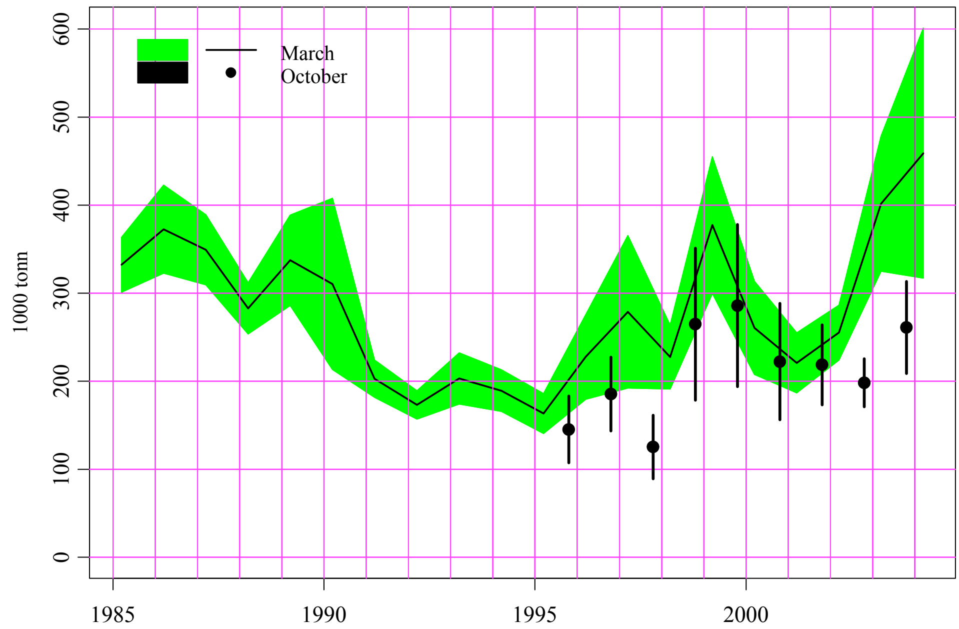


Figure 8.2.3 Total biomass indices from the groundfish surveys in March (line) and October (points). The shaded area and the vertical bar show ±1 standard error in the estimate of the indices.

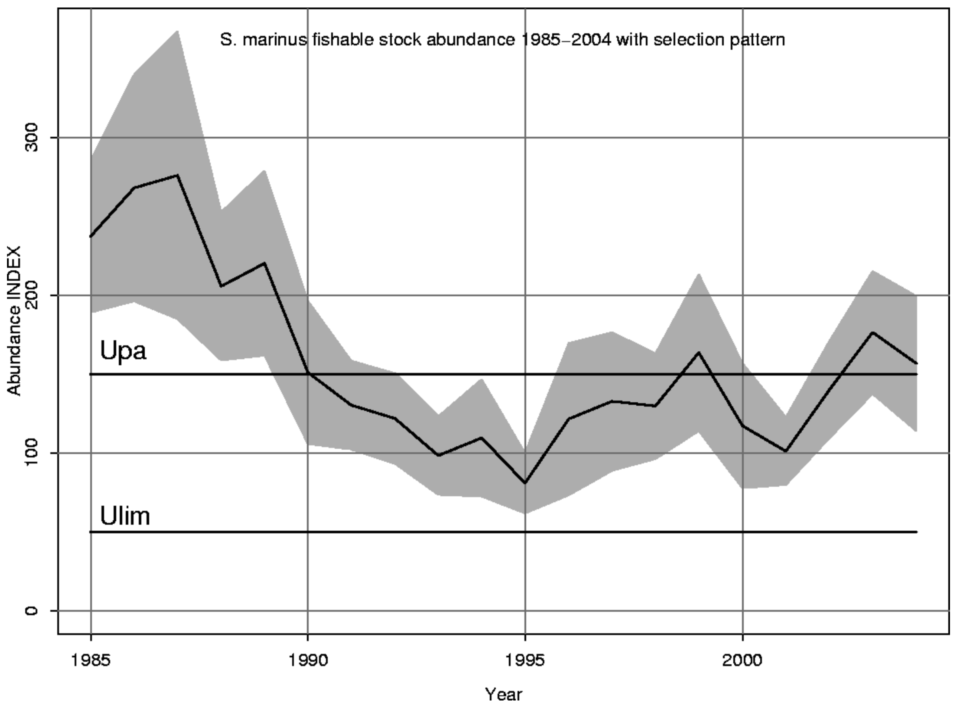


Figure 8.2.4 Index on fishable stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

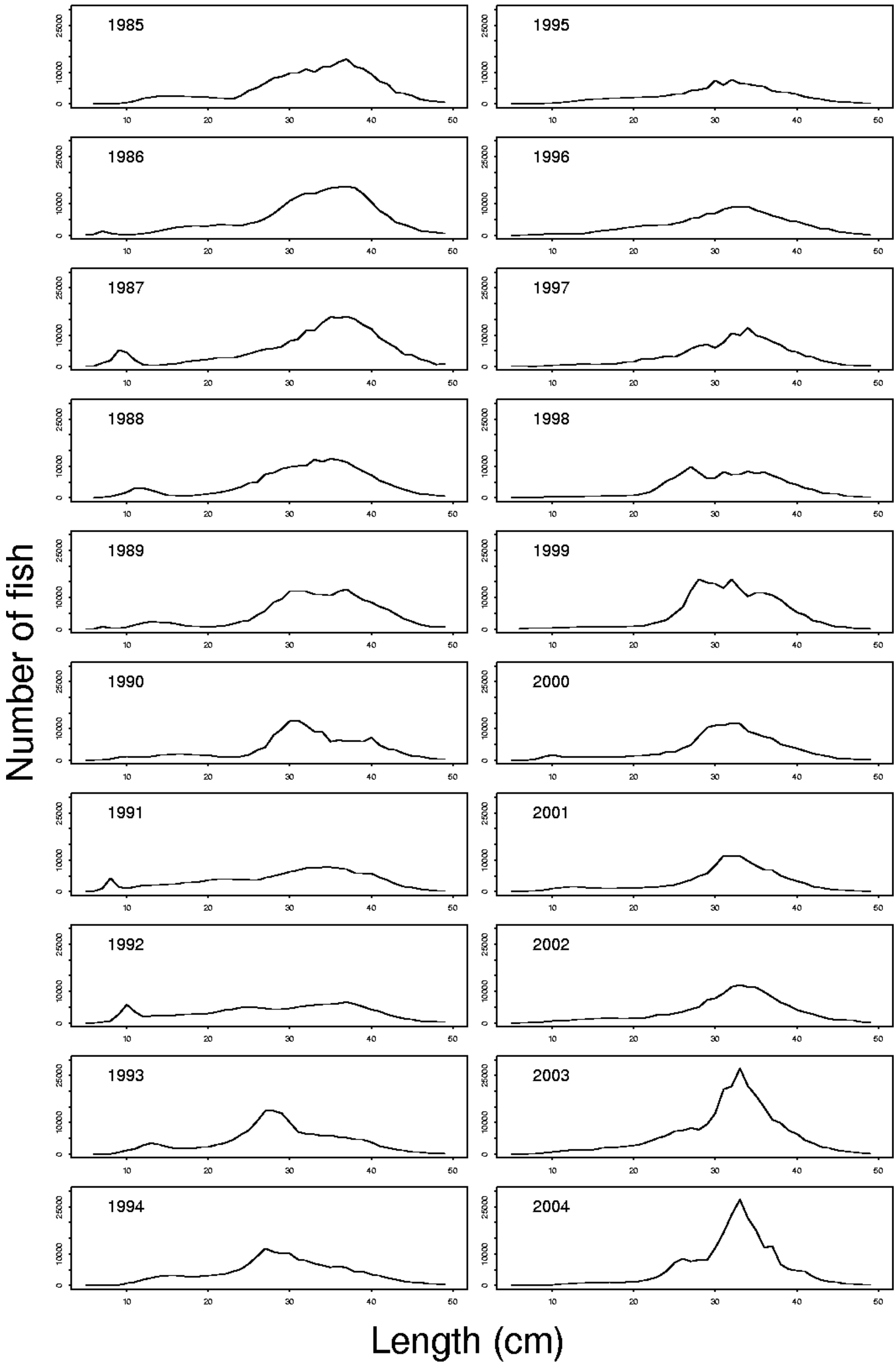


Figure 8.2.5 Length distribution of *S. marinus* in the Icelandic groundfish survey 1985-2004.

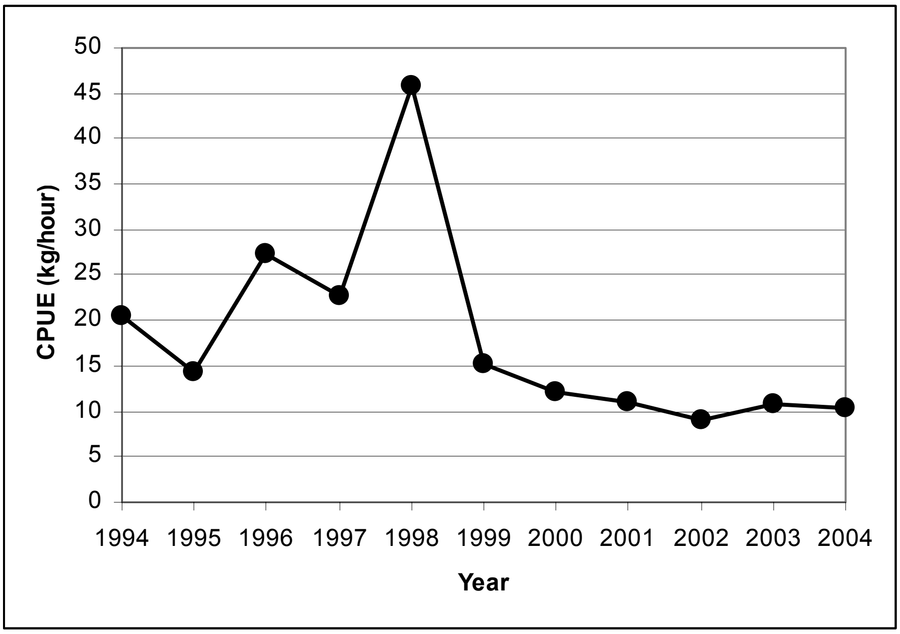


Figure 8.2.6 CPUE of *S.marinus* in the Faeroes spring groundfish survey in Division Vb 1994-2004.

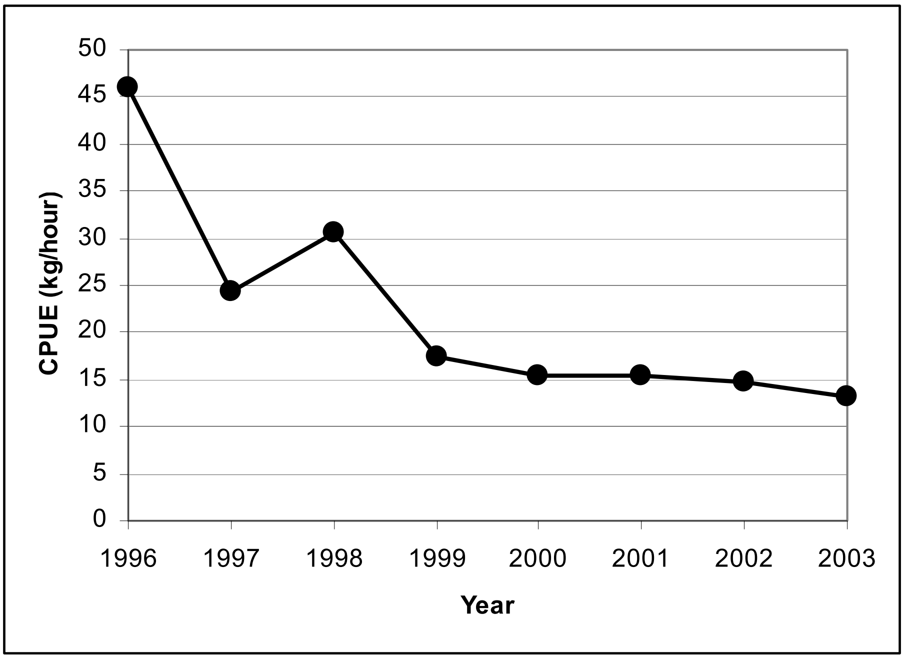


Figure 8.2.7 CPUE of *S. marinus* in the Faeroes summer groundfish survey in Division Vb1 from 1996-2003.

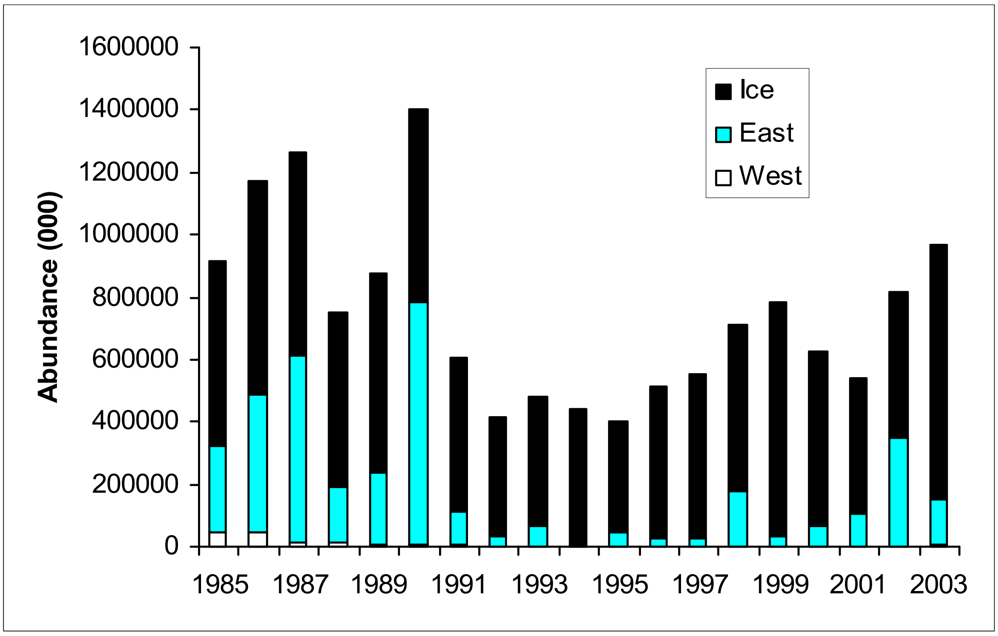


Figure 8.2.8 *S. marinus* (≥17 cm). Survey abundance indices for East, West Greenland and Iceland 1985-2003.

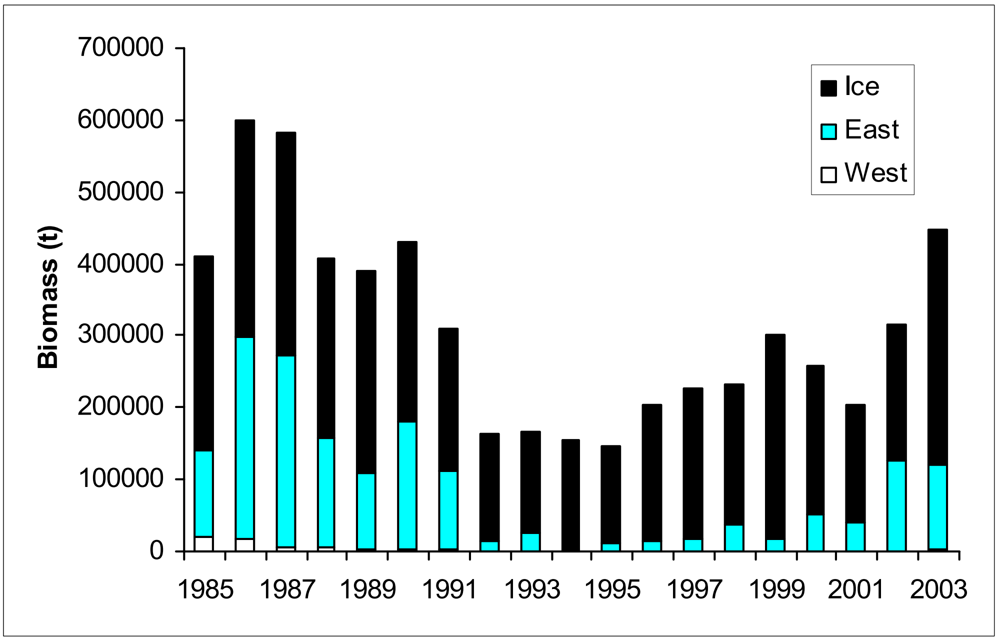


Figure 8.2.9 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland and Iceland, 1985-2003.

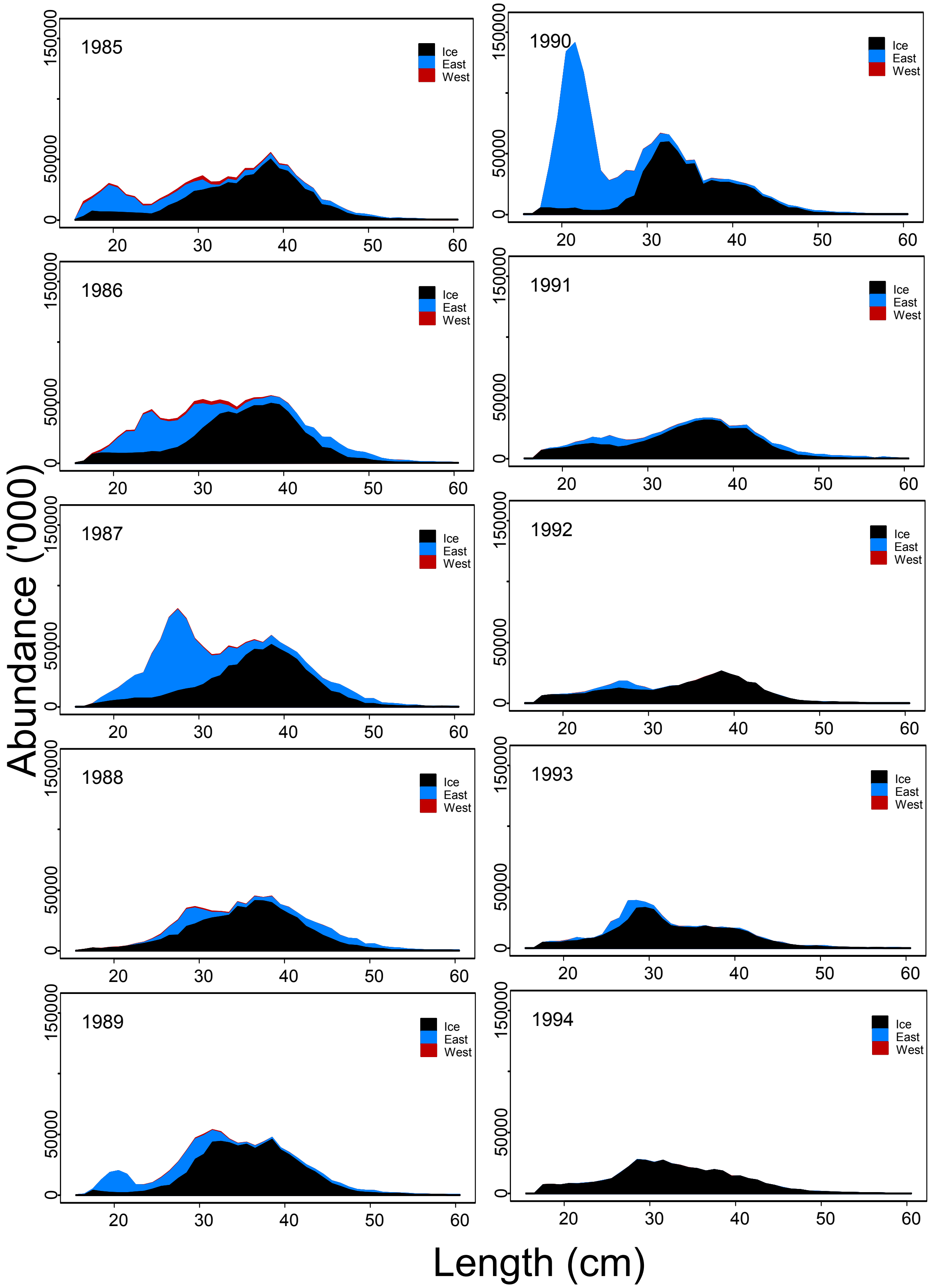


Figure 8.2.10 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland, and Iceland, 1985-1994.

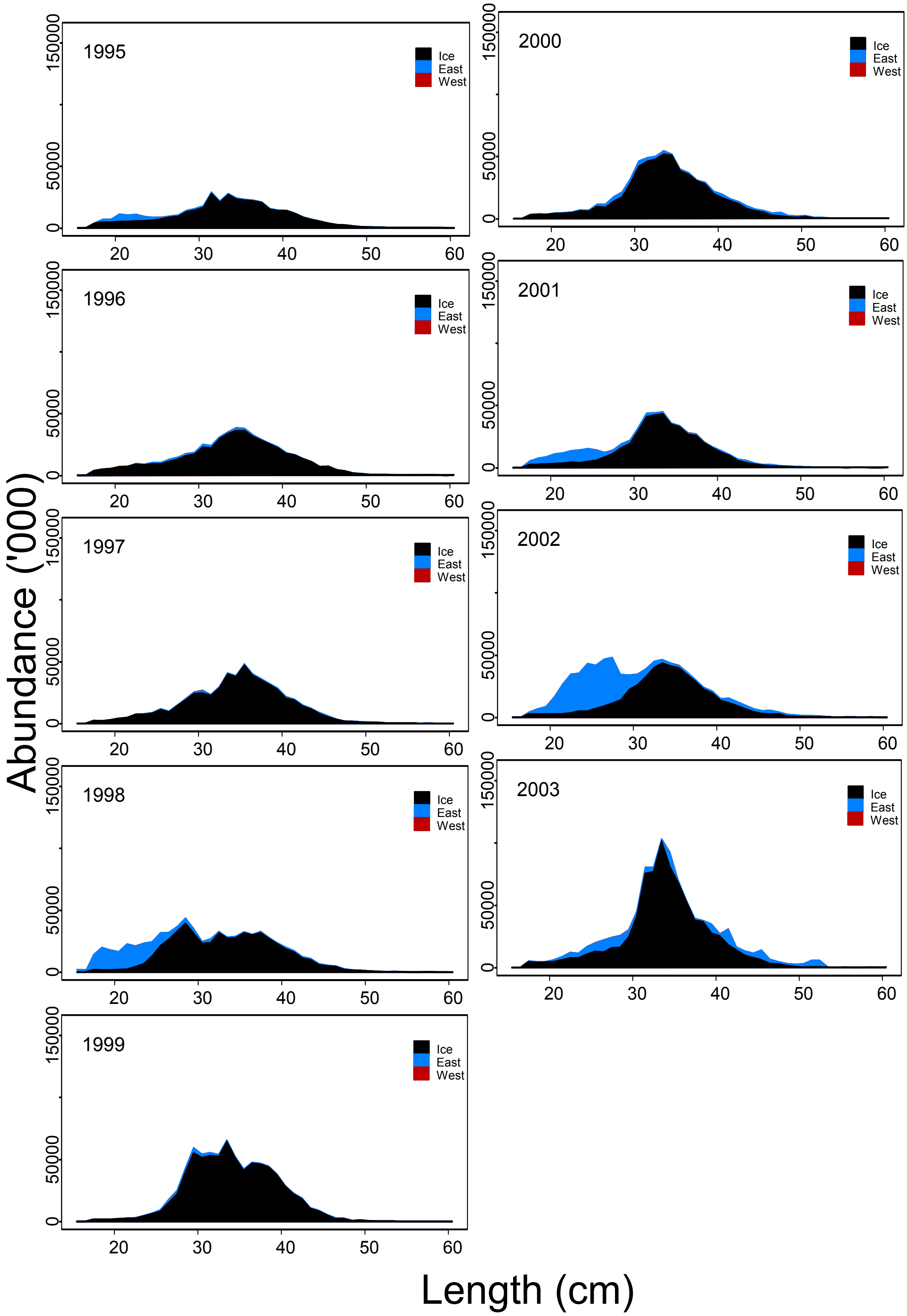


Figure 8.2.10 Continued. *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland, and Iceland, 1995-2003.

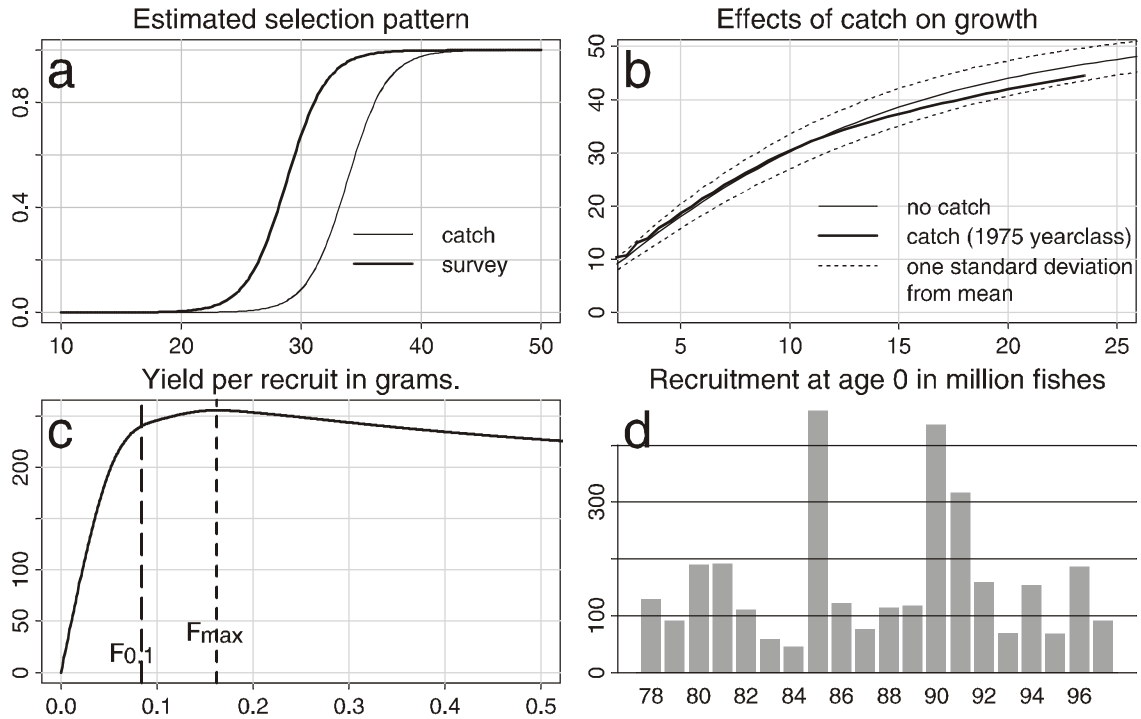


Figure 8.2.11 Results from the BORMICON model-BASE CASE, using catch data from ICES Division Va. a) Estimated selection pattern of the commercial fleet and the survey, b) Mean length (the Figure also demonstrates the effect of catch on length-at-age), c) Yield-per-recruit, and d) Estimated recruitment at age 0.

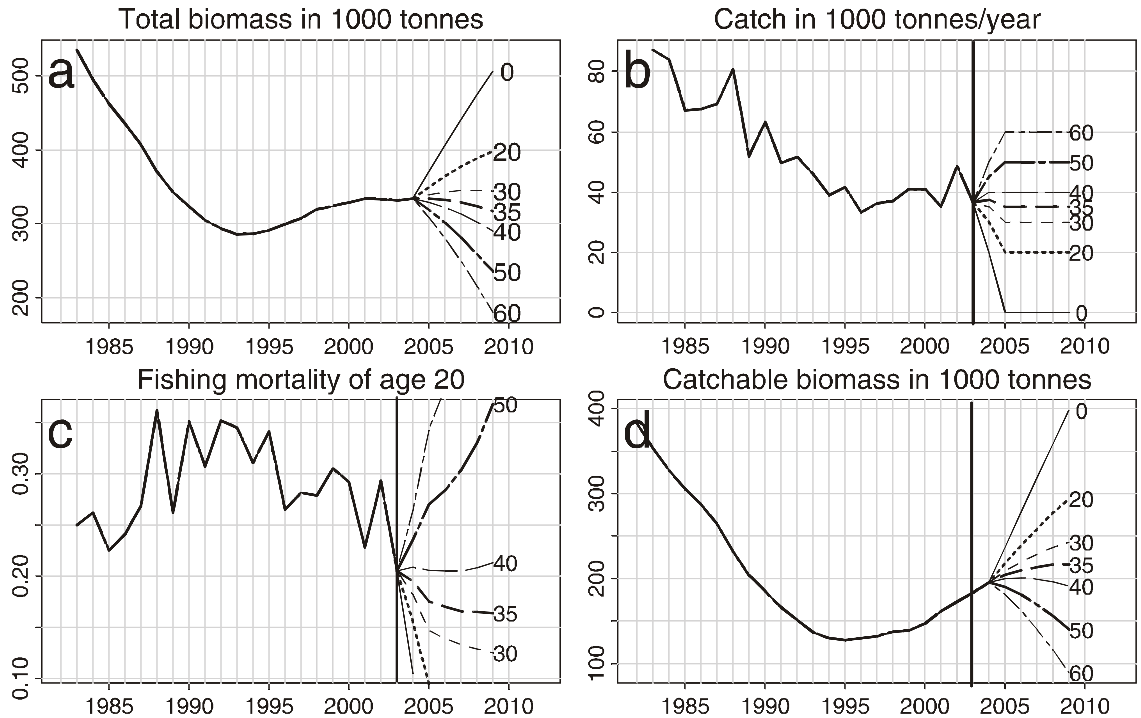


Figure 8.2.12 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different catch options (0-60 000 t) after 2003.

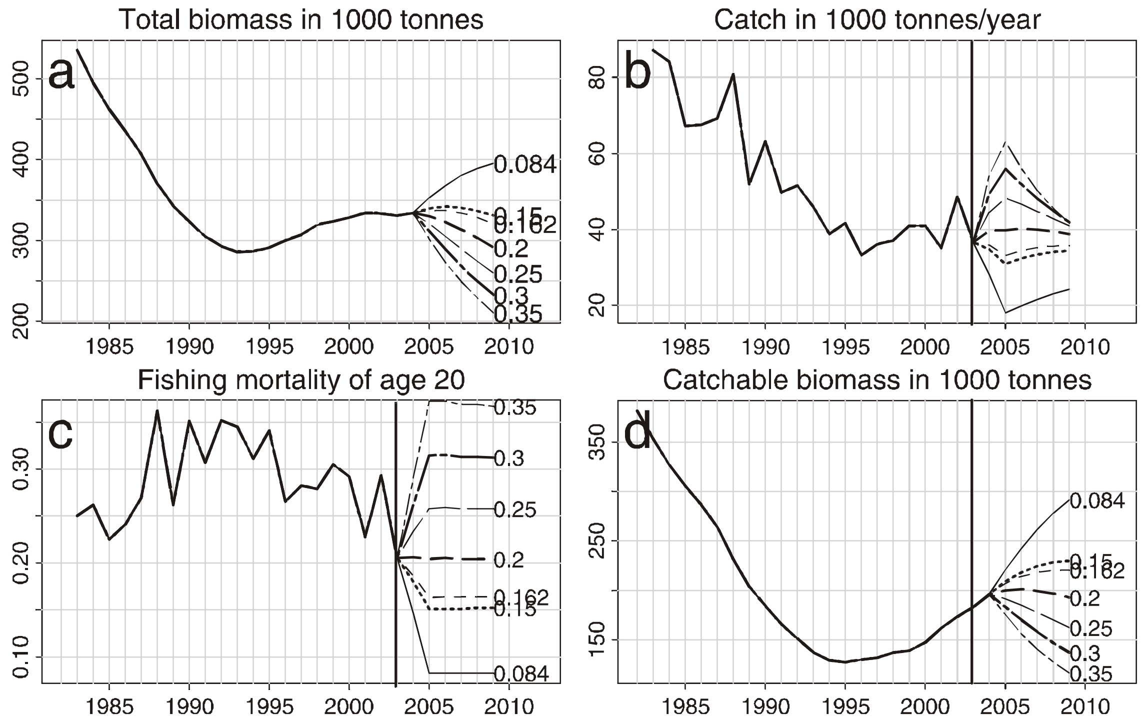


Figure 8.2.13 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different effort after 2003.

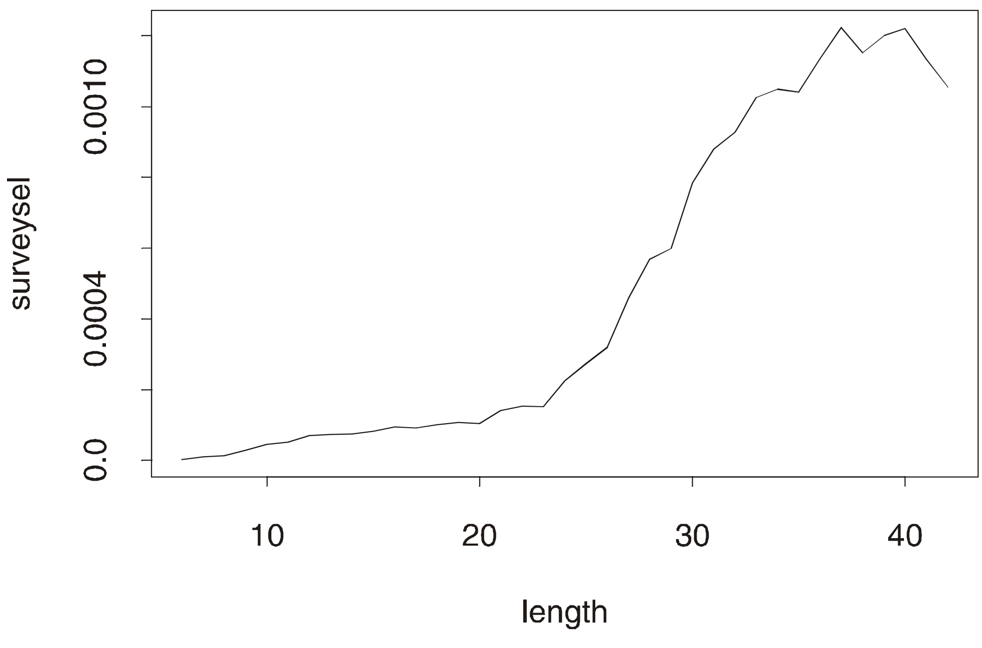


Figure 8.2.14 Estimated selection pattern as a function of length from the BASE CASE for *S. marinus* in the Icelandic groundfish survey.

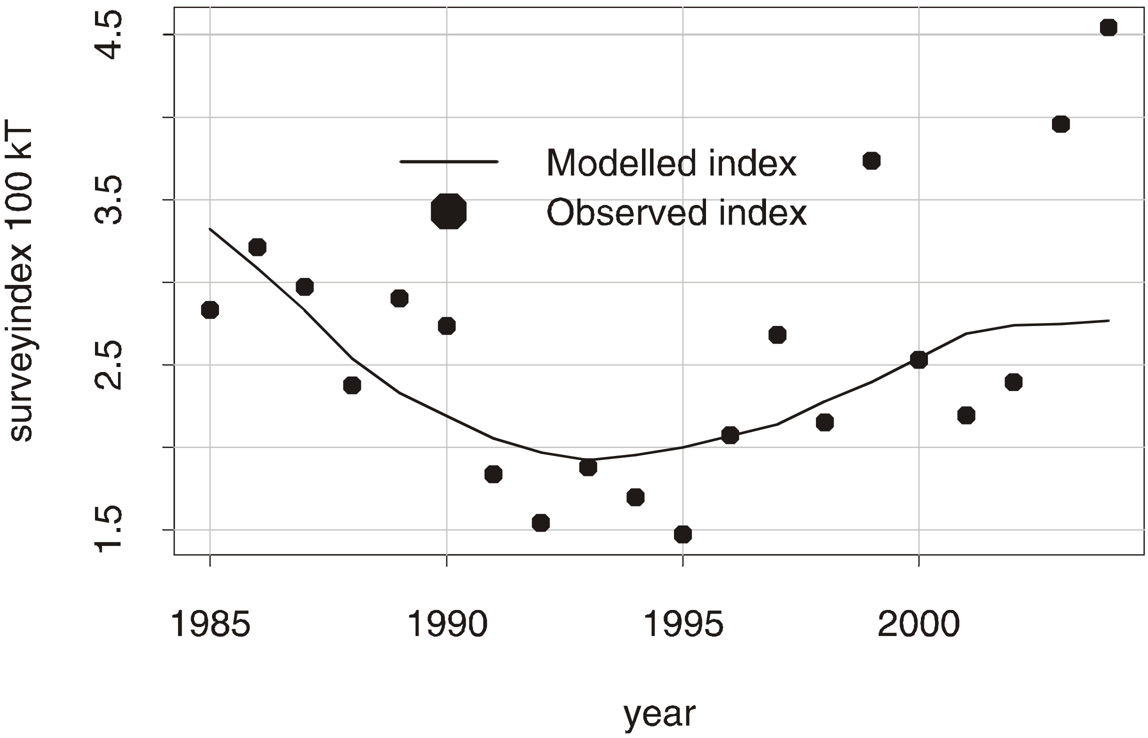


Figure 8.2.15 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figure show comparison of observed and modelled survey biomass (total biomass).

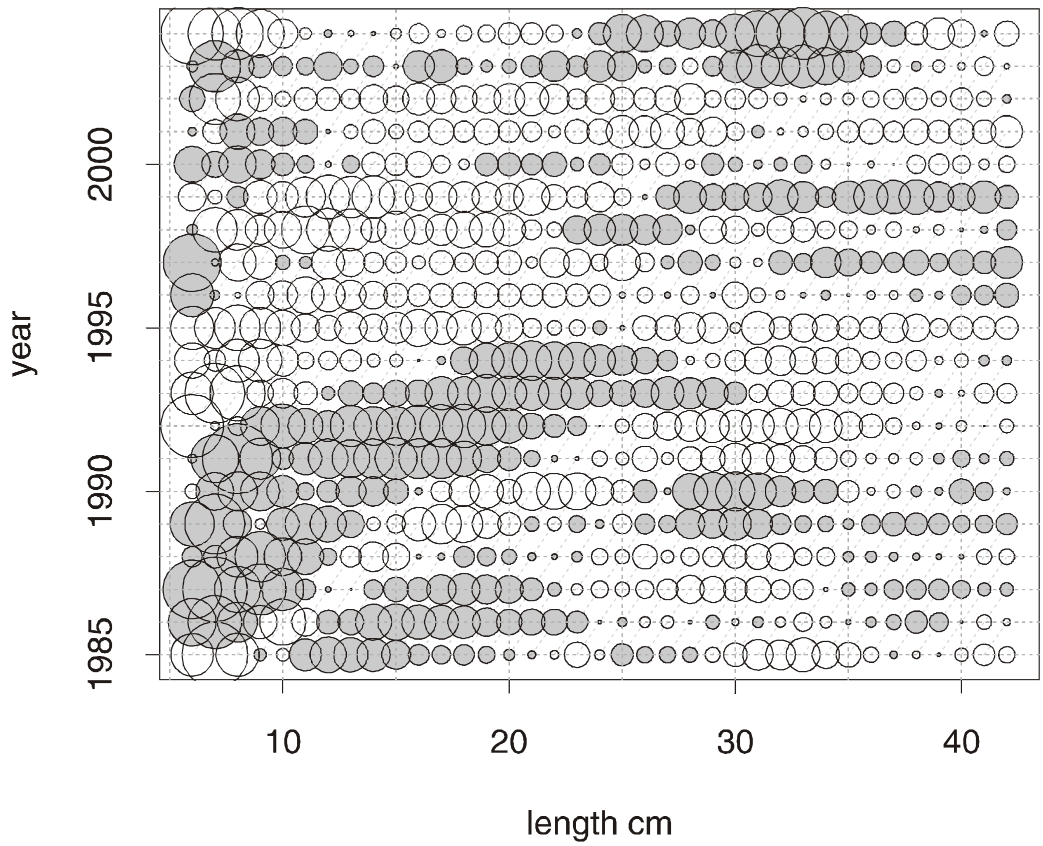


Figure 8.2.16 Results from the BASE CASE run, using catch data from ICES Division Va. Residuals from fit to survey data log(Isur/Imod). The shaded circles show positive residuals (survey results exceed model prediction).

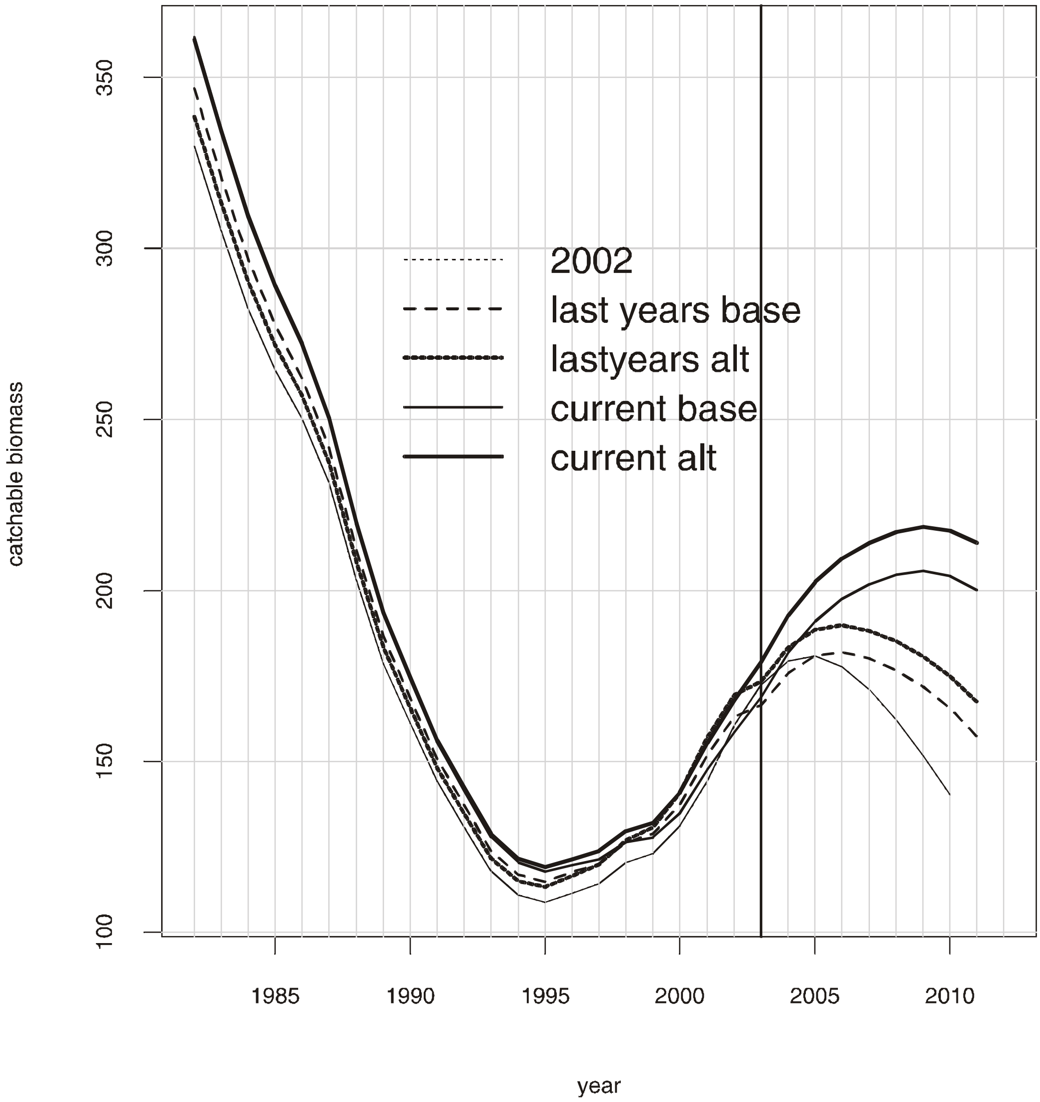


Figure 8.2.17 Comparison of catchable biomass (in thousand tonnes) using the data obtained now and last year, for same settings. Results are obtained using only the catch history from ICES Division Va.

9 DEEP-SEA *SEBASTES MENTELLA* ON THE CONTINENTAL SHELF

Deep-sea *S. mentella* on the continental shelves and slopes around the Faeroe Islands, Iceland, and East Greenland is treated as one stock unit and separated from the stock fished in the Irminger Sea (oceanic *S. mentella*, see Chapter 10). It is believed to have a common area of larval extrusion southwest of Iceland, a drift of the pelagic fry towards the nursery areas on relatively shallow waters off East Greenland, and feeding and copulation areas on the shelves and banks around the Faeroe Islands, Iceland, and East-Greenland. The main fishing grounds are in Icelandic waters.

9.1 Landings and Trends in the Fisheries

The total annual landings of deep-sea *S. mentella* from Divisions Va and Vb, and Sub-areas VI and XIV varied between 20 000 and 84 000 t in 1978-1994 (Table 9.1.1 and Figure 9.1.1). Since 1994, landings gradually decreased and in 2001and 2002 annual landings were 23 000 t, which was the lowest recorded since 1979. Landings in 2003 increased by about 7 000 t from 2002 and was mainly due to increased landings from Va.

In Division Va, annual landings gradually decreased from a record high of 57 000 t in 1994 to 17 000 t and 19 000 t in 2001 and 2002 respectively. However, in 2003 landings increased by amount of 10 000 t and to 28 500 t (Table 9.1.1 and Figure 9.1.1). For the past three years most of the catches were taken by bottom trawlers (the pelagic trawl fishery for the past three years have been negligible) along the shelf west, southwest, and southeast of Iceland (Figure 9.1.2), east of the redfish line (Figure 9.1.3). The catches in the third and fourth quarter of the year decreased considerable in 2001 compared with earlier years and continued to decrease in 2002 (Figure 9.1.4). The reason for this decrease seems to be associated with decreased effort at that time of year. The catch pattern by month changed considerably in 2003. The catches peaked in June, which was unusual compared with other years (Figure 9.1.4). This pattern is probably associated with the pelagic *S. mentella* fishery within the Icelandic EEZ (see Figure 7.5.1). The pelagic *S. mentella* fishery has in recent years moved more northwards and in 2003 it merged with the deep-sea *S. mentella* fishery in the redfish line in June (Figure 7.5.1 and Figure 9.1.3). Length distribution of deep-sea *S. mentella* from the bottom trawl fishery shows an increase in the number of small fish in the catch in recent years (Figure 9.1.5). A peak of about 32 cm in 1994 can been followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2003 was a little smaller than in 2002 and peaked around 37 cm.

In Division Vb, landings of deep-sea *S. mentella* were 2 100 t in 2003, which is a small decrease compared to 2002 (Table 9.1.1 and Figure 9.1.1). Record high was reported in 1986 as 15 000 t. Length distribution from the landings in 2001-2003 indicates that the fish caught are larger than 40 cm (Figure 9.1.6).

In Subarea VI, the annual landings varied between 200 t and 1 100 t 1978-2000 (Table 9.1.1 and Figure 9.1.1). Landing statistics for 2001 and 2002 showed that the redfish fishery in VI had ceased to a very low level (around 20 t), but increased in 2003 and to around 200 t.

In Subarea XIV, the annual deep-sea *S. mentella* landings has decreased drastically. In 1980-1994, landings varied between 2 000 and 19 000 with the lowest landings in 1989 and the highest in 1994 (Table 9.1.1 and Figure 9.1.1). In the following three years, the annual landings were less than 1 000 t and the redfish was mainly caught as bycatch in the shrimp fishery. In 1998, Germany started a directed fishery for redfish with annual landings around 1 000 t 1998-2001, but landings increased to 1 900 t in 2002. Samples taken from the German fleet indicated that substantial quantities of the redfish caught, especially in 2002, were juveniles, i.e. fish less than 30 cm (Figure 9.1.7). In 2003 there was very little deep-sea *S. mentella* fishery in XIV and only 348 t were landed from that area. The redfish was mainly taken by UK trawlers and there was no redfish fishery by the German fleet. It is not known whether the fishery by the UK trawlers was a direct fishery or whether the redfish was caught as bycatch. No biological samples were taken in Subarea XIV in 2003.

Below the table shows the 2003 biological sampling from the catch and landings of deep-sea *S. mentella* from the continental shelf divided by Division and gear type.

Area	Gear	Landings	Nos. samples	Nos. fish measured
Va	Pelagic trawl	44	0	0
Va	Bottom trawl	28 478	132	23 524
Va	Germany	1 094	2	3 221
Vb	Bottom trawl	2 123	46	4 266
XIVb	Bottom trawl	348	0	0

9.2 Trends in CPUE and survey indices

Data used to estimate CPUE for deep-sea *S. mentella* in Division Va 1986-2003 were obtained from log-books of the Icelandic trawl fleet. Only bottom trawl tows taken below 500 m depth were used and where *S. mentella* composed at least 50% of the total catch in each tow. Indices of CPUE were estimated from this data set using a GLM multiplicative model. This model takes into account changes in vessels over time as well as difference in vessel size, area (ICES statistical square), and month and year effects.

From 1986 to 1989 CPUE in Division Va was relatively stable, but gradually decreased from 1989 to a record low in 1994 (Figure 9.2.1). From 1995 to 2000, CPUE slightly increased annually, decreased in 2001 and 2002, and increased again in 2003. The fishing effort at the time when the stock was considered in stable condition, i.e. from 1986-1990, was 15 000-40 000 hours fishing. From 1991 to 1994, the fishing effort increased drastically, but decreased between 10% and 20% each year to 2001. Since 2001 there has been an increase in effort. ICES recommended 25% annual reduction in fishing effort during the same time period. Effort increased by about 12% between 2001 and 2002 and by about 40% between 2002 and 2003.

CPUE indices in Division Vb for deep-sea *S. mentella* and obtained from the Faeroese CUBA trawlers decreased from 500 kg/hour in 1991 to of 300 kg/hour in 1993 and has, since then, been at this level (Figure 9.2.2). Fishing effort during decreased between 2001 and 2002, but was in 2003 little lower than in 2002. The summer survey 1996-2003 in Division Vb shows nearly a continuous decrease in the catch rate or from about 10 kg/hour to about 2 kg/h (except in 1999 when the catches were over 10 kg/h) (Figure 9.2.3).

CPUE data from Division XIV were only available from 1998 when directed fishery for *S. mentella* by Germany started along the continental slope of East Greenland. Fishing effort was similar in the first three years or around 2 200 hours fishing, decreased to 1 000 hours in 2001, and increased again in 2002 to 1 500 hours (Figure 9.2.4). At the same time, CPUE decreased between 1998 and 1999, but has since then increased annually. No CPUE and effort data were available from Subdivision XIV in 2003, as there was no effort exerted by the German fleet and no information were available from the UK fleet.

Surveys conducted on the continental shelf of West and East Greenland and Iceland (from the spring survey conducted at depths of 0-500 m) cover only the distribution of juvenile deep-sea *S. mentella* (recruits). The results indicate that juveniles are most abundant off East Greenland, while negligible part of juveniles are distributed off West Greenland and Iceland (Figure 9.2.5). Figure 9.2.5 shows that the abundance was dominated by a single strong year class recorded for the first time in 1987 at a mean length of 20 cm. Annual growth of this cohort was about 2 cm and fully recruited to the survey gear in 1997 at a length of about 27 cm, when abundance and biomass reached its maximum (total abundance estimated 7 billion individuals and biomass 1.5 million tons). This year class seems to have left the survey area in the following years. The abundance (Figure 9.2.6) and biomass (Figure 9.2.7) records in 2003 are the second highest since 1985, indicating further recruiting year classes.

The state of the stock will be dealt with during the September session in Bergen, Norway (see Section 7.1).

9.3 Catch projections

It is possible to estimate catch for deep-sea *S. mentella* that corresponds to different effort. Here, this was done by using the formula:

$$Catch_{2005} = \text{Average CPUE index}_{2001\text{-}2003} * \text{Average Effort}_{2001\text{-}2003}$$

where effort for each year is calculated as: Effort = Catch/CPUE. This formula was applied to catch statistic and CPUE from Va and Vb, giving a catch of 21 508 t in Va and 3 070 t in Vb (Table 9.2.1). This will correspond to a catch of 24578 t for the whole stock (Table 9.2.2). The above calculation was a basis the ACFM advise last year.

9.4 Biological reference points

Not relevant here since it will be dealt with during the September session in Bergen, Norway (see Section 7.1).

9.5 Management considerations

The landings increased between 2002 and 2003 in Division Va by about 10 000t and was considerable higher than the set quota. There are two likely explanations for this increase. First, the pelagic *S. mentella* fishery has in recent years been merging with the deep-sea *S. mentella* fishery on the continental shelf (see detailed description in Chapter 10.1.2.4 where the overlap of these two fisheries in 2003 is described). It is, however, uncertain whether these represent the same stock or not and this issue will be discussed within ICES SGSIMUR working group held in Bergen Norway August 31-September 3. Second, the increase in deep-sea *S. mentella* landings could be due to decreased effort towards *S. marinus*. It should be noted that Icelandic authorities give a joint quota for *S. marinus* and *S. mentella* and the increase in deep-sea *S. mentella* landings in 2003 resulted in a decrease in *S. marinus* landings. The working group recommends that the TAC of *S. marinus* **should be given separately**. There is a strong indication that *S. mentella* and *S. marinus* in Va are spatially separated and therefore, separate quotas for these species can be given.

The WG did not conclude about the status of the stock and did not recommend any quota for this stock as it will be assessed within the NWWG in September. The advice will be based of the outcome of the SGSIMUR meeting.

The Working Group recommends, however, a maximum protection of the juveniles in Division XIV and therefore, **no directed** fishery towards deep-sea *S. mentella* in Division XIV should be allowed.

Table 9.1.1 Nominal landings (tonnes) of deep-sea *S. mentella* on the continental shelf and slopes 1978-2003, divided by ICES Division.

Year	ICES Division					Total
	Va	Vb	VI	XII	XIV	
1978	3 902	7 767	18	0	5 403	17 090
1979	7 694	7 869	819	0	5 131	21 513
1980	10 197	5 119	1 109	0	10 406	26 831
1981	19 689	4 607	1 008	0	19 391	44 695
1982	18 492	7 631	626	0	12 140	38 889
1983	37 115	5 990	396	0	15 207	58 708
1984	24 493	7 704	609	0	9 126	41 932
1985	24 768	10 560	247	0	9 376	44 951
1986	18 898	15 176	242	0	12 138	46 454
1987	19 293	11 395	478	0	6 407	37 573
1988	14 290	10 488	590	0	6 065	31 433
1989	40 269	10 928	424	0	2 284	53 905
1990	28 429	9 330	348	0	6 097	44 204
1991	47 651	12 897	273	0	7 057	67 879
1992	43 414	12 533	134	0	7 022	63 103
1993	51 221	7 801	346	0	14 828	74 196
1994	56 720	6 899	642	0	19 305	83 566
1995	48 708	5 670	536	0	819	55 733
1996	34 741	5 337	1 048	0	730	41 856
1997	37 876	4 558	419	0	199	43 051
1998	33 125	4 089	298	3	1 376	38 890
1999	28 590	5 294	243	0	865	34 992
2000	31 393	4 841	885	0	986	38 105
2001	17 292	4 247	34	0	927	22 500
2002	19 045	2 688	19	0	1 903	23 655
2003[1)]	28 478	2 123	197	0	348	31 145

1) Provisional

Table 9.2.1 Catch projection of deep-sea *S. mentella* for 2005. The table gives the nominal landings (tonnes), CPUE and fishing effort in Va and Vb, the catch projection for the 2005 fishing year in Va and Vb based on mean CPUE and effort of 2001-2003, and total catch in these two areas.

	Iceland (Va)			Faeroe Islands (Vb)		
Year	**Landings**	**CPUE**	**Effort**	**Landings**	**CPUE**	**Effort**
1986	18 898	1 000	19			
1987	19 293	1 096	18			
1988	14 290	988	14			
1989	40 269	949	43			
1990	28 429	907	31			
1991	47 651	924	52	12 897	501	26
1992	43 414	720	60	12 533	384	33
1993	51 221	652	79	7 801	321	24
1994	56 720	581	98	6 899	308	22
1995	48 708	596	82	5 670	311	18
1996	34 741	601	58	5 337	292	18
1997	37 876	631	60	4 558	337	14
1998	33 125	635	52	4 089	295	14
1999	28 590	675	42	5 294	307	17
2000	31 393	715	44	4 841	289	17
2001	17 292	699	25	4 247	308	14
2002	19 045	689	28	2 688	373	7
2003	27 478	729	39	2 123	314	7
Av. 01-03		**706**	**30**		**332**	**9**

Catch 2005 = Mean $\text{CPUE}_{(2001\text{-}2003)}$* Mean $\text{Effort}_{(2001\text{-}2003)}$

Level	**Va**	**Vb**	**Total**
120%	25 810	3 684	29 494
100%	21 508	3 070	24 578
75%	16 131	2 302	18 433
50%	10 754	1 535	12 289

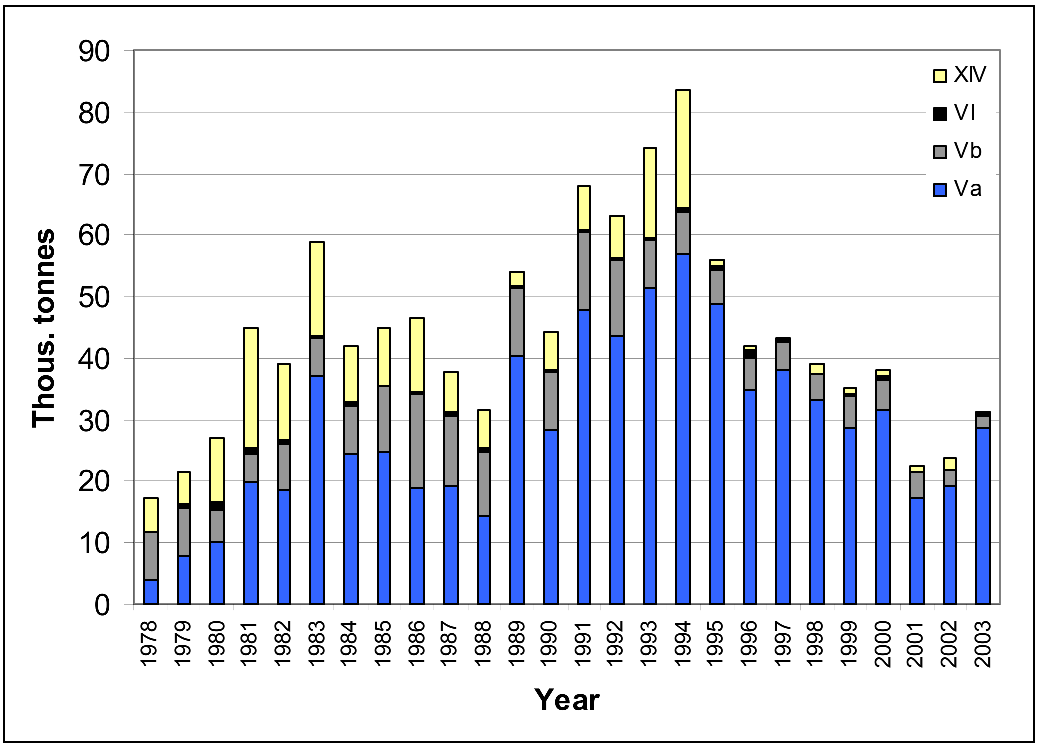


Figure 9.1.1 Nominal landings of deep-sea *S. mentella* (in tonnes) from ICES Divisions Va, Vb, VI and XIV 1978-2003.

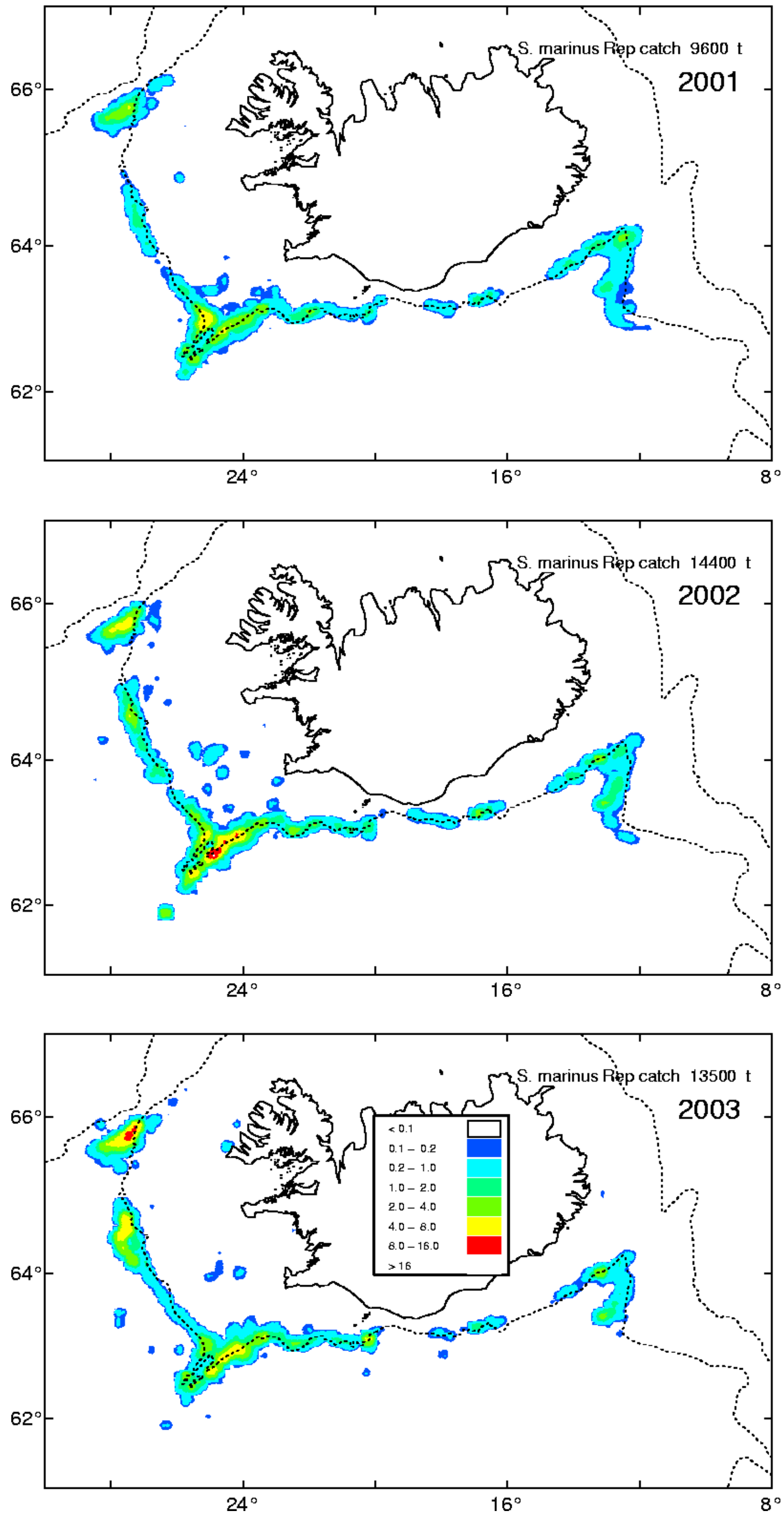


Figure 9.1.2 Geographical location of the deep-sea *S. mentella* catch in Icelandic waters 2001-2003 as reported in log-books of the Icelandic bottom trawl fleet.

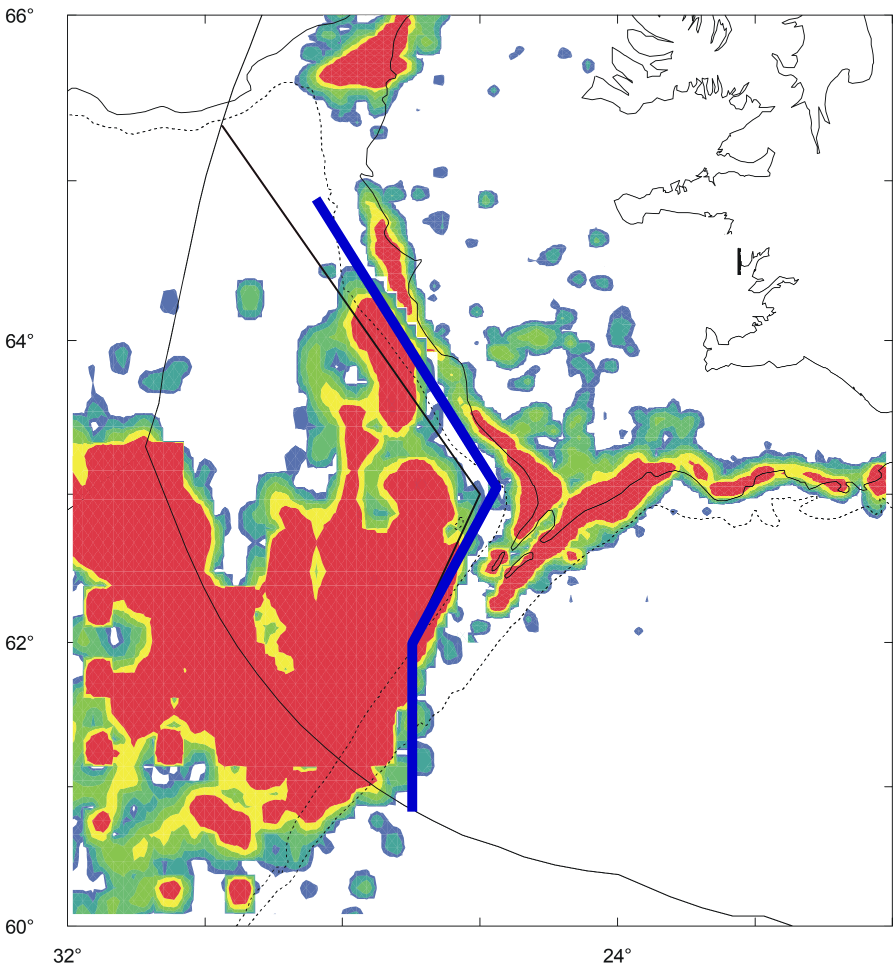


Figure 9.1.3 Geographical location of *S. mentella* (both pelagic and deep-sea) catch in Icelandic waters 2001-2003 (all years combined) as recorded by log-books. The map also shows the line used by the Icelandic authorities to separate the landing statistics between deep-sea *S. mentella* and pelagic *S.* mentella. The catches west of the “redfish line” is from the pelagic fishery, whereas the catch north and east of the line is of “shelf type”. The blue line is the one implemented in 2003, whereas the black one is the old one.

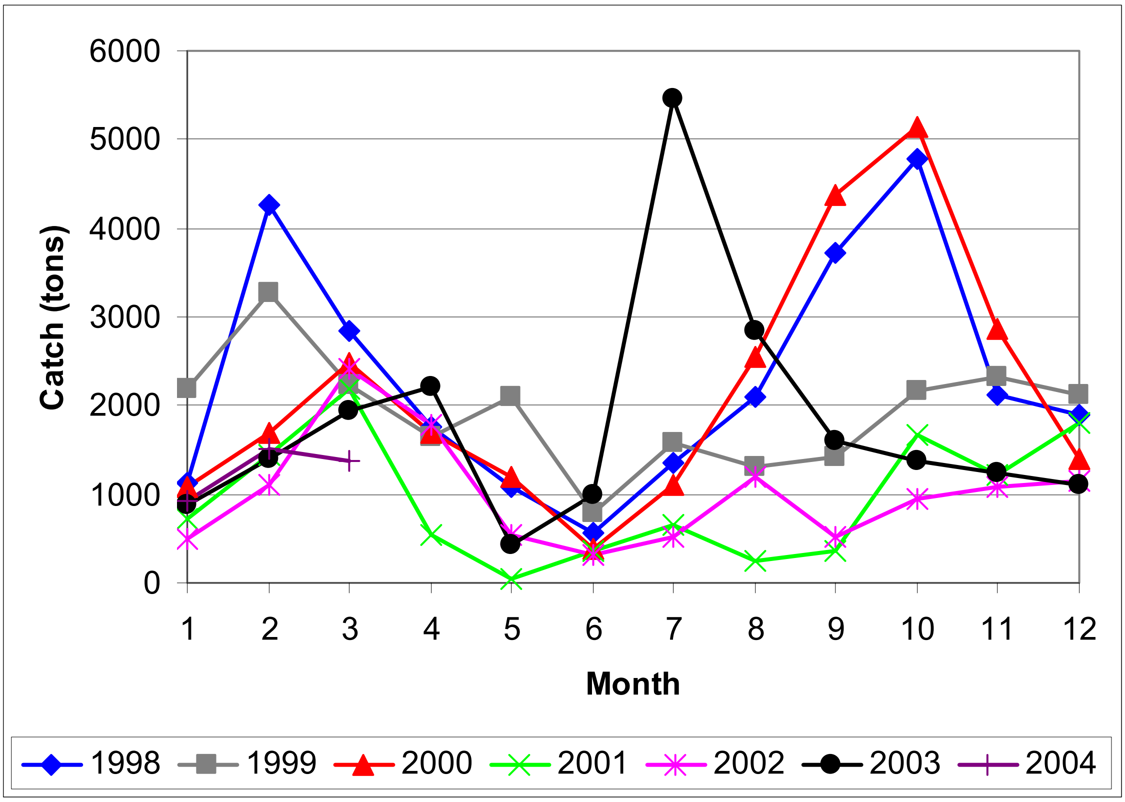


Figure 9.1.4 Nominal landings of deep-sea *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic bottom trawl fleet 1998-2004, divided by month.

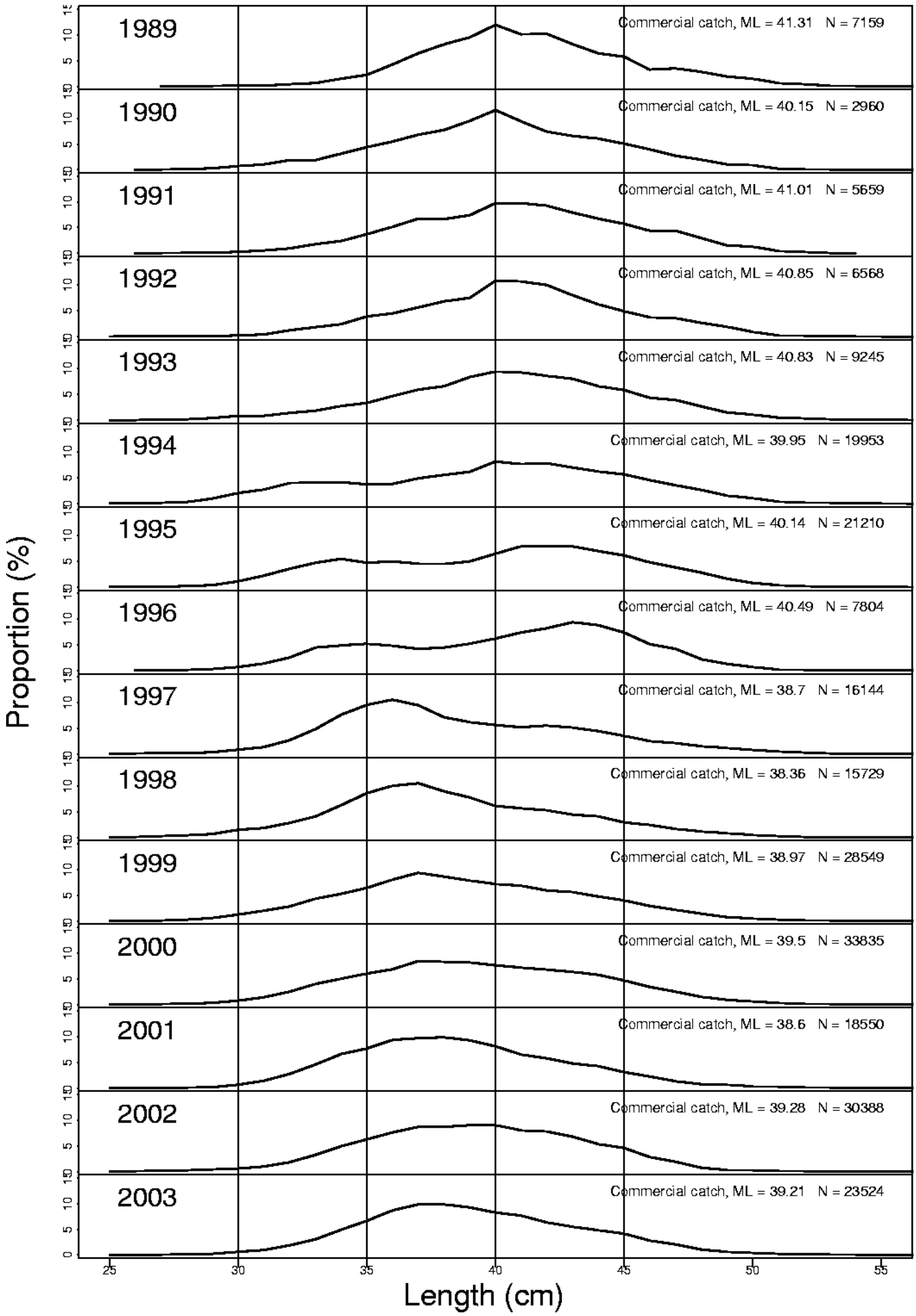


Figure 9.1.5 Length distributions of deep-sea *S. mentella* from the Icelandic bottom trawl catch and landings in Division Va 1989-2003.

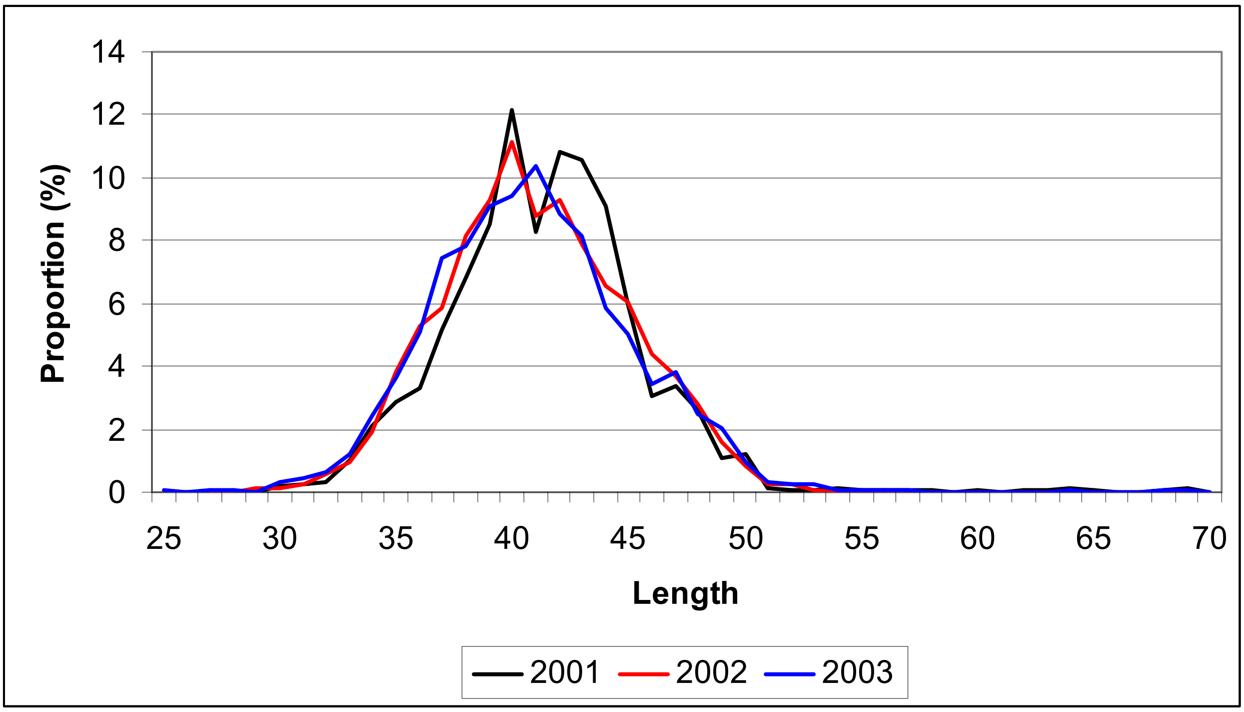


Figure 9.1.6 Length distribution of deep-sea *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2003.

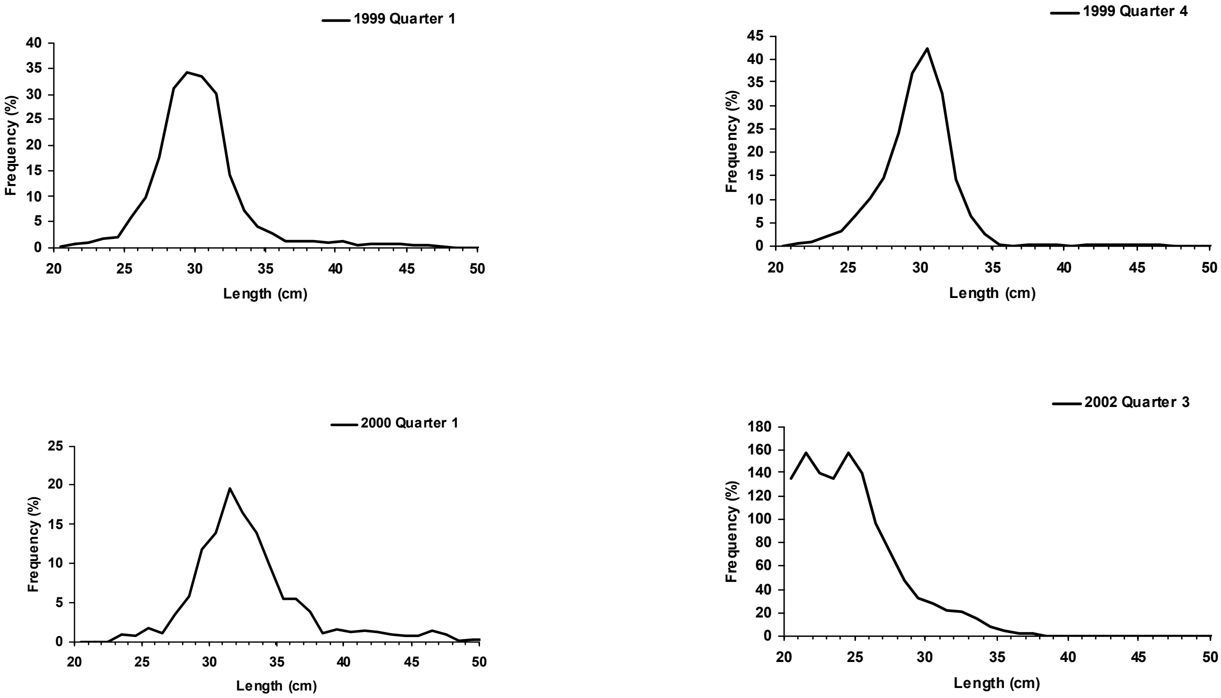


Figure 9.1.7 Length distribution of deep-sea *S. mentella* of the German commercial landings in Division XIV 1999-2002, divided by quarters of the year.

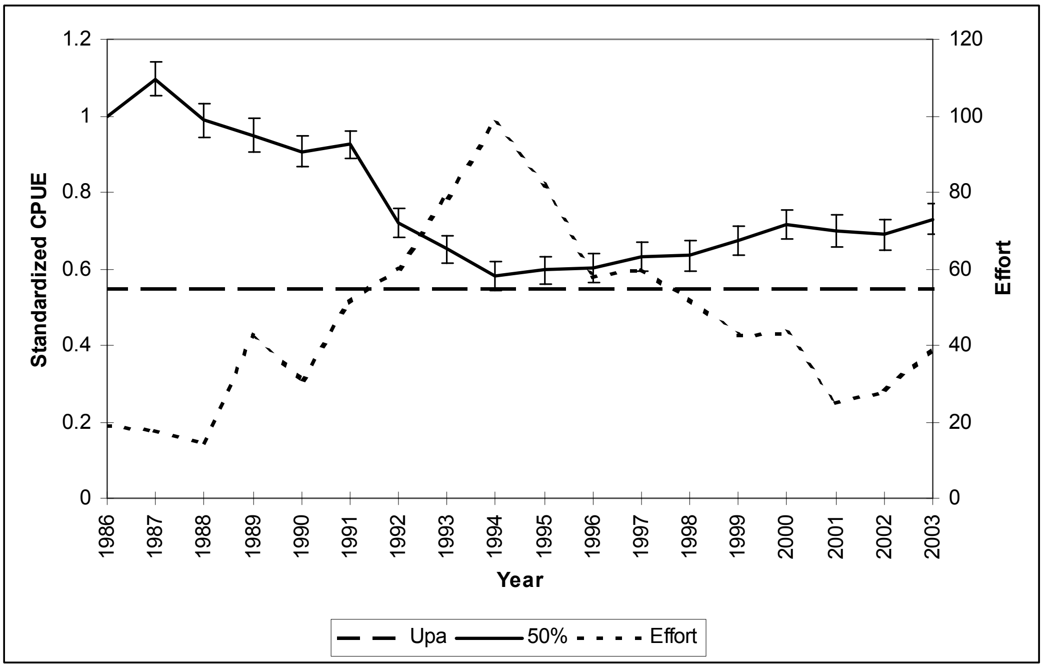


Figure 9.2.1 CPUE, relative to 1986, of deep-sea *S. mentella* from the Icelandic bottom trawl fishery in Division Va. CPUE based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was deep-sea *S. mentella*. Also shown is fishing effort (hours fished in thousands).

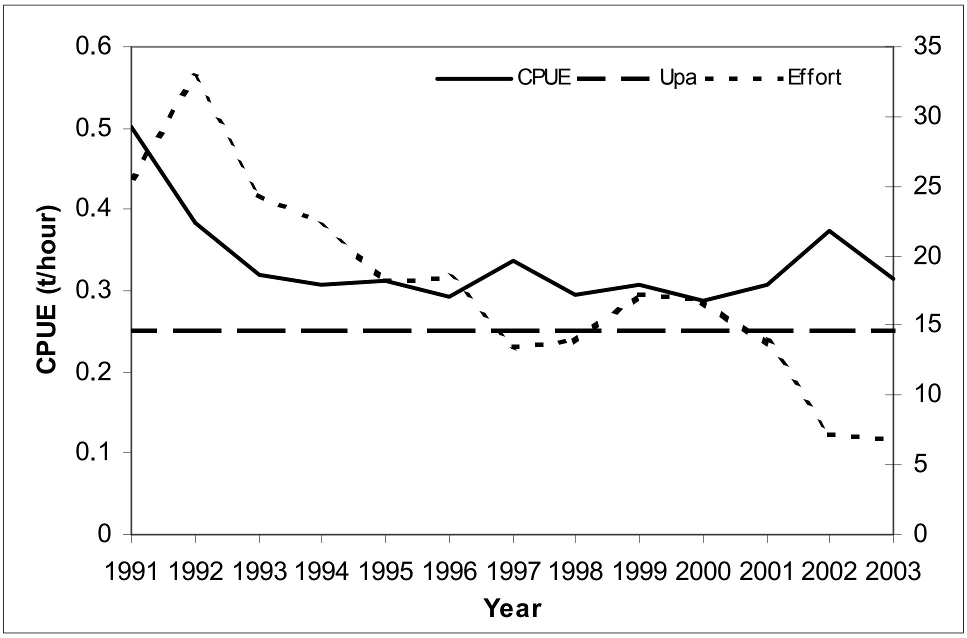


Figure 9.2.2 Deep-sea *S. mentella*.. CPUE (kg/hour) and fishing effort (in thousands) from the Faeroese CUBA fleet 1991-2003 and where 70% of the total catch was deep-sea *S. mentella* .

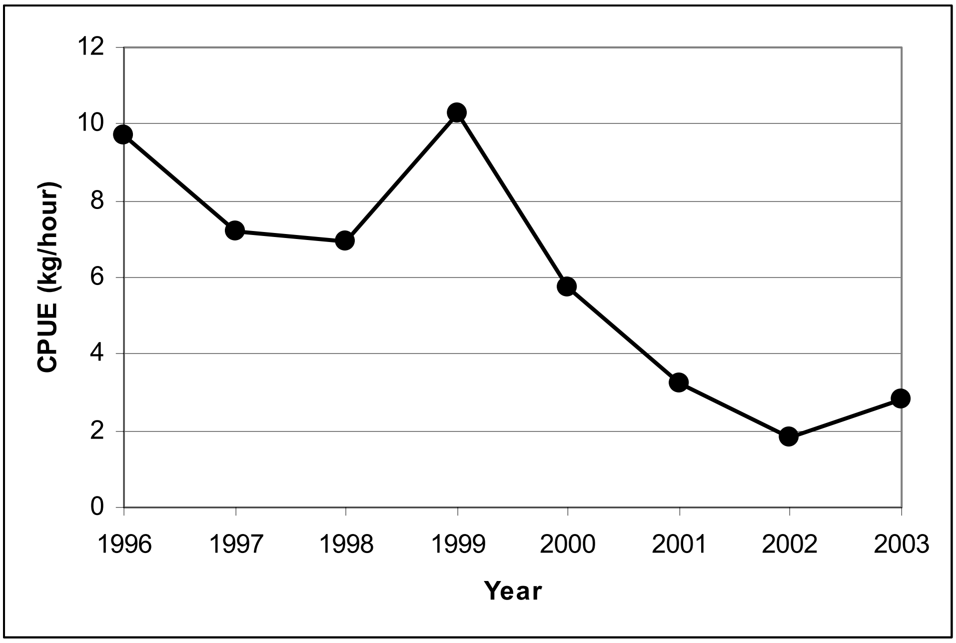


Figure 9.2.3 Deep-sea *S. mentella*. CPUE (kg/hour) from the Faeroese summer survey 1996-2003.

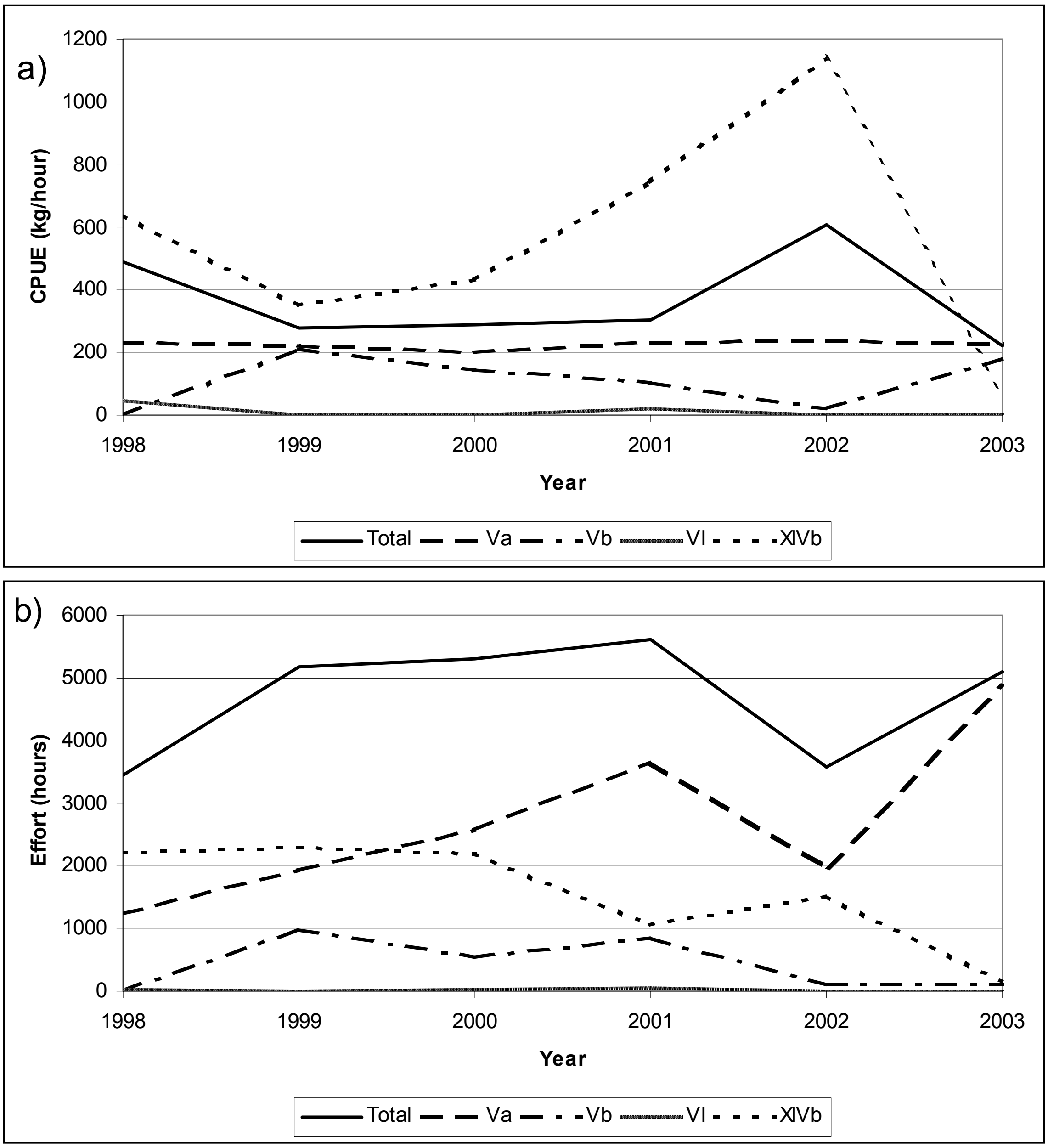


Figure 9.2.4 Deep-sea *S. mentella*. (a) CPUE (kg/hour) and (b) effort (hours fished) of the German commercial fleet 1998-2003, divided by ICES divisions.

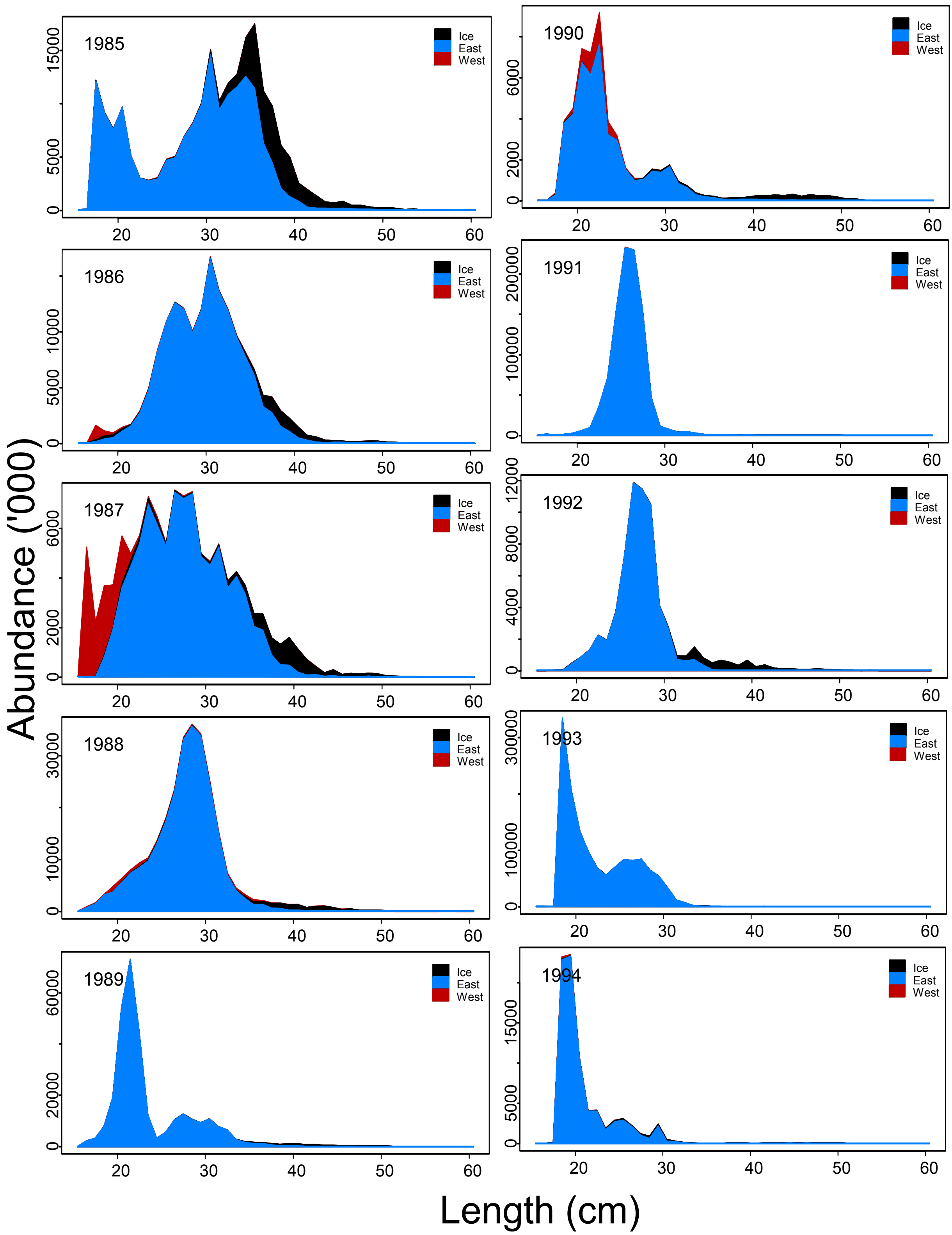


Figure 9.2.5 Deep-sea *S. mentella* (15-35 cm) on the continental shelves off West- and East-Greenland and Iceland. Length composition off Greenland and Iceland is derived from the German and Icelandic groundfish surveys 1985-2003. Note different scale on y-axis.

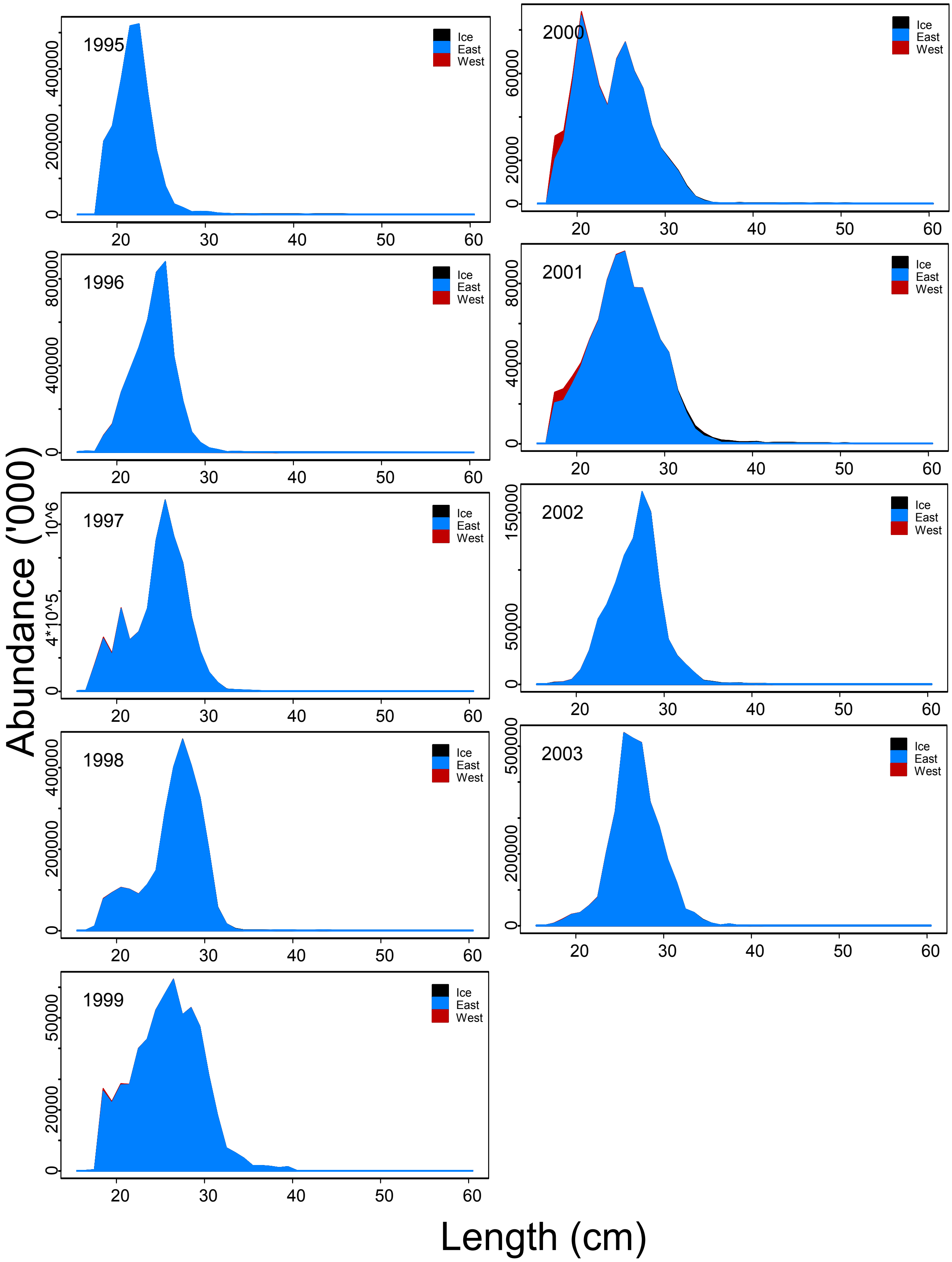


Figure 9.2.5 Continued.

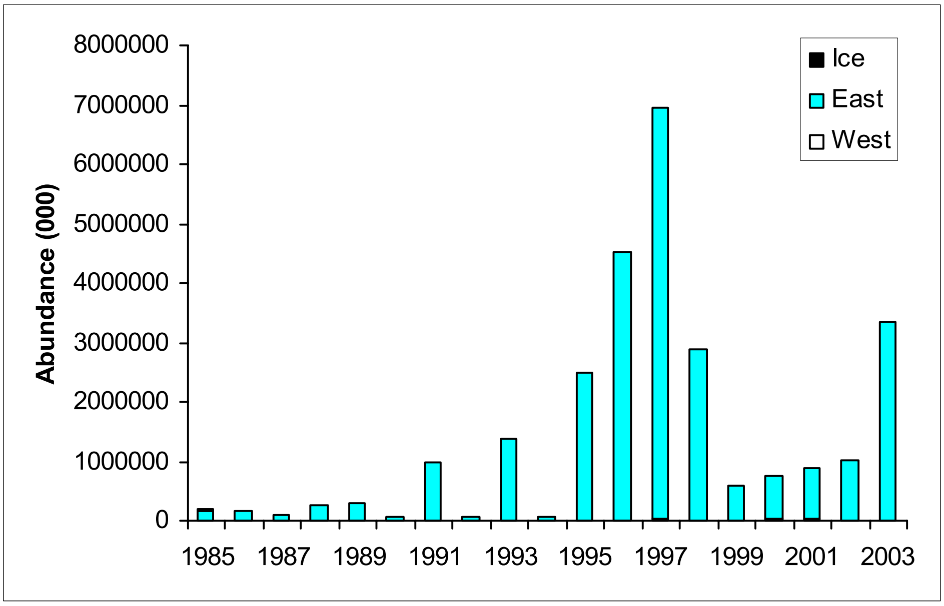


Figure 9.2.6 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland and Iceland derived from the German and Icelandic groundfish surveys, 1985–2003.

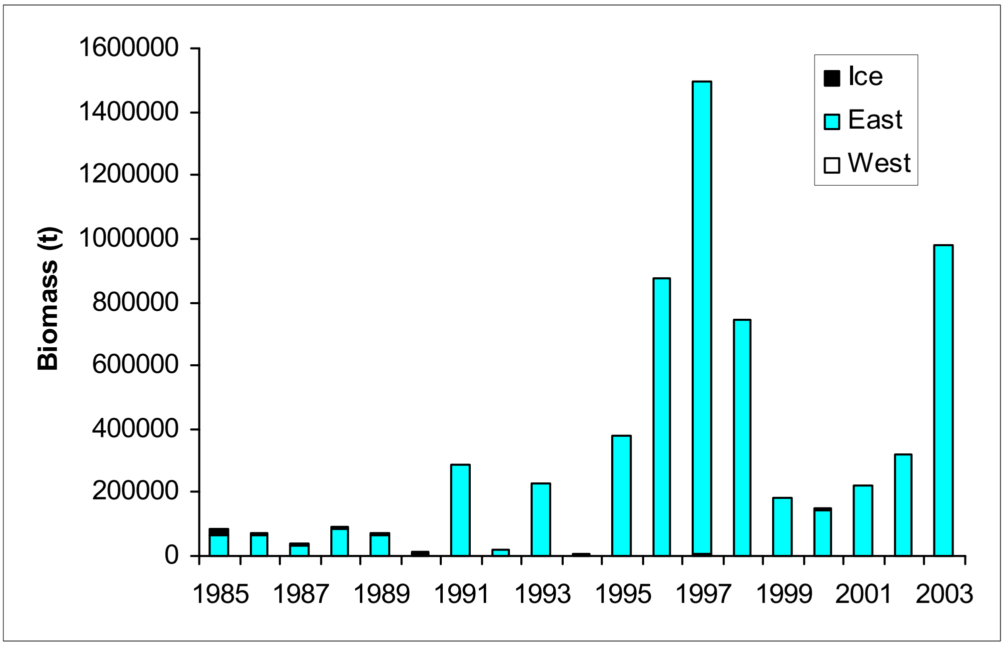


Figure 9.2.7 Deep-sea *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland and Iceland derived from the German and Icelandic groundfish surveys, 1985-2003.

10 PELAGIC SEBASTES MENTELLA

This section includes information on the pelagic fishery for *S. mentella* both shallower and deeper than 500 m in the Irminger Sea (Subarea XII, parts of Division Va, Subarea XIV and eastern parts of NAFO Divisions 1F, 2H and 2J).

Under chapter 7.5, comments are made on special requests in the ToR c) and f), on the description of the fishery. After the SGSIMUR, held in Bergen, Norway in August/September 2004, the NWWG will meet again to complete the assessment of Sebastes mentella based on the outcome of SGSIMUR. During that meeting other special request regarding stock structure and possible management units of *S. mentella* will be addressed.

The pelagic redfish straddles the ICES Div. Va, XII and XIV and NAFO Sub-areas 1 and 2, it occurs inside the EEZs of Iceland and Greenland and in the Regulatory Areas of NEAFC and NAFO. NEAFC is the responsible management body and ICES the advisory body. Management of pelagic redfish is by TAC and technical measures (minimum mesh size in the trawls is set at 100 mm.).

TACs are both agreed among NEAFC and NAFO member states and also autonomously set in addition. Some NEAFC parities have objected to the decision of NEAFC and set their own national TAC. The total TAC in 2003 and in 2004 is therefore exceeding the ICES advice of 119 000 by about 40 000 thous. tonnes.

10.1 Fishery

10.1.1 Summary of the development of the fishery

Russian trawlers started fishing pelagic *S. mentella* in 1982. Vessels from Bulgaria, the former GDR and Poland joined those from in 1984. Total catches increased from 60 600 t in 1982 to 105 000 t. in 1986. Since 1987, the total landings decreased to a minimum in 1991 of 28 000 t mainly due to effort reduction. Since 1989, the number of countries, participating in the pelagic *S. mentella* fishery gradually increased. As a consequence, total catches also increased after the 1991 minimum and reached a historical high of 180 000 t in 1996 (Tables 10.1.1–10.1.2). Since 2000, the WG estimate of the catch has been between 126 000 and 149 000 t, highest in 2003. This is probably an underestimate due to incomplete reporting of catches (see section 10.1.4).

In the period 1982–1992, the fishery was carried out mainly from April to August. In 1993–1994, the fishing season was prolonged considerably, and in 1995 the fishery was conducted from March to December. Since 1997, the main fishing season occurred during the second quarter. The pattern in the fishery has been reasonably consistent in the last 5 years and can be described as follows: In the first months of the fishing season (which usually starts in early April), the fishery is conducted in area east 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 1998-2003 at a depth range of 200 to 950 m, but mainly deeper than 600 m in the first and second quarter but at depths shallower than 500 m in third and fourth quarter. Discard is at present not considered to be significant for this fishery (see 10.1.3).

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2003:

Faroes	4 factory trawlers
Germany	6 factory trawlers
Greenland	1 factory trawler
Iceland	22 factory trawlers
Russia	27 factory trawlers
Portugal	5 factory trawlers

A summary of the catches by depth by nation as estimated by the Working Group is given in Table 10.1.2.

10.1.2 Description on the fishery of various fleet

10.1.2.1 Faroes

The Faroese fishery for pelagic redfish in the Irminger Sea and adjacent waters started in 1986. In the first years, only 1-2 trawlers participated in the fishery. Fishing depths were mainly shallower than 500 m although some trials were made down to about 700 m. From 1994 onwards, several trawlers have made trips to this area fishing almost exclusively deeper than 500-600 m.

Since 1999 the Faroese fishery started in international waters in the NE part of the Irminger Sea in the middle/late April (ICES Division XIV). Up to late July, the fishing area was mainly between 61°N-62N and 27°N-30°00'W, then they moved to the SW, to south of 60°N and west of 38°W (ICES Division XII), fishing mostly within the Greenlandic EEZ. Four trawlers participated in 2003. The fishing depth from the beginning of the fishery to July was nearly exclusively deeper than 600 m, but from July onwards, the fish was taken at shallower depths than 600 m.

10.1.2.2 Germany

The reported effort in 2003 is the lowest observed in the last eight years and amounted to 10 300 hours only. As observed in previous years, the majority of the 2003 effort was applied during the second and third quarters. During the second quarter in 2003, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Division XIV between the Greenland and Icelandic EEZs. In 2003, there was significant fishing effort exerted in the NAFO Division 1F mainly within the NAFO Regulatory Area. There was also some effort recorded in NAFO Division 2J for the first time. The overall decrease of annual landings continued in 2003 with a figure of 10 700 tons, mainly due the effort reduction. In 2003, 28 % or 3 000 tons of the total landings were taken in the NAFO Divisions. During 1995-1999, the overall unstandardised CPUE decreased from 2 055 kg/h by 53 % to 970 kg/h. In 2000-2003, the CPUE remained at that low level. Given the technical, temporal, geographical and depth changes of the fishing activities the relevance of the estimated reduction in CPUE as indicator of stock abundance remained difficult to assess. However, the continued reduction in CPUEs during 1996-1999 should be interpreted as reaction of the stock to removed biomass.

10.1.2.3 Greenland

The Greenlandic fleet was fishing in the same area as the Icelandic fleet (see below), and therefore, the greenlandic log-book data were included in the figure of the Icelandic fishery.

10.1.2.4 Iceland

Catches in 1995-2000 were generally taken in the area between the Greenlandic EEZ and the Reykjanes Ridge. Since 1996, the catches have mostly been taken close to or inside the 200-mile boundary southwest of Iceland. In recent years, the fishery has started in April close to the Icelandic 200-mile boundary and then moved northward in May-July. In the springtime and until June, the largest proportions of the catches were taken deeper than 500 m. In 1998, the fishery expanded further north in July-September. In 1999, a similar pattern was observed, except that the fishery did not continue close to the shelf of Iceland. The few vessels that had quota left after that, moved about 480 nautical miles to Southwest, to the area S-SE of Cape Farewell (Sub-area XII), where they fished shallower than 500 m depth in July-September. In 2000, the fishery started in April at the same locations as in the past and moved slowly northward until the fishery ended in July due to quota limitation. The Icelandic trawlers fished mainly at a depth of 600-800 m during the period 1995-2000 (Figure 10.1.1). In 2000, less than 8% of the catches in the log-books were reported shallower than 500 m depth and no catches were reported at depths shallower than 400 m. In 2001-2003, the fishery started in late April and until middle of July, the fishery was nearly exclusively within the Icelandic EEZ moving slowly in northward direction. In May – July over 90% of the catches were taken at depths deeper than 600 m. From the middle of July until the end of the fishing season the fishery continued in the area Southeast of Cape Farwell, mostly between 38 and 42°W. Only about 11% of the Icelandic catches in 2003 were taken in the "south-western" fishing area shallower than 400 m depth.

According to Icelandic legislation the captain shall report their catch as "pelagic redfish" while fishing redfish within given area and as a "shelf deep-sea redfish" east of that area. According to this legislation, all catch outside the Icelandic EEZ shall be reported as oceanic and in addition west of a line which was drawn approximately over the 1000-m isoline. This line (see Figure 10.1.2) was shifted further east in June 2003 due to pressure from fishermen who were following school of redfish during the pelagic redfish fishery. This new line is also shown in Figure 10.1.2. The figure also show the fishery aggregated catches of "deep-sea redfish" within the Icelandic EEZ. The fishing areas have approached each other in recent years and in 2003 they overlapped, as can be seen on the figure. This led to the fact that in June - July 2003 the fleet did actually, during the same day, both fish "pelagic redfish" and "shelf deep-sea redfish" according to the landing statistics and their log-books. After the school passed east of this pre-defined line, the fishery for "shelf deep sea redfish" continued in

July and resulted in record high catches of shelf-mentella in July 2003. This overlap of fishing areas did sharpen the problems about stock structure of *S.mentella.*

10.1.2.5 Norway

Information on the fishery in 1998 and 1999 indicated a depth shift in the fishery, from fishing 95% of its catch shallower than 500 m in 1998 to fishing exclusively deeper than 500 m in 1999. The catches in 1999 were taken in areas XII and XIV from April to August, at a ratio of about 2:3. In 2000, Norway fished 6 075 t whereof 3 823 t were taken in ICES Subarea XIV and 2 252 t in Subarea XII. The fishing season was from April – September. In 2001- 2003, the fishery started in April, close to the Icelandic 200 miles boundary (Subarea XIV). The fishery continued there until June and over 80-85% of the total catch was caught below 600 m. Then the fleet moved to Subarea XII between 55 and 58°N and between 40 and 42°W. There are no information available on length distributions in the catches.

10.1.2.6 Russia

The regular Russian commercial fishery for pelagic redfish in the Irminger Sea started in 1982. Total catch of redfish taken by the USSR/Russia makes up about 0,8 mill. t or 40% 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 and the fishing depth was nearly entirely shallower than 400 m (Figure 10.1.3), distributed over a large area in the Irminger Sea (Figure 10.1.4). In 1989-1994, the catch decreased to 9-25 thou. t. Fishing efficiency of STM-type vessels was 10-15 t per a vessel/fishing day. A shift of the fishery to the depths deeper than 500 m, and due to an increase in trawl size, an increase in fishing efficiency was observed in 1994. A reduction in redfish catches from the depths deeper than 500 m has been observed since 1997. The extension of fishing period to 8 months and extension of areas due to the increased fishery within the 200-mile zone of Greenland and adjacent areas of the Labrador Sea occurred simultaneously.

In 2003, Russian fishery for redfish in the pelagic waters of the Irminger Sea and Divs. 1F, 2H and 2J of the NAFO Convention Area lasted from late March to November. The fishery was conducted by 27 trawlers of different types. Fishing for the redfish spawning concentrations commenced in April in the traditional area close to the EEZ of Iceland in a depth range of 600 m to 900 m. During the second quarter, the redfish were fished in the open waters of the ICES Subarea XIV, where CPUE constituted 1122 kg/h compared to 825 kg/h in 2002. It was observed that 51% of the catch and 52 % of the effort fell on May and June. In the third quarter, following feeding migration of the redfish the fishery expanded towards southwest, to the ICES Subarea XII and EEZ of Greenland in a depth range of 300-650 m. At the end of July, Russian vessels started fishing of the redfish in NAFO Divs. 1F, 2H and 2J in a depth range of 250-410 m. In July-October CPUE in the NAFO Convention Area was 1211 kg/h compared to 1185 kg/h in 2002. Total Russian catch of the redfish in 2003 in ICES Subareas XI and XIV and in NAFO Divs. 1F, 2H and 2J was preliminary estimated at 31100 tonnes and 12959 tonnes, respectively (WD 10).

10.1.2.7 Spain

Four Spanish freezer trawlers fished pelagic redfish in 1995-1997, increasing to 6 vessels since 1998. The fleet has used a Gloria-type pelagic trawls, with a maximum vertical opening of 80-120 m. The fishery in ICES Sub-areas XII and XIV shows a persistent seasonal pattern in terms of its geographical and depth distribution. The main fishing occurs in the second and third quarter each year. In the second quarter, the fishery takes place in Sub-area XIV between the Greenland and Iceland EEZs deeper than 500 m, capturing fish of bigger size. The proportion of females in the catches is greater than for the males. The yields obtained in this quarter are larger and the mean trawling time of the hauls is shorter than in the third quarter. In the third quarter, the fleet moves towards the Southwest to ICES Sub-area XII, and the depth of hauls is shallower than 500 meters. The length distributions in the catches are lower than in the second quarter and are unimodal and relatively stable in time. The proportion of males in the catches is higher than for the females. The yields are smaller and the mean trawling time of the hauls is greater than those of the second quarter.

10.1.2.8 Portugal

The Portuguese fleet commenced the fishery in 1994. During the first years, the fishery was conducted in the Irminger Sea but in recent years the fishery has extended to NAFO Divisions 1F and 2J. In 2003, five trawlers participated, fishing with a large pelagic net. During the fishing season, logbooks from one vessel were available. In May - June the vessel were fishing in ICES Sub-Divison XIVb, fishing mainly at depths below 500 m. The CPUE was 754 kg/h in May and around 1100 kg/h in June and July. In September - October the vessel were mostly fishing in NAFO Divisions 1F and 2J at depths shallower than 500 m. In addition some fishery were conducted in ICES Division XIV in September. About half of the total catches of the Portuguese fleet was taken during May-July. Biological sampling was conducted from one vessel throughout the fishing season,. In Div. XII, lengths between 31cm and 37 cm dominated catches (mean length and weight of 34cm and 542gr.). In Div. XIVb at depth <500m (in September), lengths between 30cm and 37cm dominated catches (mean length and weight of 34 cm and 535 gr). At depth >500m and for the all Div.XIVb, lengths between 36 and 43cm dominated catches (mean length and weight of 39 cm and 823g). In NAFO Division 1F, the lengths were between 32 and 36 cm with a mean length of 34 cm (530 gr.).

10.1.2.9 Other nations

No information on the fishing areas, seasons and depths of other fleets was available to the Working Group.

10.1.3 Discards

Discard is at present not considered to be significant for this fishery. Icelandic landings of oceanic redfish were raised by 16% prior to 1996 taking into account discards of redfish infested with *Sphyrion lumpi*. This value of was based on measurements from 1991–1993 when the fishery was mostly on depths shallower than 500 m. In May-July 1997, discard measurements on 10 vessels showed a discard rate of 10%. This was added to the landings in 1996 and 1997. Measurements from 1998 show that the discard rate had decreased to 2%. Information from observers from 2000-2003 indicate that discards is negligible, and therefore no catches were added to the Icelandic landings during that period.

Norwegian fishermen have earlier reported approximately 3% discards of redfish infested with parasites. This percentage has in recent years become less due to a change in the production from Japanese cut to mainly fillets at present.

The Spanish discards are based on measurements made by the scientific observers. Discard of the Spanish fleet were often composed of fish infested with *Sphyrion lumpi*. In 1995, about 4% of the total catches were discarded, while in 1996, it was 6.5 %. From 1997-2000, the discards of the Spanish fleet have been insignificant. In 2001, 4.4 % of the total catches were discarded. This variability in the discard is also observed at different depths. The discarded percentage being much larger at depth greater than 500 m. Since 1997, this variability can be due to that the percentage of discards does not depend directly on parasite fish by *Sphyrion lumpi*, but it is related with the haul catch. When the haul catch is very high, the fish is discarded under worse conditions by the lack of time to processed the whole catch. When the catches are between the standard values there is enough time to process the whole fish, even the infested ones, and there are no discards.

The level of redfish discarded by the Portuguese fleet, based on the observer reports, has been very small, between 0.6 and 1.0% of the catch until 2003 where measured discarded fish to be 3.8% of the total number of the fishes.

No information on possible discards was available from other countries participating in this fishery.

10.1.4 Illegal Unregulated and Unreported Fishing (IUU)

The WG has during the last years identified problems with of unreported catches of pelagic redfish. There have been observations of individual vessels from nations not reporting catches to international organisations like ICES/NEAFC/FAO/NAFO. These unreported catches have, however, not been quantified as the number of nations not reporting have been unknown and hence the effort of their vessels is unknown. During the meeting a presentation of ongoing EC project (IMPAST) dealing with this issue was given (WD 29).

Two studies were conducted by the EC Joint Research Centre using a satellite imagery vessel detection system (VDS) to detect fishing vessels in the NEAFC regulated redfish fishery, south west Iceland. Eight images were acquired throughout June 2002 and June 2003. All available VMS positions for the areas being imaged on the image dates were requested from NEAFC in order to compare the number of reporting vessels with the number of vessels identifiable on the images, potentially giving an indication of the number of non-reporting vessels. Table 10.1.5 shows the data available for the 2002 and 2003 images, where it is shown that approx. 27% more vessels were found in the area than were reporting to NEAFC. The June 2003 data shows approx. 33% more vessels visible in the image than NEAFC had reports for.

There are several potential explanations for the discrepancy between the number of vessels appearing on the images and the number reporting to NEAFC.

The VMS positions are not polled, it is therefore possible that they could move in to the image frame by the time the image was acquired, giving the appearance of more vessels than were reporting. This was unlikely as the fishing activity was concentrated in defined zones that were in the center of the image, meaning vessels would have to travel over 100km in the time between the VMS report and the image acquisition time, which would only be about 2 hours. The area is a dedicated fishery so no commercial traffic would be likely to increase the number of vessels seen in the area. A couple of fisheries patrol vessels were in the area but do not account for such a large discrepancy. Instead, it may be that the discrepancy relates to unreported fishing vessels, especially in 2003, as the vessels were concentrated in a single region rather than spread over the area (Figure 10.1.7).

The discrepancy shown between these two sources of information indicates that the unreported effort might be of significant amount and the exercise described above indicates that during the observation days in June 2002 and 2003 the effort could be more than 25% higher than reported to NEAFC.

10.1.5 Trends in landings

Total landings in 2003 is estimated to be about 150 000 t. The landings have been increasing since 1999 from around 100 thous. tonnes. The landings estimates for most recent years might increase due to the lack of reporting from some countries participating in the fishery. Further, as described in section 10.1.4. there are information of vessels from nations not reporting catches to any international organisation. As the effort of vessels from these nations are unknown, the WG had no possibilities to estimate them. Therefore the catches given in tables 10.1.1-10.1.2 are to be considered as an underestimation of the actual catches, at least in most recent years.

At the beginning of the fishery in 1982, catches of pelagic redfish were reported from both Subareas XII and XIV. Most of the catches were taken in Subarea XII (40 000-60 000 t) prior to 1985, and then the greater part of the catches was reported from Subarea XIV. The catches from Subarea XII were again in the majority in 1994 and in 1995 with 94 000 t and 129 000 t landed respectively. In 1996–1999, the main part of the total catch was taken from Div. Va and Subarea XIV (Table 10.1.1). Since 2000, considerable amounts of the catches were taken in NAFO Div. 1F, 2J and 2H from being negligible before that period. In 2003 about 20 thous. tonnes were caught in NAFO divisions which is a record high catch. Pelagic *S. mentella* fishery in ICES Div. Va started in 1992. The catch varied from 2 000-14 000 from 1992-1995. From 1995-2000, the catches in Div. Va increased to about 45 000 t (Table 10.1.1). Total catches in 2002 and 2003 were 37 000 and 47 000 t respectively.

10.1.6 Biological sampling from the fishery

Length distributions of pelagic *S. mentella* from German, Icelandic, Russian, Portuguese and Spanish commercial catches were reported for 2003 and are given in Figure 10.1.5. A bimodal distribution over the past years could be observed as a reflection of the samples being taken from different areas. Figure 10.1.6 illustrates the depth effect on the length distributions in the German and Spanish catches, taken shallower and deeper than 500 m.

The 2003 biological sampling from catches and landings of pelagic *S. mentella* in each Subarea/Division and by gear type is shown in the text table below.

Country	Area	Gear	Landings (t)	No. of samples	No. of fish measured
Germany	XIV	Pelagic	10597	41	38866
Iceland	XII, XIV and Va	Pelagic	48399	49	3118
Russia	XII, XIV and NAFO 1F, 2J	Pelagic	44056	321	75045
Portugal	XII, XIV and NAFO 1F	Pelagic	3988	103	8240
Spain	XIV	Pelagic	10486	75	15135

Biological samples from the catches in recent years, and also the acoustic survey in 1999, suggested that a new cohort is entering into the fishable stock of pelagic redfish.

Age readings within an otolith exchange between Germany, Iceland and Norway, based on material collected in July 1999 (ICES 2002 NWWG -WD9), showed that this cohort is mainly consisting of 10 year old fish and that ageing error for fish older than 20 years is relatively high. If agreement is defined as ± 5 years, approximately 90% agreement would be obtained. A second set of age reading results within an otolith exchange program between Germany, Iceland, Norway and Spain based on material collected in 1998 and 1999 (WD11 in NWWG report 2003), shows the same results.

10.2 Trends in survey and CPUE indices.

10.2.1 Acoustic data

A trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Germany, Iceland and Russia in late May/June 2003. Approximately 405 000 nm2 were covered. A total biomass of less than 100 000 tonnes was estimated at depths between 0 and 500 m and about 700 000 tonnes below 500 m depth by use of a standardized “trawl method”. The redfish biomass of less than 100 000 t estimated acoustically down to the deep-scattering layer or about 350 m, with redfish having a mean length of 35.3 cm, is the lowest ever obtained since the beginning of the joint measurements. The highest concentrations of redfish were found around 60°N, east of Cape Farwell. Below 500 m, the densest concentrations were found in the NE part of the area. The average length of the fishes caught below 500 m was 39.0 cm. The estimated abundance derived from the trawl data is considered highly uncertain.

The results of the survey series are inconsistent and thus do hardly indicate the actual stock status of pelagic redfish. To which extent biological effects or slight changes in the survey design (RV Walther Herwig III covered the south-western survey area in 2003 about 4 weeks earlier than in 2001) contributed to this inconsistency is unknown. The fishery in the area south of Cape Farwell does not support the outcome of the survey as the CPUE from July and onwards show relatively similar situation as has been observed in recent years.

The main results of the 2003 trawl-acoustic survey (ICES CM 2003/D:08) are given in Table 10.2.1-10.2.3 and the results of earlier surveys are also given in Table 10.2.1.

Since 1994, the results of the acoustic estimate show a drastic decreasing trend. The estimate was only 0.1 and 0.7 million tonnes in 2003 and 2001, respectively, compared to 2.2, 1.6, and 0.6 million tonnes in 1994, 1996, and 1999, respectively. This represents a reduction of about 2 million tonnes in the period. During the same period, the total catch has been about one million tonnes. Therefore, the removed biomass alone cannot explain the changes in the stock estimate. During this period, the fishery has also developed towards greater depth and towards bigger fish, and in recent years, the majority of the catch has been caught at depths deeper than 500 m. Thus, acoustic estimates cannot be considered accurate measures of relative changes in stock size of the upper layer fish, as availability may have changed during the surveyed period, both horizontally and vertically.

10.2.2 Trawl estimate

In addition to the acoustic measurements, an attempt was made to estimate the redfish within and below the deep-scattering layer, using the same methods as was applied in the 2001 survey. This was done by correlating catches and acoustic values at depths between 100 and 450 m. The obtained correlation was used to convert the trawl data at greater depths to acoustic values and from there to abundance (ICES CM 2003/D:08). For that purpose, standardised trawl hauls were carried out at different depth intervals (three depths intervals in hauls deeper than 500 m and 2 depth intervals in shallower hauls), evenly distributed over the survey area (Figure 10.2.1and Figure 10.2.2). Data for the correlation calculations between trawl catches and the acoustic results were obtained during the trawl - acoustic survey in 2001, as the acoustic values in 2003 did not allow such regression during the survey. The correlation between the catch and acoustic values is very low the abundance estimation obtained from this exercise makes the method questionable and also the assumption that the catchability of the trawl is the same, regardless of the trawling depth. Estimate based on the above-described calculations both above and below 500 m depth, must be considered as a very rough measure with high uncertainty as the applicability of the method can only be verified after replicate measurements.

By applying the trawl approach, biomass in the depth layers from 0-500 depth, including the layer where the redfish are mixed with the deep-scattering layer, was estimated less than 100 thous. tonnes, nearly the same value as with the acoustics.

About 0.7 mill. t was estimated by the trawl-acoustic method deeper than 500 m. At these depths, the densest concentrations were found in the NE part of the survey area (Fig. 10.2.2). The average length of the fishes caught deeper than 500 m was 39.0 cm. Hydrographic observations indicated that the highest concentrations of redfish deeper than 500 m were associated with eddies and fronts.

10.2.3 CPUE

Non standardised CPUE (Table 10.2.4 and Figure 10.2.3), series for several fleets that have participated in the fishery 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. In recent years, there is no trend in CPUE, both shallower and deeper than 500 m, except for the Icelandic fleet where the CPUE has been increasing since 2001. The difference between these indices might be because the Icelandic EEZ is closed for other fleets and therefore only Icelandic vessels can follow the migration of the fish when it has entered the Icelandic EEZ.

Standardised CPUE (Figure 10.2.4), derived from a GLM CPUE model incorporating data from Germany (1995-2003), Iceland (1995-2003), Greenland (1999-2003), Faroe Island (1995-2003), Russia (1997-2003) and Norway (1995-2003) is given. The model takes into account year, month, vessel and area (North - south; see figure 10.2.8). The model was run on data from a joint database (WD 7) and the outcomes of 3 model runs are given in Table 10.2.4. The model shows that the index is fluctuating both for the south-western and northeastern fishing area. The model gives an increasing trend in 2002 and 2003 in the northern area with values similar to that in 2000. The CPUE in the southwestern area remains similar as in previous years.

10.2.4 Ichthyoplankton assessment

The traditional ichthyoplankton survey, conducted by Russia in 1982-1995 has not been carried out since 1996. The historical series of ichthyoplankton surveys was presented in the 2000 Working Group report.

10.2.5 State of the stock

This section will be delt with during the September session.

10.3 Management considerations

The working group had again difficulties in obtaining catch estimates from the various fleets like in the past and information presented during the meeting indicates that the unreported catch might be of substantial amount. Furthermore, catch reportings were missing from some ICES nations. The group encourages NEAFC to try to provide ICES with all information that might enable the WG to come up with more reliable catch statistics. Despite these problems with unreported catches, catch figures that were available to the WG shows that the catches are rising in the last years, exceeding the quota of 120 thous. tonnes set by NEAFC by more than 20%.

An update on the pelagic fishery, in particular with respect to seasonal and area distribution, was requested in the ToR. Catch rates shallower than 500 m remained steady but low, and deeper than 500 m remained steady. The main new feature of the fishery in recent years is a clear distinction between two widely separated grounds fished at different seasons and different depths. Since 2000 the more south-westerly fishing ground extended also into the NAFO Convention Area. The parameters analysed so far do suggest, however, that the newly discovered aggregations in the NAFO Convention Area do not form a separate stock component. NAFO Scientific Council do agree with this conclusion.

The 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. The stock stucture of *S.mentella* will be discussed within ICES SGSIMUR WG in late Augutst-September. Directly thereafter, the NWWG will meet again to complete the assessment of the *S. mentella* stock(s) based on the outcome of SGSIMUR. Therefore, the group did not conclude on the status of this stock(s) during this meeting.

10.4 Pelagic Surveys on S.mentella

The study group on redfish stocks [SGRS] was planned to meet in January 2004 to evaluate the results of the surveys conducted on the pelagic redfish, and to decide on the timing of the survey that are planned in 2005. The meeting did not take place and the ICES secretary decided that the timing of a joint trawl - acoustic survey to be conducted in 2005 should be addressed during the NWWG meeting.

The survey to monitor the pelagic redfish has been conducted in international collaboration with Iceland, Russia and Germany in 2-3 years intervals. During the last decade, the survey design changed as the fishery explored new fishing grounds in horizontal and vertical extension. The latest surveys consistently covered an area of 405 000 nautical square miles in ICES Div. Va, XII, XIV and NAFO Divisions 1F, 2GHJ, which is believed the horizontal stock extension, although there are strong indications for relationships with the demersal redfish on the continental shelves at certain areas and seasons (Icelandic fishery in 2003 close to the shelves and recruitment impulses from East Greenland). Vertical coverage of the hydro-acoustic recording of redfish varied among years in relation to the upper boundary of the deep scattering layer, in which redfish echoes are difficult to identify. Since 2001, the varying depth layer of the deep scattering layer and below down to 1 000 m were covered by standard trawl hauls to account for the incompletely covered vertical depth distribution of the pelagic redfish. Such survey hauls were converted into hydro-acoustic measured by means of regression. The stock abundance estimates deeper than 500 m are considered highly uncertain.

The survey results have recently not been used for provision of management advice as they indicated a steep decrease in stock size which hardly could be explained by the fishery. Especially the most recent results derived in 2003 are inconsistently low in the depth zone shallower than 500 m, i. e. the survey did not identify redfish concentrations which supported a successful fishery just few weeks later.

It remains unknown to which extent the tight research vessel employments in 2003, which caused a change in the survey timing to one month earlier than usual (May/June instead of June/July), affected the mismatch between the survey results and the fishery data.

Taking the importance of the availability of fishery independent information about the pelagic redfish resource and the recent changes in the survey design and their results into account, the NWWG recommends a continuation of the international survey. In order to avoid unknown seasonal effects, the survey should be conducted in June/July 2005, the period when both the pelagic redfish shallower and deeper than 500 m can be monitored. The final timing should be decided during the September session of the NWWG meeting, taking into account the development in the fishery in 2004. The NWWG recommends that the ICES Study Group on Redfish set up dealing with details of the survey design in early 2005 either by a meeting or through correspondence.

Table 10.1.1 Pelagic *S. mentella*. Catches (in tonnes) by area as used by the Working Group. Due to the lack of area reportings for some countries, the exact share in Sub-areas XII and XIV is just approximate in latest years.

Year	Va	Vb	VI	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	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	44.677	0	0	19.862	50.722	10.815			126.076
2001	28.148			31.751	62.148	5.299	1.284	208	128.838
2002	37.279			23.844	66.133	7.514			134.770
2003	46.676			25.611	56.918	16.092	3.817	325	149.439

Table 10.1.2 Pelagic *S. mentella* catches (in tonnes) in ICES Div. Va, Sub-areas XII, XIV and NAFO Div. 1F, 2H and 2J by countries used by the Working Group.

Year	Bulgaria	Canada	Estonia	Faroes	France	Germany	Greenland	Iceland	Japan	Latvia	Lithuania	Nederland	Norway	Poland	Portugal	Russia	Spain	UK	Ukraine	Total
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	581	0	60.000	0	0	0	60.581
1983	0	0	0	0	0	155	0	0	0	0	0	0	0	0	0	60.079	0	0	0	60.234
1984	2.961	0	0	0	0	989	0	0	0	0	0	0	0	239	0	60.643	0	0	0	64.832
1985	5.825	0	0	0	0	5.438	0	0	0	0	0	0	0	135	0	60.273	0	0	0	71.671
1986	11.385	0	0	5	0	8.574	0	0	0	0	0	0	0	149	0	84.994	0	0	0	105.107
1987	12.270	0	0	382	0	7.023	0	0	0	0	0	0	0	25	0	71.469	0	0	0	91.169
1988	8.455	0	0	1.090	0	16.848	0	0	0	0	0	0	0	0	0	65.026	0	0	0	91.419
1989	4.546	0	0	226	0	6.797	567	3.816	0	0	0	0	0	112	0	22.720	0	0	0	38.784
1990	2.690	0	0	0	0	7.957	0	4.537	0	0	0	0	7.085	0	0	9.632	0	0	0	31.901
1991	0	0	2.195	115	0	571	0	8.783	0	0	0	0	6.197	0	0	9.747	0	0	0	27.608
1992	628	0	1.810	3.765	2	6.447	9	15.478	0	780	6.656	0	14.654	0	0	15.733	0	0	0	65.962
1993	3.216	0	6.365	7.121	0	17.813	710	22.908	0	6.803	7.899	0	14.990	0	0	25.229	0	0	2.782	115.835
1994	3.600	0	17.875	2.896	606	17.152	0	53.332	0	13.205	7.404	0	7.357	0	1.887	17.814	0	0	5.561	148.689
1995	3.800	602	16.854	5.239	226	18.985	1.856	34.631	1.237	5.003	22.893	13	7.457	0	5.125	44.182	4.554	0	3.185	175.842
1996	3.500	650	7.092	6.271	0	21.245	3.537	62.903	415	1.084	10.649	0	6.842	0	2.379	45.748	7.229	260	518	180.322
1997	0	111	3.720	3.945	0	20.476	0	41.276	31	0	0	0	3.179	886	3.674	36.930	8.707	0	0	122.935
1998			3.968	7.474	0	18.047	1.463	48.519	31		1.768		1.139	12	4.133	25.837	4.577	0		116.968
1999			2.108	4.656	0	16.489	4.269	43.923	0				5.435	6	4.302	17.957	10.332	188		109.665
2000			11.811	2.837	0	12.499	4.204	45.232	0		450		5.194	0	3.731	29.224	10.894	0	0	126.076
2001			887	7.981		10.669	3.309	42.472			15.689		5.222		2.514	30.012	10.083			128.838
2002				4.246		13.212	4.099	44.492		1.061	14.656		5.291	1	3.086	36.219	8.407			134.770
2003				4.435		10.608	4.450	48.398		371	14.321		8.184	141	3.989	44.056	10.486			149.439

Table 10.1.3 Pelagic *S. mentella* landings (in tonnes) in 2003 by countries and depth (A), and in 1996-2003 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	Total	not splitted	shallower than 600 m	deeper than 600 m
Estonia		100 %		
Faroes			38 %	62 %
Germany			37 %	63 %
Greenland			32 %	68 %
Iceland			12 %	88 %
Lithuania		100 %		
Norway			40 %	60 %
Portugal			50 %	50 %
Russia			39 %	61 %
Spain			19 %	81 %
Total				

Derived from effort data

B.	Total	not splitted	shallower than 600 m	deeper than 600 m
1996	180,322	18 %	20 %	62 %
1997	122,935	7 %	24 %	69 %
1998	116,968	0 %	21 %	79 %
1999	109,665	5 %	20 %	75 %
2000	126,076	23 %	28 %	49 %
2001	128,838	23 %	27 %	50 %
2002	131,665	26 %	19 %	55 %
2003	149,439	10 %	25 %	65 %

Table 10.1.4 Results of dividing the Icelandic pelagic redfish catch (t) according to the Icelandic samples from the fishery.

	oceanic	Deep sea	Not classified	Catch Oceanic	Catch Deep sea	Total Catch
1995	72%	27%	0%	25186	9445	34631
1996	45%	52%	3%	29182	33721	62903
1997	36%	64%	0%	14859	26417	41276
1998	10%	85%	4%	5504	46780	52284
1999	15%	85%	0%	6765	37159	43924
2000	5%	95%	0%	2455	42507	45008
2001	34%	66%		14423	27999	42423
2002	14%	86%		6229	38262	44491
2003	16%	84%		7743	40654	48398

Table 10.1.5a. Number of vessels visible in NEAFC waters compared to the number of VMS reports from the imaged area made available to NEAFC during June 2002.

Date	# Vessels reporting to NEAFC in image region	# Vessels in NEAFC waters visible on images
15.06.02	3	2
18.06.02	42	53
25.06.02	30	40
28.06.02	27	44
Total	102	139

Table 10.1.5b. Number of vessels visible in NEAFC waters compared to the number of VMS reports from the imaged area made available to NEAFC during June 2003.

Date	# Vessels reporting to NEAFC in image region	# Vessels in NEAFC waters visible on images
13.06.03b	64	41
16.06.03	64	40
20.06.03	57	36
23.06.03	55	37
27.06.03	48	38
Total	288	192

Table 10.2.1 Pelagic redfish *S. mentella*. Time series of survey results, areas covered, hydro-acoustic abundance and biomass estimates shallower and deeper than 500 m (based on standardized trawl catches converted into hydro-acoustic estimates derived from linear regression models).

Year	Area covered (1000 NM^2)	Acoustic estimates < 500 m (10^6 ind.)	Acoustic estimates < 500 m (1000 t)	Trawl estimates < 500 m (10^6 ind.)	Trawl estimates < 500 m (1000 t)	Trawl estimates > 500 m (10^6 ind.)	Trawl estimates > 500 m (1000 t)
1991	105	3498	2235				
1992	190	3404	2165				
1993	121	4186	2556				
1994	190	3496	2190				
1995	168	4091	2481				
1996	253	2594	1576				
1997	158	2380	1225				
1999	296	1165	614			638	497
2001	420	1370	716	1955	1075	1446	1057
2003	405	160	89	175	92	960	678

Table 10.2.2a. Results from experimental estimation of redfish between 0 and 500 m in May-June 2003.

(TS = 20LgL - 71.3 / Hauls type 2 and 1)

Subarea	Area, sq. nm	Mean Sa (tr) sq. m/sq. nm	Mean Density, tonn/sq. nm	Mean Length, cm	Mean Weight, g	Abundance, 10^6 sp	Biomass, 10^3 tonn
A	114288.5	0.48	0.22	35.45	540.02	45.9	24.770
B	120560.8	0.88	0.39	35.03	517.74	91.8	47.549
C	31930.7	0.16	0.08	37.00	633.67	4.0	2.547
D	41127.8	0.20	0.10	36.87	613.39	6.4	3.927
E	62742.4	0.47	0.22	34.07	514.42	26.6	13.694
F	8217.1	0.00	0.00			0.0	0.000
Total	**378867.3**	**0.54**	**0.24**	**35.11**	**529.25**	**174.8**	**92.488**

Table 10.2.2b Results from experimental estimation of redfish at depths below 500m in May 2003.
(TS = 20LgL - 71.3 / Hauls type 3)

Subarea	Area, sq. nm	Mean Sa (tr) sq. m/sq. nm	Mean Density, tonn/sq. nm	Mean Length, cm	Mean Weight, g	Abundance, 10^6 sp	Biomass, 10^3 tonn
A	114288.5	8.18	4.16	39.36	746.86	637.1	475.854
B	120560.8	2.39	1.17	38.37	688.14	205.8	141.648
C	31930.7	1.36	0.62	36.18	561.72	35.0	19.677
D	41127.8	0.71	0.32	35.65	532.91	24.6	13.098
E	62742.4	0.99	0.44	33.84	478.13	57.3	27.411
F	8217.1	0.06	0.03	32.50	425.94	0.5	0.222
Total	**378867.3**	**3.58**	**1.79**	**38.60**	**705.83**	**960.4**	**677.909**

Table 10.2.3 Pelagic redfish *S. mentella*. 1999, 2001 and 2003 survey biomass estimates (trawl data) and area splitting between NAFO and NEAFC Convention areas by depth (shallower and deeper than 500 m).

	NAFO (000 t)	NAFO %	NEAFC (000 t)	NEAFC %	Sum (000 t)
1999 shallower than 500 m *	540	46.3	626	53.7	1166
1999 deeper than 500 m	74	11.6	564	88.4	638
1999 Sum	614	34.0	1190	66.0	1804
2001 shallower than 500 m	686	63.8	390	36.2	1076
2001 deeper than 500 m	165	15.6	892	84.4	1057
2001 Sum	851	39.9	1282	60.1	2133
2003 shallower than 500 m	18	19	75	81	93
2003 deeper than 500 m	41	6	637	94	678
2003 Sum	59	8	712	92	771

* acoustically measured

Table 10.2.4 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)
1982	-	-	-	-	1.99
1983	-	-	-	-	1.60
1984	1.25	-	-	-	1.48
1985	1.85	-	-	-	1.68
1986	2.04	-	-	-	1.35
1987	1.22	0.79	-	-	1.10
1988	0.82	1.28	-	-	1.00
1989	-	0.70	1.11	-	1.00
1990	-	0.89	1.02	1.09	0.99
1991	-	-	1.52	1.42	0.80
1992	-	-	1.66	1.79	0.63
1993	-	-	3.27	2.02	0.63
1994	-	-	2.64	2.83	1.70
1995	-	2.06	2.00	2.05	1.00
1996	-	1.45	1.74	1.20	1.30
1997	-	1.31	1.11	0.66	-[3]
1998	-	1.30	1.56	0.75	-
1999	-	0.97	1.55	0.97	-
2000	-	1.05	1.98	1.12	-
2001	-	0.91	1.40	0.88	-
2002	-	1.14	1.90	1.23	0.89
2003[1]	-	1.09	2.28	-	1.10

1 Preliminary
2 1987-1990 reported as GDR (FVSIV)
3 1997-2001 Russian effort data are only available as fishing days

Table 10.2.4. a. Results of the GLM model to calculate standardized CPUE for all pelagic redfish fishery, including single tow data from Germany (1995-2003), Iceland (1995-2003), Greenland (1999-2003), Faroe Island (1995-2003), Russia (1997-2003) and Norway (1995-2003). Note that the full output is not shown (lafli= log catch; ltogtimi=log trawling time).

glm(formula = log(catch) ~ log(trawling_time) + factor(year) + factor(month) + factor(vessel), family = gaussian(), data = tmp.data)

```
$call:
glm(formula = lafli ~ ltogtimi + factor(yy) + factor(mm) + factor(area) +
factor(skip), family = gaussian(), data = testdata)

[1] "RESULTS combinded"
                    Value Std..Error    t.value   year     index
factor(yy)1996 -0.06316871 0.06908555 -0.9143549 1996 0.9387851
factor(yy)1997 -0.39895473 0.05764742 -6.9205997 1997 0.6710211
factor(yy)1998 -0.15979202 0.05908201 -2.7045798 1998 0.8523210
factor(yy)1999 -0.35645444 0.05873205 -6.0691635 1999 0.7001544
factor(yy)2000 -0.02302269 0.06066525 -0.3795037 2000 0.9772403
factor(yy)2001 -0.27505643 0.05859598 -4.6941174 2001 0.7595293
factor(yy)2002 -0.02198948 0.06103515 -0.3602758 2002 0.9782505
factor(yy)2003  0.04196942 0.06183294  0.6787551 2003 1.0428626
Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)
              Df Deviance Resid. Df Resid. Dev  F Value     Pr(F)
          NULL                 1745   3424.808
      ltogtimi  1 2599.729      1744    825.079 10794.41 0.0000000
    factor(yy)  8   33.647      1736    791.432    17.46 0.0000000
    factor(mm) 11   82.288      1725    709.144    31.06 0.0000000
factor(reitur)  2    0.107      1723    709.036     0.22 0.8000904
  factor(skip) 89  315.503      1634    393.533    14.72 0.0000000
```

Table 10.2.4. b. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths shallower than 500 m (south-western area) including singlel tow data from Germany (1995-2003), Iceland (1995-2003), Greenland (1999-2003), Faroe Island (1995-2003), Russia (1997-2003) and Norway (1995-2003). Note that the full output is not shown.

```
[1] "Southern area"
Value Std..Error     t.value   ar     index
factor(yy)1996  0.35829925 0.27698771  1.29355649 1996 1.4308937
factor(yy)1997 -0.15104083 0.10898368 -1.38590319 1997 0.8598126
factor(yy)1998 -0.01334449 0.11233651 -0.11879031 1998 0.9867442
factor(yy)1999 -0.49481769 0.10186451 -4.85760632 1999 0.6096820
factor(yy)2000 -0.21161745 0.11787117 -1.79532834 2000 0.8092742
factor(yy)2001 -0.00337574 0.09983421 -0.03381346 2001 0.9966300
factor(yy)2002 -0.16594745 0.11253580 -1.47461917 2002 0.8470907
factor(yy)2003 -0.09373946 0.11215254 -0.83582114 2003 0.9105200
Analysis of Deviance Table
Gaussian model
Response: lafli
Terms added sequentially (first to last)
            Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                  512   1058.004
    ltogtimi  1 813.5270       511    244.477 3693.275     0
  factor(yy)  8  34.9853       503    209.492   19.853     0
  factor(mm) 10  48.6946       493    160.797   22.107     0
factor(skip) 71  67.8421       422     92.955    4.338     0
```

Table 10.2.4. c. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths deeper than 500 m (north-eastern area) including singlel tow data from Germany (1995-2003), Iceland (1995-2003), Greenland (1999-2003), Faroe Island (1995-2003), Russia (1997-2003) and Norway (1995-2003). Note that the full output is not shown.

```
$call:
glm(formula = lafli ~ ltogtimi + factor(yy) + factor(mm) + factor(skip), family
= gaussian(), data = north)

[1] "RESULTS north"
Value Std..Error    t.value   ar     index
factor(yy)1996 -0.03260107 0.08543931 -0.3815700 1996 0.9679246
factor(yy)1997 -0.43518737 0.07775368 -5.5970006 1997 0.6471434
factor(yy)1998 -0.16385057 0.07865590 -2.0831314 1998 0.8488689
factor(yy)1999 -0.23694810 0.08182112 -2.8959282 1999 0.7890322
factor(yy)2000  0.06417618 0.08134751  0.7889139 2000 1.0662802
factor(yy)2001 -0.33391863 0.07993418 -4.1774199 2001 0.7161120
factor(yy)2002  0.05460335 0.08187502  0.6669110 2002 1.0561216
factor(yy)2003  0.13752343 0.08308755  1.6551629 2003 1.1474286
Analysis of Deviance Table

Gaussian model

Response: lafli

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev  F Value Pr(F)
        NULL                  1224   2286.075
    ltogtimi  1 1709.057      1223    577.018 7888.936     0
  factor(yy)  8   34.097      1215    542.921   19.674     0
  factor(mm) 11   43.052      1204    499.870   18.066     0
factor(skip) 83  257.016      1121    242.853   14.294     0
```

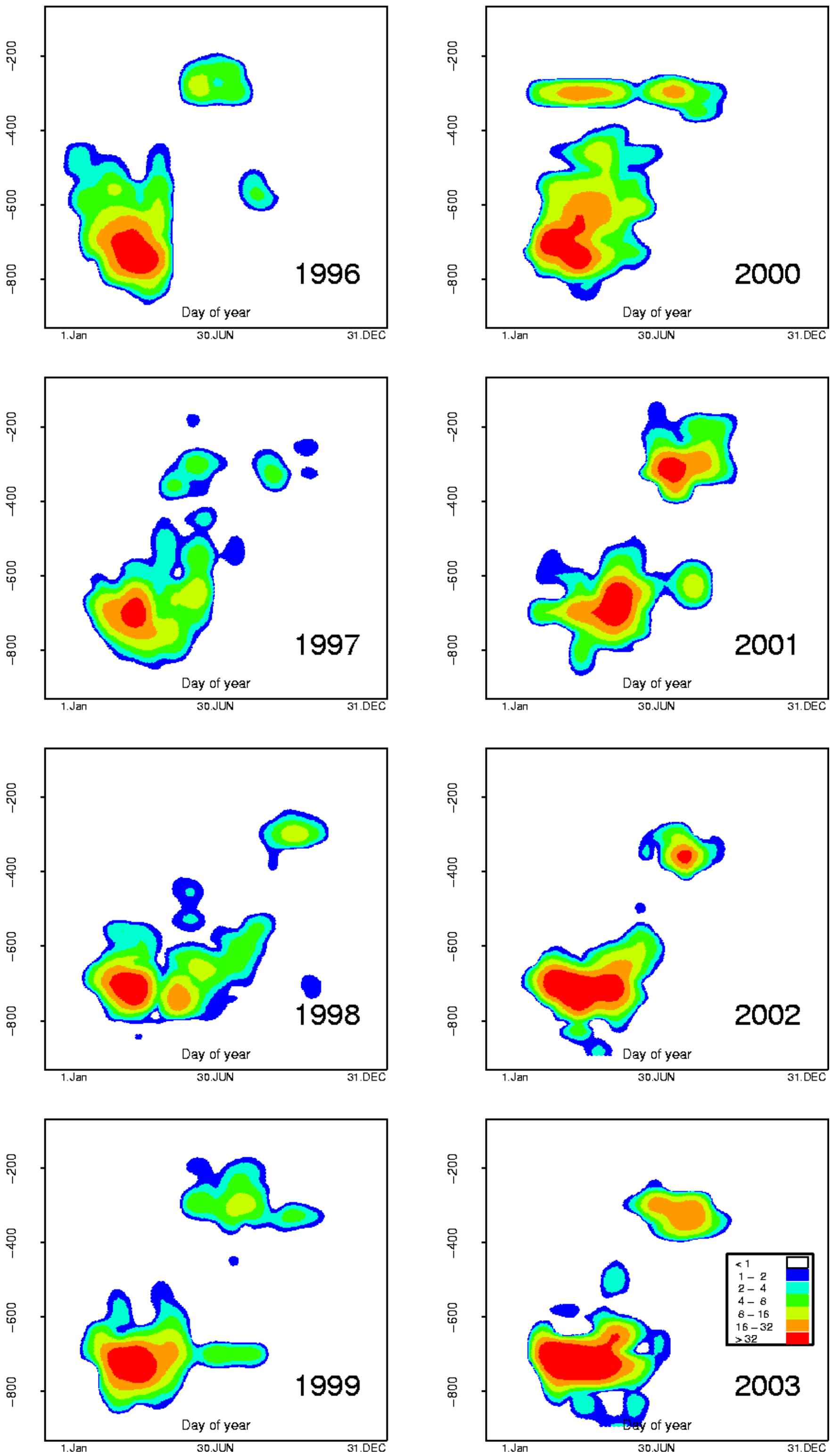


Figure 10.1.1. Depth distribution of catches for pelagic redfish as reported in the logbooks since 1996. X-axis = day of year; Y-axis = depth. Data from Iceland, Norway and Fareoes. The figure demonstrates the shifts of the trawling depth between the second and the third quarter.

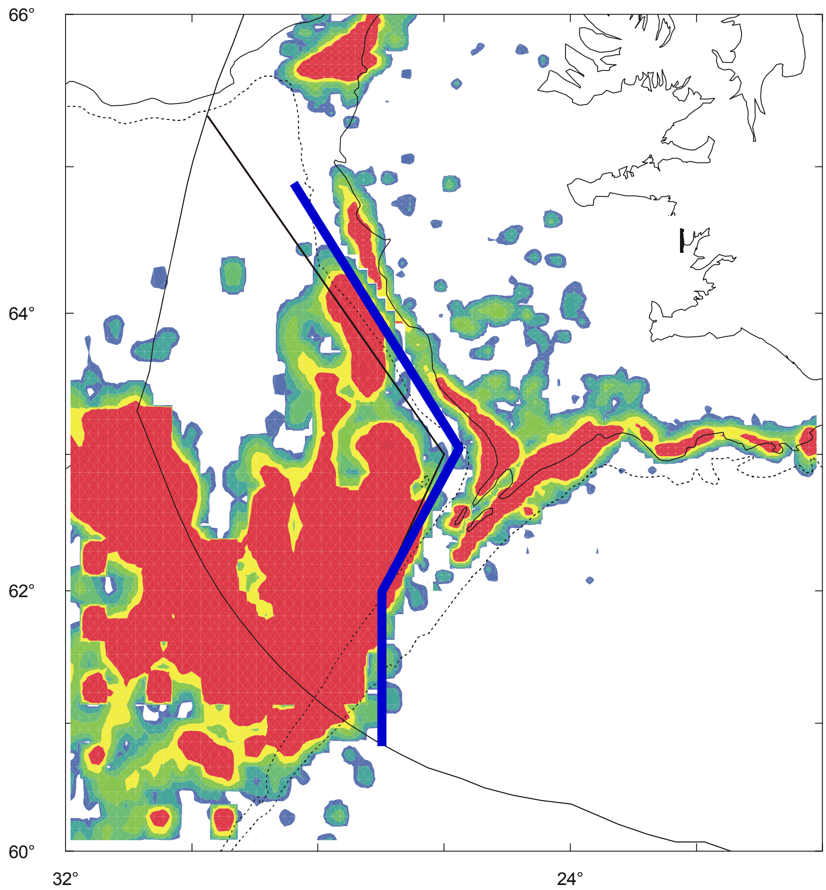


Figure 10.1.2. Icelandic redfish catch southwest of Iceland in 2001-2003. The catch west of the "redfish line" (blue line) is form the pelagic redfish as the catch north and east of the line is of "shelf type"). The thin line is the "old redfish line"; the blue one is the line set in 2003.

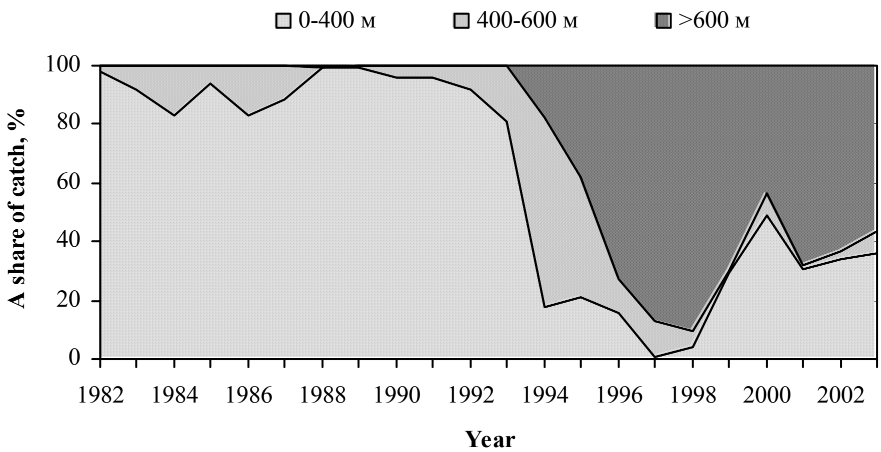


Figure 10.1.2 Precentage of the catch *of S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2003.

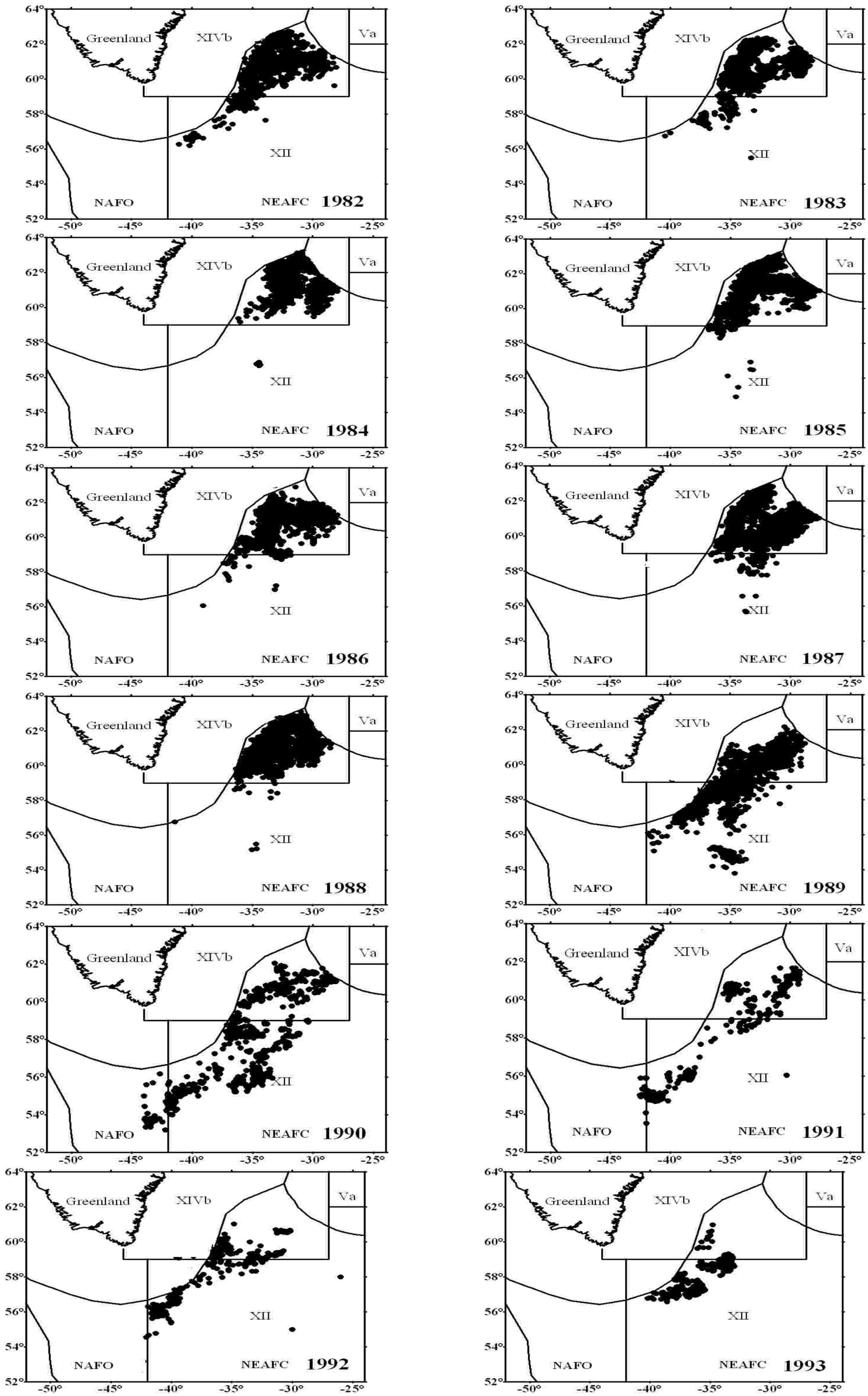


Figure 10.1.4. Location of the Russian fleet during fishery for S. mentella in the Irminger Sea in 1982-1993

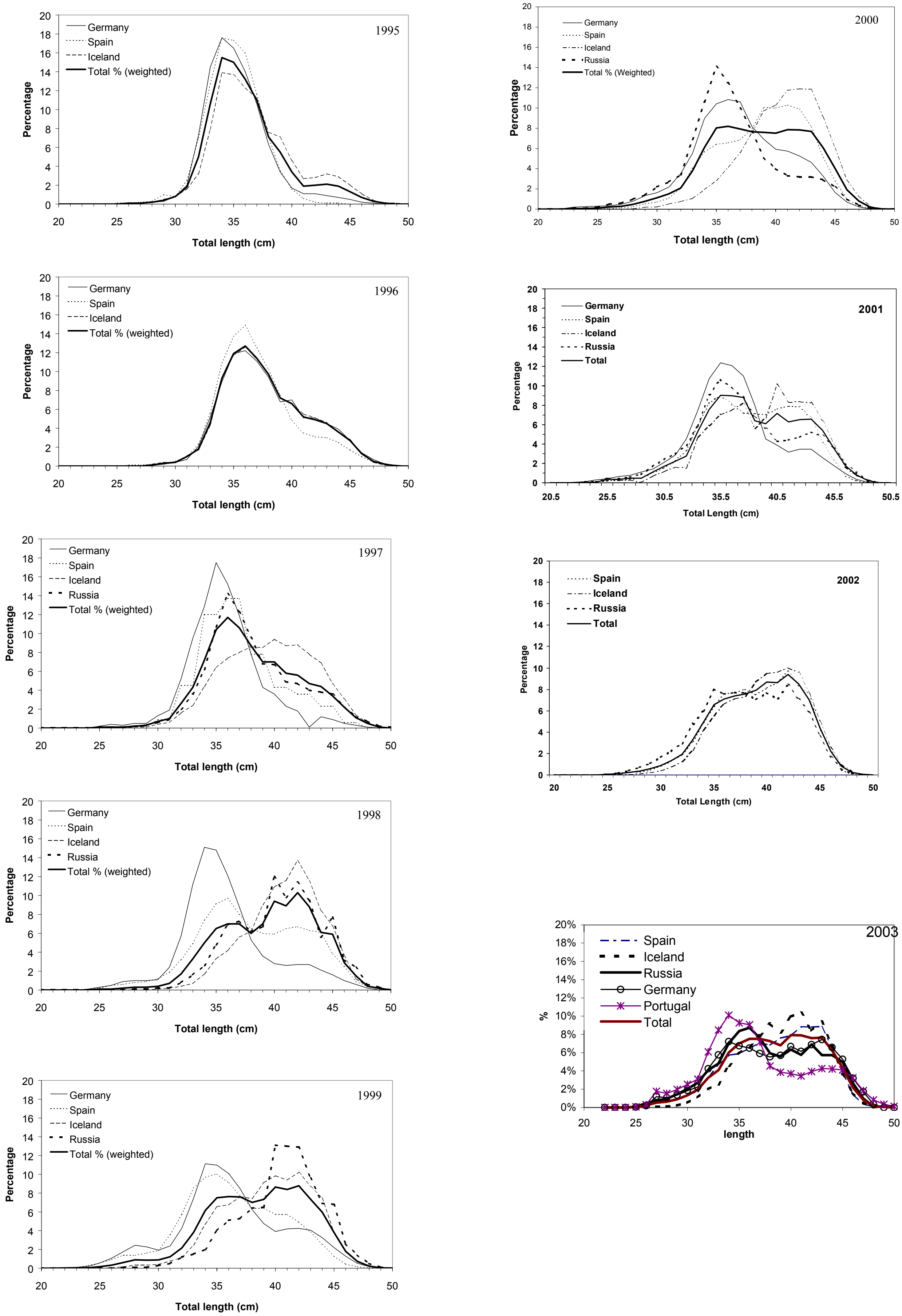


Figure 10.1.5 Length distributions from landings of pelagic *S. mentella* in 1995-2003.

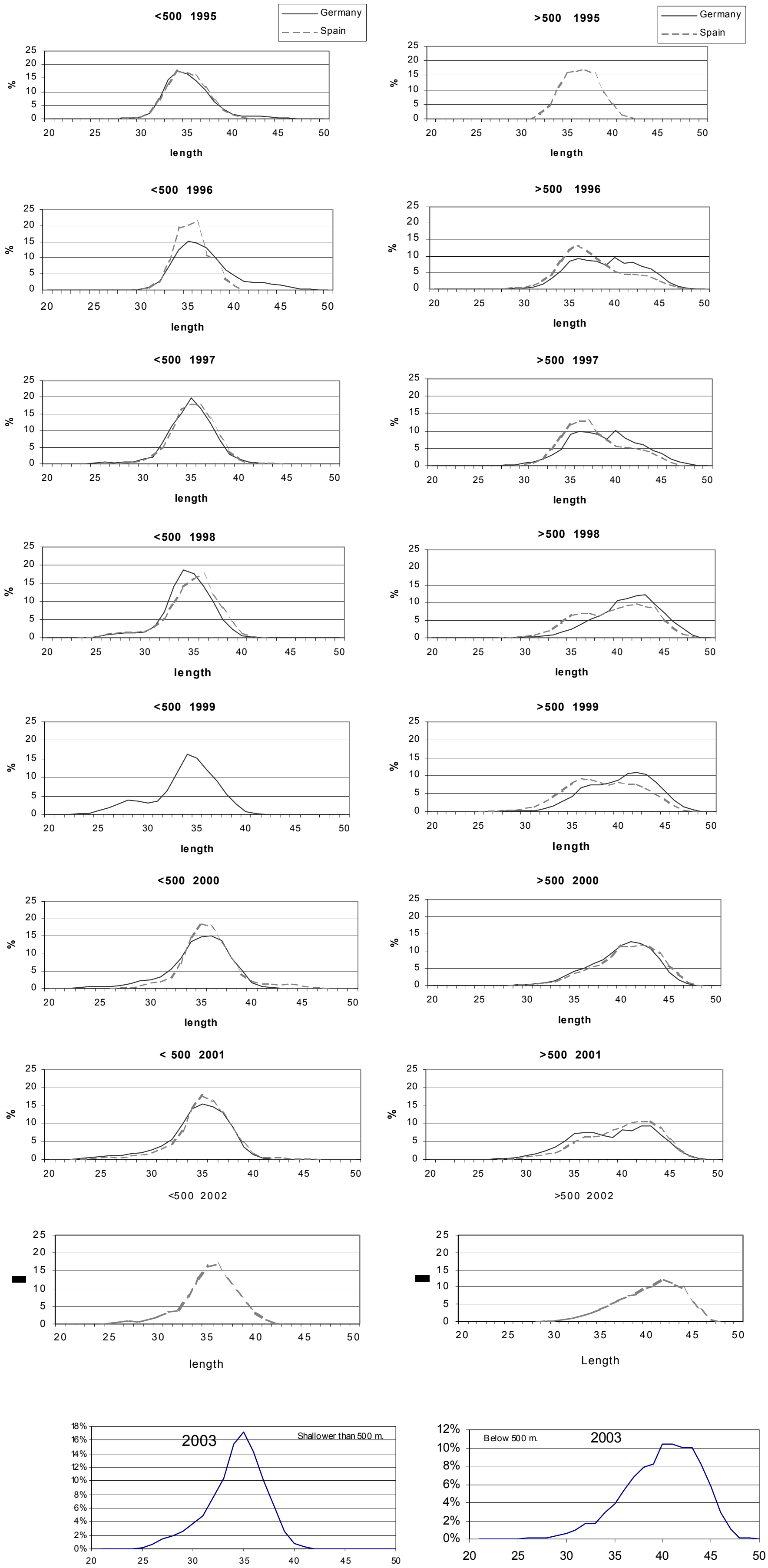


Figure 10.1.6 Length distributions from German and Spanish landings of pelagic *S. mentella* in 1995-2003, divided by depths shallower and deeper than 500 m.

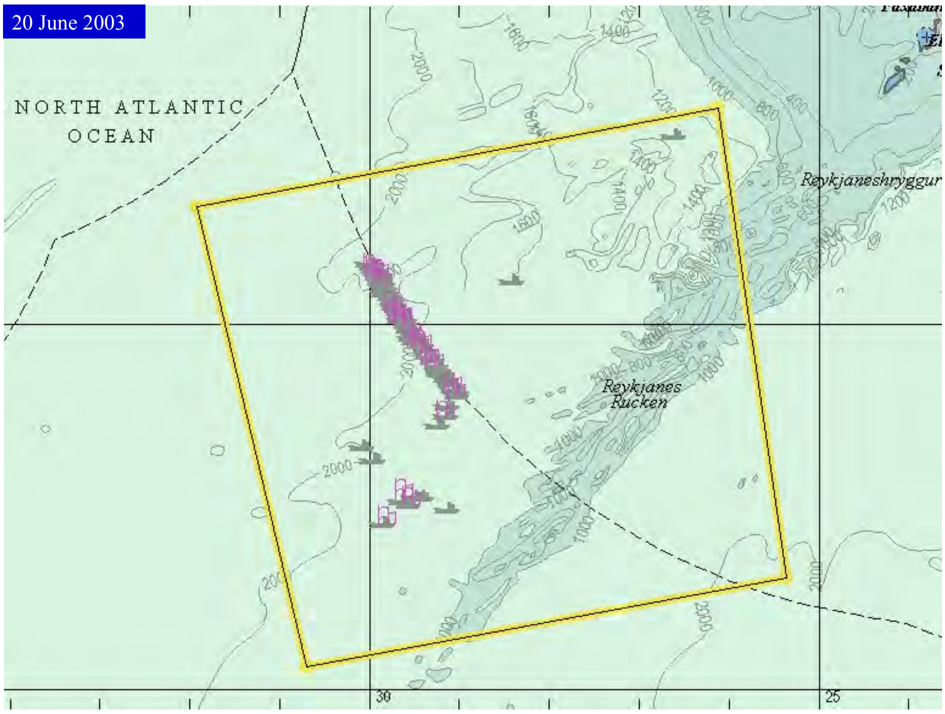


Figure 10.1.7. GIS representation of detected vessels on satellite image 20th June 2003, where vessels (green boats) can be seen in a concentrated area, away from the image edges.

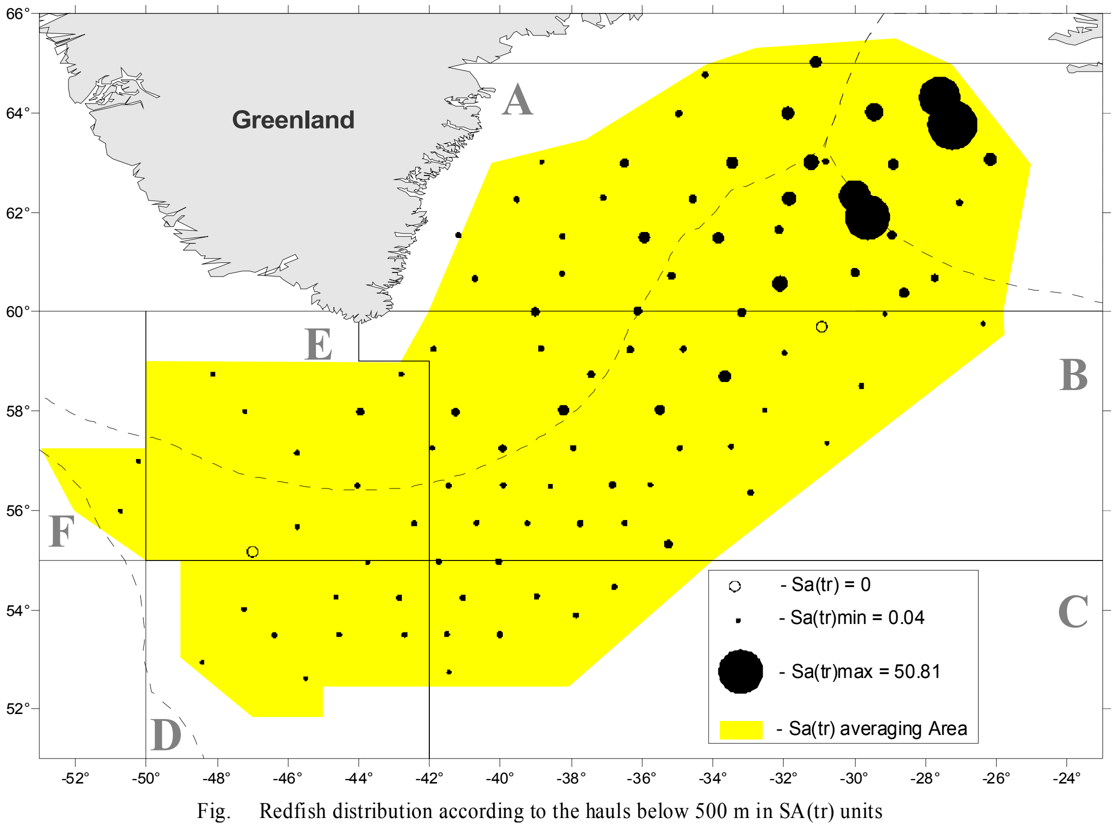


Figure 10.2.1 Geographical distribution patterns of standardised redfish catches deeper than 500m in May-June 2003 joint trawl-acoustic survey.

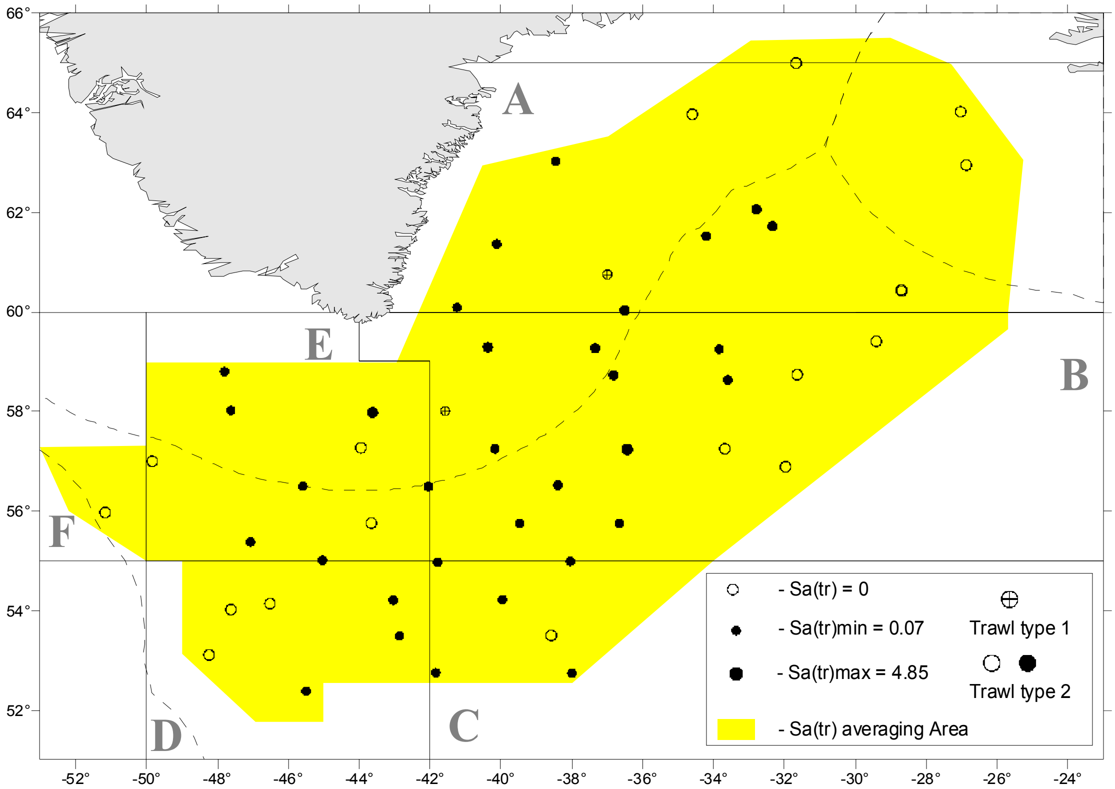


Fig. Redfish distribution according to the hauls upper 500 m in SA(tr) units

Figure 10.2.2 Geographical distribution patterns of standardised redfish catches shallower than 500m in May-June 2003 trawl-acoustic survey.

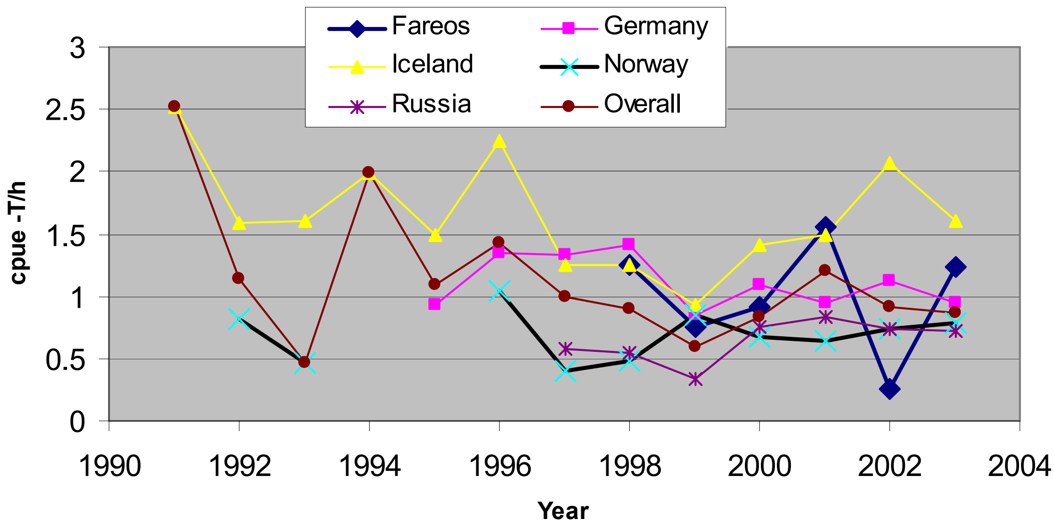


Figure 10.2.3a. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, shallower than 500m.

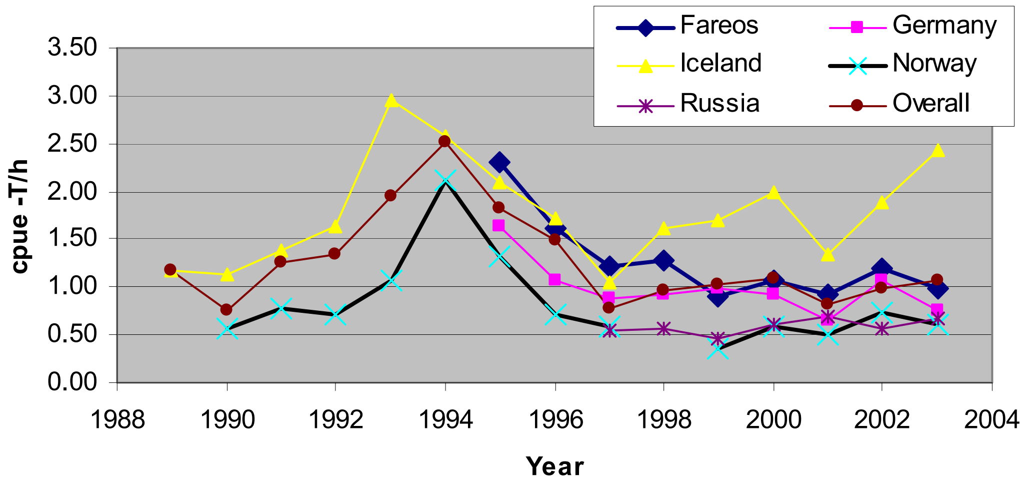


Figure 10.2.3b. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, **deeper than 500m**.

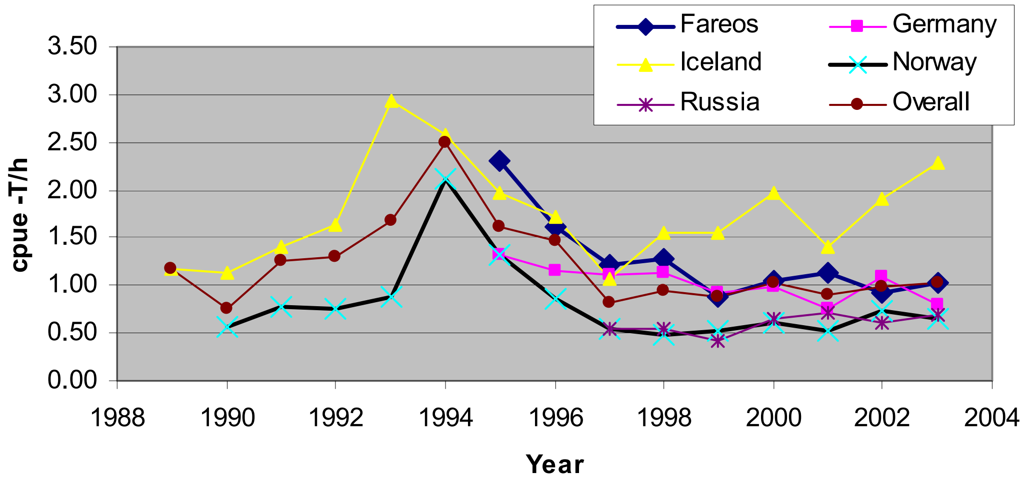


Figure 10.2.3b. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, **all data.**

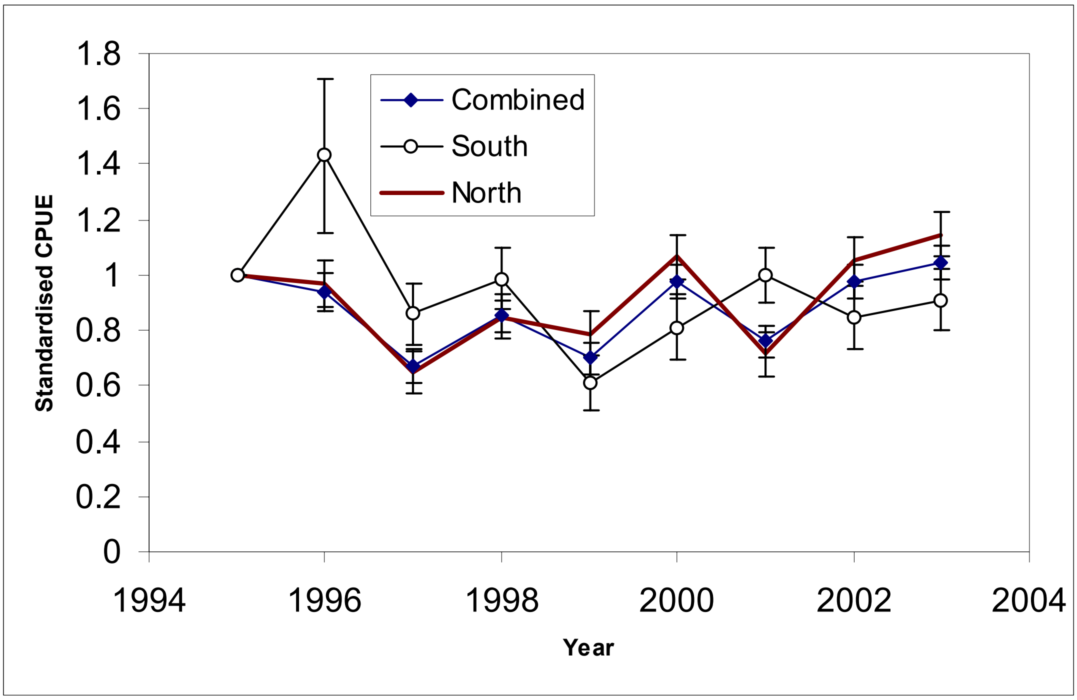
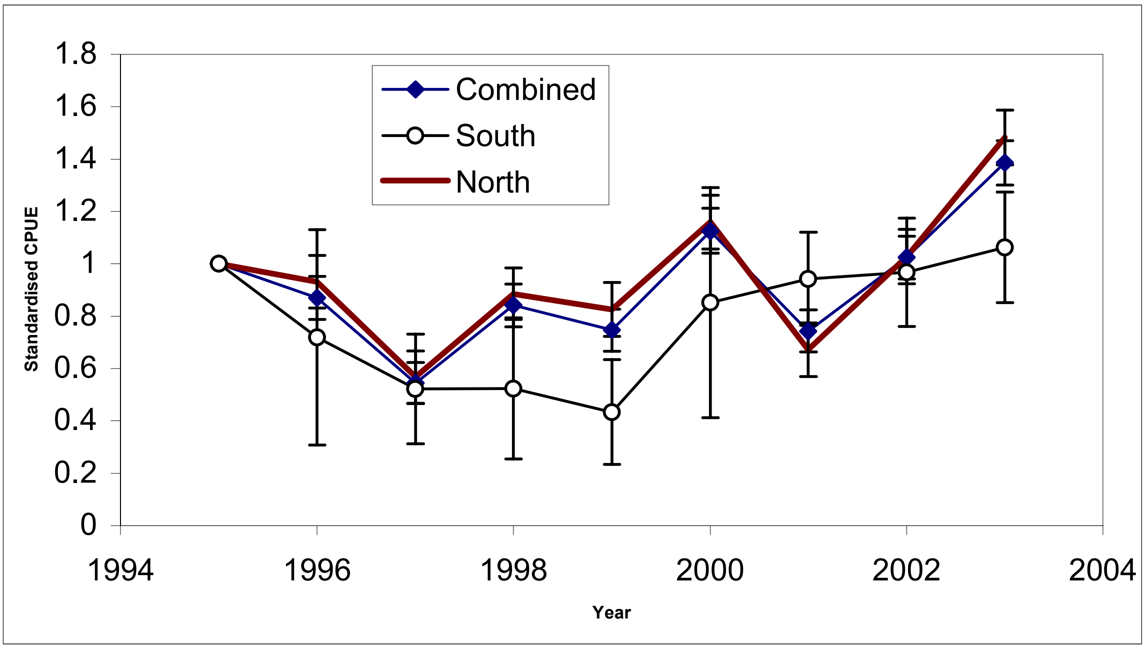


Figure 10.2.4. Standardised CPUE, as calculated by using data from Germany (1995-2003), Iceland (1995-2003), Greenland (1999-2003), Faroe Island (1995-2003), Russia (1997-2003) and Norway (1995-2003) in the GLM model (see chapter 10.2.2.), divided by depths shallower (south-western area) and deeper than 500 m (north-eastern area) and both depth layers (areas) combined (All data. 95% confidence limits are shown. Further details of the GLM models are given in Table 10.2.4



Only Icelandic data, goes out.....

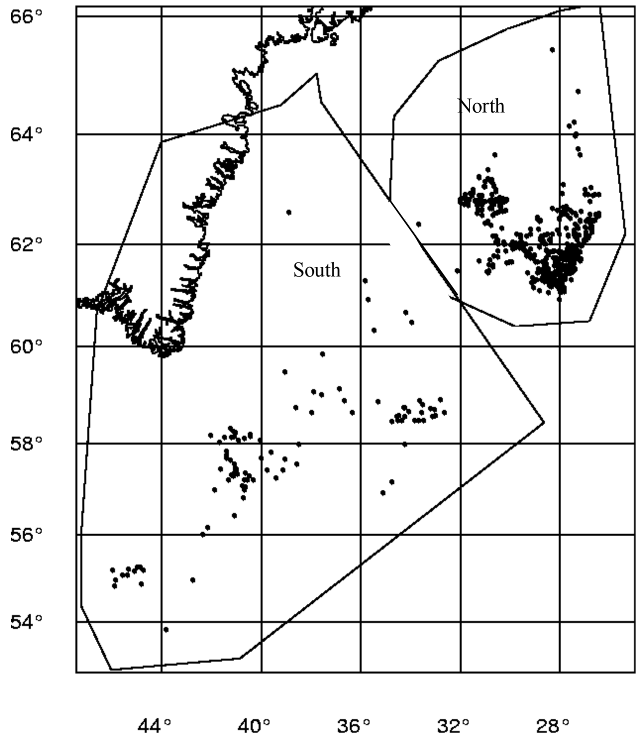


Figure 10.2.5. Division of areas between south an north. The points indicate positions of Icelandic available samples from the catches.

11 LIST OF WORKING DOCUMENTS

WD1. O.A. Jørgensen. 2004. Survey for Greenland halibut in ICES Division 14B, June 2003
WD2. Marie Storr-Paulsen. 2004. Cod stocks off Greenland – Greenland survey and commercial data
WD3. Hans-Joachim Rätz, Thorsteinn Sigurðsson and Christoph Stransky. 2004. Abundance and length composition for Sebastes marinus L., deep sea S. mentella and juvenile redfish (*Sebastes* spp.) off Greenland and Iceland based on groundfish surveys 1985-2003
WD4. Hans-Joachim Rätz, Jens Ulleweit and Kay Panten. 2004. Data on German landings and effort for Greenland halibut (*Reinhardtius hippoglossoides*), demersal redfish (Sebastes marinus and deep sea *S. mentella*), and Atlantic cod (*Gadus morhua*) in ICES Div. Va, Vb, VIa and XIV, 1995-2003.
WD5. Hans-Joachim Rätz, Jens Ulleweit and Kay Panten. 2004. On the German Fishery and Biological Characteristics of Pelagic Redfish (*Sebastes mentella* Travin) 1991-2003.
WD6. J.Boje. 2004. The fishery for Greenland halibut in ICES Div. XIVb in 2003.
WD7. Thorsteinn Sigurdsson, Hajo Rätz, Kjell Nedreaas, Sergei P. Melnikov and Jákup Reinert. 2004. Fishery on pelagic redfish (S.mentella, Travin): Information based on log-book data from Faroe Island, Germany, Greenland, Iceland, Norway and Russia.
WD8. Thorsteinn Sigurdsson. 2004. Information on the Icelandic fishery of pelagic redfish (S.*mentella* travin); Information based on log-book data and sampling from the commercial fishery
WD9. V.N. Shibanov and S.P. Melnikov. 2004. Russian fisheries for redfish (*Sebastes mentella* Travin) and biological data from commercial catches in pelagic waters of NEAFC and NAFO Convention Areas in 1982-2003
WD10. S.P. Melnikov. 2004. preliminary information about russian fishery for the oceanic *S. mentella* in ICES Subareas XII, XIV, in NAFO Divisions 1F, 2H, 2J in 2003 and biological sampling from commercial catches
WD11. Lise Helen Ofstad. 2004. Prelimary assessment of Faroe Saithe, 2004.
WD12. Hans-Joachim Rätz. 2004. Groundfish survey results for cod off Greenland (offshore component) 1982-2003.
WD13. Kristján Kristinsson and Thorsteinn Sigurdsson. 2004. Sebastes marinus in ICES Division Va. Figures and tables
WD14. Björn Ævarr Steinarsson, Einar Hjörleifsson, Höskuldur Björnsson, Ólafur Karvel Pálsson Sigfús Alexander Schopka and Guðmundur Guðmundsson. 2004. Icelandic cod in division Va: Stock assessment in 2004.
WD15. Hans-Joachim Rätz, Christoph Stransky, Thorsteinn Sigurðsson and Kristján Kristinsson. 2004. An exploratory XSA assessment of *S. marinus* in Va, Vb and XIVb.
WD16. Luis Ridao Cruz 2004. Faroe Bank Cod: Tables and figures.
WD17. Petur Steingrund. 2004. Restratification of the Faroese spring groundfish survey.
WD18. R. Alpoim, J. Vargas and E. Santos. 2004. Report of the Portuguese *Sebastes mentella* fishery in 2003: ICES Div. XII, XIVb and NAFO Div. 1F, 2J.
WD19. J.Boje and E. Hjörleifsson. 2004. Greenland halibut V+XIV. A preliminary assessment 2004.
WD20. Jákup Reinert. 2004. Some information on redfish in Vb.
WD21. Petur Steingrund. 2004. Preliminary assessment of Faroe Plateau cod: Tables and figures.
WD22. Sigurdur Jónsson. 2004. Preliminary assessment of Icelandic saithe: Tables and figures.
WD23. Jákup Reinert. 2004. Preliminary assessment of Faroe Haddock.
WD24. Kristjan Kristinsson and Thorsteinn Sigurdsson. 2004. Information on the shelf deep-sea redfish (*Sebastes mentella*) fishery in Division Va 2004: Figures and tables
WD25. Petur Steingrund. 2004. Primary production on the Faroe Shelf and its influence on cod.
WD26. Björn Ævarr Steinarsson. 2004. Prediction of mean weight at age for short-term prediction for Icelandic cod.

ANNEX 1

TECHNICAL MINUTES

ACFM Review

Technical Notes from the review of the North Western Review Group report (reviewed jointly with report of Artic Fisheries Working Group) May 25-27, 2004

Participants

Holger Hovgaard (Chair)
Frans van Beek (Reviewer)
Denis Rivard (Reviewer)
Einar Hjörleifsson (Chair, NWWG)
Yuri Kovalev (Chair, AFWG)
Vladimir Shibanov
Jakup Reinert

General observations

The ACFM North Western Review Group (NWRG) met in Copenhagen, May 25-27, 2004, to review the report of the North Western Working Group (NWWG).

The NWRG noted that the NWWG report has not addressed the ToR item b, relating to providing effort options for the stocks that are regulated through the Faroese effort regulation system. The discussions during the review meeting revealed that catch and effort data on the appropriate scale for stock assessment has not been made available for the NWWG. Although the data shortcomings are caused by purely berocratic factors it in practice nullifies one of the main benefits recognized when introducing the Faroese effort system – namely the expected improvements in the assessment data quality when using a regulation believed to remove incentives to discard and misreport catches.

The assessments were well documented overall. It was noted that the request by ICES on the changes to the structure of the report could not be addressed entirely and that this would require intersessional work (e.g. Quality Control in Annex, etc.). It was observed that there is still some confusion on the format and expected end-product and that fishery-based advice was not yet a fully operational approach. Also, the Review Group suggested that it would be useful in future reports of the NWWG to document the response of the Working Group to the comments and recommendations of the NWRG in each of the stock sections. The report rather focus on the technical aspects on assessment. In order to be able to formulate advice ACFM also needs additional information on the nature of the fisheries, regulations, biological stock and fisheries interaction. This information is also required to feed specific paragraphs in the single stock summary

It was noted that the assessments had been using a variety of models (e.g. ADAPT using the USA National Marine Fisheries Service software, AD-CAM, etc.) and that this was useful in evaluating the results. Some of these models provide a quantification of errors through bootstrap or analytically using Hessian-based calculations. The NWRG feels that these constitute a good first step in evaluation uncertainties in assessment. One of the remaining questions is how such estimates of uncertainty could be used by ACFM for providing advice. In practice, the advice is still based on point estimates and ACFM notes the questions from WG on the use of uncertainties in the determination of advice on stock status and TAC levels (what format, etc.). It was noted that where methods providing a quantification of uncertainty in stock abundance estimates have been applied, they are often used to provide a quantification of risks of various management options or catch levels.

This also raises that issue of how to deal with multiple formulations of assessments. The consideration of multiple approaches to these assessments results in a certain lack of standardization in the WG report. However, alternative approaches serve to give some confidence in assessment results when the results show consistency across models. The NWRG welcomes the inclusion of the results of alternative models in the report of the NWWG and believes that this warrants further discussions within ACFM as to how this should be used in the advisory process.

The WG chair provided an overview of the WG report using slides. One of the synthetic slide compared the trends in assessment results against the long term average. These were found to be very useful by the Review Group.

Icelandic Cod

This assessment is based on the same procedure as last year (SPALY). The principal issues discussed were:

- Calculation of SSB. Difference with old calculation is large. The reason is that the mean weight and maturity ogive is now based on survey (1st Q) information whereas it earlier were based on information from the fisheries.

- Previously available capelin stock size was used in calculation of mean weight for the stock in the forecast but the current stock size estimate is zero. Consequently, the forecast used survey weights information to predict catch weights.

It was observed that fishing mortalities continue to be high under the current catch rule which aims at reducing effort. The catch rule was changed. There are some concerns that simulations to evaluate the catch rule are sensitive to the stock recruit assumptions. Another issue is that the simulations do not assume implementation or assessment error. While it was pointed out that the assessment error was 15% but not on one side (i.e. bias was not tested). The evaluation of the catch rule also assumes that managers will follow the catch rules. This may not be the case and the implementation error should account for this, together with lack of adherence to the TACs.

The question of the level of discards was raised in the context of their impact on the medium term projections. It seems that the situation has improved but, in practice, the recent estimates are unbelievably low. The Review Group noted that there was no new information on the discards and that the information available was what has been produced and reviewed last year.

With respect to the revised estimates of SSB (the entire time series), it was noted that the new estimates are very different than the old estimates (see page 239). The new SSB calculation uses the maturity ogive, from the survey instead of that of the catch. There is quite a difference in the maturity at age from these two sources (see page 220 and compare maturity from spring survey data to maturity from catches Jan-May). In particular, the change in noted for ages 4-5. While the NWWG believes that survey-based maturities are better indication of maturation, the reasons for this are unclear but could be investigated by having a closer look at the sampling data. It was also noted that the consequence of a change in SSB estimates on the assessment is not important as the management rule is based on B4+ and the B_{PA} is not defined for the stock. However, if we need to define a limit reference point based on SSB, the reason for the differences between maturity estimates from the two sources would have to be clarified.

The Review Group notes that alternative methods give similar results, which gives confidence in the assessment results.

With respect to the use of the capelin biomass in the forecast, the absence of a biomass estimate for capelin fro 2003 add a complexity to the forecast but the Review Group is satisfied with the new model for predicting weight at age in catch from survey.

The use of AD-Cam for final assessment was discussed. It was noted that the other methods used gave similar results and the diagnostics revealed no particular issue (no strong retrospective). However, future assessments should also consider using the October survey, which is now composed of nine data points, as an additional tuning index.

Icelandic Haddock

There is a haddock outburst, being driven by incoming recruits. This is seen clearly in the surveys and confirmed in assessment results. However, there are large survey residuals, in particular in 2003 and 2004 (above model estimates, year effect). This could be due to warming and its possible effect on survey catchability.

The Review Group asked if the absence of discard information could explain large residuals or trends in residuals. These residuals may not be related to the surveys but could be arising from the catch data. The concern is that there could be high discards or incidental mortality associated with mesh size. The issue is that there is no discard info other than what reported last year. The Review Group is really missing that information (this is a general comment for all stocks).

The use of many assessment models was welcomed but the final choice of the model should be discussed in the report (also valid for other stocks). It is also unclear where we can find the output from the selected run (e.g see page 289, what is the assessment based on, which method). Instead of the XSA, we need for instance the final output of the AD-CAM (now provided in annex of the Minutes).

On Page 293, the report is also missing the maturity and other biological data needed to do the short term projections. What is presented is the detailed output table. What is needed is "input" which is not provided (now provided in the annex of the Minutes).

While ACFM had not adopted AD-CAM, we are using AD-CAM to obtain an indication of stock trends in the short term. As such, the details of the model input should be provided and documented. Page 274, some ambiguity in the text on input data. "For 2004, the mean of 2001-2003 was then used.…." This is an incomplete sentence. This needs to be checked. What is used in the catch forecast needs to be specified.

Last para on input data: page 274. It is specified that the exploitation pattern for the past 25 years is used. The Review Group had a discussion on the relation of input data for the yield-per-recruit and the purpose of the exercise. Consideration should be given to using the most recent exploitation pattern as it is the most recent fishery that needs to be evaluated in terms of long term yield per recruit. As for maturity and weight, it is likely appropriate in most situations to use the long term historical information. It was noted that another purpose might be to use yield per recruit to determine the optimum exploitation pattern. However, unless specified otherwise, the assumption should be the reason for providing yield per recruit calculations is related to evaluating the current situation in relation to growth overfishing.

Icelandic saithe

This stock has been previously assessed by ICES through TSA (NWWG 2002), using surveys as independent stock index. No assessment were made of this stock by the NWWG in 2003 However, in a Icelandic domestic 2003 assessment , the Camera model, a CAGEAN-type model, was applied to surveys using ages 3-14. The NWWG 2004 proposes to use Camera values as point estimators (ages 3-14). It was noted that a lot done but that the model still required proper documentation. However, the results look promising in hindsight.

The Review Group asked that the results of the retrospective model be checked in the quality control sheets as some values seem to be anomalous.

There is no indication in the report how the new SSB was calculated back in time (i.e. prior to the surveys which starts in 1985. The Review Group asked that that the SSB time series be produced for the old and the new (i.e. to revise table 3.2.7.8).

Regarding the catch forecast, it was noted that a TAC of 50Kt constraint was assumed for 2004. This implies a F-reduction of about 24%. This appears to be a good case for using F status quo for 2004 as F goes back up in 2005 and 2006 (See page 182). It was reported that we know little about the catch in 2004. So making the forecast with status quo F would be more appropriate. We should use 0.32 in absence of anything else.

This is a noisy assessment (not precise, see page 204) but there is no indication of precision in the projections. There are some concerns with the level of catches that come out of the projections.

Some formatting issues were reported and will be corrected in the final report. There are concerns with using camera as this method is still under development but the progress made in its application are noted.

The recruitment in the most recent year is the lowest one in the time series. It was also used in the prediction. This should have been mentioned somewhere, because now ACFM lost time by checking this not to be an error.

Faroe Plateau – Cod

This is a benchmark assessment. Last year, the assessment was based on the summer surveys only (1996-2002); this year, the spring surveys (1994-2004) were added.

While the final results are based on XSA, experimental runs were made using ADAPT. These gave similar results.

The principal issues are the year-effect in surveys, the basis for F in forward projections, the relation for LL catchability and environment, and very high Fs in 2003.

We suspect there is a year effect in the 2004 spring survey, as well as in the summer and spring 2003 surveys. Also the spring 2003 assessment was not used in the last assessment. So we now have three new survey points. So we now have three surveys now showing relatively low values. It was pointed out that the distribution of cod was not normal in the last summer.

It was noted that the signal of decline is seen not only in the survey index but also in the catch (from catch ratio analysis done by WG chair).

On page 47, the XSA residuals should have been shown in a bubble plot. Observed surveys in summer 2003 appear to be lower than predicted. Same thing, for the spring 2004. In other words, theses low survey observations are not adhered to completely in the XSA results. So the model is more optimistic than the surveys themselves.

An ADAPT was done. Adapt results in a higher F for ages 5,6,7 but lower for 8 and 9 in comparison to XSA. The power assumption is not supported strongly by the data. ADAPT gives similar results without it.

Another suggestion was to try omitting 9 year olds from the tuning.

It was observed that the recent Fs are high despite the harvest rule in place.

The review group had a look at the ranking of survey results as a means to extract information on yc strengths and stock trends from the indices themselves.

It was noted that this is an effort control system. Given this, it appears that the increase in F cannot be explained by days at sea or effort observed.

The review group run a XSA with a standard shrinkage of 0.5, as a sensitivity test. The Fbar (3-7) from this run in 2002 and 2003 were estimated at 0.73 and 0.71, respectively, as compared to 0.83 and 0.99 in the accepted run. Although lower, the fishing mortality still is very high, more than twice the Fpa of 0.35. Inspecting the diagnostics and retrospective analysis of this XSA shrunk 0.5 the review group found no reason to reject the XSA as accepted by the WG.

The use of a plus-group was discussed. The Working Group should revisit the inclusion of a plus-group and the argument by which it was taken out.

On the indices, it was observed that the two surveys are much in line with each other and in line with trawl fleet but not in line with the Long Liners.

It was noted that the results of the assessment was not carried forward in catch forecasts last year. In this case, we have an effort management control system and what is the point of doing projections.

It was noted that the results are predicting high Fs in 2003. The Fs have been estimated to go up rapidly. There is a concern that the effort regulation doesn't work. Perhaps effort control is not sufficient because catchability cannot be controlled (This should be investigated by plotting q over time, e.g. as F/E. One management objective is to keep F on average to 0.45. A relationship (in 1996) between number of days, etc. was used to reduce number of days until they reach 0.45. This is not clearly stated in the WG report. Also, simulations should be done to verify the validity of the objective and management approach.

In that context, it was observed in the graph showing primary production against LL q for ages 3-6 that catchability went down after 1997 to 2001. In other words, F went down not because effort went down but because catchability went down (and, at the same time, effort-days went up , see Table 2.1.1). Since 2001, q going back up to what it was.

It should be noted that ACFM looking at what kind of advice could be developed under an effort-based framework. This year's ACFM advice does not completely achieve this.

We also need to develop the monitoring, data and analyses in support of an effort management system.

Faroe Bank cod

Catch and effort data are uncertain as fishing trips may concurrent cover fisheries on the bank and on the plateau and the stock assessment is therefore based solely on interpreting trends in survey abundance. For its future assessments the working group may consider using more formalized analytical approaches as e.g. SURBA.

Faroe Haddock

The principal issues are that a proxy is used for current exploitation rate.

F_{bar} for the terminal year is driven by noise at age 7. There might be a sampling problem for smaller age-groups as well. Are there are few otoliths for age 7. This needs to be looked at. There is a concern that the arithmetic average on that data does not reflect fishing mortality for that stock. However, weighted averages have other disadvantages.

The haddock fishery follows year-classes which are strong. Neighboring year-classes are generally low. This is generating spurious Fs for these cells in the F matrix. Accordingly, using models that mimic the behavior of fleet selectivity or PR could offer a solution, perhaps like Camera or AMCI, etc.. This should be considered for the next benchmark assessment.

With respect to the difference between ADAPT and XSA results, it was suggested that shrinkage could explain it (page 113). Alternatively, this could be due to different estimates of abundance for the 1999 year-class or to the way the March 2004 survey was handled in ADAPT. [Was checked and seem to be OK]

Page 76. Unusual to have last two years of the spring survey almost the same for all age groups (except age 0). The survey results were accepted since length distributions by strata and the ALK's used to calculate indices at age are different in the two years. However, the WG needs to check this in details.

A new short term prediction were done, now the selectivity pattern was estimated as the average F in 2001-2003 for ages 3-5, and average F in 2000-2002 for ages 6-7, not rescaled. Input data and results are presented below.

Faroe Saithe

The assessment is calibrated with commercial CPUE data only ("the Cuba trawlers") and a principal issues are the presence of blocks in the XSA residuals and a q-trend that indicates that a technological creep has taken place in the fisheries. The trend has been observed for many years and last year the review group recommended to further investigate the issue. Since then new research (Bjarti Thomsen : Case study on efficiency change in Faroese pair-trawler fleet, ICES-FAO FTFBWG, April 2004) have documented a considerable increase in catch efficiency for the Cuba trawlers including an increase in fishing time per day of 5% and an increase in trawl speed from 3.5 to 4 knots (equivalent to an increase of 14% in swept area) during the late 1990's. The WWG report do not reflect on the recommendation provided by last year review but the WG chairman documented that XSA runs using only commercial CPUE series for the last decade had been conduced and scrutinized by the group. However, the resulting assessment from this XSA run were in essence similar to the final run that used the entire tuning series.

A wrong maturity at age was used in last year's assessment. This was a technical error that has now been corrected (Table attached). A comparison of the wrong maturity at age in that was used in last years assessment with the one used in this years assessment is shown in table 6. The biggest discrepancy is in age 3 and 4 with the values used in last years assessment being substantially higher than the ones used presently. This resulted in a much higher SSB estimation last year compared with this year. Although no calculation was one, it is considered that the error in the SSB estimation last year would not have changed the basis of the advice last year. This judgment is based on the retrospective pattern provided in this years report (figure 2.5.5.3) where it can be seen that the SSB in 2002 is estimated to be above B_{pa}.

The precision of the ADAPT estimates could be used to give a statement on the probability that SSB is below B_{lim}. The group debated the value of doing this. It was suggested that using the uncertainty around the point estimates of ADAPT or any other similar method would be a better way to convey uncertainties and provide an evaluation of the risk of various actions. As such, it is believed that this could have direct value in deriving the advice by capturing the variation in input data, describing the precision of the estimates and providing a way to calculate the probability of F not exceeding Fpa.

It was noted that the retrospective errors are small both for XSA and ADAPT.

For the projections, it was agreed that it is better to use the model weights rather than the 3-year average weights. These were compared in a graph and the model based predicted weights appear to have less of a tendency to overestimate when the weights are declining.

It was noted that this reduces SSB by about 10%.

An inconsistency in F_{max} on page 136 (0.3956) and the value appearing on page 116 in the text table (0.441) were different because they were based on different input. Need to take out the values appearing on Page 116. F_{max} calculated for ACFM should be based on long term data.

Also, on the draft Summary sheet, the catch forecast table has to be revised as it doesn't agree with B-Table.

Sebastes marinus

BORMICON. It was observed that the last two years of the survey appear as outliers in the model. The WG should investigate if it could use the October survey in addition to the March survey to do the fit. The October survey would appear to be more consistent with the trends in the BORMICON results.

It was observed that one more year of high survey changes the perspective on the 10 year forecast but not bad for the 2005 forecast.

Last year, a 25% reduction in F was sought by ACFM. But since the survey index is above U_{pa}, is there a need to project at 25% reduction? Applying a *status quo* F would give 41kt. (i.e. no 25% reduction). A catch of 38kt would correspond to 25% reduction in F. Not straight justification to use 25% reduction.

From BORMICON, any catch above 37000 t would lead to a decrease in fishable biomass. Noting that the WG proposed to use this model as a basis for advice, there is agreement that BORMICON is informative and useful for providing advice. However, as there are no reference points based on this new model, the advice will be cast in relation to precautionary limits expressed in U_{pa} and U_{lim}. As this model is now becoming the basis for the advice, the WG should present the results so that the typical output for SSB (or proxy), total biomass, F, etc, is presented in a table. Also, reference points based on BORMICON should be derived.

Catches in the range of 30-35kt (until 2009) lead to constant biomass. It was observed the model did not include a catch of about 2000 t by other countries (or areas as implied from Table 8.1.1). However, this represents a small fraction of catch in the past many years. So the advice will be 37000 t for 2005. This should be clarified in the next assessment.

The WG is encouraged to work on reference points. They should look at limit reference points in relation to targets. Also, F_{max} is in a species like redfish is often seen as a limit as opposed to a target.

Also, information on the fisheries and regulations should be provided. Can something been said on biology, environmental effect, etc., to assist in support the current efforts for reporting by ICES (using the new format) in this area?

Greenland Halibut

It was observed that the XSA is not applicable as the cohorts cannot be traced consistently in catch data. Accordingly, the assessment uses trends in various surveys and CPUE information and a production model (ASPIC) has been the basis for ACFM advice in recent years. The model uses CPUE and survey info for the Iceland area.

The production model trends do not match the dynamics observed in the surveys and the pattern of residuals and retrospective performance are worrisome. Also, this year's model results are very different than those observed in previous years. See page 367, now around twice F_{MSY}. There is a lot of "freedom" in this model. The WG chairman reported that, within the WG, there was no consensus if we should use the results of the production model or not. The fact that ASPCI is now giving completely different results is worrisome. The Review Group concluded that the ASPIC model should not be used as a basis for the advice.

It was noted that the indices went down by a factor of two in recent years. While the present stock is unknown, the indices suggest a low biomass in recent years compared to the 1980s.

The Review Group discussed the basis for advice. With the addition of the data point in 2003, the production model does not follow the trends in the input data in the last decade. There is, however, no doubt that the present state of the stock is poor in relation to that what is was in 1985. Historically, Division Va been the principle fishing ground and it is the area from which the highest yield has been taken (Figure 6.1.1.) and the area from which the longest information about likely population trends are available (Figure 6.2.1). The annual landings in Va of well above 20 thousand tonnes in the period from 1985-1996 were maintained by ever increasing effort (see in text figure below, based on data in table 6.2.1.) Although temporary reduction in effort were observed in the latter part of the 90s, effort has increased in the last three years and is presently within the order of that observed in the earlier part of the period. ACFM proceeded in formulating the advice on the basis of a catch reduction using the following argument:

- Given the likely state of the stock it is proposed that the present effort should be reduced to 1/3 of the present(60), which level led in the late 1990s to stock some recovery. That level of effort (20) also coincides with the lowest observed in the time series (1998) when the landings in Va where around 10 000 t. This would imply a reduction in landings in Division Va by 50% compared with that taken in 2003. Given that the Greenland halibut in the whole area are the same stock, a similar reduction in landings in Division Vb and XIVb is advised. The 2003 landings in those areas were around 10 thousand tonnes. Using this logic, the advice for all areas is a restriction of catches to no more than 15 thousand tonnes.

The figure with cumulative length (6.6.1) is does not well communicate the intended message. It is used in ACFM report but likely not been understood by the users (managers). We have problems to understand it ourselves. It is recommended to make this picture more user friendly.

Cod stocks in the Greenland area

The cod stocks in Greenland has been on a very low level for more than a decade with no directed cod fisheries taken plaice offshore since the early 1990's. Catch at age information from the fisheries are lacking for several years and the assessment is based only on time series from surveys and by-catch CPUE from the fisheries.

Given that few stock indicators are available more effort could have been given for describing the GLM model used for analyzing the commercial catch rates (sec. 5.1.1.1).

The German survey (table 5.1.4) indicates that 96% of the offshore stock weight is comprised of spawners. This proportion appears high considering the age structure of the catches (table 5..1.5 and 5.1.6) and should be scrutinized in next years report.

The inshore gill-net survey indicates an improved recruitment in the northern area (NAFO div. 1B) in the most recent years and most of the recent landings also appear in that area. However, a significant amount of the inshore catch that has been transshipped to foreign vessels has not been allocated to areas. To clarify the development of the inshore stocks on the geographical scale attempts should be made to allocate these landings to NAFO areas.

Editorial:

Fig.6.6.1. The caption should clarify the intent of these graphs as the legends are not self explanatory (use of > and < intended to identify segments of population (index of recruitment vs index of fishable biomass).

Fig. 6.6.4 . The caption text referencing this figure needs to be corrected.

Figure x : Effort and landings in Va

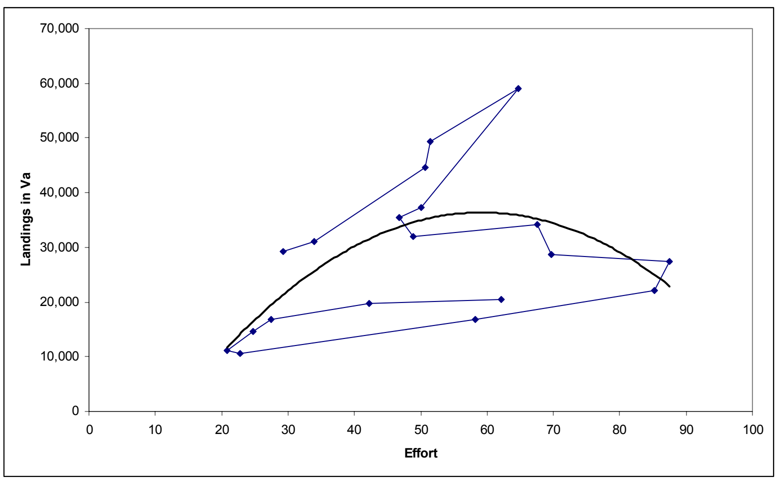


Figure x: Effort and landings in Va

Table 1. Haddock Va. Measured (1985-2004 spring survey) and predicted stock weight

year /age	1	2	3	4	5	6	7	8	9
1979	37	185	481	910	1409	1968	2496	3077	3300
1980	37	185	481	910	1409	1968	2496	3077	3300
1981	37	185	481	910	1409	1968	2496	3077	3300
1982	37	185	481	910	1409	1968	2496	3077	3300
1983	37	185	481	910	1409	1968	2496	3077	3300
1984	37	185	481	910	1409	1968	2496	3077	3300
1985	36	244	568	1187	1673	2371	2766	3197	3331
1986	35	239	671	1134	1943	2399	3190	3293	3728
1987	31	162	550	1216	1825	2605	3030	3642	3837
1988	37	176	457	974	1830	2695	3102	3481	3318
1989	26	182	441	887	1510	2380	3009	3499	3195
1990	29	184	457	840	1234	1965	2675	3052	3267
1991	31	176	501	1003	1406	1884	2496	3755	3653
1992	28	157	503	894	1365	1891	2325	2936	3682
1993	41	168	384	878	1492	1785	2562	2573	3266
1994	33	181	392	680	1235	1766	1717	2977	2131
1995	37	167	440	755	1065	1857	2689	5377	1306
1996	41	174	453	813	1076	1477	2171	2426	4847
1997	50	174	424	817	1221	1425	1915	2390	3692
1998	41	203	415	753	1241	1747	1996	2342	3076
1999	33	206	480	715	1189	1956	2366	2782	2922
2000	29	179	552	889	1159	1767	2612	2917	3132
2001	36	190	490	1056	1437	1509	2169	2765	3300
2002	67	172	475	889	1460	1949	2137	1990	3709
2003	40	230	412	801	1268	1873	3139	2343	3301
2004	34	176	556	807	1282	1690	2454	3236	2942
2005	47	193	447	1020	1233	1760	2298	2874	3383
2006	47	193	447	1020	1233	1760	2298	2874	3383
2007	47	193	447	1020	1233	1760	2298	2874	3383
2008	47	193	447	1020	1233	1760	2298	2874	3383

Table 2. Haddock Va. Measured (1979-2003) and predicted catch weight

Year/age	1	2	3	4	5	6	7	8	9
1979	-1	620	960	1410	2030	2910	3800	4560	4720
1980	-1	837	831	1306	2207	2738	3188	3843	4506
1981	-1	584	693	1081	1656	2283	3214	3409	4046
1982	-1	330	819	1365	1649	2329	3012	3384	3965
1983	-1	655	958	1436	1827	2355	2834	3569	4308
1984	-1	980	1041	1476	2105	2460	3028	3014	3807
1985	-1	599	1002	1783	2201	2727	3431	3783	4070
1986	-1	867	1187	1755	2377	2710	3591	3760	4135
1987	-1	446	1048	1629	2373	2984	3550	4483	4667
1988	-1	468	808	1474	2230	2934	3545	3769	4574
1989	-1	745	856	1170	2010	2879	4109	4035	4706
1990	-1	357	716	1039	1542	2403	3458	4186	4969
1991	-1	409	868	1111	1546	2035	2849	3464	4642
1992	-1	320	856	1253	1597	2088	2529	3133	4022
1993	-1	420	756	1372	1870	2360	2888	2975	3442
1994	-1	568	720	1058	1742	2380	2785	3447	3156
1995	-1	475	874	1145	1366	2079	2853	3251	3899
1996	-1	387	841	1189	1528	1816	2641	3499	3526
1997	-1	450	829	1192	1663	1934	2360	3059	3010
1998	-1	475	702	1108	1646	2222	2478	2839	3359
1999	-1	616	866	1096	1638	2205	2681	2863	3229
2000	-1	517	957	1324	1469	2107	2701	3253	3600
2001	-1	542	933	1451	1759	1836	2309	2966	3533
2002	-1	573	918	1256	1741	2192	2224	2844	3392
2003	-1	559	908	1266	1700	2297	2699	2626	2897
2004	-1	558	882	1292	1688	2197	2755	3113	2876
2005	-1	558	920	1324	1733	2108	2411	2812	3137
2006	-1	558	920	1324	1733	2108	2411	2812	3137
2007	-1	558	920	1324	1733	2108	2411	2812	3137
2008	-1	558	920	1324	1733	2108	2411	2812	3137

Table 3. Haddock Va. Measured and predicted maturity (1985-2004 spring survey) at age

Year/age	1	2	3	4	5	6	7	8	9
1979	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1980	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1981	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1982	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1983	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1984	-1.000	0.080	0.301	0.539	0.722	0.821	0.868	0.904	0.963
1985	-1.000	0.016	0.144	0.536	0.577	0.765	0.766	0.961	0.934
1986	-1.000	0.021	0.205	0.413	0.673	0.845	0.884	0.952	0.986
1987	-1.000	0.022	0.137	0.426	0.535	0.778	0.776	1.000	0.969
1988	-1.000	0.013	0.221	0.394	0.767	0.793	0.928	0.914	1.000
1989	-1.000	0.041	0.202	0.532	0.727	0.818	0.998	1.000	1.000
1990	-1.000	0.114	0.334	0.634	0.814	0.843	0.918	0.882	1.000
1991	-1.000	0.063	0.224	0.592	0.739	0.817	0.894	0.495	1.000
1992	-1.000	0.050	0.227	0.419	0.799	0.901	0.901	0.858	1.000
1993	-1.000	0.124	0.362	0.481	0.670	0.904	0.977	0.908	0.867
1994	-1.000	0.248	0.312	0.573	0.762	0.846	1.000	0.907	1.000
1995	-1.000	0.124	0.479	0.382	0.750	0.753	0.606	0.985	1.000
1996	-1.000	0.191	0.362	0.590	0.648	0.787	0.739	0.949	0.908
1997	-1.000	0.093	0.436	0.587	0.683	0.750	0.783	0.880	1.000
1998	-1.000	0.026	0.454	0.668	0.770	0.733	0.849	0.899	1.000
1999	-1.000	0.050	0.397	0.683	0.724	0.749	0.892	0.761	0.920
2000	-1.000	0.107	0.261	0.632	0.808	0.868	0.873	1.000	0.780
2001	-1.000	0.091	0.377	0.522	0.753	0.895	0.916	0.918	1.000
2002	-1.000	0.047	0.286	0.633	0.800	0.934	0.928	1.000	1.000
2003	-1.000	0.062	0.347	0.685	0.867	0.922	0.946	1.000	1.000
2004	-1.000	0.037	0.361	0.570	0.831	0.910	1.000	1.000	1.000
2005	-1.000	0.049	0.331	0.629	0.833	0.922	0.958	1.000	1.000
2006	-1.000	0.049	0.331	0.629	0.833	0.922	0.958	1.000	1.000
2007	-1.000	0.049	0.331	0.629	0.833	0.922	0.958	1.000	1.000
2008	-1.000	0.049	0.331	0.629	0.833	0.922	0.958	1.000	1.000

Table 4. Estimated (1979-2003) and projected fishing mortality by age and year (Fay) from ADCAM. Projection is based on assumed catch constraint in 2004 and F=0.47 in 2005-2008.

Year/age	1	2	3	4	5	6	7	8	9	F4-7
1979	-1.00	0.00	0.02	0.17	0.42	0.69	0.86	0.86	0.86	0.54
1980	-1.00	0.01	0.02	0.13	0.31	0.57	0.75	0.87	0.87	0.44
1981	-1.00	0.00	0.02	0.12	0.33	0.70	0.80	0.89	0.89	0.49
1982	-1.00	0.00	0.03	0.15	0.35	0.54	0.79	0.92	0.92	0.46
1983	-1.00	0.00	0.03	0.26	0.37	0.66	0.68	0.92	0.92	0.49
1984	-1.00	0.00	0.04	0.24	0.43	0.72	0.64	0.92	0.92	0.51
1985	-1.00	0.01	0.12	0.33	0.49	0.75	0.69	0.96	0.96	0.56
1986	-1.00	0.00	0.13	0.44	0.64	0.96	0.79	0.98	0.98	0.71
1987	-1.00	0.01	0.12	0.40	0.68	0.78	0.78	0.99	0.99	0.66
1988	-1.00	0.00	0.09	0.39	0.64	0.82	0.81	1.00	1.00	0.66
1989	-1.00	0.00	0.09	0.30	0.48	0.90	0.84	1.02	1.02	0.63
1990	-1.00	0.02	0.13	0.35	0.54	0.73	0.83	1.02	1.02	0.61
1991	-1.00	0.03	0.09	0.35	0.59	0.74	0.82	1.02	1.02	0.63
1992	-1.00	0.02	0.13	0.40	0.68	0.84	0.87	1.03	1.03	0.70
1993	-1.00	0.01	0.10	0.37	0.65	0.80	0.94	1.03	1.03	0.69
1994	-1.00	0.01	0.12	0.34	0.64	0.80	0.96	1.05	1.05	0.69
1995	-1.00	0.03	0.21	0.34	0.59	0.82	0.95	1.08	1.08	0.68
1996	-1.00	0.04	0.20	0.46	0.52	0.83	0.98	1.10	1.10	0.70
1997	-1.00	0.02	0.16	0.42	0.64	0.66	0.91	1.09	1.09	0.66
1998	-1.00	0.02	0.12	0.44	0.63	0.80	0.86	1.09	1.09	0.68
1999	-1.00	0.02	0.14	0.39	0.75	0.89	0.91	1.08	1.08	0.73
2000	-1.00	0.02	0.20	0.36	0.62	0.86	0.98	1.08	1.08	0.70
2001	-1.00	0.02	0.14	0.35	0.43	0.69	0.95	1.08	1.08	0.61
2002	-1.00	0.01	0.10	0.30	0.47	0.57	0.88	1.09	1.09	0.55
2003	-1.00	0.01	0.05	0.23	0.42	0.53	0.93	1.12	1.12	0.53
2004	-1.00	0.01	0.09	0.23	0.38	0.50	0.65	0.77	0.77	0.44
2005	-1.00	0.01	0.10	0.25	0.40	0.53	0.70	0.82	0.82	0.47
2006	-1.00	0.01	0.10	0.25	0.40	0.53	0.70	0.82	0.82	0.47
2007	-1.00	0.01	0.10	0.25	0.40	0.53	0.70	0.82	0.82	0.47
2008	-1.00	0.01	0.10	0.25	0.40	0.53	0.70	0.82	0.82	0.47

Table 5. Haddock Va. Estimated and projected population numbers by age and year (Nay) and SSB from ADCAM. Year classes 2004-2007 are assumed geometric mean.

Year/age	1	2	3	4	5	6	7	8	9	SSB
1979	45251	78996	120120	26732	20080	21202	3215	772	116	95.835
1980	11825	37049	64431	96176	18397	10767	8703	1110	267	115.951
1981	51628	9681	29913	51539	68902	11024	4963	3368	380	138.987
1982	36974	42269	7899	23978	37424	40740	4474	1818	1135	135.784
1983	22947	30272	34549	6249	16961	21680	19384	1657	596	109.297
1984	51774	18788	24749	27582	3948	9631	9159	8072	540	80.977
1985	106859	42389	15327	19511	17821	2107	3835	3941	2636	63.293
1986	203059	87489	34388	11135	11484	8943	819	1569	1239	55.314
1987	53765	166250	71392	24743	5868	4950	2795	304	483	44.026
1988	30446	44019	134412	52063	13517	2427	1867	1053	93	66.846
1989	28664	24927	35892	100632	28996	5844	877	680	316	100.099
1990	98677	23468	20312	26974	60808	14705	1943	309	201	109.655
1991	204358	80790	18845	14543	15612	28953	5783	693	92	86.960
1992	44020	167314	64068	14127	8408	7069	11331	2077	204	64.854
1993	48130	36041	134561	45998	7721	3483	2501	3891	608	69.291
1994	86279	39406	29284	99478	25910	3290	1277	796	1134	80.171
1995	43897	70639	31975	21203	57844	11131	1213	399	229	80.473
1996	119567	35940	55879	21288	12323	26266	4001	384	111	67.483
1997	18865	97893	28395	37409	10996	5980	9394	1226	105	57.387
1998	58957	15446	78843	19786	20208	4730	2528	3102	337	62.109
1999	145061	48270	12447	57050	10453	8800	1744	874	854	60.445
2000	180817	118766	38582	8838	31562	4050	2969	576	242	57.608
2001	200936	148040	95131	25987	5054	13894	1400	915	159	64.320
2002	59910	164513	119214	67783	15000	2696	5701	443	255	91.229
2003	226536	49051	133756	88149	41044	7684	1247	1943	121	135.236
2004	474229	185472	39906	103650	57411	22054	3693	403	518	163.867
2005	71118	388266	150232	29873	67412	32179	10952	1573	153	195.669
2006	71118	58227	314271	111793	19134	36846	15458	4465	567	246.998
2007	71118	58227	47130	233861	71606	10458	17700	6302	1610	310.604
2008	71118	58227	47130	35071	149792	39138	5024	7216	2272	286.869

Table 6. Haddock Va. Estimated catch at age (1979-2003) and projected catch at age based on catch constraint in 2004 and F=0.47 in 2005-2008.

Year/age	1	2	3	4	5	6	7	8	9	Yield
1979	-1	271	2403	3874	6325	9692	1709	410	62	57.633
1980	-1	465	1343	10918	4493	4305	4211	594	143	53.817
1981	-1	31	567	5294	17443	5097	2519	1823	206	61.796
1982	-1	64	242	2964	9976	15606	2250	1004	626	69.717
1983	-1	39	780	1298	4740	9615	8730	918	330	63.380
1984	-1	61	833	5292	1255	4537	3980	4464	299	49.181
1985	-1	351	1569	4997	6303	1016	1759	2235	1495	47.905
1986	-1	263	3784	3622	4981	5090	411	902	713	44.526
1987	-1	1884	7085	7513	2662	2451	1385	176	279	41.142
1988	-1	164	10439	15185	5843	1245	952	615	54	53.516
1989	-1	107	2673	24012	10082	3193	459	400	186	64.296
1990	-1	409	2315	7206	23270	7009	1007	181	118	66.847
1991	-1	2301	1443	3896	6387	13865	2983	409	54	54.775
1992	-1	2685	7163	4286	3807	3689	6048	1230	121	45.778
1993	-1	247	11855	13088	3392	1766	1407	2309	361	49.707
1994	-1	319	3076	26277	11281	1661	727	477	679	59.611
1995	-1	2166	5433	5608	23578	5736	685	243	140	59.620
1996	-1	1142	9264	7176	4588	13591	2306	236	68	55.611
1997	-1	1445	3842	11615	4780	2650	5156	751	64	45.415
1998	-1	220	8322	6408	8664	2388	1343	1900	206	42.028
1999	-1	1039	1501	16876	5052	4757	957	534	521	44.979
2000	-1	2332	6221	2430	13362	2151	1705	352	148	40.819
2001	-1	2205	11211	6989	1607	6353	791	557	97	40.108
2002	-1	1036	10484	16080	5128	1073	3060	272	156	49.802
2003	-1	280	6493	16402	12875	2901	694	1210	76	60.638
2004	-1	1793	3104	19391	16515	7930	1624	199	255	79.917
2005	-1	4001	12426	5918	20446	12159	5041	809	79	97.239
2006	-1	600	25993	22145	5803	13923	7115	2296	291	117.501
2007	-1	600	3898	46326	21718	3952	8147	3240	828	142.575
2008	-1	600	3898	6947	45432	14789	2313	3710	1168	142.701

Table 2.4.14 (revised) Faroe haddock. Management option table - Input data

MFDP version 1
Run: man
Time and date: 23:50 5/2/04
Fbar age range: 3-7

2004

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	40167	0.2	0	0	0	0.571	0.0320	0.571
3	16102	0.2	0.31	0	0	0.783	0.1784	0.783
4	23883	0.2	0.96	0	0	0.928	0.3489	0.928
5	33908	0.2	0.99	0	0	1.296	0.3532	1.296
6	4333	0.2	1	0	0	1.834	0.3386	1.834
7	974	0.2	1	0	0	2.078	0.2703	2.078
8	91	0.2	1	0	0	2.226	0.3797	2.226
9	282	0.2	1	0	0	2.365	0.3565	2.365
10	2240	0.2	1	0	0	2.792	0.3565	2.792

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14600	0.2	0.05	0	0	0.571	0.0320	0.571
3	.	0.2	0.42	0	0	0.783	0.1784	0.783
4	.	0.2	0.97	0	0	1.015	0.3489	1.015
5	.	0.2	0.99	0	0	1.192	0.3532	1.192
6	.	0.2	1	0	0	1.546	0.3386	1.546
7	.	0.2	1	0	0	1.994	0.2703	1.994
8	.	0.2	1	0	0	2.212	0.3797	2.212
9	.	0.2	1	0	0	2.288	0.3565	2.288
10	.	0.2	1	0	0	2.792	0.3565	2.792

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14500	0.2	0.05	0	0	0.571	0.0320	0.571
3	.	0.2	0.42	0	0	0.783	0.1784	0.783
4	.	0.2	0.97	0	0	1.015	0.3489	1.015
5	.	0.2	0.99	0	0	1.305	0.3532	1.305
6	.	0.2	1	0	0	1.423	0.3386	1.423
7	.	0.2	1	0	0	1.681	0.2703	1.681
8	.	0.2	1	0	0	2.123	0.3797	2.123
9	.	0.2	1	0	0	2.273	0.3565	2.273
10	.	0.2	1	0	0	2.792	0.3565	2.792

Input units are thousands and kg - output in tonnes

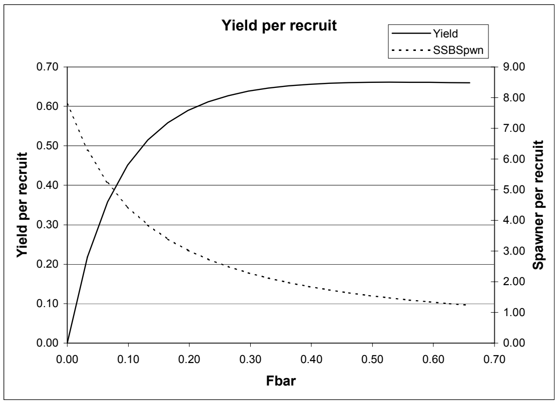
Table 2.4.15 (revised) **Faroe haddock. Management option table - Results**

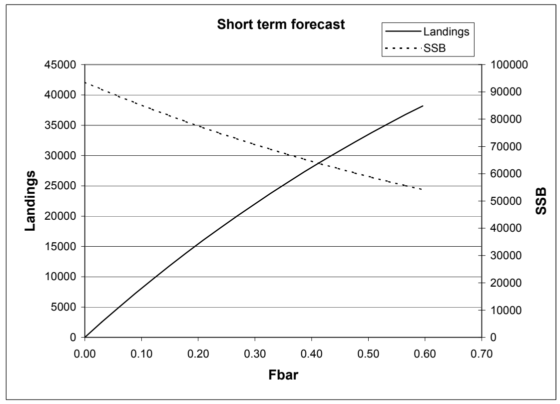
MFDP version 1
Run: jak
Index file 02/05/2004
Time and date: 12:17 5/31/04
Fbar age range: 3-7

2004				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
118746	85785	1	0.2979	24869

2005					2006	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
104467	79921	0	0	0	107748	93542
.	79921	0.1	0.0298	2499	105116	90945
.	79921	0.2	0.0596	4924	102563	88428
.	79921	0.3	0.0894	7277	100089	85988
.	79921	0.4	0.1192	9560	97689	83622
.	79921	0.5	0.1489	11775	95362	81329
.	79921	0.6	0.1787	13926	93106	79106
.	79921	0.7	0.2085	16012	90918	76951
.	79921	0.8	0.2383	18038	88796	74862
.	79921	0.9	0.2681	20004	86738	72836
.	79921	1	0.2979	21913	84741	70871
.	79921	1.1	0.3277	23766	82805	68966
.	79921	1.2	0.3575	25564	80926	67119
.	79921	1.3	0.3873	27311	79104	65327
.	79921	1.4	0.417	29007	77336	63589
.	79921	1.5	0.4468	30654	75621	61904
.	79921	1.6	0.4766	32253	73956	60269
.	79921	1.7	0.5064	33807	72341	58684
.	79921	1.8	0.5362	35316	70774	57146
.	79921	1.9	0.566	36781	69253	55653
.	79921	2	0.5958	38205	67777	54206

Input units are thousands and kg - output in tonnes





MFYPR version 1
Run: ypr-final
Time and date: 10:36 5/3/04

Reference point	F multiplier	Absolute F
Fbar(2-10)	1.0000	0.3296
FMax	1.6306	0.5375
F0.1	0.5845	0.1927
F35%SPR	0.7018	0.2313
Flow	3.0562	1.0075
Fmed	0.7302	0.2407
Fhigh	3.0562	1.0075

Weights in kilograms

MFDP version 1
Run: jak
Index file 02/05/2004
Time and date: 12:17 5/31/04
Fbar age range: 3-7

Input units are thousands and kg - output in tonnes

Faroe haddock predictions (revised May 2004)

Table 7. Saithe in Vb. Comparison between the maturity at age used in the 2003 assessment (left) and 2004 assessment (right).

Year/age	3	4	5	6	7	8	9
1983	0.10	0.28	0.61	0.88	0.96	0.99	1.00
1984	0.12	0.28	0.51	0.86	0.97	0.99	1.00
1985	0.11	0.28	0.62	0.83	0.97	1.00	1.00
1986	0.15	0.28	0.55	0.80	0.94	0.99	1.00
1987	0.13	0.27	0.50	0.78	0.93	0.98	0.99
1988	0.12	0.28	0.44	0.75	0.92	0.97	0.99
1989	0.11	0.25	0.42	0.68	0.92	0.98	0.99
1990	0.10	0.23	0.41	0.62	0.85	0.97	0.99
1991	0.10	0.22	0.41	0.64	0.83	0.94	0.99
1992	0.10	0.22	0.44	0.69	0.87	0.97	0.99
1993	0.11	0.26	0.49	0.77	0.91	0.97	0.99
1994	0.12	0.27	0.48	0.75	0.94	0.98	0.99
1995	0.12	0.30	0.51	0.74	0.91	0.98	0.99
1996	0.11	0.26	0.52	0.79	0.91	0.98	1.00
1997	0.12	0.25	0.44	0.72	0.90	0.98	1.00
1998	0.11	0.26	0.51	0.75	0.91	0.98	0.99
1999	0.11	0.27	0.51	0.78	0.93	0.98	1.00
2000	0.11	0.24	0.41	0.67	0.84	0.97	0.99
2001	0.12	0.22	0.44	0.65	0.86	0.94	0.99
2002	0.11	0.22	0.39	0.69	0.86	0.96	0.98
Average	0.114	0.257	0.481	0.742	0.907	0.975	0.993

Year/age	3	4	5	6	7	8	9
1983	0.02	0.23	0.74	0.94	0.97	1.00	1.00
1984	0.03	0.25	0.57	0.93	0.98	1.00	1.00
1985	0.03	0.25	0.75	0.89	0.99	1.00	1.00
1986	0.05	0.23	0.64	0.86	0.94	0.99	1.00
1987	0.04	0.24	0.56	0.83	0.94	0.99	0.99
1988	0.04	0.26	0.49	0.78	0.91	0.97	0.99
1989	0.03	0.20	0.45	0.69	0.91	0.98	1.00
1990	0.02	0.17	0.42	0.58	0.80	0.97	0.99
1991	0.02	0.15	0.40	0.62	0.73	0.92	0.99
1992	0.02	0.16	0.45	0.69	0.82	0.96	0.99
1993	0.03	0.20	0.54	0.82	0.91	0.97	0.99
1994	0.03	0.22	0.52	0.78	0.95	0.99	1.00
1995	0.03	0.27	0.57	0.77	0.90	0.99	0.99
1996	0.03	0.23	0.58	0.84	0.90	0.99	1.00
1997	0.03	0.19	0.47	0.74	0.89	0.98	1.00
1998	0.03	0.19	0.42	0.67	0.84	0.96	0.99
1999	0.04	0.17	0.42	0.64	0.77	0.96	0.99
2000	0.04	0.21	0.44	0.65	0.78	0.92	0.99
2001	0.04	0.19	0.46	0.68	0.81	0.94	0.98
2002	0.02	0.18	0.39	0.60	0.80	0.92	0.98
2003	0.02	0.11	0.41	0.58	0.74	0.95	0.99
Average	0.03	0.20	0.51	0.74	0.87	0.97	0.99

Table 1. Saithe in Va. Summary table based on catch weights and maturity.

Year	RECRUITS	BIO4+	TOTSPBIO	Landings	Yield/SSB	FBAR 4-9
1962	30	187	101	50	0.50	0.288
1963	77	205	107	48	0.45	0.351
1964	54	289	114	60	0.53	0.269
1965	84	360	150	60	0.40	0.249
1966	68	471	212	52	0.25	0.199
1967	67	560	280	76	0.27	0.258
1968	63	604	336	78	0.23	0.230
1969	88	632	374	116	0.31	0.268
1970	64	668	384	113	0.29	0.319
1971	52	642	370	134	0.36	0.429
1972	27	553	327	108	0.33	0.378
1973	18	461	296	111	0.38	0.336
1974	21	383	278	98	0.35	0.310
1975	26	317	236	88	0.37	0.320
1976	30	269	190	82	0.43	0.357
1977	20	237	149	62	0.42	0.302
1978	44	220	137	50	0.36	0.323
1979	54	240	132	64	0.48	0.370
1980	27	268	146	58	0.40	0.332
1981	19	261	149	59	0.40	0.333
1982	23	245	156	69	0.44	0.370
1983	31	227	154	58	0.38	0.228
1984	42	258	170	63	0.37	0.319
1985	34	278	162	57	0.35	0.285
1986	65	298	177	65	0.37	0.320
1987	94	314	169	81	0.48	0.391
1988	50	397	163	77	0.47	0.319
1989	31	384	169	82	0.49	0.311
1990	21	367	183	98	0.54	0.336
1991	31	299	178	102	0.57	0.305
1992	15	281	182	80	0.44	0.323
1993	19	238	169	72	0.42	0.386
1994	17	192	144	64	0.45	0.504
1995	33	147	108	49	0.45	0.419
1996	26	151	99	40	0.41	0.405
1997	17	157	97	37	0.38	0.367
1998	8	155	99	32	0.32	0.373
1999	28	125	92	31	0.34	0.337
2000	32	132	90	33	0.37	0.353
2001	46	154	96	32	0.33	0.315
2002	56	199	111	42	0.38	0.334
2003	99	250	125	52	0.42	0.317
2004	9	365	140			

Table 2. Saithe in Va. Short term prediction input data with catch weights and maturity - 'old SSB'.

Mean weight in the catches:

age/year	2004	2005	2006	2007	2008
3	1.370	1.370	1.370	1.370	1.370
4	1.896	2.020	1.929	1.929	1.929
5	2.550	2.503	2.972	2.972	2.972
6	3.334	3.329	3.225	3.225	3.225
7	4.398	4.306	4.258	4.258	4.258
8	5.411	5.571	5.472	5.472	5.472
9	6.800	6.800	6.800	6.800	6.800
10	7.730	7.730	7.730	7.730	7.730
11	8.780	8.780	8.780	8.780	8.780
12	9.740	9.740	9.740	9.740	9.740
13	10.790	10.790	10.790	10.790	10.790
14	11.490	11.490	11.490	11.490	11.490

Mean weight at spawning time:

age/year	2004	2005	2006	2007	2008
3	1.370	1.370	1.370	1.370	1.370
4	1.896	2.020	1.929	1.929	1.929
5	2.550	2.503	2.972	2.972	2.972
6	3.334	3.329	3.225	3.225	3.225
7	4.398	4.306	4.258	4.258	4.258
8	5.411	5.571	5.472	5.472	5.472
9	6.800	6.800	6.800	6.800	6.800
10	7.730	7.730	7.730	7.730	7.730
11	8.780	8.780	8.780	8.780	8.780
12	9.740	9.740	9.740	9.740	9.740
13	10.790	10.790	10.790	10.790	10.790
14	11.490	11.490	11.490	11.490	11.490

Sexual maturity:

age/year	2004	2005	2006	2007	2008
3	0.04	0.04	0.04	0.04	0.04
4	0.20	0.20	0.20	0.20	0.20
5	0.41	0.41	0.41	0.41	0.41
6	0.64	0.64	0.64	0.64	0.64
7	0.81	0.81	0.81	0.81	0.81
8	0.93	0.93	0.93	0.93	0.93
9	0.96	0.96	0.96	0.96	0.96
10	1.00	1.00	1.00	1.00	1.00
11	1.00	1.00	1.00	1.00	1.00
12	1.00	1.00	1.00	1.00	1.00
13	1.00	1.00	1.00	1.00	1.00
14	1.00	1.00	1.00	1.00	1.00

Table 2 (continued). Saithe in Va. Short term prediction input data with catch weights and maturity - 'old SSB'.

Natural mortality (M):

age/year	2004	2005	2006	2007	2008
3	0.2	0.2	0.2	0.2	0.2
4	0.2	0.2	0.2	0.2	0.2
5	0.2	0.2	0.2	0.2	0.2
6	0.2	0.2	0.2	0.2	0.2
7	0.2	0.2	0.2	0.2	0.2
8	0.2	0.2	0.2	0.2	0.2
9	0.2	0.2	0.2	0.2	0.2
10	0.2	0.2	0.2	0.2	0.2
11	0.2	0.2	0.2	0.2	0.2
12	0.2	0.2	0.2	0.2	0.2
13	0.2	0.2	0.2	0.2	0.2
14	0.2	0.2	0.2	0.2	0.2

Selection pattern:

age/year	2004	2005	2006	2007	2008
3	0.022	0.022	0.022	0.022	0.022
4	0.105	0.105	0.105	0.105	0.105
5	0.201	0.201	0.201	0.201	0.201
6	0.291	0.291	0.291	0.291	0.291
7	0.374	0.374	0.374	0.374	0.374
8	0.466	0.466	0.466	0.466	0.466
9	0.466	0.466	0.466	0.466	0.466
10	0.466	0.466	0.466	0.466	0.466
11	0.466	0.466	0.466	0.466	0.466
12	0.466	0.466	0.466	0.466	0.466
13	0.466	0.466	0.466	0.466	0.466
14	0.466	0.466	0.466	0.466	0.466
F4-9	**0.317**	**0.317**	**0.317**	**0.317**	**0.317**

Stock in numbers in starting year (millions):

age/year	2004		
3	9.01445	**Recruitment=**	**30.000**
4	79.5898		
5	33.2701		
6	18.0873		
7	7.69142		
8	3.72209		
9	0.530578		
10	0.547548		
11	0.415498		
12	0.248813		
13	0.0603699		
14	0.0294727		
Total=	**153.207**		

F-factor: F04=Fsq, F05 and onwards are Fsq factors in relation to Fpa

	2004	*2005*	*2006*	*2007*	*2008*	Fsq/Fpa
Opt1	1	0.09	0.09	0.09	0.09	0.10
Opt2	1	0.23	0.23	0.23	0.23	0.25
Opt3	1	0.47	0.47	0.47	0.47	0.50
Opt4	1	0.70	0.70	0.70	0.70	0.74
Opt5	1	0.84	0.84	0.84	0.84	0.89
Opt6	1	0.94	0.94	0.94	0.94	0.99
Opt7	1	1.03	1.03	1.03	1.03	1.09
Opt8	1	1.17	1.17	1.17	1.17	1.24
Opt9	1	1.41	1.41	1.41	1.41	1.49
Opt10	1	0.00	0.00	0.00	0.00	0.00

Table 3. Saithe in Va. Short term prediction with catch weights and maturity - 'old SSB'.

Icelandic SAITHE. Division Va.

Projection of stock and spawning stock biomass (thousand tonnes)
in 2005-2007 for different management strategies.

2004				**2005**					**2006**	
Stofn 4+ *Stock* *4+*	Hrygn-stofn *Spawning stock*	F	Afli *Catch*	Stofn 4+ *Stock* *4+*	Hrygn-stofn *Spawn. stock*	*F/Fpa*	F	Afli *Catch*	Stofn 4+ *Stock* *4+*	Hrygn-stofn *Spawn. stock*
365	165	0.32	63	329	194	0.10	0.03	8	382	262
				329	193	0.25	0.07	19	369	252
				329	194	0.50	0.15	37	349	236
										221
				329	194	0.90	0.27	63	320	213
				329	194	1.00	0.30	69	313	208
				329	194	1.10	0.33	74	306	202
				329	194	1.35	0.37	83	297	195
				329	194	1.50	0.45	96	281	183
				329	194	0.00	0.00	0	391	269