ICES NWWG REPORT 2005

ICES ADVISORY COMMITTEE ON FISHERY MANAGEMENT
ICES CM 2005/ACFM:21

REPORT OF THE NORTH WESTERN WORKING GROUP (NWWG)

26 APRIL – 5 MAY

ICES HEADQUARTERS

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer
H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:
ICES. 2005. Report of the North Western Working Group, 26 April - 5 May 2005,
ICES Headquarters. Diane. 604 pp.

Contents

1 INTRODUCTION

1.1 Terms of reference

The North-Western Working Group [NWWG] (Chair: E. Hjörleifsson, Iceland) will meet at ICES Headquarters from 26 April - 5 May 2005 to:

a) assess the status of and provide management options for 2006 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, haddock in Division Va, Icelandic summer spawning herring and capelin in Subareas V and XIV;

b) assess the status of and provide effort options and expected corresponding catches for 2006 for cod, haddock, and saithe in Division Vb as these stocks are under effort control;

c) 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.

d) update survey and fishery information on the stocks of redfish in Subareas V, VI, XII and XIV. In particular, update information on the on the horizontal and vertical distribution of pelagic redfish and fisheries in the Irminger Sea and adjacent waters as well as seasonal and inter annual changes in distribution. This information should allow NEAFC to further consider the appropriateness of separate management measures of different geographical areas/seasons;

e) 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;

f) for the stocks mentioned in a) and b) perform the tasks described in C.Res. 2ACFM01.

NWWG will report by 6 May 2005 for the attention of ACFM.

In ToR f referring to C.Res.2ACFM01 is given below:

WGNSSK, WGSSDS, WGHMM, WGMHSA, WGBFAS, WGNSDS, WGNPBW, AFWG, HAWG, NWWG, and WGPAND will, in addition to the tasks listed by individual group, in 2005:

1. for stocks where it is considered relevant, review limit reference points (and come forward with new ones where none exist) and develop proposals for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) following the guidelines from SGMAS (2005) and AMAWGC (2004 and 2005);
2. comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans;
3. based on input from WGRED incorporate (where appropriate) existing knowledge on important environmental drivers for stock productivity and management into assessment and prediction, and important impacts of fisheries on the ecosystem;
4. update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;
5. where misreporting is considered significant provide information on its distribution on fisheries and the methods used to obtain the information;

6. provide for each stock information on discards (its distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessment;
7. provide on a national basis an overview of the sampling of the basic assessment data for the stocks considered;
8. provide specific information on possible deficiencies in the 2005 assessments including, at least, any major inadequacies in the data on landings, 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 both the assessment of the status of the stocks and the projection should be clarified.

In addition to the ToR from ICES the NWWG is asked to address the NEAFC request to ICES on the following issues: “In particular, NEAFC requests ICES to provide the following: Regarding redfish stocks in the Irminger Sea and adjacent areas:

a) Provide information of stock identity of *Sebastes mentella* fished in pelagic and demersal fisheries. ICES is asked to describe concepts on which management of *Sebastes mentella* can be based;
b) Provide quantitative information to allow spatial and temporal limitations in catches and other measures to avoid disproportionate exploitation rate of any one component, especially to prevent local depletion;”

1.2 Working group procedure

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. The Icelandic herring, capelin and 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 an almost ceased fishery prevents an analysis based on catch at age. One redfish stock, S. *marinus* falls also in the class of analytical assessment, it being assessed by a age/length-based model (Bormicon). In the second class are the S.*mentella* management units as well as Greenland halibut.

The long list of ToR for the working groups in addition to the NWWG now having additional two additional stocks to assess (Capelin and Icelandic where moved from the WGNPBW to the NWWG this year) necessitated prioritization of the ToRs. Within the timeframe of the working group meeting the WG principally focused on addressing ICES ToR a, b, d, and e and NEAFC ToR a and b. The answer to these ToR can be found in the relevant chapters.

The ToRs from the C.Res. 2ADFM01 where not addressed systematically for all stocks. The main focus was on reviewing limit reference points where evaluate management strategies where appropriate (ToR1). The evaluation of management strategies where in principle limited to software that was familiar to the assessor and the time frame of the WG meeting. For the stocks where analytical assessment is done, misreporting (ToR1) and discards (ToR6) are considered to be relatively minor compared with what is reported to occur in EU waters and are thus not expected to result in major deficiencies in the assessment (ToR8). The quality of the surveys for those stocks are also considered to be relatively good, at least for cod and haddock. Given that fishing mortality estimates are in practice used as a proxy for effort in the Faroese waters when advice is formulated attention has focussed on understanding the discrepancies in the reference F values in the terminal years.

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 runs” only the Faroe saithe was based on a commercial tuning series since the available survey index needs to be evaluated further. 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, including a comparison with settings in the two previous years.

The S. *mentella* is in principle assessed in a subgroup within the NWWG with plenary discussions limited to the main issues. The subgroup focused on providing assessments according to presently set management units, the demersal S. *mentella* and the pelagic S. *mentella*. However, different perception on the stock structure of the S. *mentella* within the group often hampers the work process and makes the reaching of a consensus often difficult. Repeated requests for reviewing material related to the stock structure, an issue that is not suitable to address in an annual assessment working group environment, does not help.

In last two years report it was noted that changes in the structure of the report (Annex, "Quality Control") needed intercessional work. Since this work was not done prior to this meeting (except for some restructuring of the Icelandic cod section) it was decided to keep more or less the past format of the report. The format of the report for the Faroese stocks are internally relatively consistent but the format of the different Icelandic stocks is still very stock (assessor) specific. It is recognized that this may impede an efficient review of the available material. The format of the other sections are driven by the data that is available.

1.3 Software used

The assessment on the Faroese stocks has historically been based on the Lowestoft software (XSA). This year the working group continued experimenting 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 (given the model assumption) 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.

In recent years Icelandic stocks have been assessed by using various approaches. The reason for the use of different software platforms than the standard ICES packages is a result of the preference and expertise of the individual user that does the assessment. The limitation of the input control and the archaic output of the Lowestoft software when it comes to exploratory work on the diagnostic, model results and predictions has helped this move. 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.

1.4 Recommendation

The Group was repeatedly requested to provide information on stock identity of redfish. Since the Group does not have sufficient expertise to thoroughly review the scientific content of new information submitted on stock identification of redfish, the Group recommends to forward this information to the external Expert Groups holding the required expertise.

Stock	Assessment year	Assessment model	Survey at age: Tuning fleets	Year range for tuning	Age range for tuning	cpue-population model: Power	Survey-population model: Proportional	q-platau	Time series weights	Catch at age: Separability model	Time variant selection	Selectivity platau	Shrinkage year range	Shrinkage age range	S.E for shrinkage	F inertia	Plus group	Plus group model
Faroe cod	2003	XSA	Summer survey	1996-2002	2-8	2	3-8	6+	None				5	5	2			
	2004	XSA	Summer survey	1996-2003	2-8	2	3-8	6+	None				5	5	2		No	N/A
			Spring survey	1994-2004	2-9	2	3-9	6+	None								No	
	2005	XSA	Summer survey	1996-2004	2-8		2-8	6+	None				5	5	2		No	N/A
			Spring survey	1994-2005	2-9		2-9	6+	None								No	
Faroe haddock	2003	XSA	Summer survey	1996-2002	1-8	1-2	3-8	6+	None				5	5	0.5			Not modelled
			Spring survey	1994-2003	1-5	1-2	3-5	None	None									
	2004	XSA	Summer survey	1996-2003	1-8	1-2	3-8	6+	None				5	5	0.5		10+	Not modelled
			Spring survey	1994-2004	1-5	1-2	3-5	None	None									
	2005	XSA	Summer survey	1996-2004	1-8		1-8	6+	None				5	5	0.5		10+	Not modelled
			Spring survey	1994-2005	1-5		1-5	None	None									
Faroe saithe	2003	XSA	Cuba log books	1985-2002	3,5-11	3	5-11	9+	Yes				5	3	0.5		12+	Not modelled
	2004	XSA	Cuba log books	1985-2003	3-11	3,4	5-11	9+	Yes				5	3	0.5		12+	Not modelled
	2005	XSA	GLM log books	1995-2004	3-11		3-11	8+	None				5	3	2		12+	Not modelled
Icelandic saithe	2003	Camera	March survey	1985-2003	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
	2004	Camera	March survey	1985-2004	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
	2005	Camera	March survey	1985-2005	2-8		2-8	6+	None	parametric	Fixed	8+ platau				None	No	N/A
Icelandic cod	2003	ADCAM	March survey	1985-2003	1-10	1-5	6-10	None	None	parametric	RW	None				RW	No	N/A
	2004	ADCAM	March survey	1985-2004	1-10	1-5	6-10	None	None	parametric	RW	None				RW	No	N/A
	2005	ADCAM	March survey	1985-2005	1-10	1-5	6-10	None	None	parametric	RW	None				**RW****	No	N/A
Icelandic haddock	2003	ADCAM	March survey	1985-2003	1-9		1-9	None	None	parametric	RW	None				RW	No	N/A
	2004	ADCAM	March survey	1985-2004	1-9		1-9	None	None	parametric	RW	None				**RW****	No	N/A
	2005	ADCAM	March survey	1985-2005	1-9		1-9	None	None	parametric	RW	None				RW	No	N/A
Icelandic herring	2004	AMCI	Accustic survey	1981-2003	3-9		3-9	5+		parametric	RW	5+				None		
	2005	Camera	Accustic survey	1987-2004	3-4		3-4	None	None	parametric	Fixed	8+				None	No	N/A

** Reduced inertia on the random walk (RW) for fishing mortality.

Table 1.1 Overview of the observables, models and principal assumptions used for the stocks that are analytically assessed by the NWWG. Comparison of settings are made between consecutive assessment years, with changes indicated with shading.

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 licences 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. These target fishing mortalities have been evaluated during the 2005 NWWG meeting (2.1.6).

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 and its value within 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.

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 (2005), this could have pronounced effects on catchability and stock assessment as a whole. Below are the results from an analysis regarding Faroe Plateau cod, Faroe haddock and Faroe saithe.

For cod there seems to be a link between the primary production and growth of cod (Fig. 2.1.2). The growth of cod seems to be negatively correlated with the catchability of longlines (Fig. 2.1.3), suggesting that cod prefer long line 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 long line catchability and thus there is a negative relationship between cod growth and fishing mortality (Fig. 2.1.4).

For haddock there seems to be a similar mechanism as for cod. Although the catchability for longliners (which take the majority of the catch) as estimated from the longliner logbooks does not follow the expected pattern for the first part of the series (1986-1995), it may be a result of very small catches in this period when stock biomass was low. The fact that we observe a negative relationship between growth and fishing mortality (Fig. 2.1.5) suggests, that the same mechanism is valid for haddock as for cod.

It is, however, important to note that the relationship between the productivity of the ecosystem and the catchability of long lines depends on the age of the fish. The relationship is most clear for fish age 5; for cod age 3 and 4, the relationship is less clear, and for young haddock there apparently is no such relationship between productivity and catchability.

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

The analysis reported above suggests that natural factors may have a larger influence than technological ones, at least for Faroe Plateau cod and haddock on changes of catchability. In addition, the available data indicate 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 2005 assessment of Faroe Plateau cod, haddock and saithe

A summary of selected parameters from the 2005 assessment of Faroe Plateau cod, haddock and saithe is shown in Figure 2.1.6. 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 1)at the oldest, poorly sampled ages and 2)for very small poorly sampled year classes. 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. 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 2004. 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 Medium term projections and reference points for Faroe Stocks

2.1.6.1 Data and methodology

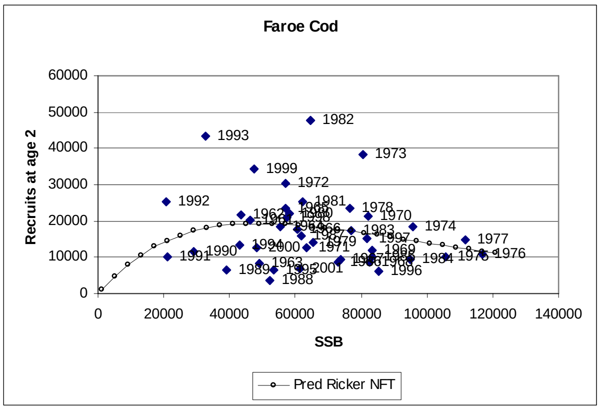
One hundred years projections using the results of the 2004 assessments were made for the Faroese demersal stocks of cod, haddock and saithe under similar assumptions. Natural mortality was assumed fixed at M = 0.20 for all ages and all years. The average of the values for 1996 to 2003 were used for the exploitation pattern, average weights at age and maturity at age. Weights at age in the stock were assumed equal to weights at age in the catch. Future recruitment was modelled from a Ricker stock – recruitment relationship fitted using the USA National Marine Fisheries Service NFT SRFIT software. The form used by SRFIT is R = S*exp(alpha + beta *S). The residuals from the fit were randomly added to the predicted recruitment in order to introduce stochasticity. If the residual added to the recruitment calculated from the equation was negative and larger than the predicted recruitment, the resulting negative value was replaced with zero. Four scenarios of fishing mortality were investigated: F status quo, F target = 0.45 corresponding to 33% exploitation rate in numbers, increasing F at 3% per year, and decreasing F at 3% per year until F had been reduced by 50%. The increasing F scenario is considered plausible in the effort management system extant on the Faroes. Each scenario was run 250 times in an excel spreadsheet using the FishLab software. The yearly SSB and Catches were recorded. The median catch, the coefficient of variation of the catch, the median SSB, and the probability that the SSB will be lower than reference points were examined.

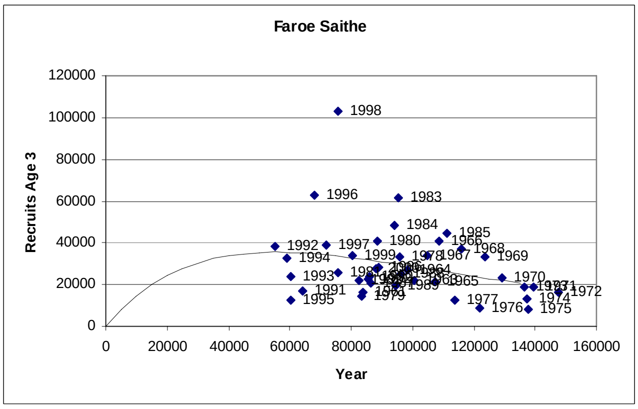
2.1.6.2 Stock and recruitment

Results of the stock and recruitment fits are provided in the text table below:

	MSY	FMSY	BMSY	ALPHA	BETA
Cod	29283	1.03	56721	0.0660415	-2.03431e-5
Haddock	20630	1.42	44885	0.790725	-2.28351e-5
Saithe	44116	1.47	58046	0.554204	-1.80126e-5

The derived estimates of MSY and BMSY are consistent with the history of the fishery and with the stock and recruitment scatter plot. FMSY is estimated to be very high for the three stocks. This is presumably linked to the maturity at age being higher than the exploitation pattern at age for the three stocks.





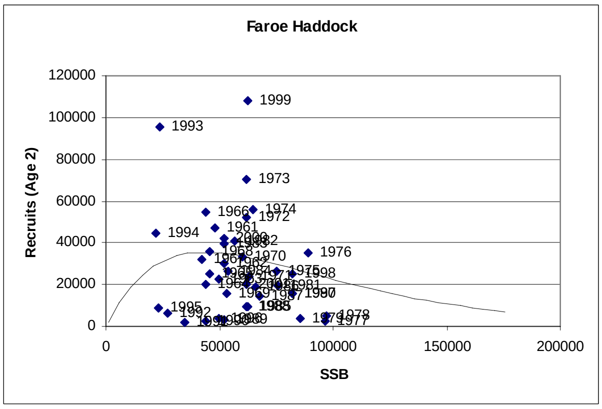


Figure 1: Stock and recruitment fits for Faroese demersal stocks using the NMFS SRFIT software.

For cod and haddock, there are stock and recruitment pairs to the left of the inflection point, but not for saithe. This is consistent with the inverse form of the data which suggest that recruitment increases as SSB decreases.

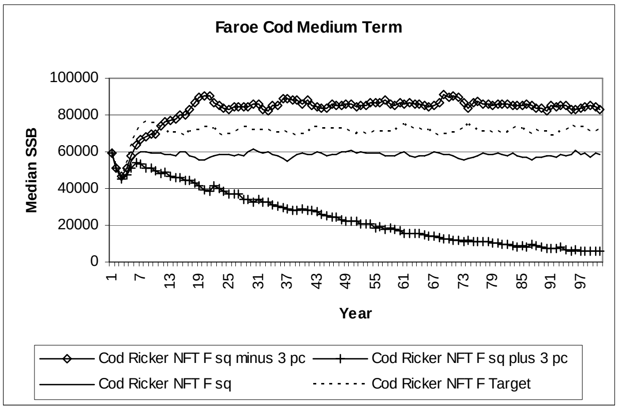
Blim

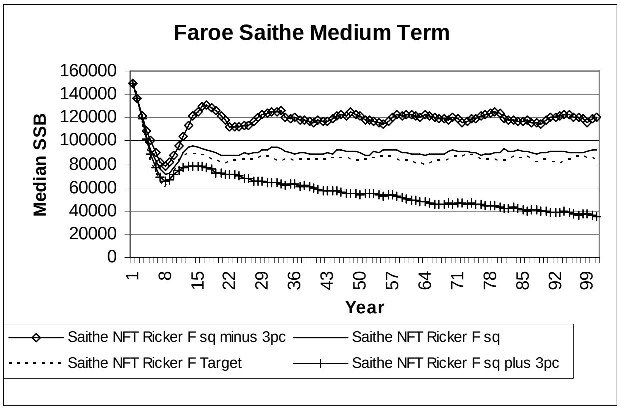
The Blim used by ICES are 21 000t for cod, 40 000t for haddock and 60 000t for saithe. The existing Blim for cod is consistent with the stock and recruitment observations and also with the results of a segmented regression analysis done for the Study Group on Precautionary Reference points for Advice on Fishery Management (SGPRP) 2003 but those for haddock and saithe are not. For haddock, the addition of new stock and recruitment pairs since the original analysis in 1998 clearly indicates that Blim is likely to be lower than the existing value. Segmented regressions done for the SGPRP 2003 indicate a breaking point in the order of 23 000t. The NWWG suggest that the new Blim for Faroe haddock be set at 23 000t. The saithe stock and recruitment pairs are of the inverse form where recruitment increases as SSB decreases. The SGPRP 2003 suggests that in such situations Bloss be used as an estimate of Bpa. The NWWG recommends that the existing Blim of 60 000t for Faroe saithe be considered as an estimate of Bpa.

There was insufficient time during the WG meeting to calculate Bpa for cod and haddock according to the methodology recommended in SGPRP 2003.

2.1.6.3 Medium term projections

Three of the effort scenarios are considered sustainable: the F status quo, the F target and the decreasing F at 3% per year. Not surprisingly, the scenario where the fishing mortality is assumed to increase at 3% per year is not sustainable.





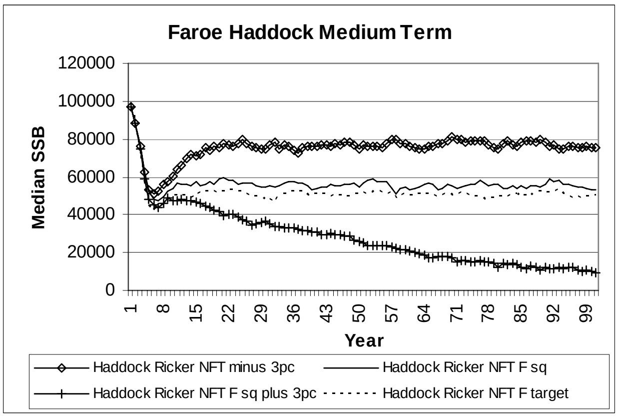
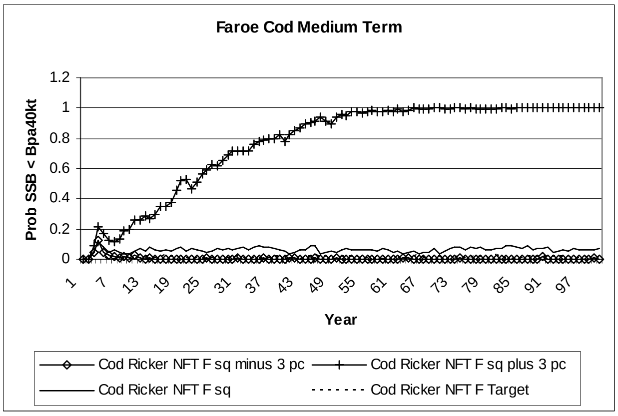


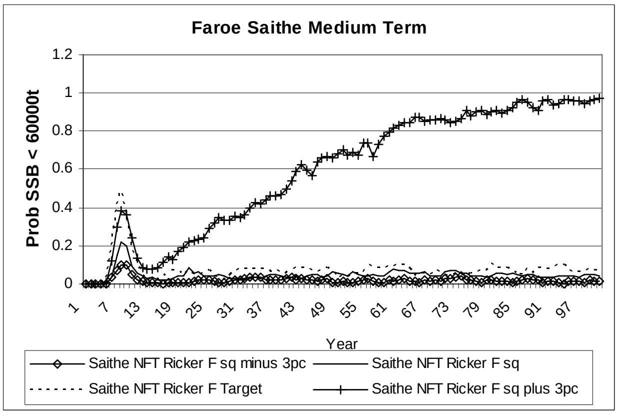
Figure 2: Medium term median SSB for Faroese demersal stocks. The medians are deceptively stable. Individual trajectories of the 250 simulations done are considerably more variable.

Under the unsustainable scenario of increasing F at 3% per year, the median SSB decreases steadily and relatively quickly towards extinction for cod and haddock.

For saithe, the decline rate is smaller because the stock and recruitment relationship used assumes that maximum recruitment occurs at biomasses lower than those that have been observed since the early 1960s. For cod, F status quo is higher than F target, and therefore the median SSB at F target are higher than at Fsq. For haddock and saithe, the reverse is observed because Fsq is lower than F target. The reverse situation occurs with catches: for cod, median catches vary between 24 000t and 28 000t with those at F target slightly smaller than at Fsq. For haddock (15 000t to 19 000t) and saithe (30 000t to 41 000t), median catches are higher at Ftarget than at Fsq. For cod, decreasing the fishing mortality to 50% of status quo would result in an increase of 1 kg (from 2.5 to 3.5) in the average weight in the catch.

The NWWG considers that it could be confusing and misguided to evaluate the medium term scenarios with respect to the existing biomass reference points for haddock and saithe. The following figure therefore illustrates the probability that the various scenarios would cause the stock to go below the recommended Blim = 23000 for haddock and below the recommended Bpa = 60 000t for saithe. For cod, because there is a negligible probability that the stock will go below Blim = 21 000t and the graph is uninformative for the three sustainable scenarios, the graph shows instead the probability that the SSB will go below Bpa = 40 000t.





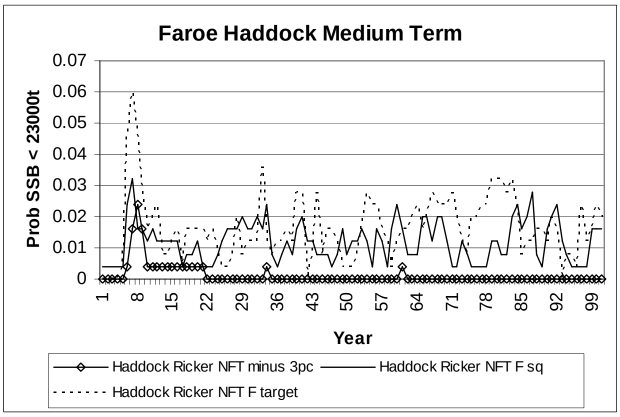


Figure 3: Probability that the SSB will be below Bpa for cod and saithe and below the recommended Blim for haddock.

For all stocks there is a higher probability of breaching reference points for the three sustainable scenarios in the short term than in the medium to long term. For the three sustainable scenarios, the probability of breaching Bpa is generally less than 10% for cod and saithe, and the probability of breaching Blim is generally less than 3% for haddock.

2.1.6.4 Flim

The 2003 SGPRP suggested that Flim be derived from the Blim through finding the F corresponding to the SSB per recruit at Blim. For cod, the SGPRP calculated that the Flim corresponding to the segmented regression would be F = 1.44. The SGPRP did not calculate an Flim for the changing point of the segmented regression. However, the recruitment at 23000t from the Ricker relationship is 30000 giving an SSB per recruit of 0.767 corresponding to an Flim of 1.677. For saithe, given that Blim is not defined, Flim cannot be defined this way. The NWWG recommends that Flim for cod be set at 1.4 and that Flim for haddock be set arbitrarily at F= 1.4.

2.1.6.5 Conclusion

Based on the above, the NWWG concludes that the F-targets set by the Faroese authorities are sustainable and consistent with the precautionary approach under current management and environmental conditions. This conclusion must be qualified however:

- The effort management system is expected to result in increased fishing mortality over time because of technological improvements etc. This means that to be sustainable, the status quo needs a mechanism to reduce fishing mortality as fishing efficiency increases.
- The ability of Faroese stocks to sustain high fishing mortality is in good part a result of the exploitation pattern being less than the maturity for ages that are not fully ma-

ture. There are indications that fishing mortality may have been increasing in recent years at least for cod. Should higher fishing mortality continue to be exerted on younger ages in the future, the status quo F may not be sustainable.

- In the 1970's and 1980's there were strings of years of poor recruitment for haddock. The possibility of having strings of poor recruitment was not taken into account in the simulations reported above. Their effect would be to lower the resilience of the stocks.
- Regime shifts resulting in changes in recruitment, changes in weights at age, or changes in maturity at ages would invalidate the results of the simulations reported above.
- The current management set up is not successful at achieving the target fishing mortality for cod.

2.1.7 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. 2005. Relationship between phytoplankton production and cod production on the Faroe Shelf. ICES Journal of Marine Science, 62: 163-176.

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

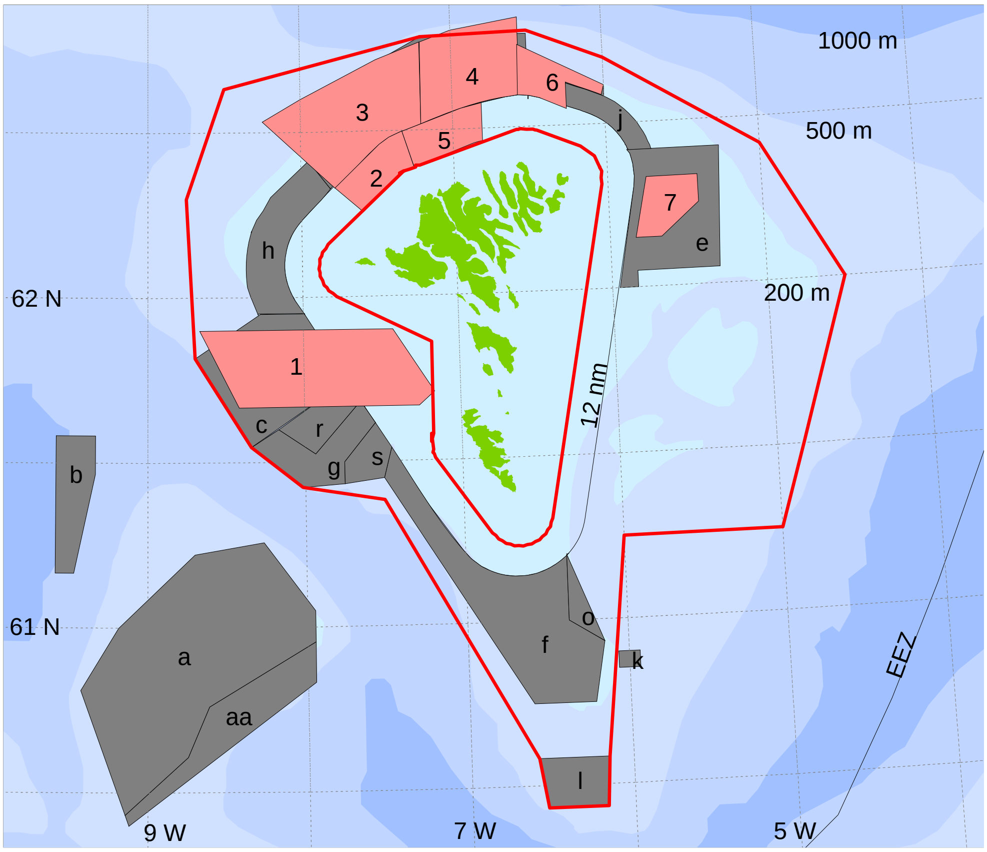
(This is the real number of days fishing not affected by doubling or tripling of days by changing areas/gears)

Year	Longliner 0-110 GRT, jiggers, trawlers < 400 HP	Longliners > 110 GRT	Pairtrawlers > 400 HP
1985	13449	2973	8582
1986	11399	2176	11006
1987	11554	2915	11860
1988	20736	3203	12060
1989	28750	3369	10302
1990	28373	3521	12935
1991	29420	3573	13703
1992	23762	2892	11228
1993	19170	2046	9186
1994	25291	2925	8347
1995	33760	3659	9346
Average(85-95)	22333	3023	10778
1998	23971	2519	6209
1999	21040	2428	7135
2000	24820	2414	7167
2001	29560	2512	6771
2002	30333	2680	6749
2003*	27642	2196	6624
2004*	22211	2728	7059
Average(98-01)	25945	2497	6816

* Preliminary, not all days included

Table 2.1.1 Number of allocated days for each fleet group since the new management scheme was adopted and number of licenses per fleet.

	Fleets	1996/1997	1997/1998	1998/1999	1999/2000	2000/2001	2001/2002	2002/2003
Group 1	Single trawlers > 400 HP				Regulated by area and by-catch limitations			
Group 2	Pair trawlers > 400 HP	8225	7199	6839	6839	6839	6839	6771
Group 3	Longliners > 110 GRT	3040	2660	2527	2527	2527	2527	2502
Group 4	Longliners and jiggers 15-110 GRT, single trawlers < 400 HP	9320	9328	8861	8861	8861	8861	8772
Group 5	Longliners and jiggers < 15 GRT	22000	23625	22444	22444	22444	22444	22220



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 regulated separate from the Faroe Plateau. It is closed to trawling and the longline fishery is regulated by individual day quotas.

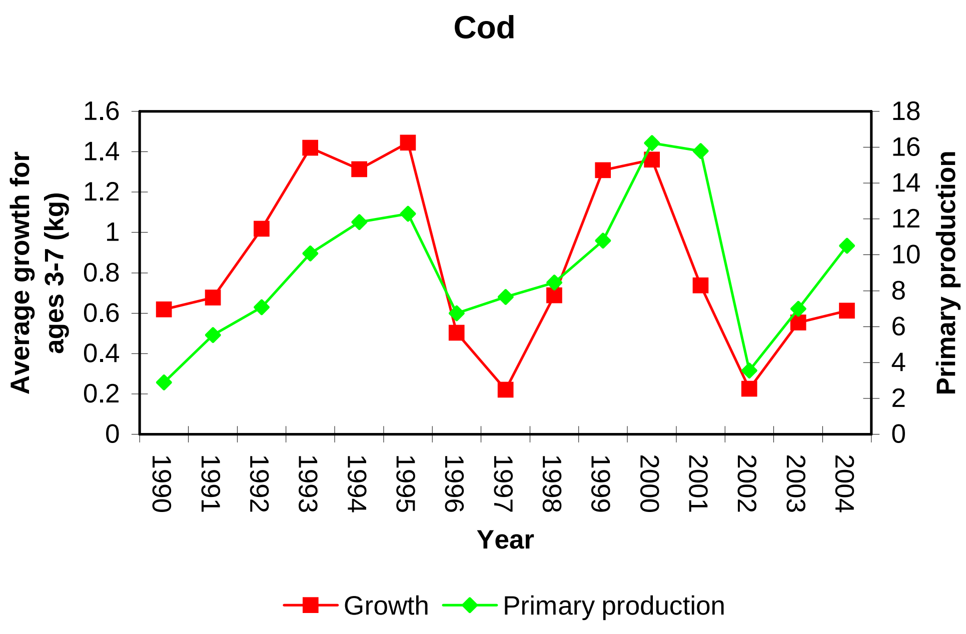


Figure 2.1.2. Faroe Plateau Cod. Relationship between primary production and growth of cod during the last 12 months.

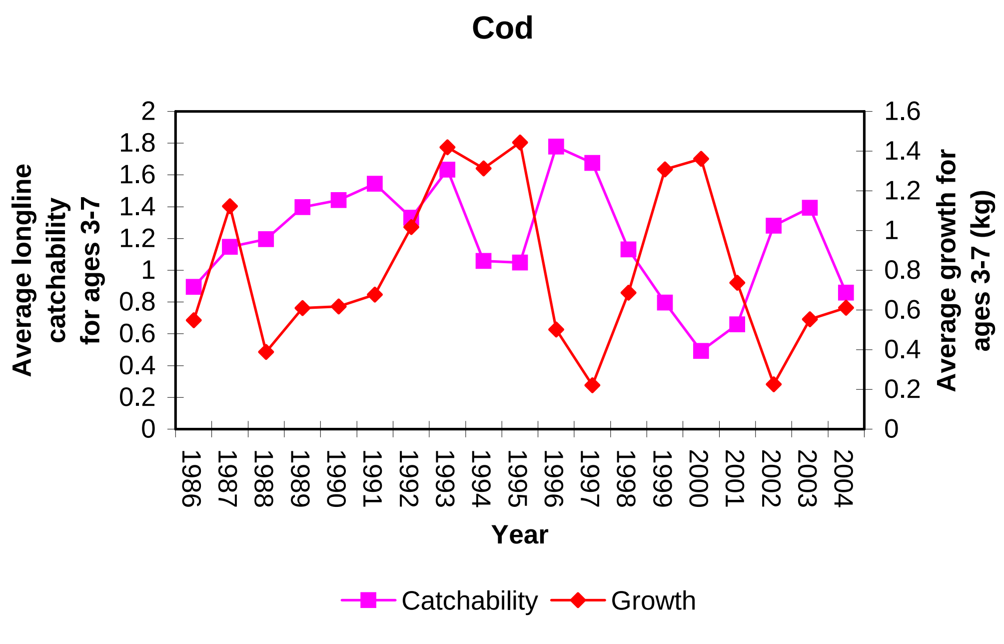


Figure 2.1.3. Faroe Plateau Cod. Relationship between long line catchability and growth of cod during the last 12 months.

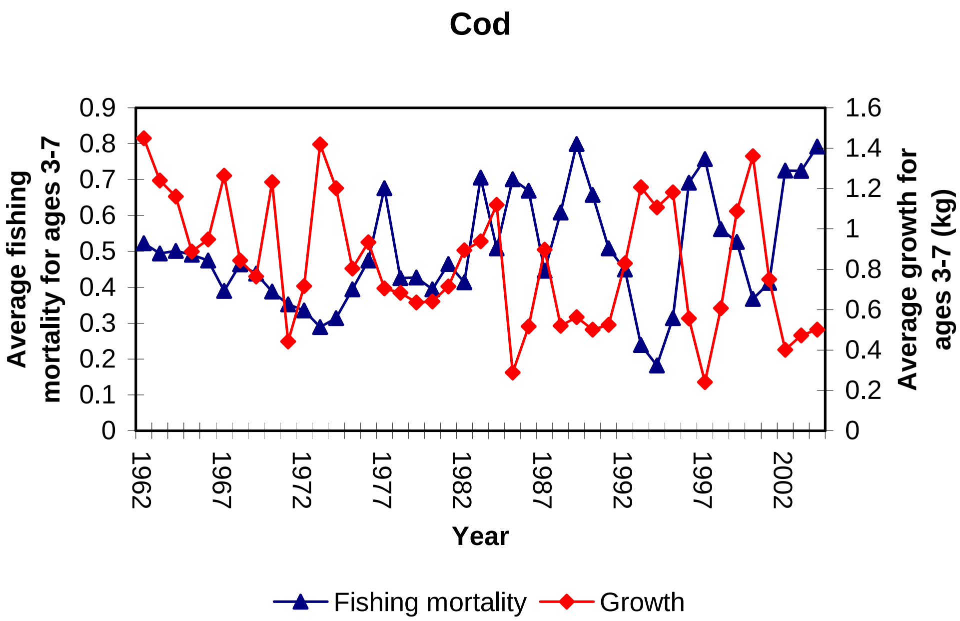


Figure 2.1.4. Faroe Plateau Cod. Relationship between fishing mortality and growth of cod during the last 12 months.

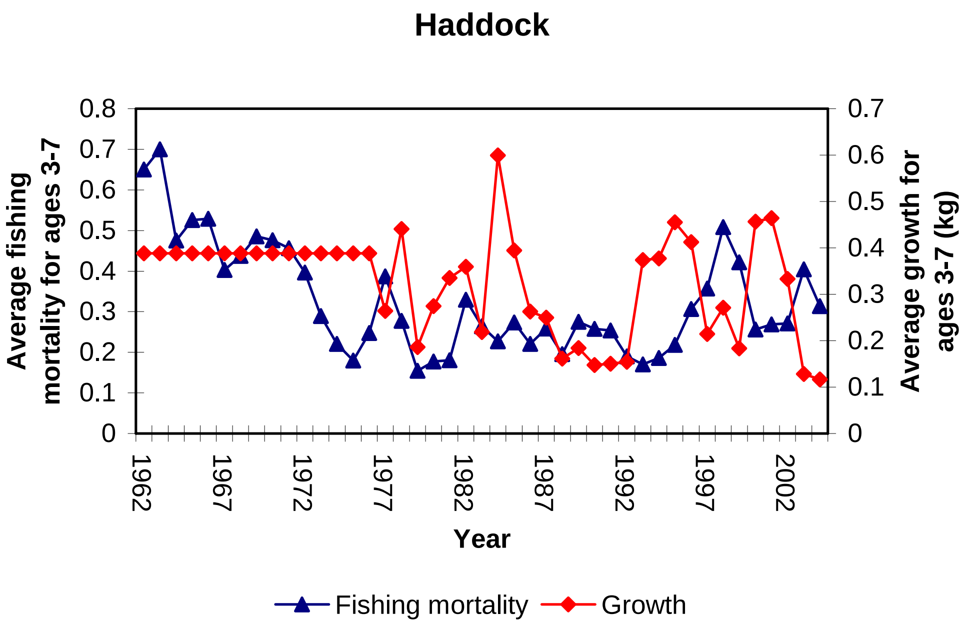


Figure 2.1.5. Faroe Haddock. Relationship between fishing mortality and growth of haddock during the last 12 months.

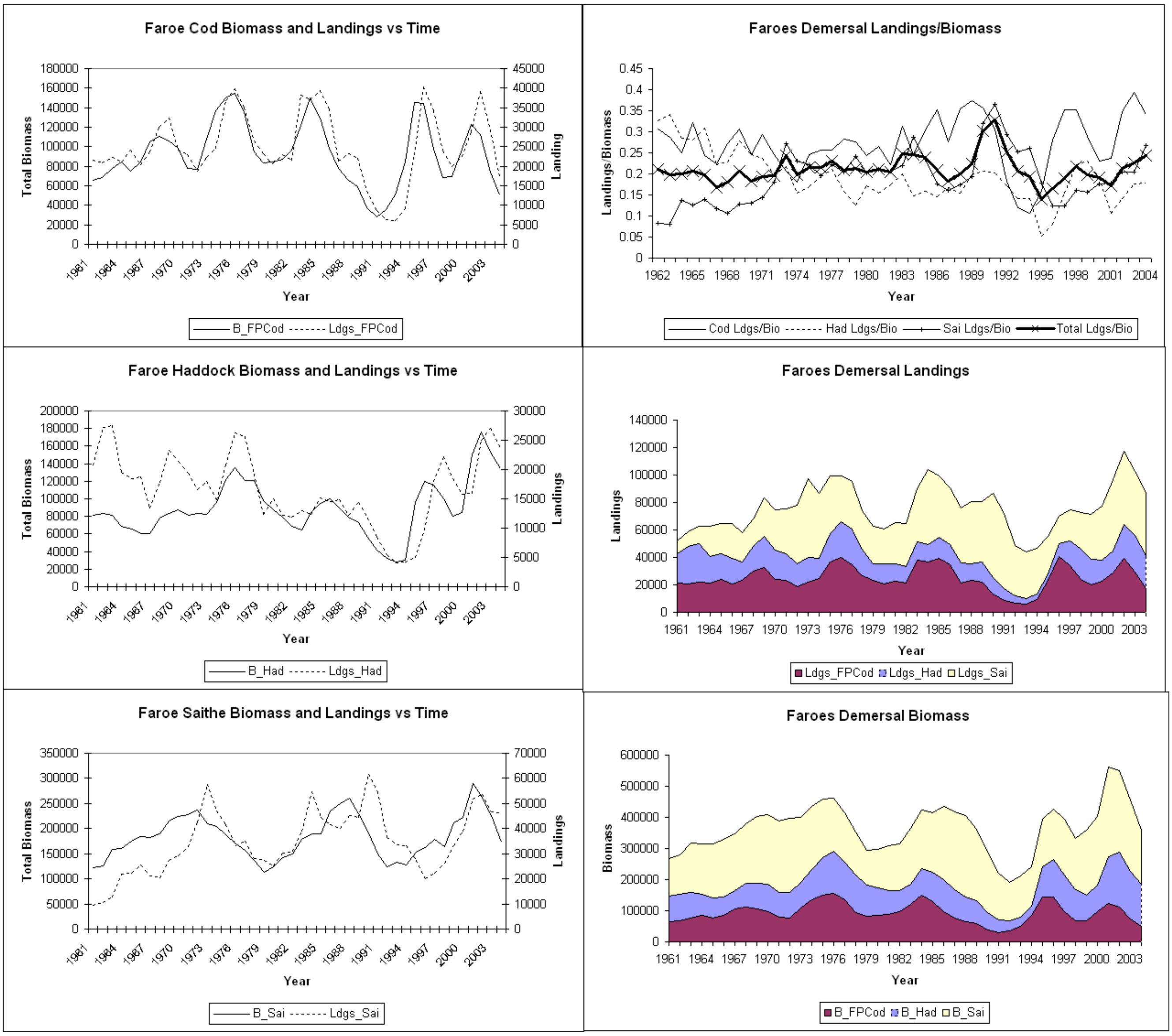


Figure 2.1.6. Faroe Plateau cod, Faroe haddock and Faroe saithe. 2005 stock summary.

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 (Table 2.2.2.1). 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 2004 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 Subdivision 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 labelled "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 (1986-2004) 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 2004, the catches were about 17 thousand tonnes, which is far below the long term average and also below the normal "downs" in the catches (20 thousand tonnes). 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 2001-2003. Landings-at-age for 2004 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 2004.

Fleet	Size	Samples	Length	Otoliths	Weights
Open boats		15	1,799	60	450
Longliners	<100 GRT	50	4,666	1,318	5,957
Longliners	>100 GRT	63	9,726	1,429	3,388
Jiggers		6	721	150	244
Sing. trawlers	<400 HP	5	738	120	320
Sing. trawlers	400-1000 HP	22	1,331	538	3,223
Sing. trawlers	>1000 HP	5	801	180	60
Pair trawlers	<1000 HP	4	693	119	119
Pair trawlers	>1000 HP	65	12,887	1,237	1,237
Total		220	31,563	5,091	14,548

2.2.4 Mean weight-at-age

Mean weight-at-age data for 1961-2004 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 2004 showed a discrepancy of 3 %.

Figure 2.2.4.1 shows the mean weight-at-age for 1961 to 2005. 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 - 2004) and shown in Figure

2.2.5.1 (1983 - 2005). The average maturity at age for 1983 to 1996 was used in years prior to 1983. Some of the 1983-1996 values were revised in 2003 but not the maturities for the 1961-1982 period. 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 2004 assessment a new stratification was adopted where five new strata were added on the spawning grounds (Figure 2.2.6.1 in ICES, 2004). The catch curves showed a normal pattern (Figure 2.2.6.1).

The overall mean catch of cod per unit effort 1983-2005 is given in Figure 2.2.6.2. The CPUE increased substantially in 1995 and remained high up to 1998. The CPUE decreased from 2002 to 2004 but increased slightly in 2005. Normally the stratified mean catch per trawl hour increases for the first 3-4 years of life of a year class, and decreases afterwards (Figure 2.2.6.1). 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 1996-2004.

In 1996, a 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) 1996-2004 is shown in Figure 2.2.6.2, and catch curves in Figure 2.2.6.3. The catch curves show that the fish are fully recruited to the survey gear at an age of 3 or 4 years.

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

Two commercial cpue series (longliners and Cuba trawlers) are updated every year, but the WG decided last year not to use them in the tuning of the VPA. The cpue for the longliners was shown to be highly dependent upon environmental conditions whereas the cpue for the Cuba trawlers could be influenced by other factors than stock size, for example the high landing price of cod compared to the price of saithe.

Since the current assessment is an update assessment, the same procedure is followed as in the benchmark assessment in 2004: to use the two surveys for tuning and not the commercial series. The commercial series showed the same overall tendency as the surveys (Figure 2.2.6.2 and Figure 2.2.7.1.1). A minor change was made in the settings in the XSA run. This year the catchability was set to be independent of all ages (no power function used) instead of having the catchability of ages 1-2 dependent on year class size. As in the 2004 assessment, the ADAPT assessment package was used for comparison with the XSA.

The log catchability residuals from the adopted XSA run are shown in Figure 2.2.7.1.2. The spring survey shows no overall trends although there seems to be a year effect for the years 1993 (actually 1994 because the survey was shifted back to the previous year) and 2003 (actually 2004). For the summer survey there was a clear year effect in 2003. In addition there seemingly is an effect of year class. The year classes 1990-1993 all have positive residuals (more commonly observed in the survey compared to the model predictions) whereas the 1994-1995 year classes have negative residuals. No year class effect is observed for younger year classes.

The results from the retrospective analysis of the XSA (Figure 2.2.7.1.3) show that there has been a tendency to overestimate fishing mortality, but the estimates of recruitment, stock biomass and spawning stock biomass have been fairly close. The overestimation of the fishing mortality (average 3-7) is mainly caused by overestimation of the fishing mortality for ages 6-7 years.

Figure 2.2.7.1.4 shows the retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8. There is a tendency to overestimate the fishing mortality while the estimates of SSB are surprisingly close given the absence of any shrinkage. The recruitment is sometimes overestimated and sometimes underestimated.

The estimated fishing mortalities are shown in Tables 2.2.7.1.3 and 2.2.7.1.5 and Figure 2.2.7.1.5. The average F for age groups 3 to 7 in 2004 (F3-7) is estimated at 0.79, considerably higher than Fmax = 0.46.

The F3-7 seems to be a problematic measure of fishing mortality for two reasons. Firstly, the fishing mortalities for ages 6-7 are generally overestimated in the terminal year leading to an overestimation of F3-7 for the terminal year. Secondly, the proportion of 6-7 year old cod in the stock or catch is small (normally less than 20%) and therefore get a disproportionate influence on the F3-7.

The yield over exploitable biomass (3 years and older) was introduced in the 2004 assessment, but has the drawback not being proportional to fishing effort. Another approach is to weight the fishing mortalities and three weighting procedures are presented in Figure 2.2.7.1.6: weighting by stock numbers, stock biomasses or catch weights. All measures of fishing mortality show high values for 2002-2004. The weighted fishing mortalities show (unlike F3-7), that the fishing mortality in 2002-2004 was less than in 1989 which was the last year with normal catches prior to the collapse in 1990-1993. The fishing mortality in 2002-2004 was, on the other hand, higher than in 1997-1998 and on the same level, or higher, than the fishing mortality in 1983-1988.

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 2.2.7.1.5. 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 and F close to the median of the bootstrapped 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 well above. The 2000-2002 year classes are estimated to be below average strength, and the 2003 year class seems also to be below 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 XSA retrospective pattern of the recruitment looked consistent so the recruitment of 2 year old cod in 2005 (2003 year class) was obtained from the XSA. The 2004-2005 year classes were estimated as the geometric mean for the period 1961-2004. 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 2002-2004 (not rescaled). The weights at age in the catches in 2005 were estimated from the weights during January-February 2005 having all fleets pooled. Ages 2 and 4 were estimated from the spring survey (March). Regression analyses were made between weights in January-February (or March), and the weights during the whole year 1996-2004. The weights in the catches in 2005 were predicted from the regressions. The weights in the catches in 2006-2007 were set to the values in 2004. The proportion mature in 2005 was set to the 2005 values from the spring groundfish survey, and for 2006-2007 to the average values for 2003-2005.

Table 2.2.8.1.2 shows that the landings in 2005 are expected to be 17 000 tonnes. The spawning stock biomass is expected to be 32 000 tonnes in 2005, 26 000 tonnes in 2006 and eventually 26 000 tonnes in 2007. The current short term prediction is therefore quite pessimistic.

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.

The reference points are dealt with in the general section of Faroese stocks.

2.2.8.3 Medium-term prediction

Medium term projections are dealt with in the general section of Faroese stocks.

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 1999-2004. The weights at age were set to the average values for 1978-2004, since no long term trend was present. The proportion mature was set to the average for 1983-2005.

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. $F_{0.1}$ was calculated as 0.25 and F_{max} as 0.46. The present average fishing mortality (F3-7) in 2004 of 0.79 is substantially above F_{max} = 0.46 and F_{med} = 0.38 (Figure 2.2.8.2.1).

2.2.9 Management considerations

The current assessment confirms the high fishing mortalities on cod in the recent years. If the hypothesis that catchability is related to productivity is true, and if productivity in 2005 is as high as in 2004, it is expected that the fishing mortality of cod will decrease in 2005-2006. In addition the recruitment in 2005 and 2006 (year classes 2003-2004) could be higher than estimated (2003) and assumed (2004) in the current assessment. Thus the situation in 2005 seems more positive than in 1989-1990 when the cod stock was on a similarly low. In order to avoid the situation in 1991-1994 (when the fishery collapsed), great care should be taken to ensure that the fishing mortality in 2005-2006 is reduced substantially.

It should also been kept in mind that a low stock size of cod may constrain the production of cod, *i.e.* the weight increase of the cod stock. In a situation with few cod and large numbers of other fish (*e.g.* haddock and saithe), a high productivity of the ecosystem will not be as beneficial for cod as for the other fish species. There will simply be too few cod present to utilize the high abundance of food organisms compared to other fish species.

2.2.10 Comment on the assessment

New or changed things compared to last years report: the assessment is done in nearly the same way as last year. The only change is that the catchability was set to be independent of year class size for all ages (in response of the technical minutes in 2004). Last year the catchability was set to be dependent of year class strength for ages 1-2 years. The method used to estimate the weights in the catches in 2005 was slightly changed: instead of using the weights in January-February 2005 for the longliners (or the survey weights in March 2005) as a basis to estimate the weights in the catches for the whole year 2005, the weights in January-February 2005 for all Faroese fleets pooled were used in the regressions. The justification was that there were more samples.

Last year there were some concerns about the year class strength of the 1999-2002 year classes because there were indications that the distribution of cod in 2003 was abnormal (high abundance in shallow waters 0-50 m depth). This issue is death with in working document #27: Incomplete area coverage of the Faroese summer groundfish survey and the effect upon stock assessment of Faroe Plateau cod. It was found that between 3 and 53 % of tagged cod were recaptured outside the area of the summer survey (mainly in areas close to land) and the value was especially high in 2003 (53 %). It was, however, also found that the summer survey was partially able to detect this signal and it proved difficult to adjust the summer survey indicies adequately according to these findings. It was also shown that the problem was much less for the spring survey, which also generally got higher weights in the assessment than the summer survey. Thus the abnormal distribution of cod in 2003 is not considered as an issue in the current assessment.

The short term prediction is quite pessimistic because the stock is on a low level and the future recruitment is considered to be low or average. Even though the 2003 year class may be underestimated (the phytoplankton bloom in 2005 may be on a high level) it is not considered to change the stock development in 2005 markedly.

The perception of the stock in the current assessment is in line with the perception in the 2004 assessment. It shows that the cod stock in 2004 was below the size in 1989, which was the last year with normal catch prior to the collapse in the fishery (1990-1994). The productivity of the Faroe Shelf ecosystem has been shown to be of ultimate importance to the cod stock (Steingrund and Gaard, 2005). The index of primary production was considerably higher in 2004 than in 1990-1992, which may prevent a collapse in the fishery in the near future. The fishing mortality in 2004 was, however, very high when the low stock size is taken into account. Under the present fishing mortality, normal catches in the near future can only achieved if the environmental conditions are favourable.

2.2.10.1 References

Gaard, E., Hansen B, and Heinesen, S. P. 1998. Phytoplankton variability on the Faroe shelf. ICES Journal of Marine Science, 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.

ICES, 2004. Report of the North-Western Working Group. ICES CM 2004/ACFM:25. 446 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.

Steingrund, P., and Gaard, E. 2005. Relationship between phytoplankton production and cod production on the Faroe Shelf. ICES Journal of Marine Science, 62: 163-176.

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, 1986-2004, 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	2004 *
Denmark	-					
Faroe Islands	19,156		29,762	40,602	30,259	17,619
France	- *	1	9 [2]	20	14	
Germany	39	2	9	6	7	3 [2]
Iceland	-	-	-	5	-	
Norway	450	374	531 *	573	527	414
Greenland	-	-	-	29 [2]	-	
Portugal						0
UK (E/W/NI)[2]	51	18	50	42	15	
UK (Scotland)[1]	-	-	-	-	-	-
United Kingdom						[1]
Total	19,696	395	30,361	41,277	30,822	18,036

* Preliminary

1) Included in Vb2.

2) Reported as Vb.

Table 2.2.2.2. Nominal catch (tonnes) of COD in sub-division Vb1 (Faroe Plateau) 1986-2004, 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	2004 *
Officially reported	19,696	395	30,361	41,277	30,822	18,036
Faroese catches in Vb1		21,793 *				
Correction of Faroese catches in Vb1 [1]			-1,766	-2,409	-1,795	-1,045
Greenland[2]						35
France[2]						2
Catches reported as Vb2:						
UK (E/W/NI)	-	-	-	-	-	-
UK (Scotland)	210	245	288	218	254	-
United Kingdom				-	-	259
Used in the assessment	19,906	22,433	28,883	39,086	29,281	17,287

*) Preliminary

1) In order to be consistent with procedures used previous years.

2) Reported to Faroese Coastal Guard.

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	Faroe catch 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
2004	4.4	31.1	2.1	0.5	6.6	1.6	12.9	2.2	11.7	26.8	0.0	0.0	16,772
Average	**4.1**	**24.0**	**6.3**	**1.0**	**10.0**	**4.9**	**6.8**	**9.9**	**13.6**	**18.6**	**0.6**	**0.2**	

Table 2.2.3.1. Faroe Plateau COD. Catch in numbers at age per fleet in 2004. 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 400-1000HP	Single trwl > 1000 HP	Pair trwl 700-999 HP	Pair trwl > 1000 HP	Longliners > 100 GRT	Gillnetters	Others	Catch-at-age
2	8	4	81	10	2	0	0	0	0	21	0	6	132
3	43	11	596	50	16	5	22	5	19	110	0	29	906
4	44	32	740	117	42	30	78	22	101	400	0	50	1656
5	111	43	1026	232	77	57	212	41	238	640	1	84	2762
6	35	8	223	48	22	13	162	25	145	251	5	28	965
7	8	2	72	9	3	5	65	10	47	83	4	7	315
8	0	1	6	0	0	0	26	2	9	36	2	3	85
9	0	0	18	0	0	0	7	1	2	24	1	2	55
10+	1	0	6	2	1	1	6	1	5	24	1	1	49
Sum	250	101	2768	468	163	111	578	107	566	1589	14	210	6925
G.weight	468	195	4705	996	319	248	1949	324	1769	4047	83	471	15574

Others include industrial bottom trawlers, longlining for halibut, small gillnetters, foreign fleets, **and scaling to correct catch.**

Gutted total catch is calculated as round weight divided by 1.11.

Table 2.2.3.2. Faroe Plateau COD. Catch in numbers at age 1961-2004.

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

YEAR,	1961,	1962,	1963,	1964,
AGE				
1,	0,	0,	0,	0,
2,	3093,	4424,	4110,	2033,
3,	2686,	2500,	3958,	3021,
4,	1331,	1255,	1280,	2300,
5,	1066,	855,	662,	630,
6,	232,	481,	284,	350,
7,	372,	93,	204,	158,
8,	78,	94,	48,	79,
9,	29,	22,	30,	41,
TOTALNUM,	8887,	9724,	10576,	8612,
TONSLAND,	21598,	20967,	22215,	21078,
SOPCOF %,	91,	94,	96,	98,

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	852,	1337,	1609,	1529,	878,	402,	328,	875,	723,	2161,
3,	3230,	970,	2690,	3322,	3106,	1163,	757,	1176,	3124,	1266,
4,	2564,	2080,	860,	2663,	3300,	2172,	821,	810,	1590,	1811,
5,	1416,	1339,	1706,	945,	1538,	1685,	1287,	596,	707,	934,
6,	363,	606,	847,	1226,	477,	752,	1451,	1021,	384,	563,
7,	155,	197,	309,	452,	713,	244,	510,	596,	312,	452,
8,	48,	104,	64,	105,	203,	300,	114,	154,	227,	149,
9,	63,	33,	27,	11,	92,	44,	179,	25,	120,	141,
TOTALNUM,	8691,	6666,	8112,	10253,	10307,	6762,	5447,	5253,	7187,	7477,
TONSLAND,	24212,	20418,	23562,	29930,	32371,	24183,	23010,	18727,	22228,	24581,
SOPCOF %,	113,	109,	102,	106,	109,	99,	123,	125,	105,	104,

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	2584,	1497,	425,	555,	575,	1129,	646,	1139,	2149,	4396,
3,	5689,	4158,	3282,	1219,	1732,	2263,	4137,	1965,	5771,	5234,
4,	2157,	3799,	6844,	2643,	1673,	1461,	1981,	3073,	2760,	3487,
5,	2211,	1380,	3718,	3216,	1601,	895,	947,	1286,	2746,	1461,
6,	813,	1427,	788,	1041,	1906,	807,	582,	471,	1204,	912,
7,	295,	617,	1160,	268,	493,	832,	487,	314,	510,	314,
8,	190,	273,	239,	201,	134,	339,	527,	169,	157,	82,
9,	118,	120,	134,	66,	87,	42,	123,	254,	104,	34,
TOTALNUM,	14057,	13271,	16590,	9209,	8201,	7768,	9430,	8671,	15401,	15920,
TONSLAND,	36775,	39799,	34927,	26585,	23112,	20513,	22963,	21489,	38133,	36979,
SOPCOF %,	100,	103,	70,	102,	101,	107,	107,	104,	99,	99,

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	998,	210,	257,	509,	2237,	243,	192,	205,	120,	573,
3,	9484,	3586,	1362,	2122,	2151,	2849,	451,	455,	802,	788,
4,	3795,	8462,	2611,	1945,	2187,	1481,	2152,	466,	603,	1062,
5,	1669,	2373,	3083,	1484,	1121,	852,	622,	911,	222,	532,
6,	770,	907,	812,	2178,	1026,	404,	303,	293,	329,	125,
7,	872,	236,	224,	492,	997,	294,	142,	132,	96,	176,
8,	309,	147,	68,	168,	220,	291,	93,	53,	33,	39,
9,	65,	47,	69,	33,	61,	50,	53,	30,	22,	23,
TOTALNUM,	17962,	15968,	8486,	8931,	10000,	6464,	4008,	2545,	2227,	3318,
TONSLAND,	39484,	34595,	21391,	23182,	22068,	13487,	8750,	6396,	6107,	9046,
SOPCOF %,	97,	97,	98,	102,	98,	101,	109,	108,	107,	103,

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	2615,	351,	200,	455,	1288,	2230,	4009,	2113,	811,	132,
3,	2716,	5164,	1278,	745,	1080,	2812,	3853,	7402,	2543,	906,
4,	2008,	4608,	6710,	1558,	869,	834,	2153,	3427,	5464,	1656,
5,	1012,	1542,	3731,	5140,	1204,	455,	377,	1699,	2303,	2762,
6,	465,	1526,	657,	1529,	2420,	719,	376,	477,	765,	965,
7,	118,	596,	639,	159,	477,	863,	736,	541,	211,	315,
8,	175,	147,	170,	118,	65,	111,	447,	420,	109,	85,
9,	44,	347,	51,	28,	19,	8,	37,	295,	137,	55,
TOTALNUM,	9153,	14281,	13436,	9732,	7422,	8032,	11988,	16374,	12343,	6876,
TONSLAND,	23045,	40422,	34304,	24005,	19906,	22433,	28883,	39086,	29281,	17287,
SOPCOF %,	103,	100,	104,	104,	102,	104,	101,	100,	101,	103,

Table 2.2.4.1. Faroe Plateau COD. Catch weight at age 1961-2004.

YEAR / AGE	1961	1962	1963	1964
1	.0000	.0000	.0000	.0000
2	1.0800	1.0000	1.0400	.9700
3	2.2200	2.2700	1.9400	1.8300
4	3.4500	3.3500	3.5100	3.1500
5	4.6900	4.5800	4.6000	4.3300
6	5.5200	4.9300	5.5000	6.0800
7	7.0900	9.0800	6.7800	7.0000
8	9.9100	6.5900	8.7100	6.2500
9	8.0300	6.6600	11.7200	6.1900
SOPCOFAC	.9068	.9444	.9573	.9824

YEAR / AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.9200	.9800	.9600	.8800	1.0900	.9600	.8100	.6600	1.1100	1.0800
3	1.4500	1.7700	1.9300	1.7200	1.8000	2.2300	1.8000	1.6100	2.0000	2.2200
4	2.5700	2.7500	3.1300	3.0700	2.8500	2.6900	2.9800	2.5800	3.4100	3.4400
5	3.7800	3.5100	4.0400	4.1200	3.6700	3.9400	3.5800	3.2600	3.8900	4.8000
6	5.6900	4.8000	4.7800	4.6500	4.8900	5.1400	3.9400	4.2900	5.1000	5.1800
7	7.3100	6.3200	6.2500	5.5000	5.0500	6.4600	4.8700	4.9500	5.1000	5.8800
8	7.9300	7.5100	7.0000	7.6700	7.4100	10.3100	6.4800	6.4800	6.1200	6.1400
9	8.0900	10.3400	11.0100	10.9500	8.6600	7.3900	6.3700	6.9000	8.6600	8.6300
SOPCOFAC	1.1262	1.0905	1.0224	1.0598	1.0851	.9943	1.2264	1.2481	1.0485	1.0432

YEAR / AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.7900	.9400	.8700	1.1120	.8970	.9270	1.0800	1.2300	1.3380	1.1950
3	1.7900	1.7200	1.7900	1.3850	1.6820	1.4320	1.4700	1.4130	1.9500	1.8880
4	2.9800	2.8400	2.5300	2.1400	2.2110	2.2200	2.1800	2.1380	2.4030	2.9800
5	4.2600	3.7000	3.6800	3.1250	3.0520	3.1050	3.2100	3.1070	3.1070	3.6790
6	5.4600	5.2600	4.6500	4.3630	3.6420	3.5390	3.7000	4.0120	4.1100	4.4700
7	6.2500	6.4300	5.3400	5.9270	4.7190	4.3920	4.2400	5.4420	5.0200	5.4880
8	7.5100	6.3900	6.2300	6.3480	7.2720	6.1000	4.4300	5.5630	5.6010	6.4660
9	7.3900	8.5500	8.3800	8.7150	8.3680	7.6030	6.6900	5.2160	8.0130	6.6280
SOPCOFAC	1.0033	1.0285	.7026	1.0228	1.0055	1.0680	1.0674	1.0428	.9901	.9872

YEAR / AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	.9050	1.0990	1.0930	1.0610	1.0100	.9450	.7790	.9890	1.1550	1.1940
3	1.6580	1.4590	1.5170	1.7490	1.5970	1.3000	1.2710	1.3640	1.7040	1.8430
4	2.6260	2.0460	2.1600	2.3000	2.2000	1.9590	1.5700	1.7790	2.4210	2.6130
5	3.4000	2.9360	2.7660	2.9140	2.9340	2.5310	2.5240	2.3120	3.1320	3.6540
6	3.7520	3.7860	3.9080	3.1090	3.4680	3.2730	3.1850	3.4770	3.7230	4.5840
7	4.2200	4.6990	5.4610	3.9760	3.7500	4.6520	4.0860	4.5450	4.9710	4.9760
8	4.7390	5.8930	6.3410	4.8960	4.6820	4.7580	5.6560	6.2750	6.1590	7.1460
9	6.5110	9.7000	8.5090	7.0870	6.1400	6.7040	5.9730	7.6190	7.6140	8.5640
SOPCOFAC	.9695	.9715	.9755	1.0153	.9810	1.0064	1.0857	1.0770	1.0652	1.0303

YEAR / AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
2	1.2180	1.0160	.9010	1.0040	1.0500	1.4160	1.1640	1.0170	.8200	1.0370
3	1.9860	1.7370	1.3410	1.4170	1.5860	2.1700	2.0760	1.7680	1.3620	1.1540
4	2.6220	2.7450	1.9580	1.8020	2.3500	3.1870	3.0530	2.8050	2.1270	1.6930
5	3.9250	3.8000	3.0120	2.2800	2.7740	3.7950	3.9760	3.5290	3.3290	2.3630
6	5.1800	4.4550	4.1580	3.4780	3.2140	4.0480	4.3940	4.0950	4.0920	3.8300
7	6.0790	4.9780	4.4910	5.4330	5.4960	4.5770	4.8710	4.4750	4.6700	5.1910
8	6.2410	5.2700	5.3120	5.8510	8.2760	8.1820	5.5630	4.6500	6.0000	6.3260
9	7.7820	5.5930	6.1720	7.9700	9.1290	11.8950	7.2770	6.2440	6.7270	7.6560
SOPCOFAC	1.0299	1.0026	1.0367	1.0376	1.0178	1.0430	1.0053	1.0019	1.0059	1.0288

Table 2.2.5.1. Faroe Plateau (sub-division Vb1) COD. Proportion mature at age 1983-2004. From 1961-1982 the average from 1983-1996 is used.

YEAR, AGE	1961,	1962,	1963,	1964,
1,	.0000,	.0000,	.0000,	.0000,
2,	.1700,	.1700,	.1700,	.1700,
3,	.6400,	.6400,	.6400,	.6400,
4,	.8700,	.8700,	.8700,	.8700,
5,	.9500,	.9500,	.9500,	.9500,
6,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,

YEAR, AGE	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
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	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.1700,	.0300,	.0700,
3,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.6400,	.7100,	.9600,
4,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.8700,	.9300,	.9800,
5,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9500,	.9400,	.9700,
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	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0600,	.0500,	.0000,	.0000,	.0600,	.0300,	.0500,
3,	.5000,	.3800,	.6700,	.7200,	.5400,	.6800,	.7200,	.5000,	.7300,	.3300,
4,	.9600,	.9300,	.9100,	.9000,	.9800,	.9000,	.8600,	.8200,	.7800,	.8800,
5,	.9600,	1.0000,	1.0000,	.9700,	1.0000,	.9900,	1.0000,	.9800,	.9100,	.9600,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9600,	1.0000,	1.0000,	.9900,	1.0000,
7,	1.0000,	.9600,	1.0000,	1.0000,	1.0000,	.9800,	1.0000,	1.0000,	1.0000,	.9600,
8,	1.0000,	.9400,	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	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0900,	.0400,	.0000,	.0000,	.0200,	.0200,	.0700,	.0400,	.0000,	.0000,
3,	.3500,	.4300,	.6400,	.6200,	.4300,	.3900,	.4700,	.3700,	.2900,	.5100,
4,	.3300,	.7400,	.9100,	.9000,	.8800,	.6900,	.8600,	.7600,	.7900,	.7800,
5,	.6600,	.8500,	.9700,	.9900,	.9800,	.9200,	.9400,	.9700,	.8800,	.9200,
6,	.9700,	.9400,	1.0000,	.9900,	1.0000,	.9900,	1.0000,	.9300,	.9800,	.8900,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9700,	1.0000,	.8700,
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 2004
1 1 0.6 0.7
2 8
 200  707.3   6614.6   3763     1322.2   714     236.2   49
 200  513.1   1502.1   6771     1479.9   180.8  139.5   30.4
 200  527      509.1    989.1   3723.7   915.6   50.5   37.2
 200  373.4   1257.4    753.8    676.1  1424.8  239.1   40.5
 200 1364.1   1153.3    673.8    309.6   436.9  600.8   35.4
 200 3422.1   2458.7   1537.8    415.9   234.8  283    242
 200 2326     5562.9   1816.5    810.8   147.7   83.3   69.5
 200  354     1038.8   2209.2    565.9   123.4   17.6   11.9
 200  437      839.9   1080.2   1550.2   344.2   80.2   25.7
SPRING SURVEY (shifted back to December)
1993 2004
1 1 0.9 1.0
1 8
 100   565.8    328.1     888.5     493.1     125.3    180.9    28        0.1
 100   707.7    778.5    1438      1490.8    1211.2    287.3   353.1     48.7
 100   395.8   3988.4    3612.4    1769.3    1315.5    403.8    79.8    160.7
 100    91.1    933.8    5492.1    2331.6     332.8    226.7    58.2      5.2
 100    75.9    428.7    1572.1    4927.7    1127.9     80.2    39.6     33.9
 100   528      636.9     956.4    1181.7    2005.5    243.5    24.2     12.9
 100   291.5   1413.4     730.2     430       494      815.2    61.2      3
 100   873.5   2266      1917.8     439.6     314.6    562.8   126.8      3.8
 100   343.9   4154.7    2708.1    1486.3     311.9    217.9   168.3    124.1
 100    79.4    703.7    4250.5    1326.7     541.8     63.4    48.1     36.8
 100   427.1    451       784.7    1197.6     299.5     66.5    22.2     11.9
 100   294.7    390.1    1046.6    1328.1     791.1    133.6    13.4      3.6
```

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

```
Lowestoft VPA Version 3.1

   29/04/2005   9:10

 Extended Survivors Analysis

 COD FAROE PLATEAU (ICES SUBDIVISION Vb1)                 COD_ind_Surveys.txt

 CPUE data from file Surveys.TXT

 Catch data for  44 years. 1961 to 2004. Ages  1 to   9.

      Fleet,            First, Last, First, Last, Alpha,  Beta
                    ,    year, year,  age ,  age
 SUMMER SURVEY       ,   1996, 2004,   2,     8,   .600,   .700
 SPRING SURVEY (shift,   1993, 2004,   1,     8,   .900,  1.000


 Time series weights :

      Tapered time weighting not applied


 Catchability analysis :

      Catchability independent of stock size for all ages

      Catchability independent of age for ages >=    6


 Terminal population estimation :

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

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

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

      Prior weighting not applied


 Tuning converged after   52 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,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004

      1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
      2,  .069,  .029,  .033,  .083,  .098,  .121,  .132,  .188,  .133,  .016
      3,  .160,  .189,  .142,  .166,  .289,  .322,  .315,  .383,  .362,  .216
      4,  .464,  .447,  .401,  .259,  .297,  .380,  .438,  .515,  .546,  .425
      5,  .280,  .807,  .814,  .620,  .327,  .250,  .295,  .755,  .804,  .595
      6,  .357,  .903, 1.038,  .992,  .681,  .331,  .337,  .756,  .968, 1.001
      7,  .308, 1.111, 1.388,  .775, 1.039,  .553,  .675, 1.219,  .942, 1.724
      8,  .221,  .795, 1.237, 1.134,  .878,  .732,  .629, 1.115,  .883, 1.473
      9,  .904,  .917,  .723,  .677,  .536,  .237,  .579, 1.225, 1.694, 2.066
```

1

XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6	7	8	9
1995	1.63E+04	4.33E+04	2.03E+04	5.98E+03	4.58E+03	1.71E+03	4.92E+02	9.74E+02	8.17E+01
1996	8.32E+03	1.34E+04	3.31E+04	1.41E+04	3.08E+03	2.84E+03	9.82E+02	2.96E+02	6.39E+02
1997	7.70E+03	6.81E+03	1.06E+04	2.24E+04	7.40E+03	1.12E+03	9.41E+02	2.65E+02	1.09E+02
1998	1.86E+04	6.31E+03	5.39E+03	7.55E+03	1.23E+04	2.69E+03	3.26E+02	1.92E+02	6.29E+01
1999	2.65E+04	1.52E+04	4.75E+03	3.74E+03	4.77E+03	5.42E+03	8.16E+02	1.23E+02	5.06E+01
2000	4.38E+04	2.17E+04	1.13E+04	2.91E+03	2.28E+03	2.82E+03	2.25E+03	2.36E+02	4.18E+01
2001	1.67E+04	3.58E+04	1.58E+04	6.71E+03	1.63E+03	1.45E+03	1.66E+03	1.06E+03	9.30E+01
2002	8.79E+03	1.36E+04	2.57E+04	9.41E+03	3.54E+03	9.94E+02	8.49E+02	6.91E+02	4.62E+02
2003	1.16E+04	7.19E+03	9.26E+03	1.44E+04	4.61E+03	1.36E+03	3.82E+02	2.05E+02	1.85E+02
2004	1.77E+04	9.48E+03	5.16E+03	5.28E+03	6.81E+03	1.69E+03	4.24E+02	1.22E+02	6.96E+01

Estimated population abundance at 1st Jan 2005

0.00E+00	1.45E+04	7.64E+03	3.40E+03	2.83E+03	3.08E+03	5.08E+02	6.18E+01	2.29E+01

Taper weighted geometric mean of the VPA populations:

1.81E+04	1.47E+04	1.10E+04	6.93E+03	3.75E+03	1.79E+03	8.08E+02	3.28E+02	1.37E+02

Standard error of the weighted Log(VPA populations) :

.5568	.5577	.5503	.5384	.5397	.5666	.6187	.6915	.7945

1

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	No data for this fleet at this age									
2	99.99	-.24	.12	.26	-.96	-.01	.42	1.04	-.24	-.38
3	99.99	.22	-.16	-.54	.57	-.36	.06	.43	-.24	.03
4	99.99	.28	.37	-.55	-.10	.09	.12	.00	-.21	.00
5	99.99	.86	.10	.39	-.56	-.66	.00	.19	-.40	.08
6	99.99	.39	.03	.75	.29	-.47	-.42	-.23	-.59	.24
7	99.99	.48	.18	-.18	.63	.22	-.15	-.35	-1.28	.64
8	99.99	-.10	-.18	.28	.64	-.24	.12	-.39	-1.09	.58

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

Age	2	3	4	5	6	7	8
Mean Log q	-7.8515	-6.8774	-6.4782	-6.3456	-6.3519	-6.3519	-6.3519
S.E(Log q)	.5606	.3656	.2737	.4799	.4550	.6056	.5346

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.89	.326	8.02	.58	9	.53	-7.85
3	.88	.740	7.18	.84	9	.33	-6.88
4	.90	.780	6.74	.89	9	.25	-6.48
5	.86	.563	6.63	.70	9	.43	-6.35
6	.72	1.429	6.70	.79	9	.31	-6.35
7	.78	.829	6.41	.68	9	.48	-6.33
8	1.29	-.847	6.62	.55	9	.70	-6.39

1

Fleet : SPRING SURVEY (shift

Age	1993	1994
1	.09	-.22
2	-.76	-.81
3	-.58	.03
4	-.48	.09
5	-.56	.87
6	-.68	.81
7	-.29	.34
8	-4.79	.82

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	.37	-.42	-.52	.53	-.42	.18	.21	-.61	.80	.00
2	.33	.02	-.08	.44	.37	.51	.62	-.13	.01	-.52
3	.08	.04	-.12	.08	.06	.19	.20	.22	-.47	.27
4	.64	.04	.29	-.19	-.46	-.11	.33	-.05	-.54	.44
5	.44	-.03	.32	.20	-.53	-.32	.05	.27	-.54	-.16
6	.45	-.11	-.09	.10	.31	.26	-.02	-.47	-.54	-.03
7	.03	-.21	-.29	-.30	-.04	-.79	-.09	-.15	-.39	-.26
8	-.03	-1.73	.68	-.06	-1.32	-1.87	.01	-.31	-.45	-.56

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

Age	1	2	3	4	5	6	7	8
Mean Log q	-8.5103	-7.0687	-6.0721	-5.8359	-5.8412	-5.9755	-5.9755	-5.9755
S.E(Log q)	.4461	.4880	.2668	.3818	.4454	.4315	.3433	1.7296

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	.88	.657	8.67	.73	12	.40	-8.51
2	.84	.843	7.48	.73	12	.41	-7.07
3	.95	.394	6.23	.86	12	.26	-6.07
4	.92	.452	6.09	.75	12	.36	-5.84
5	.88	.680	6.14	.75	12	.40	-5.84
6	.97	.122	6.02	.63	12	.44	-5.98
7	1.00	.016	6.18	.86	12	.28	-6.18
8	.56	1.455	6.25	.53	12	.81	-6.78

Terminal year survivor and F summaries :

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

Year class = 2003

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SUMMER SURVEY	1.	.000	.000	.00	0	.000	.000
SPRING SURVEY (shift	14488.	.464	.000	.00	1	1.000	.000
F shrinkage mean	0.	2.00				.000	.000

Weighted prediction :

Survivors, at end of year	Int, s.e	Ext, s.e	N	Var, Ratio	F
14488.	.46	.00	1	.000	.000

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

 Year class = 2002

 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,      5207.,   .591,       .000,    .00,   1,  .246,     .023
 SPRING SURVEY (shift,      9291.,   .343,       .656,   1.91,   2,  .732,     .013

   F shrinkage mean  ,       828.,   2.00,,,,                        .022,     .135

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      7642.,       .29,      .40,    4,   1.378,   .016


 Age  3   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       ,      3267.,   .323,       .123,    .38,   2,  .329,     .224
 SPRING SURVEY (shift,      3499.,   .226,       .249,   1.10,   3,  .660,     .211

   F shrinkage mean  ,      2052.,   2.00,,,,                        .011,     .336

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3401.,       .18,      .13,    6,    .729,   .216


1
 Age  4   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       ,      2918.,   .224,       .241,   1.08,   3,  .474,     .414
 SPRING SURVEY (shift,      2748.,   .201,       .233,   1.16,   4,  .516,     .435

   F shrinkage mean  ,      2724.,   2.00,,,,                        .010,     .438

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2827.,       .15,      .14,    8,    .944,   .425


 Age  5   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       ,      3199.,   .215,       .150,    .70,   4,  .465,     .577
 SPRING SURVEY (shift,      2950.,   .197,       .177,    .90,   5,  .520,     .614

   F shrinkage mean  ,      3953.,   2.00,,,,                        .015,     .490

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      3077.,       .15,      .11,   10,    .719,   .595


 Age  6   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       ,       528.,   .230,       .109,    .48,   5,  .455,     .975
SPRING SURVEY (shift,       472.,   .214,       .124,    .58,   6,  .517,    1.048

  F shrinkage mean  ,      1016.,   2.00,,,,                          .028,     .620

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      508.,       .16,      .08,   12,    .521,  1.001


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

Year class = 1997

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        66.,   .269,       .233,    .86,   6,  .325,    1.668
SPRING SURVEY (shift,        53.,   .232,       .116,    .50,   7,  .609,    1.860

  F shrinkage mean  ,       197.,   2.00,,,,                          .066,     .895

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       62.,       .21,      .14,   14,    .653,  1.724


Age  8   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       ,        26.,   .277,       .254,    .92,   7,  .474,    1.383
SPRING SURVEY (shift,        17.,   .202,       .094,    .46,   8,  .453,    1.685

  F shrinkage mean  ,        57.,   2.00,,,,                          .073,     .856

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       23.,       .22,      .15,   16,    .672,  1.473


Age  9   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       ,         4.,   .255,       .168,    .66,   7,  .394,    2.644
SPRING SURVEY (shift,         6.,   .177,       .069,    .39,   8,  .365,    2.218

  F shrinkage mean  ,        27.,   2.00,,,,                          .241,    1.056

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
        7.,       .50,      .24,   16,    .474,  2.066
```

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

YEAR, AGE	1961,	1962,	1963,	1964,
1,	.0000,	.0000,	.0000,	.0000,
2,	.3346,	.2701,	.2534,	.1086,
3,	.5141,	.4982,	.4138,	.2997,
4,	.4986,	.4838,	.5172,	.4523,
5,	.5737,	.7076,	.5124,	.5229,
6,	.4863,	.5569,	.5405,	.5659,
7,	.9566,	.3662,	.4879,	.6677,
8,	.8116,	.6826,	.3269,	.3531,
9,	.6715,	.5641,	.4806,	.5164,
FBAR 3- 7,	.6059,	.5226,	.4944,	.5017,

YEAR, AGE	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1209,	.0829,	.0789,	.1010,	.1099,	.0530,	.0309,	.0464,	.0657,	.0816,
3,	.2518,	.1969,	.2389,	.2318,	.3063,	.2081,	.1337,	.1476,	.2322,	.1568,
4,	.4498,	.2552,	.2687,	.3949,	.3806,	.3654,	.2225,	.2070,	.3048,	.2046,
5,	.5622,	.4499,	.3442,	.5339,	.4180,	.3409,	.3845,	.2497,	.2813,	.2953,
6,	.6604,	.5016,	.5779,	.4472,	.5709,	.3709,	.5572,	.6058,	.2526,	.3797,
7,	.5305,	.9680,	.5203,	.7132,	.5118,	.6559,	.4651,	.4686,	.3722,	.5330,
8,	.4345,	.8520,	1.0438,	.3331,	.8457,	.4208,	.7528,	.2464,	.3259,	.3052,
9,	.5318,	.6106,	.5556,	.4882,	.5499,	.4339,	.4800,	.3578,	.3091,	.3457,
FBAR 3- 7,	.4909,	.4743,	.3900,	.4642,	.4375,	.3882,	.3526,	.3358,	.2886,	.3139,

YEAR, AGE	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0774,	.0933,	.0481,	.0588,	.0433,	.0544,	.0523,	.0586,	.0992,	.1073,
3,	.3193,	.1723,	.3036,	.1896,	.2623,	.2391,	.2877,	.2227,	.4673,	.3712,
4,	.4359,	.3665,	.4748,	.4291,	.4309,	.3695,	.3409,	.3602,	.5585,	.5791,
5,	.4134,	.5568,	.7532,	.4289,	.5049,	.4337,	.4369,	.3887,	.6411,	.6609,
6,	.4544,	.5167,	.7333,	.4851,	.4906,	.5182,	.5644,	.4047,	.7836,	.4534,
7,	.3504,	.7619,	1.1138,	.5968,	.4480,	.4119,	.6940,	.6926,	1.0780,	.4761,
8,	.4485,	.6429,	.7776,	.5674,	.6903,	.6437,	.5015,	.5526,	.9417,	.4792,
9,	.4235,	.5738,	.7783,	.5054,	.5170,	.4790,	.5115,	.4834,	.8087,	.5340,
FBAR 3- 7,	.3947,	.4749,	.6757,	.4259,	.4273,	.3945,	.4648,	.4138,	.7057,	.5082,

YEAR, AGE	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0658,	.0247,	.0291,	.0673,	.1648,	.0746,	.0322,	.0201,	.0132,	.0253,
3,	.3544,	.3546,	.2209,	.3529,	.4452,	.3267,	.1929,	.0994,	.1018,	.1127,
4,	.5077,	.6228,	.4757,	.5642,	.7608,	.6378,	.4408,	.3128,	.1853,	.1904,
5,	.6135,	.7035,	.4854,	.5496,	.7627,	.7817,	.6121,	.3375,	.2404,	.2476,
6,	.9236,	.8259,	.5562,	.7747,	.9639,	.7004,	.7233,	.6650,	.1949,	.2069,
7,	1.1084,	.8402,	.4898,	.7999,	1.0616,	.8385,	.5720,	.8316,	.4748,	.1515,
8,	1.3205,	.5410,	.6226,	.8651,	1.1062,	1.1213,	.7078,	.4336,	.5043,	.3589,
9,	.9044,	.7134,	.5302,	.7175,	.9413,	.8244,	.6166,	.5202,	.3218,	.8170,
FBAR 3- 7,	.7015,	.6694,	.4456,	.6082,	.7988,	.6570,	.5082,	.4493,	.2394,	.1818,

YEAR, AGE	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR **-**
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0690,	.0294,	.0330,	.0831,	.0982,	.1205,	.1320,	.1876,	.1331,	.0155,	.1121,
3,	.1603,	.1892,	.1425,	.1657,	.2893,	.3217,	.3151,	.3829,	.3615,	.2160,	.3201,
4,	.4640,	.4467,	.4013,	.2588,	.2967,	.3804,	.4382,	.5148,	.5458,	.4253,	.4953,
5,	.2798,	.8070,	.8140,	.6197,	.3268,	.2496,	.2951,	.7552,	.8045,	.5946,	.7181,
6,	.3566,	.9031,	1.0382,	.9918,	.6805,	.3312,	.3370,	.7560,	.9684,	1.0006,	.9083,
7,	.3079,	1.1110,	1.3882,	.7748,	1.0392,	.5528,	.6751,	1.2186,	.9425,	1.7244,	1.2951,
8,	.2215,	.7953,	1.2372,	1.1344,	.8779,	.7325,	.6291,	1.1147,	.8825,	1.4726,	1.1566,
9,	.9038,	.9173,	.7233,	.6773,	.5359,	.2374,	.5795,	1.2246,	1.6942,	2.0662,	1.6617,
FBAR 3- 7,	.3137,	.6914,	.7568,	.5622,	.5265,	.3671,	.4121,	.7255,	.7245,	.7922,	

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

YEAR,	1961,	1962,	1963,	1964,
AGE				
1,	25227,	24782,	26668,	10100,
2,	12019,	20654,	20290,	21834,
3,	7385,	7042,	12907,	12893,
4,	3747,	3616,	3503,	6986,
5,	2699,	1863,	1825,	1710,
6,	666,	1245,	752,	895,
7,	668,	335,	584,	358,
8,	155,	210,	190,	294,
9,	66,	56,	87,	112,
TOTAL,	52630,	59804,	66807,	55183,

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
1,	22676,	28643,	21475,	11390,	10514,	14569,	26041,	15356,	37229,	46803,
2,	8269,	18566,	23451,	17582,	9325,	8608,	11928,	21320,	12573,	30480,
3,	16037,	5999,	13990,	17744,	13012,	6840,	6684,	9469,	16664,	9639,
4,	7823,	10207,	4034,	9020,	11522,	7843,	4548,	4788,	6689,	10816,
5,	3639,	4085,	6475,	2525,	4976,	6447,	4456,	2981,	3187,	4037,
6,	830,	1698,	2133,	3757,	1212,	2682,	3754,	2483,	1901,	1969,
7,	416,	351,	842,	980,	1967,	561,	1516,	1760,	1109,	1209,
8,	151,	200,	109,	410,	393,	965,	238,	779,	902,	626,
9,	169,	80,	70,	31,	240,	138,	519,	92,	499,	533,
TOTAL,	60009,	69829,	72579,	63439,	53161,	48654,	59683,	59029,	80752,	106115,

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
1,	22687,	12208,	13128,	18318,	28803,	17100,	27026,	30727,	58330,	21150,
2,	38319,	18575,	9995,	10748,	14997,	23582,	14000,	22127,	25157,	47756,
3,	23000,	29035,	13853,	7799,	8298,	11759,	18286,	10878,	17086,	18653,
4,	6747,	13683,	20010,	8372,	5282,	5226,	7579,	11228,	7128,	8767,
5,	7217,	3572,	7765,	10190,	4463,	2811,	2957,	4413,	6412,	3339,
6,	2460,	3908,	1676,	2993,	5433,	2206,	1491,	1564,	2450,	2765,
7,	1103,	1279,	1909,	659,	1509,	2723,	1076,	694,	854,	916,
8,	581,	636,	489,	513,	297,	789,	1477,	440,	284,	238,
9,	378,	304,	274,	184,	238,	122,	339,	732,	207,	91,
TOTAL,	102492,	83200,	69098,	59776,	69320,	66318,	74232,	82804,	117908,	103674,

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
1,	11613,	12113,	10558,	19873,	4566,	8189,	13935,	12353,	31009,	52925,
2,	17316,	9508,	9917,	8644,	16271,	3738,	6705,	11409,	10114,	25388,
3,	35122,	13274,	7594,	7887,	6617,	11297,	2841,	5316,	9156,	8172,
4,	10535,	20174,	7623,	4985,	4537,	3471,	6672,	1918,	3940,	6770,
5,	4022,	5192,	8860,	3879,	2322,	1736,	1502,	3515,	1148,	2681,
6,	1411,	1783,	2104,	4465,	1833,	887,	650,	667,	2054,	739,
7,	1439,	459,	639,	988,	1685,	572,	360,	258,	281,	1384,
8,	466,	389,	162,	321,	363,	477,	203,	166,	92,	143,
9,	121,	102,	185,	71,	111,	98,	127,	82,	88,	46,
TOTAL,	82046,	62994,	47643,	51113,	38303,	30466,	32994,	35684,	57882,	98248,

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	GMST 61-**	AMST 61-**
AGE													
1,	16341,	8315,	7703,	18594,	26513,	43775,	16672,	8785,	11579,	17696,	0,	18273,	21304,
2,	43332,	13379,	6808,	6307,	15224,	21707,	35840,	13650,	7193,	9480,	14488,	15144,	17557,
3,	20268,	33111,	10636,	5393,	4752,	11299,	15754,	25716,	9264,	5155,	7642,	11292,	13075,
4,	5978,	14136,	22436,	7552,	3741,	2913,	6706,	9412,	14357,	5283,	3401,	6860,	7921,
5,	4582,	3077,	7404,	12298,	4773,	2277,	1631,	3542,	4605,	6810,	2827,	3677,	4250,
6,	1713,	2836,	1124,	2686,	5418,	2819,	1452,	994,	1363,	1687,	3077,	1801,	2109,
7,	492,	982,	941,	326,	816,	2246,	1657,	849,	382,	424,	508,	835,	994,
8,	974,	296,	265,	192,	123,	236,	1058,	691,	205,	122,	62,	340,	428,
9,	82,	639,	109,	63,	51,	42,	93,	462,	185,	70,	23,	138,	194,
TOTAL,	93761,	76771,	57427,	53411,	61410,	87313,	80863,	64100,	49133,	46726,	32027,		

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

	RECRUITS, AGE 2	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 3- 7
1961	12019	65428	46439	21598	0.4651	0.6059
1962	20654	68225	43326	20967	0.4839	0.5226
1963	20290	77602	49054	22215	0.4529	0.4944
1964	21834	84666	55362	21078	0.3807	0.5017
1965	8269	75043	57057	24212	0.4244	0.4909
1966	18566	83919	60629	20418	0.3368	0.4743
1967	23451	105289	73934	23562	0.3187	0.39
1968	17582	110433	82484	29930	0.3629	0.4642
1969	9325	105537	83487	32371	0.3877	0.4375
1970	8608	98398	82035	24183	0.2948	0.3882
1971	11928	78218	63308	23010	0.3635	0.3526
1972	21320	76439	57180	18727	0.3275	0.3358
1973	12573	107682	80516	22228	0.2761	0.2886
1974	30480	136663	95831	24581	0.2565	0.3139
1975	38319	149774	105676	36775	0.348	0.3947
1976	18575	154919	116736	39799	0.3409	0.4749
1977	9995	136017	111863	34927	0.3122	0.6757
1978	10748	94338	76608	26585	0.347	0.4259
1979	14997	83769	65380	23112	0.3535	0.4273
1980	23582	84537	58386	20513	0.3513	0.3945
1981	14000	86907	62058	22963	0.37	0.4648
1982	22127	96625	64695	21489	0.3322	0.4138
1983	25157	121639	76932	38133	0.4957	0.7057
1984	47756	150221	94847	36979	0.3899	0.5082
1985	17316	129606	83165	39484	0.4748	0.7015
1986	9508	98522	72952	34595	0.4742	0.6694
1987	9917	77651	61527	21391	0.3477	0.4456
1988	8644	65617	51648	23182	0.4488	0.6082
1989	16271	58848	38176	22068	0.5781	0.7988
1990	3738	37906	28781	13487	0.4686	0.657
1991	6705	28548	20847	8750	0.4197	0.5082
1992	11409	35232	20223	6396	0.3163	0.4493
1993	10114	50699	32657	6107	0.187	0.2394
1994	25388	84545	42866	9046	0.211	0.1818
1995	43332	145266	54193	23045	0.4252	0.3137
1996	13379	144259	85826	40422	0.471	0.6914
1997	6808	97611	81719	34304	0.4198	0.7568
1998	6307	68360	57389	24005	0.4183	0.5622
1999	15224	68929	47648	19906	0.4178	0.5265
2000	21707	97299	48538	22433	0.4622	0.3671
2001	35840	122395	63008	28883	0.4584	0.4121
2002	13650	112213	63133	39086	0.6191	0.7255
2003	7193	74224	51004	29281	0.5741	0.7245
2004	9480	50780	33782	17287	0.5117	0.7922
Arith.						
Mean	21001	92745	63702	24853	0.3972	0.5018
0 Units	(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 61-04
YC2002	9480		
YC2003	14488		
YC2004			14732
YC2005			14732

Stock size

2005
14488
7642
3401
2827
3077
508
62
23

Directly from XSA output

Maturity

Age	Observed 2005	Av.03-05 2006	Av.03-05 2007
2	0.05	0.02	0.02
3	0.66	0.49	0.49
4	0.9	0.82	0.82
5	0.93	0.91	0.91
6	0.98	0.95	0.95
7	0.92	0.93	0.93
8	1	1	1
9	1	1	1
10	1	1	1

Exploitation pattern (not rescaled)

Av02-04 2005	Av02-04 2006	Av02-04 2007
0.1121	0.1121	0.1121
0.3201	0.3201	0.3201
0.4953	0.4953	0.4953
0.7181	0.7181	0.7181
0.9083	0.9083	0.9083
1.2952	1.2952	1.2952
1.1566	1.1566	1.1566
1.6617	1.6617	1.6617
0.7474	0.7474	0.7474

Weights

Est.from Jan-Feb 2005	As2004 2006	As2004 2007
1.0244	1.0375	1.0375
1.3640	1.1544	1.1544
1.7371	1.6932	1.6932
2.3030	2.3632	2.3632
3.4245	3.8305	3.8305
5.1771	5.1906	5.1906
7.9185	6.3257	6.3257
7.8950	7.6563	7.6563
9.8230	9.5733	9.5733

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

MFDP VERSION 1						
Run: Run1						
Index file 2/5-2005						
Time and date: 11:19 02/05/05						
Fbar age range: 3-7						
2005						
Biomass	**SSB**	**FMult**	**FBar**	**Landings**		
51523	32412	1.0000	0.7474	17199		
2006					**2007**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
49666	26114	0.0000	0.0000	0	68791	42672
.	26114	0.1000	0.0747	2104	66246	40375
.	26114	0.2000	0.1495	4057	63885	38254
.	26114	0.3000	0.2242	5872	61692	36291
.	26114	0.4000	0.2990	7561	59653	34474
.	26114	0.5000	0.3737	9136	57752	32788
.	26114	0.6000	0.4484	10607	55979	31222
.	26114	0.7000	0.5232	11984	54323	29765
.	26114	0.8000	0.5979	13274	52772	28409
.	26114	0.9000	0.6727	14484	51319	27143
.	26114	1.0000	0.7474	15622	49956	25961
.	26114	1.1000	0.8221	16693	48675	24855
.	26114	1.2000	0.8969	17703	47469	23819
.	26114	1.3000	0.9716	18656	46334	22848
.	26114	1.4000	1.0464	19557	45262	21936
.	26114	1.5000	1.1211	20411	44250	21079
.	26114	1.6000	1.1959	21220	43293	20272
.	26114	1.7000	1.2706	21988	42386	19511
.	26114	1.8000	1.3453	22718	41527	18794
.	26114	1.9000	1.4201	23412	40711	18117
.	26114	2.0000	1.4948	24074	39936	17476
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).

	EXPLOITATION	WEIGHTATAGE	PROPMATURE
	pattern		
	Average	Average	Average
	1999-2004	1978-2004	1983-2005
	Not rescaled		
Age 2	0.1145	1.0631	0.0300
Age 3	0.3144	1.6029	0.5478
Age 4	0.4335	2.3063	0.8422
Age 5	0.5043	3.1212	0.9430
Age 6	0.679	3.8907	0.9835
Age 7	0.8856	4.8529	0.9852
Age 8	0.8473	5.9260	0.9974
Age 9	0.8543	7.4842	1.0000

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: YLD1
Time and date: 12:59 02/05/05
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	4.4029	12.7983	2.9120	10.7722	2.9120	10.7722
0.1000	0.0563	0.1557	0.5694	4.0405	10.9891	2.5630	8.9978	2.5630	8.9978
0.2000	0.1127	0.2671	0.9181	3.7469	9.5821	2.2820	7.6227	2.2820	7.6227
0.3000	0.1690	0.3487	1.1287	3.5059	8.4744	2.0528	6.5446	2.0528	6.5446
0.4000	0.2253	0.4101	1.2532	3.3055	7.5915	1.8636	5.6890	1.8636	5.6890
0.5000	0.2817	0.4574	1.3241	3.1367	6.8788	1.7055	5.0017	1.7055	5.0017
0.6000	0.3380	0.4949	1.3619	2.9928	6.2963	1.5718	4.4430	1.5718	4.4430
0.7000	0.3944	0.5253	1.3793	2.8689	5.8144	1.4575	3.9834	1.4575	3.9834
0.8000	0.4507	0.5506	1.3844	2.7610	5.4110	1.3589	3.6010	1.3589	3.6010
0.9000	0.5070	0.5721	1.3821	2.6662	5.0694	1.2729	3.2792	1.2729	3.2792
1.0000	0.5634	0.5906	1.3755	2.5822	4.7772	1.1973	3.0057	1.1973	3.0057
1.1000	0.6197	0.6068	1.3665	2.5071	4.5248	1.1303	2.7710	1.1303	2.7710
1.2000	0.6760	0.6213	1.3564	2.4396	4.3047	1.0706	2.5678	1.0706	2.5678
1.3000	0.7324	0.6342	1.3457	2.3784	4.1113	1.0170	2.3904	1.0170	2.3904
1.4000	0.7887	0.6459	1.3351	2.3228	3.9399	0.9686	2.2343	0.9686	2.2343
1.5000	0.8450	0.6566	1.3246	2.2718	3.7870	0.9247	2.0961	0.9247	2.0961
1.6000	0.9014	0.6664	1.3145	2.2250	3.6498	0.8846	1.9729	0.8846	1.9729
1.7000	0.9577	0.6754	1.3047	2.1817	3.5260	0.8479	1.8624	0.8479	1.8624
1.8000	1.0140	0.6838	1.2954	2.1417	3.4136	0.8141	1.7629	0.8141	1.7629
1.9000	1.0704	0.6916	1.2866	2.1044	3.3111	0.7830	1.6728	0.7830	1.6728
2.0000	1.1267	0.6989	1.2781	2.0696	3.2173	0.7541	1.5909	0.7541	1.5909

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5634
FMax	0.8103	0.4565
F0.1	0.4458	0.2512
F35%SPR	0.7535	0.4245
Flow	0.0442	0.0249
Fmed	0.6683	0.3765
Fhigh	1.674	0.9431

Weights in kilograms

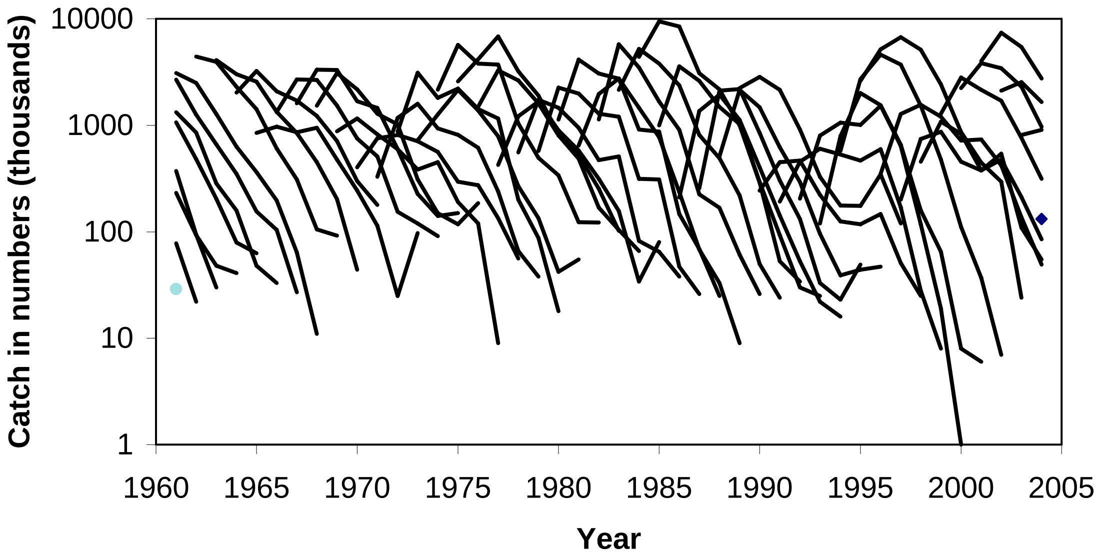


Figure 2.2.3.1. Faroe Plateau (sub-division VB1) COD. Catch in numbers.

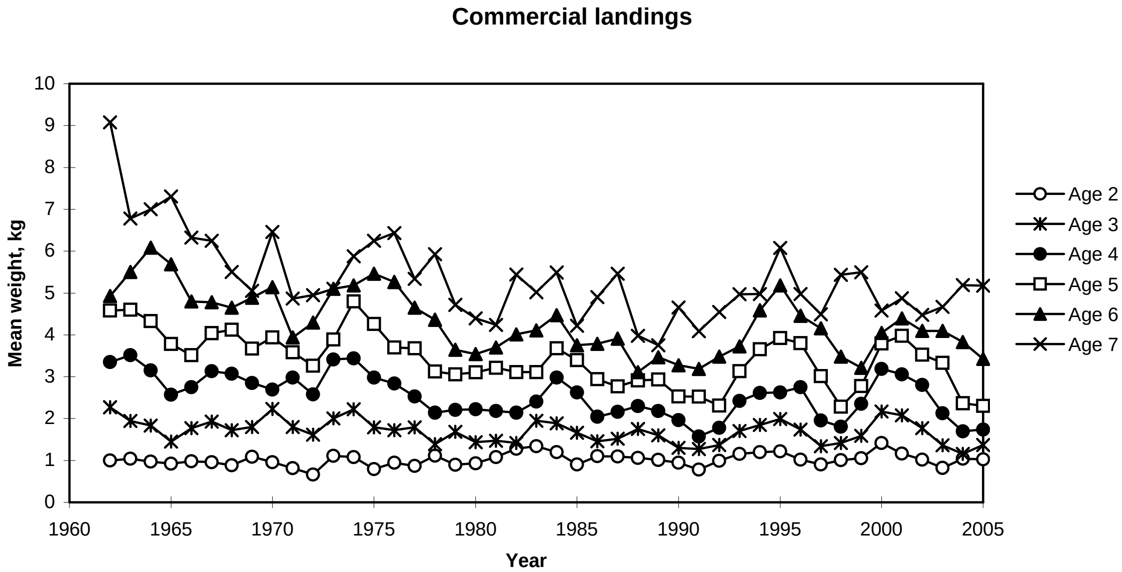


Figure 2.2.4.1. Faroe Plateau (sub-division VB1) COD. Mean weight at age 1961-2004. The estimated weights in 2005 are also shown.

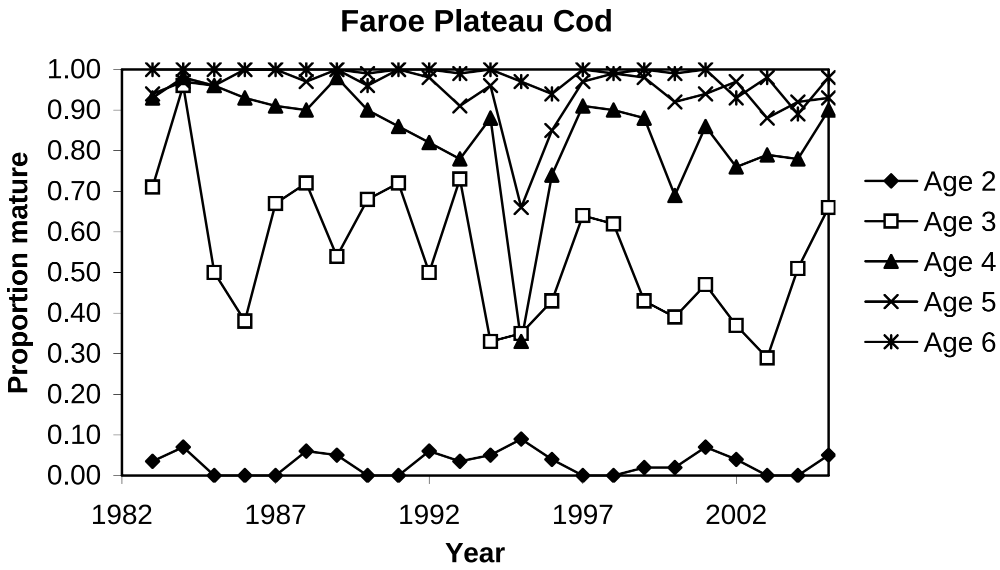


Figure 2.2.5.1. Faroe Plateau (sub-division VB1) COD. Proportion mature at age as observed in the spring groundfish survey.

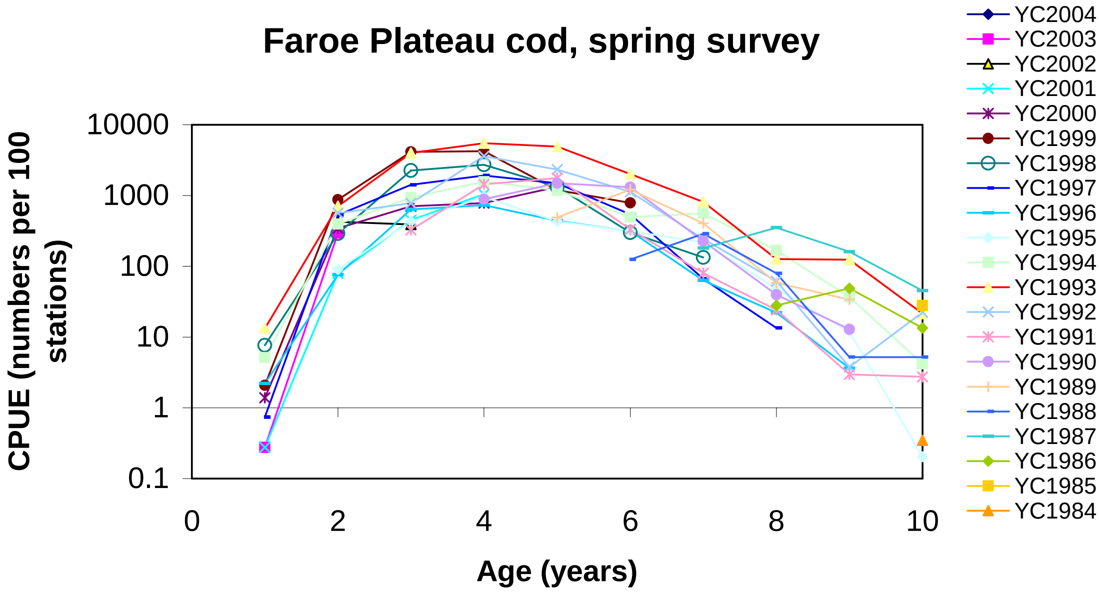


Figure 2.2.6.1. Faroe Plateau (sub-division VB1) COD. Catch curves from the spring groundfish survey.

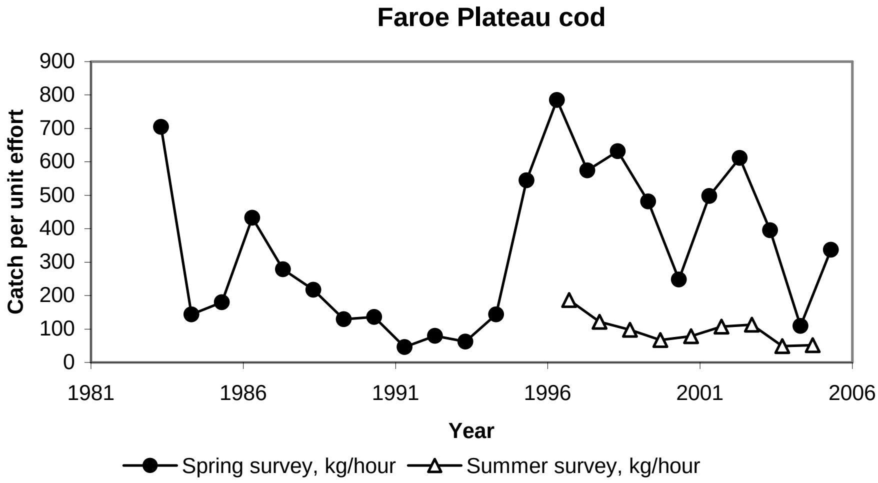


Figure 2.2.6.2. Faroe Plateau (sub-division VB1) COD. Catch per unit effort (kg/hour) in the spring, and summer groundfish survey.

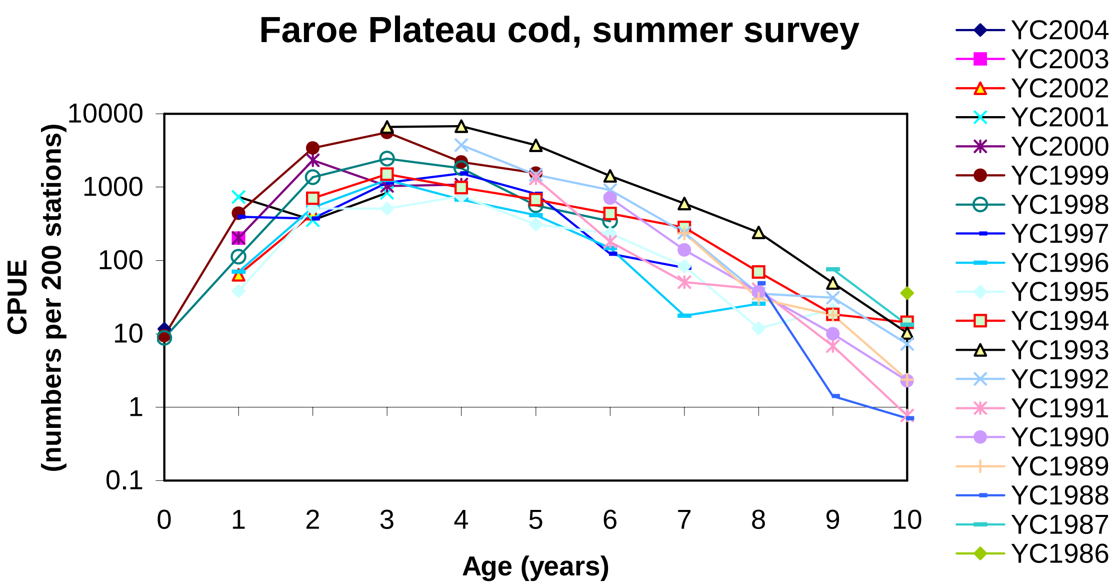


Figure 2.2.6.3. Faroe Plateau (sub-division VB1) COD. Catch curves from the summer groundfish survey.

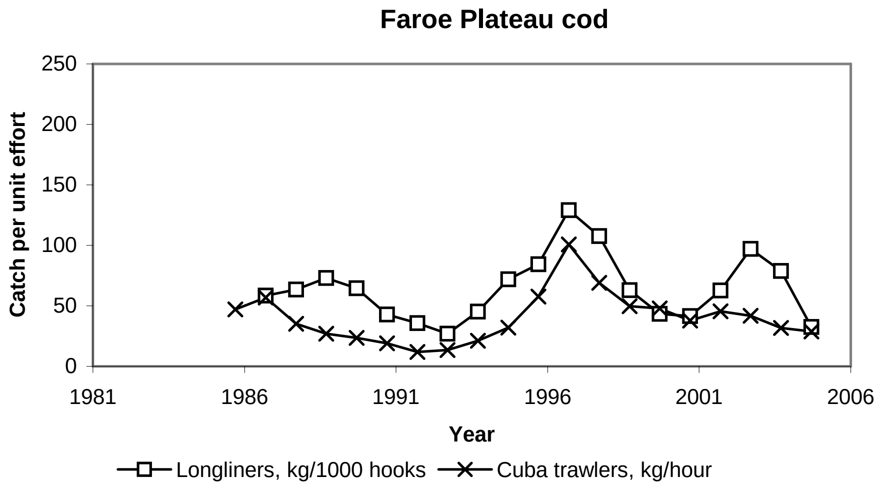


Figure 2.2.7.1.1. Faroe Plateau (sub-division VB1) COD. Catch per unit effort for Cuba trawlers and longliners.

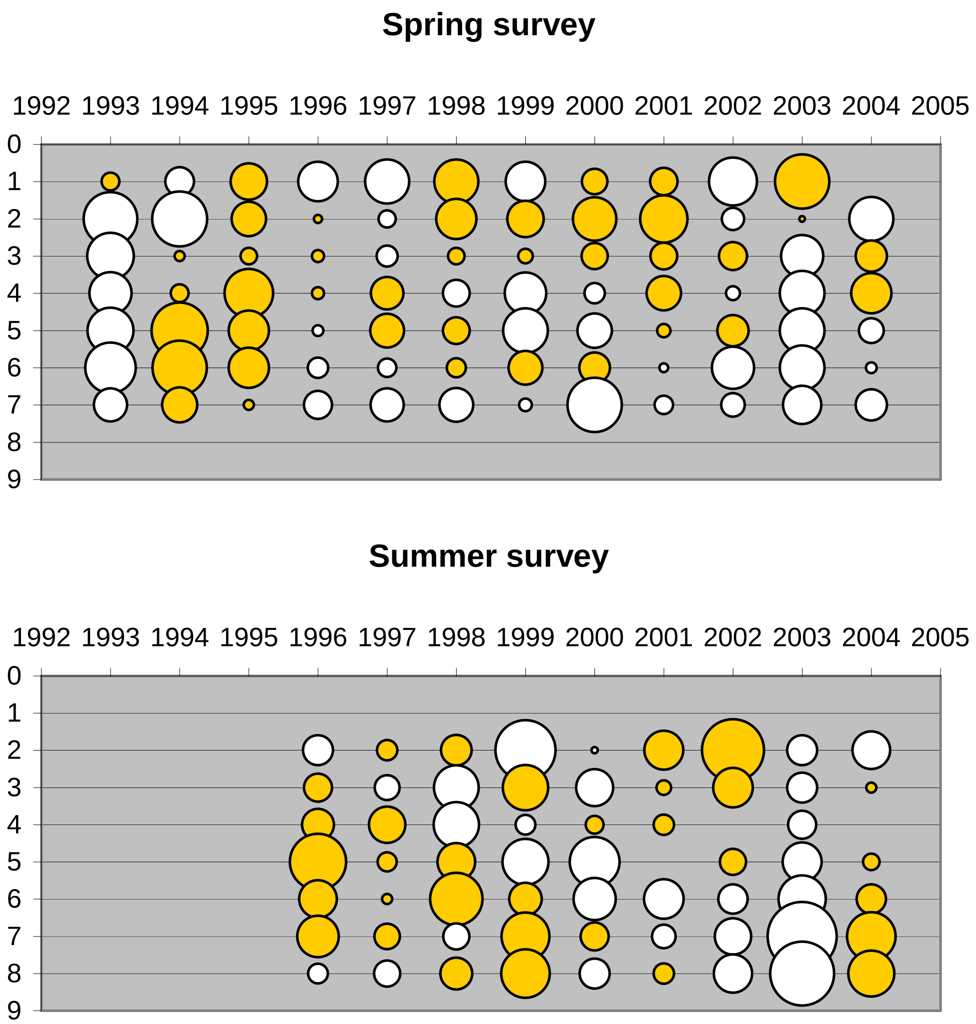


Figure 2.2.7.1.2. Faroe Plateau (sub-division VB1) COD. Log catchability residuals for the spring and summer survey. The residuals for age 8 in the spring survey are not presented because some values were off scale. White bubbles indicate negative residuals.

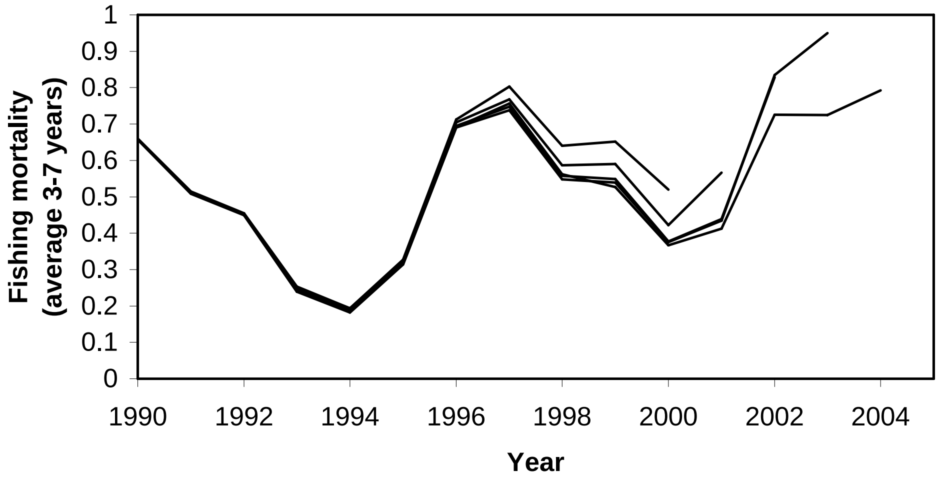


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis.

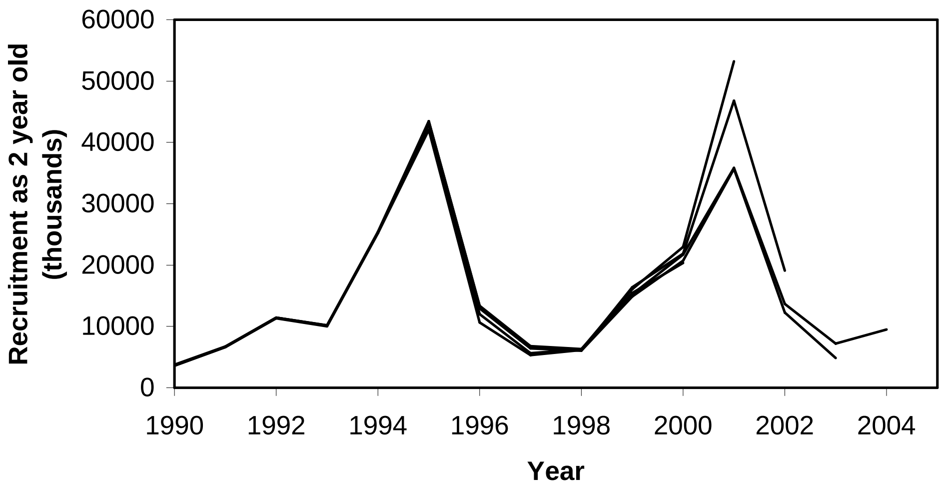


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

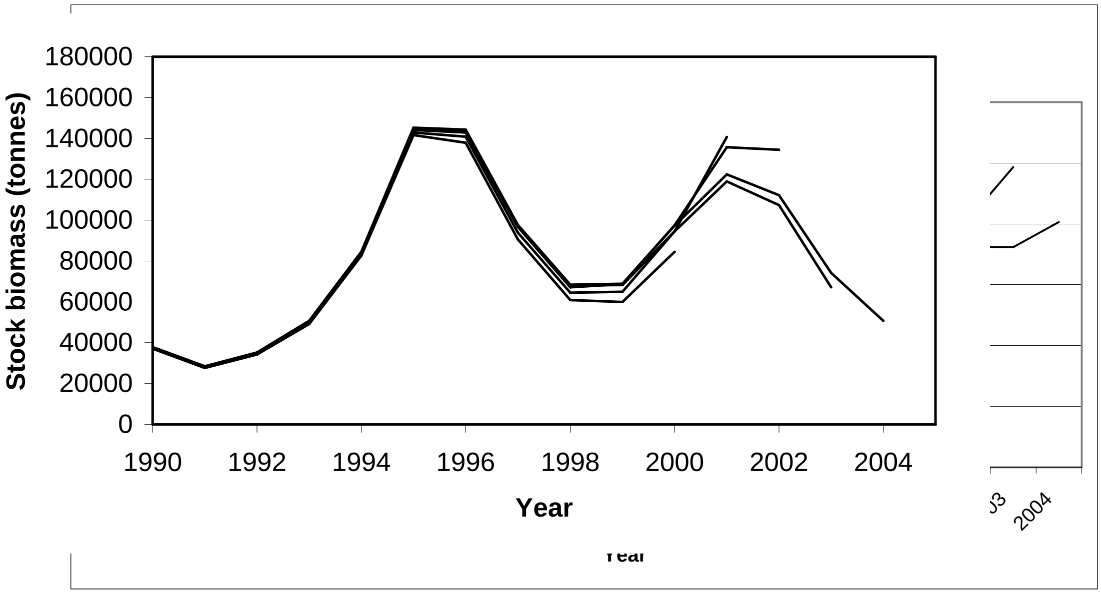


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from the XSA retrospective analysis. Continued.

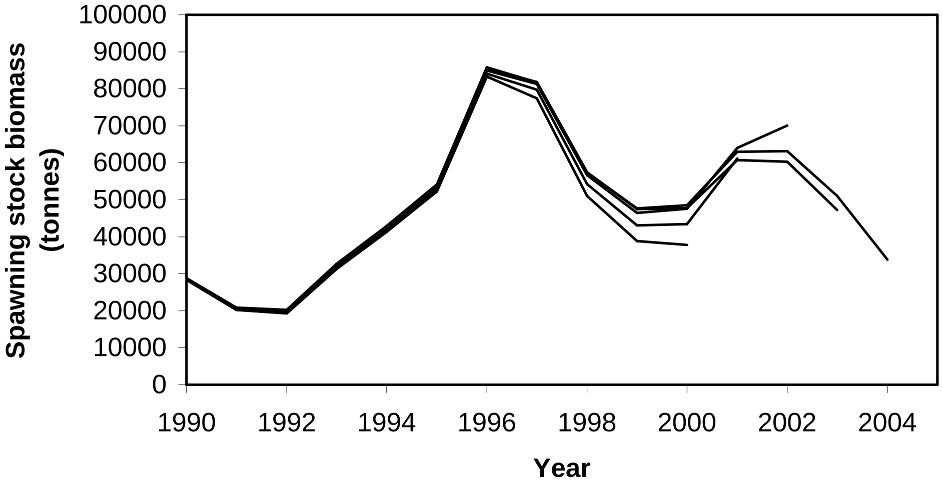
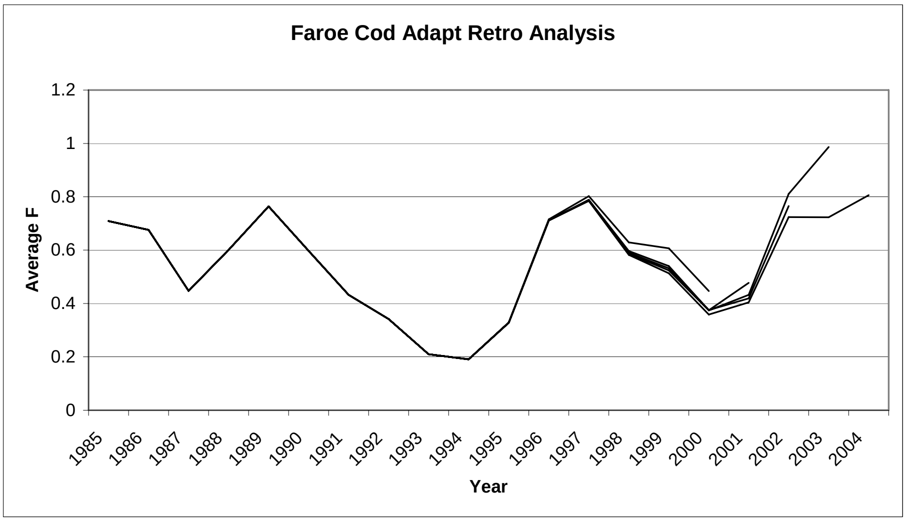
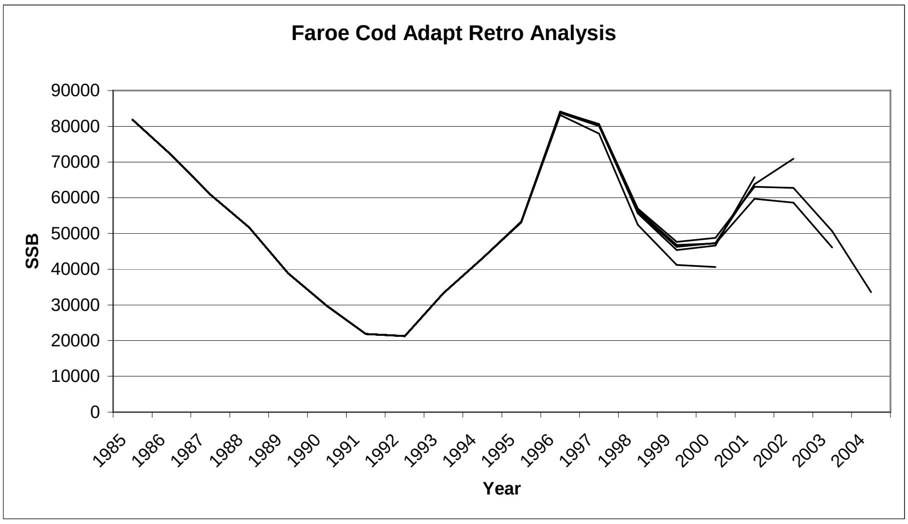


Figure 2.2.7.1.3. Faroe Plateau (sub-division VB1) COD. Results from XSA retrospective analysis. Continued.





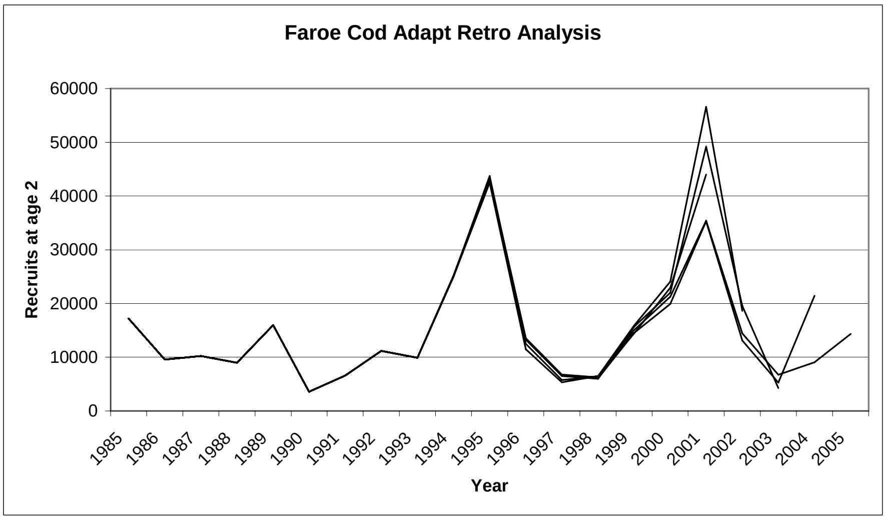
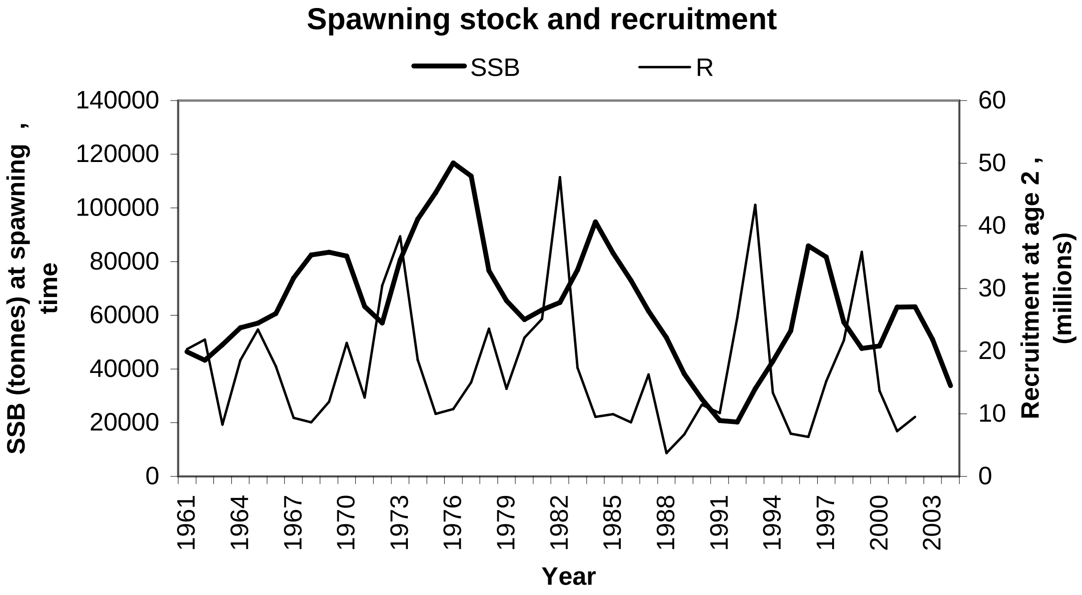


Figure 2.2.7.1.4. Retrospective pattern from the ADAPT calibrated with the summer and the spring surveys ages 2 to 8.



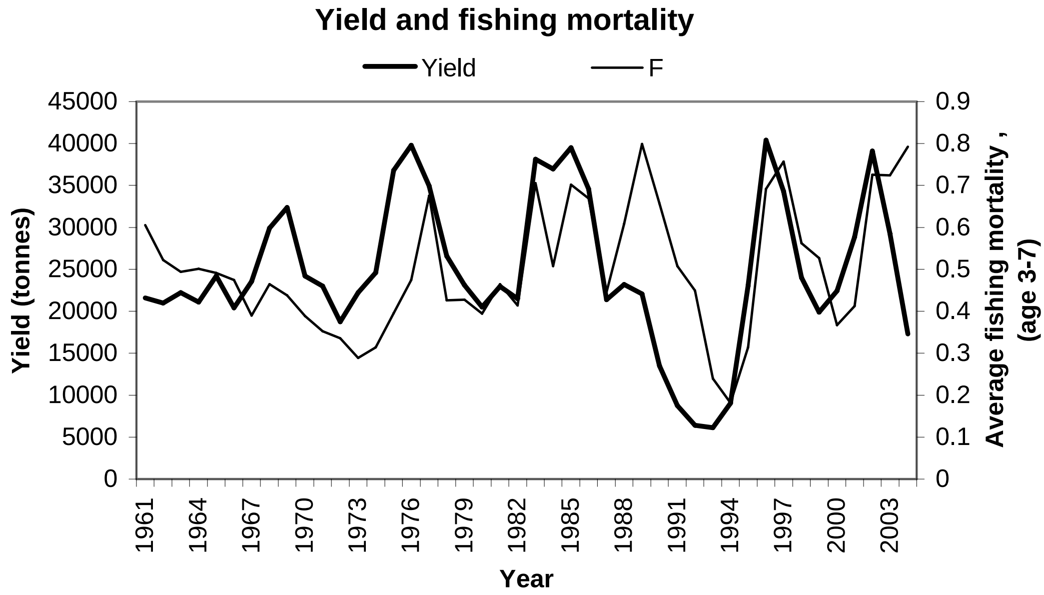


Figure 2.2.7.1.5. Faroe Plateau (sub-division VB1) COD. Yield and fishing versus year. Spawning stock biomass (SSB) and recruitment (year class) versus year.

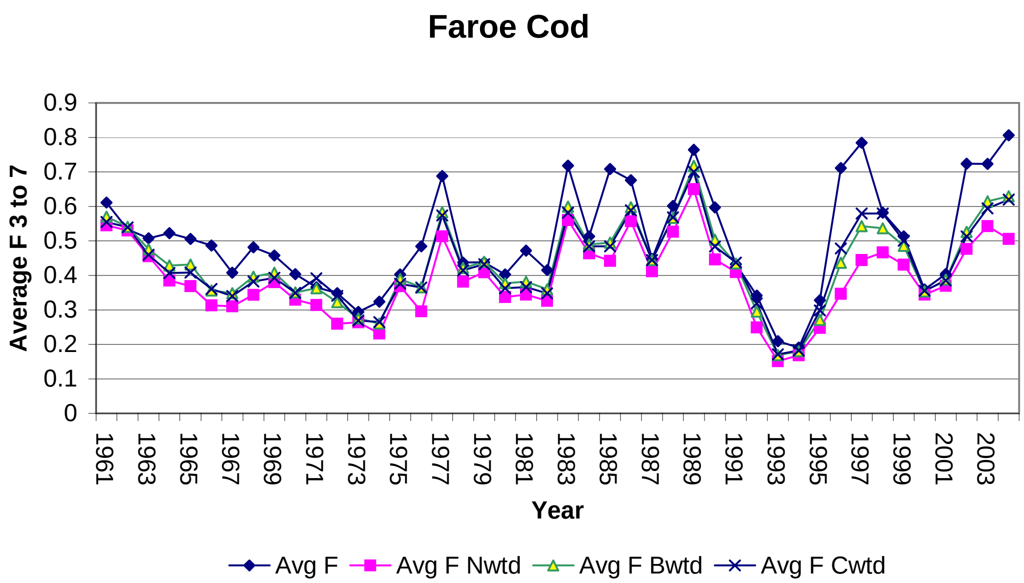


Figure 2.2.7.1.6. Faroe Plateau (sub-division VB1) COD. Different measures of fishing mortality: straight arithmetic average (Avg F), weighted by stock numbers (Nwtd), weighted by stock biomass (Bwtd) or weighted by catch (Cwtd).

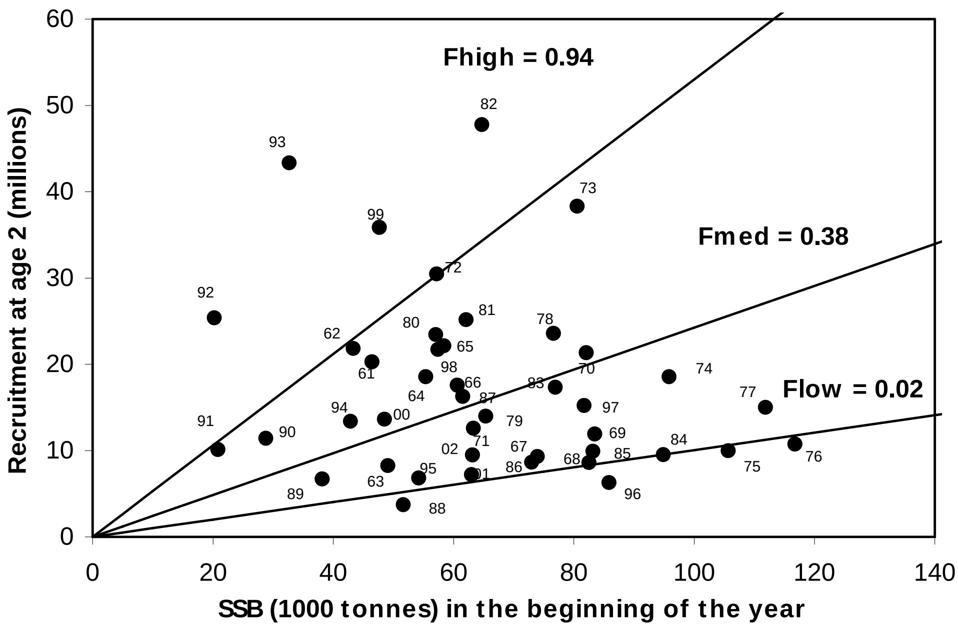


Figure 2.2.7.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock – recruitment relationship 1961-2002. Years are shown at each data point.

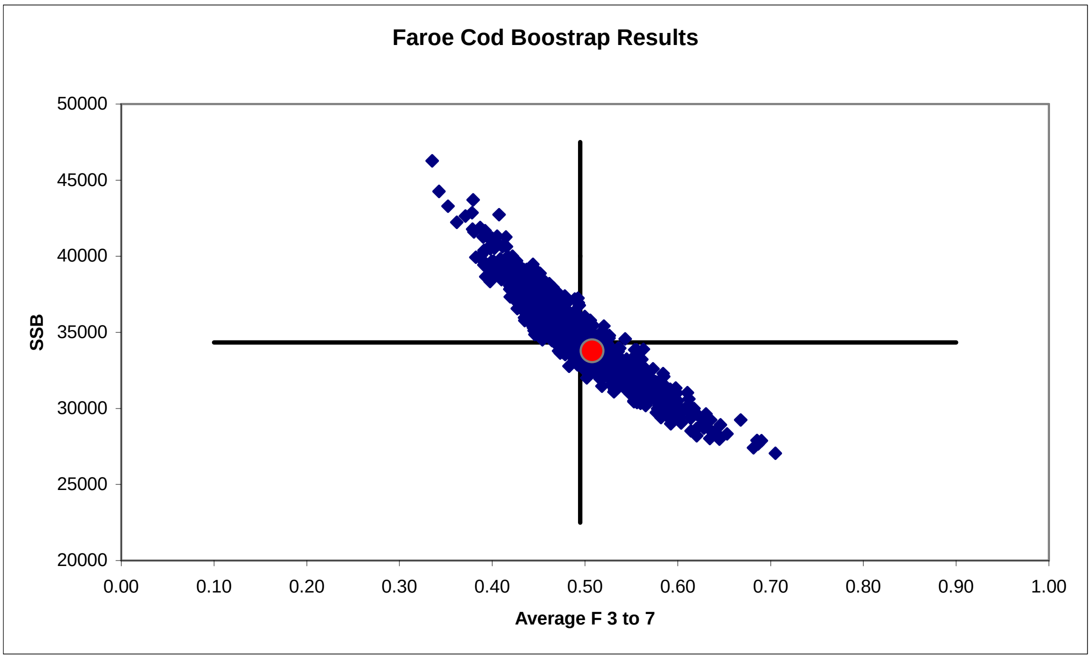


Figure 2.2.7.2.2. F and SSB's for 2004 from a 1000 bootstraps of the ADAPT with the two surveys. The XSA estimate is shown as a red point.

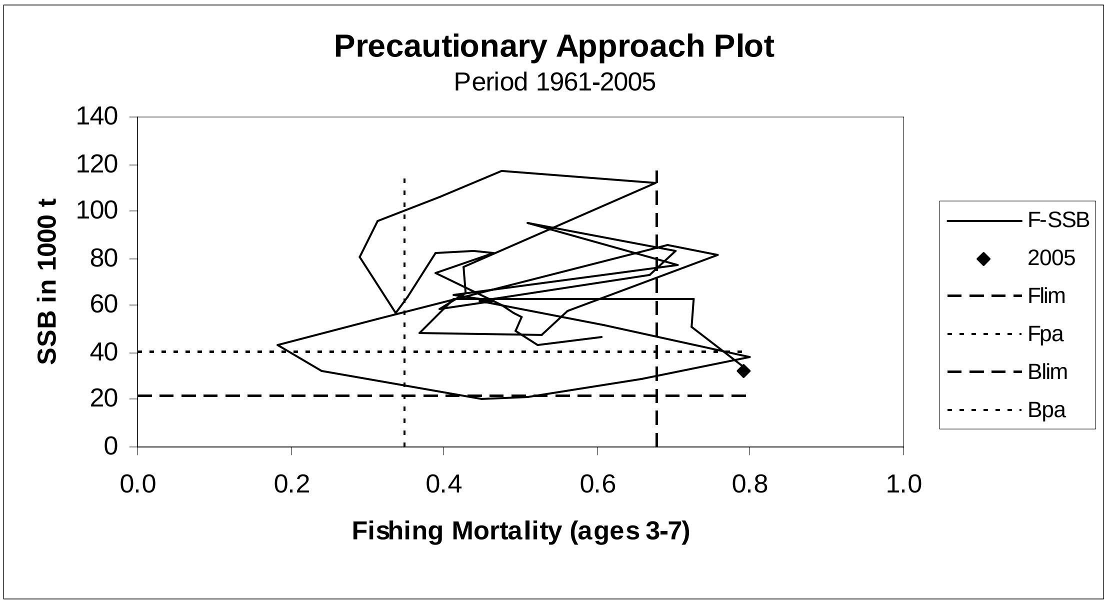
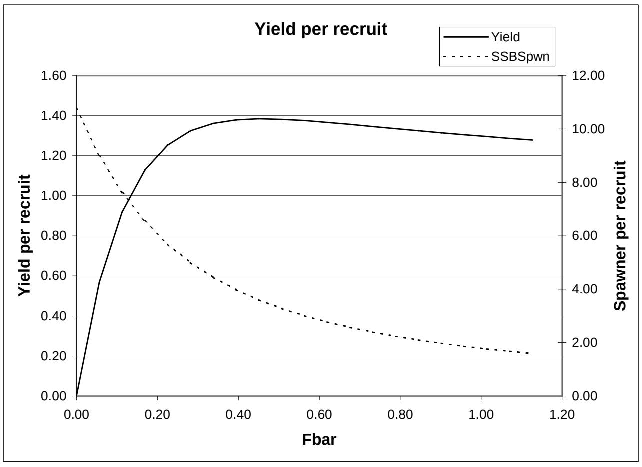
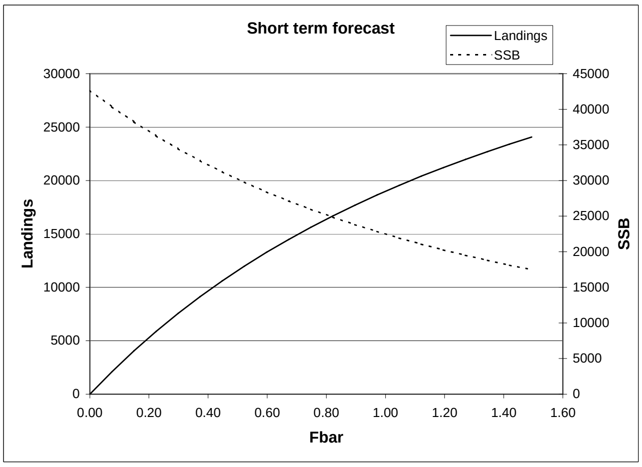


Figure 2.2.8.2.1. Faroe Plateau (sub-division VB1) COD. Spawning stock biomass versus fishing mortality 1961-2005. Output from standard graph software.





MFYPR version 1
Run: YLD1
Time and date: 12:59 02/05/05

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.5634
FMax	0.8103	0.4565
F0.1	0.4458	0.2512
F35%SPR	0.7535	0.4245
Flow	0.0442	0.0249
Fmed	0.6683	0.3765
Fhigh	1.6740	0.9431

Weights in kilograms

MFDP version 1
Run: Run1
Index file 2/5-2005
Time and date: 11:19 02/05/05
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

Answers to terms of reference for the working group will be marked with square brackets. Terms of reference which apply to the Faroe Bank Cod are:

b) assess the status of and provide effort options and expected corresponding catches for 2006 for cod, haddock, and saithe in Division Vb as these stocks are under effort control

(2) comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans

(4) update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country

(7) provide on a national basis an overview of the sampling of the basic assessment data for the stocks considered

(8) provide specific information on possible deficiencies in the 2005 assessments including, at least, any major inadequacies in the data on landings, 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 both the assessment of the status of the stocks and the projection should be clarified.

2.3.1 Trends in landings and effort

[ToR 4] Total nominal catches of the Faroe Bank cod from 1986 to 2004 as officially reported to ICES are given in Table 2.3.1.1 and since 1965 in Figure 2.3.1.1. British catches reported to be taken on the Faroe Bank are all assumed to be taken on the Faroe Plateau and are therefore not used in the assessment. 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 slightly exceeding 5 000t in 1973. The trend 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 2004 landings were estimated at 4 300t about 1 400 t less than in 2003 (Figure 2.3.1.1). Longline fishing effort increased substantially in 2003 and although it decreased in 2004 it remains the second highest fishing effort observed since 1988 (Figure 2.3.1.1).

[ToR 8] There may be problems with the catch figures for Faroe Bank. The vessels may fish on both Faroe Plateau and Faroe Bank during the same trip. The catches of cod on Faroe Bank are sometimes reported on the landing slips and vessels larger than 15 GRT are obliged to have logbooks. The Faroes Coastal Guard is splitting the landings into Vb1 and Vb2 on the basis of landing slips and logbooks. Since small boats don’t fill out logbooks and may not land the catch, the catch figures on the Faroe Bank are actually estimates rather than absolute figures.

The error in the catches of Faroe Bank cod may be in the order of some hundred tonnes, not thousand tonnes.

In 1990, the decreasing trend in cod landings from Faroe Bank lead ACFM 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 meters 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.

[ToR 4] For the fishing years from 1 Sep 2004 to 31 Aug 2005 the number of allocated fishing days has been reduced by 10%. In 2005 the authorities have introduces at total fishing ban during the spawning period, i.e. 1 March to 1 May.

2.3.2 Stock assessment

[ToR 7] Biological samples have been taken from commercial landings since 1974 (the 2004 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.

Table 2.3.2.1. Samples of lengths, otoliths, and individual weights of Faroe Bank cod in 2004

FLEET	SIZE	SAMPLES	LENGTHS	OTOLITHS	SAMPLE WEIGHTS
Longliners	< 100 GRT	4	820	120	260
Longliners	> 100 GRT	27	5411	658	2003
Total		31	6231	778	2263

[ToR 7] 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 spring survey was initiated in 1983 and discontinued in 2003. The summer survey has been carried out since 1996. The CPUE of the spring survey was low during 1988 to 1995 varying between 73 and 95 kg per tow. Although noisy, the survey suggests higher, possibly increasing biomass during 1995 - 2003. Since the spring survey has been discontinued, the summer survey is the only survey, which can give updated information on trends in stock size. The agreement is good between the two indices during 1996 to 2001, but they diverged in 2002 and 2003.

The figure of length distributions (figure 2.3.2.2 and figure 2.3.2.3) show in general good recruitment of 1 year old in the summer survey from 2000 – 2003 (lengths 26 – 40 cm), corresponding to good recruitment of 2 years old in the spring surveys from 2001 to 2003 (40 – 55 cm). The summer survey shows poor recruitment of 1 years old in 2004.

The recruitment can simply be estimated by counting number of fish in the small length groups in the surveys. The figure below shows a fairly good correlation between spring survey recruitment and summer survey recruitment. According to the summer survey the recruitment of 1 year old has been good from 2000 to 2003, while the recruitment has been relative poor in 2004 (Figure 2.3.2.4).

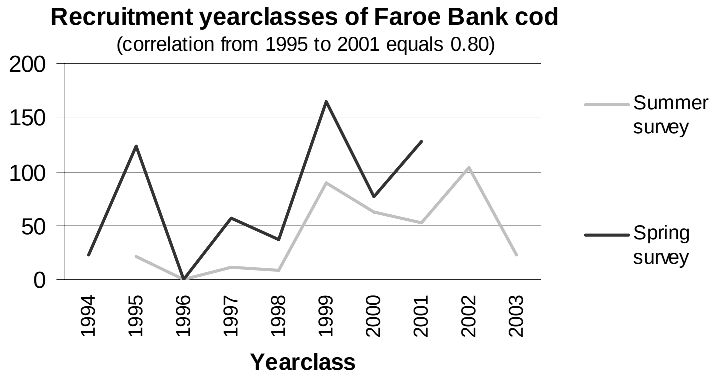


Figure 2.3.2.4. Estimated recruitment from surveys. In summer surveys the 1 year old recruitment is estimated. In spring surveys the recruitment of 2 year old is estimated.

Figure 2.3.2.5 shows a positive correlation between the survey indices and the landings in the same year., but the relationship between the summer survey and the landings deteriorates in 2003 and 2004. The ratio of landings to the survey indices provide an exploitation ratio (Figure 2.3.2.5), which can be used as a proxy to relative changes in fishing mortality. For the summer survey, the results suggest that fishing mortality has been reasonably stable during 1996 to 2002, but that it increased steeply in 2003, consistent with the 160% increase in longline fishing days in that year. The decrease in longline fishing days in 2004 did not materialise as a decrease in exploitation ratio.

In 2005 a statistical catch at age model based on summer indices was used to assess the stock. The relative fishing mortality from the separable model suggests a similar but somehow lower mortality in 2004 than the exploitation ratio (Figure 2.3.2.6).

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.

[Tor 2] The effort has been extremely high in 2003 and is still fairly high in 2004 (Fig. 2.3.1.1). An exploitation ratio can be calculated via the catches and cpue from the surveys.

The very high effort in 2003 and 2004, results in an extremely high exploitation ratio. Even though there might be uncertainties due too poor data from the surveys, there is no doubt, that the exploitation rate is very high and may not be sustainable.

[ToR b] The recruitment of the 2002 years class seems to be good, while there are indications of bad recruitment of the 2003 year class.

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
Faroe Islands	1836	3409	2960	1270	289	297	122	264	717	561
Norway	6	23	94	128	72	38	32	2	8	40
UK (E/W/NI)	-	-	-	-	-	-	+	1	1	-
UK (Scotland)	[1] 63	47	37	14	205	90	176	118	227	551
United Kingdom										
Total	1905	3479	3091	1412	566	425	330	385	953	1152
Used in assessment					289	297	122	264	717	561

	1996	1997	1998	1999	2000	2001	2002	2003	2004 *
Faroe Islands	2051	3459	3092	1001		1094	1840	5957	4535
France						- [2]			
Norway	55	135	147	88	49	51	25	72	18
UK (E/W/NI)	[2] -	[2] -	[2] -	[2] -	-	-	-	-	-
UK (Scotland)	[3] 382	277	265	210	245	288	218	254	-
United Kingdom				-	-	-	-	-	259 [3]
Total	2488	3871	3504	1299	294	1433	2083	6283	4812
Correction of Faroese catches in Vb2						-65	-109	-353	-269
Used in assessment	2051	3459	3092	1001	1194	1080	1756	5676	4284

***) Preliminary**

1) Includes Vb1

2) Included in Vb1

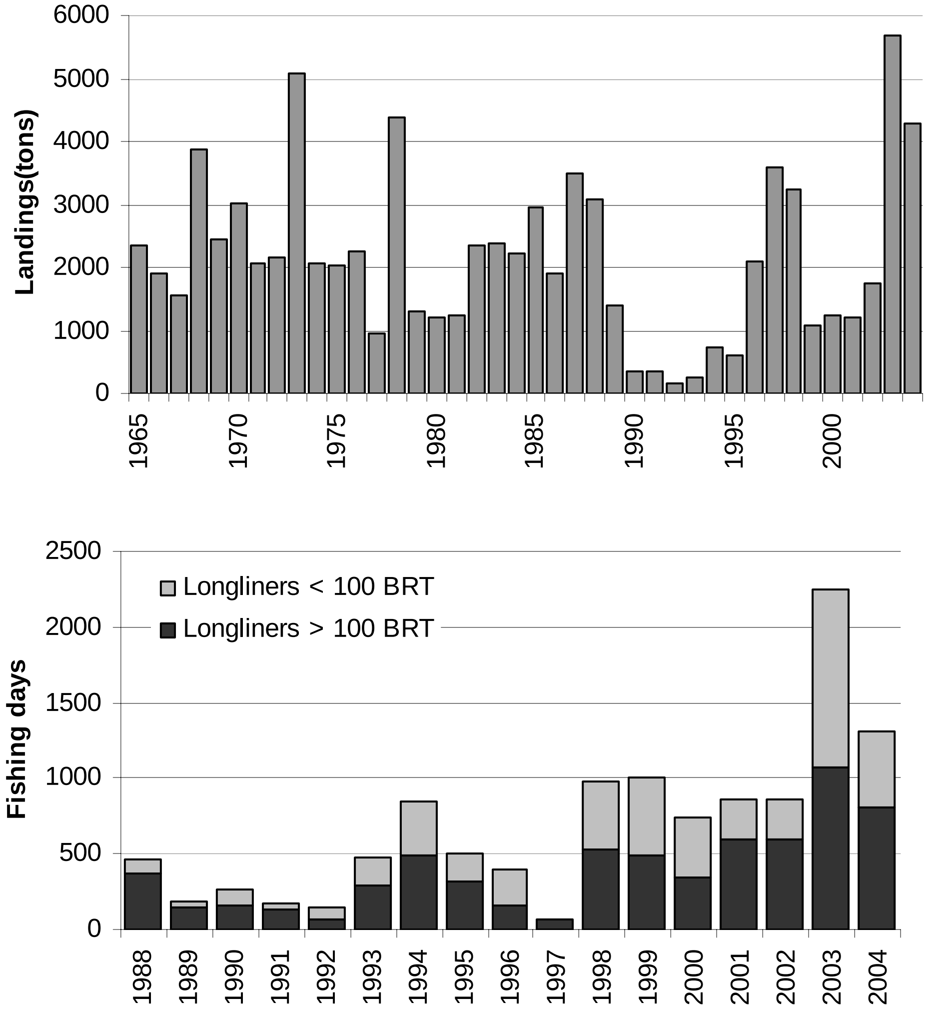


Figure 2.3.1.1. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2004. Since 1992 only catches from Faroese and Norwegian vessels are considered to be taken on Faroe Bank. Lower plot: fishing days 1988-2004 for long line gear type in the Faroe Bank (exerted).

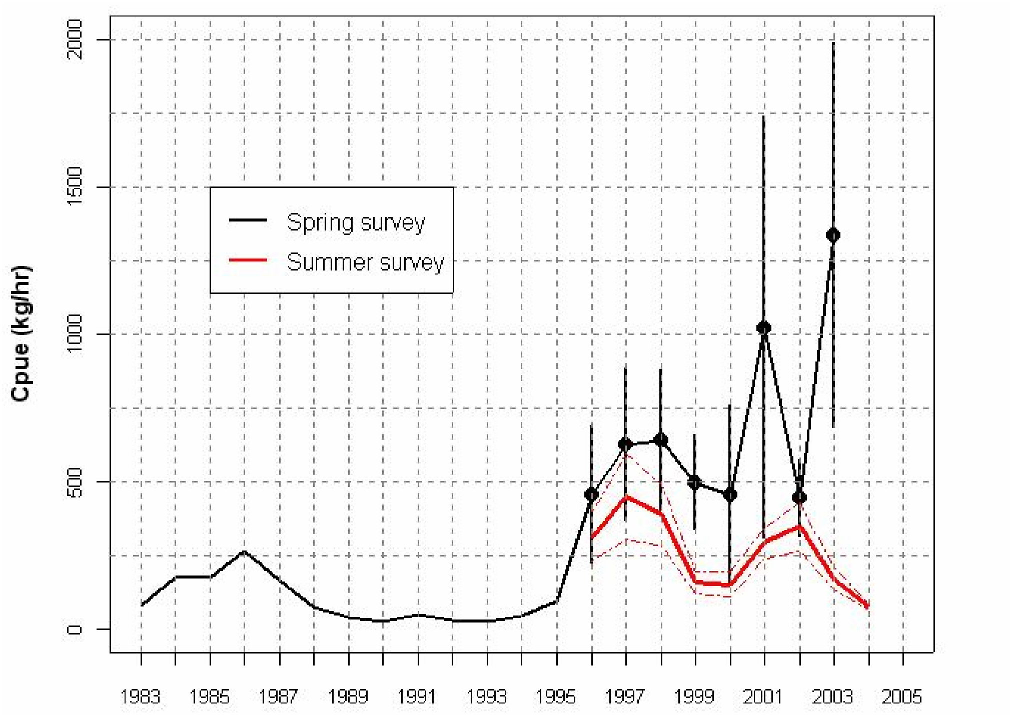


Figure 2.3.2.1. Faroe Bank (sub-division Vb2) cod. Catch per unit of effort in the spring groundfish survey and summer survey.

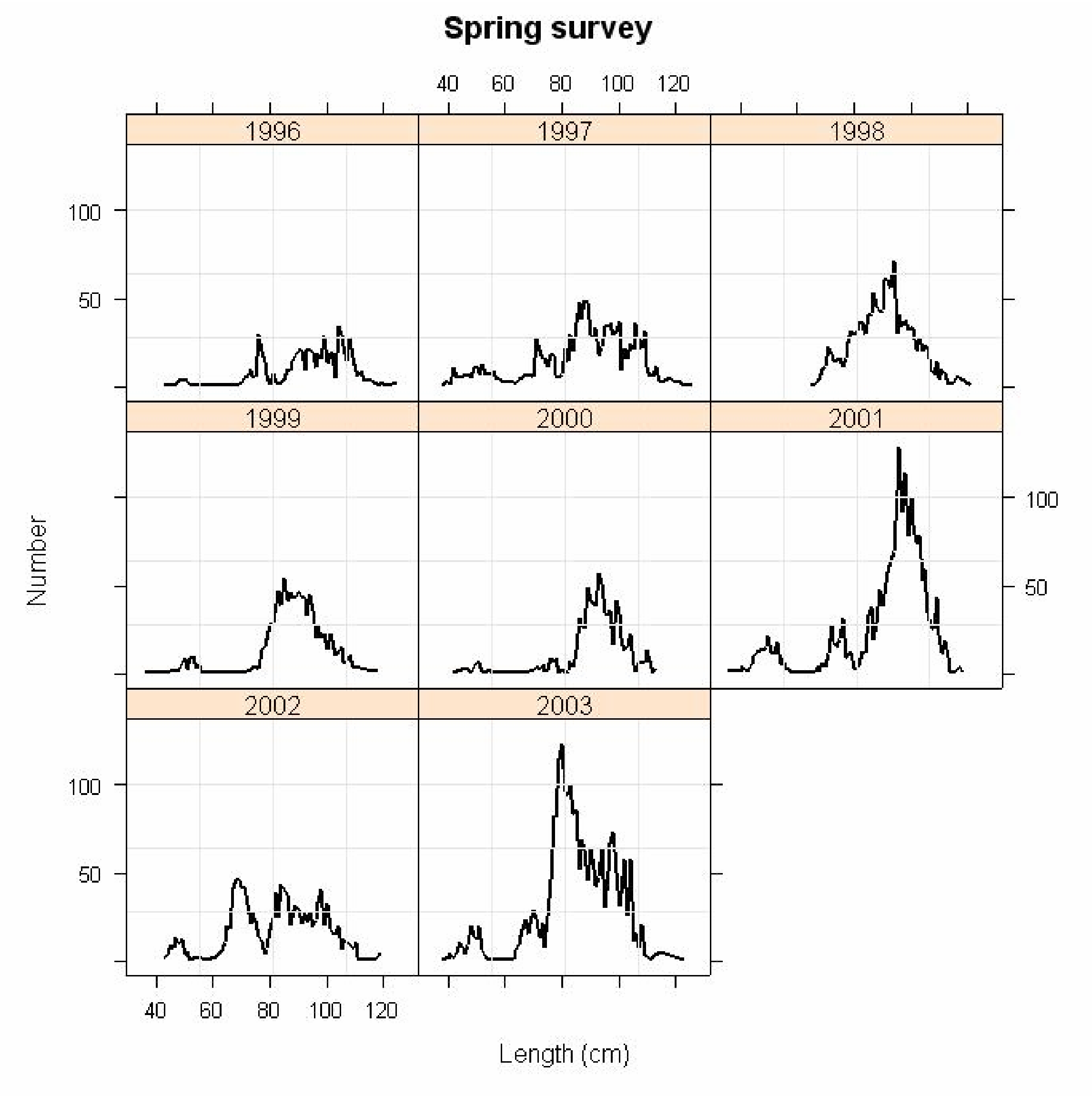


Figure 2.3.2.2. Faroe Bank (sub-division Vb2) cod. Length distributions in the spring survey

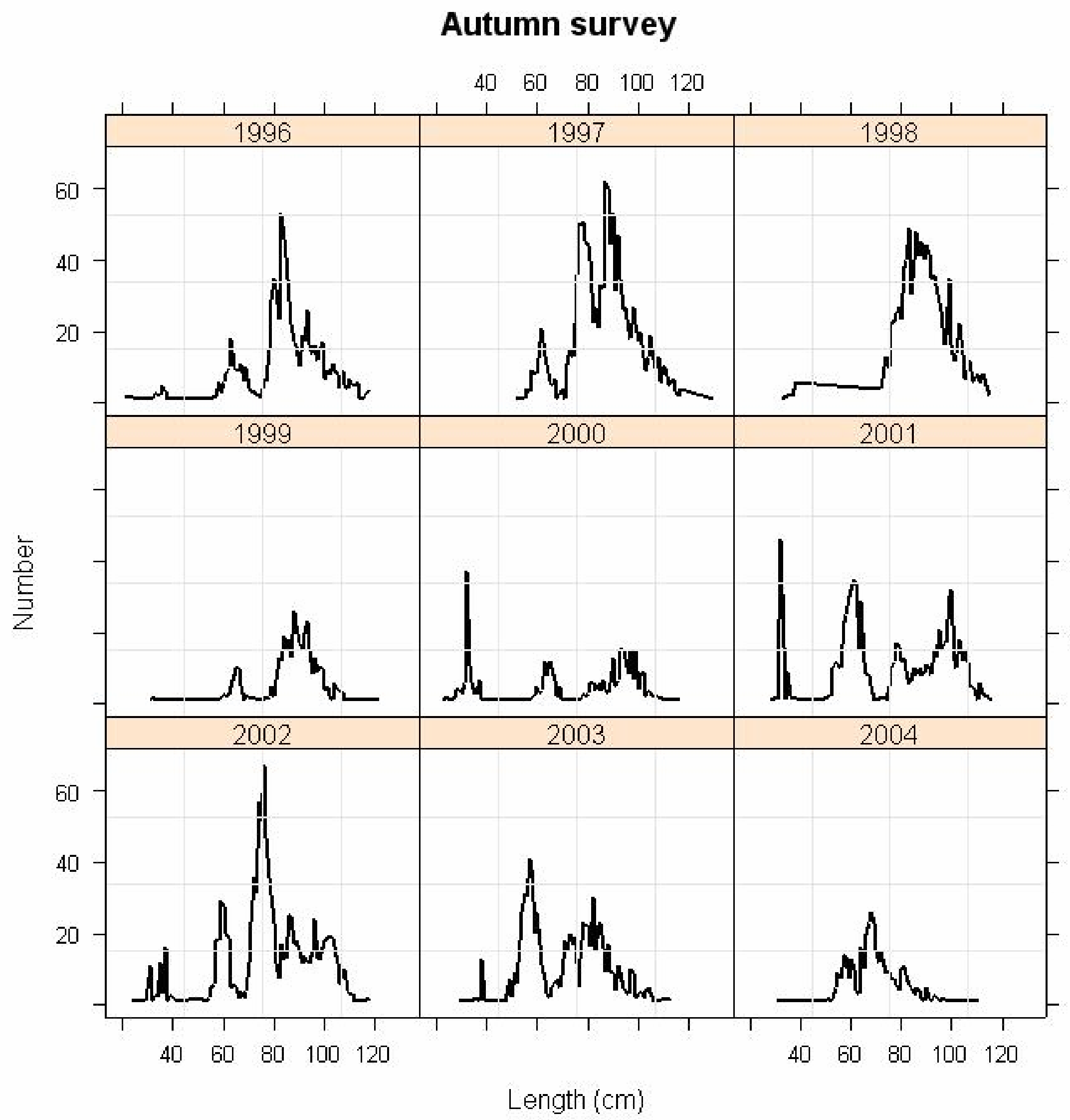


Figure 2.3.2.3. Faroe Bank (sub-division Vb2) cod. Length distributions in the summer survey.

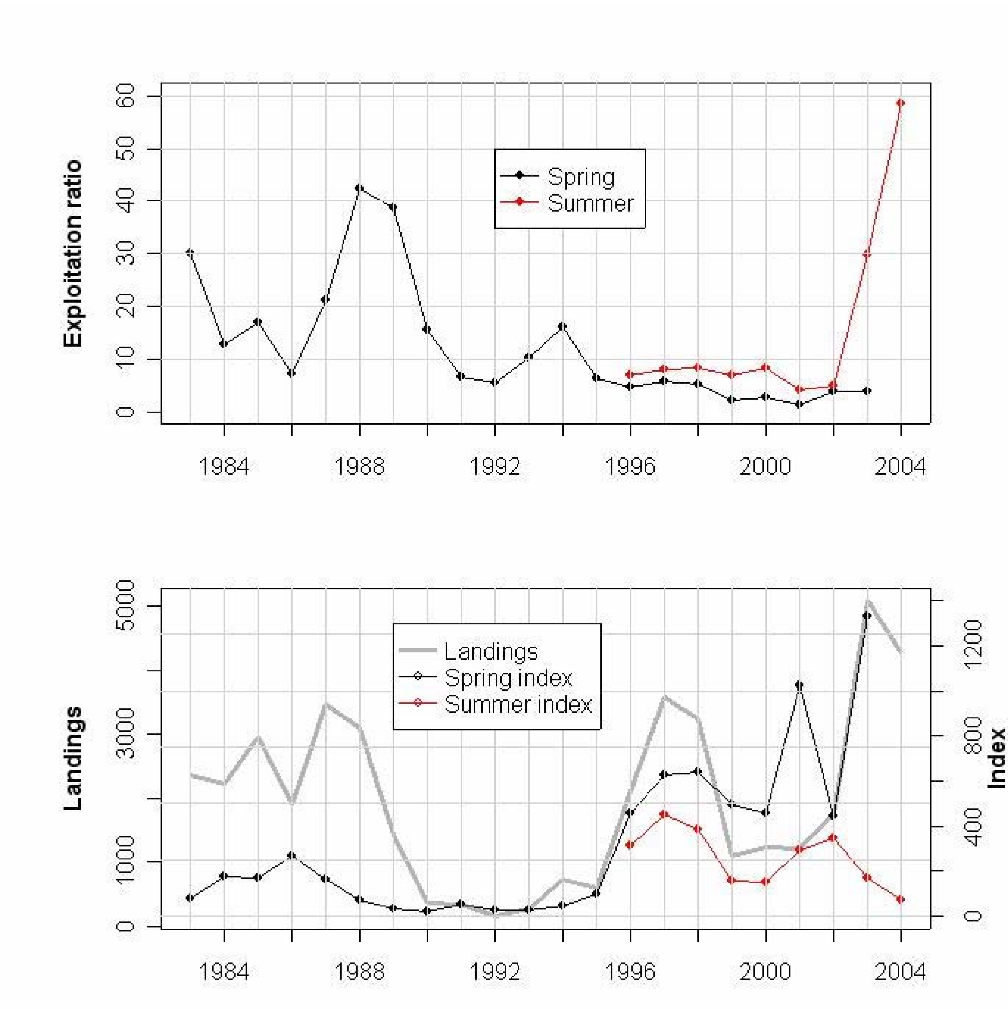


Figure 2.3.2.5. Faroe Bank (Sub-division Vb2) cod. Exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate). Lower plot: Landings and cpue (kg/hr) in spring and summer survey

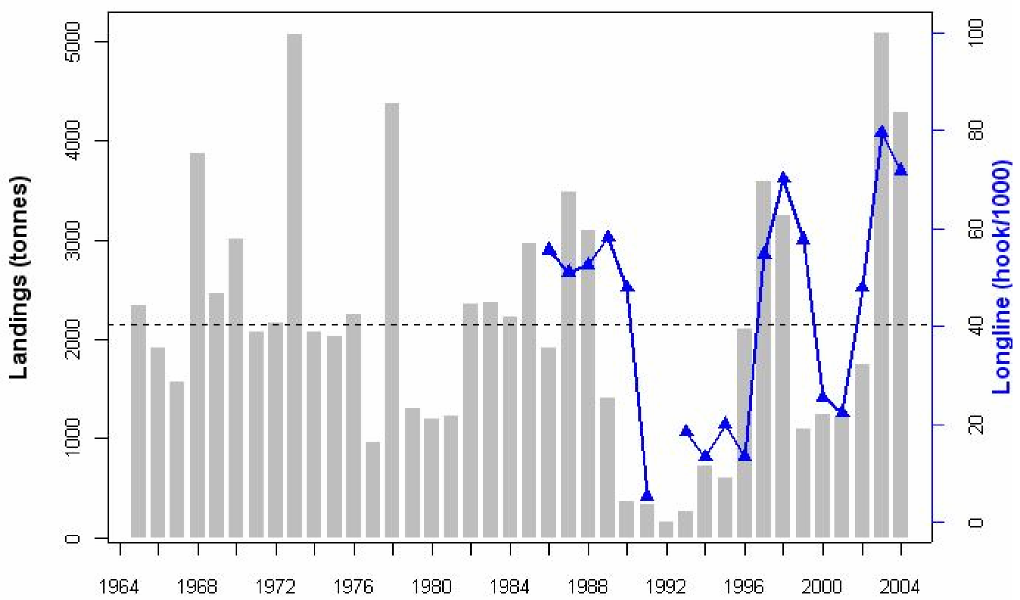


Figure 2.3.2.5. Faroe Bank (sub-division Vb2) cod. Reported landings 1965-2004 and cpue (hook/100) based on logbooks of five longliners.

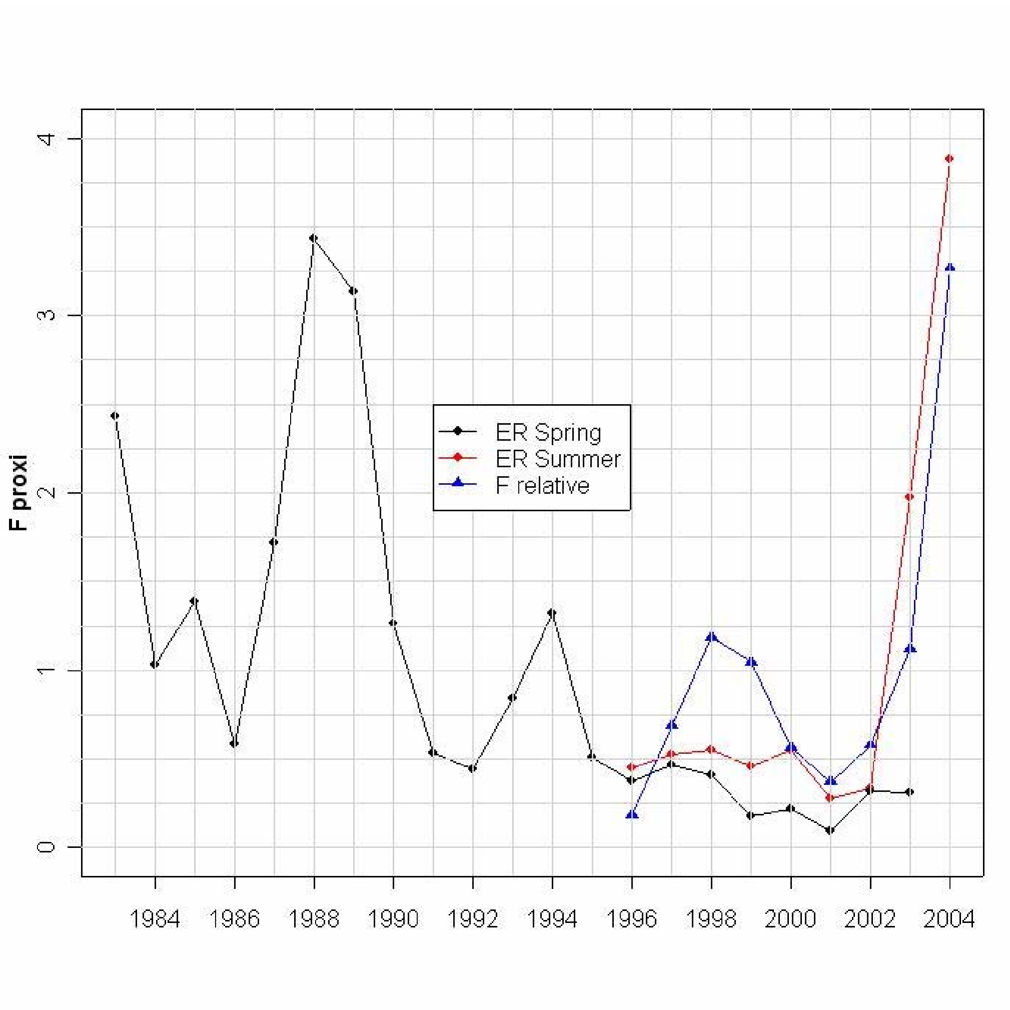


Figure 2.3.2.6. Faroe Bank (Sub-division Vb2) cod. Relation between exploitation ratio (ratio of landings to survey interpreted as an index of exploitation rate) and relative fishing mortality from statistical catch at age

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; the 2004 landings amounted to about 24 000t which is in line with the figure from the short term prediction last year. Most of the landings are taken from the Faroe Plateau, but the landings from the Faroe Bank (Sub-Division Vb2) have in recent years been increasing and were in 2002-2004 at about 4-5 000t (Tables 2.4.1 and 2.4.2). As can be seen from Figure 2.4.1, landings in 2002-2004 reached historical highs. The cumulative landings by month (Figure 2.4.2) suggest that landings are expected to stay high in 2005.

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 2004 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 2004 showed almost the same pattern as on the Plateau.

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 2004, which has decreased somewhat as compared to 2003 (except for weight measurements which have increased considerable), is shown in the table below.

	OPEN BOATS	LLINERS <100GRT	LLINERS <100GRT	OB TRAWL <400HP	OB TRAWL >400HP	PAIRTRAWL <1000HP	PAIRTRAWL >1000HP	TOTAL
No. of samples	9	71	101	2	17	3	53	256
No. of length measurements	1456	14623	20531	440	3188	602	11525	52365
No. of age measurements	609	1558	2632	60	300	60	1079	6298
No. of weighted fish	60	7419	7349	60	2455	60	1079	18482

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 2004 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 2003-2004 is 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 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 during the most recent 2-3 years except for age 2 to very low values in 2004). From commercial sampling in Jan-Feb, mean weights for most ages are increasing again in 2005 (Figure 2.4.5B). This increase was also observed in the 2005 spring survey.

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 1982–2005. 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 2.4.6). The proportion mature for the youngest ages has been declining the last 2-3 years.

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 previous reports of this WG 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. The opposite may also happen if prices of haddock become high as compared to other species. However, the age-aggregated cpue series are presented and compared to the present VPA estimates of biomass (Figure 2.4.7). In general there is agreement between the series and the VPA biomass estimates, although in some periods the two series are conflicting.

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 total exploitable biomass of haddock; in general, there is a good agreement between these series.

Since the Faroe haddock this year is on the update list, it was intended 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 keep the same settings in the XSA (Table 2.4.9). However, survey indices have been updated and revised because not all available data were included previously to construct the ALK-key used to calculate the age disaggregated indices. Moreover, in the spring survey last year the 2003 ALK key was used to calculate the 2004 age disaggregated indices. The 2003 and 2004 indices were also questioned by the ACFM review group last year (see Technical minutes). To illustrate the effect of the revisions, the spaly 2004 XSA was performed using these new indices, and the results are presented in the text table below.

Text table: %-change with revised tuning series:

	R at age 2	Exploit. B	SSB	F (3-7)
2000	-1.6	4.3	7.1	-2.8
2001	11.6	7.9	7.0	0.5
2002	2.6	7.9	8.6	-0.6
2003	10.9	7.7	8.7	1.2

The revised tuning indices all in all produce a more optimistic view of the stock status.

Also the settings in the XSA have been slightly changed (in accordance with the technical minutes from the ACFM Review Group 2004 for Faroe Plateau cod on the use of a power function for the youngest ages). As was the case last year, this years VPA didn't converge (the absolute residual between iterations 49 and 50 was .0002). The use of a power function for the youngest ages was not supported by the statistical diagnostics and a run without power was tried. This time convergence was obtained after 40 iteration and the statistical diagnostics were slightly improved. Since the SE on age 1 in the summer survey was very high this age was omitted in the tuning. Again the statistical diagnostics were slightly improved and the XSA converged in 39 iterations. A comparison between point estimates in the terminal year from these runs is shown below (and the actual runs can be found in the \personal\jakup folder):

Comparisons of 2005 runs	Recruits age 2	Total BIO	Total SSB	Fbar(3-7)
Spaly prel.	29292	135668	101855	0.3113
Spaly, -power	28718	133093	99781	0.3173
Spaly, - power, - age 1 summersurvey	28964	134250	100749	0.3136

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 years 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, overestimation of fishing mortality and corresponding underestimate of spawning stock biomass is evident in recent years. The retrospective pattern of the fishing mortality is hampered by strange values of some small poorly sampled year classes which in some years are included in the FBAR reference ages (se below).

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 2004.

As discussed in last years report there are problems in using the standard FBAR(3-7) to illustrate fishing mortality on this stock. The main issue here is that some small year classes are so noisy that they deteriorate the arithmetic average of F's ages 3-7. This is illustrated in Figure 2.4.19 with very high fishing mortality on age 8 in 2004 but the number at age is very small. For calculation of reference FBAR(age 3-7) this year it is not a problem but as input for the prediction the default for this stock has been to use last 3 years average unscaled and here these small year classes in some cases will have too big weight in the average F. This problem is not solved by using a weighted FBAR (by pop. numbers) or a proxy for exploitation rate (catch divided by total exploitable biomass) although they seem to be more robust than the arithmetic FBAR (Figure 2.4.20). The main issue is the strange performance of some small year classes; an ad hoc solution could be to simply take them out of the calculation of FBAR. Inspecting recent F's by year class, especially the year classes from 1992 and 1996 create problems and they were consequently taken out from the F matrix. The results of this exercise are shown in Figure 2.4.21.

This will not make the retrospective pattern of F smoother because when going back in time, other small year classes will create noise. For this years assessment, the suggested procedure may be sufficient but in a coming benchmark assessment this needs to be investigated much more in details.

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 69 000 t in 1987 to 24 000 t in 1994, increased again to 90 000 t in 1998, decreased to about 60 000 t in 2000 and has increased since to above 115 000 t in 2003; the 2004 point estimate is 101 000t (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 of which the 1999 year class is the highest on record. 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 year classes has improved; as last year it was not felt worthwhile to repeat the use of RCT3 for this purpose since the same information is derived directly from the XSA. The 1999 YC is now confirmed being the highest on record at age 2 (126 mio.), the YC's from 2000 and 2001 are estimated above average and the 2002 YC slightly below average, 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 2003 are from the final VPA, the 2004-2005 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 2005 at age 2 in 2007 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 2002–2004 fishing mortality matrices from the final VPA without rescaling to the recent value and omitting the 1996 year class as explained above (1.4.6.1). This is in line with what was done last year when the same effect was obtained by using years without the noisy year classes in the average. The same exploitation pattern was used for all three years.

The mean weight-at-age for ages 2-10 in 2005-2007 was calculated as last year using the cohort approach as described in the 2003 WG report. The weights at age in 2004 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 weight at age 2 in year 2004 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 2004 was also applied in 2005-2007. The same weights-at-age were used for the catch and for the stock as was done in the assessment.

The maturity ogive for 2005 is based on samples from the Faroese Groundfish Spring Survey 2005 and the ogives in 2006-2007 are estimated as the average of the smoothed 2003-2005 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 1977–2004 period. The maturity ogives are averages for the years 1982-2004. The exploitation pattern is the same as 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 0.52 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 0.30 and 1.44, 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 2.4.23) 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 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 $\mathbf{B}_{lim}$.

This year the NWWG has analysed existing reference points (see 2.1.6). The addition of new stock and recruitment pairs since the original analysis in 1998 clearly indicates that B_{lim} is likely to be lower than the existing value. Segmented regressions done for the SGPRP 2003 indicate a breaking point in the order of 23 000t. The 2005 NWWG suggest that the new B_{lim} for Faroe haddock be set at 23 000t.

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 2005 as the average of some recent years, here the unscaled average of F(2002-2004); however, possible changes in the catchability of the fleets (which seem to be linked to productivity changes in the environment) could undermine this assumption. The fleet is almost the same and the number of fishing days per fleet was only reduced by 1.5% for the fishing year 1 Sept 2004 – 31 Aug 2005. The landings in 2005 are then predicted to be about 28 500 t (highest on record), and continuing with this fishing mortality will result in 2006 landings of about 22 000 t. The SSB will decrease to 97 000 t in 2005, 77 000 t in 2006, and to 57 000 t in 2007. 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 have been made using the the ADAPT results from last year, the USA National Marine Fisheries Service NFT SRFIT software and the Fish Lab software (see 2.1.6).

2.4.9 Management considerations

Since management of haddock also need to take into account measures for cod and saithe, management considerations are given in Chapter 1.2 for all 3 stocks.

2.4.10 Comments on the assessment

As explained in 3.4.6.1, the tuning files this year have been revised and one of the settings of XSA changed, but this did not result in any major differences as compared to last years assessment. By updating the input files with the newest information, following changes in the 2003 estimates were observed as compared to last year:

Assessment year	Recruitment age 2	Exploitable biomass	Spawning stock biomass	Fishing mortality (F_{3-7})
2004	20 000 000	122 000 t	96 000 t	0.48
2005	36 000 000	153 000 t	115 000 t	0.40

Since the 2003 estimate of recruitment in this years assessment is higher and the fishing mortalities considerable smaller, the perception of stock status now is more optimistic.

As in 2004, 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.

Figure 2.4.25 shows the time trends in recruitment, SSB and fishing mortality of ADAPT calibrations as compared to the accepted 2005 XSA as well as the stock in numbers in 2005. In general, both methods are producing similar estimates for R, SSB and stock in numbers whereas there are some differences in the F estimates with ADAPT producing somewhat higher values. The role of the small year classes in calculations of FBAR are similar in the two methods. In the figure, 3 different weightings of the FBAR are shown, producing much lower values in recent years than the arithmetic average F(3-7).

Figure 2.4.26 shows the F and SSB's from a 1000 bootstraps of the ADAPT. The figure also shows the F and SSB from the XSA assessment. F in both methods is the FBAR weighted with stock numbers. The XSA results fall almost in the middle of the cloud of bootstrapped ADAPT results.

Figure 2.4.27 shows the retrospective pattern of the ADAPT. It is comparable with the XSA retro.

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 1982-2004, 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	1993
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	3,622
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	28
UK (Engl. and Wales)	-	-	-	-	-	2	-	-	7	-	54	81
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	3,731
Working Group estimate[4,8]	11,937	12,894	12,378	15,143	14,477	14,882	12,178	14,325	11,726	8,429	5,476	4,026

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [2]
Faroe Islands	3,675	4,549	9,152	16,585	19,135	16,643		13,821	21,337	22,199	19,184
France[1]					2 [2]	- [2]	6	8 [5]	2	4	1
Germany		5	-	-		33	1	2	6	1	6
Greenland											
Iceland									4		
Norway	22	28	45	45 [2]	71	411	355	257 [2]	227 [2]	292	229
UK (Engl. and Wales)	31	23	5	22	30 [1]	59 [5]	19 [5]	4 [5]	11 [5]	14 [5]	
UK (Scotland)[11]	-	-	…	…	…						
United Kingdom											201 [5]
Total	3,728	4,605	9,202	16,652	19,238	17,146	381	14,092	21,587	22,510	19,621
Working Group estimate[4,8,9]	4,252	4,948	9,642	17,924	22,210	18,482	15,821	15,890	25,011	26,970	23,811

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) Reported as Division Vb.

6) Included in Vb2

7) Includes 14 reported as Vb

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

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

Table 2.4.2 Faroe Bank (Sub-division Vb2) HADDOCK. Nominal catches (tonnes) by countries, 1982-2004, 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	1993
Faroe Islands	1,533	967	925	1,474	1,050	832	1,160	659	325	217	338	185
France[1]	-	-	-	-	-	-	-	-	-	-	-	-
Norway	1	2	5	3	10	5	43	16	97	4	23	8
UK (Engl. and Wales)	-	-	-	-	-	-	-	-	-	-	+	+
UK (Scotland)[3]	48	13	+	25	26	45	15	30	725	287	869	102
Total	1,582	982	930	1,502	1,086	882	1,218	705	1,147	508	1,230	295

Country	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [2]
Faroe Islands	353	303	338	1,133	2,810	1,110		2,001	3,878	4,934	4,804
France[1]	-	-	-	-							
Norway	1	1	40	4	60	3	48	66	28	55	17
UK (Engl. and Wales)	+	... [1]	… [1]	… [1]	… [1]	[1]	[1]	[1]	[1]	[1]	[1]
UK (Scotland)[3]	170	39	62	135	102	193	185	148	177 [4]	185 [4]	[1]
Total	524	343	440	1,272	2,972	1,306	233	2,215	4,083	5,174	4,821

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.

Table 2.4.3 Total Faroese landings of haddock from Division Vb 1985-2004 and the contribution (%) by each fleet category (metier). 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	2004
Open boats	7	7	11	2	3	2	3	2	1	1	1	2	2	2	2	1	2	3	4	4
Longliners < 100GRT	39	39	39	49	58	60	56	46	24	18	23	28	31	30	23	24	29	31	34	40
Longliners > 100GRT	13	12	13	19	18	18	18	22	25	25	38	36	38	40	40	36	38	34	42	42
Otterboard trawlers < 400HP	1	2	2	2	1	1	2	2	8	8	7	6	3	2	2	4	2	2	1	1
Otter board trawlers 400-999HP	6	3	5	4	3	3	1	1	3	2	5	7	6	6	5	5	5	4	3	2
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	2
Pairtrawlers > 1000HP	6	10	9	9	6	8	11	14	22	29	16	13	12	12	14	19	12	10	8	7
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	0
Total catch, tonnes gutted	13570	12967	13829	10697	12866	10319	7469	4103	3275	3629	4371	8535	15890	19669	16062	13881	13555	21842	22516	19396

Table 2.4.4

Haddock in ICES Division Vb 2004
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 Others	Vb2 All Faroese Fleets
1	0	0	2	0	0	0	0	0	0	3	0	0	0	0
2	4	69	21	0	0	0	1	2	9	108	104	28	10	141
3	62	625	256	6	15	7	19	46	177	1157	660	182	49	891
4	172	1850	1506	34	57	31	78	210	486	4398	333	95	18	446
5	358	3442	3130	77	112	72	177	501	865	8782	1301	384	45	1730
6	50	388	434	8	12	6	16	42	103	1067	79	23	3	106
7	19	162	139	2	5	1	6	13	39	387	20	6	0	27
8	2	19	24	0	1	1	3	9	9	66	19	6	0	25
9	3	32	69	0	1	0	2	5	14	126	31	9	2	41
10	11	154	142	1	2	1	3	9	33	360	38	12	1	51
11	11	150	161	1	3	1	3	7	39	376	26	8	1	34
12	0	1	0	0	0	0	0	0	0	2	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total no.	691	6892	5884	129	207	119	309	844	1774	16833	2611	751	129	3491
Catch, t.	679	6652	5963	114	191	106	285	772	1721	16484	3413	986	160	4559

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 16/04/2005 14:27

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

YEAR,	1961,	1962,	1963,	1964,
AGE				
0,	0,	0,	0,	0,
1,	0,	0,	0,	0,
2,	7932,	9631,	13552,	2284,
3,	7330,	13977,	8907,	7457,
4,	5134,	5233,	7403,	3899,
5,	1937,	2361,	2242,	2360,
6,	1305,	1407,	1539,	1120,
7,	838,	868,	860,	728,
8,	236,	270,	257,	198,
9,	59,	72,	75,	49,
+gp,	0,	0,	0,	0,
0 TOTALNUM,	24771,	33819,	34835,	18095,
TONSLAND,	20831,	27151,	27571,	19490,
SOPCOF %,	89,	90,	90,	101,

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	1368,	1081,	1425,	5881,	2384,	1728,	717,	750,	3300,	5633,
3,	4286,	3304,	2405,	4097,	7539,	4855,	4393,	3744,	8388,	2899,
4,	5133,	4804,	2599,	2812,	4567,	6581,	4727,	4179,	1236,	3970,
5,	1443,	2710,	1785,	1524,	1565,	1624,	3267,	2706,	2786,	451,
6,	1209,	1112,	1426,	1526,	1485,	1383,	1292,	1171,	916,	976,
7,	673,	740,	631,	923,	1224,	1099,	864,	696,	1051,	466,
8,	1345,	180,	197,	230,	378,	326,	222,	180,	150,	535,
9,	43,	54,	52,	68,	114,	68,	147,	113,	68,	68,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	11,	147,
0 TOTALNUM,	15500,	13985,	10520,	17061,	19256,	17664,	15629,	13539,	17906,	15145,
TONSLAND,	18479,	18766,	13381,	17852,	23272,	21361,	19393,	16485,	17976,	14773,
SOPCOF %,	94,	109,	102,	103,	108,	103,	99,	98,	98,	97,

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	19881,	1982,	1983,	1984
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	7337,	4396,	255,	32,	1,	143,	74,	539,	441,	1195,
3,	7952,	7858,	4039,	1022,	1161,	58,	455,	934,	1969,	1561,
4,	2097,	6798,	5168,	4248,	1754,	3724,	202,	784,	383,	2462,
5,	1371,	1251,	4918,	4054,	3341,	2583,	2586,	298,	422,	147,
6,	247,	1189,	2128,	1841,	1850,	2496,	1354,	2182,	93,	234,
7,	352,	298,	946,	717,	772,	1568,	1559,	973,	1444,	42,
8,	237,	720,	443,	635,	212,	660,	608,	1166,	740,	861,
9,	419,	258,	731,	243,	155,	99,	177,	1283,	947,	388,
+gp,	187,	318,	855,	312,	74,	86,	36,	214,	795,	968,
0 TOTALNUM,	20199,	23086,	19483,	13104,	9320,	11417,	7051,	8373,	7234,	7858,
TONSLAND,	20715,	26211,	25555,	19200,	12418,	15016,	12233,	11937,	12894,	12378,
SOPCOF %,	117,	107,	98,	99,	104,	100,	109,	92,	106,	106,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	985,	230,	283,	655,	63,	105,	77,	40,	113,	277,
3,	4553,	2549,	1718,	444,	1518,	1275,	1044,	154,	298,	191,
4,	2196,	4452,	3565,	2463,	658,	1921,	1774,	776,	274,	307,
5,	1242,	1522,	2972,	3036,	2787,	768,	1248,	1120,	554,	153,
6,	169,	738,	1114,	2140,	2554,	1737,	651,	959,	538,	423,
7,	91,	39,	529,	475,	1976,	1909,	1101,	335,	474,	427,
8,	61,	130,	83,	151,	541,	885,	698,	373,	131,	383,
9,	503,	71,	48,	18,	133,	270,	317,	401,	201,	125,
+gp,	973,	712,	334,	128,	81,	108,	32,	162,	185,	301,
0 TOTALNUM,	10773,	10443,	10646,	9510,	10311,	8978,	6942,	4320,	2768,	2587,
TONSLAND,	15143,	14477,	14882,	12178,	14325,	11726,	8429,	5476,	4026,	4252,
SOPCOF %,	106,	101,	102,	97,	100,	102,	106,	106,	104,	100,

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

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

Table 2.4.5 (Con'd)

	YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
	AGE										
	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	1,	0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
	2,	804,	326,	77,	106,	174,	1461,	4380,	1520,	133,	251,
	3,	452,	5234,	2913,	1055,	1142,	3061,	3128,	14083,	3423,	2069,
	4,	235,	1019,	10517,	5269,	942,	210,	2423,	2888,	13599,	4950,
	5,	226,	179,	710,	9856,	4677,	682,	173,	1203,	2216,	10747,
	6,	132,	163,	116,	446,	6619,	2685,	451,	133,	946,	1198,
	7,	295,	161,	123,	99,	226,	2846,	1151,	240,	162,	421,
	8,	290,	270,	93,	87,	26,	79,	1375,	846,	333,	92,
	9,	262,	234,	220,	95,	20,	1,	17,	1099,	855,	171,
	+gp,	295,	394,	516,	502,	192,	71,	18,	34,	930,	836,
0	TOTALNUM,	2991,	7980,	15285,	17515,	14018,	11096,	13116,	22046,	22597,	20735,
	TONSLAND,	4948,	9642,	17924,	22210,	18482,	15821,	15890,	25011,	26970,	23811,
	SOPCOF %,	103,	100,	103,	101,	100,	104,	100,	100,	100,	99,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 16/04/2005 14:27

Table 2 Catch weights at age (kg)

YEAR, AGE	1961,	1962,	1963,	1964,
0,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,
2,	.4700,	.4700,	.4700,	.4700,
3,	.7300,	.7300,	.7300,	.7300,
4,	1.1300,	1.1300,	1.1300,	1.1300,
5,	1.5500,	1.5500,	1.5500,	1.5500,
6,	1.9700,	1.9700,	1.9700,	1.9700,
7,	2.4100,	2.4100,	2.4100,	2.4100,
8,	2.7600,	2.7600,	2.7600,	2.7600,
9,	3.0700,	3.0700,	3.0700,	3.0700,
+gp,	3.5500,	3.5500,	3.5500,	3.5500,
0 SOPCOFAC,	.8938,	.9011,	.8964,	1.0131,

Table 2 Catch weights at age (kg)

YEAR, AGE	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
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,	.9401,	1.0920,	1.0166,	1.0278,	1.0835,	1.0274,	.9874,	.9795,	.9776,	.9718,

Table 2 Catch weights at age (kg)

YEAR, AGE	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
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,	.3110,	.3570,	.3570,	.6430,	.4520,	.7000,	.4700,	.6810,
3,	.7300,	.7300,	.6330,	.7900,	.6720,	.7130,	.7250,	.8960,	.7400,	1.0110,
4,	1.1300,	1.1300,	1.0440,	1.0350,	.8940,	.9410,	.9570,	1.1500,	1.0100,	1.2550,
5,	1.5500,	1.5500,	1.4260,	1.3980,	1.1560,	1.1570,	1.2370,	1.4440,	1.3200,	1.8120,
6,	1.9700,	1.9700,	1.8250,	1.8700,	1.5900,	1.4930,	1.6510,	1.4980,	1.6600,	2.0610,
7,	2.4100,	2.4100,	2.2410,	2.3500,	2.0700,	1.7390,	2.0530,	1.8290,	2.0500,	2.0590,
8,	2.7600,	2.7600,	2.2050,	2.5970,	2.5250,	2.0950,	2.4060,	1.8870,	2.2600,	2.1370,
9,	3.0700,	3.0700,	2.5700,	3.0140,	2.6960,	2.4650,	2.7250,	1.9610,	2.5400,	2.3680,
+gp,	3.5500,	3.5500,	2.5910,	2.9200,	3.5190,	3.3100,	3.2500,	2.8560,	3.0400,	2.6860,
0 SOPCOFAC,	1.1712,	1.0746,	.9784,	.9947,	1.0380,	1.0017,	1.0870,	.9238,	1.0554,	1.0602,

Table 2 Catch weights at age (kg)

YEAR, AGE	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.5280,	.6080,	.6050,	.5010,	.5800,	.4380,	.5470,	.5250,	.7550,	.7540,
3,	.8590,	.8870,	.8310,	.7810,	.7790,	.6990,	.6930,	.7240,	.9820,	1.1030,
4,	1.3910,	1.1750,	1.1260,	.9740,	.9230,	.9390,	.8840,	.8170,	1.0270,	1.2540,
5,	1.7770,	1.6310,	1.4620,	1.3630,	1.2070,	1.2040,	1.0860,	1.0380,	1.1920,	1.4650,
6,	2.3260,	1.9840,	1.9410,	1.6800,	1.5640,	1.3840,	1.2760,	1.2490,	1.3780,	1.5930,
7,	2.4400,	2.5190,	2.1730,	1.9750,	1.7460,	1.5640,	1.4770,	1.4300,	1.6430,	1.8040,
8,	2.4010,	2.5830,	2.3470,	2.3440,	2.0860,	1.8180,	1.5740,	1.5640,	1.7960,	2.0490,
9,	2.5320,	2.5700,	3.1180,	2.2480,	2.4240,	2.1680,	1.9300,	1.6330,	1.9710,	2.2250,
+gp,	2.6860,	2.9220,	2.9330,	3.2950,	2.5140,	2.3350,	2.1530,	2.1260,	2.2400,	2.4230,
0 SOPCOFAC,	1.0559,	1.0141,	1.0197,	.9695,	1.0025,	1.0195,	1.0635,	1.0554,	1.0361,	.9969,

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

Table 2 Catch weights at age (kg)

Table 2.4.6 (Cont'd)

	YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
	AGE										
	0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
	1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
	2,	.6660,	.5340,	.5190,	.6220,	.5040,	.6610,	.6080,	.5840,	.5710,	.5740,
	3,	1.0540,	.8580,	.7710,	.8460,	.6240,	.9360,	.9400,	.8570,	.7150,	.7700,
	4,	1.4890,	1.4590,	1.0660,	1.0160,	.9740,	1.1660,	1.3740,	1.4050,	1.0080,	.8870,
	5,	1.7790,	1.9930,	1.7990,	1.2830,	1.2200,	1.4830,	1.7790,	1.7990,	1.5370,	1.1590,
	6,	1.9400,	2.3300,	2.2700,	2.0800,	1.4900,	1.6160,	1.9710,	1.9740,	1.9110,	1.6380,
	7,	2.1820,	2.3510,	2.3400,	2.5560,	2.4560,	1.8930,	2.1190,	2.3010,	2.0910,	1.8700,
	8,	2.3570,	2.4690,	2.4750,	2.5720,	2.6580,	2.8210,	2.3730,	2.3700,	2.3010,	2.4380,
	9,	2.4900,	2.7770,	2.5010,	2.4520,	2.5980,	3.7490,	2.7500,	2.6260,	2.4060,	2.3570,
	+gp,	2.6780,	2.5820,	2.6760,	2.7530,	2.9530,	3.1960,	3.9660,	3.1300,	2.5350,	2.4170,
0	SOPCOFAC,	1.0331,	1.0043,	1.0250,	1.0106,	.9975,	1.0363,	.9963,	1.0008,	1.0002,	.9929,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 16/04/2005 14:27

Table 5 Proportion mature at age

YEAR, AGE	1961,	1962,	1963,	1964,
0,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,
2,	.0600,	.0600,	.0600,	.0600,
3,	.4800,	.4800,	.4800,	.4800,
4,	.9100,	.9100,	.9100,	.9100,
5,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,

Table 5 Proportion mature at age

YEAR, AGE	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
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 5 Proportion mature at age

YEAR, AGE	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
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,	.0800,	.0800,	.0800,
3,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.4800,	.6200,	.6200,	.7600,
4,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.9100,	.8900,	.8900,	.9800,
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, AGE	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0300,	.0300,	.0500,	.0500,	.0200,	.0800,	.1600,	.1800,	.1100,	.0500,
3,	.6200,	.4300,	.3200,	.2400,	.2200,	.3700,	.5800,	.6500,	.5000,	.4200,
4,	.9600,	.9500,	.9100,	.8900,	.8700,	.9000,	.9300,	.9100,	.8500,	.8600,
5,	1.0000,	.9900,	.9800,	.9800,	.9900,	1.0000,	1.0000,	1.0000,	.9700,	.9600,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.9900,	.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 2.4.7 (cont.) Faroe Haddock. Proportion mature-at-age.

Table 5 Proportion mature at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0300,	.0300,	.0100,	.0100,	.0100,	.0200,	.0900,	.0800,	.0700,	.0000,
3,	.4700,	.4700,	.4700,	.3600,	.3500,	.3600,	.5400,	.4900,	.4500,	.3500,
4,	.9100,	.9300,	.9100,	.8700,	.8600,	.8700,	.9300,	.9700,	.9700,	.9400,
5,	.9600,	.9800,	1.0000,	.9900,	.9900,	.9900,	1.0000,	1.0000,	.9900,	.9900,
6,	.9900,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 2.4.8 Faroe haddock. Spaly tuning files.

```
FAROE Haddock (ICES SUBDIVISION VB)       COMB-SURVEY-SPALY.dat
102
SUMMER SURVEY
1996 2004
1 1 0.6 0.7
2 8
200   33809.09  61257.93   1138.05    210.25   286.72   238.48   416.44
200   10153.82  26402.10  47024.66    852.22   177.11    81.49   163.30
200    1688.61   3499.92  14734.54  18399.09   285.78    89.61    73.64
200    9167.29   5844.31   1548.86   8698.75  9829.62   204.06     7.89
200   17723.85   8395.42    416.41   1308.52  4645.47  5699.29    85.81
200  100503.06  11990.85   4426.07    174.57   629.27  2615.71  3209.95
200   51168.91  57922.82   5538.84   1909.63   162.47   395.07  1256.27
200   35959.21  26787.80  35943.72   3962.66   621.93   101.63   428.87
200   29942.18  16914.49  15178.57  16633.34   885.68   185.66    24.20
SPRING SURVEY SHIFTED
1993 2004
1 1 0.95 1.0
0 6
100  16196.00   1960.30    270.20    339.50    173.40         305.60   399.60
100  40990.90  19464.30   1067.30    217.80    150.70          49.00   141.10
100  27375.80  29575.90  21281.30    663.10     98.20          73.90    56.00
100   3190.50   7534.90  16164.90  25478.90    628.10         146.10    37.00
100   3628.60    363.30   4482.00  10150.50  12687.70         336.20     9.90
100   5180.40   6746.60    113.70   1542.20   4417.10        3139.20    48.70
100  26833.10   8354.40   4858.70    198.10    443.90        1669.60  1940.70
100  30814.70  36511.50   3582.40   1063.20     26.80         110.60   427.70
100  22179.90  17168.00  25895.60   1934.90    684.90          40.60   101.70
100  12024.50  19448.80  13525.50  12734.40    776.10         230.10    19.30
100   1823.10  15626.50  10769.00   7487.70  11212.50         487.50    79.10
100   5814.70   4064.20   9667.50   6182.00   4565.90        4912.80   238.60
```

Table 2.4.9 Faroe haddock 2005 xsa.

```
Lowestoft VPA Version 3.1                          28/04/2005  16:00

Extended Survivors Analysis

FAROE HADDOCK (ICES DIVISION Vb)                HAD1_IND

CPUE data from file D:\Vpa\vpa2005\Tuning\comb-survey-spaly-revsum.dat

Catch data for  44 years. 1961 to 2004. Ages  0 to  10.

     Fleet,            First, Last, First, Last, Alpha,  Beta
                   ,    year, year,  age ,  age
SUMMER SURVEY      ,   1996, 2004,   2,     8,   .600,   .700
SPRING SURVEY SHIFTE,   1993, 2004,   0,     6,   .950,  1.000


Time series weights :

     Tapered time weighting not applied


Catchability analysis :

     Catchability independent of stock size for all ages

     Catchability independent of age for ages >=    6


Terminal population estimation :

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

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

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

     Prior weighting not applied


Tuning converged after   39 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,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004

     0,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
     1,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000,  .000
     2,  .009,  .008,  .009,  .032,  .012,  .070,  .039,  .031,  .004,  .010
     3,  .103,  .070,  .089,  .167,  .570,  .305,  .209,  .170,  .091,  .081
     4,  .312,  .357,  .197,  .230,  .221,  .189,  .422,  .305,  .247,  .184
     5,  .297,  .416,  .454,  .287,  .329,  .247,  .235,  .384,  .406,  .315
     6,  .172,  .364,  .526,  .582,  .319,  .319,  .257,  .287,  .597,  .402
     7,  .208,  .327,  .518, 1.277,  .670,  .219,  .219,  .211,  .681,  .586
     8,  .172,  .298,  .319,  .882, 1.769,  .524,  .156,  .249,  .508, 1.131
     9,  .233,  .205,  .424,  .632,  .507,  .260,  .200,  .181,  .428,  .537
```

Table 2.4.9 (cont.) Faroe haddock 2005 xsa.

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1995	1.39E+04	5.69E+04	1.05E+05	5.08E+03	9.69E+02	9.71E+02	9.25E+02	1.74E+03	2.03E+03	1.39E+03
1996	5.47E+03	1.14E+04	4.66E+04	8.51E+04	3.75E+03	5.81E+02	5.91E+02	6.38E+02	1.16E+03	1.40E+03
1997	2.38E+04	4.48E+03	9.33E+03	3.78E+04	6.49E+04	2.15E+03	3.14E+02	3.36E+02	3.76E+02	7.03E+02
1998	3.57E+04	1.94E+04	3.67E+03	7.57E+03	2.83E+04	4.36E+04	1.12E+03	1.52E+02	1.64E+02	2.24E+02
1999	1.89E+05	2.93E+04	1.59E+04	2.91E+03	5.24E+03	1.84E+04	2.68E+04	5.11E+02	3.46E+01	5.56E+01
2000	8.17E+04	1.54E+05	2.40E+04	1.29E+04	1.35E+03	3.44E+03	1.09E+04	1.60E+04	2.14E+02	4.83E+00
2001	5.35E+04	6.69E+04	1.26E+05	1.83E+04	7.77E+03	9.11E+02	2.20E+03	6.46E+03	1.05E+04	1.04E+02
2002	4.32E+04	4.38E+04	5.48E+04	9.96E+04	1.22E+04	4.17E+03	5.90E+02	1.39E+03	4.25E+03	7.35E+03
2003	1.21E+04	3.54E+04	3.59E+04	4.35E+04	6.88E+04	7.34E+03	2.33E+03	3.62E+02	9.24E+02	2.71E+03
2004	1.97E+04	9.92E+03	2.90E+04	2.92E+04	3.25E+04	4.40E+04	4.00E+03	1.05E+03	1.50E+02	4.55E+02

Estimated population abundance at 1st Jan 2005

	0	1	2	3	4	5	6	7	8	9
	0.00E+00	1.62E+04	8.12E+03	2.35E+04	2.21E+04	2.21E+04	2.63E+04	2.19E+03	4.78E+02	3.97E+01

Taper weighted geometric mean of the VPA populations:

	0	1	2	3	4	5	6	7	8	9
	2.85E+04	2.39E+04	2.04E+04	1.57E+04	1.04E+04	6.10E+03	3.49E+03	1.96E+03	9.98E+02	4.93E+02

Standard error of the weighted Log(VPA populations) :

	0	1	2	3	4	5	6	7	8	9
	1.0248	1.0286	1.0294	1.0096	1.0187	1.0033	.9623	1.0096	1.1842	1.4470

Log catchability residuals.

Fleet : SUMMER SURVEY

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	No data for this fleet at this age									
1	No data for this fleet at this age									
2	99.99	-.09	.31	-.53	-.32	-.04	.02	.17	.23	.26
3	99.99	-.06	-.07	-.44	1.30	.00	-.06	-.20	-.20	-.27
4	99.99	-.32	.45	.14	-.43	-.41	.35	.06	.15	.00
5	99.99	-.02	.10	.05	.19	-.08	-.77	.20	.38	-.04
6	99.99	.35	.60	-.15	.04	.19	-.25	-.27	-.10	-.41
7	99.99	.06	-.25	1.14	.35	-.05	.07	-.29	.01	-.52
8	99.99	.01	.21	.61	.50	.26	-.25	-.22	.40	-.26

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	-5.3891	-5.3957	-5.8119	-5.8959	-6.0024	-6.0024	-6.0024
S.E(Log q)	.2838	.5044	.3214	.3225	.3284	.4795	.3650

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	.89	1.374	5.92	.96	9	.24	-5.39
3	1.36	-1.998	3.71	.81	9	.59	-5.40
4	.85	3.019	6.37	.98	9	.19	-5.81
5	.92	1.207	6.11	.97	9	.29	-5.90
6	1.07	-.742	5.90	.95	9	.36	-6.00
7	1.15	-1.160	5.80	.90	9	.53	-5.94
8	1.14	-2.196	5.81	.97	9	.31	-5.86

Table 2.4.9 (cont.) Faroe haddock 2005 xsa.

```
Fleet : SPRING SURVEY SHIFTED

 Age  ,  1993,  1994
    0 , -1.05,   .70
    1 ,  -.19,  -.68
    2 ,  -.29,  -.21
    3 ,   .00,   .01
    4 ,  -.17,  -.02
    5 ,  -.06,  -.86
    6 ,   .46,  -.06
    7 , No data for this fleet at this age
    8 , No data for this fleet at this age


 Age  ,  1995,  1996,  1997,  1998,  1999,  2000,  2001,  2002,  2003,  2004
    0 ,  1.90,   .68,  -.66,  -.71,  -.73,   .25,   .34,  -.06,  -.67,   .00
    1 ,   .55,   .79, -1.30,   .15,  -.05,  -.23,  -.15,   .40,   .39,   .32
    2 ,  -.03,   .50,   .83, -1.89,   .38,  -.28,   .00,   .18,   .35,   .46
    3 ,  -.22,   .57,   .48,   .28,  -.42,  -.49,  -.33,  -.18,   .04,   .24
    4 ,   .06,   .61,   .61,   .42,  -.20, -1.68,   .03,  -.40,   .48,   .27
    5 ,   .00,  1.31,   .87,  -.07,   .20,  -.91,  -.60,  -.24,  -.03,   .40
    6 ,   .02,   .24,  -.28,   .09,   .34,  -.26,  -.16,  -.48,  -.14,   .23
    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 ,         0,         1,         2,         3,         4,         5,         6
Mean Log q,   -5.6327,   -5.6185,   -5.9617,   -6.1218,   -6.4601,   -6.6928,   -7.0694,
S.E(Log q),     .8390,     .5754,     .6896,     .3443,     .6238,     .6514,     .2829,


Regression statistics :


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

Age, Slope , t-value , Intercept, RSquare, No Pts, Reg s.e,  Mean Q

 0,    1.49,   -1.433,      3.27,     .47,     12,    1.19,   -5.63,
 1,     .96,     .286,      5.82,     .81,     12,     .57,   -5.62,
 2,     .81,    1.522,      6.70,     .87,     12,     .53,   -5.96,
 3,     .92,    1.257,      6.40,     .96,     12,     .31,   -6.12,
 4,     .82,    2.082,      6.91,     .93,     12,     .45,   -6.46,
 5,    1.00,    -.001,      6.69,     .84,     12,     .68,   -6.69,
 6,     .92,    1.425,      7.12,     .97,     12,     .25,   -7.07,


Terminal year survivor and F summaries :

Age  0   Catchability constant w.r.t. time and dependent on age

Year class = 2004

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 SHIFTE,     16166.,  .873,       .000,    .00,   1, 1.000,     .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,
    16166.,       .87,      .00,    1,    .000,   .000
```

Table 2.4.9 (cont.) Faroe haddock 2005 xsa

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

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 SHIFTE,      8123.,   .494,       .461,    .93,   2, 1.000,     .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,
     8123.,       .49,      .46,    2,    .933,   .000


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

Year class = 2002

Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,     30468.,   .300,       .000,    .00,   1,  .524,     .007
SPRING SURVEY SHIFTE,     32257.,   .407,       .141,    .35,   3,  .285,     .007

  F shrinkage mean  ,      7142.,    .50,,,,                         .191,     .031

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    23487.,       .22,      .33,    5,   1.498,   .010


Age  3   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       ,     24552.,   .261,       .211,    .81,   2,  .446,     .073
SPRING SURVEY SHIFTE,     29647.,   .269,       .039,    .15,   4,  .422,     .061

  F shrinkage mean  ,      6028.,    .50,,,,                         .133,     .270

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    22069.,       .18,      .23,    7,   1.328,   .081


Age  4   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       ,     23253.,   .207,       .092,    .44,   3,  .526,     .176
SPRING SURVEY SHIFTE,     23921.,   .249,       .068,    .27,   5,  .358,     .172

  F shrinkage mean  ,     13954.,    .50,,,,                         .116,     .278

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    22138.,       .15,      .08,    9,    .506,   .184
```

Table 2.4.9 (cont.) Faroe haddock 2005 xsa.

```
Age  5   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       ,     26666.,   .180,       .060,    .34,   4,  .573,     .311
SPRING SURVEY SHIFTE,     25926.,   .236,       .150,    .63,   6,  .300,     .319

  F shrinkage mean  ,     25572.,    .50,,,,                        .126,     .322

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
    26302.,       .14,      .06,   11,    .453,   .315


Age  6   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       ,      2078.,   .169,       .151,    .89,   5,  .489,     .420
SPRING SURVEY SHIFTE,      2242.,   .201,       .111,    .55,   7,  .389,     .394

  F shrinkage mean  ,      2520.,    .50,,,,                        .122,     .358

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
     2191.,       .13,      .08,   13,    .624,   .402


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

Year class = 1997

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,       431.,   .178,       .135,    .76,   6,  .490,     .634
SPRING SURVEY SHIFTE,       405.,   .206,       .080,    .39,   7,  .297,     .664

  F shrinkage mean  ,       767.,    .50,,,,                        .213,     .403

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
      478.,       .15,      .10,   14,    .674,   .586


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

Year class = 1996

Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
     ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
SUMMER SURVEY       ,        29.,   .174,       .139,    .80,   7,  .486,    1.344
SPRING SURVEY SHIFTE,        21.,   .202,       .196,    .97,   7,  .192,    1.607

  F shrinkage mean  ,        91.,    .50,,,,                        .322,     .647

Weighted prediction :

Survivors,        Int,      Ext,    N,    Var,     F
at end of year,   s.e,      s.e,     ,   Ratio,
       40.,       .19,      .21,   15,   1.119,  1.131
```

Table 2.4.9 (cont.) Faroe haddock 2005 xsa.

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

 Year class = 1995

 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Esti-
mated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SUMMER SURVEY       ,       212.,   .152,       .132,    .87,   7,  .526,     .548
 SPRING SURVEY SHIFTE,       226.,   .192,       .219,   1.14,   7,  .257,     .522

   F shrinkage mean  ,       223.,    .50,,,,                        .216,     .528

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       218.,       .14,      .10,   15,    .671,   .537
```

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 28/04/2005 16:01

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR, AGE	1961,	1962,	1963,	1964,
0,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,
2,	.1875,	.3232,	.3801,	.0876,
3,	.4162,	.5866,	.5639,	.3722,
4,	.4209,	.5980,	.7261,	.5193,
5,	.4387,	.3480,	.5591,	.5369,
6,	.5879,	.6706,	.4026,	.6107,
7,	.9483,	1.0499,	1.2493,	.3375,
8,	.8742,	.9736,	1.1139,	1.2027,
9,	.6600,	.7351,	.8185,	.6472,
+gp,	.6600,	.7351,	.8185,	.6472,
0 FBAR 3- 7,	.5624,	.6506,	.7002,	.4753,

Table 8 Fishing mortality (F) at age

YEAR, AGE	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0691,	.0609,	.0641,	.1261,	.0860,	.0552,	.0526,	.0253,	.1671,	.1266,
3,	.2354,	.2370,	.1872,	.2647,	.2363,	.2528,	.1937,	.4226,	.4307,	.2172,
4,	.4767,	.4515,	.2971,	.3483,	.5320,	.3344,	.4187,	.2854,	.2384,	.3728,
5,	.3678,	.5006,	.2997,	.2847,	.3329,	.3639,	.2755,	.4518,	.3133,	.1278,
6,	.5882,	.5421,	.5406,	.4540,	.4975,	.5559,	.5559,	.1495,	.2694,	.1713,
7,	.9618,	.9128,	.6906,	.8367,	.8276,	.8739,	.8376,	.6719,	.1945,	.2133,
8,	2.3618,	.7509,	.6634,	.5851,	1.0630,	.5429,	.4223,	.4058,	.2906,	.1433,
9,	.9619,	.6372,	.5022,	.5057,	.6565,	.5385,	.5060,	.3956,	.2626,	.2067,
+gp,	.9619,	.6372,	.5022,	.5057,	.6565,	.5385,	.5060,	.3956,	.2626,	.2067,
0 FBAR 3- 7,	.5260,	.5288,	.4030,	.4376,	.4853,	.4762,	.4563,	.3963,	.2893,	.2205,

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR, AGE	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.1228,	.0907,	.0108,	.0010,	.0004,	.0324,	.0236,	.0382,	.0249,	.0326,
3,	.2649,	.1875,	.1126,	.0546,	.0456,	.0284,	.1370,	.4601,	.1907,	.1155,
4,	.2412,	.3808,	.1811,	.1662,	.1252,	.2019,	.1307,	.3696,	.3462,	.3870,
5,	.2114,	.2215,	.5268,	.2110,	.1908,	.2743,	.2105,	.2897,	.3481,	.2156,
6,	.0956,	.2869,	.7241,	.3814,	.1404,	.2129,	.2257,	.2763,	.1371,	.3312,
7,	.0859,	.1600,	.3900,	.5752,	.2716,	.1696,	.1997,	.2513,	.2974,	.0845,
8,	.1598,	.2537,	.3784,	.4960,	.3296,	.3943,	.0916,	.2256,	.3085,	.2907,
9,	.1594,	.2620,	.4433,	.3683,	.2125,	.2519,	.1724,	.2841,	.2891,	.2632,
+gp,	.1594,	.2620,	.4433,	.3683,	.2125,	.2519,	.1724,	.2841,	.2891,	.2632,
0 FBAR 3- 7,	.1798,	.2474,	.3869,	.2777,	.1547,	.1774,	.1807,	.3294,	.2639,	.2268,

Table 8 Fishing mortality (F) at age

YEAR, AGE	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0274,	.0094,	.0326,	.0383,	.0043,	.0120,	.0277,	.0164,	.0707,	.0481,
3,	.1674,	.0920,	.0905,	.0656,	.1170,	.1121,	.1593,	.0712,	.1627,	.1641,
4,	.2362,	.2455,	.1798,	.1814,	.1310,	.2130,	.2250,	.1705,	.1747,	.2515,
5,	.3442,	.2556,	.2573,	.2293,	.3214,	.2226,	.2087,	.2164,	.1768,	.1395,
6,	.4122,	.3541,	.3016,	.2984,	.3077,	.3405,	.2986,	.2456,	.1529,	.1989,
7,	.2064,	.1553,	.4652,	.2025,	.4979,	.3988,	.3770,	.2468,	.1840,	.1745,
8,	.1701,	.5110,	.5737,	.2313,	.3743,	.4354,	.2470,	.2101,	.1435,	.2224,
9,	.2753,	.3060,	.3578,	.2297,	.3285,	.3240,	.2727,	.2189,	.1671,	.1982,
+gp,	.2753,	.3060,	.3578,	.2297,	.3285,	.3240,	.2727,	.2189,	.1671,	.1982,
0 FBAR 3- 7,	.2733,	.2205,	.2589,	.1955,	.2750,	.2574,	.2537,	.1901,	.1702,	.1857,

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

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,
AGE										
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0085,	.0078,	.0092,	.0325,	.0122,	.0698,	.0390,	.0311,	.0041,	.0096,
3,	.1035,	.0704,	.0890,	.1672,	.5699,	.3048,	.2094,	.1700,	.0910,	.0814,
4,	.3120,	.3569,	.1972,	.2301,	.2213,	.1894,	.4223,	.3047,	.2466,	.1843,
5,	.2972,	.4165,	.4542,	.2871,	.3291,	.2472,	.2355,	.3837,	.4063,	.3146,
6,	.1717,	.3637,	.5258,	.5818,	.3185,	.3192,	.2568,	.2867,	.5965,	.4019,
7,	.2076,	.3271,	.5179,	1.2771,	.6704,	.2194,	.2193,	.2111,	.6813,	.5860,
8,	.1722,	.2983,	.3189,	.8825,	1.7692,	.5238,	.1564,	.2486,	.5081,	1.1310,
9,	.2333,	.2048,	.4245,	.6322,	.5072,	.2596,	.1996,	.1806,	.4284,	.5366,
+gp,	.2333,	.2048,	.4245,	.6322,	.5072,	.2596,	.1996,	.1806,	.4284,	.5366,
0 FBAR 3- 7,	.2184,	.3069,	.3568,	.5086,	.4218,	.2560,	.2687,	.2713,	.4043,	.3136,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 28/04/2005 16:01

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1961,	1962,	1963,	1964,
AGE				
0,	70656,	44920,	33782,	30144,
1,	47070,	57849,	36777,	27658,
2,	51279,	38537,	47362,	30111,
3,	23796,	34806,	22837,	26515,
4,	16517,	12850,	15850,	10638,
5,	6028,	8877,	5786,	6278,
6,	3245,	3182,	5132,	2708,
7,	1512,	1476,	1332,	2809,
8,	448,	480,	423,	313,
9,	135,	153,	148,	114,
+gp,	0,	0,	0,	0,
0 TOTAL,	220684,	203130,	169430,	137288,

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

YEAR,	1965,	1966,	1967,	1968,	1969,	1970,	1971,	1972,	1973,	1974,
AGE										
0,	37828,	81825,	47695,	53093,	23056,	49503,	35349,	78098,	104643,	83617,
1,	24680,	30971,	66992,	39049,	43469,	18877,	40530,	28941,	63941,	85674,
2,	22645,	20206,	25357,	54849,	31971,	35589,	15455,	33183,	23695,	52351,
3,	22586,	17302,	15565,	19471,	39585,	24018,	27574,	12005,	26489,	16414,
4,	14961,	14614,	11176,	10568,	12234,	25588,	15272,	18601,	6441,	14098,
5,	5182,	7605,	7618,	6799,	6108,	5884,	14995,	8226,	11448,	4155,
6,	3005,	2937,	3774,	4622,	4187,	3584,	3348,	9321,	4287,	6852,
7,	1204,	1366,	1398,	1800,	2403,	2085,	1683,	1572,	6572,	2681,
8,	1641,	377,	449,	574,	638,	860,	712,	596,	657,	4429,
9,	77,	127,	146,	189,	262,	180,	409,	382,	325,	403,
+gp,	0,	0,	0,	0,	0,	0,	0,	0,	52,	866,
0 TOTAL,	133808,	177328,	180170,	191013,	163913,	166169,	155328,	190926,	248551,	271539,

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

Run title : FAROE HADDOCK (ICES DIVISION Vb) HAD1_IND

At 28/04/2005 16:01

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR,	1975,	1976,	1977,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE										
0,	39142,	52483,	4174,	7393,	5222,	23722,	29545,	61449,	60031,	40354,
1,	68460,	32047,	42970,	3418,	6053,	4275,	19422,	24189,	50310,	49149,
2,	70144,	56050,	26238,	35180,	2798,	4956,	3500,	15901,	19804,	41191,
3,	37764,	50790,	41912,	21251,	28774,	2290,	3928,	2799,	12531,	15816,
4,	10816,	23723,	34473,	30660,	16474,	22508,	1822,	2804,	1446,	8478,
5,	7950,	6958,	13272,	23548,	21259,	11901,	15058,	1309,	1587,	838,
6,	2994,	5268,	4564,	6416,	15611,	14382,	7406,	9989,	802,	917,
7,	4727,	2228,	3238,	1812,	3587,	11108,	9517,	4839,	6204,	573,
8,	1773,	3551,	1554,	1795,	834,	2239,	7675,	6381,	3081,	3773,
9,	3142,	1237,	2256,	872,	895,	491,	1236,	5734,	4169,	1853,
+gp,	1396,	1516,	2615,	1110,	425,	424,	250,	950,	3477,	4595,
0 TOTAL,	248309,	235852,	177267,	133456,	101934,	98296,	99360,	136345,	163444,	167535,

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

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
0,	14541,	28770,	24324,	14453,	4641,	4062,	2728,	9716,	156380,	69462,
1,	33039,	11905,	23555,	19915,	11833,	3800,	3326,	2233,	7955,	128033,
2,	40240,	27050,	9747,	19285,	16305,	9688,	3111,	2723,	1828,	6513,
3,	32643,	32054,	21938,	7724,	15196,	13292,	7837,	2477,	2193,	1395,
4,	11536,	22606,	23937,	16407,	5922,	11068,	9729,	5472,	1889,	1526,
5,	4714,	7458,	14480,	16373,	11204,	4253,	7324,	6360,	3778,	1299,
6,	553,	2735,	4729,	9166,	10658,	6652,	2787,	4867,	4194,	2592,
7,	539,	300,	1572,	2864,	5568,	6415,	3874,	1693,	3117,	2947,
8,	431,	359,	210,	808,	1915,	2771,	3525,	2176,	1083,	2123,
9,	2310,	298,	176,	97,	525,	1078,	1468,	2254,	1444,	768,
+gp,	4440,	2965,	1218,	685,	317,	428,	147,	906,	1323,	1841,
0 TOTAL,	144985,	136499,	125886,	107777,	84086,	63508,	45855,	40877,	185184,	218497,

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,
AGE											
0,	13924,	5468,	23751,	35750,	188640,	81750,	53501,	43210,	12117,	19745,	0,
1,	56870,	11400,	4477,	19446,	29270,	154446,	66931,	43803,	35377,	9921,	16166,
2,	104824,	46561,	9333,	3666,	15921,	23964,	126449,	54798,	35863,	28964,	8123,
3,	5082,	85095,	37826,	7572,	2905,	12877,	18298,	99565,	43490,	29241,	23487,
4,	969,	3752,	64934,	28334,	5245,	1345,	7773,	12151,	68774,	32509,	22069,
5,	971,	581,	2150,	43648,	18430,	3442,	911,	4172,	7335,	44002,	22138,
6,	925,	591,	314,	1117,	26818,	10857,	2201,	590,	2327,	4000,	26302,
7,	1739,	638,	336,	152,	511,	15967,	6460,	1394,	362,	1049,	2191,
8,	2026,	1157,	376,	164,	35,	214,	10498,	4247,	924,	150,	478,
9,	1392,	1397,	703,	224,	56,	5,	104,	7351,	2712,	455,	40,
+gp,	1558,	2340,	1635,	1170,	528,	341,	109,	226,	2924,	2202,	1272,
0 TOTAL,	190281,	158979,	145835,	141241,	288357,	305208,	293235,	271506,	212205,	172240,	122265,

Table 2.4.12 Faroe haddock. Stock summary VPA 2005.

	Table	16	Summary	(without	SOP	correction)		
Terminal	Fs		derived	using	XSA	(With	F	shrinkage)
	Recruits	Recruits	Total	Total	Landings	Yield/SSB	FBAR(3-7)	FBAR(3-7)REV
Year	Age 0	Age 2	Biomass	SSB				
1961	70656	51279	81164	47797	20831	0.4358	0.5624	0.5624
1962	44920	38537	83420	51875	27151	0.5234	0.6506	0.6506
1963	33782	47362	80753	49547	27571	0.5565	0.7002	0.7002
1964	30144	30111	68577	44128	19490	0.4417	0.4753	0.4753
1965	37828	22645	65655	45556	18479	0.4056	0.526	0.5260
1966	81825	20206	60934	43953	18766	0.427	0.5288	0.5288
1967	47695	25357	60207	41960	13381	0.3189	0.403	0.4030
1968	53093	54849	78079	45381	17852	0.3934	0.4376	0.4377
1969	23056	31971	83820	53425	23272	0.4356	0.4853	0.4853
1970	49503	35589	87308	59865	21361	0.3568	0.4762	0.4762
1971	35349	15455	81767	62918	19393	0.3082	0.4563	0.4563
1972	78098	33183	83099	61990	16485	0.2659	0.3963	0.3962
1973	104643	23695	82778	61599	17976	0.2918	0.2893	0.2893
1974	83617	52351	95451	64658	14773	0.2285	0.2205	0.2205
1975	39142	70144	121867	75442	20715	0.2746	0.1798	0.1798
1976	52483	56050	135741	89285	26211	0.2936	0.2474	0.2473
1977	4174	26238	121194	96488	25555	0.2649	0.3869	0.3869
1978	7393	35180	120787	97396	19200	0.1971	0.2777	0.2777
1979	5222	2798	97901	85582	12418	0.1451	0.1547	0.1547
1980	23722	4956	87863	82112	15016	0.1829	0.1774	0.1774
1981	29545	3500	79214	76089	12233	0.1608	0.1807	0.1807
1982	61449	15901	68567	57019	11937	0.2094	0.3294	0.3294
1983	60031	19804	64311	52063	12894	0.2477	0.2639	0.2639
1984	40354	41191	84061	54204	12378	0.2284	0.2268	0.2268
1985	14541	40240	95120	63214	15143	0.2396	0.2733	0.2733
1986	28770	27050	100141	66532	14477	0.2176	0.2205	0.2205
1987	24324	9747	89460	68612	14882	0.2169	0.2589	0.2589
1988	14453	19285	79416	63449	12178	0.1919	0.1955	0.1954
1989	4641	16305	72740	53393	14325	0.2683	0.275	0.2750
1990	4062	9688	56662	45865	11726	0.2557	0.2574	0.2574
1991	2728	3111	41663	37351	8429	0.2257	0.2537	0.2537
1992	9716	2723	31805	29603	5476	0.185	0.1901	0.1901
1993	156380	1828	28632	25843	4026	0.1558	0.1702	0.1702
1994	69462	6513	30229	24287	4252	0.1751	0.1857	0.1911
1995	13924	104824	96344	25570	4948	0.1935	0.2184	0.2255
1996	5468	46561	120159	56939	9642	0.1693	0.3069	0.2537
1997	23751	9333	115657	89175	17924	0.201	0.3568	0.2680
1998	35750	3666	100376	89717	22210	0.2476	0.5086	0.2281
1999	188640	15921	80440	70377	18482	0.2626	0.4218	0.2896
2000	81750	23964	84050	60558	15821	0.2613	0.256	0.2727
2001	53501	126449	150039	71418	15890	0.2225	0.2687	0.2770
2002	43210	54798	176354	102883	25011	0.2431	0.2713	0.2674
2003	12117	35863	153439	115100	26970	0.2343	0.4043	0.3351
2004	19745	28964	134250	100749	23811	0.2363	0.3136	0.3136
Arith.								
Mean	43288	30572	88898	62749	16613	0.2726	0.3327	0.3193
Units	(Thousands)	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

Table 2.4.13 Management option tables INPUT DATA FAROE HADDOCK

Stock size

The yearclasses up to 2003 included are derived from the final 2005 XSA.
The yearclasses 2004-2005 at age 2 are estimated from the 2005 XSA
and apply a natural mortality of 0.2 in forward calculations of the numbers using standard VPA equations
The yearclass 2005 at age 2 in 2007 is estimated as the geomean of the yearclasses since 1980

	Age0	Age1	Age2
YC2003	12117	9921	8123
YC2004	19745	16166	13235
YC2005			14751
0.818731			

Age	2005	2006	2007
2	8123	13000	14750
3	23487		
4	22069		
5	22138		
6	26302		
7	2191		
8	478		
9	40		
10+	1272		

Predicted values rounded

Year	age 2	Geomean(1980-2004)
1980	4956	
1981	3500	
1982	15901	
1983	19804	
1984	41191	
1985	40240	
1986	27050	
1987	9747	
1988	19285	14751
1989	16305	
1990	9688	
1991	3111	
1992	2723	
1993	1828	
1994	6513	
1995	104824	
1996	46561	
1997	9333	
1998	3666	
1999	15921	
2000	23964	
2001	126449	
2002	54798	
2003	35863	
2004	28964	
2005	8123	
2006	13235	
2007	14751	

Proportion mature at age

Age	2005	2006	2007	2003	2004	2005	Avg(02-04)
2	0.00	0.02	0.02	0.07	0.00	0.00	0.02
3	0.41	0.40	0.40	0.45	0.35	0.41	0.40
4	0.93	0.95	0.95	0.97	0.94	0.93	0.95
5	0.99	0.99	0.99	0.99	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 2006-2007 is estimated as the
average of the maturity at age 2003-2005

Catch/stock weights at age

Age	2005	2006	2007
2	0.574	0.574	0.574
3	0.786	0.786	0.786
4	0.997	1.018	1.018
5	1.134	1.275	1.302
6	1.373	1.343	1.510
7	1.744	1.462	1.431
8	1.964	1.832	1.536
9	2.506	2.018	1.883
10+	2.417	2.417	2.417

Prediction using mean catch weight at age a+1 = mean catch weight at age a in year t + avg weight increase b

	2004	2005	2006	2007	
2	0.574	0.574	0.574	0.574	Age 2 = age 2 in 2004
3	0.77	0.786	0.786	0.786	
4	0.887	0.997	1.018	1.018	
5	1.159	1.134	1.275	1.302	
6	1.638	1.373	1.343	1.510	
7	1.87	1.744	1.462	1.431	
8	2.438	1.964	1.832	1.536	
9	2.357	2.506	2.018	1.883	
10+	2.417	2.417	2.417	2.417	Age 10+ = age 10+ in 2004

Growth rate estimated her as the geomean of YC increments since 1975

Exploitation pattern

Age	2003	2004	2005
2	0.0149	0.0149	0.0149
3	0.1141	0.1141	0.1141
4	0.2452	0.2452	0.2452
5	0.3682	0.3682	0.3682
6	0.4992	0.4992	0.4992
7	0.3986	0.3986	0.3986
8	0.3784	0.3784	0.3784

2002.0000	2003.0000	2004.0000	Average F for 2002-04 Age		YPR-analysis Age	Av F(2002-2004)
0.0311	0.0041	0.0096	2	0.0149	2	0.0149
0.1700	0.0910	0.0814	3	0.1141	3	0.1141
0.3047	0.2466	0.1843	4	0.2452	4	0.2452
0.3837	0.4063	0.3146	5	0.3682	5	0.3682
	0.5965	0.4019	6	0.4992	6	0.4992
0.2111		0.5860	7	0.3986	7	0.3986
0.2486	0.5081		8	0.3784	8	0.3784

Table 2.4.14 Faroe haddock. Management option table - Input data

MFDP version 1
Run: jr1
Time and date: 17:06 4/30/2005
Fbar age range: 3-7

2005

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	8123	0.2	0	0	0	0.574	0.0149	0.574
3	23487	0.2	0.41	0	0	0.786	0.1141	0.786
4	22069	0.2	0.93	0	0	0.997	0.2452	0.997
5	22138	0.2	0.99	0	0	1.134	0.3682	1.134
6	26302	0.2	1	0	0	1.373	0.4992	1.373
7	2191	0.2	1	0	0	1.744	0.3986	1.744
8	478	0.2	1	0	0	1.964	0.3784	1.964
9	40	0.2	1	0	0	2.506	0.3819	2.506
10	1272	0.2	1	0	0	2.417	0.3819	2.417

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	13000	0.2	0	0	0	0.574	0.0149	0.574
3	.	0.2	0.4	0	0	0.786	0.1141	0.786
4	.	0.2	0.95	0	0	1.018	0.2452	1.018
5	.	0.2	0.99	0	0	1.275	0.3682	1.275
6	.	0.2	1	0	0	1.343	0.4992	1.343
7	.	0.2	1	0	0	1.462	0.3986	1.462
8	.	0.2	1	0	0	1.832	0.3784	1.832
9	.	0.2	1	0	0	2.018	0.3819	2.018
10	.	0.2	1	0	0	2.417	0.3819	2.417

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	14750	0.2	0	0	0	0.574	0.0149	0.574
3	.	0.2	0.4	0	0	0.786	0.1141	0.786
4	.	0.2	0.95	0	0	1.018	0.2452	1.018
5	.	0.2	0.99	0	0	1.302	0.3682	1.302
6	.	0.2	1	0	0	1.51	0.4992	1.510
7	.	0.2	1	0	0	1.431	0.3986	1.431
8	.	0.2	1	0	0	1.536	0.3784	1.536
9	.	0.2	1	0	0	1.883	0.3819	1.883
10	.	0.2	1	0	0	2.417	0.3819	2.417

Input units are thousands and kg - output in tonnes

Table 2.4.15 Faroe haddock. Management option table - Results

MFDP version 1
Run: jr1
Index file 02/05/2004
Time and date: 17:06 4/30/2005
Fbar age range: 3-7

2005				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
114278	96932	1	0.3251	28581

2006					2007	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
88578	76973	0.0	0.0000	0	93032	79090
.	76973	0.1	0.0325	2612	90381	76455
.	76973	0.2	0.0650	5127	87831	73919
.	76973	0.3	0.0975	7550	85375	71478
.	76973	0.4	0.1300	9884	83012	69129
.	76973	0.5	0.1625	12133	80737	66868
.	76973	0.6	0.1950	14300	78546	64692
.	76973	0.7	0.2275	16388	76437	62597
.	76973	0.8	0.2601	18400	74406	60580
.	76973	0.9	0.2926	20340	72449	58637
.	76973	1.0	0.3251	22209	70565	56767
.	76973	1.1	0.3576	24012	68750	54966
.	76973	1.2	0.3901	25750	67002	53231
.	76973	1.3	0.4226	27425	65317	51560
.	76973	1.4	0.4551	29042	63694	49950
.	76973	1.5	0.4876	30601	62130	48399
.	76973	1.6	0.5201	32104	60623	46904
.	76973	1.7	0.5526	33555	59170	45464
.	76973	1.8	0.5851	34955	57769	44076
.	76973	1.9	0.6176	36306	56419	42739
.	76973	2.0	0.6501	37610	55117	41450

Input units are thousands and kg - output in tonnes

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

MFYPR version 1
Run: jr2
Index file 02/05/2004
Time and date: 18:11 4/30/2005
Fbar age range: 3-7

Age	M	Mat	PF	PM	SWt	Sel	CWt
2	0.2	0.06	0	0	0.527	0.0149	0.527
3	0.2	0.46	0	0	0.786	0.1141	0.786
4	0.2	0.91	0	0	1.107	0.2452	1.107
5	0.2	0.99	0	0	1.477	0.3682	1.477
6	0.2	1.00	0	0	1.836	0.4992	1.836
7	0.2	1.00	0	0	2.179	0.3986	2.179
8	0.2	1.00	0	0	2.447	0.3784	2.447
9	0.2	1.00	0	0	2.704	0.3819	2.704
10	0.2	1.00	0	0	3.079	0.3819	3.079

Weights in kilograms

Table 2.4.17 **Faroe haddock. Long-term Prediction - Results**

MFYPR version 1
Run: jr2
Time and date: 18:11 4/30/2005
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0	0.0000	0.0000	0.0000	5.5167	9.1829	4.0700	8.2663	4.0700	8.2663
0.1	0.0325	0.1125	0.2259	4.9564	7.6342	3.5115	6.7194	3.5115	6.7194
0.2	0.0650	0.1938	0.3704	4.5520	6.5492	3.1087	5.6360	3.1087	5.6360
0.3	0.0975	0.2554	0.4663	4.2463	5.7538	2.8046	4.8423	2.8046	4.8423
0.4	0.1300	0.3036	0.5317	4.0070	5.1502	2.5669	4.2405	2.5669	4.2405
0.5	0.1625	0.3426	0.5773	3.8143	4.6794	2.3759	3.7713	2.3759	3.7713
0.6	0.1950	0.3747	0.6095	3.6557	4.3038	2.2188	3.3973	2.2188	3.3973
0.7	0.2275	0.4016	0.6324	3.5227	3.9983	2.0874	3.0934	2.0874	3.0934
0.8	0.2601	0.4247	0.6488	3.4094	3.7457	1.9756	2.8423	1.9756	2.8423
0.9	0.2926	0.4446	0.6606	3.3115	3.5338	1.8792	2.6320	1.8792	2.6320
1.0	0.3251	0.4620	0.6690	3.2260	3.3539	1.7952	2.4536	1.7952	2.4536
1.1	0.3576	0.4774	0.6750	3.1505	3.1993	1.7212	2.3005	1.7212	2.3005
1.2	0.3901	0.4912	0.6790	3.0833	3.0652	1.6554	2.1679	1.6554	2.1679
1.3	0.4226	0.5036	0.6818	3.0229	2.9477	1.5965	2.0519	1.5965	2.0519
1.4	0.4551	0.5148	0.6834	2.9683	2.8441	1.5433	1.9497	1.5433	1.9497
1.5	0.4876	0.5250	0.6843	2.9185	2.7518	1.4950	1.8589	1.4950	1.8589
1.6	0.5201	0.5344	0.6846	2.8730	2.6692	1.4509	1.7777	1.4509	1.7777
1.7	0.5526	0.5430	0.6845	2.8311	2.5948	1.4104	1.7046	1.4104	1.7046
1.8	0.5851	0.5510	0.6840	2.7924	2.5273	1.3731	1.6385	1.3731	1.6385
1.9	0.6176	0.5585	0.6832	2.7564	2.4658	1.3385	1.5783	1.3385	1.5783
2.0	0.6501	0.5654	0.6822	2.7229	2.4094	1.3063	1.5233	1.3063	1.5233

Reference point	F multiplier	Absolute F
Fbar(3-7)	1	0.3251
FMax	1.6103	0.5235
F0.1	0.5848	0.1901
F35%SPR	0.7782	0.2530
Flow	-99	
Fmed	0.9507	0.3091
Fhigh	4.4366	1.4422

Weights in kilograms

Table 2.4.18. Faroe haddock (Division Vb) standard graphs from the 2004 assessment.

Year	Recruitment Age 2 thousands	SSB tonnes	Landings tonnes	Mean F Ages 3-7
1961	51276	47797	20831	0.5624
1962	38537	51875	27151	0.6506
1963	47362	49547	27571	0.7002
1964	30111	44128	19490	0.4753
1965	22645	45556	18479	0.5260
1966	20206	43953	18766	0.5288
1967	25357	41960	13381	0.4030
1968	54849	45381	17852	0.4376
1969	31971	53425	23272	0.4853
1970	35589	59865	21361	0.4762
1971	15455	62918	19393	0.4563
1972	33183	61990	16485	0.3963
1973	23695	61599	17976	0.2893
1974	52351	64658	14773	0.2205
1975	70144	75442	20715	0.1798
1976	56050	89285	26211	0.2474
1977	26238	96488	25555	0.3869
1978	35180	97396	19200	0.2777
1979	2798	85582	12418	0.1547
1980	4956	82112	15016	0.1774
1981	3500	76089	12233	0.1807
1982	15901	57019	11937	0.3294
1983	19804	52063	12894	0.2639
1984	41191	54204	12378	0.2268
1985	40240	63214	15143	0.2733
1986	27050	66532	14477	0.2205
1987	9747	68612	14882	0.2589
1988	19285	63449	12178	0.1955
1989	16305	53393	14325	0.2750
1990	9688	45865	11726	0.2574
1991	3111	37351	8429	0.2537
1992	2723	29603	5476	0.1901
1993	1828	25843	4026	0.1702
1994	6513	24287	4252	0.1857
1995	104824	25570	4948	0.2184
1996	46561	56939	9642	0.3069
1997	9333	89175	17924	0.3568
1998	3666	89717	22210	0.5086
1999	15921	70377	18482	0.4218
2000	23964	60558	15821	0.2560
2001	126449	71418	15890	0.2687
2002	54798	102883	25011	0.2713
2003	35863	115100	26970	0.4043
2004	28964	100749	23811	0.3136
2005	8123	96932	28581	0.3251
Average	30073	63509	16879	0.3325

Yield and spawning biomass per Recruit
F-reference points:

	Fish Mort Ages 3-7	Yield/R	SSB/R
Average last 3 years	0.330	0.670	2.430
Fmax	0.523	0.685	1.770
F0.1	0.190	0.605	3.449
Fmed	0.299	0.662	2.597

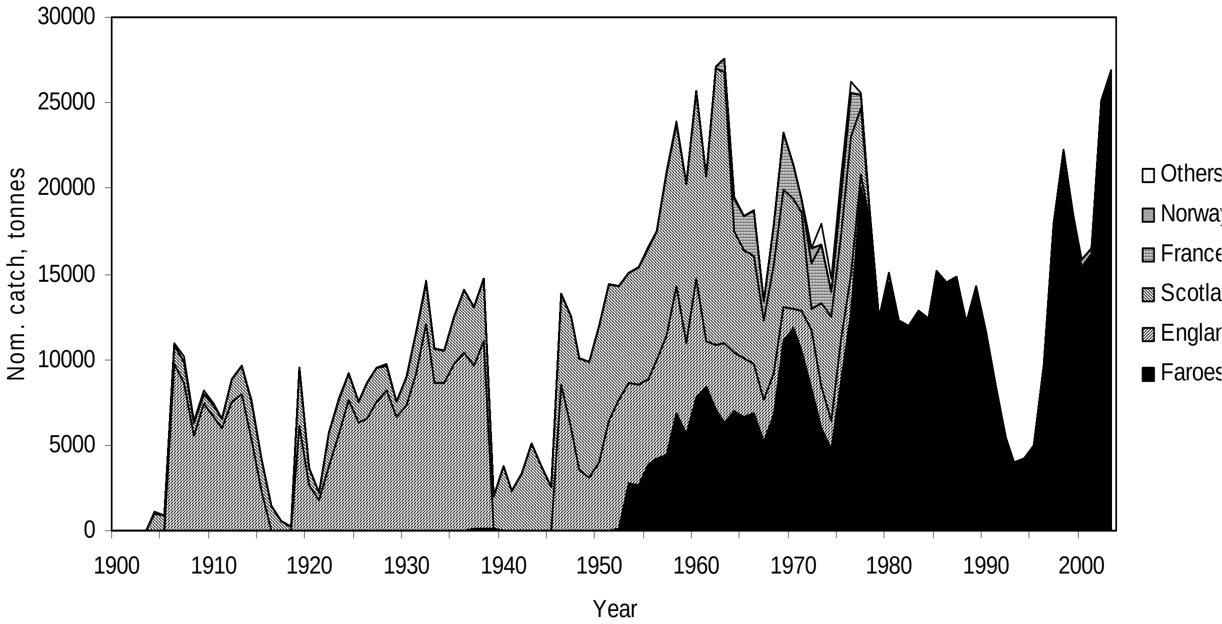


Figure 2.4.1. Haddock in ICES Division Vb. Landings by all nations 1903-2004.

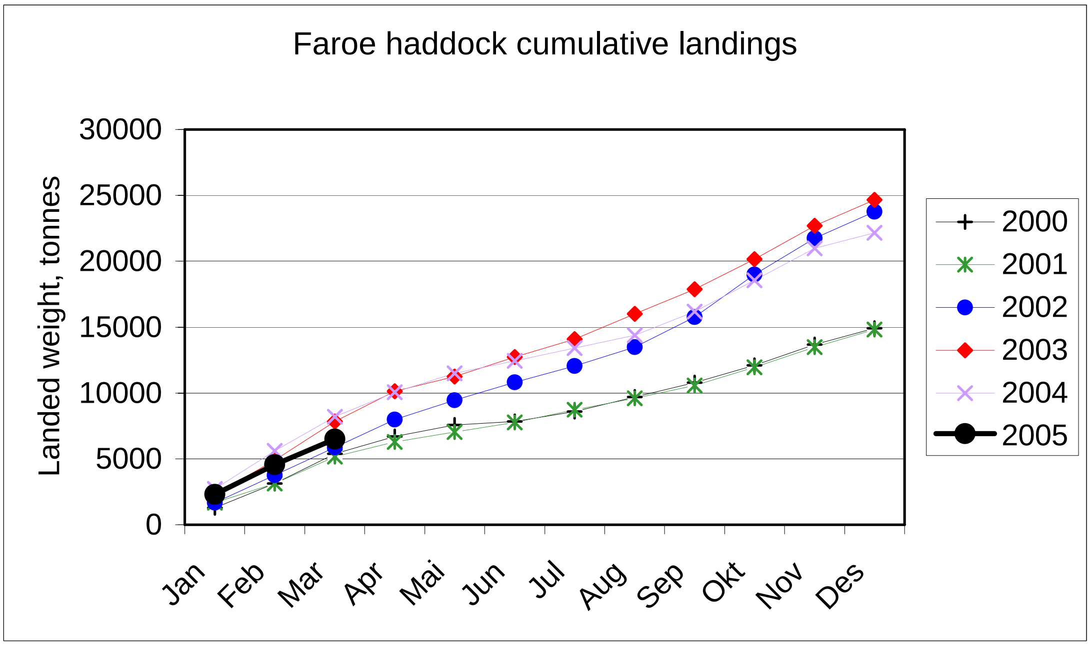


Figure 2.4.2. Faroe Haddock Cumulative Faroese Landings from Vb.

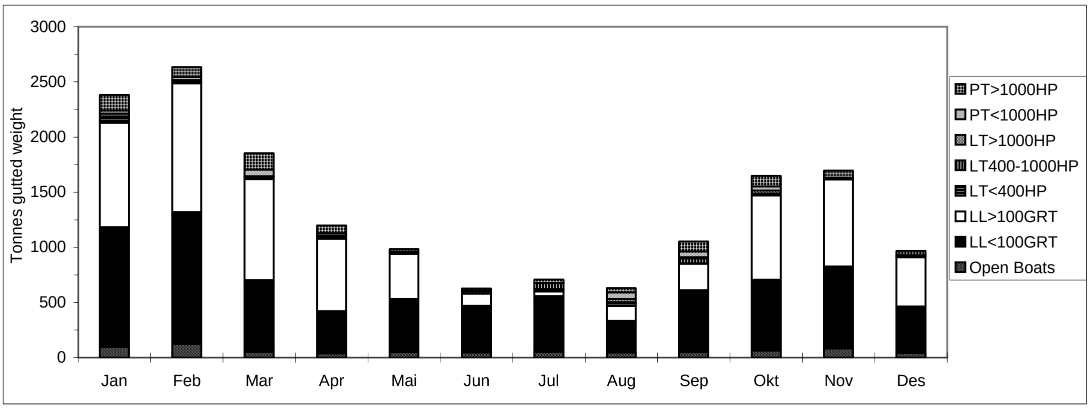


Figure 2.4.3.A. Faroese landings of haddock from Vb1 in 2004 by fleet. Tonnes ungutted weight.

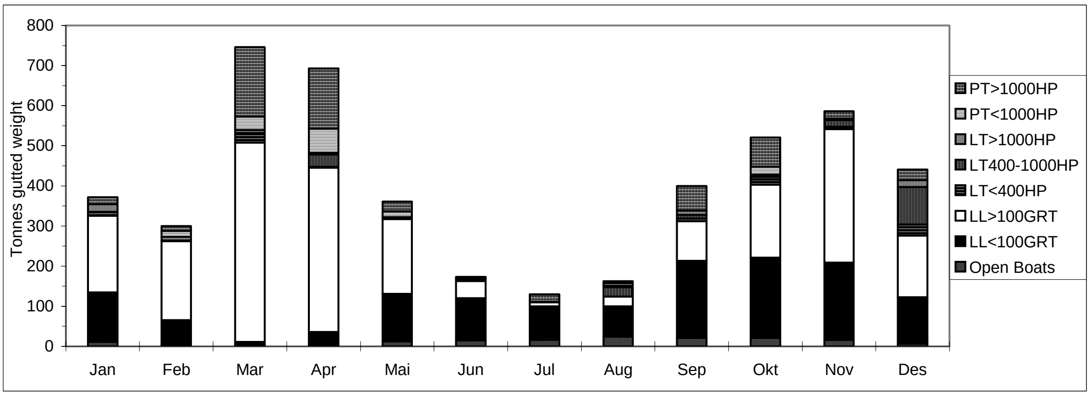


Figure 2.4.3.B. Faroese landings of haddock from Vb2 in 2004 by fleet. Tonnes ungutted weight.

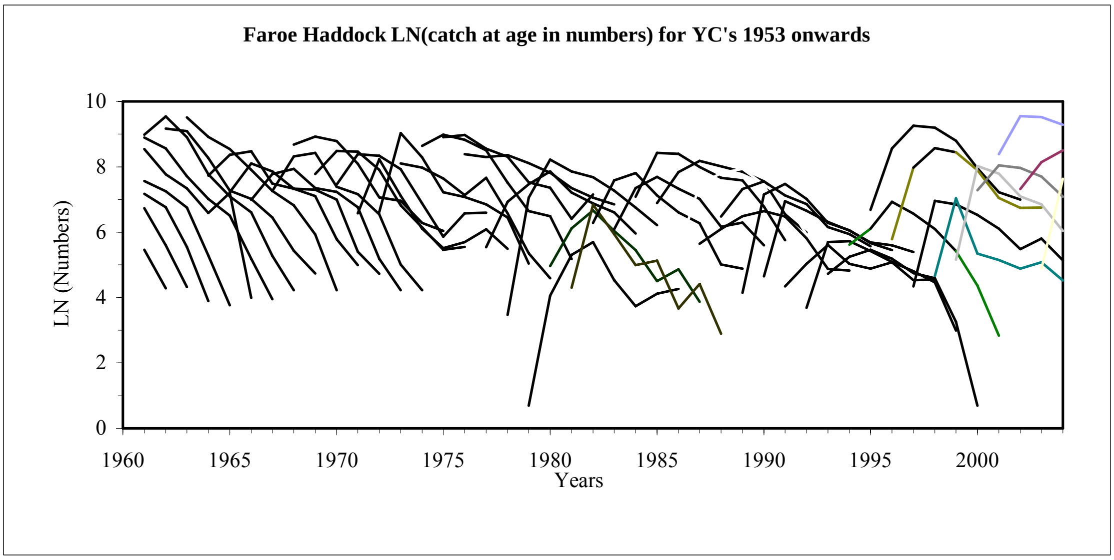


Figure 2.4.5.a Faroe Haddock. LN (catch-at-age in numbers) for YC's 1953 onwards.

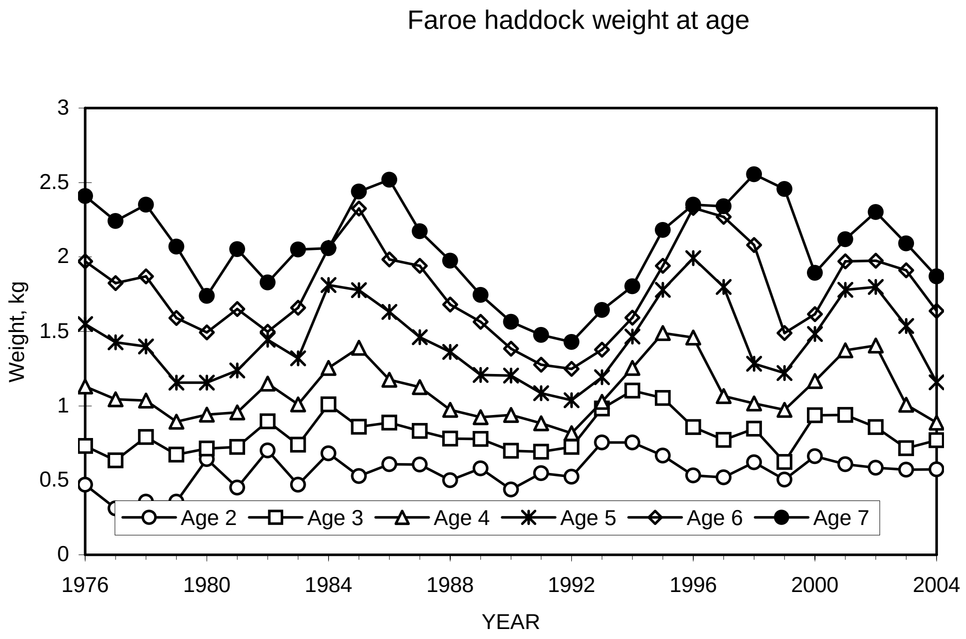


Figure 2.4.5A. Faroe Haddock. Mean weight at age (2-7).

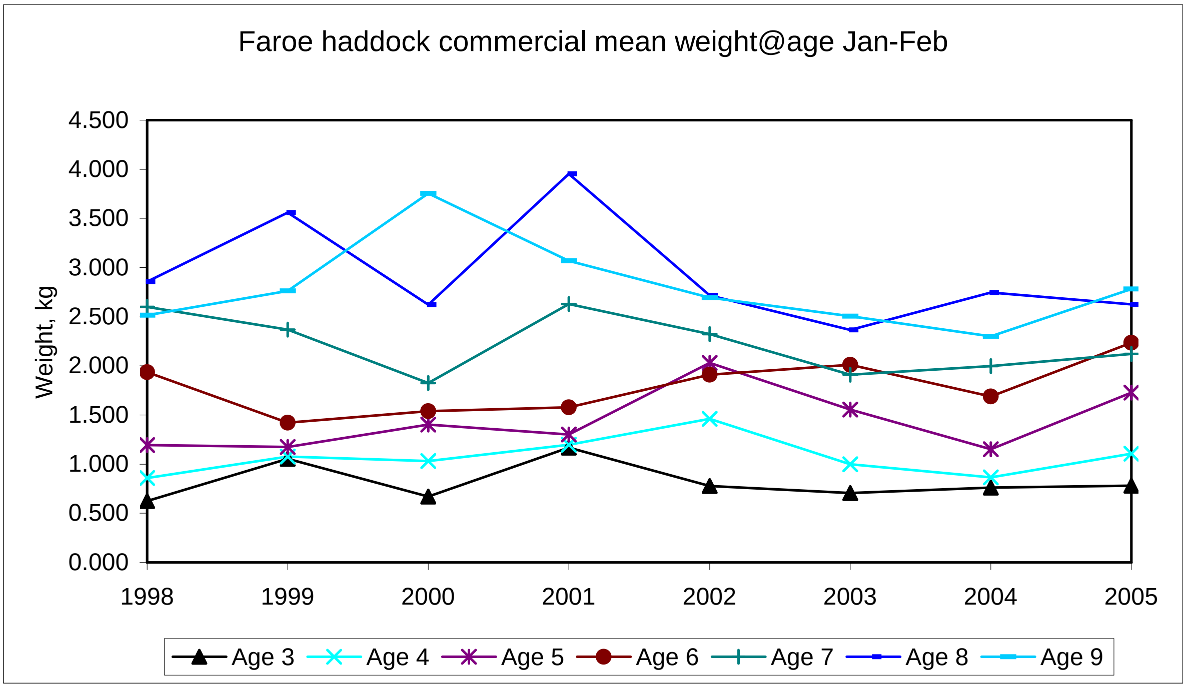
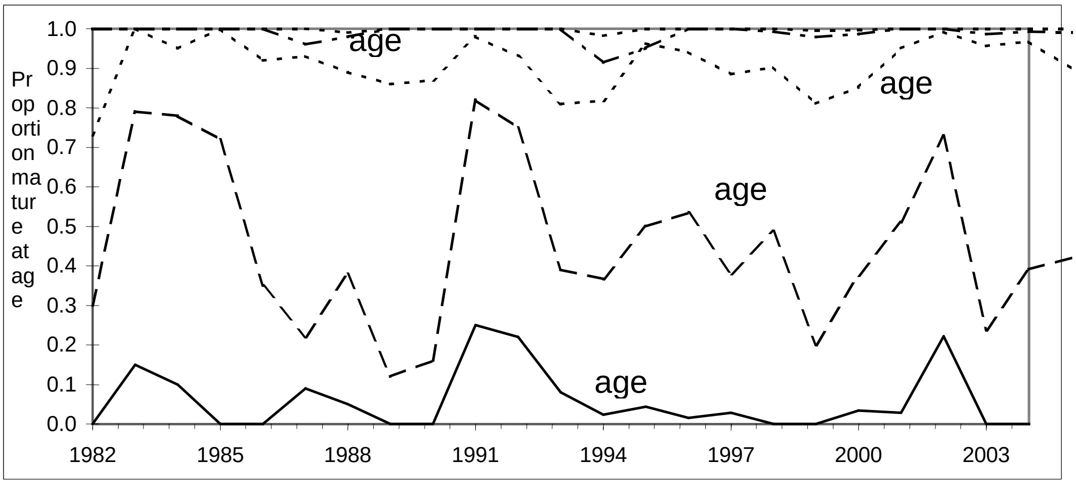
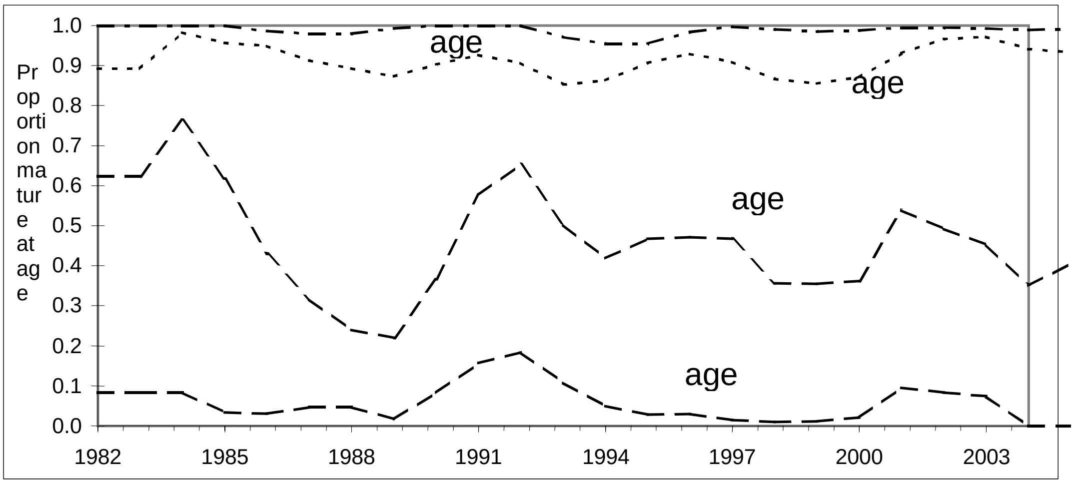


Figure 2.4.5.B. Faroe haddock. Mean weight at age in Jan-Feb.



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



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

Figure 2.4.6. Haddock in ICES Division Vb. Maturity at age.

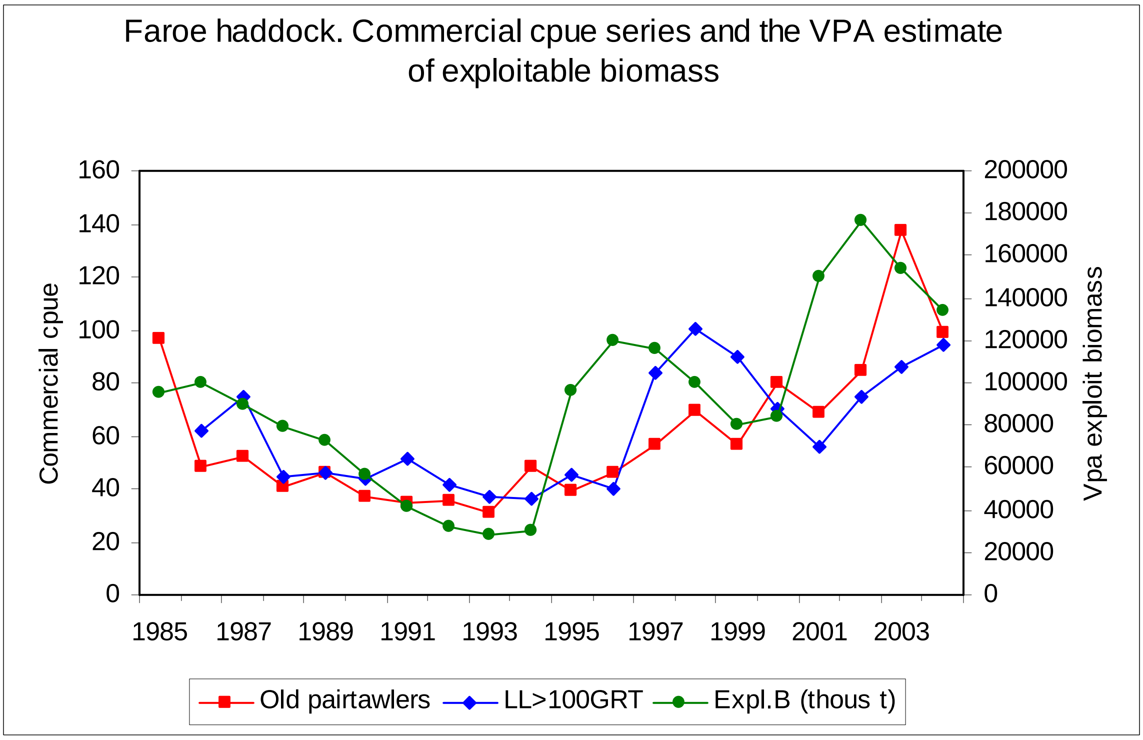


Figure 2.4.7.

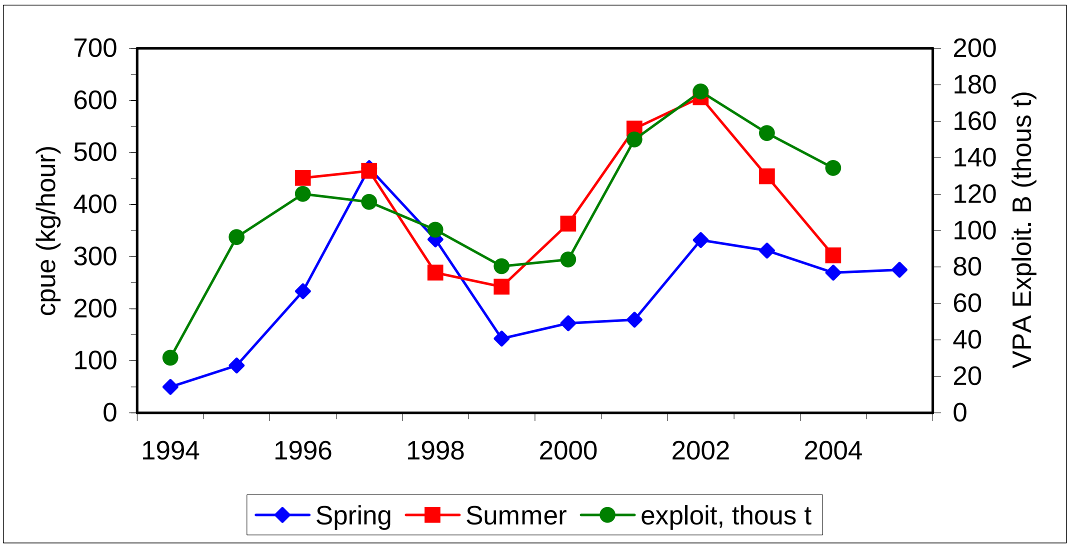


Figure 2.4.8. Faroe haddock. CPUE (kg/trawlhour) in the Faroese groundfish surveys

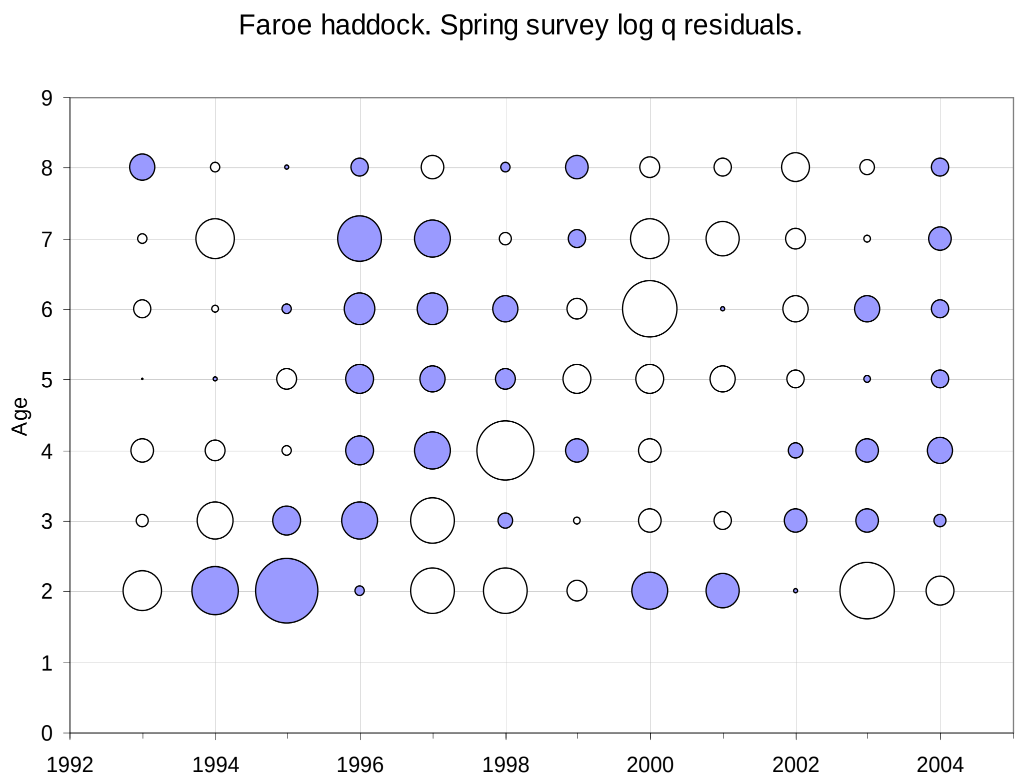


Figure 2.4.9. (Filled symbols positive, open symbols negative).

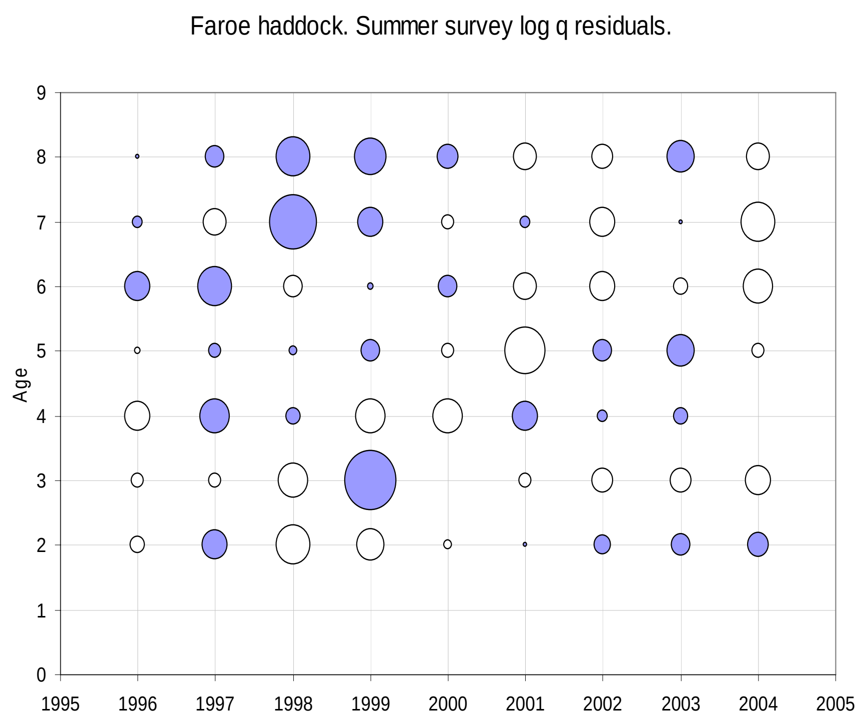


Figure 2.4.10. (Filled symbols positive, open symbols negative).

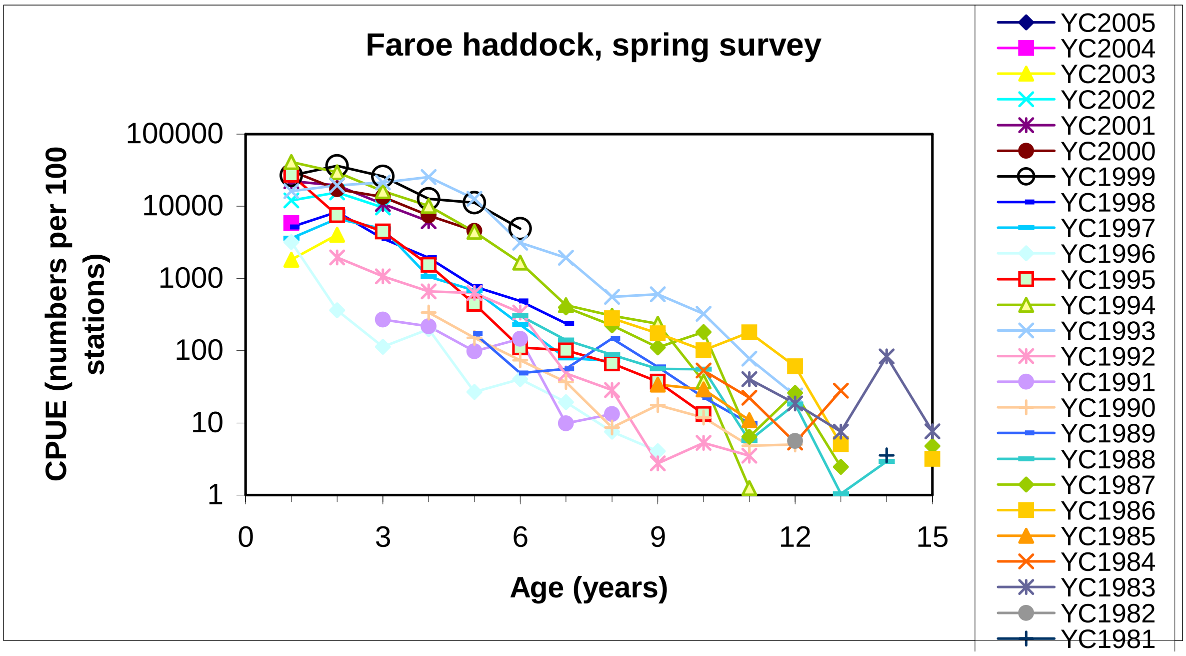


Figure 2.4.11. Faroe haddock. LN (c@age in numbers) in the spring survey.

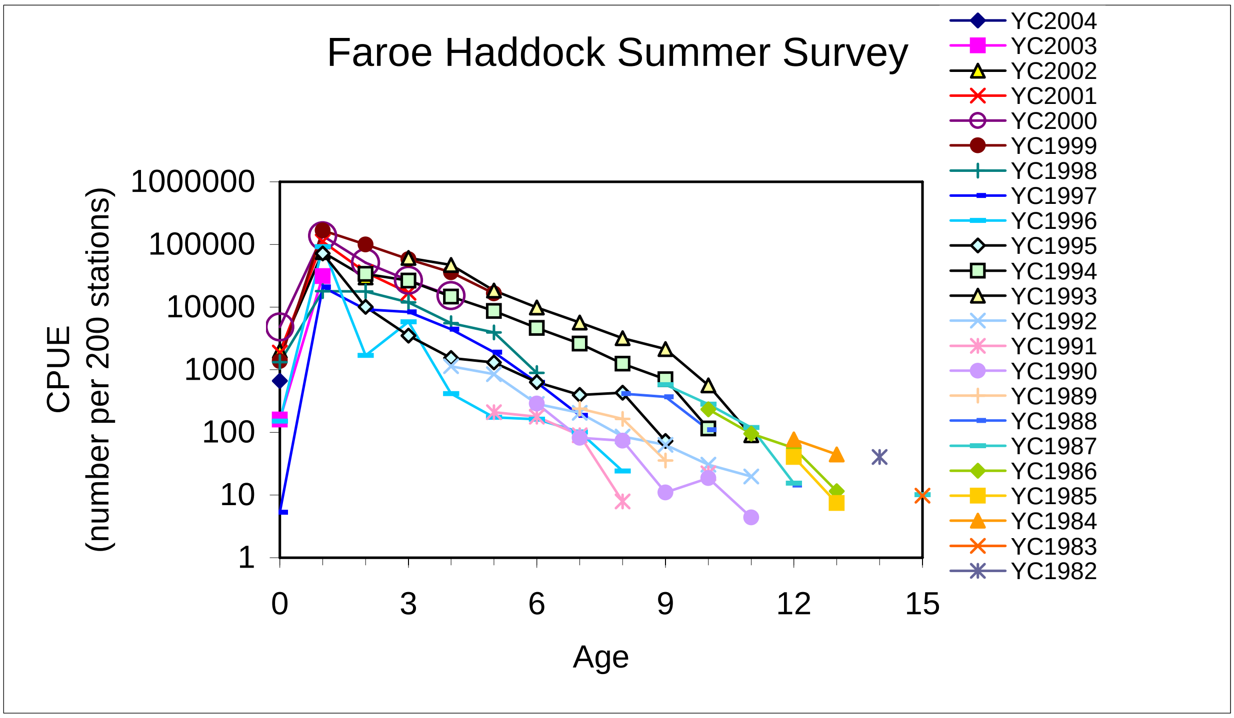


Figure 2.4.12. Faroe haddock. LN (c@age in numbers) in the summer survey.

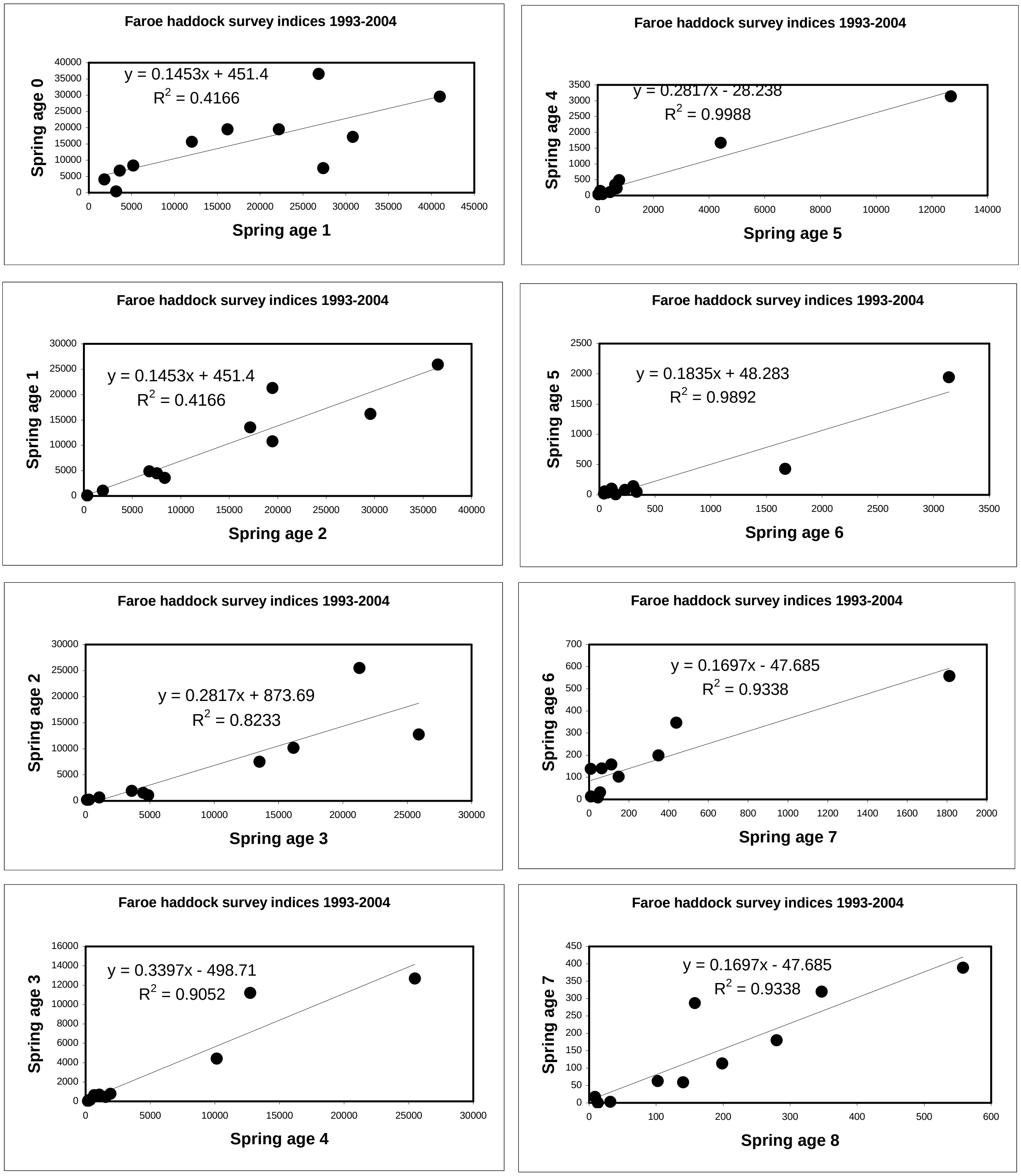


Figure 2.4. 13. Faroe haddock. Comparison between spring survey indices at age and the indices of the same YC one year later.

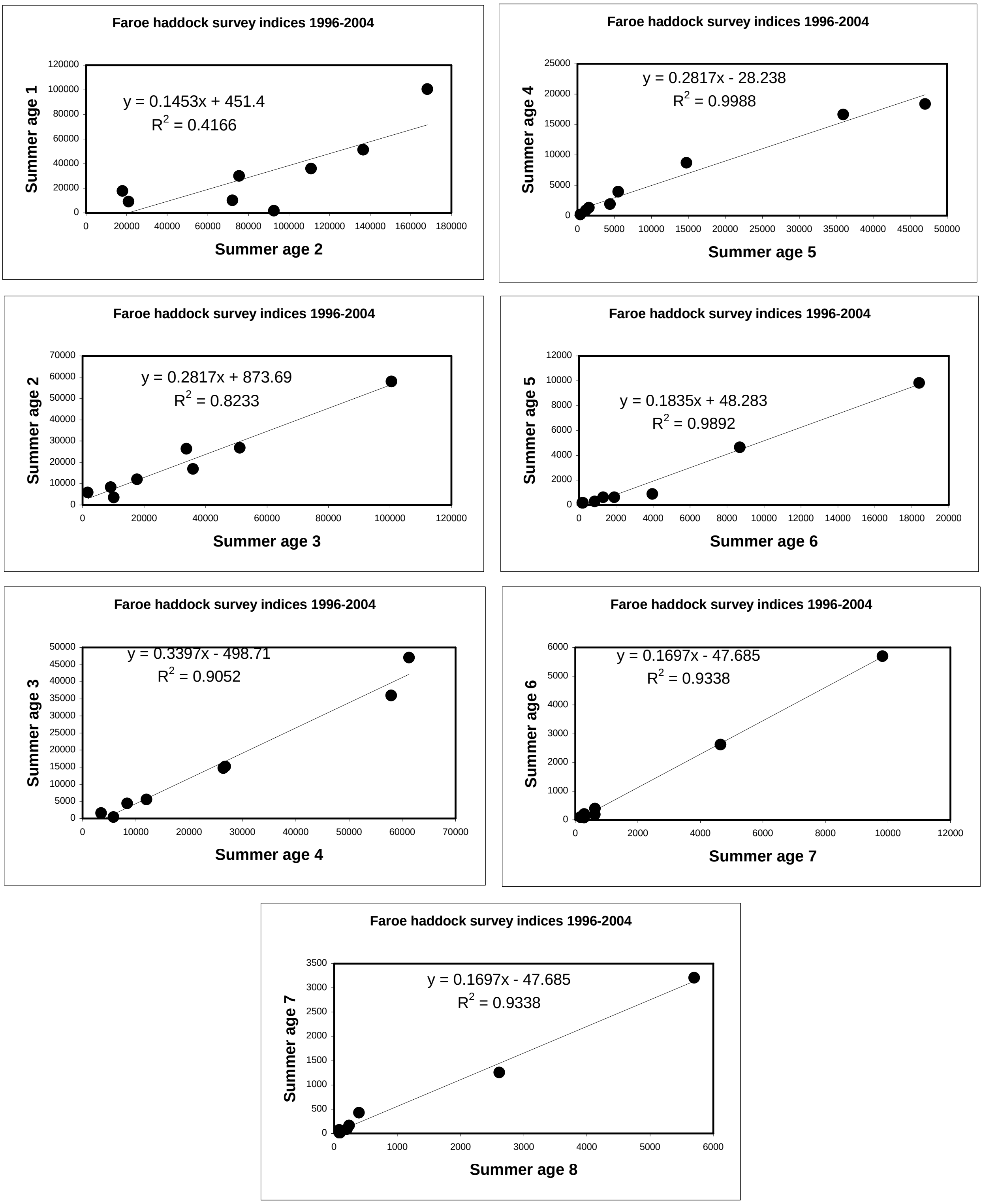


Figure 2.4. 14. Faroe haddock. Comparison between summer survey indices at age and the indices of the same YC one year later.

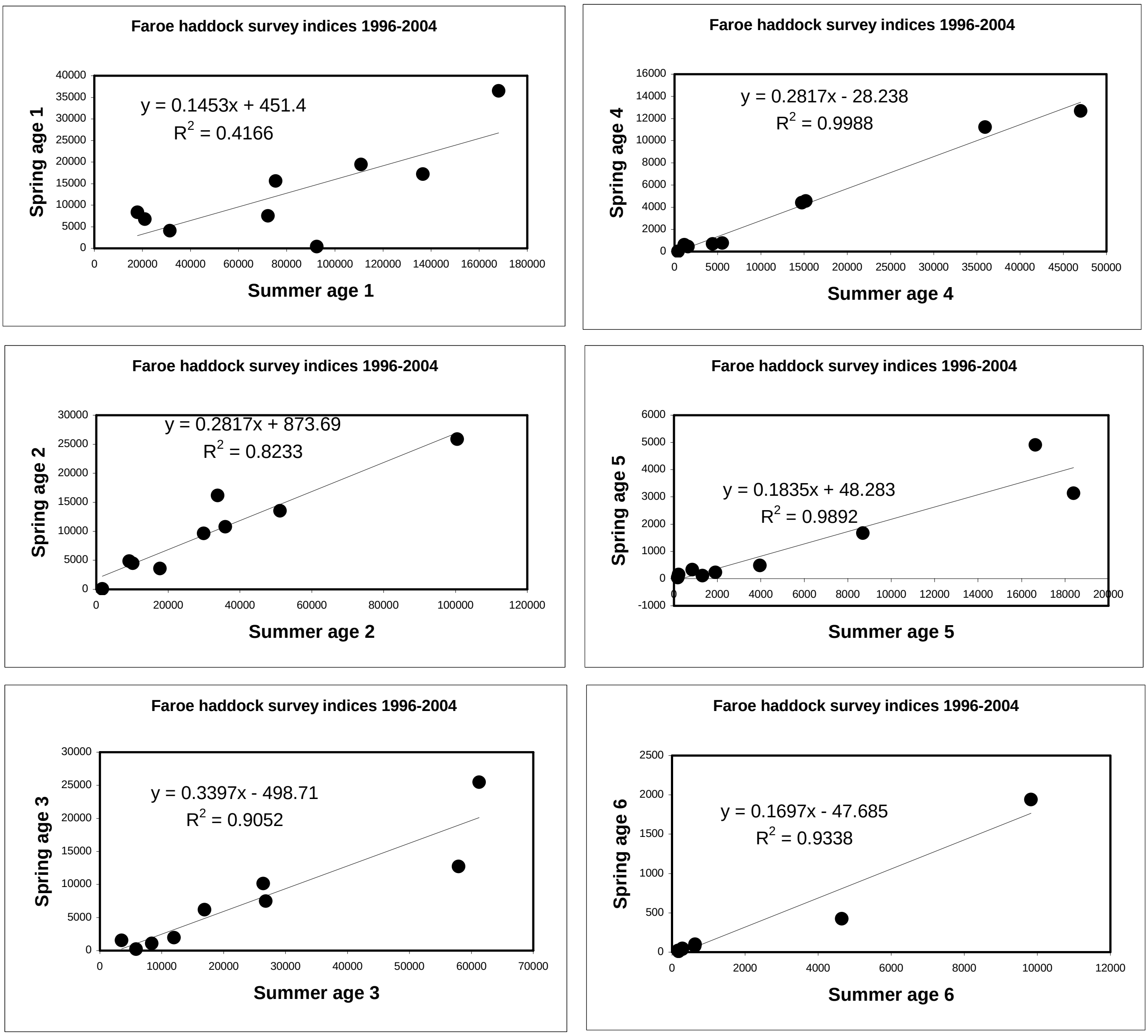


Figure 2.4. 15. Faroe haddock. Comparison between indices at age from the spring and summer surveys.

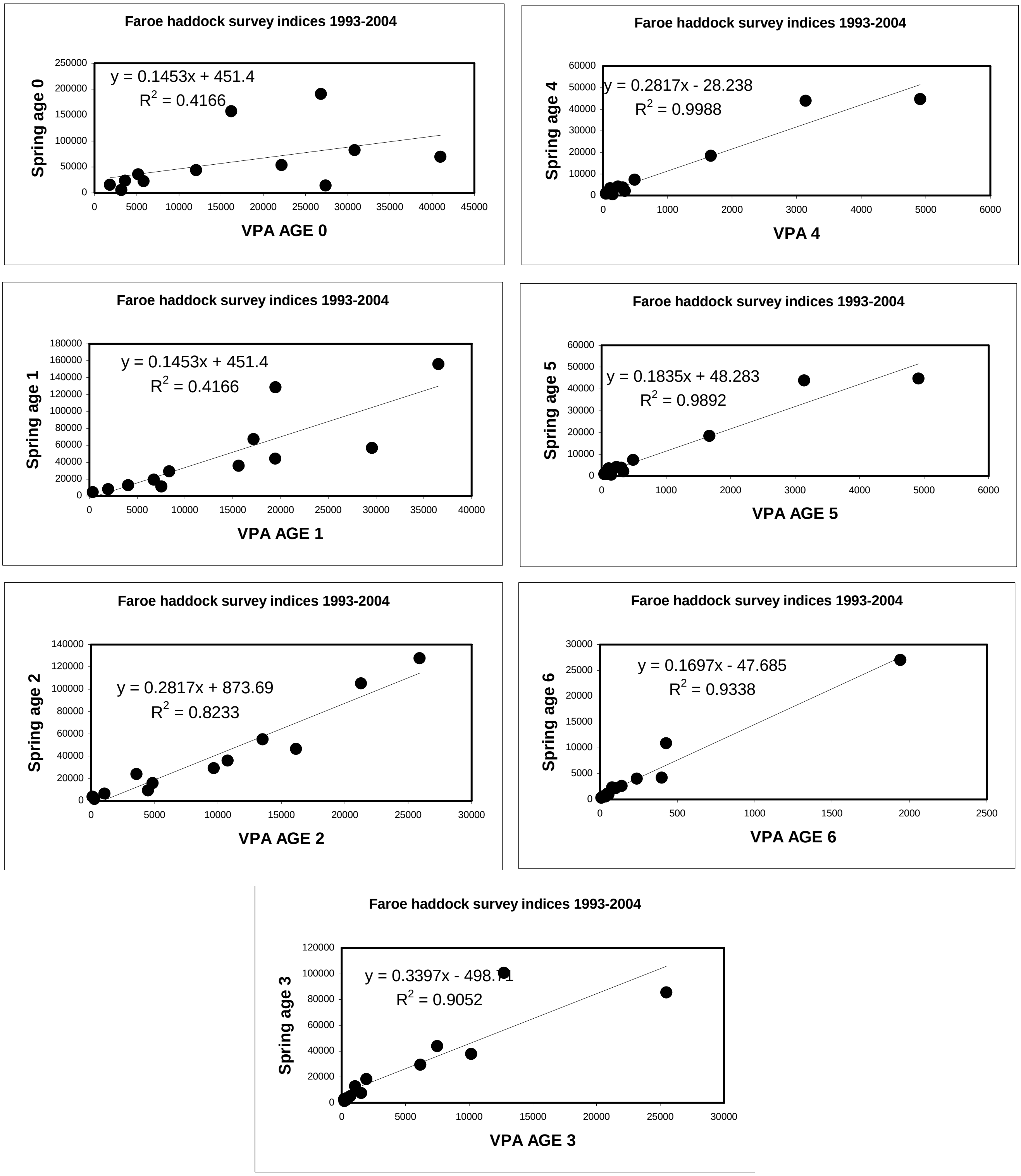


Figure 2.4. 16. Faroe haddock. Comparison between spring survey indices at age and the corresponding VPA estimates at age.

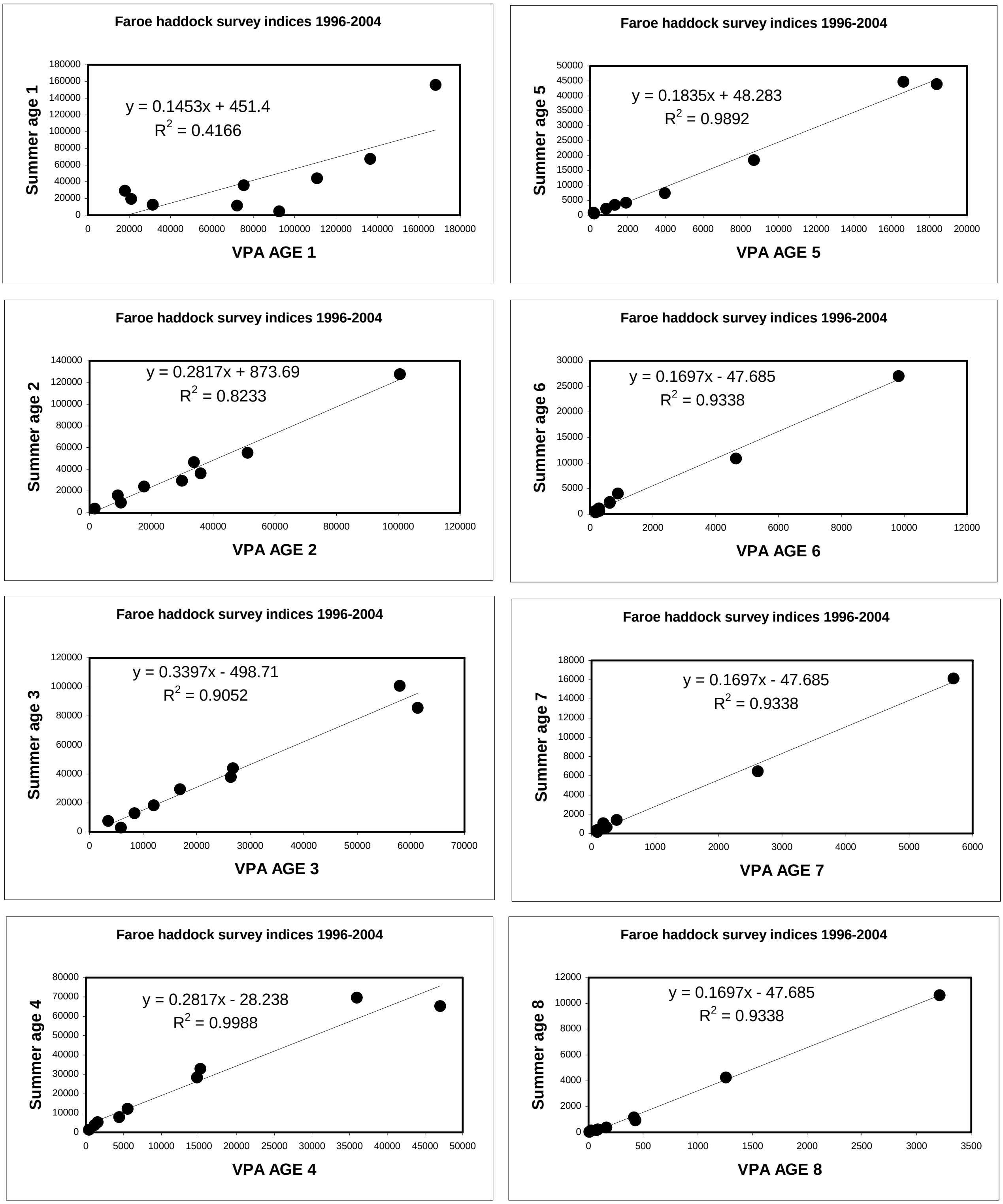


Figure 2.4. 17. Faroe haddock. Comparison between summer survey indices at age and the corresponding VPA estimates at age.

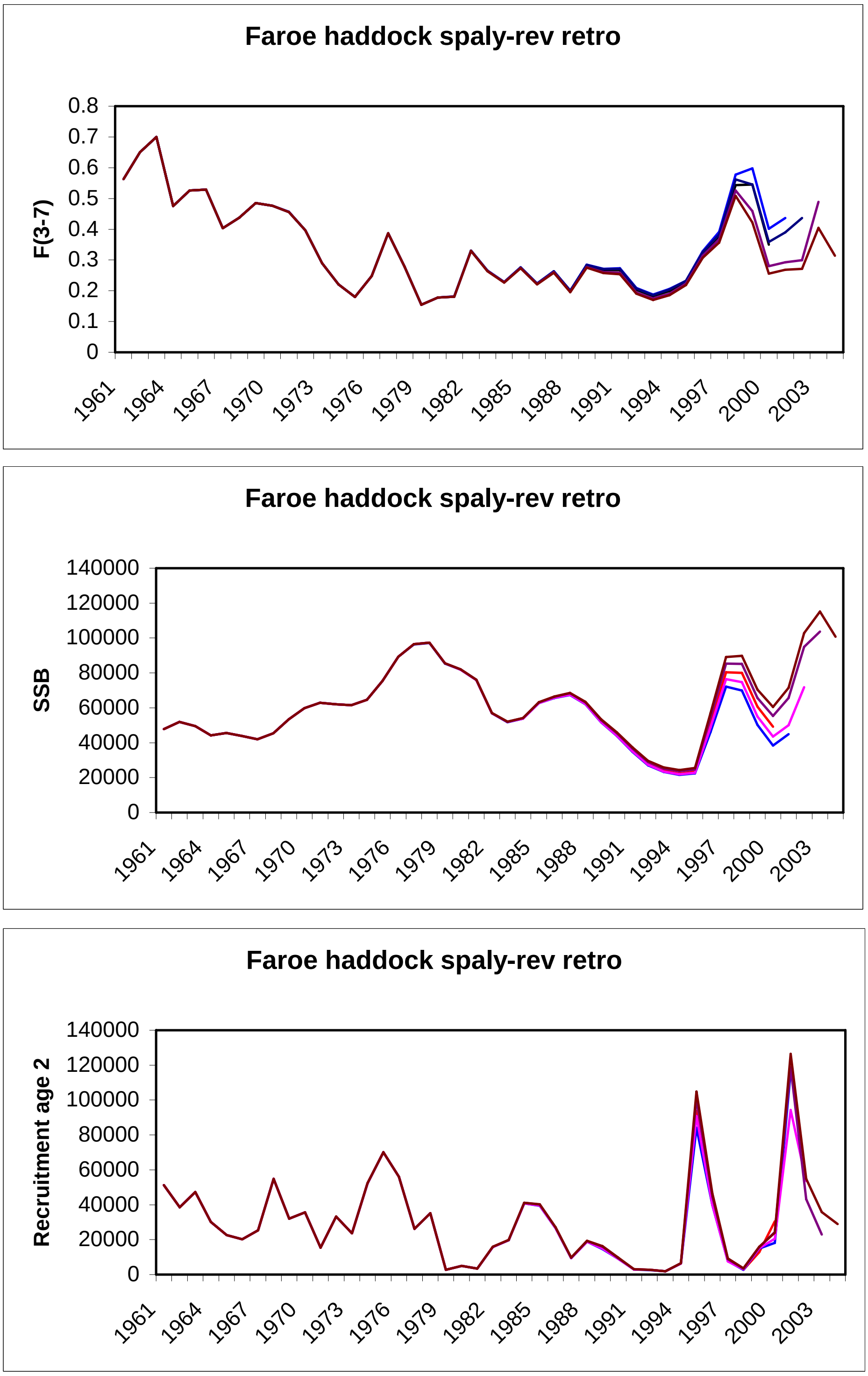
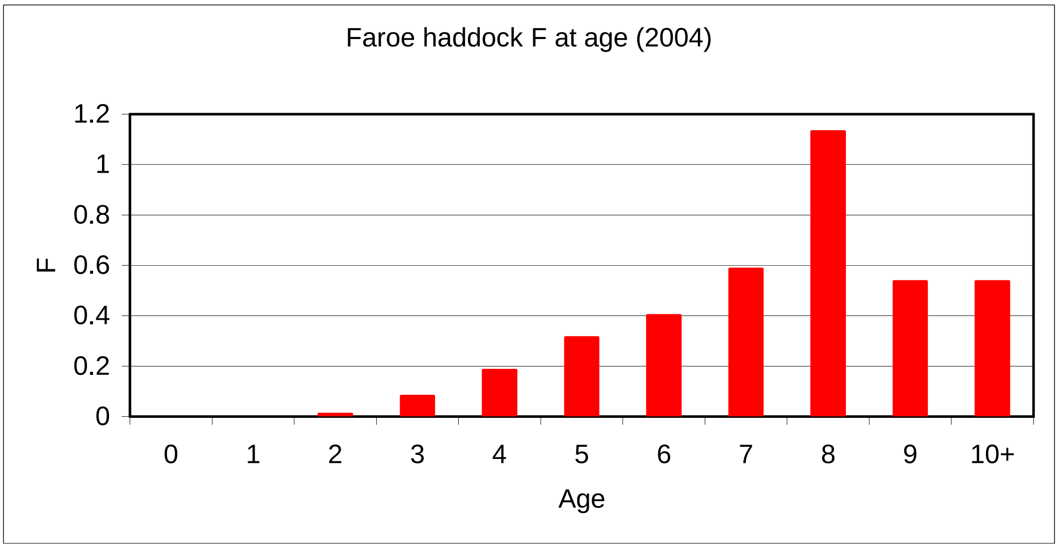


Figure 2.4.18. Faroe haddock. Retrospective analysis on the 2005 XSA (SPALY-REV run).



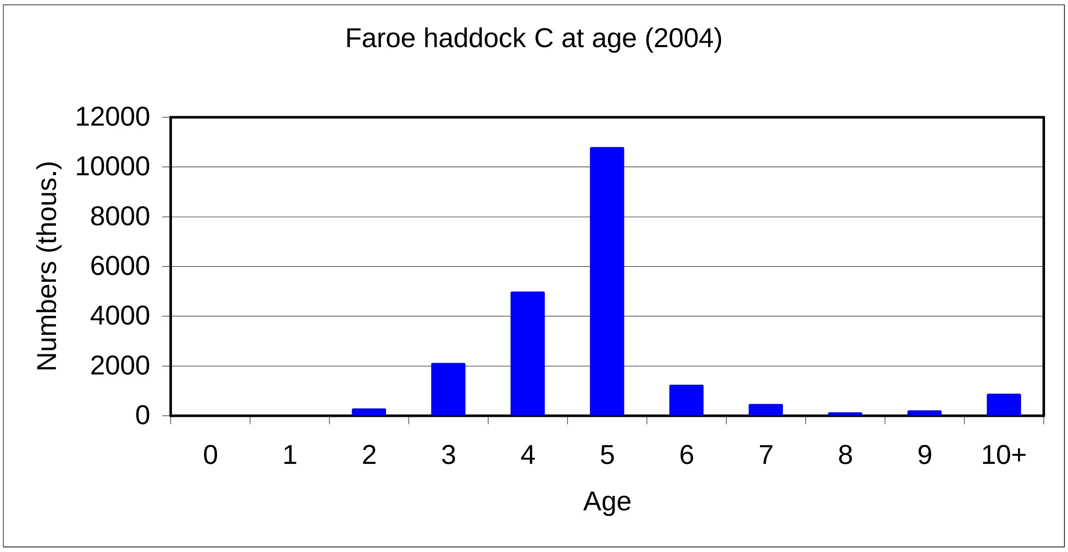


Figure 2.4.19. XSA 2005. The 2004 F@age and C@age.

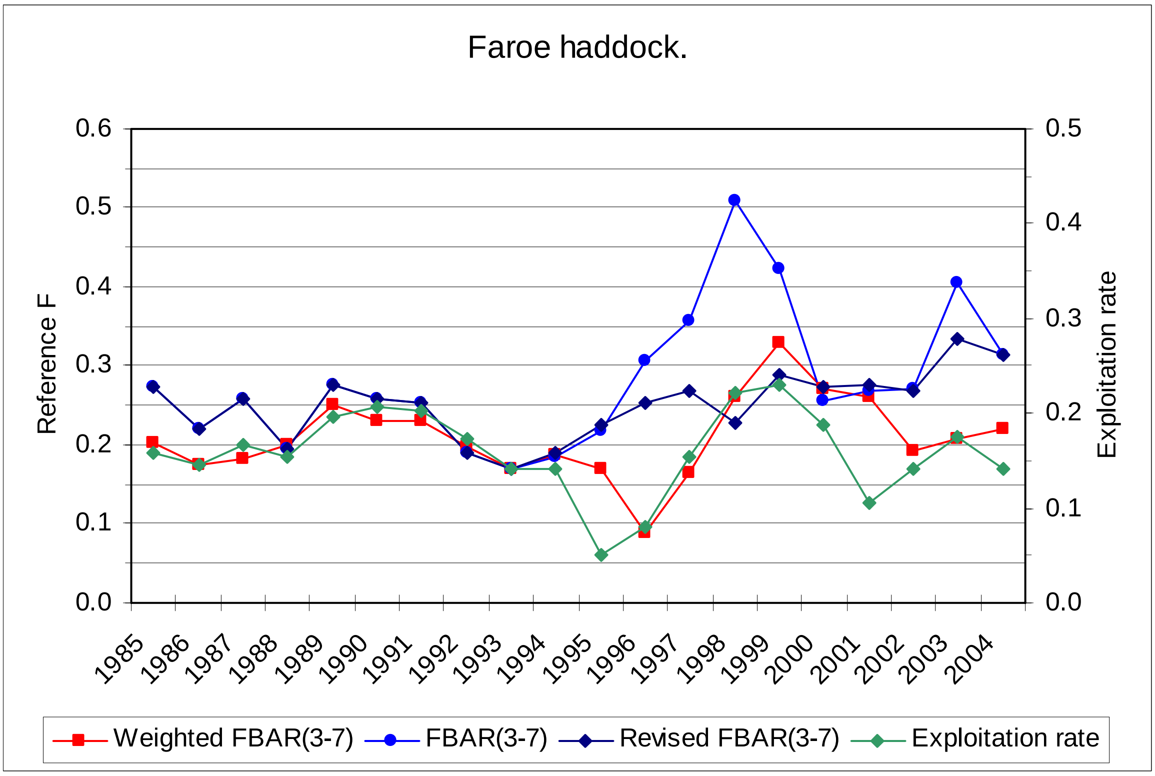


Figure 2.4.20. Different proxies for fishing mortality.

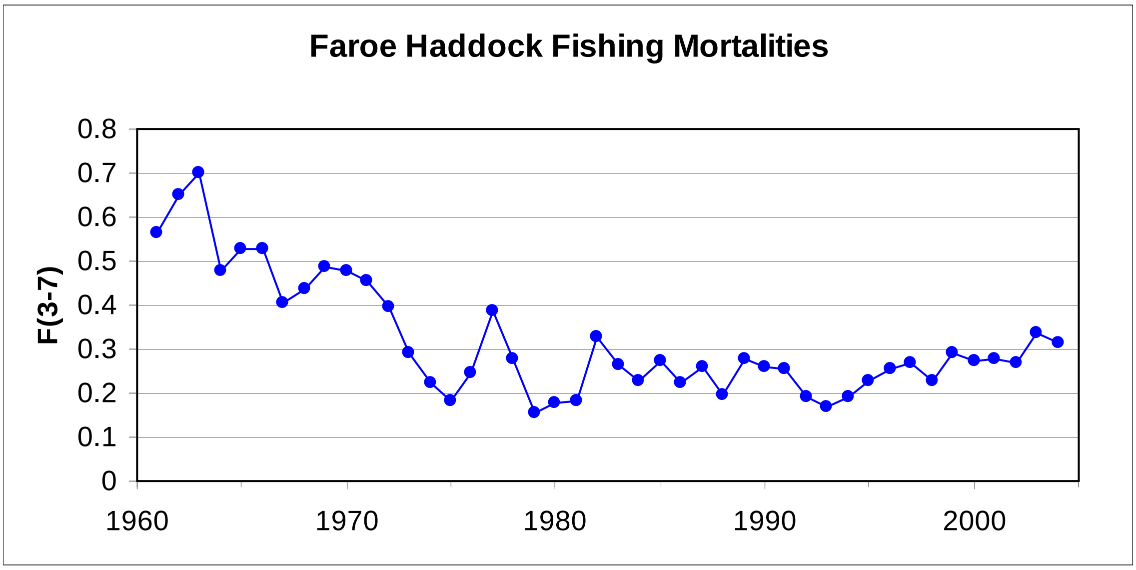


Figure 2.4.21. FBAR(3-7) with the 1992 and 1996 yea rclasses removed.

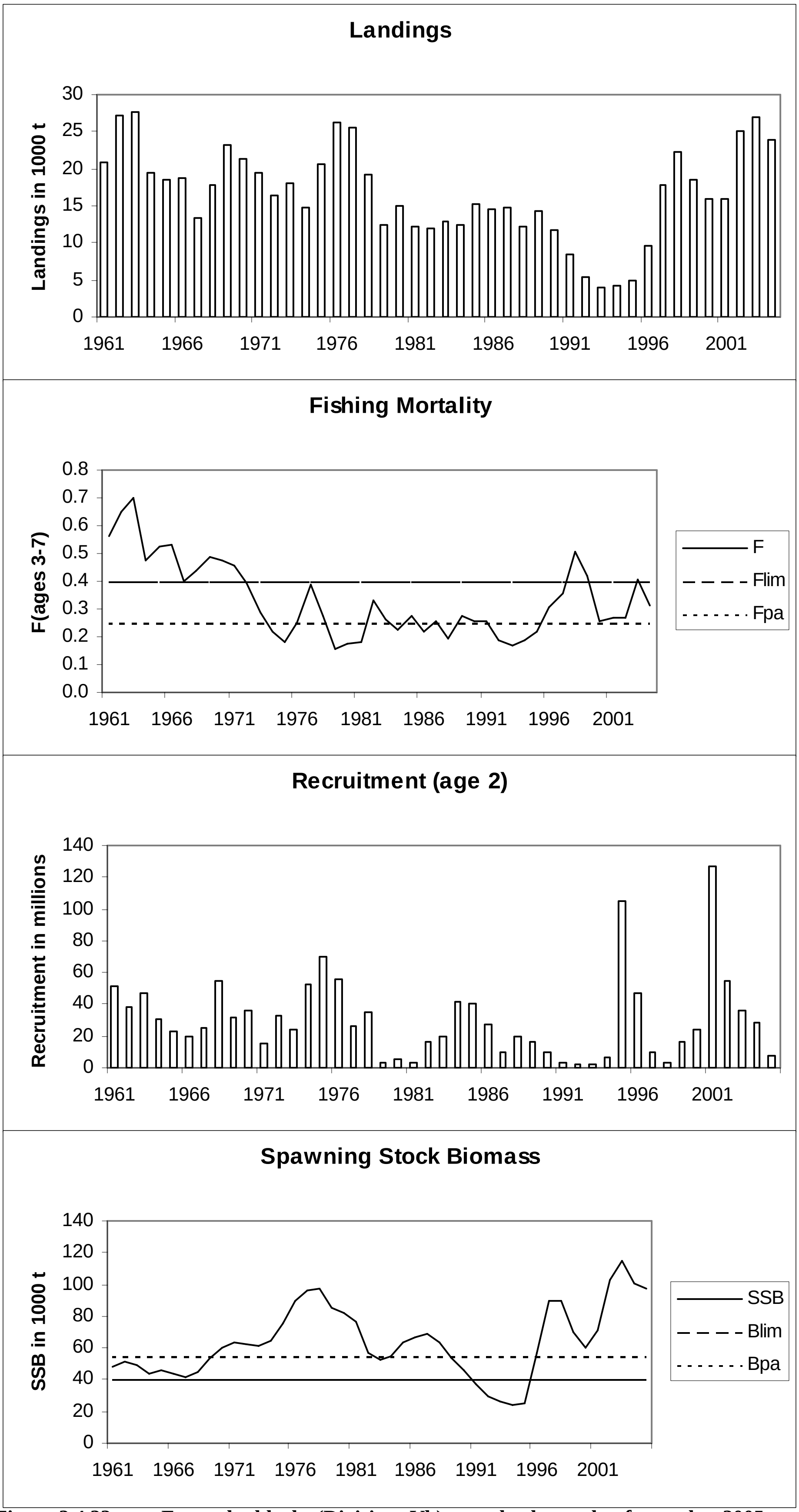
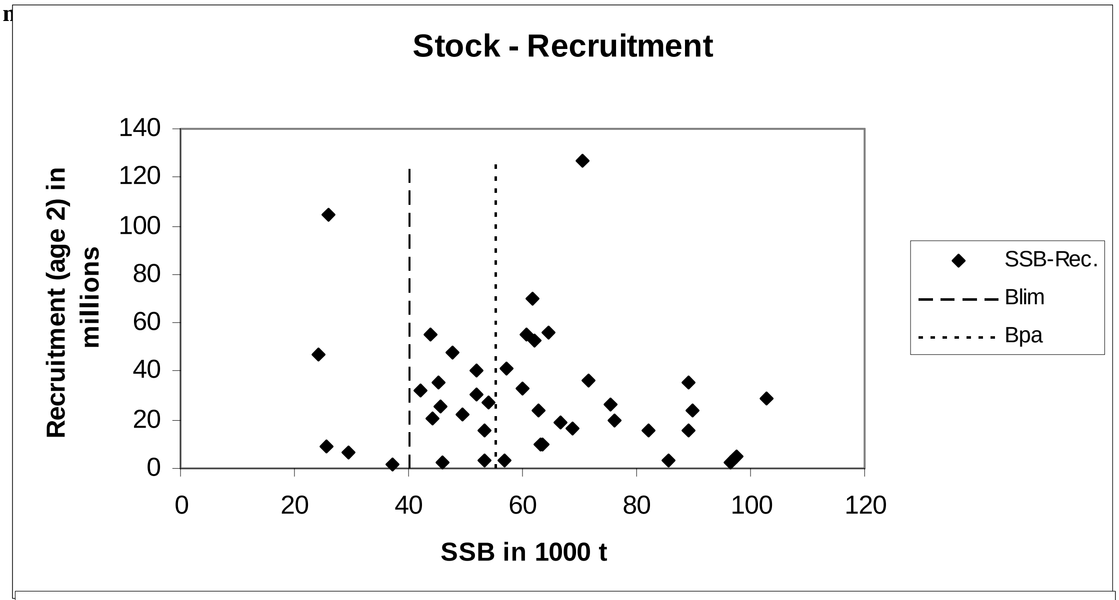
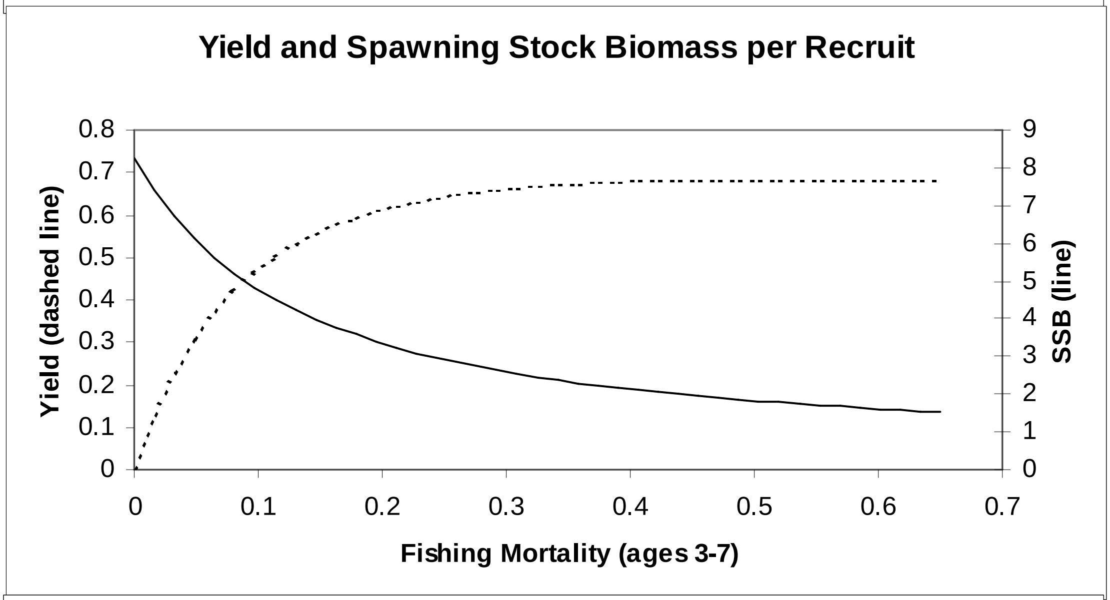
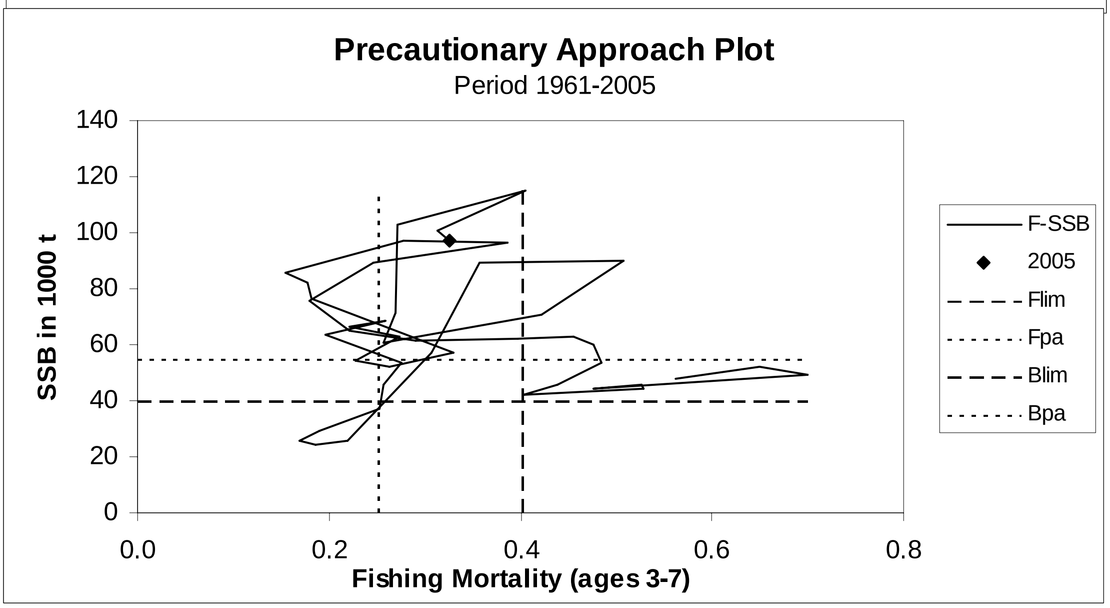


Figure 2.4.22. **Faroe haddock (Division Vb) standard graphs from the 2005 assessment**

Figure 2.4.22 (Cont.). **Faroe haddock (Division Vb) standard graphs from the 2005 assess-**







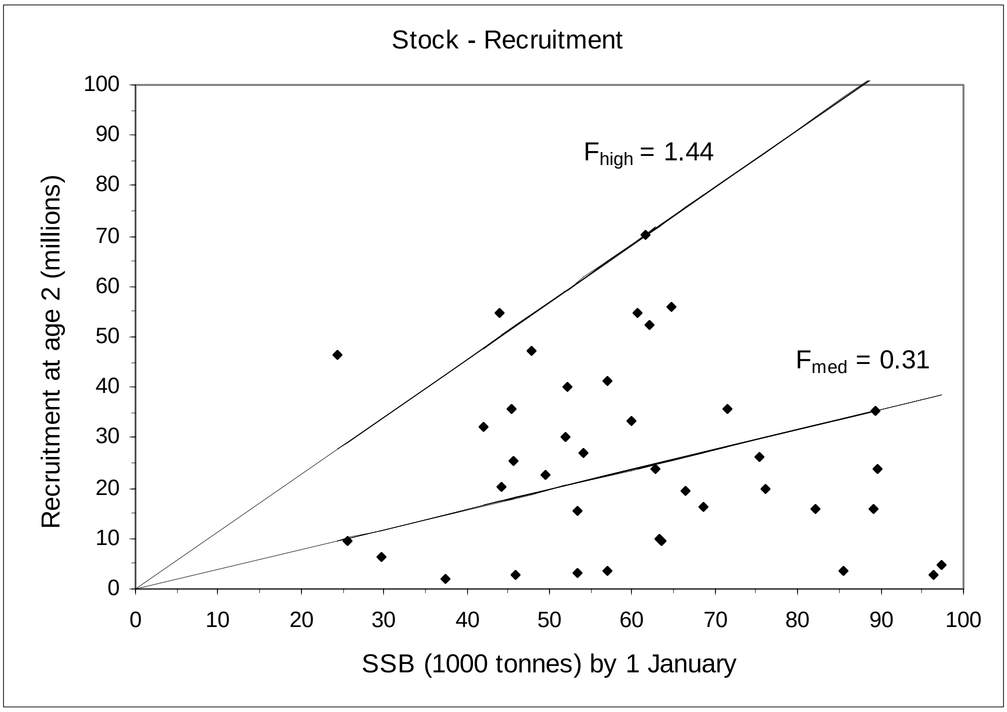
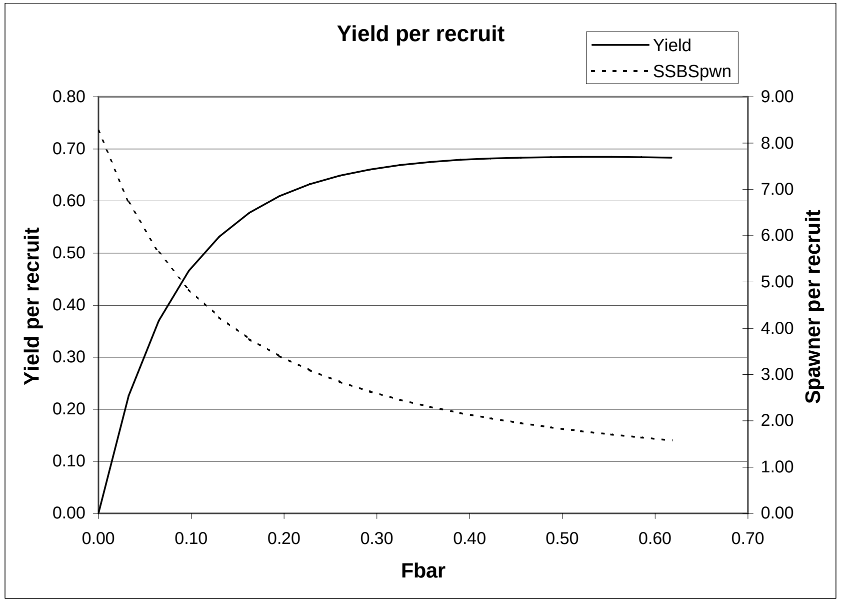
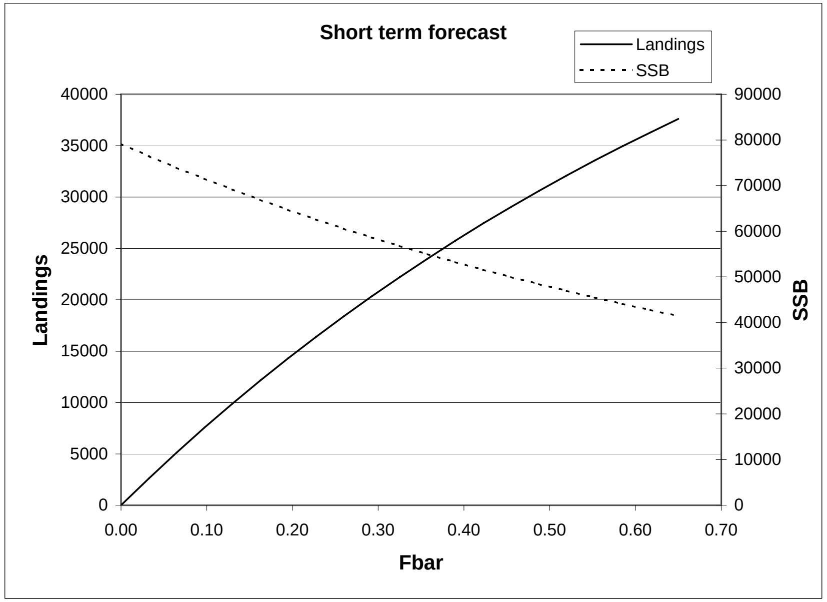


Figure 2.4.23. Faroe haddock. SSB-R plot.





MFYPR version 1
Run: jr2
Time and date: 18:11 4/30/2005

Reference point	F multiplier	Absolute F
Fbar(3-7)	1.0000	0.3251
FMax	1.6103	0.5235
F0.1	0.5848	0.1901
F35%SPR	0.9507	0.3091
Flow	-99.0000	
Fmed	0.9507	0.3091
Fhigh	4.4366	1.4422

Weights in kilograms

MFDP version 1
Run: jr1
Index file 02/05/2004
Time and date: 17:06 4/30/2005
Fbar age range: 3-7

.

Figure 2.4.24. Faroe Haddock prediction outputs.

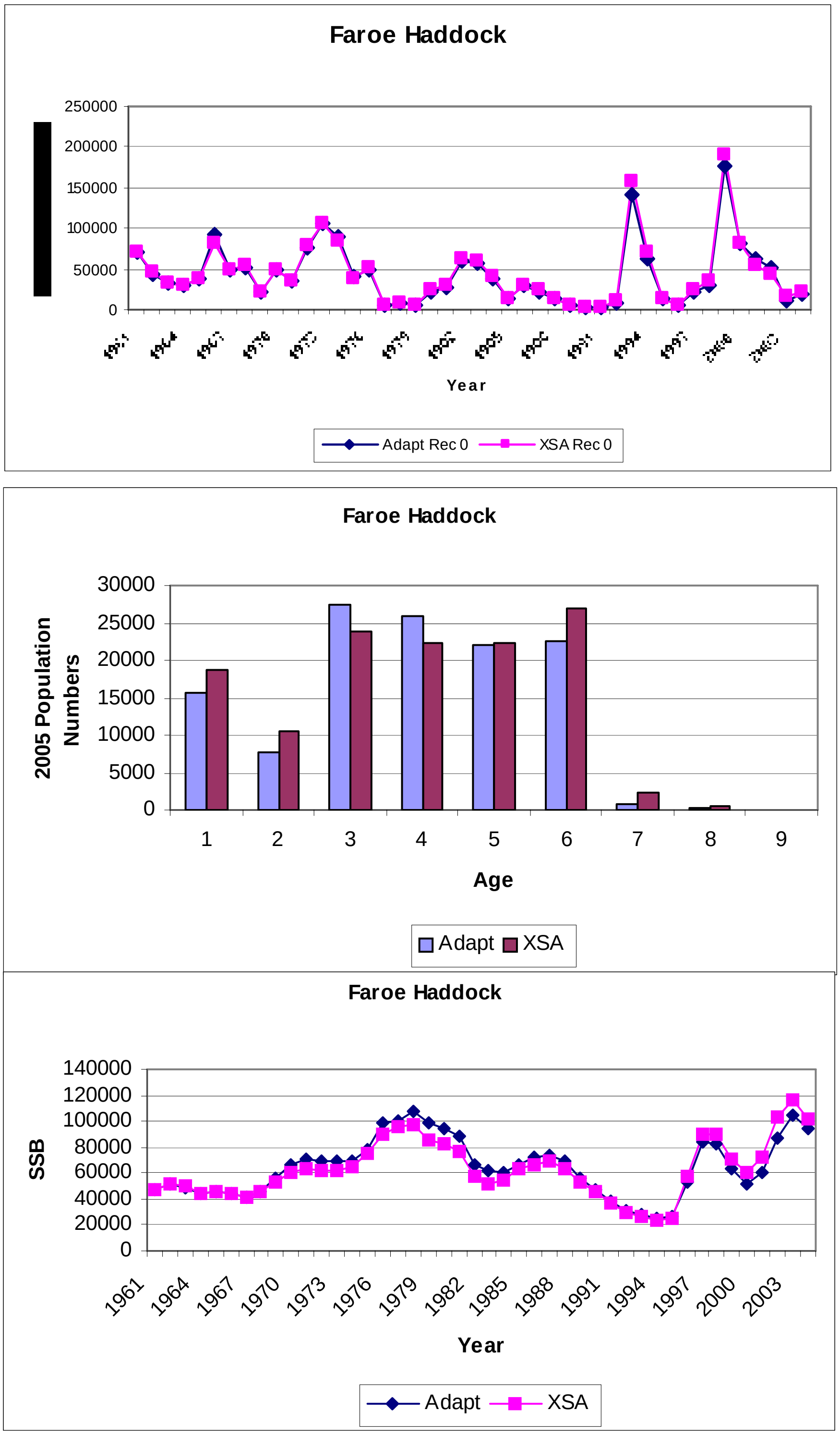


Figure 2.4.25. Comparisons of the 2005 ADAPT and XSA runs.

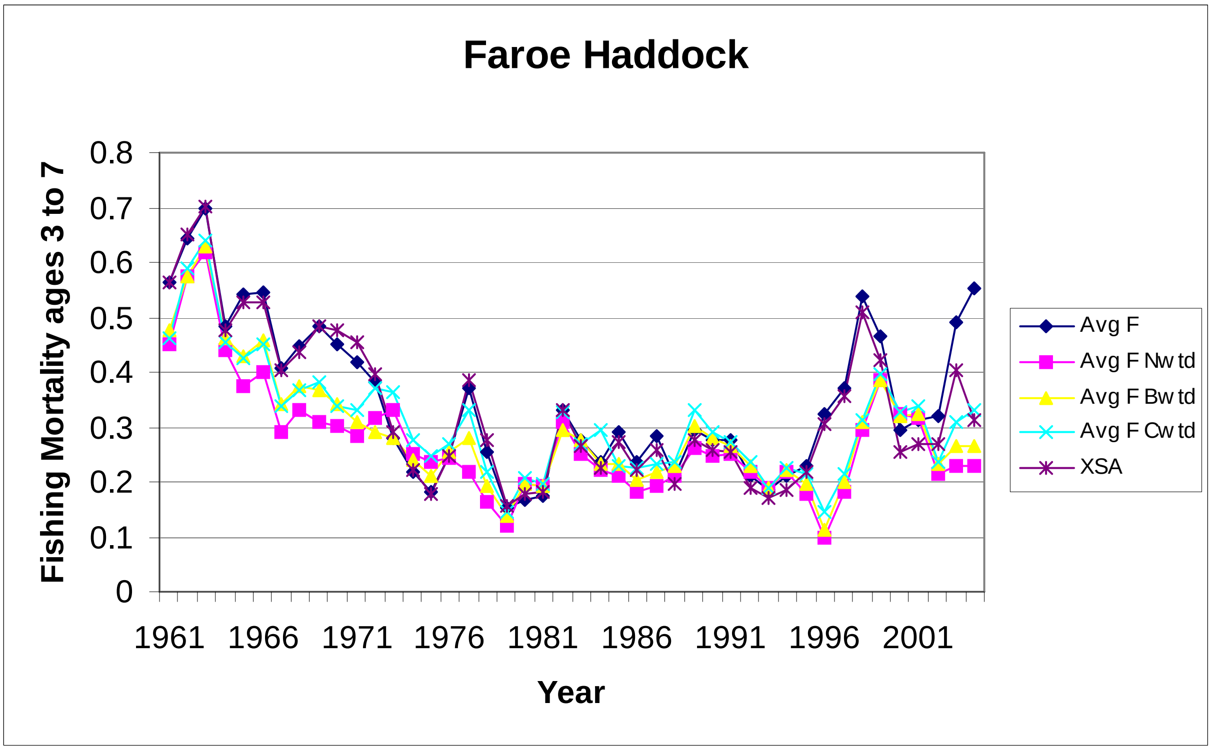


Figure 2.4.25 (cont.). Comparisons of the 2005 ADAPT and XSA runs.

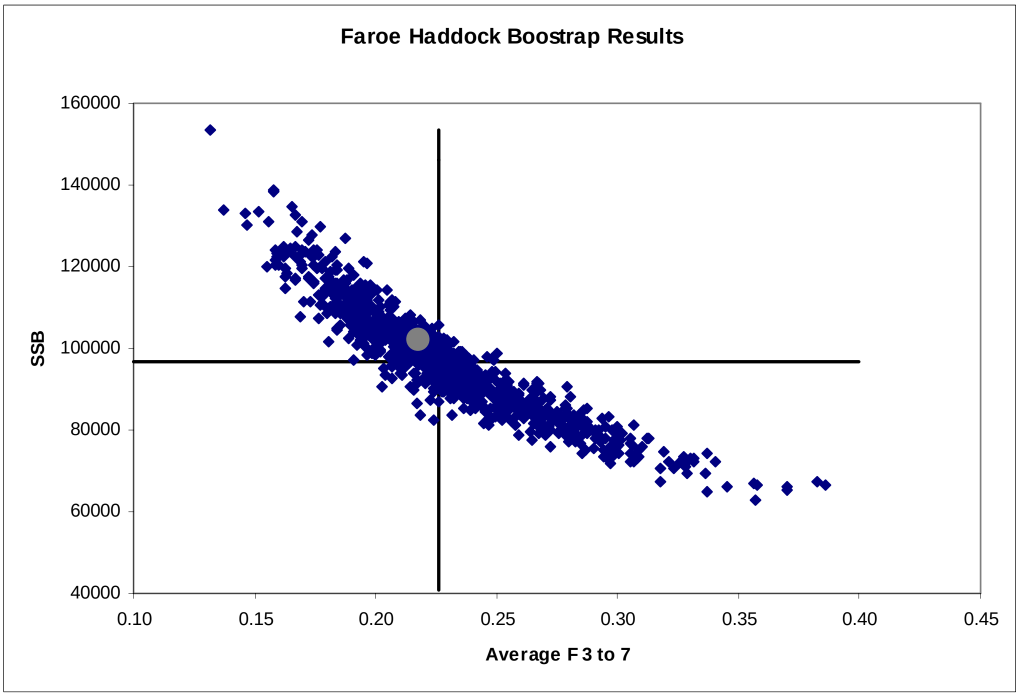
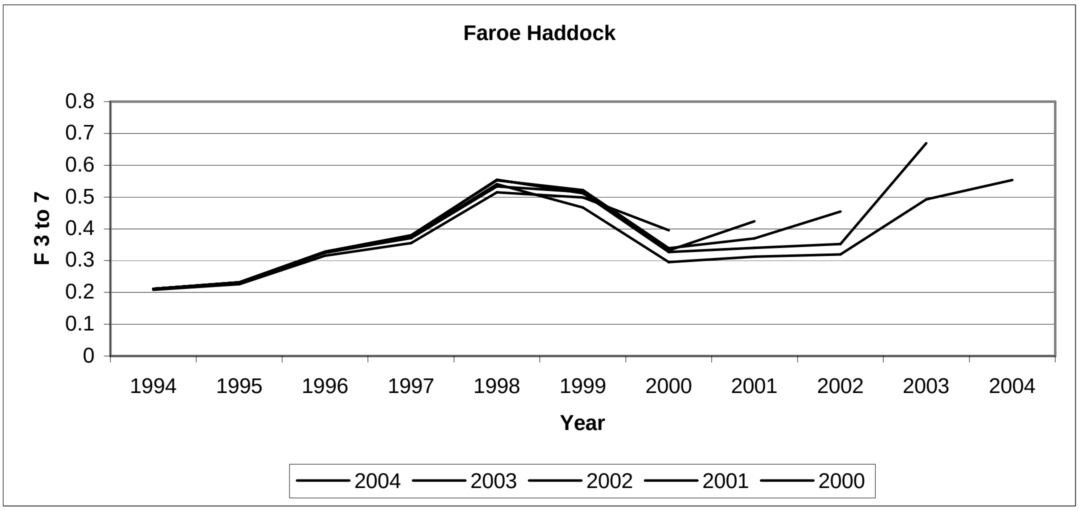
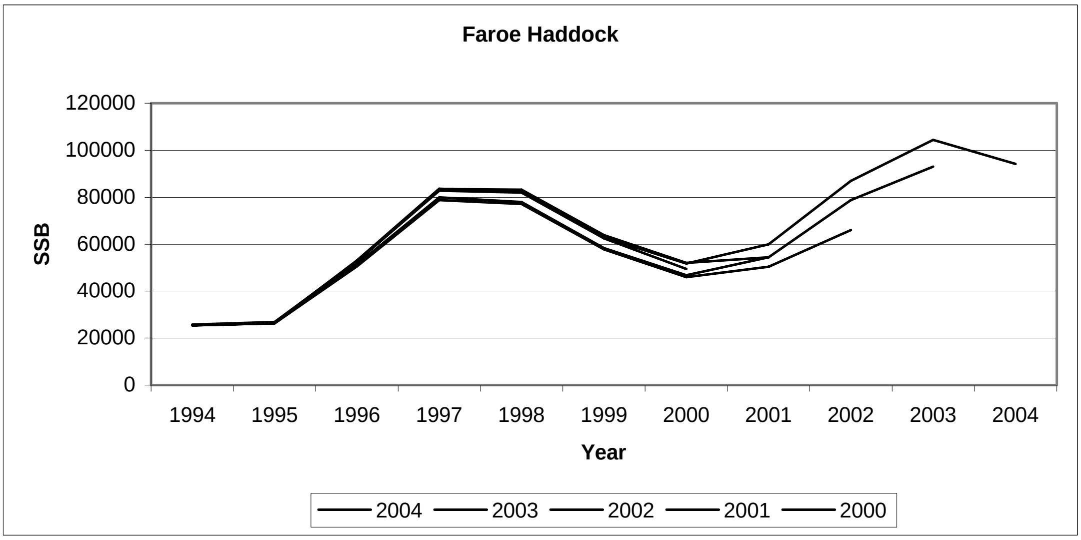


Figure 2.4.26. The f and SSB's from a 1000 bootstraps of the ADAPT. Inserted are the F and SSB from the accepted XSA





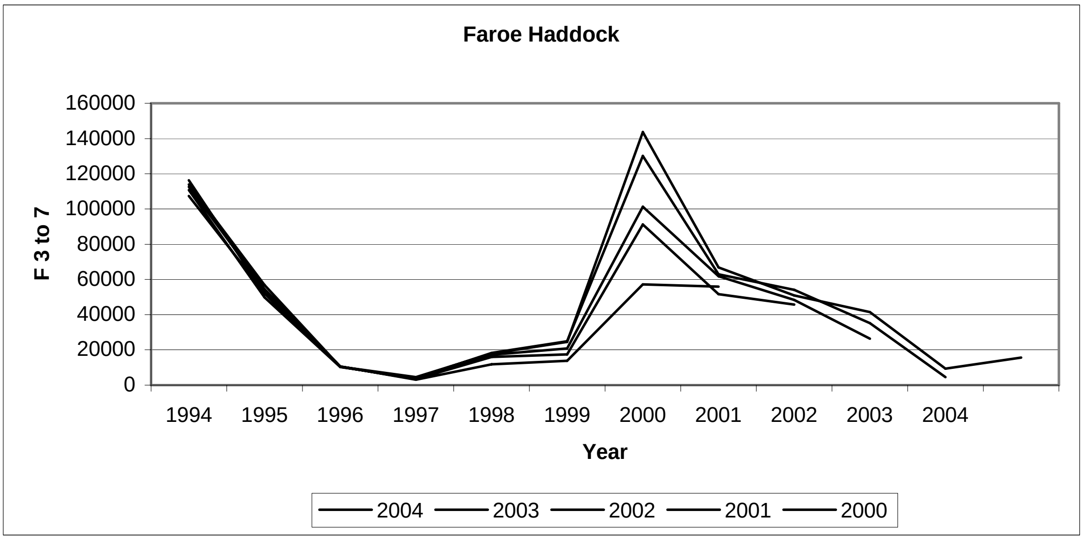


Figure 2.4.27. The ADAPT retrospective patterns

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 cyclically between 10 000 t and 60 000 t since 1960. After a third 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) and they have declined since to 46 100 t in 2004.

With the introduction of the 200 miles EEZ in 1977, mostly Faroese vessels have prosecuted the saithe fishery. 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 1993-2004 (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 1993-2004. 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 trawlers and jiggers. In 2003 and 2004 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 Subdivision IIa, which lies immediately north of the Faroes, have also been included. Little discarding is thought to occur in this fishery.

2.5.2 Catch at age

Catch at age is based on length and otolith samples from Faroese landings of 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 and the total was 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 2.5.2.3). The sampling intensity in 2004 was similar to that in 2003 (Table 2.5.2.2).

2.5.3 Weight at age

Mean weights at age have varied by a factor of about 2 during 1961-2004. Mean weights at age were generally high during the early 1980s and they subsequently decreased from the mid 1980s to the early 1990s (Table 2.5.3.1 and Figure 2.5.3.1). The mean weights increased again in the period 1992-96 but have shown a general decreased since. Weights at age for 2004 are at their lowest since 1991. There appears to be a relationship between weight at age and catchability at age 3 (Figure 2.5.3.2). The SOP for 2004 was 100%.

2.5.4 Maturity at age

Maturity at age data from the spring survey 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 has been used since 1993 (ICES C.M.1993/Assess:18), to predict maturity at age in order to reduce the year to year variability associated with small samples. The initial 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 (WD 12, 2005). Year class strength was not significant and was excluded from the model in this year's assessment. This model was applied to predict the maturity at age for 1983-2004 (Table 2.5.4.1 and Figure 2.5.4.1). For 1961 to 1982, fixed values are used.

2.5.5 Stock assessment

2.5.5.1 Tuning and estimation of fishing mortality

The 2005 Faroe saithe assessment is a benchmark assessment. Several different settings and combinations of tuning series were run in the XSA (WD 16, 2005). The CPUE series that has been 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 2002/2003, 4 of these trawlers left the fleet. The 4 remaining trawlers have larger CPUE, but they show the same trends. In 2004 a new pair of trawlers (>1000 HP) was introduced and they showed the same trends, but lower value in CPUE In 2005 a new pair of trawlers (>1000 HP) was introduced to this common fleet showing the same trend as the Cuba-trawlers during 1999-2003. In the pair trawler series, information for each haul was supplied and only those hauls where saithe contributed to more than 50% of the total catches of cod, haddock and saithe were used.

A systematic check of the age based indices from the different pairs of the commercial series showed that there were differences between the pairs (Fig. 2.5.5.1-3), especially in 2004. A GLM model was run using data from each haul to standardize the CPUE-data. The model fitted CPUE values have been estimated for the period from 1995 to 2004 including years, month, pair and geographical square (WD 37, 2005). The different pairs of trawlers are described in the appendix.

As the 2005 assessment is a benchmark assessment, various combinations of indices and XSA settings were explore. In addition, ADAPT was also run with various combination of indices. The indices were used independently as well as jointly in the same calibration as follows: SPALY – Cuba 4 Trawlers; GLM Pair Trawlers; Spring Survey; Summer Survey; GLM Pairs, Spring Survey, Summer Survey; GLM Pairs, Spring Survey. A SPALY run was not done with ADAPT.

The summer survey (1996-2004) showed large standard errors of log q and marked trend in residuals whether used alone or jointly with other indices. This may be related to the observation that the biomass estimates obtained using different stratification schemes vary greatly in absolute abundance. The calibrations with the summer survey alone also indicated unrealistically high stock sizes.

The spring survey (1994-2004) used alone does show some promises as a potential index of stock size, but here again the stratification scheme influences the absolute biomass estimate. The NWWG considered that the inclusion of the spring survey in the assessment would be useful, but it was concerned that the stratification scheme could be introducing trends. Pending the resolution of the best stratification to use, the NWWG decided to use the XSA with the GLM Pair Trawlers as a final assessment with catchability independent of stock size for all ages, catchability independent of age for ages ≥ 8, the shrinkage of the SE of the mean = 2.0, and no time tampered weighting. 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. Residual values in recent years are relatively random (Figure 2.5.5.4).

The ADAPT assessments gave results very similar to those of the XSA with a slight tendency to overestimate F and consequently underestimate SSB in the terminal year (Figure 2.5.5.5). The point estimator of the SSB historical time trajectory from the ADAPT and the XSA deviate only in the final year (Figure 2.5.5.6). The bootstrap probability profile (Figure 2.5.5.7) for the SSB and the reference F in 2004 show that the point estimator from the final XSA run does not differ significantly from the ADAPT results.

The exploitation pattern for the cuba trawlers 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 a GLM model run on all available data from the pair-trawlers during 1995-2004 (AllPairGLM3-11). Working Group accepted the XSA calibrated with the CPUE from this GLM-model.

Retrospective analysis of the average fishing mortality from the XSA for age groups 4-8 (Figure 2.5.5.8) shows a tendency to overestimate F in the last three years. This implies that biomass was correspondingly underestimated (Figure 2.5.5.9). With respect to recruitment, the analysis indicated an overestimate (Figure 2.5.5.10). The new stock size index and XSA settings appear to result in an improved retrospective. The fishing mortalities for 1961-2004 are presented in Table 2.5.5.3 and in Figure 2.5.5.11. The average fishing mortality for age groups 4-8 was 0.34 in 2004.

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 29 millions (Figure 2.5.5.12). The 1998 year class is the largest ever (> 89 mill.) and can be seen in the modal length progression in the summer survey from 1999 to 2004 (Figure 2.5.5.13). Even though recruitment had been above average in the 1960s and 1970s, SSB declined from nearly 115 000 t in 1985 to 64 000 t in 1991 as a result of high fishing mortality yielding the highest (1990) and third highest (1991) landings of the whole 1961-2001 period. The historically low SSB persisted in 1992-1995 (Table 2.5.5.5 and Figure 2.5.5.14). The SSB has increased since 1996 to 2001 (91 000 tonnes) with the maturation of the 1992, 1994, 1996 and 1998 year-classes but in 2004 the SSB decreased to 74 000 t. The relation between stock and recruitment is showed in Figure 2.5.5.15.

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 2001 year class are from the final VPA run whereas values for the 2002-2004 year classes are the geometric mean of the 1977 to 2001 year classes. 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 1987-2004 (Table 2.5.6.1.), for the other ages the arithmetic mean for 2002-2004 were used. Catch weight at age for year 2005-2007 was predicted in the same way as the mean weight at age. In the long term prediction (yield per recruit) mean weights for 1961-2004 were used.

In the short term prediction the fitted proportion mature values from the model for 2005 were used for that year. For 2006 and 2007 the average of fitted values for 2003-2005 was used. In the long term prediction the average of fitted values for 1983-2005 was used.

For all three years in the short term prediction the average exploitation pattern in the final VPA for 2002-2004, unscaled to Fbar (ages 4-8) in 2004 in view of a retrospective problem (as suggested by ACFM, 2004), was used. In the long term prediction the exploitation pattern was set equal to the average of exploitation patterns for 2000-2004 (as suggested from ACFM, 2004).

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 2004 average fishing mortality of 0.33 in age groups 4-8, $\mathbf{F}_{max}$ is 0.42, $\mathbf{F}_{0.1}$ is 0.12, $\mathbf{F}_{med}$ is 0.36 and $\mathbf{F}_{high}$ is 1.00 (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	YIELD/R	SSB/R
	Ages 4-8		
Average last 3 years	0.459	1.530	3.088
Fmax	0.423	1.531	3.281
F0.1	0.119	1.323	7.773
Fmed	0.363	1.529	3.684

Medium term projections and reference points for Faroese stocks are discussed in the introductory section for the Faroese waters.

The history of the stock/fishery in relation to the existing 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 44 600 t in 2005 and 35 700 t in 2006. The spawning stock biomass would be about $\mathbf{B}_{pa}$ in 2005 and 2006.

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 2005 and weight composition in SSB by year classes in 2006 is presented in Figure 2.5.6.4. The catch in 2005 is predicted to rely on the five most recent year classes (98%). In 2006 the 1998 year class are expected to contribute about 44% of the SSB, and 1999, 2000 year classes with 38%.

2.5.7 Management considerations

Management consideration for saithe is under the general section for Faroese stocks.

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 have been changed. The tuning fleets had to be changed due to replacement of vessels in the commercial index tuning fleet. The cpue standardisation with GLM is considered an improvement.

The geometric mean is used at age 3 in the short term prediction. There are indications that the spring survey could be helpful as an index of age 2 or 3 in the terminal year. This question will be further investigated once an appropriate stratification scheme has been identified.

The question of migration has been brought up previously. Although tagging data indicate that saithe migrates 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 2005 assessment indicates that the point estimator of biomass is lower than in the 2004 assessment (2004 SSB = 94 000t compared to 74 000t) and the fishing mortality is almost the same.

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. The introduction of GLM standardisation could mitigate the problems of vessel replacement if sufficient overlaps occur with other vessels. Nevertheless, the introduction of the spring survey as an index of stock size in the assessment would be an improvement (Table 2.5.8.1-5, Figure 2.5.8.1-3).

The ADAPT calibrations conducted appear to offer promises, but the results were not examined closely because ADAPT was intended mostly as a validation of the XSA results. The NMFS NFT ADAPT software does offer some advantages over the XSA however, particularly with regards to medium term predictions. Time permitting, the possibility of migrating the assessment to the NFT environment will be evaluated intersessionally.

Bycatch

In the last years concerns have been raised about the bycatch of saithe in the blue whiting fishery around the Faroes and Iceland (Pálsson 2005). The catch of blue whiting in ICES sub-area Vb was 468 thousand tonnes in 2003 (ICES, 2004) and only small percentages of by-catch may thus become important in absolute terms. There are indications that the bycatch of saithe is most important in Faroese waters whereas the bycatch of cod is restricted to Icelandic waters (Pálsson 2005). There are also indications that the by-catch may vary by year (was higher in 2004 than in 2003) (Pálsson *et al.* 2005).

Sampling the by-catch of saithe in Faroese and Icelandic waters indicate a high variability between hauls, but the overall percentage in 2003 was 0.32% and in 2004 0.69% (Pálsson et al. 2005). Sampling on a Faroese vessel in November 2004 indicated an average by-catch of saithe of 3.2% (Lamhauge, 2004).

The length distribution of saithe in the blue whiting fishery is variable. Icelandic samples indicate and average length of about 64 cm (Pálsson, 2005) whereas Faroese samples indicate about 75 cm (Lamhauge, 2004).There are also indications that the by-catch varies by season (Pálsson 2005, Pálsson *et al.* 2005).

An attempt is made to estimate the by-catch of saithe in Faroese waters in 2004, see table below. It was assumed that the catch in 2004 was on the same level as in 2003. In Scenario 1, the mean overall percentage in Pálsson *et al.* 2005 is used (0.69%). The length measurements in Lamhauge (2005) were used as basis and the age-length key for the Faroese pair trawlers. In Scenario 2, the mean overall percentage in Lamhauge (2004) is used (3.2%). In Scenario 1, the by-catch is estimated to 3231 tonnes and in Scenario 2 to 10770 tonnes. In order to account for the by-catch of saithe in the blue whiting fishery, the catch-at-age should be scaled up by a factor of 1.0-1.7 in Scenario 1 and 1.0-3.2 in Scenario 2.

The exercise shows that it is important to get more information about the by-catch of saithe in the blue whiting fishery and that the by-catch may affect the stock assessment of saithe in Vb. The exercise is on a very broad scale and the result should be taken as illustrative rather than quantitative. In order to get more precise estimates of the by-catch of saithe in Faroese waters it is necessary to sample the blue whiting fishery representatively by area, season and by year.

Estimating by-catch of saithe in Vb in the blue whiting fishery.

	SCENARIO 1	SCENARIO 2
Total blue whiting catch in Vb (tonnes)	468269	468269
By-catch of saithe (%)	0.69	3.2
By-catch of saithe (tonnes)	3231	14985
Relative change in catch at age in 2004		

Age		
3	1.0	1.0
4	1.0	1.0
5	1.0	1.0
6	1.0	1.1
7	1.1	1.5
8	1.1	1.6
9	1.1	1.4
10	1.1	1.4
11	1.5	3.5
12+	1.7	4.1

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 pair trawlers

The tuning fleet consists of several pair of trawlers (>1000 HP). For all of the vessels the mesh size of the trawl is 135 mm. The catch is stored on ice on board the trawlers and landed as fresh fish.

Four of the pairs were built in East Germany in 1970 as part of a help-programme for Cuba (called Cuba trawlers). In 1973 "Faroe Ship" bought 8 of these trawlers and brought them to Faroe Islands. Today, the Runavik Trawl Company "Beta" keeps them, which is the company that has operated the trawlers during all these years and has registered the catches. 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. Loading capacity is approximately. 100 tons catch per vessel. 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 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 in Faroe waters since the 1986 fishing cod, haddock and saithe, but have in later years been mainly targeting for saithe.. 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 engine power is 1350 HP. The engines of both boats were overhauled in 2000. Improvements have been carried out when needed (*e.g.* winch 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. Loading capacity is approximately 2 500 boxes of fish corresponding to *ca*. 125 tons catch per vessel.

The new tuning fleet introduced in the assessment in 2005, called SV&PV, consists of two trawlers > 1000 HK, operating as a pair. The pair ”Vestursøki” and ”Vesturleiki” consists of identical vessels (renamed from ”Stjørnan” and ”Polarhav” when they switched owner in 2003) built in Poland in 1990 and presently owned by P/F Rávan in Sandavágur. The vessels are 36 m long and cargo 265 BRT.

The data on which the tuning series are based origin from all available log-books from the above mentioned trawlers since 1995. The data are stored in the database on the Faroese Fisheries Laboratory in Torshavn, and they are corrected and quality controlled.

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

References

ICES C.M. 1993/Assess:18.

ICES C.M. 1998/ACFM:19.

ICES C.M. 2003/ACFM:24.

ICES C.M. 2004. Report of the northern pelagic blue whiting fisheries working group. ICES CM/ACFM:24. 305pp.

Lamhauge, S. 2004. Hjáveiða í flótitroli (By-catch in pelagic trawl). Faroese Fisheries Laboratory, technical report.

Ofstad, L.H. 2005. Preliminary assessment for Faroe saithe. WD 16, NWWG 2005.

Ofstad, L.H. 2005. Faroese ground fish surveys as tunings series of Faroe saithe. WD 29, NWWG 2005.

Pálsson, Ó. K., 2005. An analysis of by-catch in the Icelandic blue whiting fishery. Fisheries Research 73: 135-146.

Pálsson, Ó. K., Karlsson, G., Jóhannesson, G., Arason, A., Gísladóttir, H., and Ottesen, Þ., 2005. Meðafli í kolmunnaveiðum Íslendinga 2004 (By-catch in the Icelandic blue whiting fishery in 2004). Hafrannsóknastofnunin, Fjölrit.

Reinert, R. 2005. GLM fitted cpue for Faroe Saithe. WD 37, NWWG 2005.

Ridao Cruz, L. 2005. Some exploratory analysis on the GLM model used to predict maturity for Faroe Saithe. WD 12, NWWG 2005.

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

Table 2.5.1.1. Saithe in the Faroes (Division Vb). Nominal catches (tonnes) by countries, 1989-2004, as officially reported to ICES.

Country	1989	1990	1991	1992	1993	1994	1995	1996
Denmark	-	2	-	-	-	-	-	-
Faroe Islands	43,624	59,821	53,321	35,979	32,719	32,406	26,918	19,267
France [3]	-	-	-	120	75	19	10	12
Germany	-	-	32	5	2	1	41	3
German Dem.Rep.	9	-	-	-	-	-	-	-
German Fed. Rep.	20	15	-	-	-	-	-	-
Netherlands	22	67	65	-	32	-	-	-
Norway	51	46	103	85	279	156	10	16
UK (Eng. & W.)	-	-	5	74	425	151	21	53
UK (Scotland)	9	33	79	98		438	200	580
USSR/Russia [2]	-	30	-	12	-	-	-	18
Total	43,735	60,014	53,605	36,373	33,532	33,171	27,200	19,949
Working Group estimate [4,5]	44,477	61,628	54,858	36,487	33,543	33,182	27,209	20,029

Country	1997	1998	1999	2000	2001	2002	2003	2004 [1]
Estonia	16	-	-	-	-	-	-	-
Faroe Islands	21,721	25,995	32,439		49,676	55,165	47,933	47,866
France	9	17	-	273	934	607	370	
Germany	5	-	100	230	667	422	281	186
Greenland	-	-	-	-		442		426
Irland	-	-	-	-	5	-	-	-
Norway	67	53	160	72	60	77	94	82
Portugal	-	-	-	-	-	-	-	3
Russia	28	-	-	20	1	10	32	
UK (E/W/NI)	-	19	67	32	80	58	89	
UK (Scotland)	460	337	441	534	708	540	610	
United Kingdom								829
Total	22,306	26,421	33,207	1,161	52,131	57,321	49,409	49,392
Working Group estimate [4,5,6,7]	22,306	26,421	33,207	39,020	51,786	53,546	46,555	46,115

[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.

[7] The 2001-2004 catches from Faroe Islands, as stated from Faroese coastal guard service, are recalculeted because of discrepancy in converting gutted weight to round weight (factor 1.2 agains 1.11).

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 1985-2004 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	1.6	0.1	26.5	10.5	60.8	0.1	0.0	0.0	53698
2003	0.0	0.0	1.9	0.0	0.9	0.4	17.4	14.7	64.7	0.1	0.0	0.0	46555
2004	0.1	0.2	3.7	0.0	1.9	0.4	15.1	14.4	63.8	0.2	0.0	0.0	46115
Average	0.3	0.2	0.4	0.1	6.5	2.2	16.1	20.2	53.2	0.2	0.6	0.1	39283

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 Hp*	*PT<1000 Hp*	*PT>1000Hp*	*Others*	*Tot. Faroe*	*Foreign*	*Total*
0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	1	1	10	43	11	75	0	75
4	35	49	267	1200	163	1985	15	2000
5	133	295	1170	5089	570	8406	94	8500
6	150	670	1047	5116	360	8505	212	8717
7	38	390	215	1035	40	1990	124	2114
8	29	434	182	762	26	1659	138	1797
9	6	58	31	113	2	244	19	263
10	6	76	31	116	2	267	24	291
11	4	44	10	53	1	132	14	146
12	2	30	8	36	1	90	9	99
13	0	5	0	1	0	8	2	10
14	0	0	0	2	0	3	0	3
15	0	0	0	0	0	0	0	0
Total No.	405	2053	2972	13566	1177	23362	651	24013
Catch, t.	785	5806	5477	24434	1729	44276	1839	46115

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). Sampling intensity in 2004.

FLEET	SAMPLES	LENGTHS	OTOLITHS	WEIGHTS
Jiggers	4	916	180	180
Single trawlers 400 – 999 HP	9	1 781	240	1 364
Single trawlers 1500 - 1999 HP	8	1 759	120	60
Single trawlers > 2000 HP	4	906	60	60
Pair trawlers 700 – 999 HP	16	3 455	240	120
Pair trawlers 1000 – 1499 HP	154	35 609	3 537	3 357
Total	195	44 426	4 377	5 141

Table 2.5.2.3. Saithe in the Faroes (Division Vb). Catch numbers at age (Thousands).

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

YEAR	1961	1962	1963	1964
AGE				
3	183	562	614	684
4	379	542	340	1908
5	483	617	340	1506
6	403	495	415	617
7	216	286	406	572
8	129	131	202	424
9	116	129	174	179
10	82	113	158	150
11	45	71	94	100
+gp	82	105	274	174
TOTALNUM	2118	3051	3017	6314
TONSLAND	9592	10454	12693	21893
SOPCOF %	108	93	96	99

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	996	488	595	614	1191	1445	2857	2714	2515	3504
4	850	1540	796	1689	2086	6577	3316	1774	6253	4126
5	1708	1201	1364	1116	2294	1558	5585	2588	7075	4011
6	965	1686	792	1095	1414	1478	1005	2742	3478	2784
7	510	806	1192	548	1118	899	828	1529	1634	1401
8	407	377	473	655	589	730	469	1305	693	640
9	306	294	217	254	580	316	326	1017	550	368
10	201	205	190	128	239	241	164	743	403	340
11	156	156	97	89	115	86	100	330	215	197
+gp	285	225	140	187	190	132	100	210	186	265
TOTALNUM	6384	6978	5856	6375	9816	13462	14750	14952	23002	17636
TONSLAND	22181	25563	21319	20387	27437	29110	32706	42663	57431	47188
SOPCOF %	92	98	104	102	97	96	109	100	120	113

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	2062	3178	1609	611	287	996	411	387	2483	368
4	3361	3217	2937	1743	933	877	1804	4076	1103	11067
5	3801	1720	2034	1736	1341	720	769	994	5052	2359
6	1939	1250	1288	548	1033	673	932	1114	1343	4093
7	1045	877	767	373	584	726	908	380	575	875
8	714	641	708	479	414	284	734	417	339	273
9	302	468	498	466	247	212	343	296	273	161
10	192	223	338	473	473	171	192	105	98	52
11	193	141	272	407	368	196	92	88	98	65
+gp	298	287	330	535	691	786	1021	902	540	253
TOTALNUM	13907	12002	10781	7371	6371	5641	7206	8759	11904	19566
TONSLAND	41576	33065	34835	28138	27246	25230	30103	30964	39176	54665
SOPCOF %	116	107	104	100	102	99	96	96	100	100

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	1224	1167	1581	866	451	294	1030	521	1316	690
4	3990	1997	5793	2950	5981	3833	5125	4067	2611	3961
5	5583	4473	3827	9555	5300	10120	7452	3667	4689	2663
6	1182	3730	2785	2784	7136	9219	5544	2679	1665	2368
7	1898	953	990	1300	793	5070	3487	1373	858	746
8	273	1077	532	621	546	477	1630	894	492	500
9	103	245	333	363	185	123	405	613	448	307
10	38	104	81	159	83	61	238	123	245	303
11	26	67	43	27	55	60	128	63	54	150
+gp	275	158	97	60	39	79	118	108	52	49
TOTALNUM	14592	13971	16062	18685	20569	29336	25157	14108	12430	11737
TONSLAND	44605	41716	40020	45285	44477	61628	54858	36487	33543	33182
SOPCOF %	94	94	96	99	97	98	99	105	102	102

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	398	297	344	163	322	811	1125	302	330	75
4	1019	1087	832	1689	655	2830	2452	8399	2432	2000
5	3468	1146	2440	1934	3096	1484	8437	5962	11152	8500
6	1836	1449	1767	3475	2551	4369	2155	9786	3994	8717
7	1177	1156	1335	1379	4113	2226	3680	862	4287	2114
8	345	521	624	683	915	2725	1539	1280	417	1798
9	241	132	165	368	380	348	1334	465	419	263
10	192	77	71	77	147	186	293	362	304	291
11	104	64	29	32	24	56	90	33	91	145
+gp	117	82	100	73	69	25	56	45	43	111
TOTALNUM	8897	6011	7707	9873	12272	15060	21161	27496	23469	24014
TONSLAND	27209	20029	22306	26421	33207	39020	51786	53546	46555	46115
SOPCOF %	102	103	100	102	102	102	100	100	100	100

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

Table 2 Catch weights at age (kg)

YEAR	1961	1962	1963	1964
AGE				
3	1.4300	1.2730	1.2800	1.1750
4	2.3020	2.0450	2.1970	2.0550
5	3.3480	3.2930	3.2120	3.2660
6	4.2870	4.1910	4.5680	4.2550
7	5.1280	5.1460	5.0560	5.0380
8	6.1550	5.6550	5.9320	5.6940
9	7.0600	6.4690	6.2590	6.6620
10	7.2650	6.7060	8.0000	6.8370
11	7.4970	7.1500	7.2650	7.6860
+gp	9.3399	9.0237	8.8589	8.5591
SOPCOFAC	1.0779	.9342	.9590	.9933

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	1.1810	1.3610	1.2730	1.3020	1.1880	1.2440	1.1010	1.0430	1.0880	1.4300
4	2.1250	2.0260	1.7800	1.7370	1.6670	1.4450	1.3160	1.4850	1.4610	1.5250
5	2.9410	3.0550	2.5340	2.0360	2.3020	2.2490	1.8180	2.0550	1.5820	2.2070
6	4.0960	3.6580	3.5720	3.1200	2.8530	2.8530	2.9780	2.8290	2.2490	2.5000
7	4.8780	4.5850	4.3680	4.0490	3.6730	3.5150	3.7020	3.7910	3.6870	3.1200
8	5.9320	5.5200	5.3130	5.1830	5.0020	4.4180	4.2710	4.1750	4.3850	4.6010
9	6.3210	6.8370	5.8120	6.2380	5.7140	5.4440	5.3880	4.8080	5.1280	5.5590
10	7.2880	7.2650	6.5540	7.5200	6.4050	5.7330	5.9720	5.2940	5.2760	5.7140
11	8.0740	7.6620	7.8060	8.0490	6.5540	6.6620	6.4900	6.9480	6.7270	6.2590
+gp	8.9035	9.2233	8.1494	9.0925	8.0870	8.5844	8.0047	7.5146	8.0307	8.0104
SOPCOFAC	.9220	.9769	1.0357	1.0194	.9663	.9634	1.0935	1.0043	1.2006	1.1296

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	1.1140	1.0880	1.2230	1.4930	1.2200	1.2300	1.3100	1.3370	1.2080	1.4310
4	1.6580	1.6760	1.6410	2.3240	1.8800	2.1200	2.1300	1.8510	2.0290	1.9530
5	2.2600	2.8780	2.6600	3.0680	2.6200	3.3200	3.0000	2.9510	2.9650	2.4700
6	3.1200	3.0810	3.7900	3.7460	3.4000	4.2800	3.8100	3.5770	4.1430	3.8500
7	3.5570	4.2870	4.2390	4.9130	4.1800	5.1600	4.7500	4.9270	4.7240	5.1770
8	4.0960	4.3520	5.5970	4.3680	4.9500	6.4200	5.2500	6.2430	5.9010	6.3470
9	5.1280	4.7900	5.3500	5.2760	5.6900	6.8700	5.9500	7.2320	6.8110	7.8250
10	6.0940	5.9120	5.9120	5.8320	6.3800	7.0900	6.4300	7.2390	7.0510	6.7460
11	7.1960	6.6190	6.8370	6.0530	7.0200	7.9300	7.0000	8.3460	7.2480	8.6360
+gp	8.5982	7.8941	7.7085	7.5756	8.6262	9.2153	8.9618	10.0411	10.0547	10.0976
SOPCOFAC	1.1607	1.0680	1.0442	1.0049	1.0248	.9937	.9564	.9632	.9997	.9991

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	1.4010	1.7180	1.6090	1.5000	1.3090	1.2230	1.2400	1.2640	1.4080	1.5030
4	2.0320	1.9860	1.8350	1.9750	1.7350	1.6330	1.5680	1.6020	1.8600	1.9510
5	2.9650	2.6180	2.3950	1.9780	1.9070	1.8300	1.8640	2.0690	2.3230	2.2670
6	3.5960	3.2770	3.1820	2.9370	2.3730	2.0520	2.2110	2.5540	3.1310	2.9360
7	5.3360	4.1860	4.0670	3.7980	3.8100	2.8660	2.6480	3.0570	3.7300	4.2140
8	7.2020	5.5890	5.1490	4.4190	4.6670	4.4740	3.3800	4.0780	4.3940	4.9710

9	6.9660	6.0500	5.5010	5.1150	5.5090	5.4240	4.8160	5.0120	5.2090	5.6570
10	9.8620	6.1500	6.6260	6.7120	5.9720	6.4690	5.5160	6.7680	6.5400	5.9500
11	10.6700	9.5360	6.3430	9.0400	6.9390	6.3430	6.4070	7.7540	8.4030	6.8910
+gp	11.9501	10.2181	10.2439	9.3369	9.9364	8.2869	7.7285	8.2297	8.0501	9.1086
SOPCOFAC	.9415	.9419	.9620	.9928	.9698	.9811	.9938	1.0506	1.0169	1.0240

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	1.4560	1.4320	1.4760	1.3880	1.3740	1.4770	1.3300	1.1420	1.1230	1.1430
4	2.1770	1.8750	1.7830	1.7110	1.7120	1.6060	1.5900	1.4600	1.3040	1.3330
5	2.4200	2.4960	2.0320	1.9540	1.9050	2.0770	1.7850	1.6520	1.6140	1.4500
6	2.8950	3.2290	2.7780	2.4050	2.3960	2.3600	2.5860	1.9690	1.9770	1.7890
7	3.6510	3.7440	3.5980	3.3000	2.8450	2.9770	3.0590	3.1300	2.5320	2.5600
8	5.0640	4.9640	4.7660	4.2200	4.1240	3.4800	3.8710	3.5890	3.9700	3.1590
9	5.4400	6.3750	5.9820	4.9990	5.2560	4.8510	4.3740	4.5130	4.8340	4.1540
10	6.1670	6.7450	7.6580	6.3910	5.5260	5.2680	5.5650	5.1380	5.4990	5.1670
11	7.0800	7.4660	7.8820	6.6650	6.9560	6.5230	6.7030	6.4220	6.0990	6.0150
+gp	7.5392	7.9806	9.2453	8.4847	8.5237	5.9024	6.9076	7.5192	6.9154	6.3221
SOPCOFAC	1.0205	1.0319	.9994	1.0221	1.0182	1.0154	1.0017	1.0004	1.0012	1.0040

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

Table 5 Proportion mature at age

YEAR	1961	1962	1963	1964
AGE				
3	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0400	.0200	.0300
4	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2600	.2300	.2500
5	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.5700	.7500	.5800
6	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.9500	.9300
7	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9700	.9900
8	.9800	.9800	.9800	.9800	.9800	.9800	.9800	.9800	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
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	.0300	.0500	.0400	.0400	.0300	.0200	.0200	.0200	.0300	.0300
4	.2500	.2300	.2400	.2600	.2000	.1600	.1400	.1500	.2000	.2300
5	.7600	.6400	.5600	.4800	.4400	.4100	.3900	.4500	.5400	.5100
6	.9000	.8700	.8400	.7800	.6800	.5600	.6100	.6900	.8200	.7900
7	.9900	.9500	.9500	.9200	.9200	.7900	.7200	.8200	.9100	.9500
8	1.0000	.9900	.9900	.9700	.9800	.9700	.9000	.9600	.9700	.9900
9	1.0000	1.0000	1.0000	.9900	1.0000	1.0000	.9900	.9900	.9900	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
AGE										
3	.0300	.0300	.0300	.0300	.0300	.0300	.0400	.0200	.0200	.0200
4	.2700	.2200	.1900	.1800	.1600	.1900	.1600	.2000	.1100	.1100
5	.5700	.5900	.4700	.4200	.4100	.4400	.4200	.3400	.4300	.2800
6	.7700	.8500	.7400	.6600	.6400	.6400	.6800	.5600	.5200	.5600
7	.9000	.9100	.8900	.8400	.7600	.7800	.8000	.8000	.7100	.6800
8	.9900	.9800	.9800	.9600	.9500	.9000	.9300	.9100	.9400	.8700
9	1.0000	1.0000	1.0000	.9900	.9900	.9900	.9800	.9800	.9900	.9700
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
+gp	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

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

```
Faroe Saithe (ICES Div. Vb)    AllpairGLM3-11.dat
101
All pair (GLM) >1000 HP
1995 2004
1 1 0 1
3 11
10338 90    343   1101  450   278   93    46    36    27
6116  99    306   262   358   161   90    43    41    22
7369  76    205   571   389   295   128   28    13    4
8283  46    281   492   637   313   139   73    17    5
12250 89    249   794   1031  1035  418   97    42    6
11156 205   741   432   1278  631   759   91    50    15
13121 315   742   2554  602   958   386   319   66    15
11110 58    1741  1736  3016  228   299   108   77    11
7900  50    528   2321  839   800   70    75    44    13
7931  14    381   1618  1627  329   242   36    37    17
```

Table 2.5.5.2. Saithe in the Faroes (Division Vb). Diagnostics from XSA with commercial pair trawler tuning series.

Lowestoft VPA Version 3.1
3/05/2005 16:41

Extended Survivors Analysis

FAROE SAITHE (ICES Division Vb) SAI_IND

CPUE data from file D:\Stovnsmeting\Ices2005\Xsa\allpairGLM3-11.DAT

Catch data for 44 years. 1961 to 2004. Ages 3 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
All pair (GLM) >1000	1995	2004	3	11	.000	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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 = 2.000

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

Prior weighting not applied

Tuning converged after 30 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	.011	.014	.012	.014	.006	.026	.014	.007	.012	.013
4	.090	.039	.049	.073	.073	.069	.102	.138	.074	.091
5	.414	.139	.116	.152	.186	.235	.299	.384	.274	.398
6	.408	.303	.328	.241	.307	.433	.635	.680	.483	.359
7	.716	.490	.508	.462	.501	.484	.815	.567	.736	.513
8	.646	.834	.539	.534	.647	.747	.746	.766	.600	.815
9	.857	.552	.701	.724	.654	.550	1.091	.526	.616	1.003
10	.523	.754	.662	.865	.730	.803	1.399	1.066	.804	1.282
11	.655	.328	.729	.728	.741	.694	1.302	.545	.878	1.272

XSA population numbers (Thousands)

	AGE								
YEAR	3	4	5	6	7	8	9	10	11
1995	3.86E+04	1.31E+04	1.13E+04	6.06E+03	2.54E+03	8.01E+02	4.63E+02	5.21E+02	2.39E+02
1996	2.40E+04	3.12E+04	9.79E+03	6.12E+03	3.30E+03	1.02E+03	3.44E+02	1.61E+02	2.53E+02
1997	3.28E+04	1.94E+04	2.46E+04	6.98E+03	3.70E+03	1.65E+03	3.62E+02	1.62E+02	6.19E+01
1998	1.27E+04	2.65E+04	1.51E+04	1.79E+04	4.12E+03	1.82E+03	7.90E+02	1.47E+02	6.84E+01
1999	5.80E+04	1.03E+04	2.02E+04	1.07E+04	1.15E+04	2.12E+03	8.75E+02	3.14E+02	5.07E+01
2000	3.50E+04	4.72E+04	7.83E+03	1.37E+04	6.41E+03	5.72E+03	9.10E+02	3.72E+02	1.24E+02
2001	8.92E+04	2.80E+04	3.61E+04	5.07E+03	7.30E+03	3.24E+03	2.22E+03	4.30E+02	1.37E+02

2002	4.63E+04	7.20E+04	2.07E+04	2.19E+04	2.20E+03	2.64E+03	1.26E+03	6.10E+02	8.69E+01
2003	3.13E+04	3.76E+04	5.14E+04	1.15E+04	9.09E+03	1.02E+03	1.01E+03	6.08E+02	1.72E+02
2004	6.46E+03	2.53E+04	2.86E+04	3.20E+04	5.82E+03	3.57E+03	4.59E+02	4.45E+02	2.23E+02

Table 2.5.5.2. (Continued)

Estimated population abundance at 1st Jan 2005

0.00E+00 5.22E+03 1.89E+04 1.57E+04 1.83E+04 2.85E+03 1.29E+03 1.38E+02 1.01E+02

Taper weighted geometric mean of the VPA populations:

2.39E+04 1.87E+04 1.26E+04 7.38E+03 3.94E+03 2.12E+03 1.14E+03 6.30E+02 3.36E+02

Standard error of the weighted Log(VPA populations) :

.5626 .5605 .5878 .5725 .5247 .5515 .6539 .7999 .9882

Log catchability residuals.

Fleet : All pair (GLM) >1000

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	-.19	.90	.14	.47	-.78	.66	-.01	-.89	-.30	.00
4	.36	-.12	-.23	-.33	.11	-.24	.14	.23	.00	.07
5	.67	-.22	-.56	-.32	-.51	-.05	.06	.44	.11	.39
6	-.10	.14	-.09	-.69	-.05	.06	.23	.56	.18	-.24
7	.21	-.17	.14	-.04	-.25	-.08	.19	.02	.27	-.28
8	.03	.36	-.09	-.22	.39	.13	-.14	-.02	-.25	-.17
9	-.04	.59	-.02	.05	-.19	-.24	.19	-.40	-.16	.05
10	-.55	1.38	.00	.34	.04	.16	.37	.21	-.11	.22
11	.00	.12	-.19	-.18	-.08	.01	.00	.00	-.04	.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	9	10	11
Mean Log q	-15.0097	-13.1065	-11.9537	-11.4537	-11.2405	-11.0300	-11.0300	-11.0300	-11.0300
S.E(Log q)	.5788	.2246	.4138	.3301	.1969	.2273	.2710	.5370	.1087

Regression statistics :

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.41	-1.145	16.93	.50	10	.80	-15.01
4	1.07	-.507	13.32	.85	10	.25	-13.11
5	.97	.113	11.90	.69	10	.43	-11.95
6	1.11	-.533	11.69	.75	10	.38	-11.45
7	1.06	-.456	11.41	.88	10	.22	-11.24
8	1.02	-.175	11.11	.88	10	.25	-11.03
9	1.22	-1.222	12.02	.80	10	.32	-11.05
10	1.85	-1.735	15.08	.34	10	.82	-10.82
11	.87	3.915	10.26	.99	10	.06	-11.05

Terminal year survivor and F summaries :

Age 3 Catchability constant w.r.t. time and dependent on age
Year class = 2001

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	5229.	.607	.000	.00	1	.915	.013
F shrinkage mean	5172.	2.00				.085	.013

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
5224.	.58	.00	2	.005	.013

Table 2.5.5.2. (Continued)

```
Age  4   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
All pair (GLM) >1000         18938.    .269        .148     .55    2   .981      .091

  F shrinkage mean           18910.    2.00                              .019      .091

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e          Ratio
    18938.        .27       .10     3     .388    .091

Age  5   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
All pair (GLM) >1000         15579.    .229        .276    1.21    3   .980      .401

  F shrinkage mean           24095.    2.00                              .020      .277

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e          Ratio
    15716.        .23       .23     4     .992    .398

Age  6   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
All pair (GLM) >1000         18420.    .194        .119     .61    4   .984      .356

  F shrinkage mean           11809.    2.00                              .016      .512

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e          Ratio
    18287.        .19       .11     5     .547    .359

Age  7   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
All pair (GLM) >1000          2867.    .175        .144     .82    5   .983      .511

  F shrinkage mean            2197.    2.00                              .017      .626

Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e          Ratio
     2854.        .18       .13     6     .734    .513

Age  8   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
All pair (GLM) >1000          1286.    .176        .127     .72    6   .975      .817

  F shrinkage mean            1580.    2.00                              .025      .708
Weighted prediction :

Survivors         Int       Ext     N     Var      F
at end of year    s.e       s.e          Ratio
     1293.        .18       .11     7     .641    .815
```

Table 2.5.5.2. (Continued)

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	136.	.164	.062	.38	7	.973	1.013
F shrinkage mean	238.	2.00				.027	.694

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
138.	.17	.07	8	.395	1.003

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	98.	.182	.069	.38	8	.943	1.303
F shrinkage mean	160.	2.00				.057	.971

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
101.	.21	.07	9	.363	1.282

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
All pair (GLM) >1000	50.	.188	.074	.40	9	.955	1.283
F shrinkage mean	71.	2.00				.045	1.045

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
51.	.20	.07	10	.364	1.272

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 3/05/2005 16:43

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963	1964
AGE				
3	.0226	.0465	.0307	.0478
4	.0556	.0863	.0358	.1260
5	.0994	.1208	.0716	.2198
6	.1219	.1401	.1115	.1797
7	.0933	.1192	.1634	.2213
8	.0852	.0752	.1157	.2566
9	.0972	.1150	.1355	.1424
10	.0915	.1295	.2012	.1658
11	.0916	.1069	.1514	.1891
+gp	.0916	.1069	.1514	.1891
FBAR 4- 8	.0911	.1083	.0996	.2007

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	.0495	.0250	.0248	.0320	.0328	.0479	.0885	.0935	.1271	.2293
4	.0772	.1007	.0518	.0910	.1452	.2547	.1480	.0728	.3227	.3170
5	.1588	.1492	.1217	.0954	.1719	.1538	.3579	.1649	.4582	.3543
6	.2137	.2326	.1388	.1357	.1684	.1597	.1404	.2985	.3486	.3276
7	.2216	.2784	.2564	.1345	.2000	.1536	.1262	.3286	.2919	.2297
8	.2424	.2536	.2615	.2183	.2094	.1943	.1118	.2995	.2425	.1770
9	.2983	.2770	.2269	.2182	.3063	.1656	.1244	.3759	.1982	.1960
10	.2355	.3346	.2903	.2027	.3289	.2008	.1213	.4600	.2496	.1809
11	.2601	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854
+gp	.2601	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854
FBAR 4- 8	.1827	.2029	.1660	.1350	.1790	.1832	.1769	.2329	.3328	.2811

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	.1505	.2055	.1478	.0837	.0374	.0926	.0137	.0285	.0693	.0158
4	.3595	.3705	.2977	.2367	.1776	.1536	.2415	.1832	.1061	.4955
5	.5442	.3153	.4251	.2881	.2890	.2024	.1958	.2031	.3629	.3460
6	.2891	.3432	.4140	.1915	.2780	.2299	.4379	.4823	.4648	.5672
7	.1957	.2048	.3665	.2001	.3213	.3217	.5551	.3197	.4954	.6364
8	.1752	.1767	.2537	.4119	.3572	.2550	.6322	.5384	.5284	.4650
9	.1183	.1664	.2026	.2642	.3872	.3127	.5593	.5698	.8446	.5173
10	.1485	.1202	.1740	.3018	.4698	.5105	.5211	.3288	.3718	.3693
11	.1479	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4539
+gp	.1479	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4539
FBAR 4- 8	.3127	.2821	.3514	.2657	.2846	.2325	.4125	.3453	.3915	.5020

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	.0629	.0211	.0367	.0215	.0176	.0159	.0470	.0299	.0634	.0466
4	.2367	.1385	.1386	.0891	.2026	.2043	.4160	.2641	.2058	.2752
5	.5028	.4552	.4274	.3560	.2287	.6240	.7726	.5993	.5546	.3349

6	.2917	.7618	.5769	.6420	.4944	.7892	.8669	.7168	.6074	.6110
7	.5662	.4057	.4624	.5887	.3758	.8096	.8101	.5400	.5275	.6112
8	.4141	.7505	.4173	.5987	.5298	.4081	.6726	.4956	.3760	.6820
9	.3185	.8262	.5485	.5648	.3542	.2135	.7394	.5811	.4987	.4275
10	.2173	.6211	.7314	.5554	.2383	.1877	.8264	.5210	.4855	.7638
11	.3185	.7397	.5705	.5778	.3765	.2712	.7535	.5369	.4568	.6300
+gp	.3185	.7397	.5705	.5778	.3765	.2712	.7535	.5369	.4568	.6300
FBAR 4- 8	.4023	.5023	.4045	.4549	.3662	.5670	.7076	.5232	.4542	.5029

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE											
3	.0115	.0137	.0117	.0142	.0062	.0259	.0140	.0072	.0117	.0129	.0106
4	.0900	.0392	.0485	.0729	.0730	.0685	.1020	.1380	.0742	.0913	.1011
5	.4137	.1385	.1161	.1521	.1855	.2350	.2988	.3839	.2743	.3984	.3522
6	.4080	.3031	.3282	.2410	.3075	.4329	.6346	.6799	.4829	.3586	.5071
7	.7160	.4900	.5083	.4624	.5010	.4840	.8151	.5673	.7360	.5130	.6054
8	.6461	.8340	.5394	.5344	.6472	.7471	.7459	.7657	.6000	.8146	.7267
9	.8574	.5523	.7009	.7237	.6540	.5495	1.0912	.5260	.6162	1.0031	.7151
10	.5233	.7540	.6623	.8647	.7301	.8028	1.3993	1.0658	.8045	1.2823	1.0509
11	.6551	.3284	.7293	.7279	.7407	.6938	1.3018	.5445	.8778	1.2722	.8982
+gp	.6551	.3284	.7293	.7279	.7407	.6938	1.3018	.5445	.8778	1.2722	
FBAR 4- 8	.4548	.3610	.3081	.2926	.3428	.3935	.5193	.5070	.4335	.4351	

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 3/05/2005 16:43

Terminal Fs derived using XSA (With F shrinkage)

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

YEAR	1961	1962	1963	1964
AGE				
3	9047	13663	22431	16192
4	7739	7241	10678	17809
5	5643	5993	5438	8435
6	3881	4183	4349	4145
7	2680	2813	2977	3185
8	1746	1999	2044	2070
9	1384	1313	1518	1491
10	1036	1028	958	1085
11	568	774	740	641
+gp	1032	1141	2147	1111
TOTAL	34757	40149	53279	56164

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
3	22803	21830	26879	21514	40798	34135	37285	33607	23282	18897
4	12638	17769	17432	21468	17059	32325	26640	27941	25059	16786
5	12854	9578	13154	13551	16048	12079	20514	18811	21271	14859
6	5543	8979	6755	9536	10085	11064	8480	11742	13059	11013
7	2835	3665	5826	4814	6816	6978	7721	6033	7132	7545
8	2090	1860	2272	3691	3445	4569	4899	5572	3556	4361
9	1311	1343	1182	1432	2429	2288	3080	3587	3381	2285
10	1059	797	833	771	942	1464	1587	2227	2016	2271
11	753	685	467	510	515	555	981	1151	1151	1286
+gp	1367	981	670	1067	846	848	977	727	990	1722
TOTAL	63253	67486	75468	78354	98985	106305	112164	111397	100898	81024

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
3	16306	18910	12940	8414	8632	12450	33326	15215	40976	25961
4	12301	11484	12607	9138	6336	6808	9292	26913	12107	31301
5	10010	7030	6492	7664	5905	4343	4780	5975	18346	8914
6	8536	4756	4199	3475	4704	3621	2905	3218	3993	10449
7	6498	5234	2763	2273	2349	2917	2356	1535	1626	2054
8	4910	4375	3492	1568	1523	1395	1731	1107	913	811
9	2991	3374	3002	2218	850	872	885	753	529	441
10	1537	2176	2339	2007	1394	473	522	414	349	186
11	1551	1085	1580	1609	1215	714	232	254	244	197
+gp	2385	2199	1907	2100	2262	2840	2549	2579	1330	759
TOTAL	67026	60623	51319	40466	35171	36433	58578	57963	80412	81075

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
3	22191	61704	48481	44973	28502	20654	24789	19528	23677	16747
4	20922	17061	49463	38262	36037	22927	16644	19364	15517	18194
5	15614	13520	12162	35255	28657	24093	15303	8990	12174	10341
6	5164	7732	7022	6494	20219	18667	10569	5786	4042	5724
7	4852	3158	2955	3229	2798	10097	6942	3637	2313	1803
8	890	2255	1723	1524	1467	1573	3679	2528	1735	1118
9	417	482	872	930	686	707	856	1537	1261	975
10	215	248	173	412	433	394	468	335	704	627
11	105	142	109	68	194	279	267	168	163	355
+gp	1106	329	244	149	136	365	243	284	155	114
TOTAL	71477	106631	123203	131297	119129	99757	79761	62156	61741	55999

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 61-**	AMST 61-**
AGE													
3	38600	24047	32802	12747	58032	35036	89219	46268	31316	6463	0	24476	28178
4	13087	31243	19419	26544	10289	47221	27951	72029	37608	25341	5224	18309	21406
5	11312	9792	24596	15146	20204	7831	36101	20666	51372	28590	18938	11951	13796
6	6057	6124	6980	17930	10651	13741	5069	21923	11525	31969	15716	7055	8156
7	2544	3298	3703	4116	11535	6412	7297	2200	9094	5822	18287	3823	4369
8	801	1018	1654	1823	2122	5723	3235	2644	1021	3566	2854	2131	2465
9	463	344	362	790	875	910	2220	1256	1007	459	1293	1164	1426
10	521	161	162	147	314	372	430	610	608	445	138	635	862
11	239	253	62	68	51	124	137	87	172	223	101	345	532
+gp	266	321	211	154	144	55	83	117	80	167	89		
TOTAL	73890	76600	89950	79467	114217	117424	171742	167800	143804	103046	62640		

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

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 3/05/2005 16:43

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	9047	121972	83798	9592	.1145	.0911
1962	13663	126462	85635	10454	.1221	.1083
1963	22431	158238	100631	12693	.1261	.0996
1964	16192	160429	98383	21893	.2225	.2007
1965	22803	174777	107215	22181	.2069	.1827
1966	21830	184152	108779	25563	.2350	.2029
1967	26879	181651	104635	21319	.2037	.1660
1968	21514	189804	115962	20387	.1758	.1350
1969	40798	215030	123795	27437	.2216	.1790
1970	34135	224447	129143	29110	.2254	.1832
1971	37285	228425	139500	32706	.2345	.1769
1972	33607	237048	147569	42663	.2891	.2329
1973	23282	210526	136682	57431	.4202	.3328
1974	18897	204072	137611	47188	.3429	.2811
1975	16306	187420	137886	41576	.3015	.3127
1976	18910	169750	122017	33065	.2710	.2821
1977	12940	156334	114098	34835	.3053	.3514
1978	8414	137397	96026	28138	.2930	.2657
1979	8632	113047	83557	27246	.3261	.2846
1980	12450	124847	88942	25230	.2837	.2325
1981	33326	142230	76327	30103	.3944	.4125
1982	15215	150234	83368	30964	.3714	.3453
1983	40976	179272	97192	39176	.4031	.3915
1984	25961	190385	96330	54665	.5675	.5020
1985	22191	190138	114869	44605	.3883	.4023
1986	61704	235603	91983	41716	.4535	.5023
1987	48481	250262	89315	40020	.4481	.4045
1988	44973	260365	97994	45285	.4621	.4549
1989	28502	229029	95873	44477	.4639	.3662
1990	20654	192253	86893	61628	.7092	.5670
1991	24789	149841	64327	54858	.8528	.7076
1992	19528	124118	56259	36487	.6485	.5232
1993	23677	133177	61393	33543	.5464	.4542
1994	16747	126806	59606	33182	.5567	.5029
1995	38600	152373	60285	27209	.4513	.4548
1996	24047	162358	69064	20029	.2900	.3610
1997	32802	179456	71294	22306	.3129	.3081
1998	12747	163755	75003	26421	.3523	.2926
1999	58032	210839	78443	33207	.4233	.3428
2000	35036	222786	84144	39020	.4637	.3935
2001	89219	289089	90737	51786	.5707	.5193
2002	46268	261927	82146	53546	.6518	.5070
2003	31316	226803	83524	46555	.5574	.4335
2004	6463	172586	73978	46115	.6234	.4351
Arith. Mean	27756	184125	95505	34718	.3837	.3383
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 2.5.6.1. Saithe in the Faroes (Division Vb). Input data for prediction with management options.

MFDP VERSION 1A								
Run: sai1								
Time and date: 09:11 04/05/2005								
Fbar age range: 4-8								
2005								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
3	27988	0.2	0.02	0	0	1.136	0.011	1.136
4	5224	0.2	0.14	0	0	1.411	0.101	1.411
5	18938	0.2	0.35	0	0	1.647	0.352	1.647
6	15716	0.2	0.48	0	0	1.792	0.507	1.792
7	18287	0.2	0.68	0	0	2.214	0.605	2.214
8	2854	0.2	0.87	0	0	3.172	0.727	3.172
9	1293	0.2	0.98	0	0	4.500	0.715	4.500
10	138	0.2	1.00	0	0	5.268	1.051	5.268
11	101	0.2	1.00	0	0	6.179	0.898	6.179
12	89	0.2	1.00	0	0	6.919	0.898	6.919
2006								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
3	27988	0.2	0.02	0	0	1.136	0.011	1.136
4	.	0.2	0.20	0	0	1.411	0.101	1.411
5	.	0.2	0.39	0	0	1.647	0.352	1.647
6	.	0.2	0.63	0	0	1.792	0.507	1.792
7	.	0.2	0.72	0	0	2.214	0.605	2.214
8	.	0.2	0.88	0	0	3.172	0.727	3.172
9	.	0.2	0.97	0	0	4.500	0.715	4.500
10	.	0.2	1.00	0	0	5.268	1.051	5.268
11	.	0.2	1.00	0	0	6.179	0.898	6.179
12	.	0.2	1.00	0	0	6.919	0.898	6.919
2007								
Age	**N**	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
3	27988	0.2	0.02	0	0	1.136	0.011	1.136
4	.	0.2	0.20	0	0	1.411	0.101	1.411
5	.	0.2	0.39	0	0	1.647	0.352	1.647
6	.	0.2	0.63	0	0	1.792	0.507	1.792
7	.	0.2	0.72	0	0	2.214	0.605	2.214
8	.	0.2	0.88	0	0	3.172	0.727	3.172
9	.	0.2	0.97	0	0	4.500	0.715	4.500
10	.	0.2	1.00	0	0	5.268	1.051	5.268
11	.	0.2	1.00	0	0	6.179	0.898	6.179
12	.	0.2	1.00	0	0	6.919	0.898	6.919
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: sai10							
Index file 4/5/2005							
Time and date: 09:29 04/05/2005							
Fbar age range: 4-8							
Age	**M**	**Mat**	**PF**	**PM**	**SWt**	**Sel**	**CWt**
3	0.2	0.029	0	0	1.308	0.014	1.308
4	0.2	0.197	0	0	1.799	0.095	1.799
5	0.2	0.495	0	0	2.402	0.318	2.402
6	0.2	0.729	0	0	3.124	0.518	3.124
7	0.2	0.861	0	0	3.972	0.623	3.972
8	0.2	0.960	0	0	4.893	0.735	4.893
9	0.2	0.993	0	0	5.697	0.757	5.697
10	0.2	1.000	0	0	6.414	1.071	6.414
11	0.2	1.000	0	0	7.269	0.938	7.269
12	0.2	1.000	0	0	8.559	0.938	8.559
Weights in kilograms							

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

MFYPR version 2a
Run: sai10
Time and date: 09:29 04/05/2005
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	22.2595	3.3218	18.1982	3.3218	18.1982
0.1000	0.0458	0.1690	0.8712	4.6753	16.0224	2.4994	12.0261	2.4994	12.0261
0.2000	0.0915	0.2616	1.2146	4.2157	12.8987	2.0576	8.9625	2.0576	8.9625
0.3000	0.1373	0.3219	1.3718	3.9174	11.0350	1.7760	7.1546	1.7760	7.1546
0.4000	0.1831	0.3652	1.4500	3.7036	9.7979	1.5779	5.9692	1.5779	5.9692
0.5000	0.2288	0.3984	1.4909	3.5401	8.9148	1.4292	5.1344	1.4292	5.1344
0.6000	0.2746	0.4250	1.5125	3.4094	8.2504	1.3126	4.5152	1.3126	4.5152
0.7000	0.3204	0.4470	1.5238	3.3017	7.7306	1.2182	4.0376	1.2182	4.0376
0.8000	0.3661	0.4656	1.5290	3.2106	7.3112	1.1398	3.6580	1.1398	3.6580
0.9000	0.4119	0.4817	1.5308	3.1323	6.9647	1.0735	3.3488	1.0735	3.3488
1.0000	0.4577	0.4958	1.5304	3.0639	6.6728	1.0165	3.0922	1.0165	3.0922
1.1000	0.5034	0.5082	1.5286	3.0034	6.4229	0.9669	2.8756	0.9669	2.8756
1.2000	0.5492	0.5194	1.5261	2.9493	6.2062	0.9234	2.6905	0.9234	2.6905
1.3000	0.5950	0.5295	1.5231	2.9006	6.0161	0.8847	2.5303	0.8847	2.5303
1.4000	0.6408	0.5386	1.5198	2.8564	5.8477	0.8501	2.3904	0.8501	2.3904
1.5000	0.6865	0.5470	1.5163	2.8160	5.6974	0.8189	2.2671	0.8189	2.2671
1.6000	0.7323	0.5547	1.5128	2.7789	5.5621	0.7907	2.1577	0.7907	2.1577
1.7000	0.7781	0.5619	1.5093	2.7446	5.4395	0.7650	2.0599	0.7650	2.0599
1.8000	0.8238	0.5685	1.5058	2.7128	5.3279	0.7415	1.9719	0.7415	1.9719
1.9000	0.8696	0.5747	1.5024	2.6832	5.2257	0.7198	1.8923	0.7198	1.8923
2.0000	0.9154	0.5805	1.4991	2.6555	5.1317	0.6999	1.8200	0.6999	1.8200

Reference point	F multiplier	Absolute F
Fbar(4-8)	1.0000	0.4577
FMax	0.9249	0.4233
F0.1	0.2604	0.1192
F35%SPR	0.3619	0.1656
Flow	0.1913	0.0876
Fmed	0.7925	0.3627
Fhigh	2.1967	1.0054

Weights in kilograms

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

MFDP VERSION 1A						
Run: sai1						
Index file 4/5/2005						
Time and date: 09:11 04/05/2005						
Fbar age range: 4-8						
2005						
Biomass	**SSB**	**FMult**	**FBar**	**Landings**		
155845	69180	1.0000	0.4585	44588		
2006					**2007**	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
141262	65332	0.0000	0.0000	0	178444	91820
.	65332	0.1000	0.0459	4581	172988	87130
.	65332	0.2000	0.0917	8897	167861	82739
.	65332	0.3000	0.1376	12965	163042	78626
.	65332	0.4000	0.1834	16802	158510	74773
.	65332	0.5000	0.2293	20423	154246	71163
.	65332	0.6000	0.2751	23840	150234	67778
.	65332	0.7000	0.3210	27068	146457	64605
.	65332	0.8000	0.3668	30118	142899	61629
.	65332	0.9000	0.4127	33001	139546	58836
.	65332	1.0000	0.4585	35729	136386	56216
.	65332	1.1000	0.5044	38310	133405	53756
.	65332	1.2000	0.5502	40753	130593	51446
.	65332	1.3000	0.5961	43068	127938	49276
.	65332	1.4000	0.6420	45263	125431	47238
.	65332	1.5000	0.6878	47344	123063	45322
.	65332	1.6000	0.7337	49318	120824	43520
.	65332	1.7000	0.7795	51193	118707	41826
.	65332	1.8000	0.8254	52974	116703	40232
.	65332	1.9000	0.8712	54667	114806	38732
.	65332	2.0000	0.9171	56276	113010	37319
Input units are thousands and kg - output in tonnes						

Table 2.5.8.1. Saithe in the Faroes (Division Vb). Effort (hours) and catch in number at age for commercial pair trawlers and spring survey combined.

```
Faroe Saithe (ICES Div. Vb)  (springsurvandtrawl.dat)
102
Spring survey org shifted
1993 2004
1 1 0.95 1.0
2  8
100     127     843     469     426     110      70      52
100     152     510     925     938     381      89      60
100      62     270     117     134     107      58      35
100      79     106     251     133      97      66      24
100     332     921     809    1394     340     150     108
100     218     207     697     557     664      90      40
100     212     379     309    1256     507     574      28
100     785     364    1122     299     437     165     132
100     320    8109    3430    3569     255     229      82
100     824     919    3317     979     604      77      49
100     526    5296    7982    4811     301     121      13
100    1410    1201    2768    4600    1516     223      86
All pair (GLM) >1000 HP
1995 2004
1 1 0 1
3 11
10338 90    343   1101  450   278   93    46    36    27
6116  99    306   262   358   161   90    43    41    22
7369  76    205   571   389   295   128   28    13    4
8283  46    281   492   637   313   139   73    17    5
12250 89    249   794   1031  1035  418   97    42    6
11156 205   741   432   1278  631   759   91    50    15
13121 315   742   2554  602   958   386   319   66    15
11110 58    1741  1736  3016  228   299   108   77    11
7900  50    528   2321  839   800   70    75    44    13
7931  14    381   1618  1627  329   242   36    37    17
```

Table 2.5.8.2. Saithe in the Faroes (Division Vb). Diagnostics from XSA with some commercial tuning series.

Lowestoft VPA Version 3.1
3/05/2005 16:01
Extended Survivors Analysis
FAROE SAITHE (ICES Division Vb) SAI_IND
CPUE data from file D:\Stovnsmeting\Ices2005\Xsa\divxsa\springsurvandtrawl.DAT

Catch data for 44 years. 1961 to 2004. Ages 2 to 12.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Spring survey org sh	1993	2004	2	8	.950	1.000
All pair (GLM) >1000	1995	2004	3	11	.000	1.000

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability independent of stock size for all ages

Catchability independent of age for ages >= 8

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 = 2.000

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

Prior weighting not applied

Tuning converged after 32 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000
3	.011	.014	.012	.014	.006	.025	.012	.006	.008	.003
4	.090	.039	.049	.073	.073	.069	.100	.121	.057	.060
5	.414	.139	.116	.152	.186	.236	.302	.375	.233	.286
6	.408	.303	.329	.241	.308	.433	.639	.692	.466	.289
7	.716	.490	.509	.463	.501	.485	.817	.574	.763	.484
8	.643	.835	.540	.536	.649	.747	.748	.769	.612	.882
9	.855	.548	.702	.725	.657	.553	1.092	.529	.621	1.052
10	.532	.750	.652	.868	.734	.811	1.423	1.069	.813	1.310
11	.662	.336	.720	.706	.747	.701	1.343	.568	.885	1.311

XSA population numbers (Thousands)

	AGE									
YEAR	2	3	4	5	6	7	8	9	10	11
1995	2.94E+04	3.86E+04	1.31E+04	1.13E+04	6.05E+03	2.54E+03	8.04E+02	4.63E+02	5.15E+02	2.37E+02
1996	4.00E+04	2.40E+04	3.12E+04	9.78E+03	6.12E+03	3.30E+03	1.02E+03	3.46E+02	1.61E+02	2.48E+02
1997	1.55E+04	3.28E+04	1.94E+04	2.46E+04	6.97E+03	3.70E+03	1.65E+03	3.61E+02	1.64E+02	6.24E+01
1998	7.03E+04	1.27E+04	2.65E+04	1.51E+04	1.79E+04	4.11E+03	1.82E+03	7.88E+02	1.47E+02	6.99E+01
1999	4.35E+04	5.76E+04	1.03E+04	2.02E+04	1.06E+04	1.15E+04	2.12E+03	8.72E+02	3.12E+02	5.04E+01
2000	1.23E+05	3.56E+04	4.68E+04	7.80E+03	1.37E+04	6.40E+03	5.72E+03	9.06E+02	3.70E+02	1.23E+02
2001	7.33E+04	1.01E+05	2.84E+04	3.58E+04	5.05E+03	7.29E+03	3.23E+03	2.22E+03	4.27E+02	1.35E+02
2002	5.71E+04	6.00E+04	8.16E+04	2.11E+04	2.17E+04	2.18E+03	2.64E+03	1.25E+03	6.09E+02	8.42E+01
2003	3.49E+04	4.68E+04	4.89E+04	5.92E+04	1.18E+04	8.88E+03	1.01E+03	1.00E+03	6.04E+02	1.71E+02
2004	2.53E+05	2.86E+04	3.80E+04	3.78E+04	3.84E+04	6.09E+03	3.39E+03	4.47E+02	4.40E+02	2.19E+02

Estimated population abundance at 1st Jan 2005

0.00E+00	2.07E+05	2.34E+04	2.93E+04	2.33E+04	2.36E+04	3.07E+03	1.15E+03	1.28E+02	9.72E+01

Taper weighted geometric mean of the VPA populations:

3.30E+04	2.51E+04	1.91E+04	1.27E+04	7.42E+03	3.94E+03	2.12E+03	1.13E+03	6.29E+02	3.35E+02

Standard error of the weighted Log(VPA populations) :

.6124	.5488	.5845	.6064	.5839	.5247	.5507	.6547	.7999	.9893

Table 2.5.8.2. (Continued)

Log catchability residuals.
Fleet : Spring survey org sh

Age	1993	1994
2	.11	-.55
3	.59	.42
4	-.08	.51
5	-.02	.71
6	-.05	.85
7	-.02	.54
8	-.15	.72
9	No data for this fleet at this age	
10	No data for this fleet at this age	
11	No data for this fleet at this age	

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	-.97	-1.04	1.34	-.59	-.14	.13	-.25	.95	.99	.00
3	-1.09	-1.55	.30	-.24	-1.16	-.70	1.35	-.31	1.69	.69
4	-1.41	-1.57	.09	-.35	-.21	-.44	1.20	.13	1.46	.66
5	-1.24	-1.38	.03	-.37	.19	-.24	.78	.08	.50	.96
6	-.67	-.88	.26	-.10	.22	-.06	.60	.06	-.25	.01
7	-.12	-.47	.25	-.41	.45	-.23	.30	.18	-.59	.13
8	.48	.05	.78	-.31	-.71	-.06	.04	-.25	-.77	.17
9	No data for this fleet at this age									
10	No data for this fleet at this age									
11	No data for this fleet at this age									

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	-9.5990	-8.2719	-7.6298	-7.1971	-7.3753	-7.3708	-7.3945
S.E(Log q)	.7670	1.0154	.9102	.7365	.4789	.3696	.4930

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1.25	-.640	9.29	.40	12	.99	-9.60
3	.75	.595	8.80	.37	12	.79	-8.27
4	.68	1.026	8.44	.51	12	.62	-7.63
5	.58	2.538	8.30	.78	12	.35	-7.20
6	1.04	-.181	7.30	.65	12	.52	-7.38
7	1.08	-.366	7.30	.70	12	.41	-7.37
8	1.16	-.524	7.37	.52	12	.59	-7.39

Fleet : All pair (GLM) >1000

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	No data for this fleet at this age									
3	.04	1.13	.37	.70	-.55	.87	.09	-.92	-.48	-1.26
4	.45	-.04	-.14	-.25	.19	-.15	.21	.18	-.19	-.26
5	.72	-.17	-.51	-.27	-.46	.00	.12	.47	.00	.11
6	-.08	.16	-.06	-.67	-.03	.08	.26	.60	.17	-.43
7	.21	-.17	.14	-.04	-.25	-.07	.20	.03	.30	-.33
8	.01	.35	-.10	-.23	.38	.12	-.15	-.03	-.24	-.11
9	-.05	.57	-.03	.04	-.19	-.25	.18	-.40	-.16	.08
10	-.54	1.37	-.02	.33	.03	.16	.37	.20	-.11	.23
11	.00	.14	-.21	-.22	-.09	.01	.02	.03	-.04	.14

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	9	10	11
Mean Log q	-15.2382	-13.1892	-12.0034	-11.4759	-11.2408	-11.0190	-11.0190	-11.0190	-11.0190
S.E(Log q)	.7917	.2407	.3859	.3551	.2121	.2194	.2690	.5317	.1256

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

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	2.41	-1.306	21.85	.10	10	1.84	-15.24
4	1.18	-1.204	13.70	.85	10	.28	-13.19
5	1.04	-.205	12.10	.72	10	.43	-12.00
6	1.20	-.921	11.91	.72	10	.43	-11.48
7	1.07	-.478	11.43	.86	10	.24	-11.24
8	1.01	-.072	11.05	.89	10	.23	-11.02
9	1.22	-1.241	12.02	.80	10	.32	-11.04
10	1.82	-1.680	14.91	.35	10	.81	-10.82
11	.86	3.350	10.17	.99	10	.07	-11.04

Terminal year survivor and F summaries :

Table 2.5.8.2. (Continued)

Age 2 Catchability constant w.r.t. time and dependent on age
Year class = 2002

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Spring survey org sh	206932.	.798	.000	.00	1	1.000	.000
All pair (GLM) >1000	1.	.000	.000	.00	0	.000	.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
    206932.        .80       .00     1     .000    .000

Age  3   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
 Spring survey org sh      56541.    .637        .144     .23    2   .592      .001
 All pair (GLM) >1000       6605.    .830        .000     .00    1   .348      .010

   F shrinkage mean         5858.    2.00                            .060      .012
 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     23356.        .49       .62     4    1.265    .003

Age  4   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
 Spring survey org sh      83200.    .529        .278     .53    3   .217      .022
 All pair (GLM) >1000      21949.    .282        .067     .24    2   .766      .079

   F shrinkage mean        20600.    2.00                            .016      .084
 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     29293.        .25       .26     6    1.055    .060

 Age  5   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
 Spring survey org sh      38452.    .435        .422     .97    4   .217      .182
 All pair (GLM) >1000      20161.    .232        .184     .80    3   .769      .323

   F shrinkage mean        25042.    2.00                            .014      .268
 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     23264.        .20       .18     8     .907    .286

Age  6   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
 Spring survey org sh      29711.    .332        .186     .56    5   .271      .235
 All pair (GLM) >1000      21819.    .199        .154     .77    4   .718      .309

   F shrinkage mean        11811.    2.00                            .011      .512

 Weighted prediction :

 Survivors         Int       Ext     N     Var      F
 at end of year    s.e       s.e           Ratio
     23554.        .17       .11    10     .656    .289

Age  7   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
 Spring survey org sh       3202.    .266        .136     .51    6   .326      .468
 All pair (GLM) >1000       3027.    .178        .165     .93    5   .663      .490
```

Table 2.5.8.2. (Continued)

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
F shrinkage mean	2164.	2.00				.012	.633

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3071.	.15	.10	12	.659	.484

Age 8 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
Spring survey org sh	987.	.271	.169	.62	7	.288	.974
All pair (GLM) >1000	1213.	.180	.110	.61	6	.692	.851
F shrinkage mean	1568.	2.00				.020	.712

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1149.	.15	.09	14	.580	.882

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1995

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Spring survey org sh	112.	.257	.234	.91	7	.180	1.137
All pair (GLM) >1000	129.	.166	.067	.40	7	.796	1.046
F shrinkage mean	236.	2.00				.024	.697

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
128.	.15	.08	15	.549	1.052

Age 10 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1994

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Spring survey org sh	93.	.262	.130	.49	7	.127	1.346
All pair (GLM) >1000	95.	.184	.069	.38	8	.822	1.327
F shrinkage mean	158.	2.00				.052	.981

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
97.	.19	.06	16	.322	1.310

Age 11 Catchability constant w.r.t. time and age (fixed at the value for age) 8
Year class = 1993

Fleet	Estimated Survivors	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Spring survey org sh	42.	.239	.145	.61	7	.068	1.415
All pair (GLM) >1000	48.	.189	.076	.40	9	.888	1.314
F shrinkage mean	66.	2.00				.043	1.094

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
48.	.19	.06	17	.311	1.311

Table 2.5.8.3. Saithe in the Faroes (Division Vb). Fishing mortality (F) at age.

```
Run title : FAROE SAITHE (ICES Division Vb)                SAI_IND
At  3/05/2005  16:02
               Terminal Fs derived using XSA (With F shrinkage)
```

Table 8 Fishing mortality (F) at age

YEAR	1961	1962	1963	1964
AGE				
2	.0000	.0000	.0000	.0000
3	.0226	.0465	.0307	.0478
4	.0556	.0863	.0358	.1260
5	.0994	.1208	.0716	.2198
6	.1219	.1401	.1115	.1797
7	.0933	.1192	.1634	.2213
8	.0852	.0752	.1157	.2566
9	.0972	.1150	.1355	.1424
10	.0915	.1295	.2012	.1658
11	.0916	.1069	.1514	.1891
+gp	.0916	.1069	.1514	.1891
0 FBAR 4- 8	.0911	.1083	.0996	.2007

YEAR	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
AGE										
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.0495	.0250	.0248	.0320	.0328	.0479	.0885	.0935	.1271	.2293
4	.0772	.1007	.0518	.0910	.1452	.2547	.1480	.0728	.3227	.3170
5	.1588	.1492	.1217	.0954	.1719	.1538	.3579	.1649	.4582	.3543
6	.2137	.2326	.1388	.1357	.1684	.1597	.1404	.2985	.3486	.3276
7	.2216	.2784	.2564	.1345	.2000	.1536	.1262	.3286	.2919	.2297
8	.2424	.2536	.2615	.2183	.2094	.1943	.1118	.2995	.2425	.1770
9	.2983	.2770	.2269	.2182	.3063	.1656	.1244	.3759	.1982	.1960
10	.2355	.3346	.2903	.2027	.3289	.2008	.1213	.4600	.2496	.1809
11	.2601	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854
+gp	.2601	.2900	.2609	.2141	.2831	.1877	.1196	.3810	.2312	.1854
0 FBAR 4- 8	.1827	.2029	.1660	.1350	.1790	.1832	.1769	.2329	.3328	.2811

YEAR	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
AGE										
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.1505	.2055	.1478	.0837	.0374	.0926	.0137	.0285	.0693	.0158
4	.3595	.3705	.2977	.2367	.1776	.1536	.2415	.1832	.1061	.4955
5	.5442	.3153	.4251	.2881	.2890	.2024	.1958	.2031	.3629	.3460
6	.2891	.3432	.4140	.1915	.2780	.2299	.4379	.4823	.4648	.5672
7	.1957	.2048	.3665	.2001	.3213	.3217	.5551	.3197	.4955	.6364
8	.1752	.1767	.2537	.4119	.3572	.2550	.6322	.5384	.5285	.4650
9	.1183	.1664	.2026	.2642	.3872	.3127	.5593	.5698	.8447	.5174
10	.1485	.1202	.1740	.3018	.4698	.5105	.5211	.3288	.3718	.3693
11	.1479	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4539
+gp	.1479	.1550	.2111	.3279	.4075	.3617	.5757	.4826	.5866	.4539
0 FBAR 4- 8	.3127	.2821	.3514	.2657	.2846	.2325	.4125	.3453	.3915	.5020

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.0629	.0211	.0367	.0215	.0176	.0159	.0470	.0299	.0634	.0466

4	.2367	.1385	.1386	.0891	.2028	.2043	.4158	.2641	.2058	.2754
5	.5028	.4552	.4274	.3560	.2287	.6246	.7724	.5988	.5546	.3350
6	.2917	.7619	.5769	.6422	.4945	.7895	.8686	.7165	.6065	.6111
7	.5663	.4057	.4625	.5889	.3759	.8098	.8108	.5422	.5271	.6096
8	.4141	.7505	.4173	.5988	.5300	.4084	.6731	.4965	.3784	.6812
9	.3186	.8263	.5486	.5650	.3543	.2136	.7403	.5818	.5000	.4316
10	.2173	.6211	.7315	.5555	.2384	.1878	.8271	.5222	.4866	.7678
11	.3185	.7398	.5706	.5780	.3767	.2714	.7542	.5378	.4584	.6325
+gp	.3185	.7398	.5706	.5780	.3767	.2714	.7542	.5378	.4584	.6325
0 FBAR 4- 8	.4023	.5024	.4046	.4550	.3664	.5673	.7081	.5236	.4545	.5025

YEAR	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	FBAR **-**
AGE											
2	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
3	.0115	.0138	.0117	.0143	.0062	.0255	.0124	.0056	.0078	.0029	.0054
4	.0901	.0392	.0485	.0730	.0732	.0691	.1002	.1207	.0566	.0599	.0791
5	.4140	.1386	.1161	.1522	.1857	.2359	.3019	.3752	.2333	.2856	.2980
6	.4081	.3035	.3286	.2411	.3078	.4334	.6386	.6918	.4660	.2888	.4822
7	.7163	.4904	.5091	.4633	.5011	.4847	.8165	.5739	.7627	.4842	.6069
8	.6431	.8347	.5401	.5358	.6493	.7474	.7479	.7688	.6125	.8822	.7545
9	.8551	.5476	.7021	.7254	.6572	.5528	1.0924	.5287	.6211	1.0525	.7341
10	.5315	.7496	.6521	.8680	.7337	.8111	1.4228	1.0692	.8126	1.3104	1.0640
11	.6620	.3364	.7204	.7056	.7469	.7009	1.3431	.5677	.8851	1.3109	.9212
+gp	.6620	.3364	.7204	.7056	.7469	.7009	1.3431	.5677	.8851	1.3109	
0 FBAR 4- 8	.4543	.3613	.3085	.2931	.3434	.3941	.5210	.5061	.4262	.4001	

Table 2.5.8.4. Saithe in the Faroes (Division Vb). Stock number at age (start of year) (Thousands).

```
Run title : FAROE SAITHE (ICES Division Vb)                    SAI_IND
 At  3/05/2005  16:02
                Terminal Fs derived using XSA (With F shrinkage)
```

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

YEAR / AGE	1961	1962	1963	1964
2	16689	27397	19777	27852
3	9047	13663	22431	16192
4	7739	7241	10678	17809
5	5643	5993	5438	8435
6	3881	4183	4349	4145
7	2680	2813	2977	3185
8	1746	1999	2044	2070
9	1384	1313	1518	1491
10	1036	1028	958	1085
11	568	774	740	641
+gp	1032	1141	2147	1111
0 TOTAL	51445	67545	73056	84016

YEAR / AGE	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
2	26663	32830	26278	49830	41693	45540	41047	28436	23080	19916
3	22803	21830	26879	21514	40798	34135	37285	33607	23282	18897
4	12638	17769	17431	21468	17059	32325	26640	27941	25059	16786
5	12854	9578	13154	13551	16048	12079	20514	18811	21271	14859
6	5543	8979	6755	9536	10085	11064	8480	11742	13059	11013
7	2835	3665	5826	4814	6816	6978	7721	6033	7132	7545
8	2090	1860	2272	3691	3445	4569	4899	5572	3556	4361
9	1311	1343	1182	1432	2429	2288	3080	3587	3381	2285
10	1059	797	833	771	942	1464	1587	2227	2016	2271
11	753	685	467	510	515	555	981	1151	1151	1286
+gp	1367	981	670	1067	846	848	977	727	990	1722
0 TOTAL	89917	100316	101746	128185	140678	151845	153211	139834	123979	100940

YEAR / AGE	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
2	23097	15805	10277	10543	15207	40704	18583	50047	31708	27102
3	16306	18910	12940	8414	8632	12450	33325	15214	40975	25960
4	12301	11484	12607	9138	6336	6808	9292	26913	12106	31301
5	10010	7030	6492	7664	5905	4343	4780	5975	18346	8914
6	8536	4756	4199	3475	4704	3621	2905	3218	3993	10449
7	6498	5234	2763	2273	2349	2917	2356	1535	1626	2054
8	4910	4375	3492	1568	1523	1395	1731	1107	913	811
9	2991	3374	3002	2218	850	872	885	753	529	441
10	1537	2176	2339	2007	1394	473	522	414	349	186
11	1551	1085	1580	1609	1215	714	232	254	244	197
+gp	2385	2199	1907	2100	2262	2840	2549	2579	1330	759
0 TOTAL	90123	76428	61596	51009	50378	77136	77160	108009	112119	108174

YEAR / AGE	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	75360	59204	54900	34816	25236	30276	23846	28907	20438	47141
3	22189	61699	48472	44948	28505	20662	24788	19523	23667	16733
4	20922	17059	49459	38255	36017	22929	16650	19363	15513	18186
5	15613	13519	12160	35252	28651	24076	15305	8995	12173	10338
6	5163	7731	7021	6493	20216	18662	10555	5788	4046	5723
7	4852	3158	2955	3228	2797	10095	6938	3625	2314	1806
8	890	2255	1723	1523	1467	1572	3677	2525	1726	1119
9	417	482	872	929	685	707	856	1536	1258	968
10	215	248	173	412	432	394	467	334	703	625
11	105	142	109	68	194	279	267	167	162	354
+gp	1106	329	244	149	136	365	243	284	155	114
0 TOTAL	146832	165826	178088	166075	144337	130017	103592	91047	82156	103108

YEAR / AGE	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	GMST 61-**	AMST 61-**
2	29351	40041	15519	70295	43515	123291	73310	57119	34945	252747	0	31373	36254
3	38596	24031	32783	12706	57553	35627	100942	60021	46765	28611	206932	24701	28784
4	13076	31239	19406	26529	10255	46829	28435	81626	48868	37989	23356	18365	21634
5	11305	9784	24593	15136	20192	7804	35780	21062	59230	37809	29293	11951	13796
6	6055	6118	6973	17927	10642	13730	5046	21660	11849	38403	23264	7051	8148
7	2543	3296	3698	4110	11533	6405	7288	2182	8879	6088	23554	3822	4368
8	804	1017	1653	1820	2117	5721	3230	2637	1006	3390	3071	2131	2464
9	463	346	361	788	872	906	2218	1252	1001	447	1149	1163	1425
10	515	161	164	147	312	370	427	609	604	440	128	635	861
11	237	248	62	70	50	123	135	84	171	219	97	344	531
+gp	264	315	212	157	143	54	82	114	80	164	85		

0	TOTAL	103210	116596	105425	149685	157185	240859	256893	248366	213399	406308	310930

Table 2.5.8.5. Saithe in the Faroes (Division Vb). Summary table.

Run title : FAROE SAITHE (ICES Division Vb) SAI_IND

At 3/05/2005 16:02

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	9047	121972	83798	9592	.1145	.0911
1962	13663	126462	85635	10454	.1221	.1083
1963	22431	158238	100631	12693	.1261	.0996
1964	16192	160429	98383	21893	.2225	.2007
1965	22803	174777	107215	22181	.2069	.1827
1966	32830	184152	108779	25563	.2350	.2029
1967	26879	181651	104635	21319	.2037	.1660
1968	21514	189804	115962	20387	.1758	.1350
1969	40798	215030	123795	27437	.2216	.1790
1970	34135	224447	129142	29110	.2254	.1832
1971	37285	228425	139500	32706	.2345	.1769
1972	33607	237048	147569	42663	.2891	.2329
1973	23282	210526	136682	57431	.4202	.3328
1974	18897	204072	137611	47188	.3429	.2811
1975	16306	187420	137886	41576	.3015	.3127
1976	18910	169750	122017	33065	.2710	.2821
1977	12940	156334	114097	34835	.3053	.3514
1978	8414	137397	96026	28138	.2930	.2657
1979	8632	113047	83557	27246	.3261	.2846
1980	12450	124846	88941	25230	.2837	.2325
1981	33325	142229	76326	30103	.3944	.4125
1982	15214	150232	83368	30964	.3714	.3453
1983	40975	179269	97190	39176	.4031	.3915
1984	25960	190380	96328	54665	.5675	.5020
1985	22189	190128	114864	44605	.3883	.4023
1986	61699	235585	91977	41716	.4536	.5024
1987	48472	250231	89305	40020	.4481	.4046
1988	44948	260298	97977	45285	.4622	.4550
1989	28505	228971	95848	44477	.4640	.3664
1990	20662	192210	86861	61628	.7095	.5673
1991	24788	149798	64291	54858	.8533	.7081
1992	19523	124061	56209	36487	.6491	.5236
1993	23667	133101	61336	33543	.5469	.4545
1994	16733	126715	59549	33182	.5572	.5025
1995	38596	152270	60214	27209	.4519	.4543
1996	24031	162208	68953	20029	.2905	.3613
1997	32783	179387	71281	22306	.3129	.3085
1998	12706	163639	74982	26421	.3524	.2931
1999	57553	210021	78337	33207	.4239	.3434
2000	35627	222879	83948	39020	.4648	.3941
2001	100942	304722	91115	51786	.5684	.5210
2002	60021	291628	85055	53546	.6295	.5061
2003	46765	271496	90772	46555	.5129	.4262
2004	28611	239650	86396	46115	.5338	.4001
Arith. Mean	41144	187658	96008	34718	.3802	.3374
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

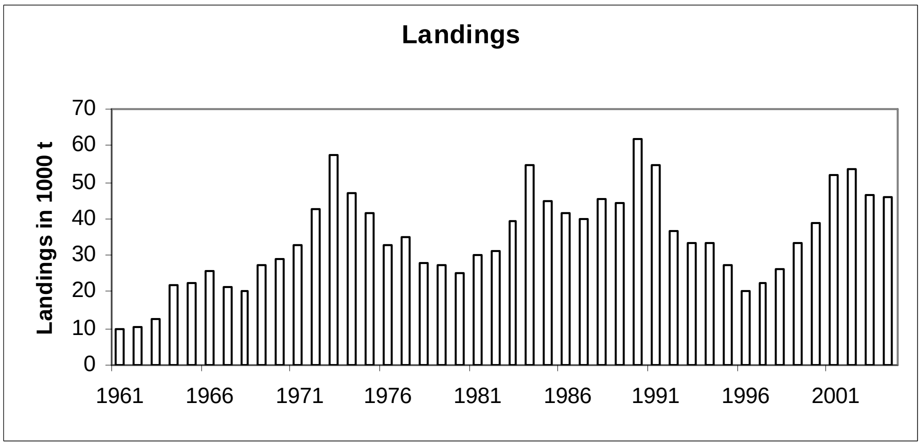


Figure 2.5.1.1. Saithe in the Faroes (Division Vb). Landings in 1000 tonnes.

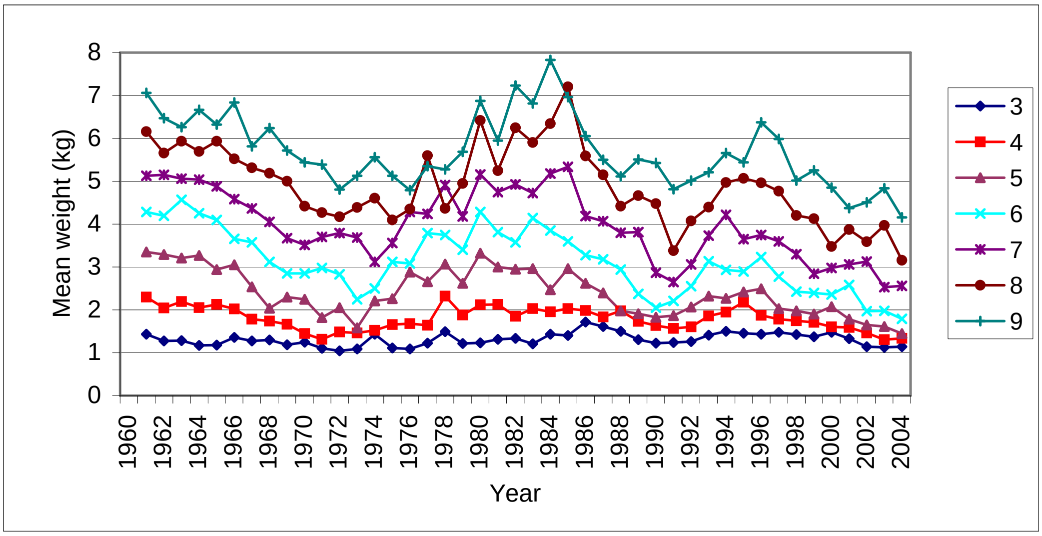


Figure 2.5.3.1. Saithe in the Faroes (Division Vb). Mean weight (kg) at age in the catches in 1961-2004.

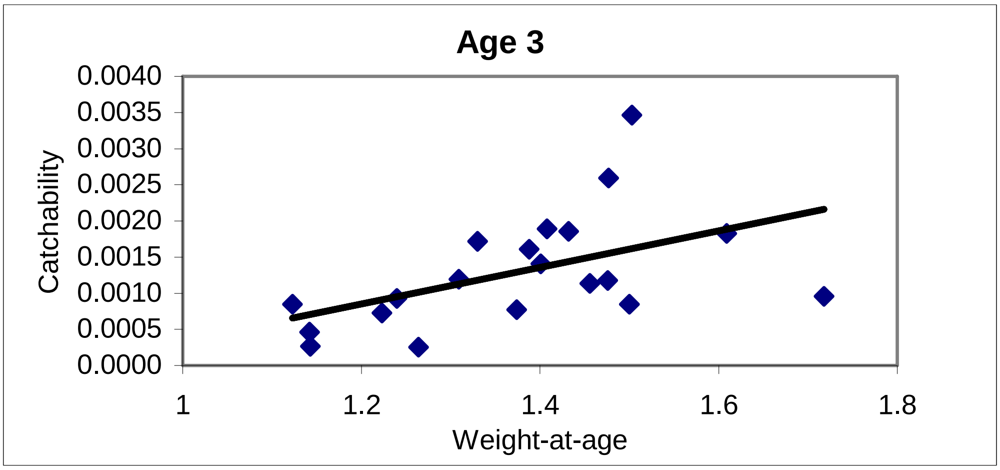
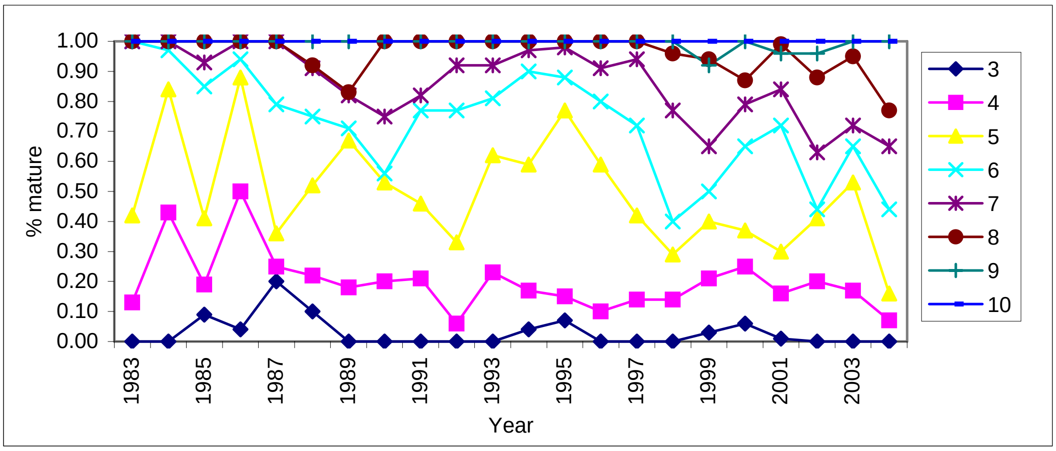


Figure 2.5.3.2. Saithe in the Faroes (Division Vb). Relation between weight at age and catchability for age 3.



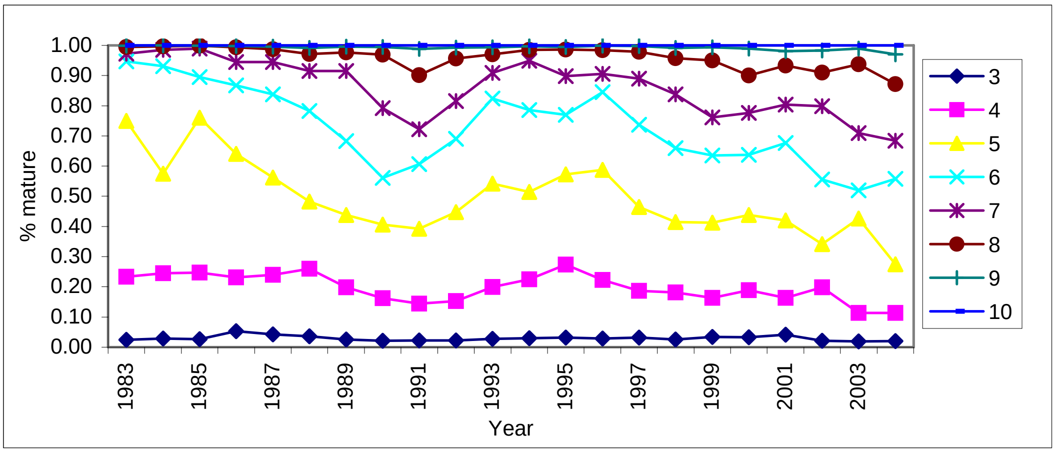


Figure 2.5.4.1. Saithe in the Faroes (Division Vb). Observed (upper figure) and fitted values (lower figure) proportion mature at age for the period 1983-2004.

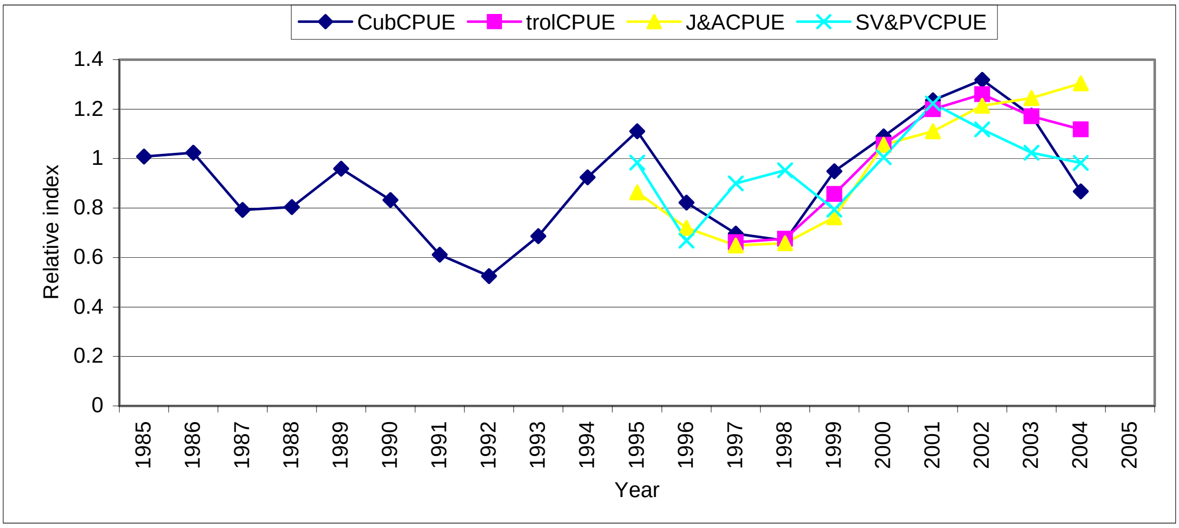


Figure 2.5.5.1. Saithe in the Faroes (Division Vb). Relative CPUE index for the different trawlers.

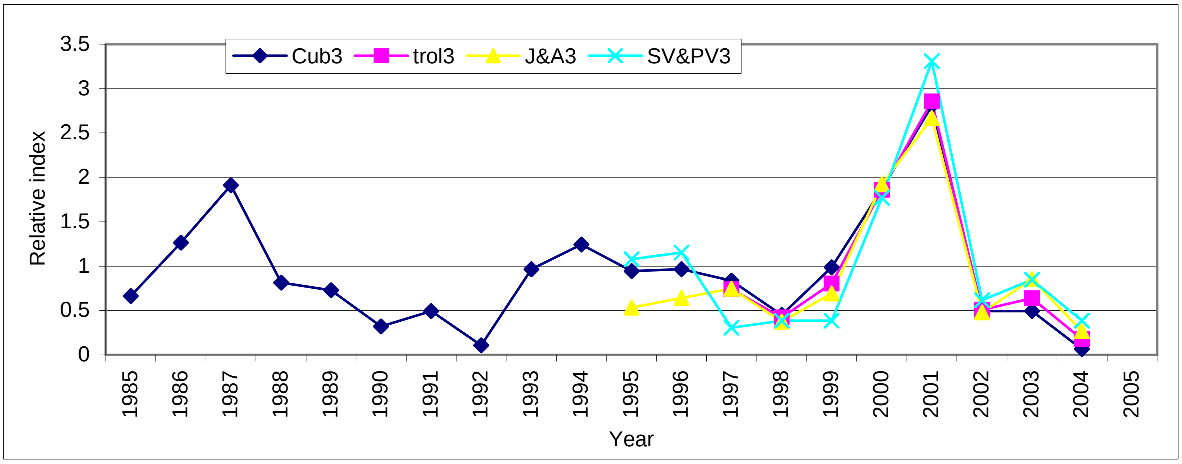


Figure 2.5.5.2. Saithe in the Faroes (Division Vb). Relative index age 3 for the different trawlers.

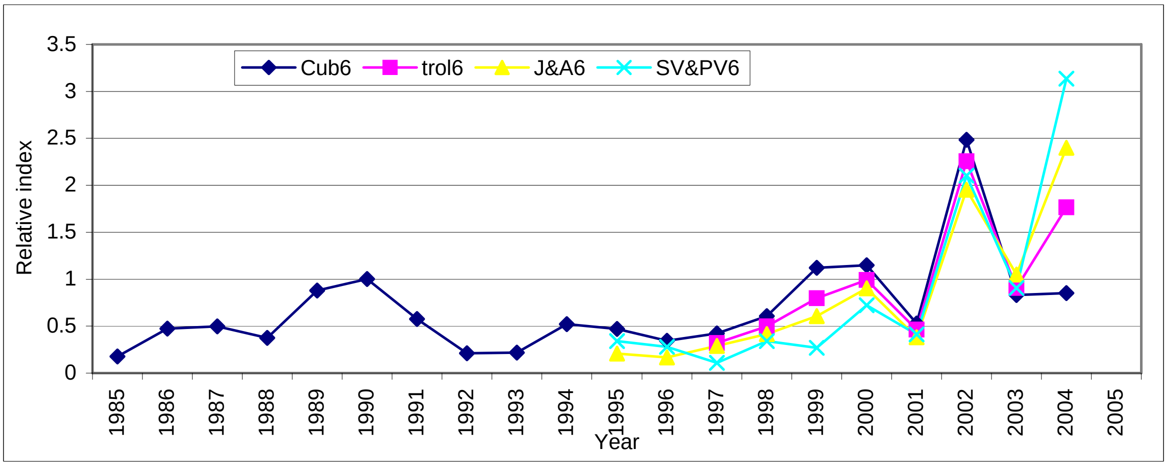


Figure 2.5.5.3. Saithe in the Faroes (Division Vb). Relative index age 6 for the different trawlers.

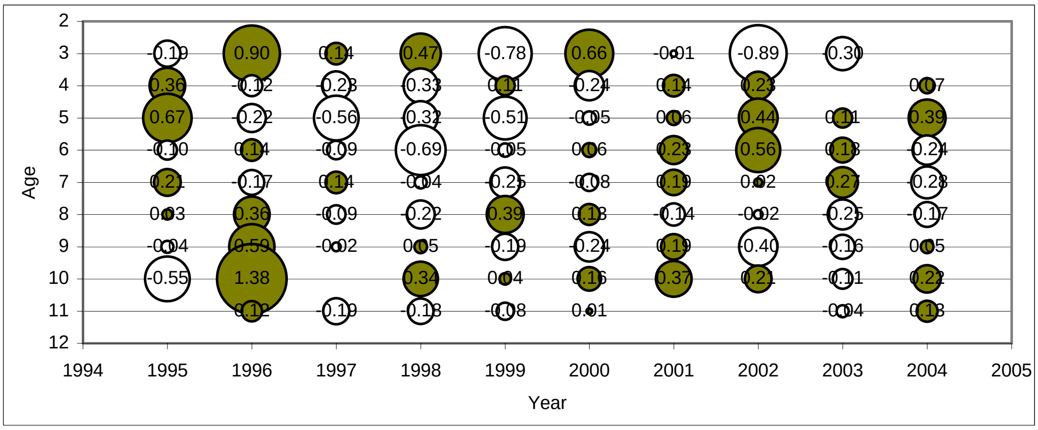
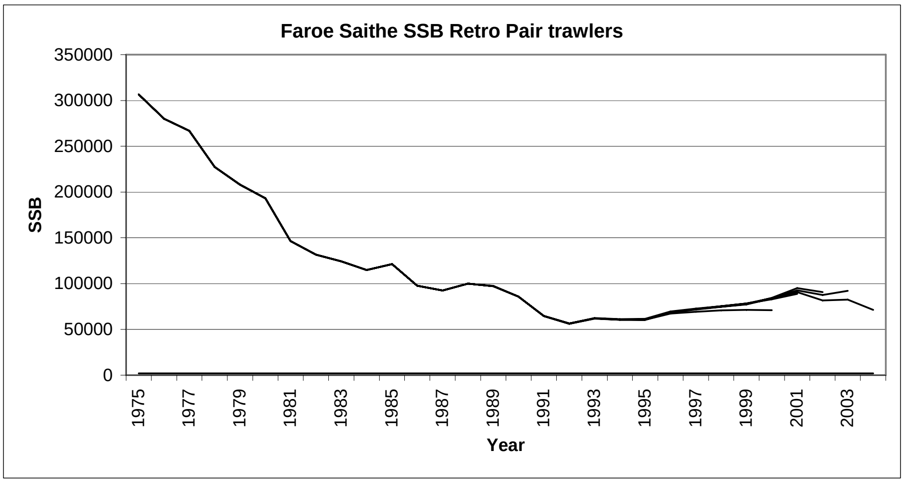


Figure 2.5.5.4. Saithe in the Faroes (Division Vb). Log catchability residuals for age groups 3 -11 from XSA.



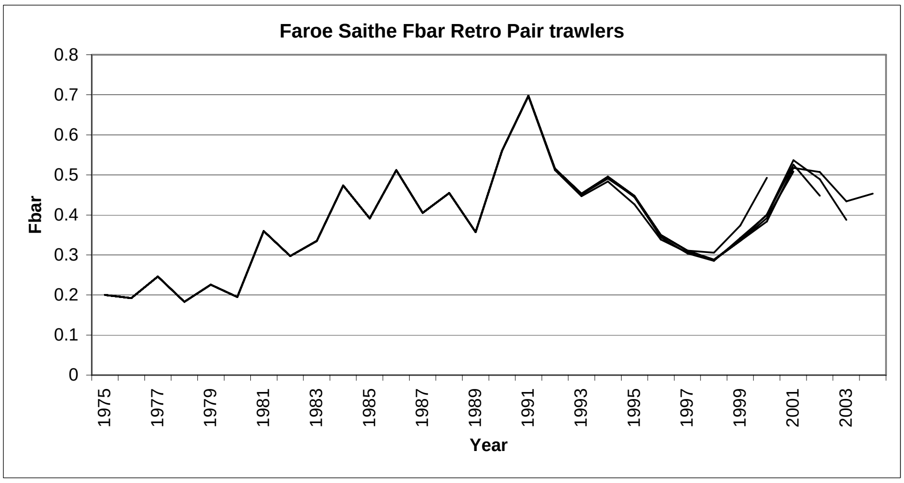


Figure 2.5.5.5. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from Adapt (upper figure) and retrospective analysis of average fishing-mortality of age groups 4-8 from Adapt (lower figure).

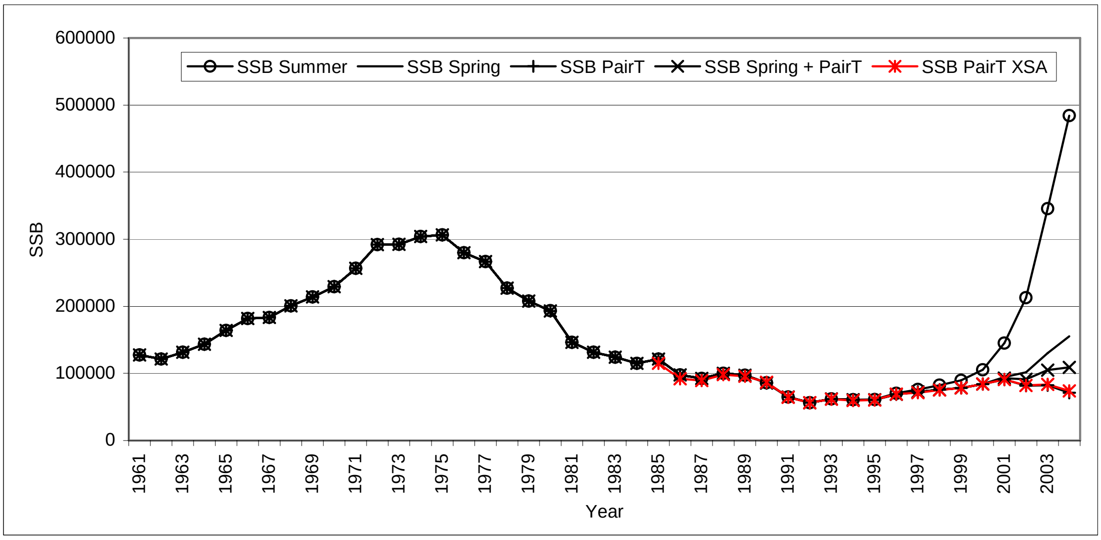


Figure 2.5.5.6. Saithe in the Faroes (Division Vb). Comparison between SSB from Adapt run and XSA run.

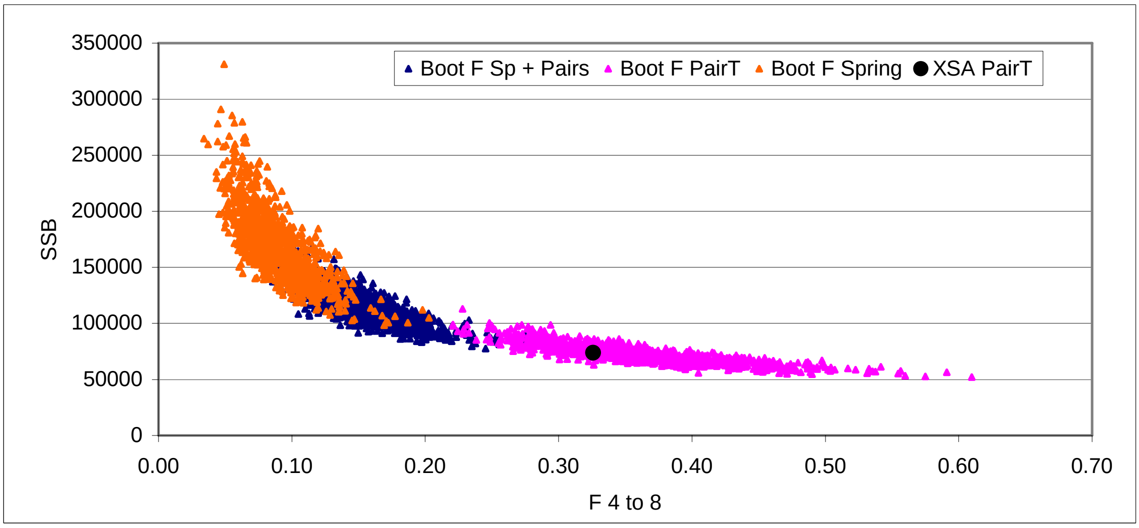


Figure 2.5.5.7. Saithe in the Faroes (Division Vb). Bootstrapped SSB and F on the pair trawler fleet ages 3-11, spring survey ages 3-9, pair trawlers and spring survey combined and the output from XSA on the pair trawlers.

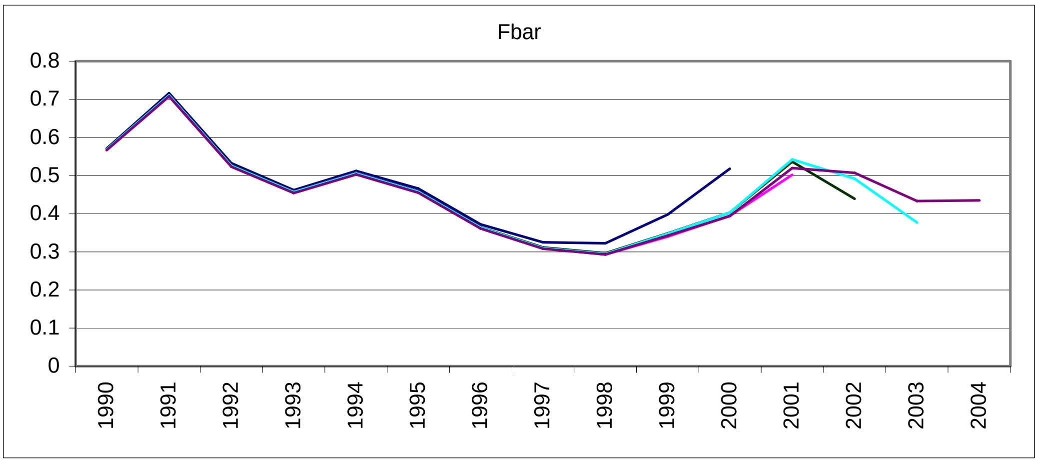


Figure 2.5.5.8. Saithe in the Faroes (Division Vb). Retrospective analysis of average fishingmortality of age groups 4-8 from XSA for the years 1997-2004.

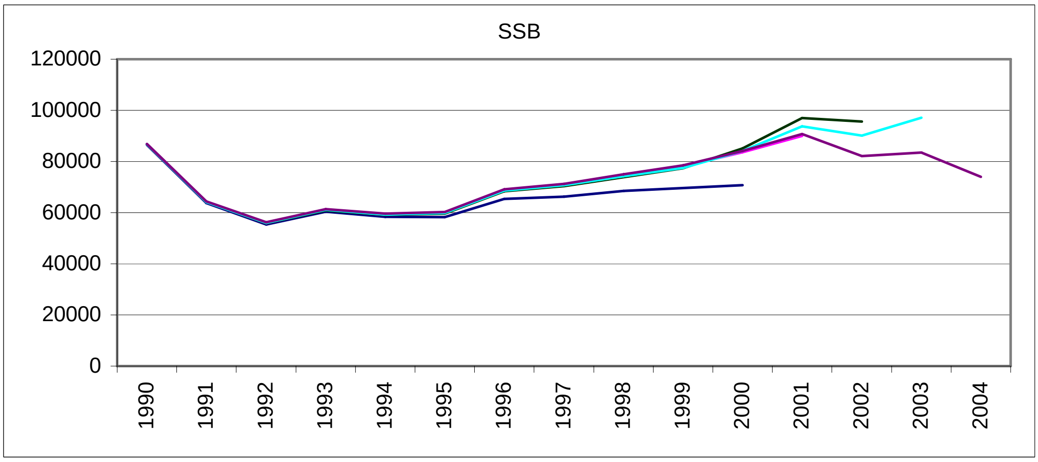


Figure 2.5.5.9. Saithe in the Faroes (Division Vb). Retrospective analysis of spawning stock biomass of age groups 4-8 from XSA for the years 1997-2004.

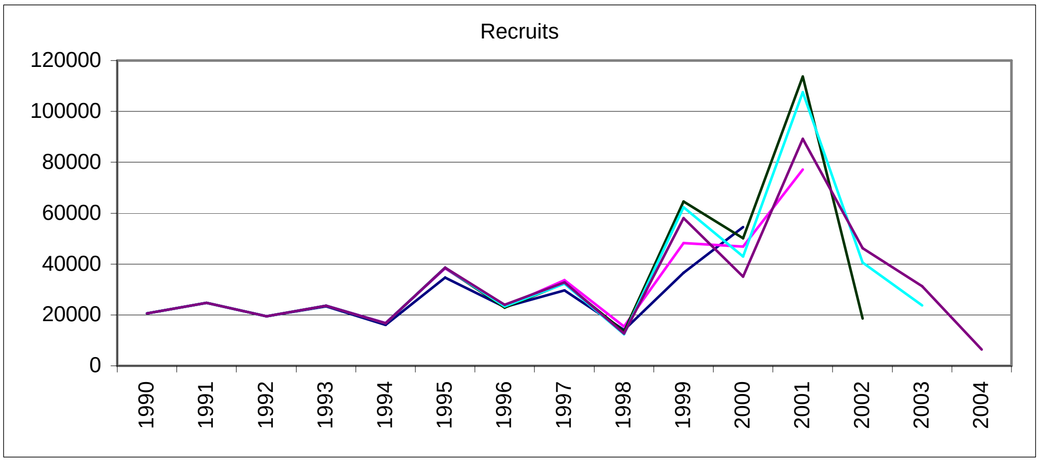


Figure 2.5.5.10. Saithe in the Faroes (Division Vb). Retrospective analysis of average recruitment for age 3 from XSA for the years 1997-2004.

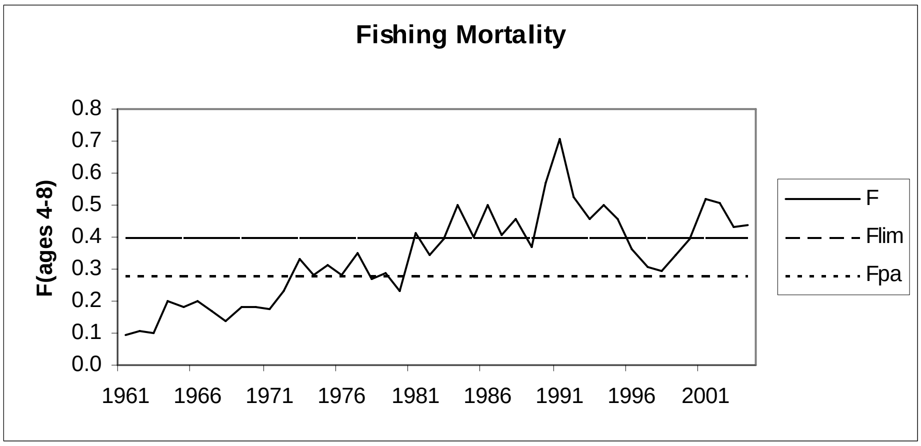


Figure 2.5.5.11. Saithe in the Faroes (Division Vb). Fishing mortality (average F ages 4-8).

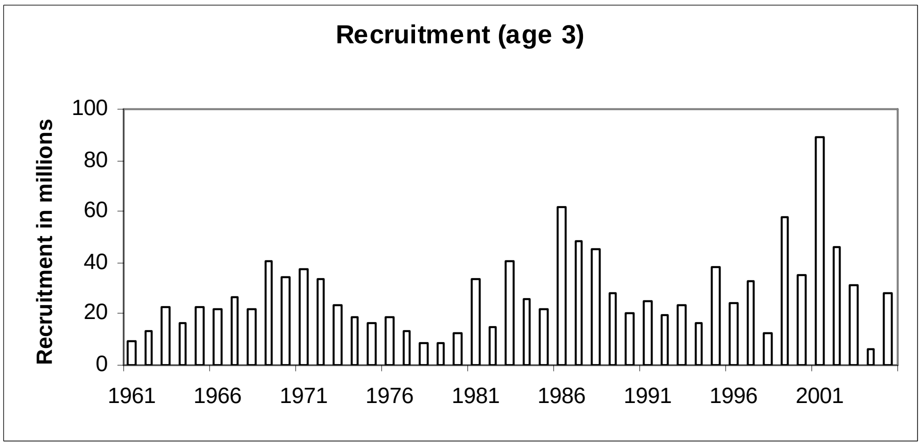


Figure 2.5.5.12. Saithe in the Faroes (Division Vb). Recruitment at age 3 (millions).

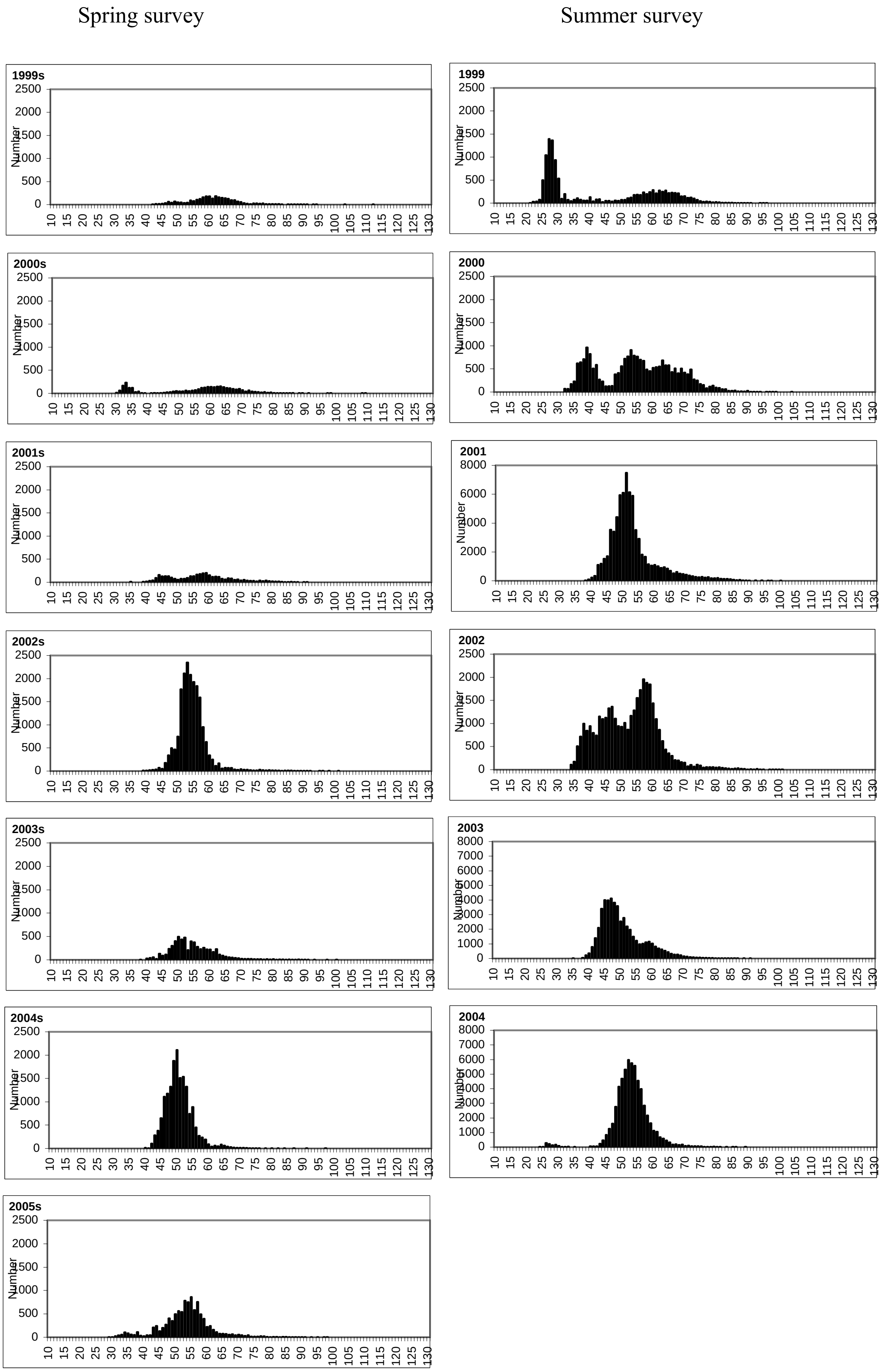


Figure 2.5.5.13. Saithe in the Faroes (Division Vb). Length distribution from spring (s) and summer survey 1999-2005. NB! Different scale for year 2001, 2003 and 2004 summer survey.

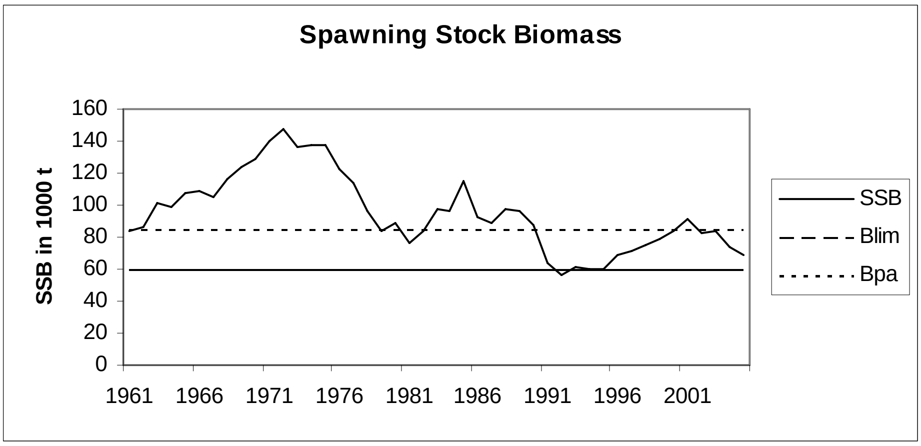


Figure 2.5.5.14 **Saithe in the Faroes (Division Vb). Spawning stock biomass (1000 tonnes).**

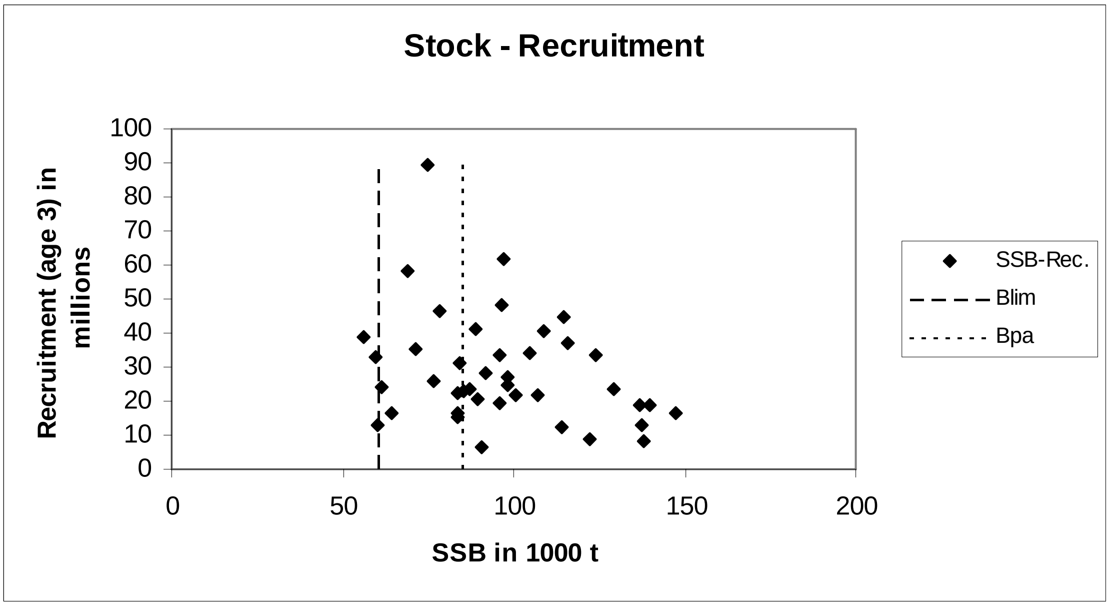


Figure 2.5.5.15 **Saithe in the Faroes (Division Vb). Stock-Recruitment plot.**

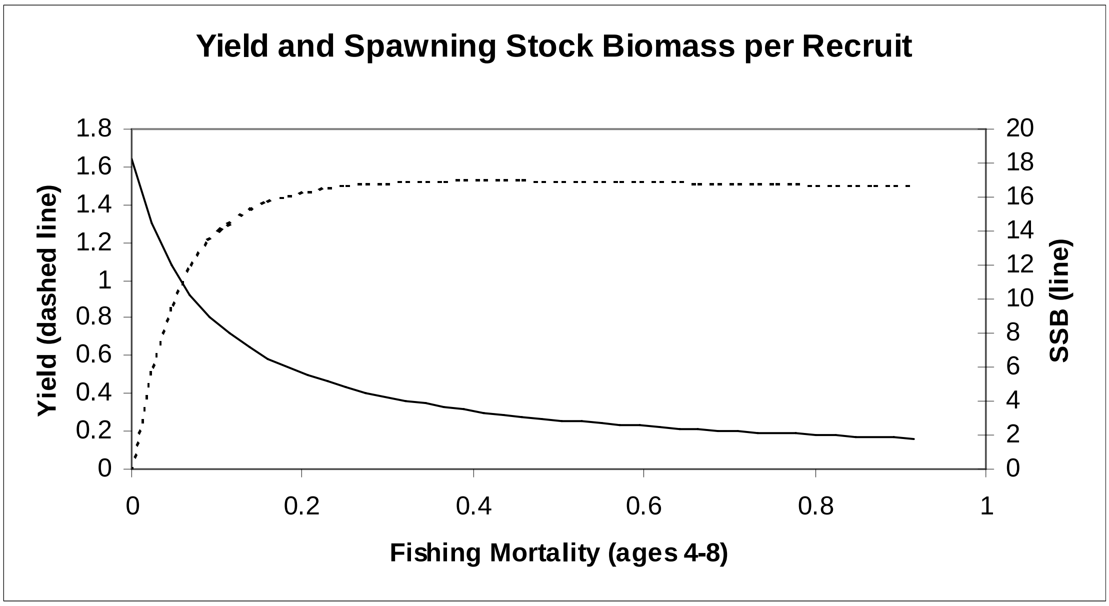


Figure 2.5.6.1 Saithe in the Faroes (Division Vb). Fish stock summary.

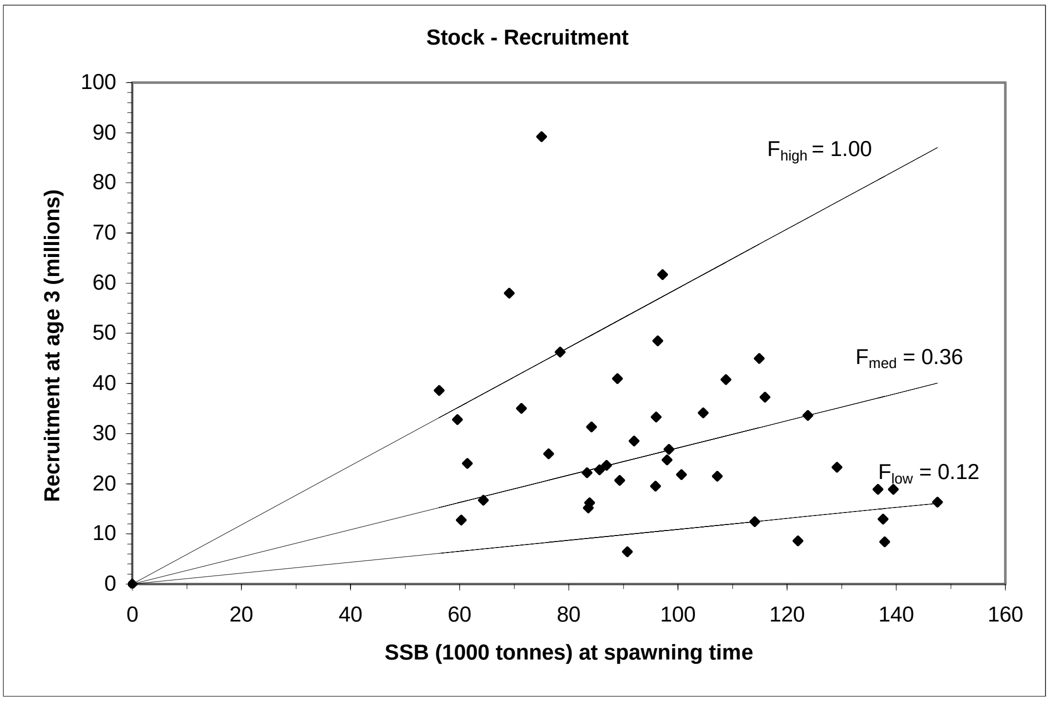


Figure 2.5.6.2 Saithe in the Faroes (Division Vb). Stock- recruitment.

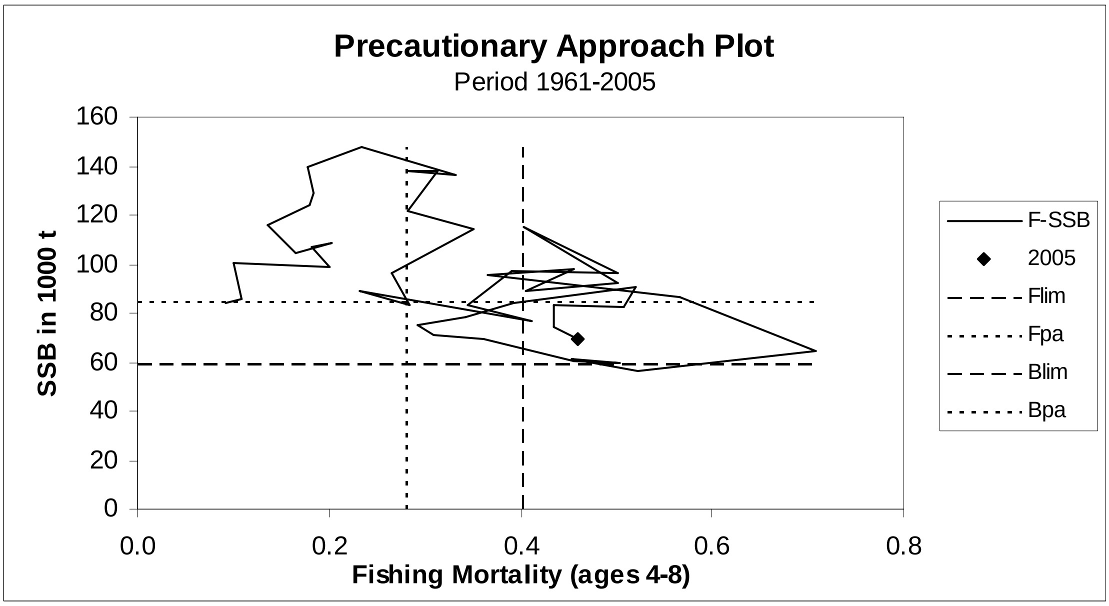
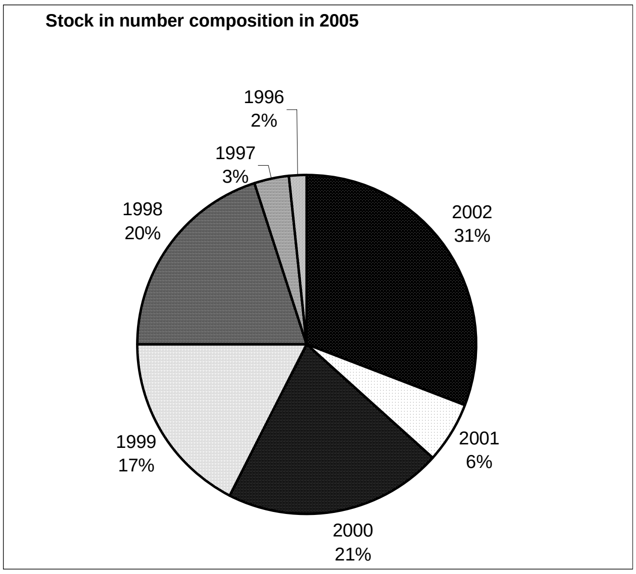


Figure 2.5.6.3. Saithe in the Faroes (Division Vb). The history of the stock/fishery in relation to the four reference points.



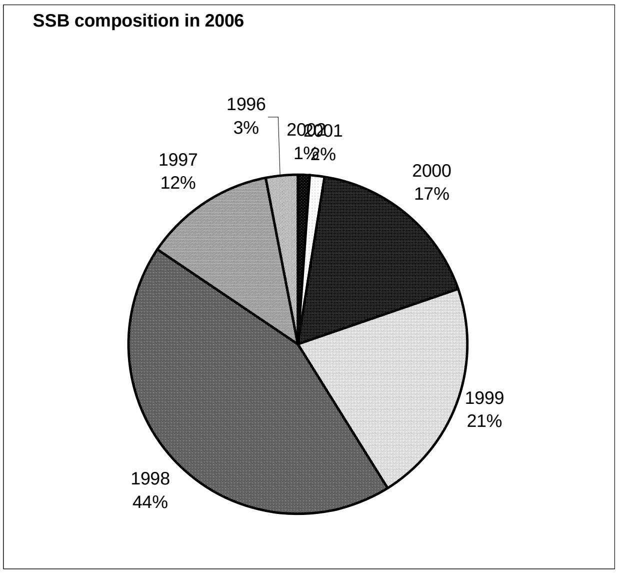


Figure 2.5.6.4. Saithe in the Faroes (Division Vb). Projected composition in number by year classes in the catch in 2005 (left figure) and the composition in SSB in 2006 by year classes (right figure).

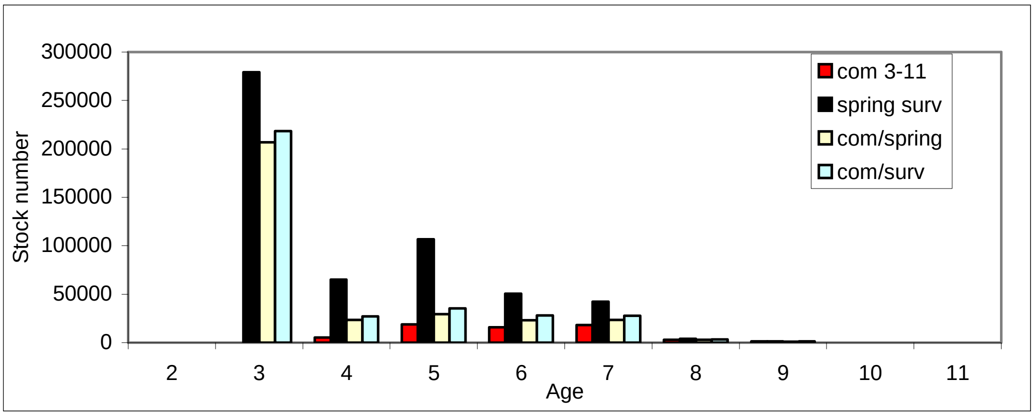


Figure 2.5.8.1. Saithe in the Faroes (Division Vb). Stock number at age in year 2005 a comparison between different XSA runs. Approved serie of the commercial pair trawlers are in the red columns (com 3-11). spring surv- spring survey series, com/spring- combined commercial and spring survey and com/surv- commercial, spring and summer survey combined.

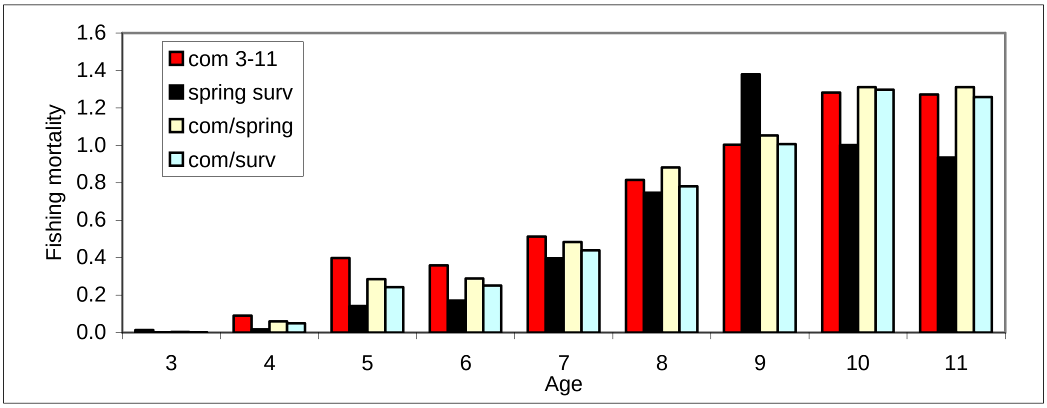


Figure 2.5.8.2. Saithe in the Faroes (Division Vb). Fishingmortality at age in year 2003. Comparison between different XSA runs. Approved serie of the commercial pair trawlers are in the red columns. Legends are explained in the text in figure 2.5.8.1.

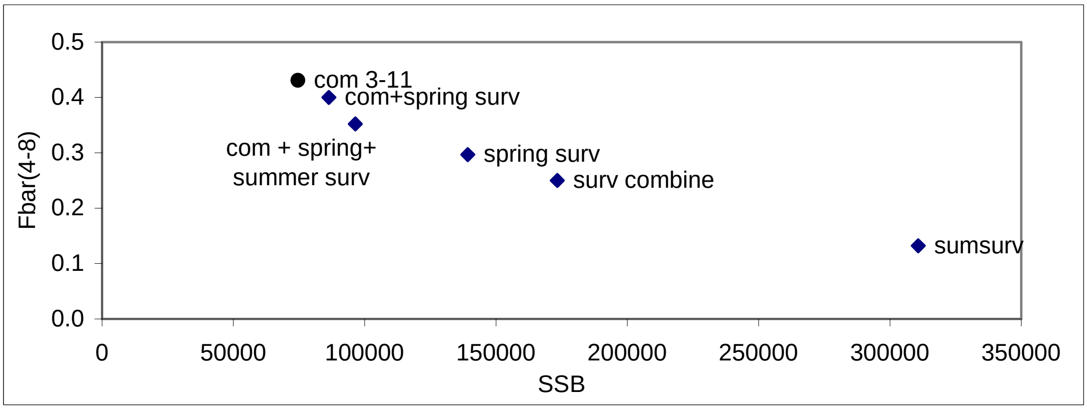


Figure 2.5.8.3. Saithe in the Faroes (Division Vb). Comparison between results from different XSA runs. The results from the approved run is showed as a black circle. Legends are explained in the text in figure 2.5.8.1.

3 Stocks in Icelandic waters

3.1 Ecosystem overview

3.1.1 Historical

The marine ecosystem around Iceland is located south of the Polar Front in the northern North Atlantic. The area to the south and west of Iceland is dominated by the warm and saline Atlantic water of the North Atlantic Current. Of the highest importance for the ecosystem of Icelandic waters, is the westernmost branch of the North Atlantic Current system, called the Irminger Current, running north just west of the Reykjanes Ridge. The Irminger Current splits off NW-Iceland.. The eastern branch rounds the Vestfirdir peninsula and continues east over the N-Icelandic shelf where the Atlantic water mixes with colder waters of the East Icelandic Current, an offshoot from the East Greenland Current which carries cold polar water south along the E-Greenland shelf. The other branch of the Irminger Currents runs west across the northern Irminger Sea and then south along the Greenland shelf edge. Since most commercial fish species spawn in the Atlantic water off S- and SW-Iceland and initially drift to the west and northwest, both branches of the Irminger Current play a key role in the transport of larval and juvenile fish from spawning grounds south and west of Iceland to nursery areas, not only off N- and E-Iceland but also across to E- and then W-Greenland.

Hydrobiological conditions are most stable in the Atlantic water south and west of Iceland, but more variable in the mixing areas over the North- and East-Icelandic shelf. In these northern and eastern areas large hydrobiological changes, caused by relative variability of the influence of these warm and cold watermasses, have been observed both on short (annual) and longer (decadal) time scales. The general effects of such changes have been increased bioproduction during warm periods as compared to cold ones, and resulted in extensive distribution and productivity changes of many commercial stocks. Historically, cod and herring are the most prominent examples of such change.

3.1.2 Present observations

Around the mid-1990s a rise in both temperature and salinity were observed in the Atlantic water south and west of Iceland. The positive trend has continued ever since and west of Iceland amounts to an increase of temperature of about 1˚C and salinity by one unit (0.1 promille). These are very large changes for Atlantic water in this area and are shown in Figure 3.1.

Off central N-Iceland a similar trend is observed, but is of necessity more irregular since this is an area of variable mixing of warm and cold watermasses. Nevertheless, the trend is unmistakable and is indeed larger than in the Atlantic water off W-Iceland (the same has been observed off SE-Iceland as well). The increase of temperature and salinity north of Iceland in the last 10 years is on average about 1.5˚C and 1.5 salinity units as shown in Figure 2.

It appears that these changes have had considerable effects on the fish fauna of the Icelandic ecosystem. Such changes would be expected to first affect pelagic species and indeed have been observed for herring, capelin and blue whiting. Thus, the Icelandic summer spawning herring have increased their distribution in the last few years despite little changes of stock abundance. Capelin have both shifted their larval drift and nursing areas far to the west to the colder waters off E-Greenland, the arrival of adults on the overwintering grounds on the outer shelf off N-Iceland has been delayed and migration routes to the spawning grounds off S- and W-Iceland have been located farther off N- and E-Iceland and not reached as far west along the south coast as was the rule in most earlier years. However, these changes have not had a negative effect on the size of the capelin stock. The semi-pelagic blue whiting has lately been found and fished in E-Icelandic water in far larger quantities than ever before. Finally, part of the Norwegian spring spawning herring, albeit very small, was observed and fished east Iceland in autumn 2004. This has not happened since 1968.

The effect of warmer waters has also been conspicuous for those demersal species, which are at or near their northern distribution limit in Icelandic waters (Fig. 3). The most obvious examples of increased abundance of such species in the mixed water area north of Iceland are haddock, whiting, monkfish, lemon sole and witch. On the other hand, coldwater species like Greenland halibut and northern shrimp have become more scarce.

However, there is one demersal stock (not shown in Fig. 3) , which apparently has not taken advantage, or not been able to take advantage, of the milder marine climate of Icelandic waters. This is the Icelandic cod, which flourished during the last warm epoch, which began around 1920 and lasted until 1965. By the early 1980s the cod had been fished down to a very low level as compared to previous decades and has remained relatively low since. During the last 20 years the Icelandic cod stock has not produced a large year class and the average number of age 3 recruits in the last 20 years is about 150 million fish per annum, as compared to 205-210 recruits in almost any period prior to that, even the ice years of 1965-1971. Immigrants from Greenland are not included in this comparison. It is not possible to pinpoint exactly what has caused this change, but a very small and young spawning stock is the most obvious common denominator for this protracted period of impaired recruitment to the Icelandic cod stock. Regulations, particularly the implementation of the catch rule in 1993 have resulted in lower fishing mortalities in the last ten years compared with the ten years prior and has, despite low recruitment resulted in almost doubling of the spawning stock biomass since 1993. These improvement in the SSB biomass has however not resulted in significant increase in production in recent years, despite increased inflow of warmer Atlantic water.

Associated with the large warming of the 1920s, was a well documented drift of larval and 0-group cod. as well as some other fish species, from Iceland across the northern Irminger Sea to E- and then W-Greenland. Although many of these fish apparently returned to Iceland to spawn and did not leave again, there is little doubt that those cod, remaining in W-Greenland waters which also had warmed, were instrumental in establishing a self-sustaining Greenlandic cod stock that eventually became very large. It seems that significant numbers of cod of the 2003 year class have drifted across to Greenland in that year and are now growing at W-Greenland.

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

This sections 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 thoughough analysis that is a requisite to making a fishery based advice.

3.1.4 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 2004. 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 2004 amounted to 1.6 million tonnes where pelagic fishes amounted to 1.1 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 2004 by species and gear type is given in **Table 3.1**. Overview of where catches of most importand demersal species are taken in 2004 are given in **Figure 3.3-1**-**Figure 3.3-3**, divided by gear type and distribution of effort is shown in figures **Figure 3.3-4** and **Figure 3.3-5**. In the electronic logbook data total of 189.266 individual hauls/sets, divided by gear as follows:

GEAR TYPE	NO. OF HAULS/SETS
Pelagic trawl	5 446
Bottom trawl	64 438
Shrimp trawl	9 129
Nephrops trawl	5 326
Gillnet	18 231
Longline	20 977
Purse seine	3 112
Jiggers *	17 319
Danish seine	45 268
* number of fising days	

3.1.4.1 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 3.3-6

3.1.4.2 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. (Figure 3.3-7) Targetted 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 2004, divided by gear type and overview of the number of vessels in each fleet category is given in the textable above.

Figure 3.3-1 gives overview where the most importand demersal species in Icelandic waters are caught with bottom trawl. **Figure 3.3-2** shows where the same species are caught using longline and **Figure 3.3-3** shows the distribution of the catches in 2004 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). 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, dab, lemon sole 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 3.3-4** - **Figure 3.3-5**. In general, the trawlers operate further away from the shore than the longliners.

3.1.5 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 (Figure 3.3-7) which is fished in waters deeper than 500 m west and southeast of Iceland. The bycatch in the greenland halibut fishery in these areas 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 total 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 3.3-8 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 3.3-9** 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 3.3-10** 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 3.3-8** and in **Figure 3.3-9**, 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.

3.1.6 Discards in demersal fisheries

Discarding measurements have been carried out in Icelandic fisheries since 2001, based on extensive data collection and length based analysis of the data (Pálsson 2003). The data collection is mainly directed towards main fisheries for cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) and towards saithe (*Pollachius virens*) and golden redfish (*Sebastes marinus*) fisheries in demersal trawl and plaice in Danish seine. Sampling for other species is not sufficient to warrant a satisfactory estimation of discarding. The estimated cod discards is amounted to 1227 metric tons in 2004, 0.60% of landings, slightly more than in 2003 and considerably less than in 2001 and 2002. Haddock discards were estimated 2544 tons in 2004, 3.13%, considerably more than in 2002 and 2003 and similar as in 2001. Discarding of saithe and golden redfish was nil in 2004 and was negligible in previous years. Discards of plaice in the Danish seine fishery was estimated for the first time in 2004 and amounted to 7.11% of landings.

3.1.7 By-catch in the Icelandic blue whiting fishery

During May - December 2004 by-catch in the Icelandic blue whiting fishery in Icelandic and Faroese waters was analysed. Methods of data collection and analysis were the same as introduced in this project in 2003 (Pálsson 2005). From 42 trips (10.0% of all trips) 411 samples were collected in a randomized manner. By-catch species in the samples were quantified and length measured. In general, by-catch was a relatively rare occurrence, but associated with rather wide confidence limits. The by-catch can be divided into 3 groups in terms of quantity of a species: 1) Saithe and cod were recorded in 35.3% and 21.7% of samples, and their total by-catch was 2901 and 1076 tons, respectively. By-catch of saithe more than doubled since 2003 and that of cod was sevenfold by weight and ninefold as a proportion of total catch. 2) Silver smelt and lumpfish were less frequent than in 2003, and were recorded in 8.0% and 3.6% of samples, respectively, and their total by-catch was 79 and 76 tons, respectively. 3) The remaining 4 fish species were recorded in less than 2% of samples. In addition, unidentified cephalopods were recorded in 1.7% of samples. Spatial distributions of main species indicate that the by-catch is primarily caught in Icelandic waters. Length distributions indicate that the by-catch mainly constitutes the catchable component of the stocks in question. By-catches of saithe and cod were significantly higher in 2004 than in 2003.

3.1.8 Misreporting

Misreporting is not considered a major problem but no analytical assessment is available to support that general perspective. All landings from Icelandic fishing vessels are weighted and recorded at authorized ports of landing and send daily electronically to the Directorate of fisheries. Production figures from processing plants seem to be in "good" coherence with landings figures according to verbal statements from the Fisheries Directorate.

3.1.9 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.

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 2004, 73 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 3.3-11** shows map of such legislation that was in force in 2004. Some of them are temporarily, but others have been closed for fishery for decades.

3.1.9.1 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 in May 2004. The report has not been published and is only available in Icelandic. Based on simulation work with, the criterion to maximize the current value of the revenue from the cod fisheries taking into account biological interaction, the group recommended a new HCR using the average of last years TAC and 22% of the estimated reference biomass (B4+) in the assessment year. This HCR has not been adopted.

3.1.10 Comments

At present, ICES only assessess 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 adviced should be given for the Icelandic fishery ICES would also need to evaluate the status of these stocks.

3.1.11 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.

Pálsson, Ó K. 2003. A length based analysis of haddock discards in Icelandic fisheries. Fish. Res. **59**: 437-446 (http://www.sciencedirect.com).

Pálsson, Ó K. 2005. An analysis of by-catch in the Icelandic blue whiting fishery. Fish. Res. **73**: *135-146.* (http://www.sciencedirect.com).

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 2004. 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	Jiggers	Danish seine	Bottom trawl	Pelagic trawl	Nephrops trawl	Purse seine	Shrimp trawl	Other gears	Total
Capelin						161529		439521		0	601050
blue whiting						361865		0		0	361865
Herring	0				2	44517		77274		0	121793
Cod	57416	37348	14686	14224	95129	345	1334	0	44	585	221111
Haddock	23199	1701	68	8175	49850	350	419	0	30	18	83810
Saithe	1058	2220	2629	1334	54613	635	154	0	0	37	62680
Redfish	843	144	139	589	33289	48	443	0	8	0	35504
Deep water prawn		0				0		0	17036	0	17036
Greenland halibut	170	1392		0	13618	297		0	1	0	15478
Atlantic wolffish	5746	71	11	2011	5214	5	82	0	16	16	13173
deepwater redfish	1	0	0	0	12232	110		0		0	12343
Plaice	56	204	0	4040	1360	2	4	0	4	34	5705
ling	2016	545	7	174	656	0	320	0	0	7	3726
greater argentine,					3565	80		0		0	3645
spotted wolffish, leopard	1412	11	0	22	1820	6	3	0	1	4	3279
tusk, torsk, cusk	3006	28	8	0	85	0	7	0		0	3135
Dab	6	18	0	2896	33	0	0	0		0	2953
Monkfish	16	780	1	278	308	0	353	0		488	2224
Lemon sole	0	5	0	1569	609	1	25	0	1	0	2210
Witch	0	0		1732	57	0	333	0		0	2122
Long rough dab	6	4	0	1780	144	0	35	0	1	0	1970
Norway lobster			0			0	1437	0		0	1437
blueling, European ling	145	5		39	876	2	23	0		0	1090
whiting	224	24	2	84	690	0	22	0		0	1048
starry ray, thorny skate	314	133	0	440	117	1	0	0	0	7	1012
Other species											12708
Total	**95634**	**44633**	**17553**	**39389**	**274269**	**569794**	**4996**	**516795**	**17142**	**1195**	**1594109**

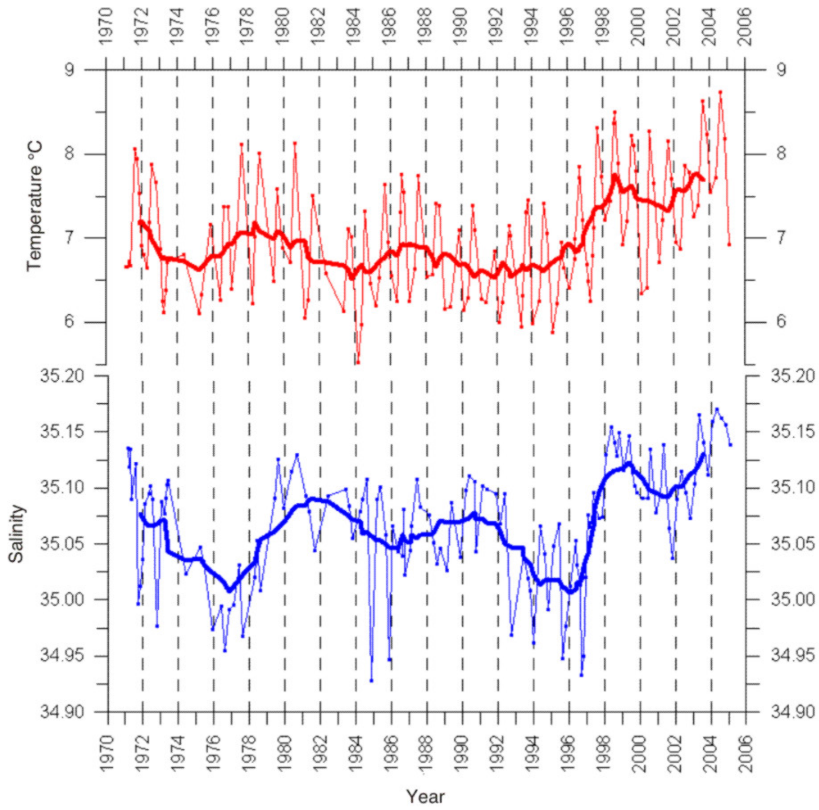


Figure 1. Changes of temperature and salinity west of Iceland 1970-2005.

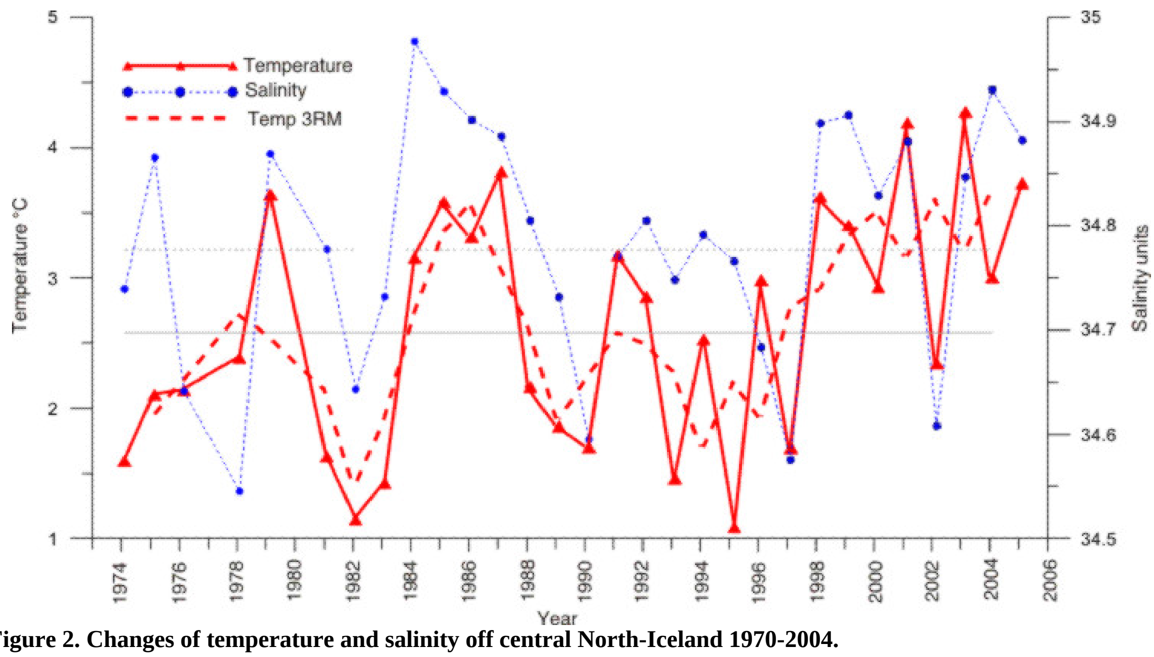


Figure 2. Changes of temperature and salinity off central North-Iceland 1970-2004.

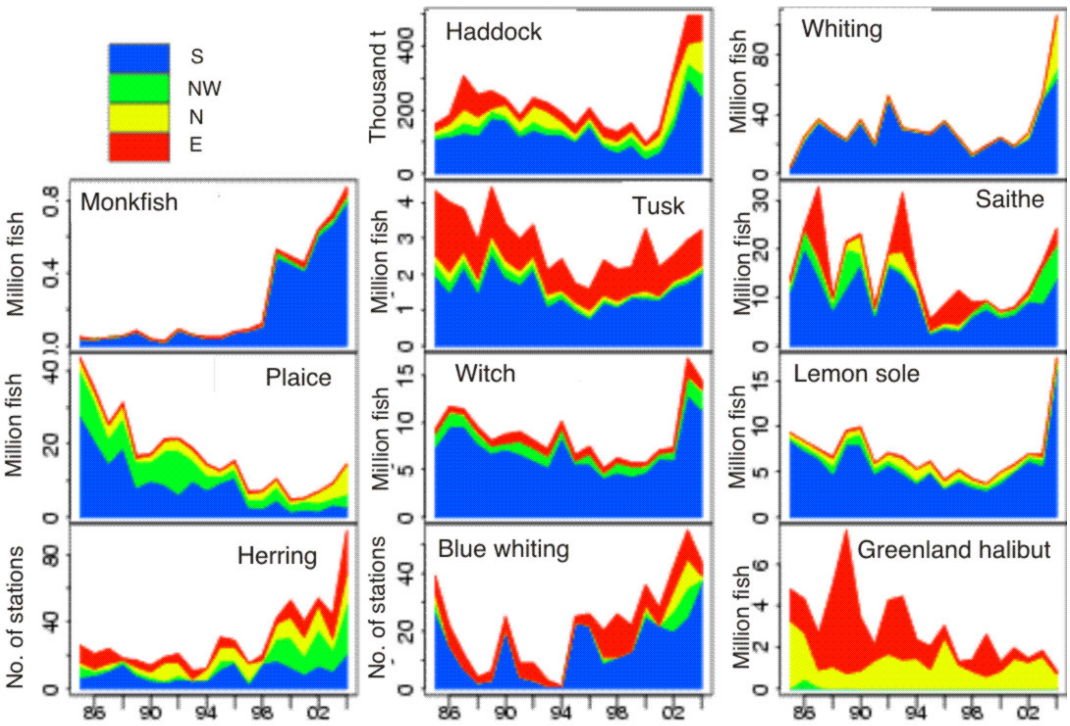


Figure 3. Changes of indices of abundance and geographical distribution of several fish stocks in Icelandic waters, 1985 - 2005. The denotations S, NW, N and E beside the color code shown in the top left corner stand for South-, Northwest-, North- and East-Iceland in that order.

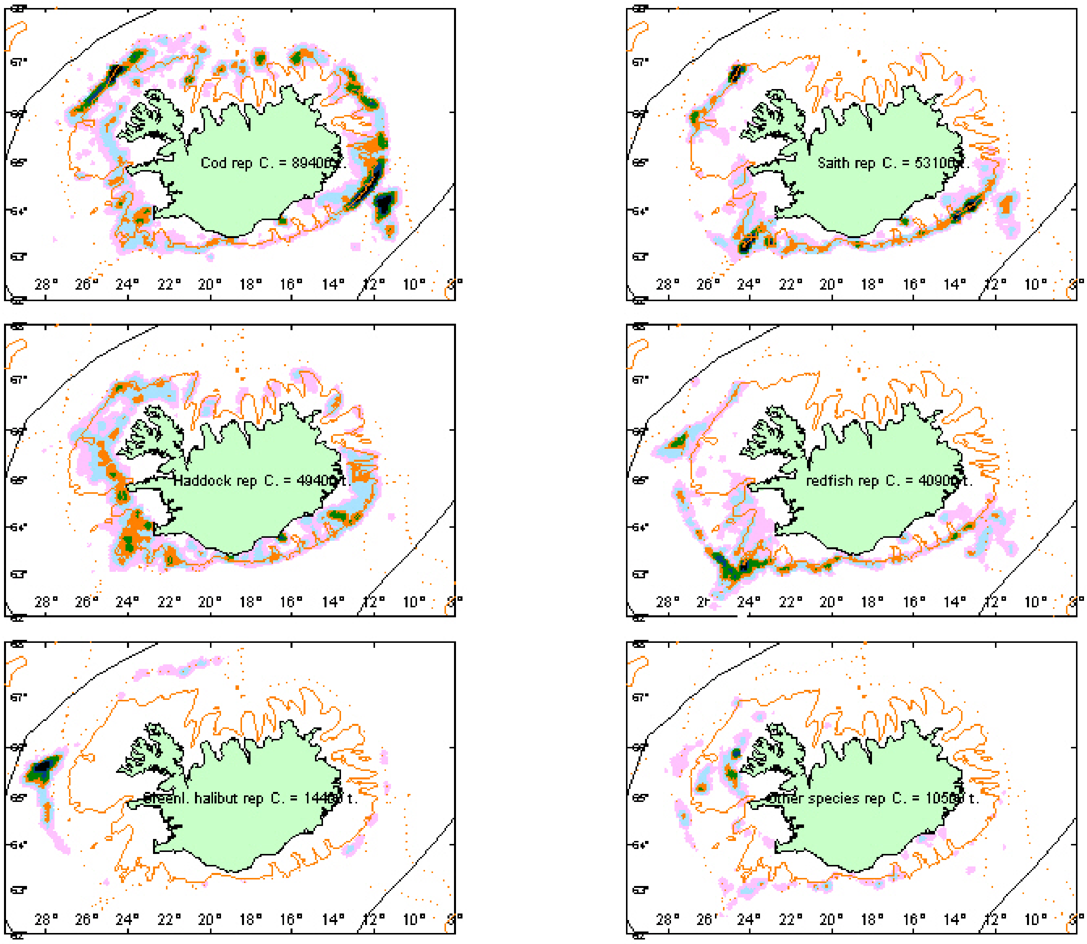


Figure 3.3-1. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with bottom trawl 2004.

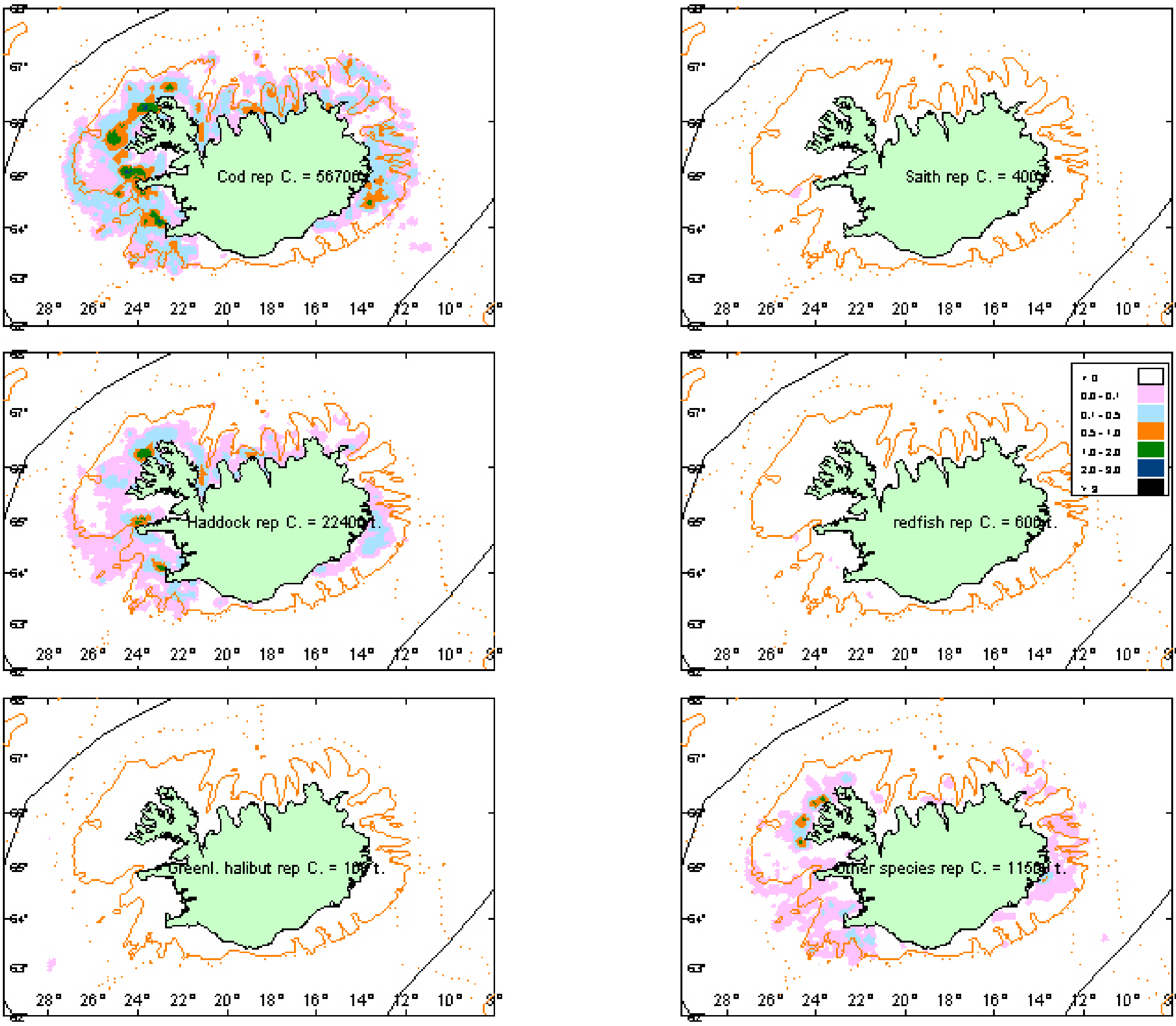


Figure 3.3-2. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with long-line in 2004.

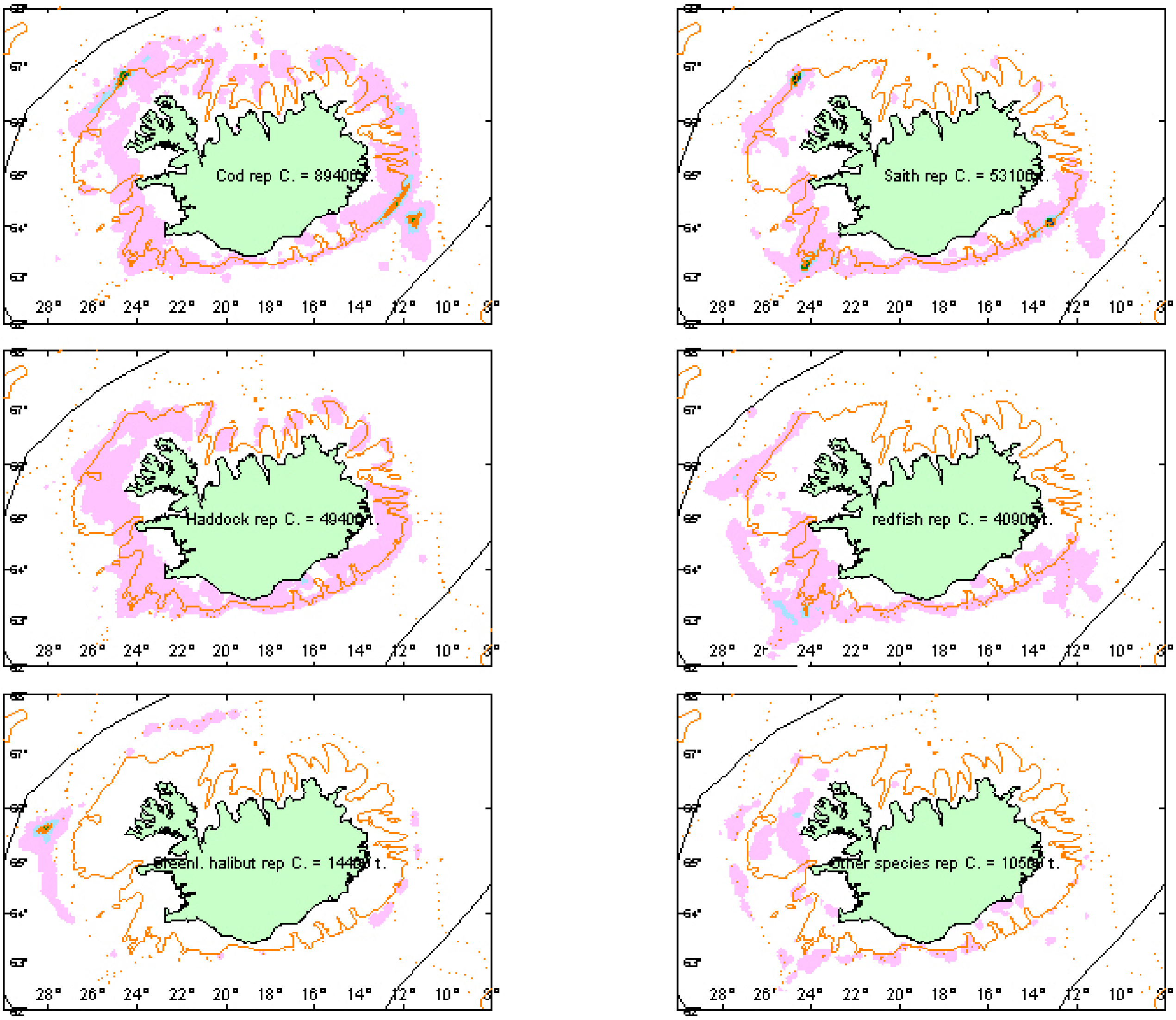


Figure 3.3-3. Location of catches of cod, saith, haddock, redfish, greenland halibut and others caught with gillnets in 2004.

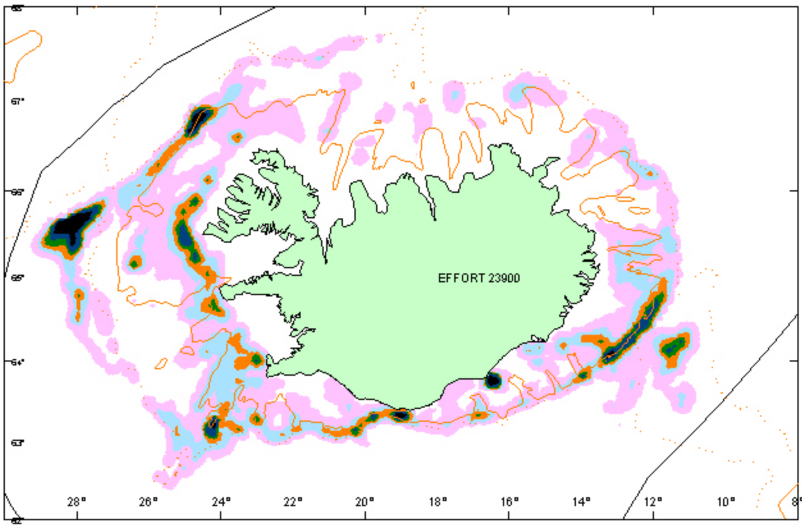


Figure 3.3-4. Effort of the trawler fleet in 2004. The dark colours show the areas of the greatest fishing effort to be off the southeast to the west coast and off Northwest Iceland.

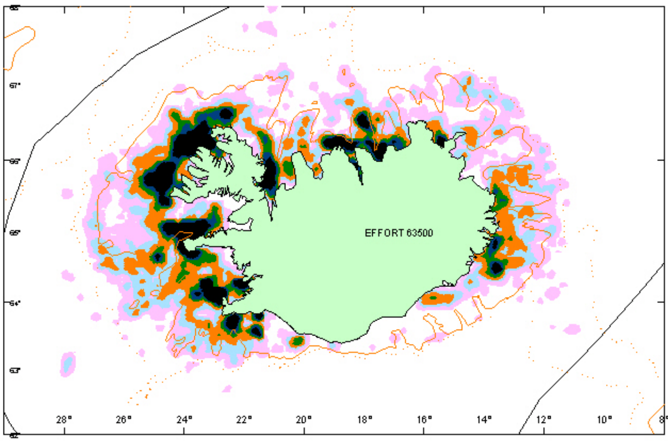


Figure 3.3-5. Effort in the longline fleet in 2004. The dark colours show the areas of the greatest fishing effort to be off the northwest and west coast but fishing is also concentrated along the entire southwest and south coast. The main targeted species for longline fishing are cod, haddock, catfish and tusk.

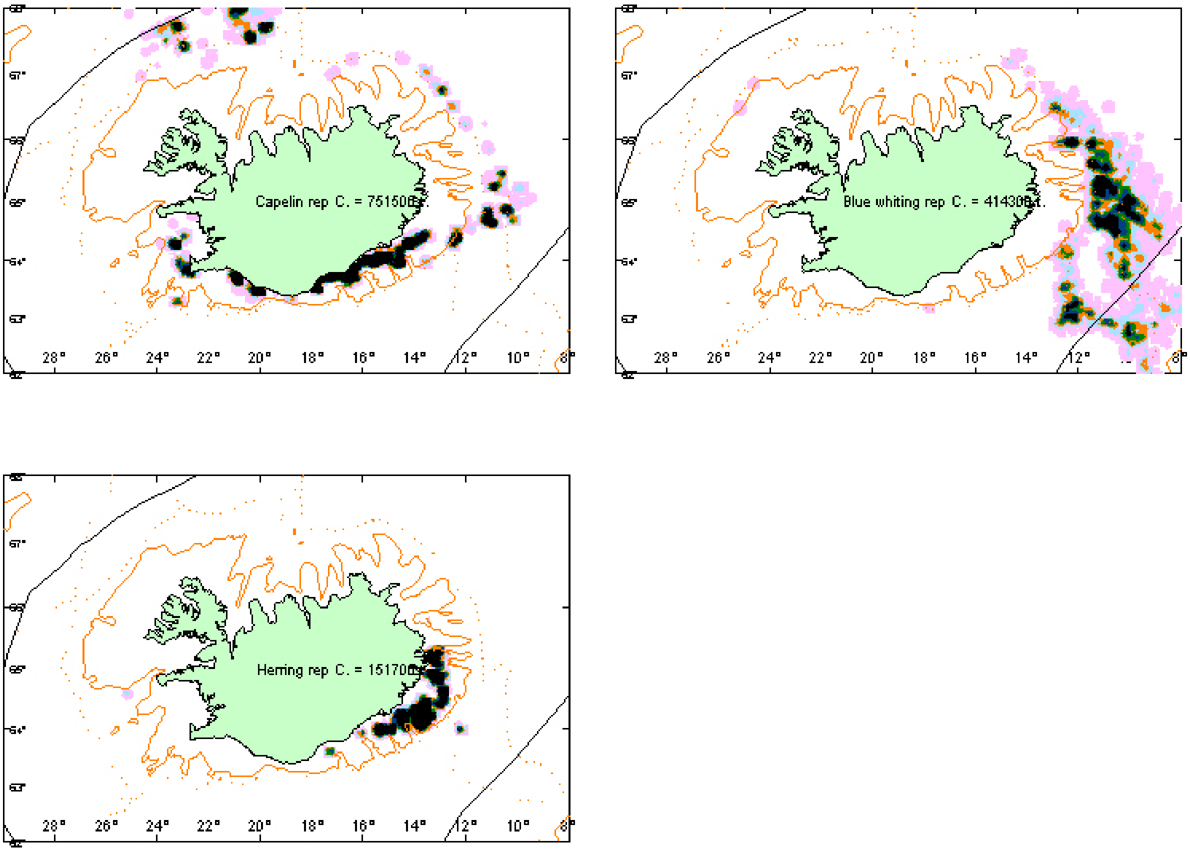


Figure 3.3-6. Location of catches of capelin, icelandic spring spawning herring and blue whiting with purse seine and pelagic trawls in 2004.

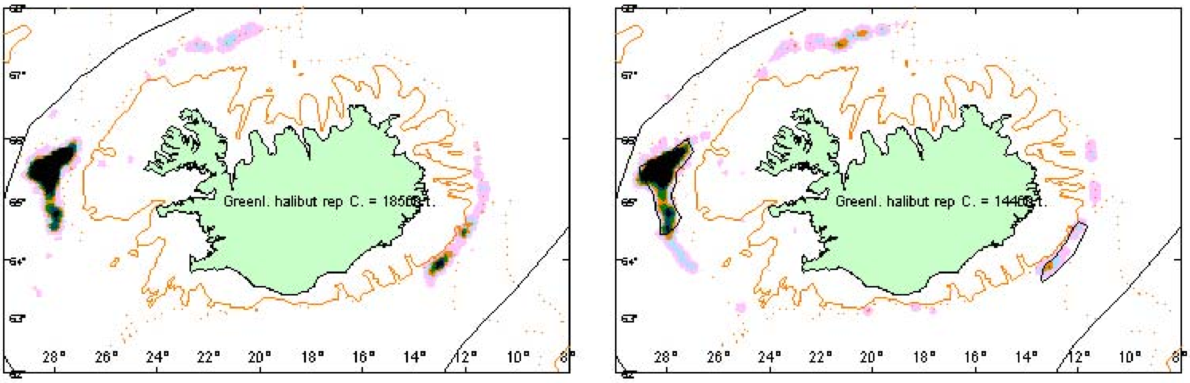


Figure 3.3-7. Greenland halibut Catches in 2003 (left) and 2004 (right). The boxes drawn on the figure indicates the areas refereed to in table the textable.

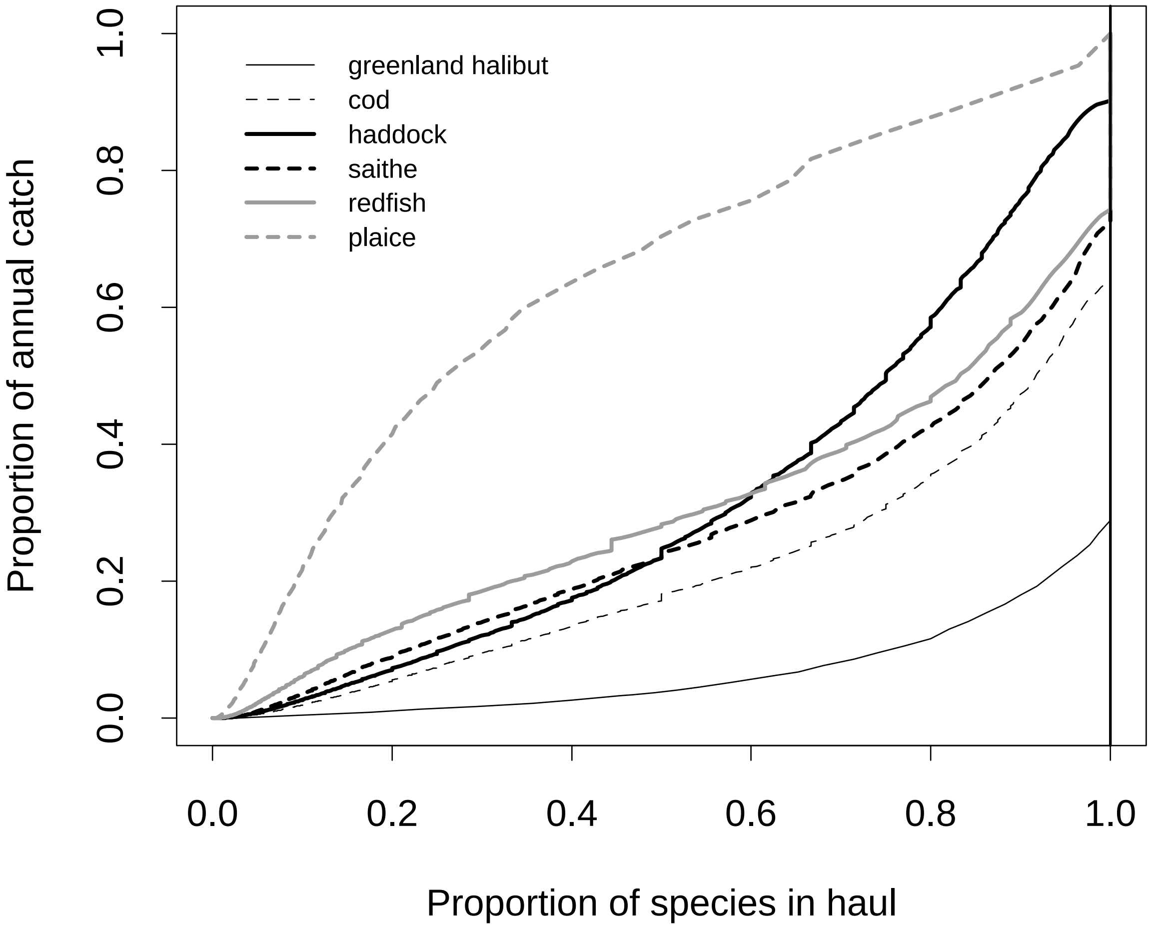


Figure 3.3-8. Cumulative plot for bottom trawl in 2004. An example describes this probably best. Looking at the figure above it can be seen from the dashed lines that 30% of the catch of haddock comes from hauls where haddock is less than 50% of the total catch while only 4% of the catch of greenland 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

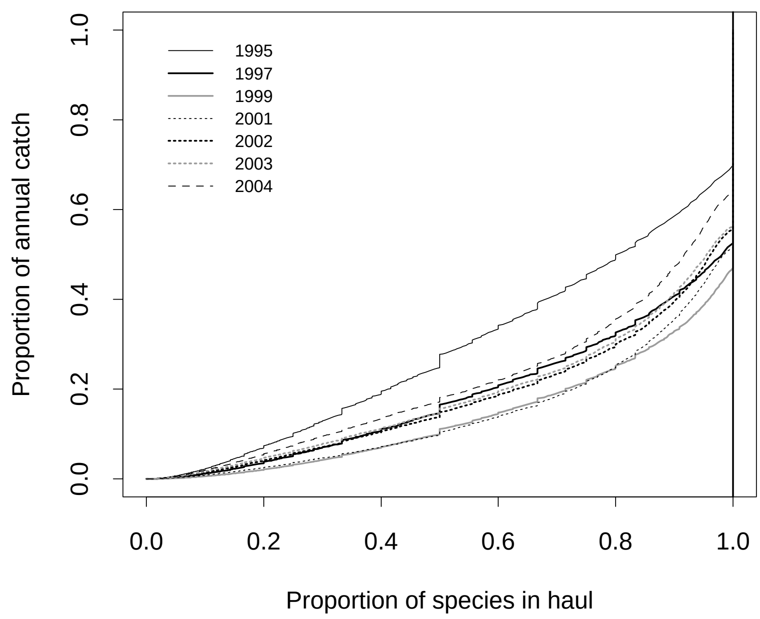


Figure 3.3-9. Cumulative plot for cod in the bottom trawl fishery.

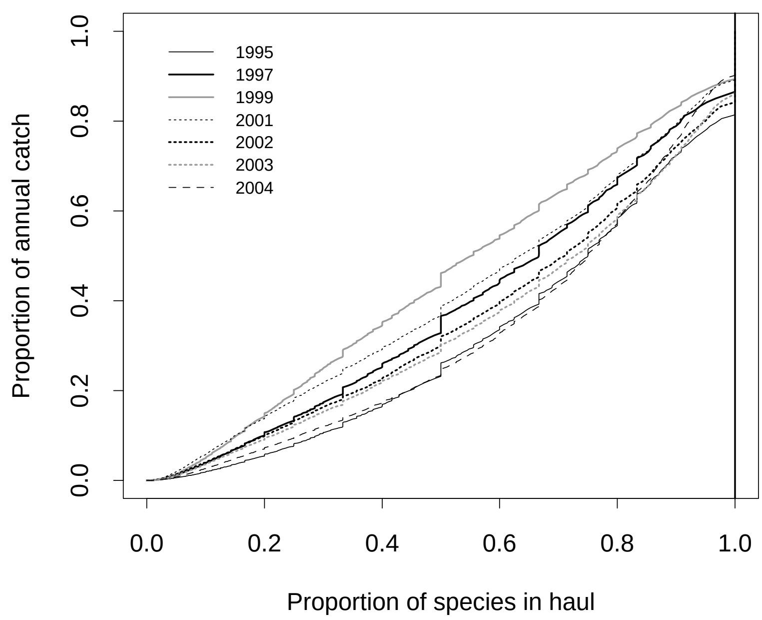


Figure 3.3-10. Cumulative plot showing haddock catch as proportion of haddock and cod catch in a haul instead as proportion of the total catch as in Figure 3.3-8-Figure 3.3-9.

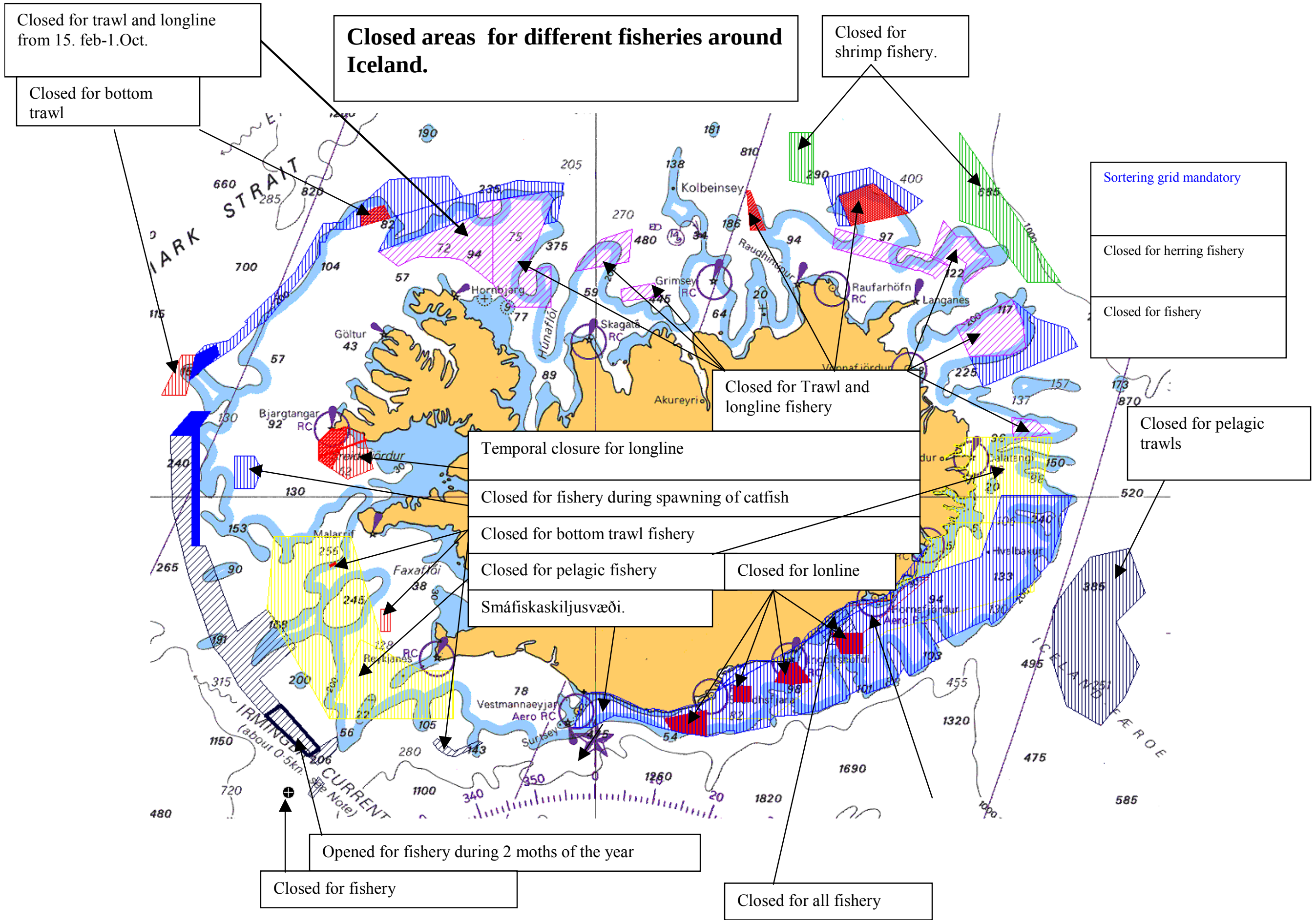


Figure 3.3-11. Overview of closed areas around Iceland. The boxes are of differnt nature and can be closed for differnt time period and gear type.

3.2 Saithe in Icelandic waters

3.2.1 Trends in landings, discards and bycatch

Saithe landings from Icelandic waters (ICES division Va) have increased gradually from a low of ~30 Kt in 1998-2001 to 65 Kt in 2004 (Table 3.2.1.1 and Figure 3.2.1.1). Icelandic landings in the quota year September 2004/August 2005 amounted to 55 954 t, exceeding the national TAC by 5 Kt. The saithe TAC has increased from 30 Kt in 1997-2001 to 70 Kt for the fishing year 2004/2005.

Landings of saithe in quota years 2003/2004 and 2004/2005 and in calendar years 2004 and 2005 show how the fishery proceeds at a steady rate, landings in 2004 have reached ~20 Kt. Landings in 2004 in the current fishing year amounted to 28304 t, which leaves 22 Kt of the quota for 2004/2005. With foreign catches, estimates of bycatch from the blue whiting fishery and transfers within the quota system, likely total landings in 2005 are of the order 75 - 80 Kt, depending on TAC given after the 2005 assessment and inpredictable transfers between species and years in the quota system (Figure 3.2.1.2).

Negligible discards of saithe were detected in a sampling program conducted by the Directorate of fisheries and the MRI, which samples vessel landings and subsequently from catches at sea (ref as in cod and had-sections or fishery section).

Estimates of bycatch from the blue whiting fishery E and SE of Iceland are available for 2003 and 2004 (Table 3.2.1.1). They are based on a program that monitors bycatch in landings from the blue whiting fishery (Pálsson 2005, An analysis of by-catch in the Icelandic blue whiting fishery. Fisheries Research 73:135-146 and draft of 2004 results 'bycatchBlueWhiting2004draft.doc' in Relevant reports).

3.2.2 Fleets and fishing grounds

More than 85% of landings in 2004 were taken in bottom trawl, approximately 4% both 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 Figure 3.2.2.3. Various GLM-CPUE-indices were fitted to the whole data set and a selection of the main participants in the fishery (vessels landing more than 100 t each year in the series) show similar trends or a more or less continuous increase in 1999-2004 for all hauls where saithe is more than 50% of reported catch. The most conservative change in CPUE is from 80% to 120% of the 1999-2004 average, or an increase of 50%. The commercial CPUE indices are not used assessment but are shown here as a reference to which stock size estimates can be compared.

3.2.3 Landings at age

Compared to predicted landings at age in the 2004 assessment, the proportion of the landings in numbers at age 4 was lower than predicted for age group 4, but higher for age groups 5 and 6, or for the large 2000 year class and the 1998 and 1999 year classes, respectively. A higher proportion of numbers at age 3 in the catch are worthy of note, i. e. larger numbers than predicted were caught of the poor year class of 2001 in 2004 (Figure 3.2.3.1).

Data from samples from catch of most gear types, collected systematically over the year (SÝNÓ-system) and representative of the distribution of the fishery (Figs. 3.2.2.2 and 3.2.3.2), 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	2209	3	150	5	588
Jiggers	2575	3	145	9	1146
Danish seine	1333	2	100	4	534
Bottom trawl	54579	98	4854	245	38723
Other gear	1918	-	-	3	227
Foreign landings	477	-	-	-	-
Bycatch	1700	-	-	-	-
Total	64791	106	5249	266	40684

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 (W = 0.02498 * L^2.75674) was applied to length distributions from both fleets. (Table 3.2.3.1 and Figure 3.2.3.3).

Estimated bycatch in the blue whiting fishery in the Icelandic EEZ was added to catch in numbers in 2004 and 2003 landings at age were raised by the estimated bycatch. The bycatch is a insignificant part of the total landings and estimates prior to 2003 They split on age groups according to samples from landings as length distributions of saithe in bycatch samples was similar to that in landings.

Log catch ratios indicate a relatively moderate total mortality in the stock (Fig. 3.2.3.4).

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. Weight at age of the 1998 and 1999 year class (age groups 6 and 5) was among the lowest on record (Figure 3.2.4.1 and Table 3.2.4.1). Weight at age in 2004 generally decreased from 2003.

Weight at age in stock is computed based on weights at age from the Icelandic ground fish survey (IGFS), which are available for 2005 to NWWG. The data show similar trends as catch weight at age (Figure 3.2.4.1 and Tables 3.2.4.1 and 2), year classes 1998 and 1999 had low weight at age 7 and 6. Year class 2001 has higher than average weight at age 4 in the survey, in line with its low abundance estimate. Persistently lower weight at age for year classes 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 comparison 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, as well as inadequate sampling. Migration and density dependent growth or a combination of both have been hypothesized as explanations for drastic fluctuations in both mean weight at age and maturity. A GLM-model has been used to describe maturity at age as a function of age and year class strength based on maturity at age in landings (ICES NWWG 1993).

In the 2004 assessment, maturity at age was based on survey data, which are available for the current year at the time of assessment, was used for calculating SSB. The same type of GLM-smoother as previously used on maturity at age from samples of landings was used. Diagnostics of for the fit is given in Table 3.2.5.3 and residuals from the fit are shown in Figure 3.2.1. Although the fit is not very good (p-value ~0.2 of adding recruit numbers), the SPALY smoother captures the at leas part of the effect previously seen of large year classes having low maturity at age. Maturity as observed in the survey is given in Table 3.2.5.1 and the results of applying a smoother on the data with age as a factor and recruitment as a linear explanatory variable is given in Table 3.2.5.2 and show in Figure 3.2.5.2. Concerns have been raised about how changes in fit can be caused by by applying the smoother as more data on maturity, and especially recruitment, accumulate. Retrospective SSB calculated by applying the smoother to data sets changed by omitting one year of maturity data in each fit is shown in Figure 3.2.5.3. Simultaneous retrospective estimation of recruit numbers was not possible at NWWG 2005, but as the recruitment retrospective plot (Fig. 3.2.7.9) shows signs of improvement, as compared assessments prior to using the IGFS (QCS for saithe), variability in recruit estimates should not affect the prediction radically. Alternative approaches were explored, such as using weight at age in the stock instead of year class strength, adding a time trend or applying non-parametric smoothers, inconclusively. Only a model estimating a time trend in maturity had more balanced residuals, but using that model would lead to an increase in maturity in 2006 and 2007 that was not accepted by the group. Further work is needed both on the underlying data and the method used for smoothing.

3.2.6 Migration of saithe

According to available data approximately 115 thousand saithe were tagged in the NE-Atlantic in the 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 magnitude lower. Taken at face value, this leads to the conclusion that there is not a significant difference in the rates of semi-trans-Atlantic migrations of saithe east and west. Since there are more saithe in distant waters than on Icelandic grounds the latter might on average be on the receiving end of a NE-Atlantic saithe migratory budget.

Other evidence of saithe migrations 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 decreases along an approximately NW-SE-NE gradient, migration of e.g. north-east 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 (~1000 of ~16000 tags released have been returned). 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 '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 3.2.2.3 and 3.2.2.4.

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 commerical catches they have been included in assessment of the stock since 2002. Both the IGFS in March and the Icelandic autumn survey show a wider geographical distribution of saithe around Iceland, more frequent occurrence and a general increase in survey abundance of saithe from 1997-2005 (Figs. 3.2.7.1-2). A similar development is also apparent in the geographical distribution of the fishery (Fig. 3.2.2.2). A stratified mean index of survey biomass (Figure 3.2.7.3) shows high fluctuations in 1985-1992 but has in recent years been more stable. It shows an increase similar to that observed in CPUE indices shown in Figures 3.2.2.3-4.

In this assessment and the 2003-2004 assessments age disaggregated indices of numbers in the IGFS have been used for tuning. Correspondence between index at age for the same year class from one year to the next is noisy (Fig. 3.2.7.4), but notably shows that 2004-2005 observations of age groups 4-8 all have positive residuals from a linear fit. This could indicate year effects in the survey but a reduction in effort is also a possible explanation (Fig. 3.2.7.5). A study shown in NWWG 2004 in showed that when only data from 1992 are studied the correspondence improves.

The stratified indices for saithe have been modified by setting the most extreme outlier (in the earlier part of the series, see Fig. 3.2.7.3) equal to the second highest observation, in the same way as previously. 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 and shown in Figure 3.2.3.3 juxtaposed with landings in numbers at age. A general structure is apparent in both landings at age and index at age which, with some exceptions, is common to the two matrices.

In TSA an index based on indices for age groups 3-5 were used as a recruitment index. In separable model (SPALY assessment) and ADAPT, AD-CAM models of saithe population dynamics, an age disaggregated index of numbers at age 2-8 from the IGFS was used. (Section 3.2.7.2).

3.2.7.2 Estimates of fishing mortality

The assessment model 'camera', used by NWWG 2004, was run, with reference to ADAPT (run with 'cadapt') and time series analysis (TSA), all tuned to IGFS indices at age. 'camera' and 'cadapt' have been presented to WGMG (see 2002 & 2003 reports of that group).Seperable model 'camera'

Strict, separable population dynamics (time-invariant commercial selectivity and survey catchability) were modelled with catch-at-age 3-14 in 1985-2004 and tuned to IGFS indices of numbers at age 2-8 in 1985-2005. Survey catchability model was assumed proportional for all ages, common for age groups 6-8 (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 to the inverse of mean square age group residual from Sheperd-Nicolson models fit to landings at age and index at age. The same weights as in 2004 were used. Estimated parameters the two model with reported AD-ModelBuilder estimates of standard deviations on log-scale are given in Table 3.2.7.3.

Modelled numbers at age vs. indices at age are shown in Figure 3.2.7.6 show that after the model has been run, a clearer correspondence than might be expected on the basis of year class index at age vs. index at age one year preciously (Fig. 3.2.7.4).TSA

TSA was run by external expert Guðmundur Guðmundsson of the National Bank of Iceland. As has been done in previous assessments, a migration was estimated as described in NWWG2001,2002 and 2004. 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. Terminal estimates, retrospecitve results and time trajectories are shown in Figures 3.2.7.10-14

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 catchability model (as in 'camera'). 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. The inverse variance case weights were calculated in the fit. Terminal estimates, retrospecitve results and time trajectories are shown in Figures 3.2.7.9-14.

Retrospective results

Retrospective plots of R3, B4+ (FSB), SSB and F4-9 from 'camera', ADAPT and TSA are shown in Figures 3.2.7.9-12. The TSA starts at age 4 and is therefore missing from the recruitment retrospective plot. It should also be noted that it also migration estimation, age range assessed is 4-11. Inclusion of indices-at-age 2-3 in the separable models enables estimation of the incoming year classes. The retrospective analysis indicates that recruitment, biomasss and F4-9 estimation is better with the seperable model than in ADAPT. Retrospective biomass estimation in TSA and the separable model is similar, but F4-9 estimation has different characteristics which are, in part, due to migration estimation in the TSA .

Time trajectories

The models run show similar development of B4+ (FSB) in recent years but in 1985-1990 different assumptions in the models (back and forth, with and without migration) show up as differences in model results (Fig. 3.2.7.13). Fishing mortality is more variable (Fig. 3.2.7.13). The range in biomass is ~250-280 Kt, and in F4-9 from 0.26 for ADAPT to 0.39 for TSA, while the separable model estimate is 0.32.

Terminal estimates

Estimated N2005 and F4-9,2004 shows prediction made in 2004 and results from 'camera' (and a variant tuned with indices at age 1989-2005), ADAPT and TSA are shown in Figure 3.2.7.14 and terminal estimates in Figure3.2.7.14. Survivor estimates from TSA are slightly lower and terminal F4-9 higher than from the results of the separable model and ADAPT. Comparison of model results and estimation of uncertainty

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

	N2005,3 ESTIMATES	CV	N2005,4 ESTIMATES	CV	SD	SSB2005 ESTIMATES	SD	F2004,4-9 ESTIMATES	SD
'camera'	69.0	63%	17.4			100.0	16.3	0.32	
'cadapt'	69.2	42%	12.5	36%		114.716.0	0.26		
TSA			15.2		9.1			0.39	0.13

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. A bootstrap of the separable model ('camera'), with 1000 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 the pairs of SSB vs. F4-9 is shown in Figure 3.2.7.15. This figure is shown here as an example only since treatment of residual between observed and predicted yield needs further work.

Bootstrap distributions of recruitment estimates, shown in Figure 3.2.7.16, indicate the relative uncertainty of year class estimation from the model.

Adopted assessment

The 'spaly' separable model 'camera' was used as 'final' run as it includes more information on incoming year classes, show no retrospective pattern and is run by the stock expert.

3.2.7.3 Spawning stock and recruitment

The spawning stock biomass is shown in Figure 3.2.7.20 and given, based on weight at age in stock in Tables 3.2.7.8, and in landings in Table 3.2.7.8b for comparison. Stock estimates prior to 1985 are taken from a long 'camera' run with the whole data series from 1962 tuned to the IGFS, results from the final run used for the recent period, as selectivity can not change in time in 'camera'. 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 2005 is estimated at 100Kt or 110 Kt when calculated with weight at age from landings.

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 3.2.7.19). First estiamtes of the size of the 2002 year class indicate it is above average. The scatter of SSB and recruitment is shown in figure 3.2.7.18 and with a hockey stick/segmented regression in Figure 3.2.7.19.

3.2.8 Prediction of catch and biomass

3.2.8.1 Input data

Predicted catch in 2005 is ~74 KT corresponding to status quo F (Section 3.2.1). The input data for the catch projections is given in Table 3.2.8.1A for prediction with SSB based on weight at age in stock and in Table 3.2.8.1B based on weight at age in landings.

For predictions of weight-at-age in stock in 2006-2007 a linear model with weight-at-age of the same year class in stock the previous year and year class strength was used for prediction for age groups 4-8. Predicted stock weight-at-age in 2005 was used to predict for 2006 and also as input in the prediction for weight at age in landings. Age group 3 and 9-14 weights were set at average weight at age in the IGFS (WD26 NWWG 2005, note that the model has been simplified by modelling age as a linear instead of as a categorical variable). For predictions of weight at age in catches 2005-2006, weight-at-age 4-8 was predicted using survey weight at age (observed in 2005, predicted for 2006) and weight at age landings of the same year class in the previous year. Age group 3 and 9-14 weights were set at average weight at age in landings 2001-2004.

For short-term predictions, maturity at age was predicted by applying the maturity smoother described in Section 3.2.5 with stock weight at age in 2005 and as predicted for 2006 for age groups 4-8. Age group 3 and 9-14 maturity at age was set at the long term average maturity at age from the IGFS survey. The selection pattern was that estimated in the final separable model run. Size of year classes 2001-2002 is set at point estimates from the adopted run. In the 2002-2004 assessments of the stock, estimates of numbers at age 3 from models tuned with IGFS indices have been used for guidance in decisions regarding the size of poorly determined year classes to use in predictions, with reasonable results (see QCS for saithe). Previously size of incoming year classes were set at ad hoc long or short term average recruitment (see QCS for saithe).

Short term prediction based on these inputs is given in Table 3.2.8.2A with SSB based on weight at age in stock and in Table 3.2.8.2B based on weight at age in landings.

3.2.8.2 Biological reference points

The ACFM set Bpa at 150 Kt, Blim tentatively at 90 Kt when SSB was calculated with catch-weight-at-age. With survey weights- and maturity-at-age, NWWG 2004 noted this corresponded to SSBs of ~100 and ~50 Kt, respectively. Fpa is set at 0.3, Flim has not been set for this stock. The stock in 2004 was assessed close to or slightly below the ad hoc Bpa and is estimated 100Kt in 2005. Hockey-stick/segmented regressions (Fig. 3.2.7.19) to the SSB/R data using survey weights were performed at the meeting and gave a Bloss of 53 Kt, a recruitment plateau at 35 million and an R to SSB at the breakpoint of 0.65. This corresponds to an Floss of 0.6, with SSB/R calculations based on long term average weight and maturity at age from survey, and selectivity from adopted run.

The group proposes that Blim for the stock be changed from the tentative value of 90Kt to 53Kt, that Fpa remain unchanged , Flim remain undefined and Bpa set as undefined.

Some unsolved issues remain, treatment of maturity at age might be improved on, both with scrutiny of maturity data and further analysis of modelling/smoothing, the influence of migration on SSB has to be considered and SSB/R relationships should be investigated further.

3.2.8.3 Medium term projections

AD-CAM medium term simulations of the development of the stock with referfence to the current Fpa and the proposed Blim are underway and will be presented to ACFM. The model and deterministic results from it are described below:

AD-CAM

Settings for saithe

- Nonparametric fishing mortality. Random walk model of fishing mortality with light weight.
- Catch at age data from 1971 to 2004, survey data 1985 – 2005 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 (the same as in TSA)

Prognosis were done using 75 Kt catch in 2005, fishing at F=Fpa=0.3 after that. Results are shown in Figure 3.2.7.17. The results show general agreement with the separable model for historical estimates and a gradual increase in SSB from 2005-2008..

3.2.9 Management considerations

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 Bpa in 2005 The reference F4-9 values have shown a gradual decrease and are estimated close to Fpa in 2003-4b Recruitment in recent years has shown an increase (1998-2000 year classes all above average).

It is advisable not to increase fishing mortality above Fpa.

3.2.10 Comments on the assessment

In 2002 the stock was assessment 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 'camera' tuned with IGFS age-disaggregated indices. That procedure was a adopted by NWWG 2004 and the final run that year was an updated 'camera' run. The adopted 2005 assessment is a SPALY of the one in 2004, with the exception of the use of survey weight at age in the SSB.

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. Low weight at age of year classes 1998-2000 in both the Icelandic and the Faroe saithe might indicate migrations of NEA saithe to the stocks and should be studied in next assessment.

Table 3.2.1.1. Nominal catch (tonnes) of SAITHE in Division Va by countries, 1997-2004, as officially reported to ICES with working group estimates when data are missing and bycatch estimates included.

SAITHE Va

COUNTRY	1997	1998	1999	2000	2001	2002	2003*	2004
Faroe Islands	716	997	700	228**	128**	366**	143	214
Germany	-	3	2	1	14	6	56	157
Iceland	36,548	30,531	30,583	32,914	31,854	41,687	51,857	62614
Norway	-	-	6	1	44*	3*	164	1
UK (E/W/NI)	-	-	1	2	23	7	...	105
UK (Scotland)	-	-	1	-	-	2	...	
United Kingdom							35	
Total	37,264	31,531	31,293				52091	63091
Bycatch							403	1700
WG estimate				33,146	32,063	42,071	52494	64791

*Preliminary.

**WG estimate.

Table 3.2.3.1. Saithe in division Va. Catch in numbers (thousands) 1962--2004.

YEAR\A	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*	2284	4363	6031	2472	1942	285	438	289	196	28	29	15
2004*	952	7841	7195	5363	1563	1057	211	224	157	74	39	11

*** 2003 and 2004 including esitmated bycach from blue whiting fishery.**

Table 3.2.4.1. 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	1.47	1.85	2.18	2.92	4.02	5.13	7.12	7.73	8.42	8.93	10.42	10.62
2005*	1.36	2.03	2.5	2.95	3.89	5.31	7.04	7.64	8.57	9.59	10.49	11.34
2006*	1.36	1.85	2.73	3.23	3.9	5.02	7.04	7.64	8.57	9.59	10.49	11.34

***Predicted**

Table 3.2.4.2. Saithe in Division Va. Mean weight at age in the stock from IGFS 1985-2005. Age groups 2-3 and 9-14 and 1962-1984 set at long term averages.

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	0.32	0.67	1.41	1.88	2.42	3.6	5.56	6.32	7.94	9.78	11.54	12.44	13.91
2006*	0.29	0.79	1.03	2.21	2.58	3.57	4.85	6.32	7.94	9.78	11.54	12.44	13.91
2007*	0.29	0.79	1.31	1.72	3.18	3.48	4.76	6.32	7.94	9.78	11.54	12.44	13.91

*Predicted

1985-2005 average weight at age from IGFS

2	3	4	5	6	7	8	9	10	11	12	13	14
0.29	0.79	1.37	2.05	2.94	4.07	5.29	6.33	8.00	9.78	11.48	12.36	13.98

Table 3.2.5.1A. Saithe in Division Va. Sexual maturity at age, mean values from IGFS survey.

YEAR\A	A4	A5	A6	A7	A8	A9
1985	0.	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.	0.
1991	0.	0.	0.	0.	0.	0.
1992	0.	0.	0.	0.	0.	0.
1993	0.	0.	0.	0.	0.	0.
1994	0.	0.	0.	0.	0.	0.
1995	0.	0.	0.	0.	0.	0.
1996	0.	0.	0.	0.	0.	0.
1997	0.	0.	0.	0.	0.	0.
1998	0.	0.	0.	0.	0.	0.
1999	0.	0.	0.	0.	0.	0.
2000	0.	0.	0.	0.	0.	0.
2001	0.	0.	0.	0.	0.	0.
2002	0.	0.	0.	0.	0.	0.
2003	0.	0.	0.	0.	0.	0.
2004	0.	0.	0.	0.	0.	0.
2005	0.	0.	0.	0.	0.	0.

Table 3.2.5.1B. Saithe in Division Va. Sexual maturity at age, smoothed values from IGFS survey, maturity modelled as a funcion of age as a factor and year class strength. In the assessment, age group 3 was set immature, age groups 9 – 14 at long term survey average.

	4	5	6	7	8
1985	0.06	0.24	0.51	0.70	0.79
1986	0.06	0.22	0.48	0.69	0.81
1987	0.04	0.24	0.45	0.66	0.80
1988	0.03	0.16	0.47	0.63	0.78
1989	0.05	0.11	0.36	0.65	0.75
1990	0.06	0.20	0.27	0.55	0.77
1991	0.07	0.24	0.42	0.44	0.68
1992	0.06	0.27	0.48	0.60	0.58
1993	0.08	0.24	0.52	0.66	0.73
1994	0.08	0.29	0.48	0.70	0.78
1995	0.08	0.28	0.54	0.66	0.80
1996	0.06	0.28	0.53	0.71	0.78
1997	0.07	0.24	0.53	0.70	0.81
1998	0.08	0.26	0.48	0.71	0.81
1999	0.09	0.28	0.50	0.66	0.81
2000	0.07	0.31	0.53	0.68	0.77
2001	0.06	0.26	0.57	0.71	0.79
2002	0.05	0.24	0.50	0.73	0.81
2003	0.04	0.20	0.48	0.68	0.83
2004	0.03	0.17	0.42	0.66	0.79
2005	0.07	0.11	0.38	0.60	0.78

Table 3.2.5.1C. Saithe in Division Va. Sexual maturity at age, 1985-2005 average values from IGFS survey

AGE	3	4	5	6	7	8	9	10	11	12	1	1
maturity	0.01	0.06	0.23	0.47	0.66	0.76	0.83	0.9	0.93	0.96	1	1

Table 3.2.5.2. Saithe in Va. Diagnostics of glm-model (maturity smoother) applied to IGFS maturity data.

```
Call:
glm(formula = mat ~ factor(age) + rec, family = binomial, data
= mdata)

Deviance Residuals:
     Min        1Q    Median        3Q       Max
-.55205  -0.24085  -0.01449   0.22968   0.72840

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.24206    0.98945  -2.266 0.023453 *
factor(age)5  1.55844    1.05449   1.478 0.139434
factor(age)6  2.62490    1.01697   2.581 0.009849 **
factor(age)7  3.37471    1.02712   3.286 0.001018 **
factor(age)8  3.94287    1.05633   3.733 0.000190 ***
rec          -0.01436    0.01178  -1.219 0.223023
---
Signif. codes:  0 `***' 0.001 `**' 0.01 `*' 0.05 `.' 0.1 ` ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 44.070  on 104  degrees of freedom
Residual deviance:  9.341  on  99  degrees of freedom
AIC: 92.905

Number of Fisher Scoring iterations: 5

Analysis of Deviance Table

Model: binomial, link: logit

Response: mat

Terms added sequentially (first to last)


             Df Deviance Resid. Df Resid. Dev P(>|Chi|)
NULL                           104     44.070
factor(age)   4   33.181       100     10.889 1.097e-06
rec           1    1.548        99      9.341 0.213
```

Table 3.2.7.1. Saithe in Division Va. IGFS indices of numbers at age used for tuning in seperable 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
2005	0.23	4.32	2.32	6.85	4.27	2.17	0.85

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 2001 in 2005) as a index of recruitment as 4 year olds.

STANDARDIZED CATCH PREDICTION ERRORS

1985	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1986	-0.63	-0.90	-0.60	0.17	0.81	-0.35	1.63	-0.61
1987	0.56	2.01	0.90	1.85	2.02	1.16	1.65	-0.86
1988	-0.13	0.20	0.28	-1.68	0.61	2.06	-1.48	1.19
1989	0.89	0.72	1.32	-2.02	-0.58	-0.33	-1.05	0.72
1990	-0.92	0.51	2.27	1.85	1.94	0.36	-0.29	-0.04
1991	-1.28	0.30	2.12	1.74	0.13	0.58	2.27	0.43
1992	-0.72	1.61	1.78	-0.42	-1.63	-1.28	-0.50	-1.06
1993	-0.38	-1.34	-1.40	-0.94	0.28	0.13	1.06	1.14
1994	-0.40	0.17	-0.73	-1.58	-1.09	0.40	0.76	0.92
1995	1.05	-1.31	0.74	0.94	-0.55	-1.40	-0.88	-1.85
1996	0.06	-0.82	-1.64	-2.06	-0.23	-1.07	-0.66	-0.59
1997	0.76	-0.66	-0.44	-0.49	-0.06	-1.46	-1.64	-0.98
1998	-0.04	-1.64	-1.55	-0.29	-0.13	1.21	0.45	1.44
1999	-0.15	-0.40	0.02	-0.35	-0.43	-0.81	-0.59	-1.86
2000	0.33	-0.28	0.16	0.11	0.99	-0.36	0.06	-0.74
2001	0.39	-0.87	-0.94	-0.46	-0.06	-0.15	0.39	0.46
2002	1.67	-0.12	1.52	0.61	1.67	0.77	-1.21	0.57
2003	0.47	1.23	-0.50	-0.13	-0.46	1.00	0.37	-0.16
2004	0.26	1.33	0.98	-0.67	-0.45	1.88	0.85	0.68
2005	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

SKEWNESS AND KURTOSIS
1.528 -1.659
VARIANCE AT AGE

0.5200 1.0496 1.5054 1.4197 0.9423 1.0903 1.2003 0.9638
VARIANCE AT YEAR

0.6780 2.1813 1.3951 1.1523 1.7050 1.8673 1.5175 0.9137 0.7481 1.3407
VARIANCE AT YEAR

1.2006 0.9025 1.1134 0.6162 0.2367 0.2997 1.3319 0.4229 1.0190
CORRELATION WITHIN COHORTS 0.02

CORRELATION WITHIN AGES AND YEARS 0.39 0.07

FINAL ESTIMATES

STOCK

	4	5	6	7	8	9	10	11	BIOM
1985	37258.	20583.	9804.	5621.	3774.	4605.	1416.	286.	263.9
1986	27928.	26921.	13906.	6331.	3294.	2089.	3640.	793.	302.4
1987	57839.	21408.	18316.	8798.	3711.	1762.	1107.	1865.	331.0
1988	58663.	42478.	13318.	10288.	4592.	1840.	842.	538.	371.0
1989	46167.	43473.	28552.	7788.	5586.	2213.	837.	413.	368.1
1990	25452.	33790.	28130.	17069.	4460.	2870.	1075.	410.	353.0
1991	18472.	19069.	22302.	17628.	8422.	2079.	1341.	502.	287.1
1992	22693.	13874.	12271.	11829.	5759.	3732.	905.	542.	231.4
1993	12152.	15866.	7589.	6331.	5851.	9001.	1749.	418.	220.1
1994	15760.	8915.	10185.	4145.	3095.	2718.	4028.	776.	176.5
1995	14549.	10278.	5691.	5894.	2113.	1388.	1137.	1661.	146.6
1996	10421.	9903.	6168.	3067.	2807.	942.	623.	513.	115.5
1997	19935.	6214.	6391.	3602.	1675.	1297.	429.	284.	122.3
1998	13107.	13384.	3099.	3696.	1909.	841.	644.	214.	117.8
1999	6041.	9580.	9001.	4670.	1954.	942.	389.	292.	112.2
2000	20970.	4316.	6385.	5337.	4610.	989.	475.	195.	128.4
2001	20202.	14994.	2763.	3821.	2900.	2264.	496.	239.	139.0
2002	40172.	14177.	10136.	1702.	2191.	1529.	1123.	248.	188.6
2003	43278.	28939.	8808.	5790.	909.	1097.	754.	566.	233.2
2004	65404.	31447.	18360.	5055.	3047.	466.	530.	364.	289.6
2005	15241.	46394.	19313.	10380.	2658.	1486.	210.	242.	255.4

Table 3.2.7.2 (Cont'd)

STANDARD DEVIATION OF STOCK ESTIMATES

1985	1350.	828.	436.	161.	98.	77.	55.	34.	-1.0
1986	1047.	1057.	603.	292.	120.	83.	64.	44.	-1.0
1987	2096.	835.	786.	407.	189.	86.	63.	83.	-1.0
1988	3100.	1622.	536.	480.	242.	115.	60.	42.	-1.0
1989	1593.	2470.	1177.	345.	314.	153.	76.	40.	-1.0
1990	855.	1222.	1764.	736.	222.	194.	100.	46.	-1.0
1991	629.	673.	861.	1090.	424.	130.	125.	59.	-1.0
1992	722.	491.	474.	503.	667.	259.	85.	71.	-1.0
1993	408.	564.	290.	270.	304.	428.	164.	48.	-1.0
1994	520.	324.	420.	193.	176.	198.	321.	100.	-1.0
1995	507.	399.	232.	279.	126.	115.	133.	209.	-1.0
1996	847.	373.	284.	143.	166.	78.	76.	81.	-1.0
1997	722.	663.	270.	188.	93.	103.	51.	45.	-1.0
1998	520.	540.	475.	171.	113.	55.	65.	29.	-1.0
1999	272.	417.	407.	332.	114.	74.	38.	40.	-1.0
2000	1190.	214.	307.	271.	221.	74.	49.	24.	-1.0
2001	1608.	954.	156.	205.	174.	147.	48.	29.	-1.0
2002	3387.	1319.	728.	111.	142.	118.	106.	30.	-1.0
2003	5236.	2850.	1035.	554.	81.	102.	85.	74.	-1.0
2004	8493.	4252.	2278.	776.	418.	59.	75.	58.	25.5
2005	9124.	6911.	3431.	1788.	582.	321.	46.	55.	31.4

FISHING MORTALITY RATES

	4	5	6	7	8	9	10	11	FGBAR	FBAR
1985	0.122	0.192	0.236	0.335	0.392	0.047	0.384	0.333	0.180	0.221
1986	0.062	0.185	0.256	0.331	0.426	0.435	0.469	0.445	0.237	0.282
1987	0.106	0.275	0.371	0.450	0.501	0.538	0.523	0.499	0.331	0.374
1988	0.099	0.194	0.335	0.409	0.527	0.584	0.513	0.528	0.305	0.358
1989	0.107	0.235	0.312	0.353	0.466	0.521	0.512	0.522	0.296	0.332
1990	0.087	0.208	0.411	0.506	0.563	0.560	0.563	0.573	0.325	0.389
1991	0.082	0.239	0.436	0.782	0.614	0.632	0.698	0.683	0.370	0.464
1992	0.151	0.393	0.459	0.505	0.798	0.555	0.570	0.612	0.427	0.477
1993	0.110	0.240	0.389	0.501	0.562	0.600	0.607	0.613	0.347	0.400
1994	0.177	0.248	0.345	0.457	0.571	0.643	0.657	0.630	0.369	0.407
1995	0.182	0.276	0.408	0.529	0.586	0.581	0.576	0.565	0.393	0.427
1996	0.216	0.236	0.334	0.405	0.558	0.574	0.570	0.561	0.361	0.387
1997	0.192	0.354	0.348	0.435	0.486	0.500	0.492	0.514	0.368	0.386
1998	0.113	0.197	0.407	0.437	0.503	0.567	0.576	0.567	0.323	0.370
1999	0.132	0.205	0.323	0.486	0.481	0.484	0.490	0.486	0.316	0.352
2000	0.135	0.245	0.312	0.409	0.511	0.489	0.486	0.483	0.319	0.350
2001	0.151	0.189	0.282	0.350	0.439	0.501	0.491	0.487	0.292	0.319
2002	0.125	0.272	0.359	0.427	0.490	0.506	0.486	0.506	0.330	0.363
2003	0.117	0.254	0.355	0.442	0.464	0.526	0.527	0.526	0.323	0.359
2004	0.143	0.288	0.370	0.443	0.518	0.596	0.583	0.573	0.357	0.393
2005	0.131	0.255	0.360	0.461	0.535	0.562	0.562	0.562	0.344	0.384

VPA - F

1985	0.126	0.200	0.248	0.340	0.360	0.181	0.502	0.333	0.242
1986	0.058	0.186	0.240	0.317	0.444	0.334	0.692	0.445	0.263
1987	0.103	0.260	0.390	0.449	0.503	0.517	0.481	0.499	0.370
1988	0.065	0.187	0.358	0.368	0.547	0.691	0.333	0.528	0.369
1989	0.113	0.148	0.324	0.297	0.455	0.552	0.494	0.522	0.315
1990	0.077	0.205	0.264	0.499	0.553	0.505	0.517	0.573	0.351
1991	0.056	0.235	0.426	0.497	0.532	0.556	0.953	0.683	0.384
1992	0.157	0.371	0.491	0.459	0.351	0.422	0.464	0.612	0.375
1993	0.106	0.225	0.388	0.509	0.551	0.623	0.531	0.613	0.400
1994	0.225	0.252	0.331	0.436	0.595	0.671	0.857	0.630	0.418
1995	0.159	0.324	0.440	0.571	0.576	0.613	0.591	0.565	0.447
1996	0.133	0.237	0.342	0.375	0.670	0.519	0.654	0.561	0.379
1997	0.187	0.203	0.341	0.438	0.507	0.562	0.315	0.514	0.373
1998	0.115	0.163	0.167	0.407	0.469	0.637	0.767	0.567	0.326
1999	0.142	0.199	0.309	0.325	0.459	0.447	0.570	0.486	0.313
2000	0.136	0.258	0.300	0.396	0.573	0.440	0.458	0.483	0.350
2001	0.157	0.178	0.270	0.323	0.426	0.560	0.470	0.487	0.319
2002	0.119	0.287	0.389	0.404	0.494	0.496	0.426	0.506	0.365
2003	0.116	0.249	0.378	0.472	0.401	0.532	0.503	0.526	0.358
2004	0.143	0.288	0.370	0.443	0.518	0.596	0.583	0.573	0.393

Table 3.2.7.2 (Cont'd)

STANDARD DEVIATIONS OF LOG(F)

1985	0.08	0.08	0.06	0.06	0.07	0.08	0.09	0.09	-1.000
1986	0.09	0.07	0.06	0.06	0.07	0.07	0.08	0.09	-1.000
1987	0.11	0.09	0.06	0.06	0.07	0.07	0.09	0.09	-1.000
1988	0.11	0.08	0.06	0.05	0.06	0.07	0.08	0.09	-1.000
1989	0.11	0.10	0.06	0.06	0.06	0.07	0.09	0.09	-1.000
1990	0.06	0.08	0.07	0.06	0.07	0.08	0.09	0.10	-1.000
1991	0.05	0.07	0.06	0.06	0.06	0.07	0.09	0.10	-1.000
1992	0.05	0.08	0.06	0.06	0.07	0.08	0.09	0.10	-1.000
1993	0.07	0.05	0.05	0.05	0.06	0.07	0.09	0.10	-1.000
1994	0.05	0.07	0.05	0.05	0.06	0.07	0.08	0.09	-1.000
1995	0.13	0.04	0.06	0.06	0.06	0.07	0.08	0.09	-1.000
1996	0.08	0.06	0.05	0.05	0.06	0.07	0.09	0.09	-1.000
1997	0.09	0.07	0.06	0.06	0.06	0.07	0.09	0.09	-1.000
1998	0.09	0.06	0.06	0.06	0.07	0.08	0.09	0.10	-1.000
1999	0.07	0.07	0.06	0.06	0.07	0.08	0.09	0.10	-1.000
2000	0.10	0.07	0.07	0.07	0.06	0.08	0.09	0.10	-1.000
2001	0.12	0.08	0.07	0.07	0.08	0.08	0.10	0.11	-1.000
2002	0.20	0.10	0.09	0.09	0.09	0.10	0.11	0.12	-1.000
2003	0.18	0.15	0.11	0.11	0.11	0.12	0.13	0.14	-1.000
2004	0.16	0.18	0.15	0.16	0.16	0.17	0.17	0.17	0.126
2005	0.38	0.24	0.19	0.19	0.19	0.19	0.19	0.19	0.184

Table 3.2.7.3A. Saithe in Division Va. Log catch residuals from adopted 'camera' run.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	-0.54	0.30	0.00	-0.08	0.16	-0.09	-0.46	0.51	0.14	-0.55	0.30	0.00
1986	0.82	-0.59	-0.08	-0.29	-0.13	0.09	-0.19	0.80	0.24	0.30	0.24	-0.81
1987	-0.92	-0.12	0.07	0.08	-0.05	-0.04	0.08	0.08	0.18	-0.56	0.17	1.22
1988	0.23	-0.31	0.05	0.19	-0.01	0.09	0.42	-0.06	0.40	-0.43	-0.52	-2.19
1989	-0.70	0.18	-0.07	0.24	-0.20	0.00	0.04	-0.03	0.45	0.40	-0.09	-0.71
1990	-1.16	-0.35	0.04	0.10	0.31	0.13	0.03	-0.17	-0.02	-0.20	0.42	-0.21
1991	-1.14	-0.51	0.20	0.43	0.57	0.14	0.15	0.53	0.09	-0.58	-1.64	-1.54
1992	-0.29	0.24	0.60	0.40	0.11	-0.08	-0.17	-0.15	-0.32	-0.72	0.32	-0.13
1993	0.34	-0.21	-0.25	-0.01	-0.10	-0.15	0.35	-0.08	-0.07	0.17	0.18	-0.65
1994	0.21	0.35	-0.23	-0.43	-0.33	-0.41	-0.18	0.32	-0.11	0.16	0.74	0.77
1995	0.58	0.14	0.19	0.16	0.11	0.01	-0.11	-0.08	0.04	-0.49	-0.27	-0.86
1996	0.48	-0.12	-0.08	-0.11	-0.17	0.00	0.00	-0.04	-0.07	0.07	0.63	1.31
1997	0.40	0.32	-0.24	0.02	0.03	0.07	-0.13	-0.26	-0.21	0.19	-0.16	0.31
1998	-0.07	-0.09	-0.49	-0.72	-0.03	-0.11	0.26	0.06	0.42	0.36	0.62	0.66
1999	0.53	0.18	-0.08	-0.08	-0.05	0.00	0.00	0.16	-0.42	-0.32	0.12	0.09
2000	0.17	0.11	0.04	-0.08	-0.10	0.25	-0.05	0.02	-0.09	-0.56	-0.06	-0.62
2001	0.20	0.16	-0.16	-0.18	-0.08	-0.11	0.26	0.16	0.21	0.00	0.08	0.47
2002	-0.09	0.14	0.00	0.18	-0.05	0.09	0.00	-0.09	0.17	-0.42	0.00	-0.24
2003	0.16	0.00	0.25	-0.12	0.10	-0.22	0.17	0.03	0.16	-0.40	0.37	0.71
2004	0.74	0.09	0.15	0.15	-0.33	-0.17	0.09	0.11	0.03	-0.20	0.54	0.00

Table 3.2.7.3B. Saithe in Division Va. Log survey residuals from adopted 'camera' run.

	2	3	4	5	6	7	8
1985	-0.38	-1.29	-0.36	0.45	0.20	0.37	-0.19
1986	0.59	-0.49	-0.47	-0.64	-0.41	-0.37	-0.45
1987	-0.57	0.70	0.72	0.75	0.40	0.84	0.46
1988	-0.32	-1.86	-1.22	-0.72	-0.12	-0.48	-0.62
1989	1.61	0.73	0.02	-0.24	-0.38	0.46	0.12
1990	-0.20	0.29	0.46	0.34	0.83	0.40	0.62
1991	0.05	-0.30	-0.18	-0.24	-0.95	-0.27	-1.43
1992	-0.60	-0.04	0.63	1.09	0.46	0.44	0.07
1993	1.68	2.28	0.30	0.93	0.74	0.78	0.11
1994	0.62	-0.37	0.06	0.31	0.19	-0.18	0.50
1995	0.30	0.00	-0.41	-1.10	-0.95	-0.90	-1.14
1996	-0.58	-1.13	0.18	-0.25	0.10	0.37	0.85
1997	1.06	-0.13	0.62	0.36	0.09	-0.24	-0.28
1998	-1.21	1.20	0.34	0.12	-0.30	0.33	0.11
1999	0.55	0.81	0.16	-0.16	0.18	-0.54	-0.49
2000	-0.58	0.05	-0.04	-0.16	-0.08	-0.44	-0.17
2001	0.04	-0.46	-0.16	-0.39	-0.79	-0.89	-0.14
2002	-0.24	-0.53	-0.49	0.10	0.36	0.43	0.43
2003	-1.78	0.48	-0.19	-0.40	-0.27	-0.18	0.30
2004	-0.04	0.04	-0.05	0.06	0.41	0.31	0.47
2005	0.00	0.03	0.09	-0.22	0.20	0.26	0.35

Table 3.2.7.4. Saithe in Division Va. Estimated parameters and their standard errrors from FINAL 'camera' run 1985-2004 landings, 1985-2005 IGFS used as input. All parameters estimated on log scale, standard deviations can be interpreted as Cvs of exponentiated values.

Parameters by year:

	Log age 2 numbers			Log fully selected fishing mortality		
Year	Para.	Est.	Std.	Param.	Est.	Std.
1985	logPopYearOn	10.45	0.11	logFullF	-0.87	0.12
1986	logPopAgeOne	11.29	0.11	logFullF	-0.76	0.12
1987	logPopAgeOne	11.66	0.11	logFullF	-0.56	0.12
1988	logPopAgeOne	11.03	0.11	logFullF	-0.76	0.12
1989	logPopAgeOne	10.55	0.11	logFullF	-0.79	0.12
1990	logPopAgeOne	10.15	0.11	logFullF	-0.71	0.12
1991	logPopAgeOne	10.55	0.11	logFullF	-0.81	0.12
1992	logPopAgeOne	9.84	0.11	logFullF	-0.75	0.12
1993	logPopAgeOne	10.03	0.11	logFullF	-0.57	0.12
1994	logPopAgeOne	9.96	0.11	logFullF	-0.3	0.11
1995	logPopAgeOne	10.59	0.11	logFullF	-0.49	0.11
1996	logPopAgeOne	10.37	0.11	logFullF	-0.53	0.12
1997	logPopAgeOne	9.94	0.12	logFullF	-0.63	0.12
1998	logPopAgeOne	9.2	0.12	logFullF	-0.62	0.12
1999	logPopAgeOne	10.4	0.13	logFullF	-0.73	0.12
2000	logPopAgeOne	10.56	0.14	logFullF	-0.68	0.13
2001	logPopAgeOne	11.01	0.16	logFullF	-0.8	0.13
2002	logPopAgeOne	11.24	0.19	logFullF	-0.76	0.15
2003	logPopAgeOne	11.69	0.22	logFullF	-0.81	0.17
2004	logPopAgeOne	10.19	0.31	logFullF	-0.76	0.2
2005	logPopAgeOne	11.34	0.63	logFullF	-0.95	0.75

Parameters by age:

Log commercial selectivity relative to 8+ (logsel)

Age	3	4	5	6	7
Param.	-3	-1.48	-0.82	-0.45	-0.23
Est	0.16	0.1	0.1	0.1	0.08

Log starting population (logPopYearOne)

Age	3	4	5	6	7	8	9	10	11	12	13	14
Est.	10.5	10.01	9.2	8.53	8.33	8.24	6.83	5.33	4.85	5.14	5.43	10.45
Std.	0.11	0.12	0.13	0.14	0.15	0.2	0.24	0.29	0.38	0.52	1	0.11

Table 3.2.7.6. Saithe in Division Va. Fishing mortality from adopted 'camera' run, a seperable model calibrated with IGFS survey 1985-2005.

	3	4	5	6	7	8	9	10	11	12	13	14
1985	0.021	0.095	0.183	0.266	0.333	0.417	0.417	0.417	0.417	0.417	0.417	0.417
1986	0.023	0.106	0.205	0.298	0.374	0.468	0.468	0.468	0.468	0.468	0.468	0.468
1987	0.028	0.130	0.250	0.364	0.456	0.571	0.571	0.571	0.571	0.571	0.571	0.571
1988	0.023	0.106	0.204	0.297	0.372	0.467	0.467	0.467	0.467	0.467	0.467	0.467
1989	0.023	0.103	0.199	0.290	0.363	0.455	0.455	0.455	0.455	0.455	0.455	0.455
1990	0.024	0.111	0.215	0.313	0.391	0.490	0.490	0.490	0.490	0.490	0.490	0.490
1991	0.022	0.101	0.195	0.284	0.356	0.446	0.446	0.446	0.446	0.446	0.446	0.446
1992	0.024	0.107	0.207	0.301	0.377	0.472	0.472	0.472	0.472	0.472	0.472	0.472
1993	0.028	0.128	0.248	0.360	0.451	0.565	0.565	0.565	0.565	0.565	0.565	0.565
1994	0.037	0.168	0.323	0.470	0.589	0.738	0.738	0.738	0.738	0.738	0.738	0.738
1995	0.030	0.139	0.268	0.390	0.488	0.611	0.611	0.611	0.611	0.611	0.611	0.611
1996	0.029	0.134	0.259	0.376	0.471	0.590	0.590	0.590	0.590	0.590	0.590	0.590
1997	0.027	0.121	0.234	0.340	0.426	0.534	0.534	0.534	0.534	0.534	0.534	0.534
1998	0.027	0.123	0.236	0.344	0.430	0.539	0.539	0.539	0.539	0.539	0.539	0.539
1999	0.024	0.110	0.212	0.308	0.386	0.483	0.483	0.483	0.483	0.483	0.483	0.483
2000	0.025	0.116	0.223	0.324	0.406	0.508	0.508	0.508	0.508	0.508	0.508	0.508
2001	0.022	0.103	0.198	0.288	0.360	0.451	0.451	0.451	0.451	0.451	0.451	0.451
2002	0.023	0.107	0.206	0.299	0.375	0.469	0.469	0.469	0.469	0.469	0.469	0.469
2003	0.022	0.101	0.195	0.284	0.355	0.445	0.445	0.445	0.445	0.445	0.445	0.445
2004	0.023	0.106	0.205	0.298	0.373	0.467	0.467	0.467	0.467	0.467	0.467	0.467

Table 3.2.7.5. Saithe in Division Va. Stock in numbers (in thousands) from adopted 'camera' run, a seperable model calibrated with IGFS survey 1985-2005.

	2	3	4	5	6	7	8	9	10	11	12	13	14
1985	79881	34529	36132	22154	9943	5086	4137	3795	925	206	128	171	229
1986	115674	65401	27689	26908	15109	6240	2985	2232	2047	499	111	69	92
1987	61688	94706	52313	20382	17944	9178	3516	1530	1144	1050	256	57	35
1988	38324	50506	75364	37614	12991	10206	4763	1626	708	529	485	118	26
1989	25510	31377	40401	55495	25102	7900	5759	2446	835	363	272	249	61
1990	38073	20886	25114	29829	37226	15379	4499	2992	1271	434	189	141	129
1991	18708	31172	16688	18394	19700	22296	8514	2256	1500	637	218	95	71
1992	22761	15317	24961	12346	12388	12140	12792	4464	1183	787	334	114	50
1993	21218	18635	12249	18356	8219	7505	6819	6531	2279	604	402	171	58
1994	39608	17372	14834	8820	11731	4693	3914	3172	3038	1060	281	187	79
1995	31833	32428	13710	10270	5226	6001	2132	1532	1242	1189	415	110	73
1996	20676	26063	25754	9768	6432	2897	3016	947	681	552	528	184	49
1997	9938	16928	20720	18438	6175	3614	1481	1368	430	309	250	240	84
1998	32985	8137	13496	15026	11948	3597	1933	711	657	206	148	120	115
1999	38506	27006	6485	9775	9713	6936	1915	923	339	314	99	71	57
2000	60476	31526	21585	4757	6475	5843	3861	967	466	171	158	50	36
2001	76060	49513	25166	15744	3117	3834	3189	1901	476	229	84	78	24
2002	119068	62272	39638	18596	10578	1914	2190	1663	991	248	120	44	41
2003	26595	97485	49806	29167	12393	6419	1077	1121	851	507	127	61	23
2004	84245	21774	78063	36851	19645	7638	3683	565	588	446	266	67	32
2005	20553	68974	17417	57472	24583	11939	4307	1890	290	302	229	137	34
2006	34383	16827	55446	13116	40050	15920	7289	2441	1071	164	171	130	77

Table 3.2.7.6A. Saithe in Division Va. Summary table from adopted 'camera' run for 1985-2005, 1962-1984 estimates from a long 'camera' run (same selectivity in 1962-2004). Above results from final run, below with pre-1985 values and the final run concatenated.

Year	FSB (4+)	R3	SSB	F4-9
1985	220500	34544	96484	0.285
1986	235240	65382	108200	0.320
1987	249620	94750	110260	0.391
1988	316710	50514	104400	0.319
1989	317750	31382	108760	0.311
1990	325390	20889	132670	0.335
1991	250710	31163	119980	0.305
1992	247530	15317	130120	0.323
1993	213670	18639	129010	0.386
1994	195640	17372	117280	0.504
1995	136640	32435	80415	0.418
1996	127410	26056	63266	0.403
1997	122600	16928	56310	0.365
1998	113920	8136	56333	0.369
1999	107800	27011	58343	0.330
2000	107800	31540	53360	0.347
2001	135030	49513	59162	0.308
2002	170440	62255	66664	0.321
2003	197760	97441	69241	0.304
2004	292850	21764	91303	0.318
2005	281060	68941	100280	

	RECRUI Age 3	TOTALBI	TOTSPBI	LANDING	YIELD/SS	FBAR 4-9
1962	29546	139720	67698	50409	0.745	0.288
1963	76762	152160	70907	48449	0.683	0.351
1964	54227	209500	74287	60417	0.813	0.269
1965	84200	256960	94399	60108	0.637	0.249
1966	68248	336030	127480	52176	0.409	0.199
1967	66853	403720	172660	76270	0.442	0.258
1968	62993	439880	205500	77946	0.379	0.230
1969	88011	466860	234970	116347	0.495	0.268
1970	63534	497100	247150	113315	0.458	0.319
1971	51807	478000	240660	133891	0.556	0.429
1972	27060	411690	210640	107873	0.512	0.378
1973	18487	347180	192350	111113	0.578	0.336
1974	20614	288970	174290	97568	0.560	0.310
1975	26126	241610	150720	87924	0.583	0.320
1976	29746	207920	124930	81945	0.656	0.357
1977	19582	184080	100030	62026	0.620	0.302
1978	44173	170530	91982	49672	0.540	0.323
1979	54210	184290	86881	63504	0.731	0.370
1980	27419	207930	83687	58347	0.697	0.332
1981	18638	210480	91369	59001	0.646	0.333
1982	23127	198440	99949	68910	0.689	0.370
1983	31306	179850	96233	58266	0.605	0.228
1984	41600	190500	99986	62719	0.627	0.319
1985	34544	220500	96484	57072	0.592	0.285
1986	65382	235240	108200	64868	0.600	0.320
1987	94750	249620	110260	80531	0.730	0.391
1988	50514	316710	104400	77247	0.740	0.319
1989	31382	317750	108760	82425	0.758	0.311
1990	20889	325390	132670	98127	0.740	0.335
1991	31163	250710	119980	102316	0.853	0.305
1992	15317	247530	130120	79597	0.612	0.323
1993	18639	213670	129010	71648	0.555	0.386
1994	17372	195640	117280	64339	0.549	0.504
1995	32435	136640	80415	48629	0.605	0.418
1996	26056	127410	63266	40101	0.634	0.403
1997	16928	122600	56310	37264	0.662	0.365
1998	8136	113920	56333	31531	0.560	0.369
1999	27011	107800	58343	31293	0.536	0.330
2000	31540	107800	53360	33146	0.621	0.347
2001	49513	135030	59162	32063	0.542	0.308
2002	62255	170440	66664	42071	0.631	0.321
2003	97441	197760	69241	52494	0.758	0.304
2004	21764	292850	91303	64791	0.710	0.318
2005	68941	281060	100280			
Arith. Mean 4	41894	242751	115691	68689	0.618	0.328
0 Units	(Thousan	(Tonnes	(Tonnes	(Tonnes		

Table 3.2.7.6B. Saithe in Division Va. SSB from adopted 'camera' run with weight at age from landings as the basis for SSB calculation.

SSB with old weights

1985	113980
1986	125800
1987	124750
1988	119290
1989	124860
1990	137900
1991	135600
1992	139510
1993	132490
1994	111050
1995	78124
1996	68351
1997	65727
1998	69150
1999	65224
2000	60904
2001	62241
2002	68907
2003	80412
2004	91619
2005	111060

Table 3.2.8.1A. Saithe in Va. Prediction with management option/short term prediction - input data. Using survey weights at age for calculation of SSB (new SSB).

Icelandic SAITHE. Division Va.

Prognosis - input parameters

Starting year = 2005

Desired TAC:

	2005	2006	2007	2008	2009
Opt1	74	64	70	71	67
Opt2	74	68	73	73	69
Opt3	74	71	76	75	70
Opt4	74	75	79	77	70
Opt5	74	79	81	78	71
Opt6	74	82	84	79	72
Opt7	74	86	86	81	72
Opt8	74	89	88	82	72
Opt9	74	92	90	83	72
Opt10	74	96	92	83	72

F-factor:

	2005	2006	2007	2008	2009
Opt1	1	0.75	0.75	0.75	0.75
Opt2	1	0.8	0.8	0.8	0.8
Opt3	1	0.85	0.85	0.85	0.85
Opt4	1	0.9	0.9	0.9	0.9
Opt5	1	0.95	0.95	0.95	0.95
Opt6	1	1	1	1	1
Opt7	1	1.05	1.05	1.05	1.05
Opt8	1	1.1	1.1	1.1	1.1
Opt9	1	1.15	1.15	1.15	1.15
Opt10	1	1.2	1.2	1.2	1.2

Mean weight in the catches:

	age/year	2005	2006	2007	2008	2009
1.28	**3**	1.36	1.360	1.360	1.360	1.360
1.88	**4**	2.03	1.850	1.850	1.850	1.850
2.6	**5**	2.5	2.730	2.730	2.730	2.730
3.7	**6**	2.95	3.230	3.230	3.230	3.230
4.42	**7**	3.89	3.900	3.900	3.900	3.900
5.54	**8**	5.31	5.020	5.020	5.020	5.020
5.64	**9**	7.04	7.040	7.040	7.040	7.040
7.98	**10**	7.64	7.640	7.640	7.640	7.640
9.06	**11**	8.57	8.570	8.570	8.570	8.570
9.94	**12**	9.59	9.590	9.590	9.590	9.590
	13	10.48	10.480	10.480	10.480	10.480
	14	11.35	11.340	11.340	11.340	11.340

Mean weight at spawning time:

age/year	2005	2006	2007	2008	2009
3	0.67	0.790	1.360	1.360	1.360
4	1.41	1.030	1.850	1.850	1.850
5	1.88	2.210	2.730	2.730	2.730
6	2.42	2.580	3.230	3.230	3.230
7	3.6	3.570	3.900	3.900	3.900
8	5.56	4.850	5.020	5.020	5.020
9	6.52	6.330	6.330	6.330	6.330
10	8.99	8.000	8.000	8.000	8.000
11	9.87	9.780	9.780	9.780	9.780
12	10.42	11.480	11.480	11.480	11.480
13	11.37	12.360	12.360	12.360	12.360
14	14.68	13.980	13.980	13.980	13.980

Sexual maturity:

age/year	2005	2006	2007	2008	2009
3	0.00	0.00	0.00	0.00	0.00
4	0.07	0.04	0.06	0.06	0.06
5	0.11	0.27	0.16	0.16	0.16
6	0.38	0.27	0.52	0.52	0.52
7	0.60	0.57	0.43	0.43	0.43
8	0.78	0.73	0.69	0.69	0.69
9	0.83	0.83	0.83	0.83	0.83
10	0.91	0.91	0.91	0.91	0.91
11	0.93	0.93	0.93	0.93	0.93
12	0.96	0.96	0.96	0.96	0.96
13	1	1	1	1	1
14	1	1	1	1	1

Natural mortality (M):

age/year	2005	2006	2007	2008	2009
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	2005	2006	2007	2008	2009
3	0.022	0.02	0.02	0.02	0.02
4	0.105	0.11	0.11	0.11	0.11
5	0.201	0.20	0.20	0.20	0.20
6	0.291	0.29	0.29	0.29	0.29
7	0.374	0.37	0.37	0.37	0.37
8	0.466	0.47	0.47	0.47	0.47
9	0.466	0.47	0.47	0.47	0.47
10	0.466	0.47	0.47	0.47	0.47
11	0.466	0.47	0.47	0.47	0.47
12	0.466	0.47	0.47	0.47	0.47
13	0.466	0.47	0.47	0.47	0.47
14	0.466	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):

Recruitment= 30.000

age/year	2005
3	68.97
4	17.42
5	57.45
6	24.59
7	11.95
8	4.31
9	1.89
10	0.29
11	0.3
12	0.23
13	0.14
14	0.03
Total=	**187.580**

Table 3.2.8.1B. Saithe in Va. Prediction with management/short term prediction -input data. Using weights at age in landings (old SSB).

Icelandic SAITHE. Division Va.

Prognosis - input parameters

Starting year = 2005

Desired TAC:

	2005	2006	2007	2008	2009
Opt1	74	64	70	71	67
Opt2	74	68	73	73	69
Opt3	74	71	76	75	70
Opt4	74	75	79	77	70
Opt5	74	79	81	78	71
Opt6	74	82	84	79	72
Opt7	74	86	86	81	72
Opt8	74	89	88	82	72
Opt9	74	92	90	83	72
Opt10	74	96	92	83	72

F-factor:

	2005	2006	2007	2008	2009
Opt1	1	0.75	0.75	0.75	0.75
Opt2	1	0.8	0.8	0.8	0.8
Opt3	1	0.85	0.85	0.85	0.85
Opt4	1	0.9	0.9	0.9	0.9
Opt5	1	0.95	0.95	0.95	0.95
Opt6	1	1	1	1	1
Opt7	1	1.05	1.05	1.05	1.05
Opt8	1	1.1	1.1	1.1	1.1
Opt9	1	1.15	1.15	1.15	1.15
Opt10	1	1.2	1.2	1.2	1.2

Mean weight in the catches:

	age/year	2005	2006	2007	2008	2009
1.28	3	1.36	1.360	1.360	1.360	1.360
1.88	4	2.03	1.850	1.850	1.850	1.850
2.6	5	2.5	2.730	2.730	2.730	2.730
3.7	6	2.95	3.230	3.230	3.230	3.230
4.42	7	3.89	3.900	3.900	3.900	3.900
5.54	8	5.31	5.020	5.020	5.020	5.020
5.64	9	7.04	7.040	7.040	7.040	7.040
7.98	10	7.64	7.640	7.640	7.640	7.640
9.06	11	8.57	8.570	8.570	8.570	8.570
9.94	12	9.59	9.590	9.590	9.590	9.590
	13	10.48	10.480	10.480	10.480	10.480
	14	11.35	11.340	11.340	11.340	11.340

Mean weight at spawning time:

age/year	2005	2006	2007	2008	2009
3	1.36	1.360	1.360	1.360	1.360
4	2.03	1.850	1.850	1.850	1.850
5	2.5	2.730	2.730	2.730	2.730
6	2.95	3.230	3.230	3.230	3.230
7	3.89	3.900	3.900	3.900	3.900
8	5.31	5.020	5.020	5.020	5.020
9	7.04	7.040	7.040	7.040	7.040
10	7.64	7.640	7.640	7.640	7.640
11	8.57	8.570	8.570	8.570	8.570
12	9.59	9.590	9.590	9.590	9.590
13	10.48	10.480	10.480	10.480	10.480
14	11.35	11.350	11.350	11.350	11.350

Sexual maturity:

age/year	2005	2006	2007	2008	2009
3	0.00	0.00	0.00	0.00	0.00
4	0.07	0.04	0.06	0.06	0.06
5	0.11	0.27	0.16	0.16	0.16
6	0.38	0.27	0.52	0.52	0.52
7	0.60	0.57	0.43	0.43	0.43
8	0.78	0.73	0.69	0.69	0.69
9	0.83	0.83	0.83	0.83	0.83
10	0.91	0.91	0.91	0.91	0.91
11	0.93	0.93	0.93	0.93	0.93
12	0.96	0.96	0.96	0.96	0.96
13	1	1	1	1	1
14	1	1	1	1	1

Natural mortality (M):

age/year	2005	2006	2007	2008	2009
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	2005	2006	2007	2008	2009
3	0.022	0.02	0.02	0.02	0.02
4	0.105	0.11	0.11	0.11	0.11
5	0.201	0.20	0.20	0.20	0.20
6	0.291	0.29	0.29	0.29	0.29
7	0.374	0.37	0.37	0.37	0.37
8	0.466	0.47	0.47	0.47	0.47
9	0.466	0.47	0.47	0.47	0.47
10	0.466	0.47	0.47	0.47	0.47
11	0.466	0.47	0.47	0.47	0.47
12	0.466	0.47	0.47	0.47	0.47
13	0.466	0.47	0.47	0.47	0.47
14	0.466	0.47	0.47	0.47	0.47
F 4-9	**0.32**	**0.32**	**0.32**	**0.32**	**0.32**

Stock in numbers in starting year (millions):

Recruitment= 30.000

age/year	2005
3	68.97
4	17.42
5	57.45
6	24.59
7	11.95
8	4.31
9	1.89
10	0.29
11	0.3
12	0.23
13	0.14
14	0.03
Total=	**187.580**

Table 3.2.8.2A. Saithe in Va. Prediction with management/short term prediction. Using survey weights at age (new SSB).

Icelandic SAITHE. Division Va.

in 2005-2007 for different management strategies.

2005				2006				2007				2008		
Stofn	Hrygn-				Stofn	Hrygn-			Stofn	Hrygn-		Stofn	Hrygn-	
4+	stofn				4+	stofn			4+	stofn		4+	stofn	
Stock	*Spawninç*	F	Afli	Afli	*Stock*	*Spawn.*	F	Afli	*Stock*	*Spawn.*	F	*Stock*	*Spawn.*	
4+	*stock*		*Catch*	*Catch*	*4+*	*stock*		*Catch*	*4+*	*stock*		*4+*	*stock*	
281	100	0.32	74	64	298	115	0.24	70	377	149	0.24	356	181	0.75
				68	298	115	0.25	73	373	146	0.25	348	175	0.8
				71	298	115	0.27	76	369	144	0.27	341	170	0.85
				75	298	115	0.29	79	364	142	0.29	333	165	0.9
			Fpa	79	298	115	0.30	81	360	140	0.30	326	161	0.95
				82	298	115	0.32	84	356	137	0.32	320	156	1
				86	298	115	0.33	86	353	135	0.33	313	152	1.05
				89	298	115	0.35	88	349	133	0.35	307	147	1.1
				92	298	115	0.36	90	345	131	0.36	300	143	1.15
				96	298	115	0.38	92	341	129	0.38	294	139	1.2

Table 3.2.8.1B. Saithe in Va. Prediction with management/short term prediction. Using weights at age in landings (old SSB).

Icelandic SAITHE. Division Va.

in 2005-2007 for different management strategies.

2005				2006				2007				2008		
Stofn	Hrygn-				Stofn	Hrygn-			Stofn	Hrygn-		Stofn	Hrygn-	
4+	stofn				4+	stofn			4+	stofn		4+	stofn	
Stock	*Spawninç*	F	Afli	Afli	*Stock*	*Spawn.*	F	Afli	*Stock*	*Spawn.*	F	*Stock*	*Spawn.*	
4+	*stock*		*Catch*	*Catch*	*4+*	*stock*		*Catch*	*4+*	*stock*		*4+*	*stock*	
343	111	0.32	74	64	382	130	0.24	70	378	149	0.24	357	181	0.75
				68	382	130	0.25	73	374	147	0.25	349	176	0.8
				71	382	130	0.27	76	370	145	0.27	342	171	0.85
				75	382	130	0.29	79	365	143	0.29	335	166	0.9
			Fpa	79	382	130	0.30	81	361	140	0.30	328	161	0.95
				82	382	130	0.32	84	357	138	0.32	321	157	1
				86	382	130	0.33	86	354	136	0.33	314	152	1.05
				89	382	130	0.35	88	350	134	0.35	308	148	1.1
				92	382	130	0.36	90	346	132	0.36	301	144	1.15
				96	382	130	0.38	92	342	130	0.38	295	140	1.2

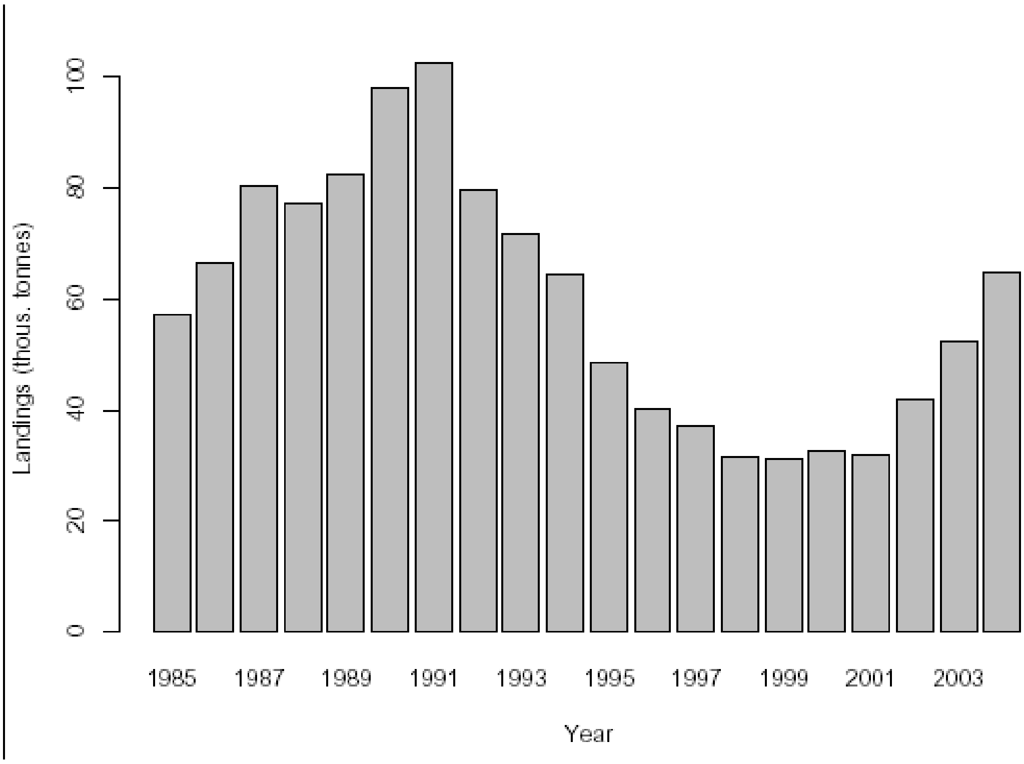


Figure 3.2.1.1. Saithe in Va. Nominal landings 1985-2003.

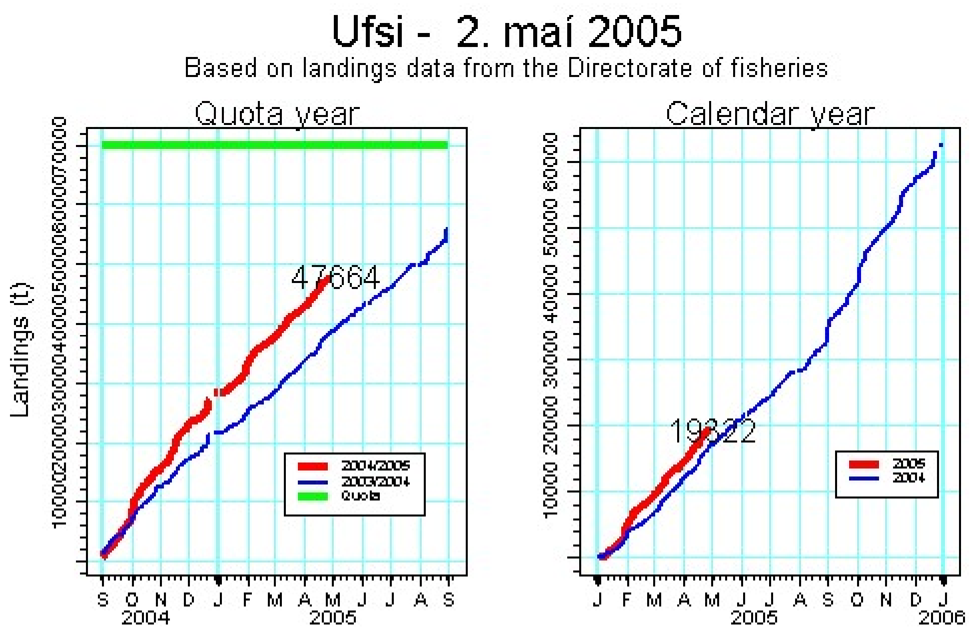


Figure 3.2.1.2. Saithe in Va. Landings in qouta years 2004/2005 (blue) and 2004/2005 and calendar years 2004 and 2005 (www.hafro.is/~sigurdur/Landings).

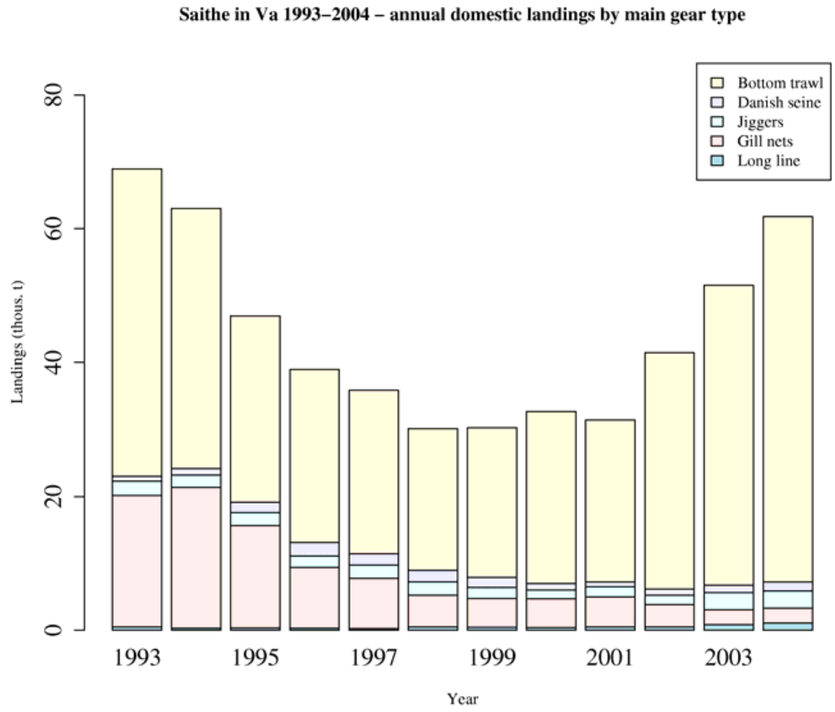


Figure 3.2.2.1. Saithe in Va. Annual domestic landings in 1993-2004 by gear type.

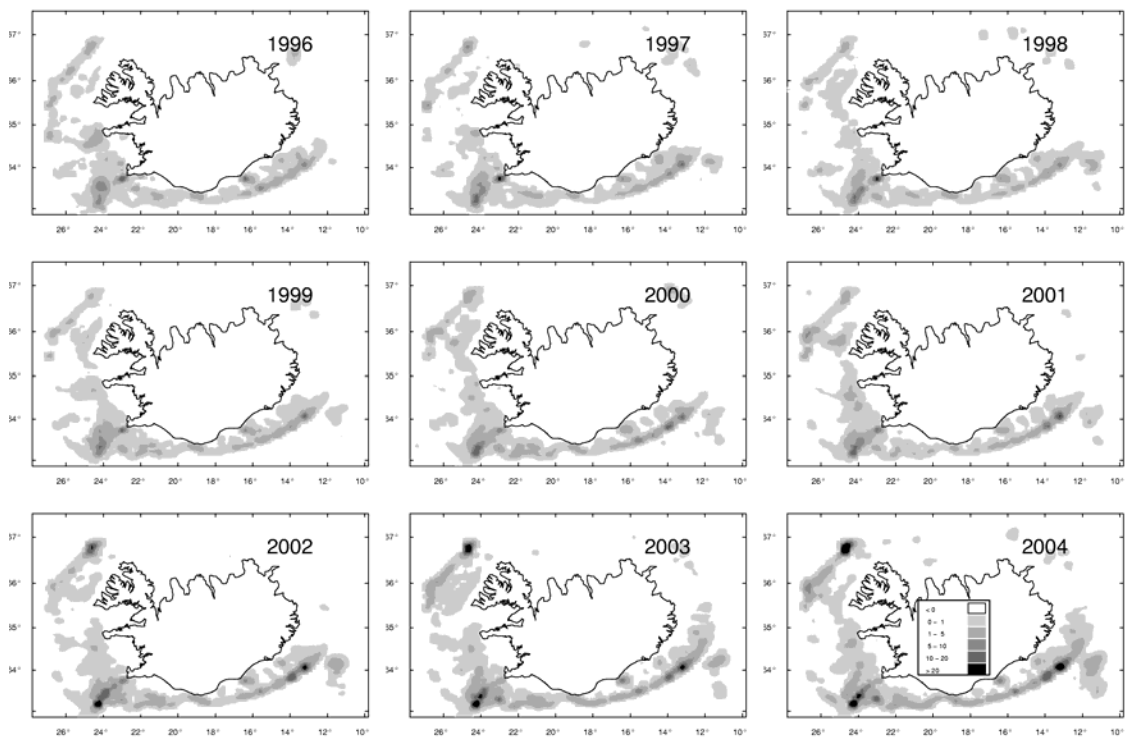


Figure 3.2.2.2. Saithe in Va. Geographical distribution of the trawler fishery 1996-2004.

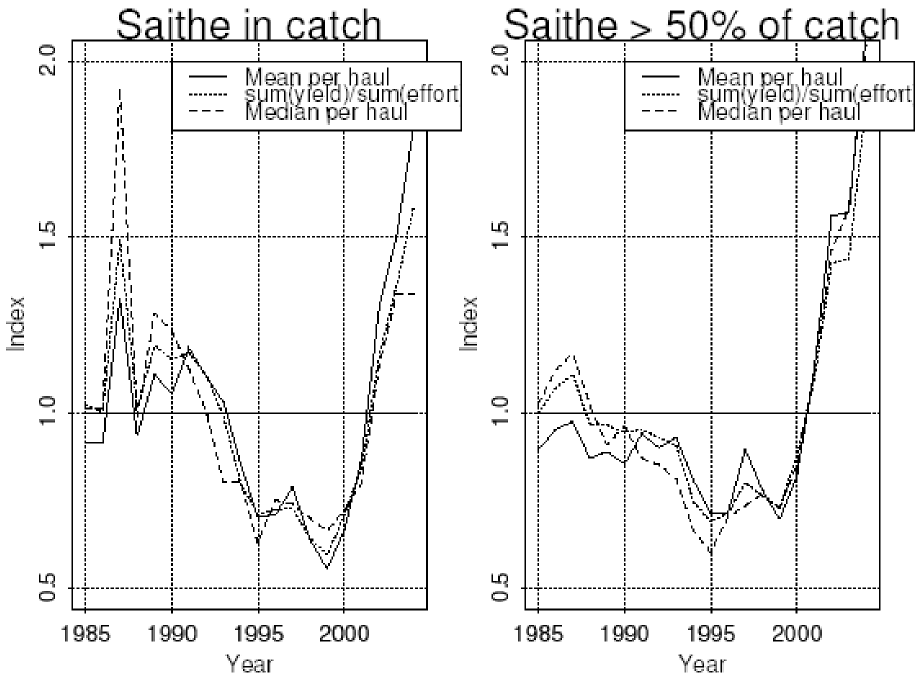


Figure 3.2.2.3. Saithe in Va. Simple CPUE indices from the trawler fleet for 1985-2004.

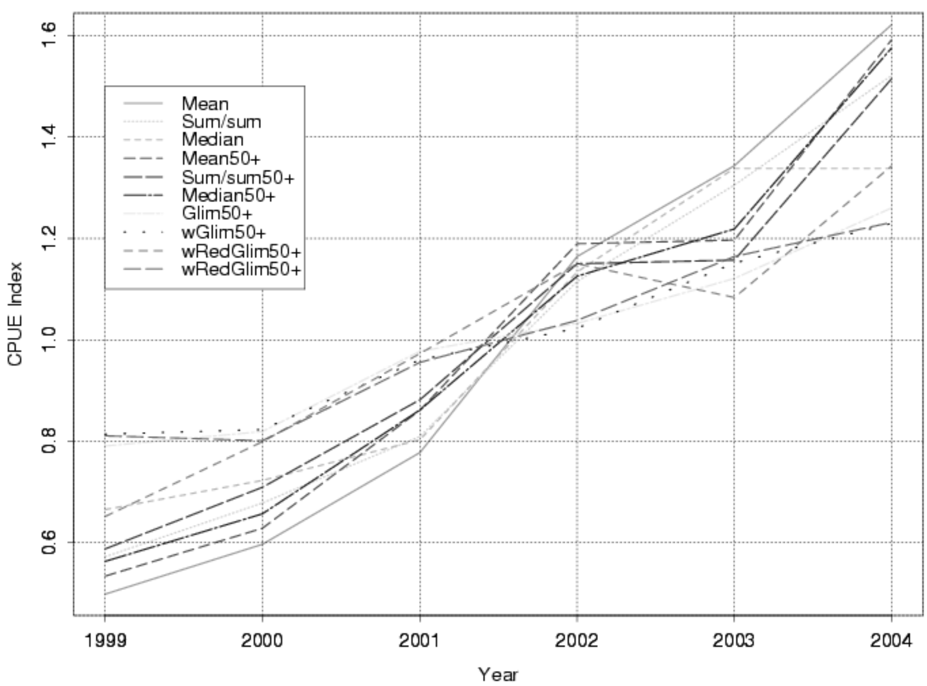
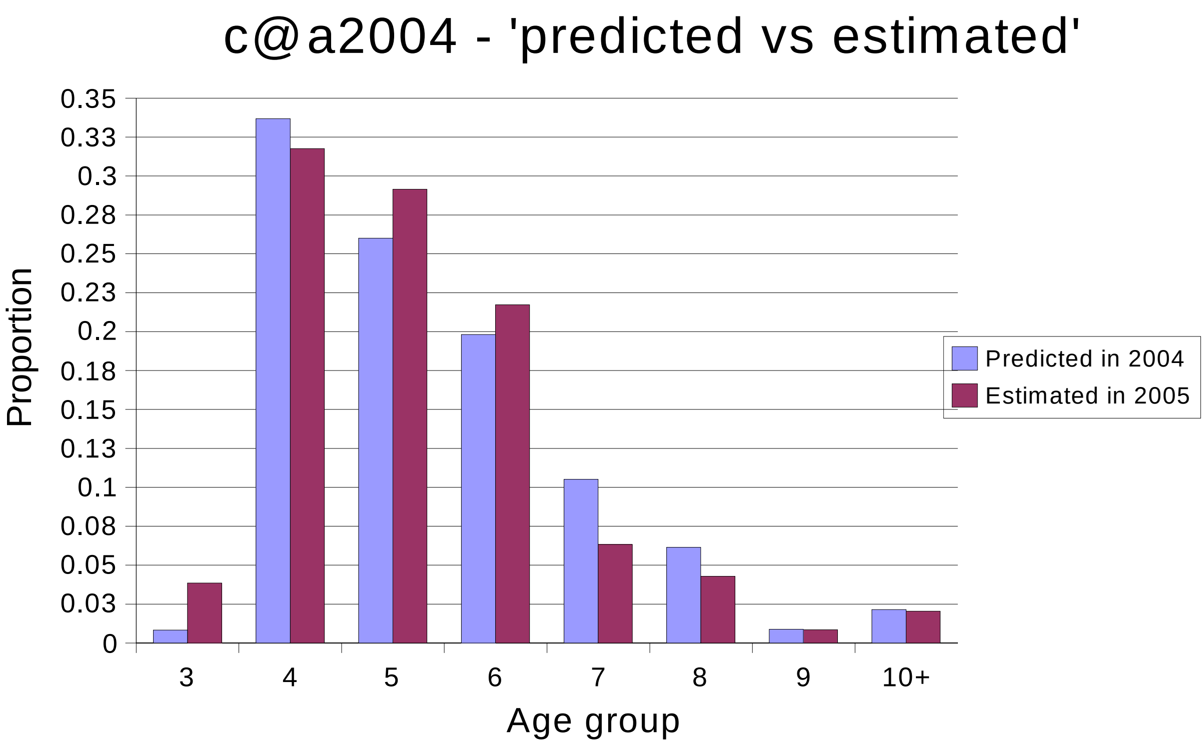


Figure 3.2.2.4. Saithe in Va. SIMPLE and GLIM CPUE indices from the trawler fleet for 1999-2004. Cells in GLIM are by quarter, BORMICON/GADGET area (10 in number on the shelf within the 500m depth contour), and vessel. Reduced GLIM is on data from vessels participating and reporting more than 100 t/year for the 1999-2004 period.



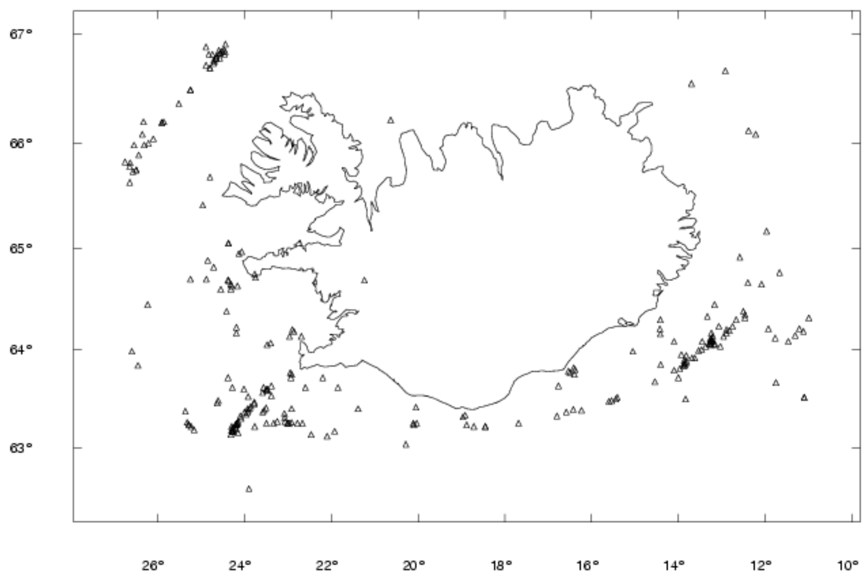


Figure 3.2.3.1. Saithe in Va. Prognosis in May 2004 and estimate in April 2005 of proportional distribution of landings in numbers at age in 2004.

Figure 3.2.3.2. Saithe in Va. Geographical distribution samples from landings in 2004.

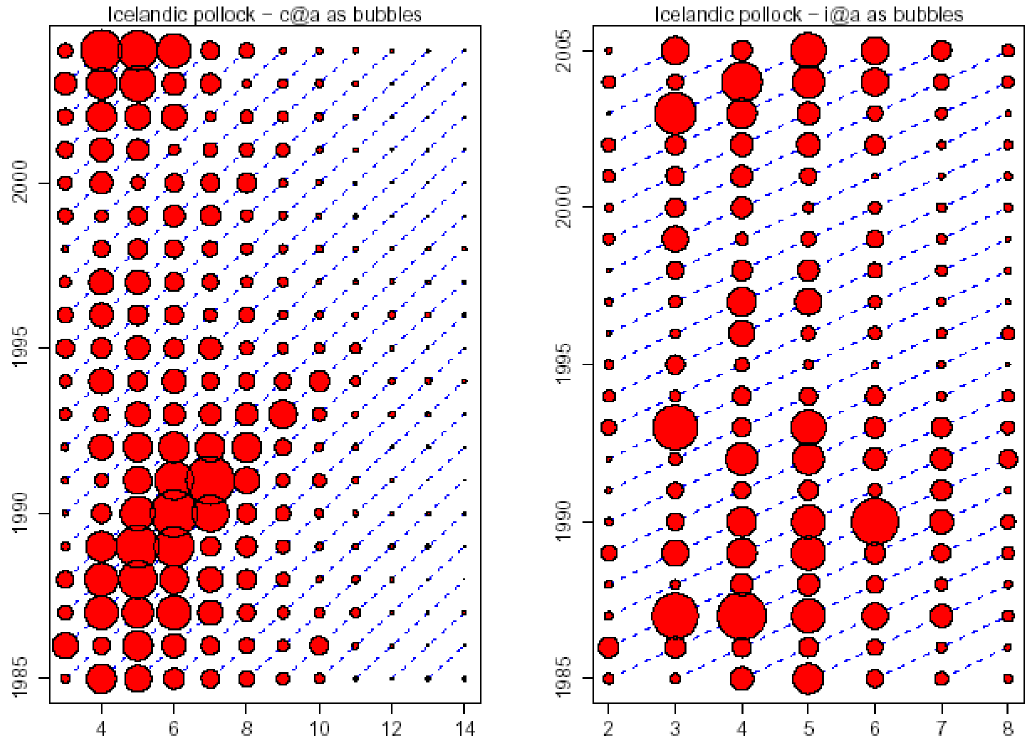


Figure 3.2.3.3. Saithe in Va. Circles representing landings at age 3-14 in1985-2003 (right) and of index at age 2-8 in 1985-2004 juxtaposed.

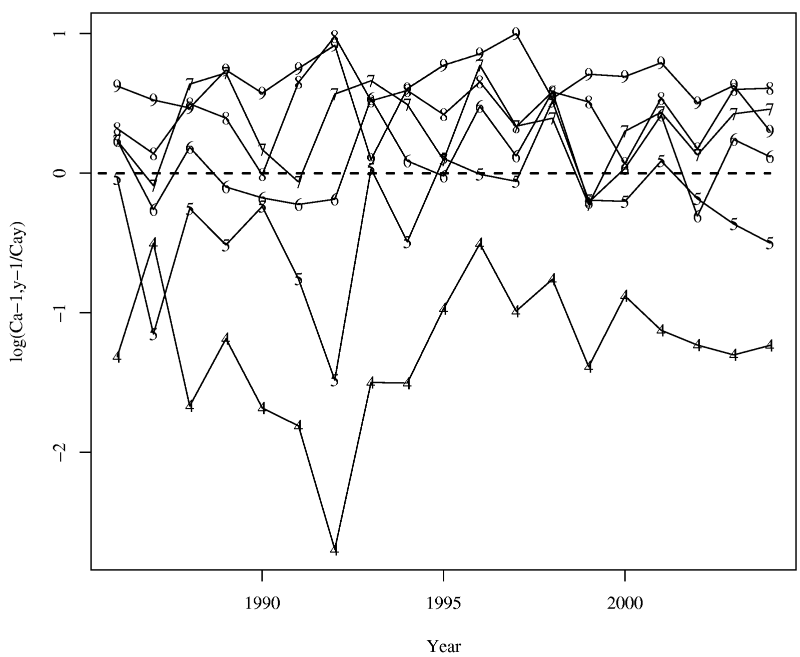
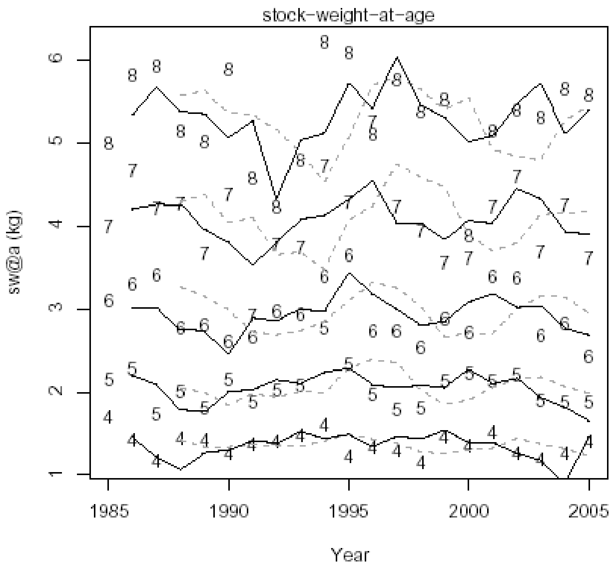


Figure 3.2.3.4. Saithe in Va. Catch curves for catch-at-age for age groups 3-14 in1985-2004.EÐA LOGRATIOS



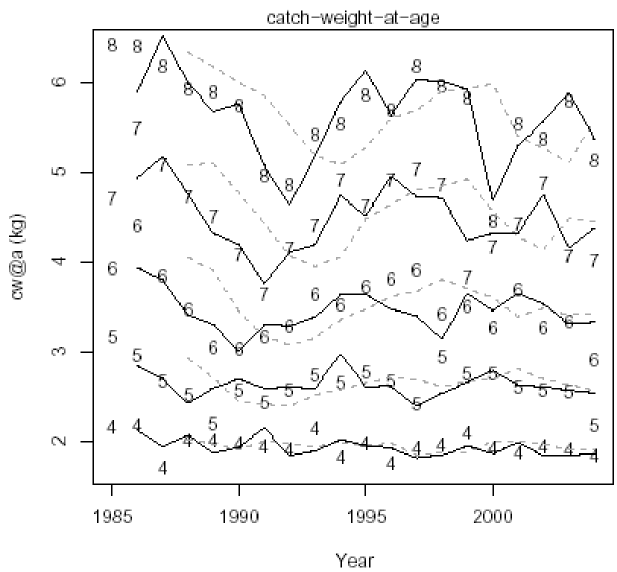


Figure 3.2.4.1. Saithe in Va. Mean weight at age 4-8 in the stock in 1985-2004 and in landings 1985-2004. Modelled weight at age is shown as black unbroken lines, through the observations, previous 3 years average as grey dashed lines, following them.

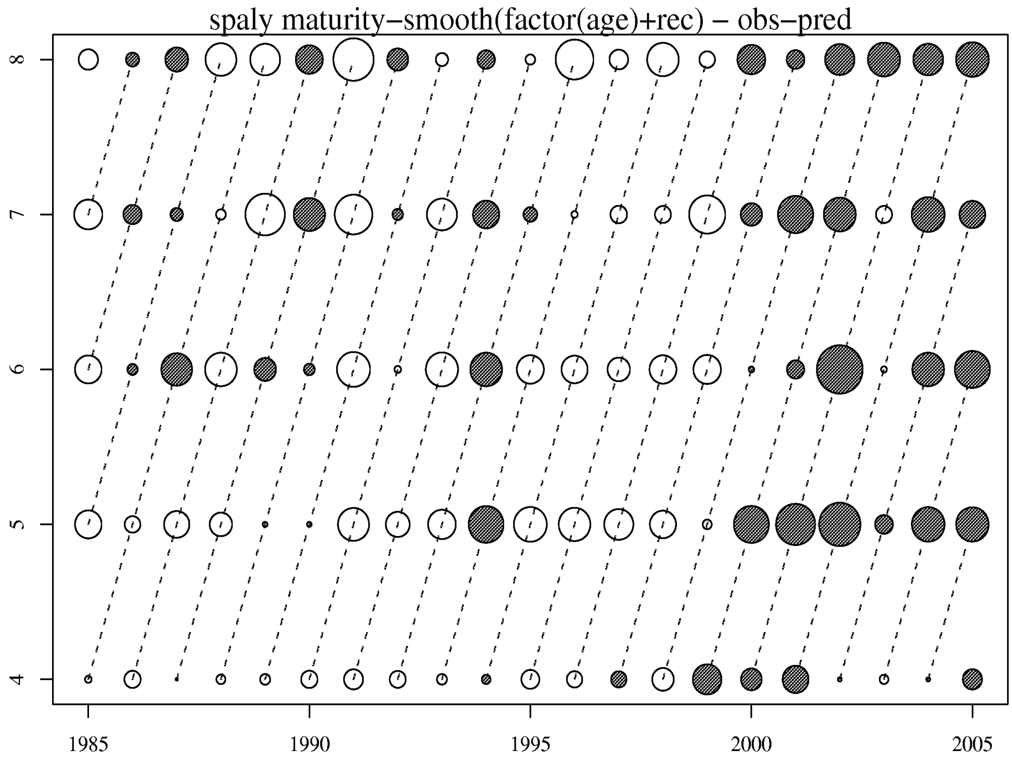


Figure 3.2.5.1. Saithe in Va. Residuals (observed – predicted maturity) from GLM-SPALY-maturity smoother on IGFS survey maturity 1985-2005.

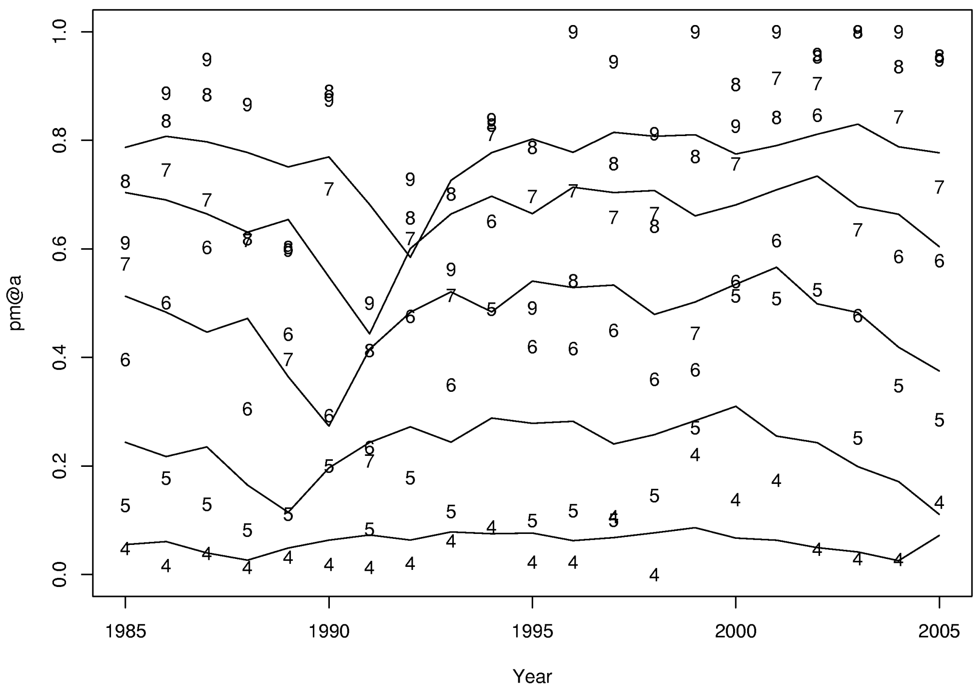


Figure 3.2.5.2. Saithe in Va.. Observed maturity for age groups 4-9 (labelled with age) and predicted for age groups 4-8 (drawn as lines) in IGFS 1985-2005.

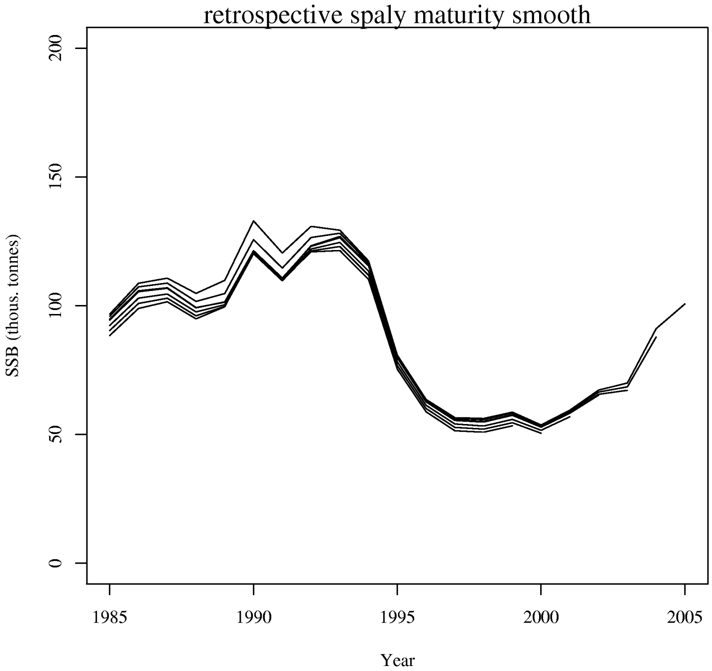


Figure 3.2.5.3. Saithe in Va.. SSB- trajectories 1985-2005 from 'cadapt' based on proportion mature as observed in IGFS, smoothed and with a fixed average IGFS ogive.

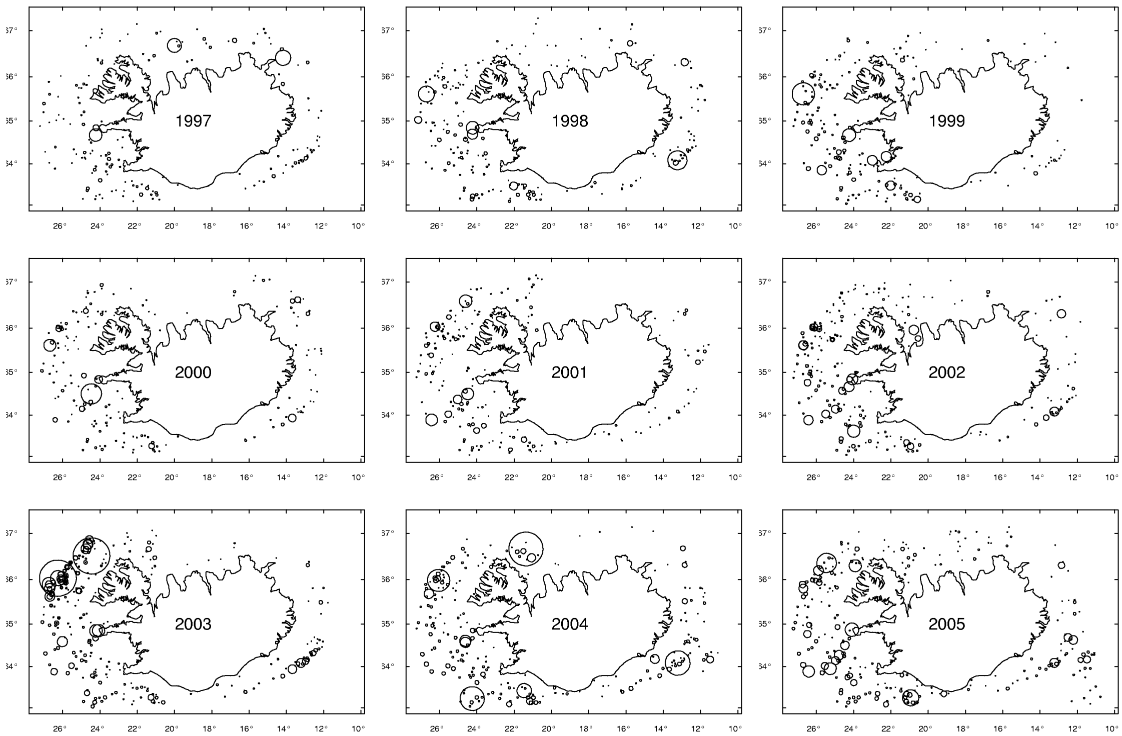


Figure 3.2.7.1. Saithe in Va. Geographic distribution of abundance in IGFS 1997-2005. Circle area propotional to abundance. Only stations on which saithe occurred are shown.

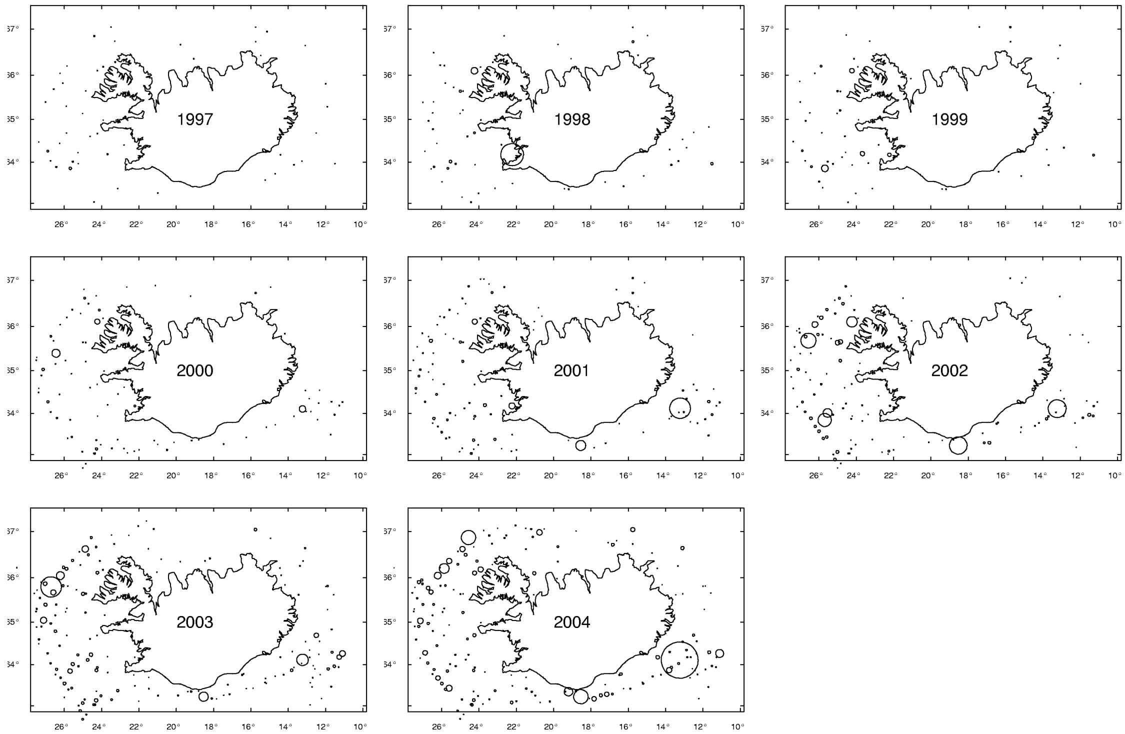


Figure 3.2.7.2. Saithe in Va. Geographic distribution of abundance in Icelandic autumn survey 1997-2004. Circle area propotional to abundance scaled to the maximum for the period. Only stations on which saithe occurred are shown.

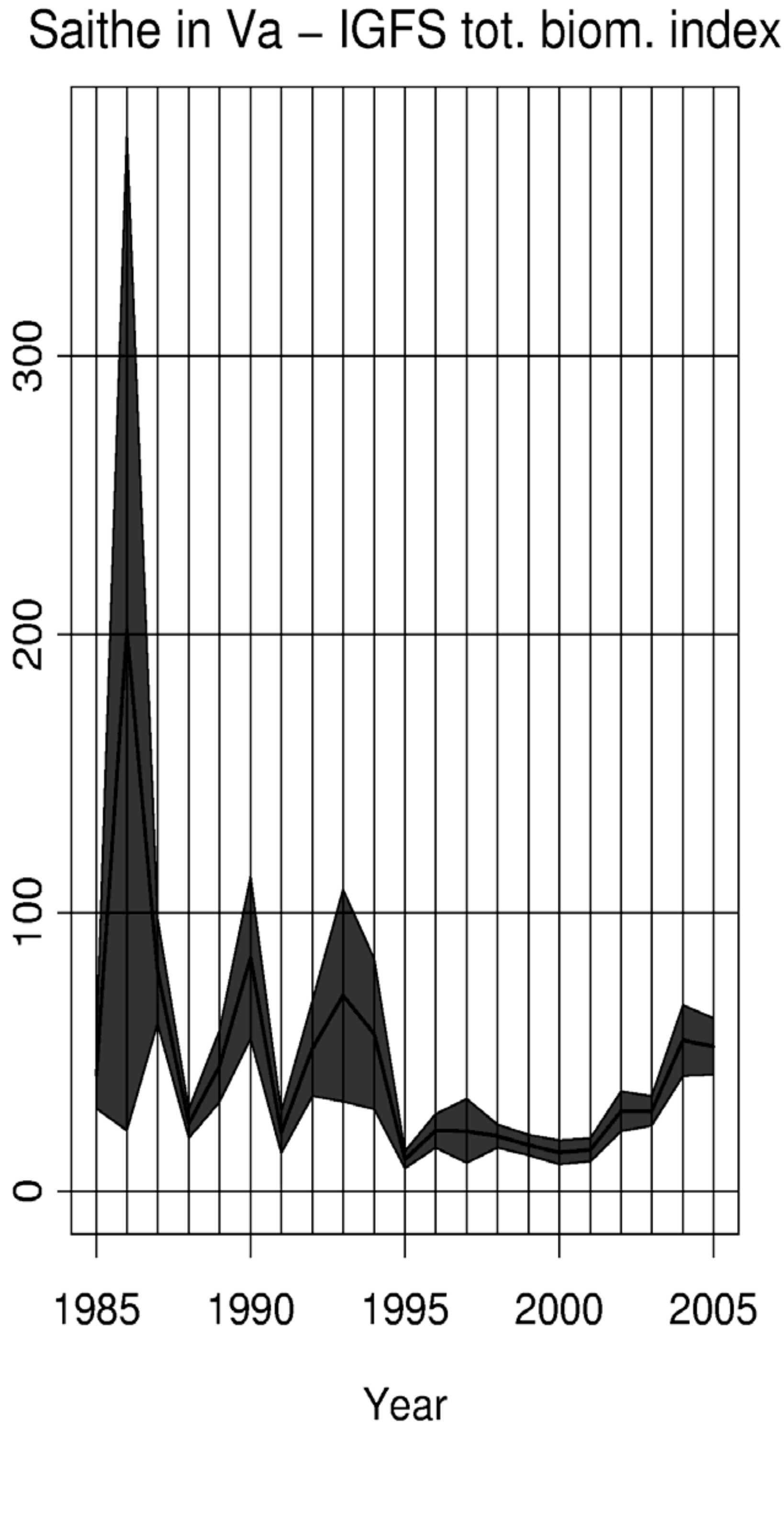


Figure 3.2.7.3. Saithe in Va. Stratified mean survey biomass index from IGFS 1985-2005.

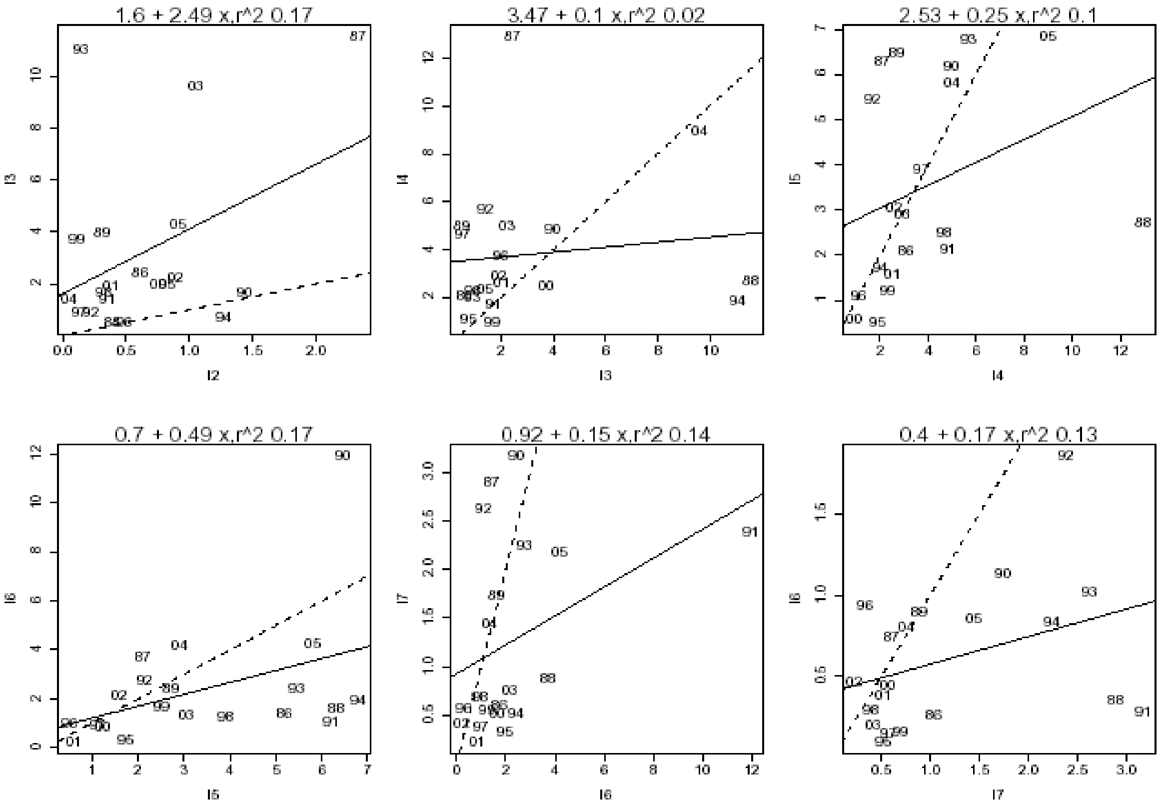


Figure 3.2.7.4. Saithe in Va. Between year and age correspondance for year classes in IGFS 1985-2004 with R^2 from linear fit. Year at older age is shown.

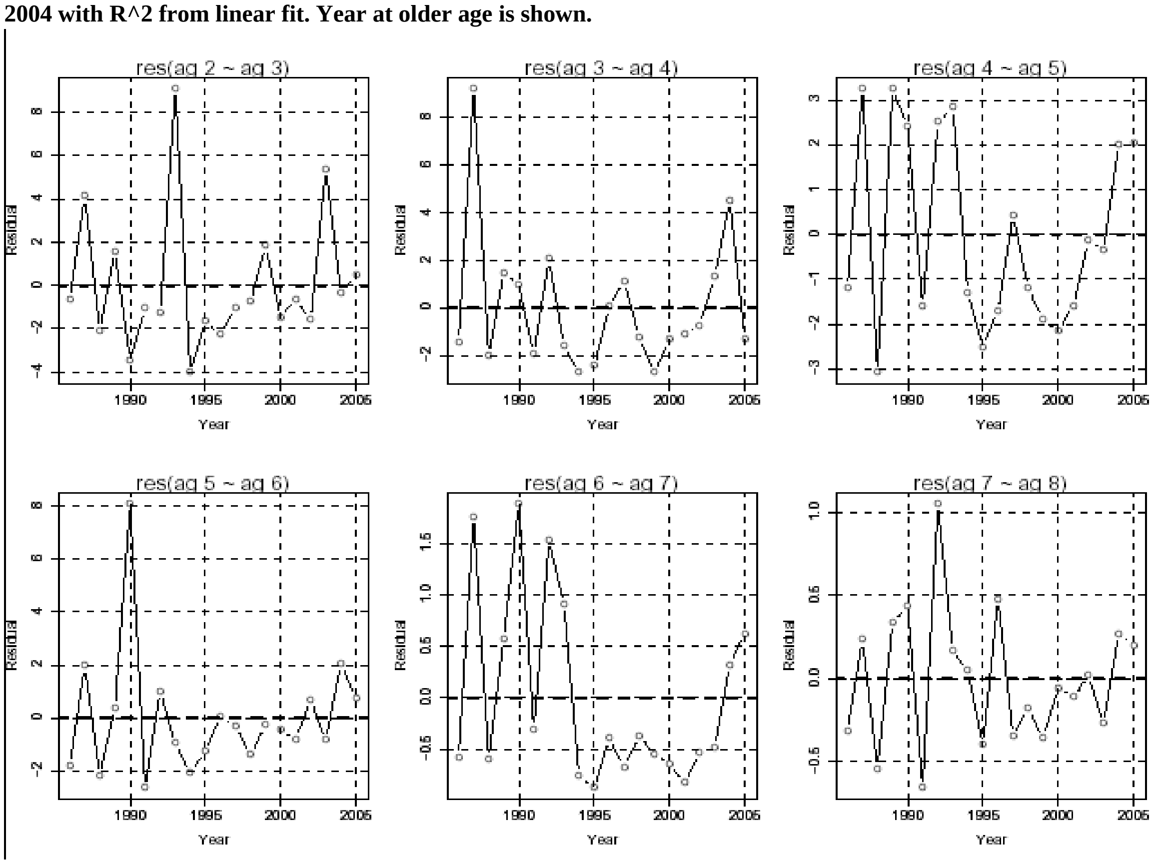


Figure 3.2.7.5. Saithe in Va. Numbers at age from 'SPALY-camera' vs. index at age for age groups 3-8 in 1985:2005.

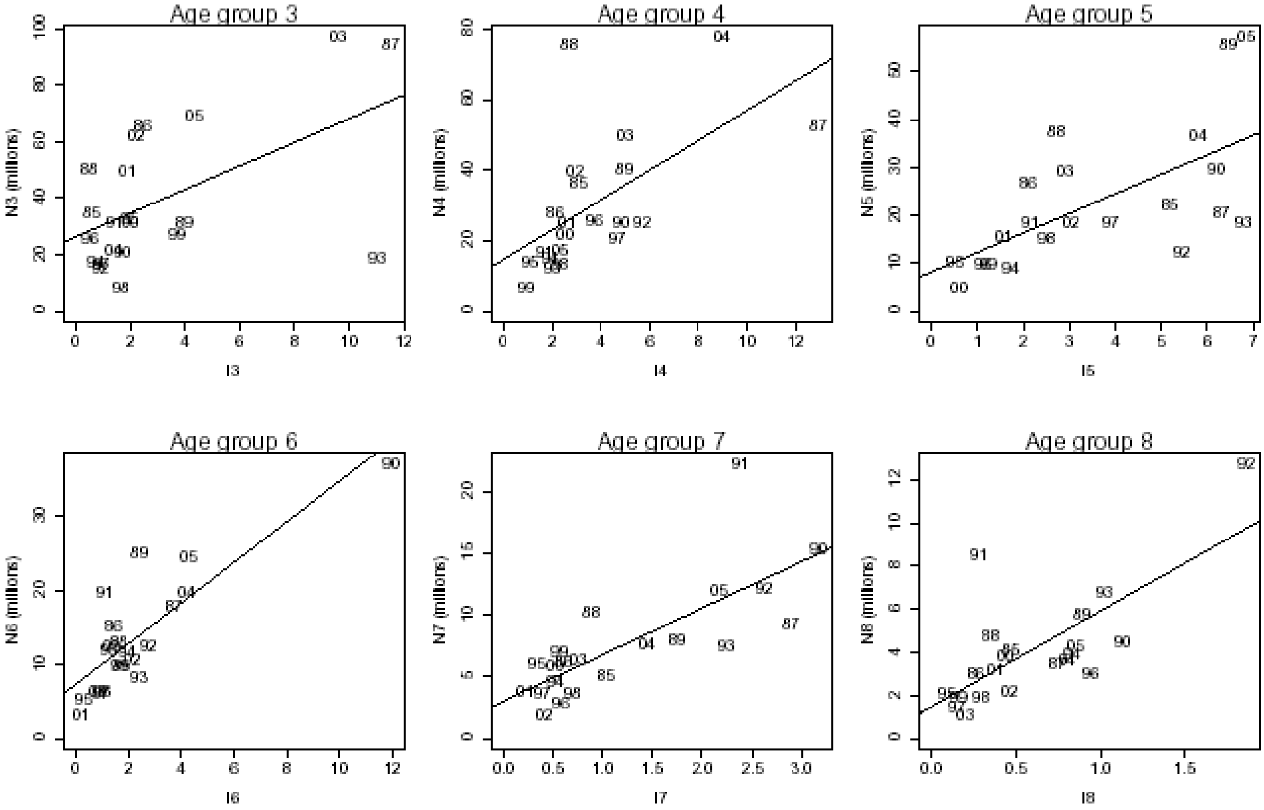


Figure 3.2.7.6. Saithe in Va. Numbers at age from 'SPALY-camera' vs. index at age for age groups 3-8 in 1985-2005.

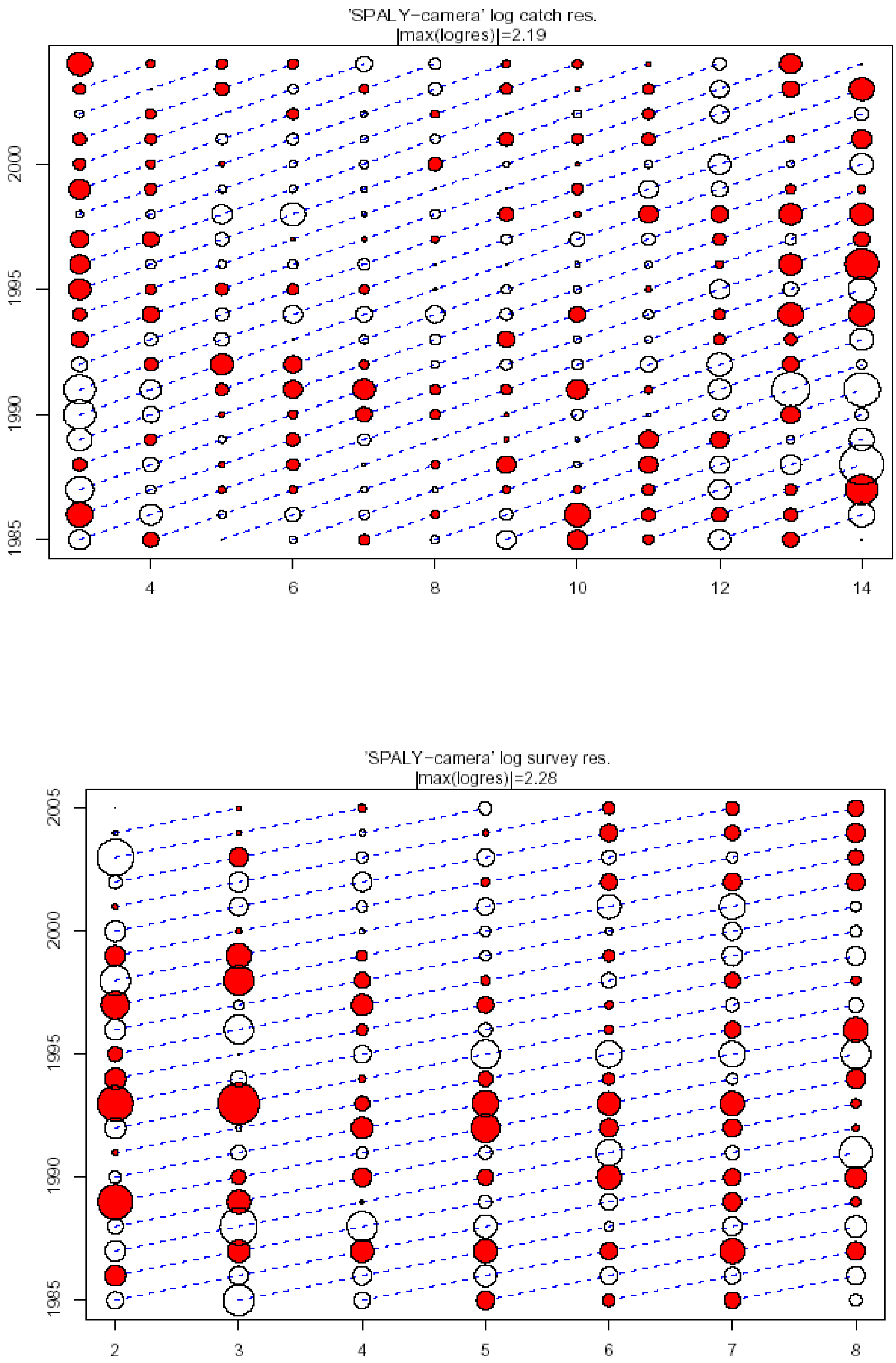


Figure 3.2.7.7. Saithe in Va. 'SPALY-camera' catch (lower) and survey (lower)-log-residuals.

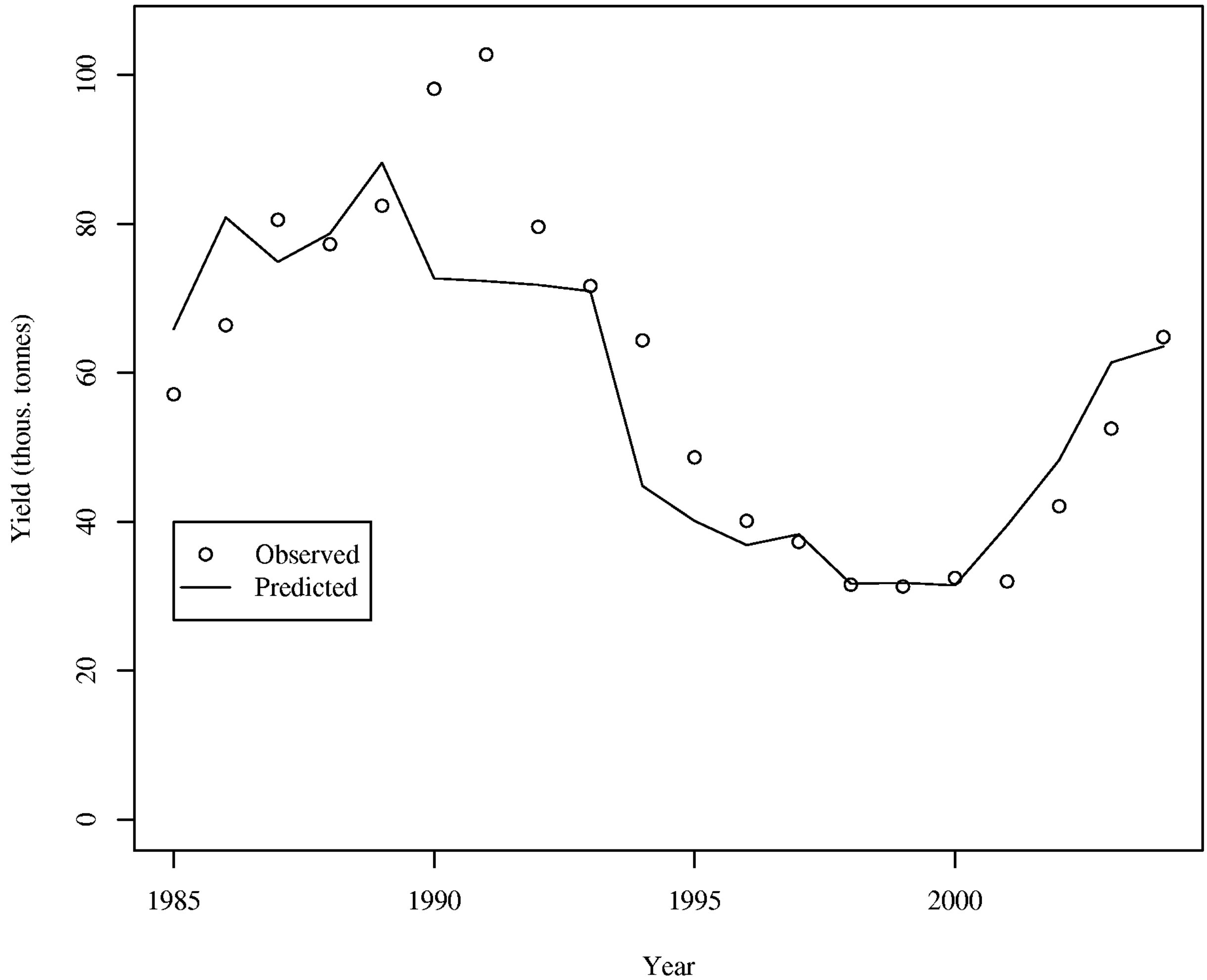
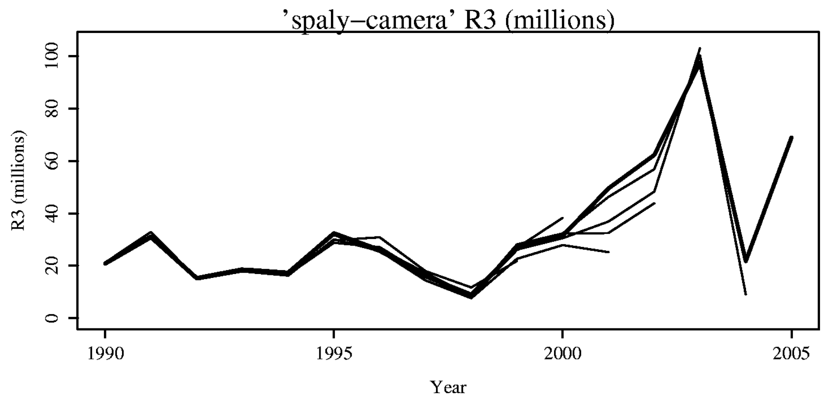


Figure 3.2.7.8. Saithe in Va. Reported landings and predicted yield from 'camera'.



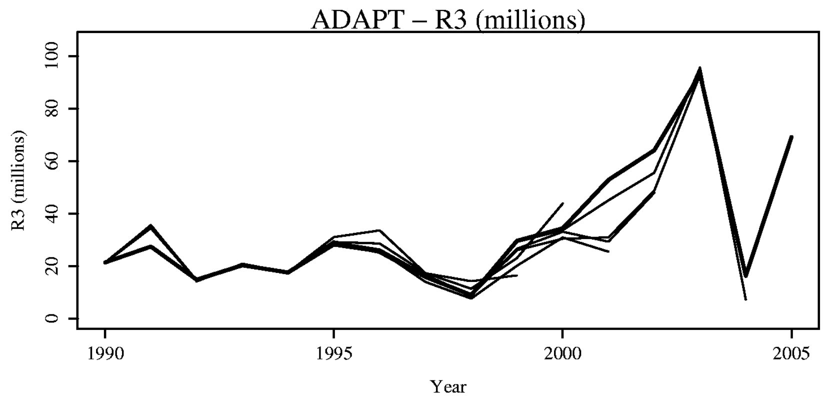


Figure 3.2.7.9. Saithe in Va. Retrospective analysis of 'camera' and 'cadapt' R3, TSA missing as recruiting age is 4 in that model.

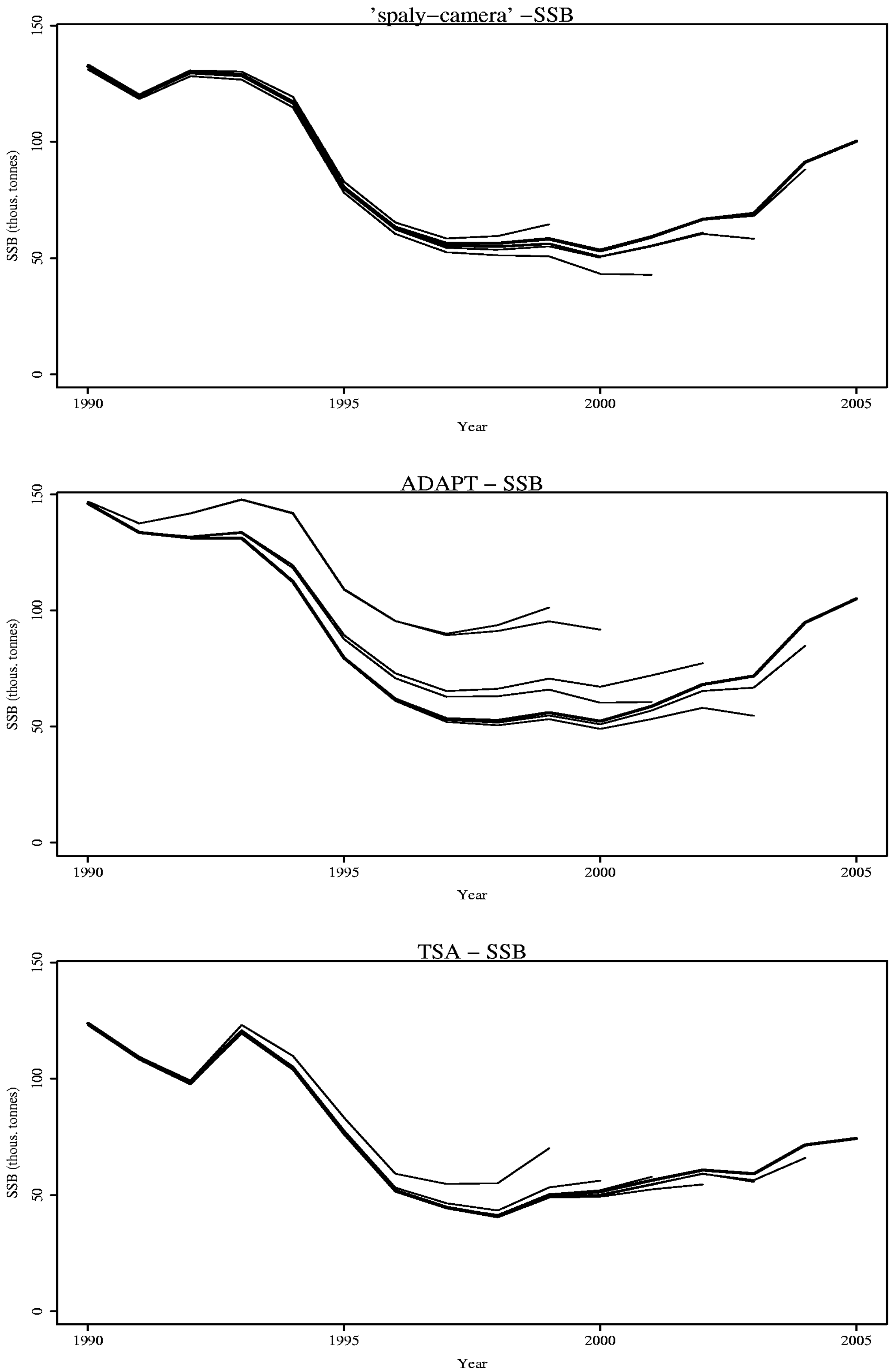


Figure 3.2.7.10. Retrospective analysis of 'camera', 'cadapt' and TSA SSB. Note that migration is estimated in TSA.

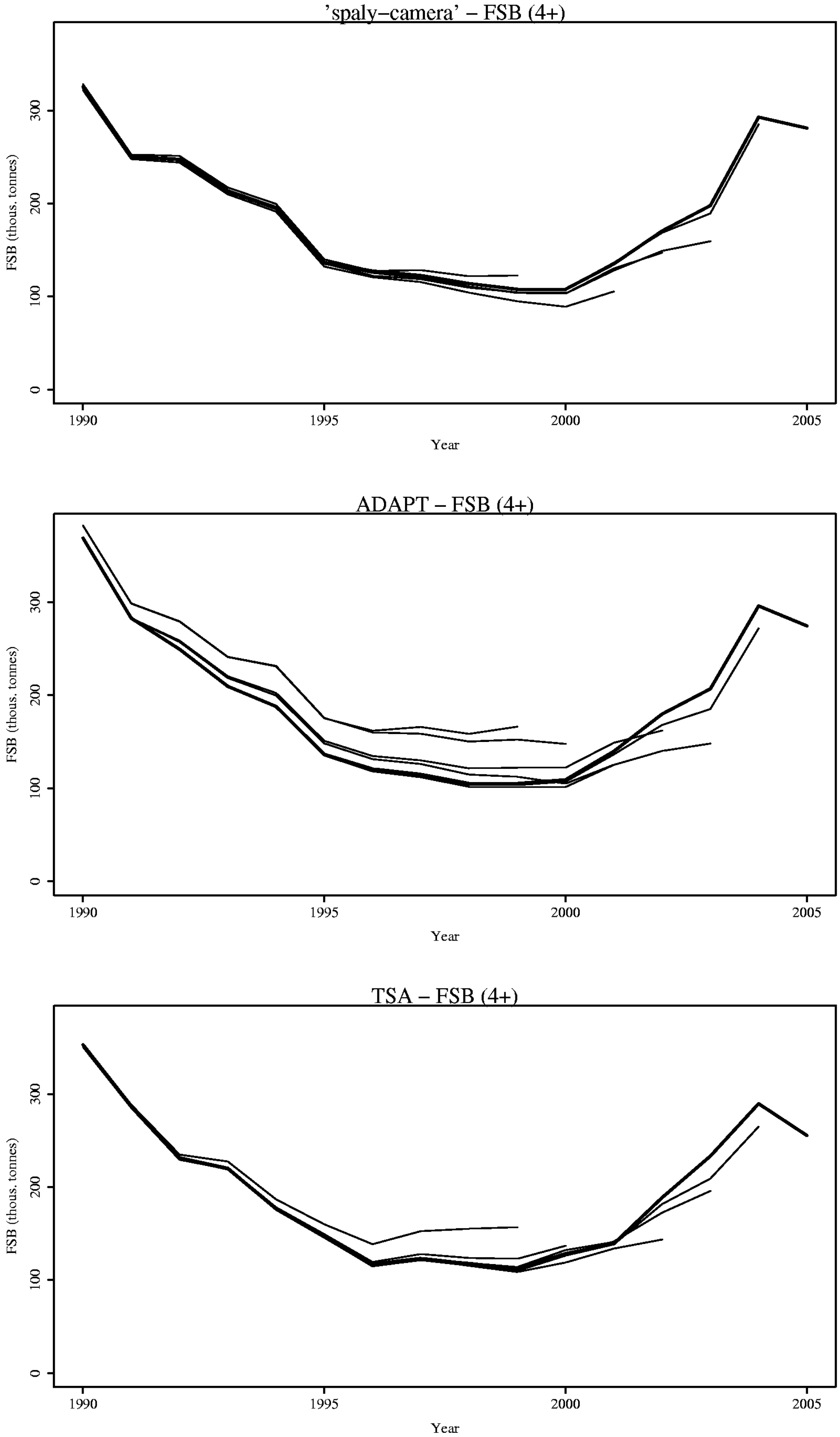


Figure 3.2.7.11. Saithe in Va. Retrospective analysis of seperable model, ADAPT and TSA 'fish-able' biomass (age 4+) . Note that migration is estimated in TSA.

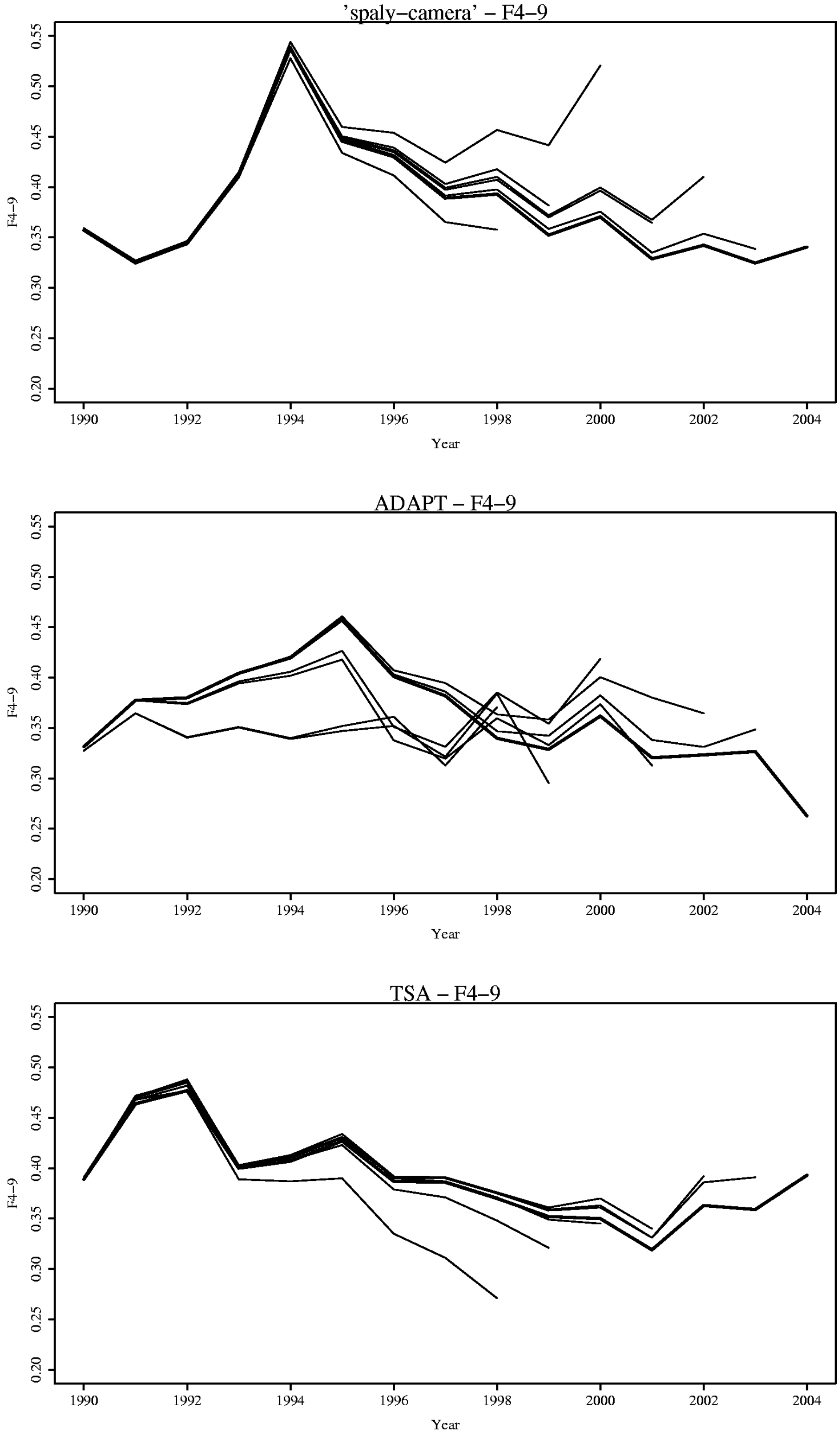
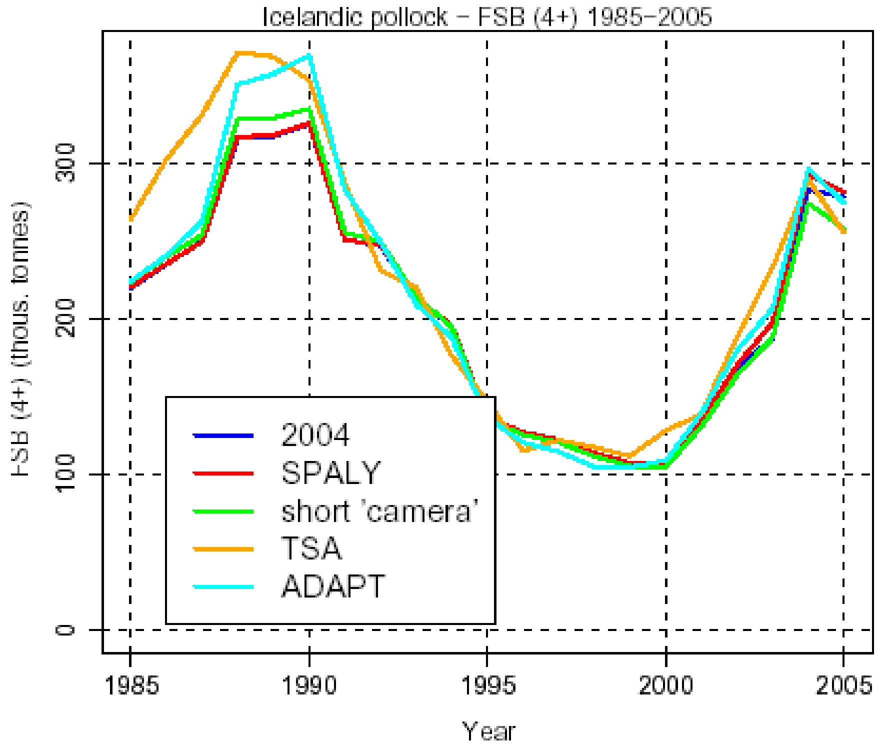


Figure 3.2.7.12 Saithe in Va. Retrospective analysis of seperable model 'camera', ADAPT and TSA reference fishing mortality (average of age groups 4-9).



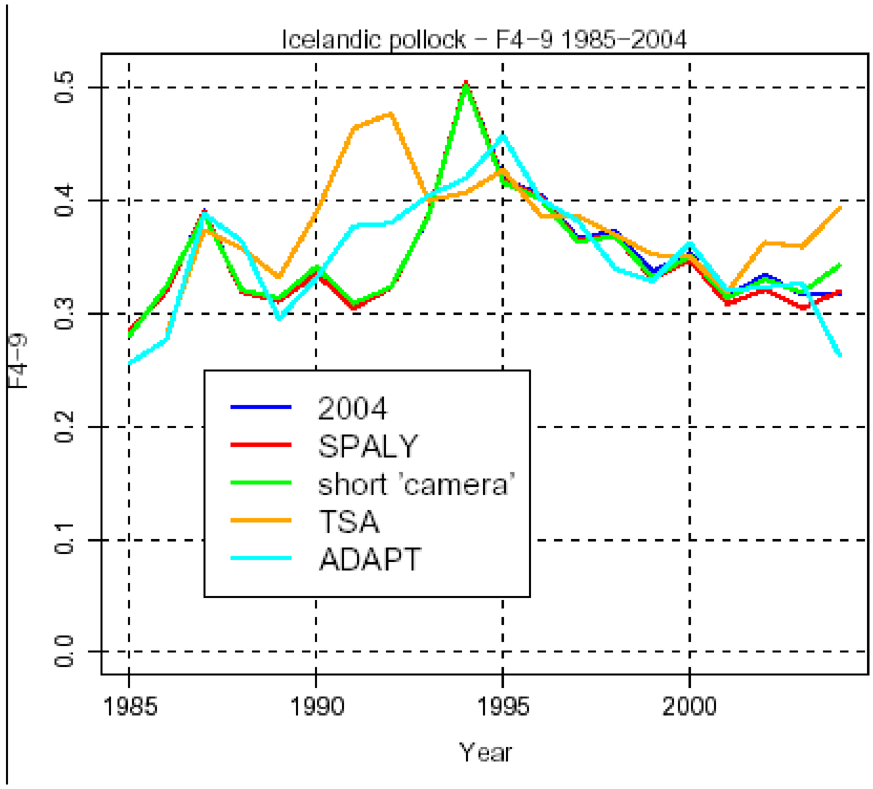
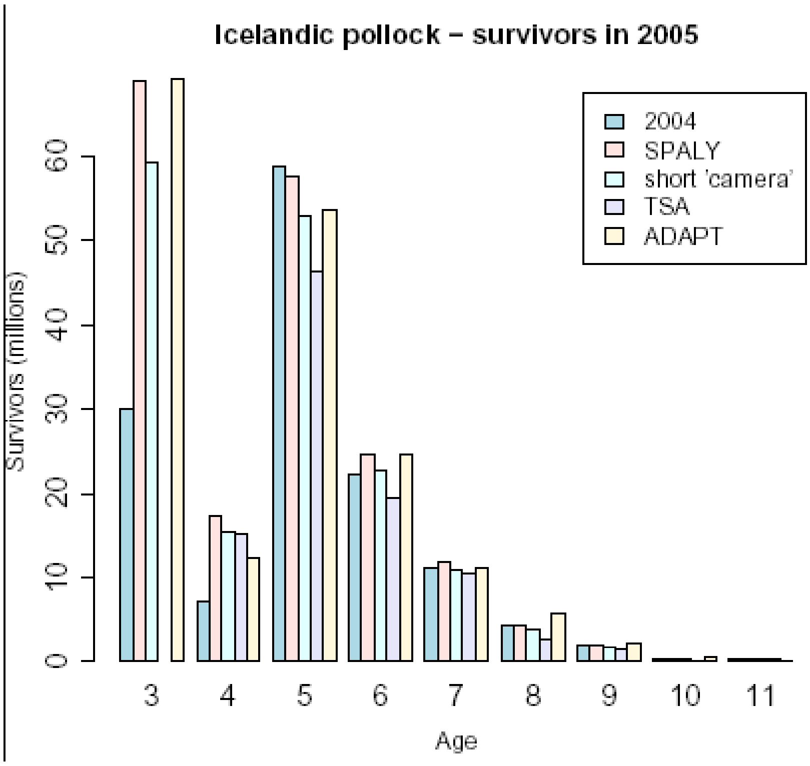


Figure 3.2.7.13. Saithe in Va. 'Fishable stock biomass' (B4+) and F4-9 1985-2004 from 2004 assessment, SPALY seperable model 'camera', a shorter seperable model, 'cadapt', and TSA. Note that TSA includes estimation of migration.



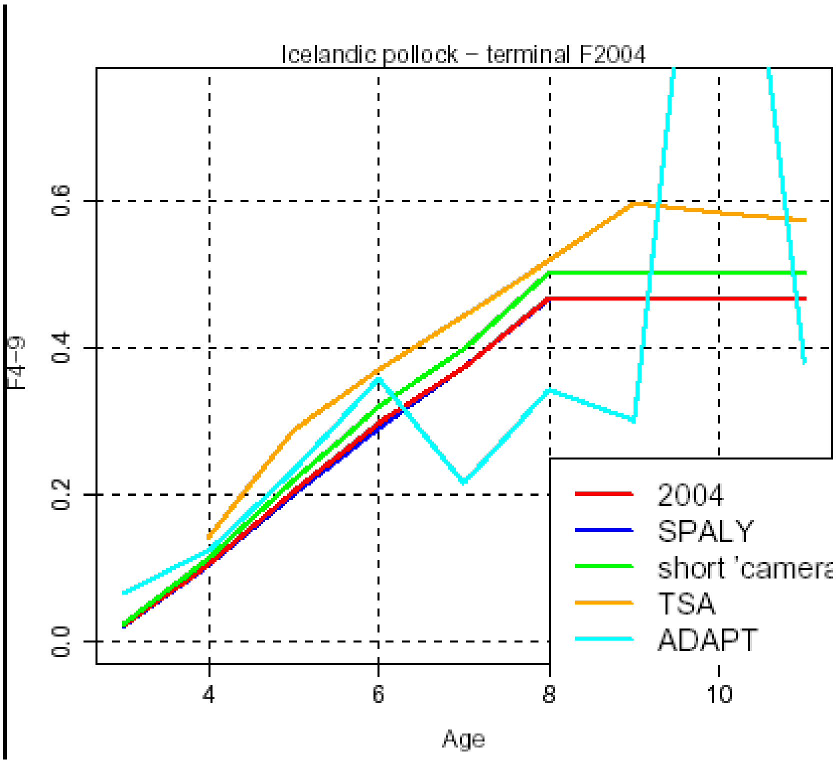


Figure 3.2.7.14. Saithe in Va. Comparison of 2004 terminal F4-9 and 2005 survivor estimates from last years prediction, a spaly seperable run, a seperable run tuned with 1989-2005 survey.

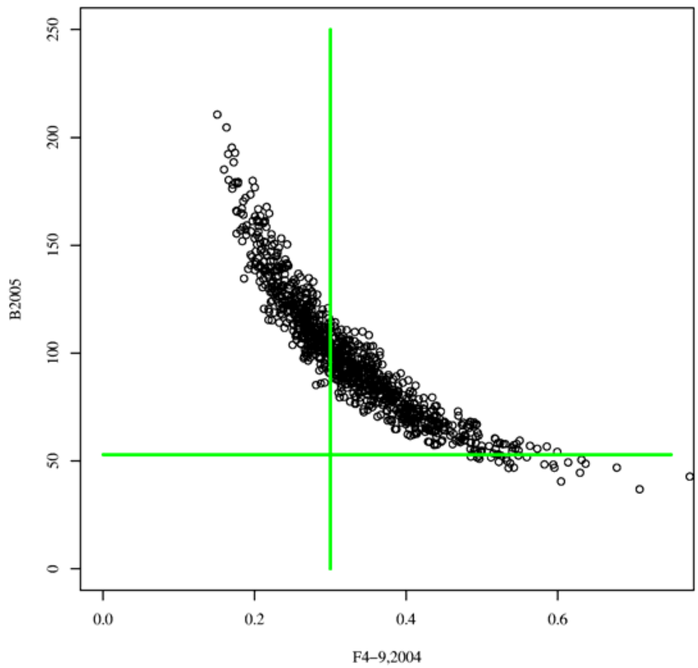


Figure 3.2.7.15. 'camera' boostrap distribution of SSB2005 vs F2004,4-9 from 1000 bootstrap runs of 'camera'. Lines corresponding to Fpa=0.3 and the proposed new Blim of 53 Kt are drawn..

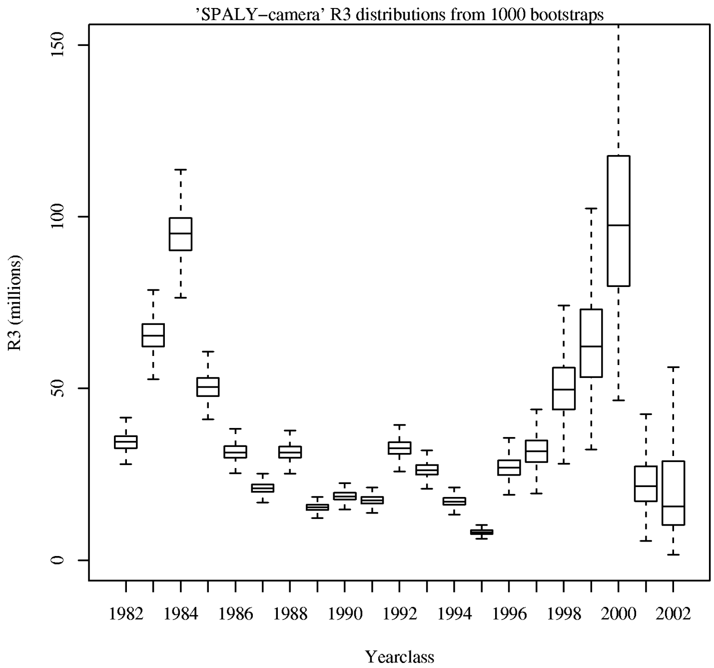


Figure 3.2.7.16. Bootstrap distributions of recruits at age 3 from 1000 bootstraps of the 'camera' seperable model.

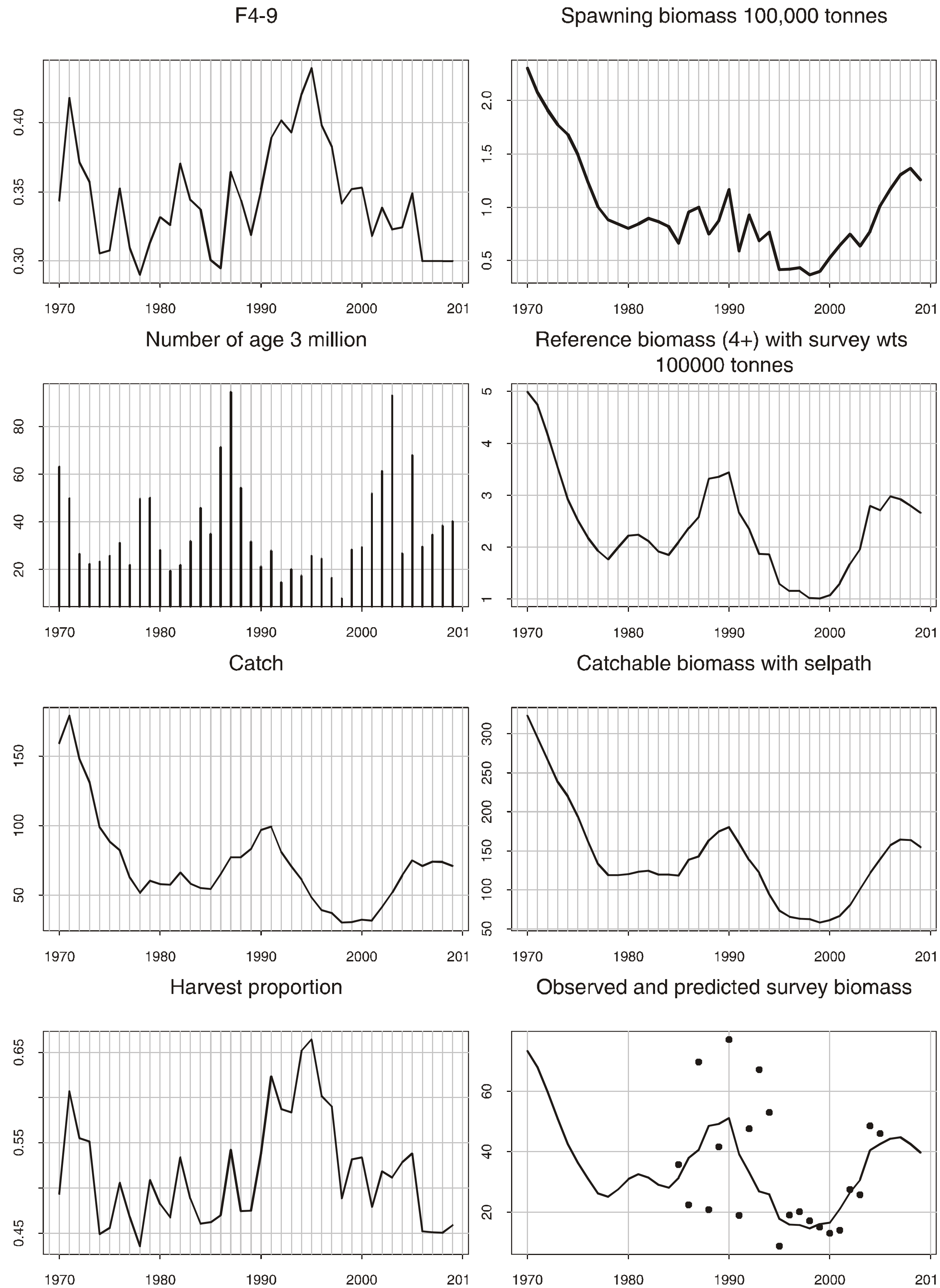


Figure 3.2.7.17. AD-CAM projection of saithe in Va. Yield in 2005 75 Kt, fishery at Fpa=0.3 from 2006 onwards.

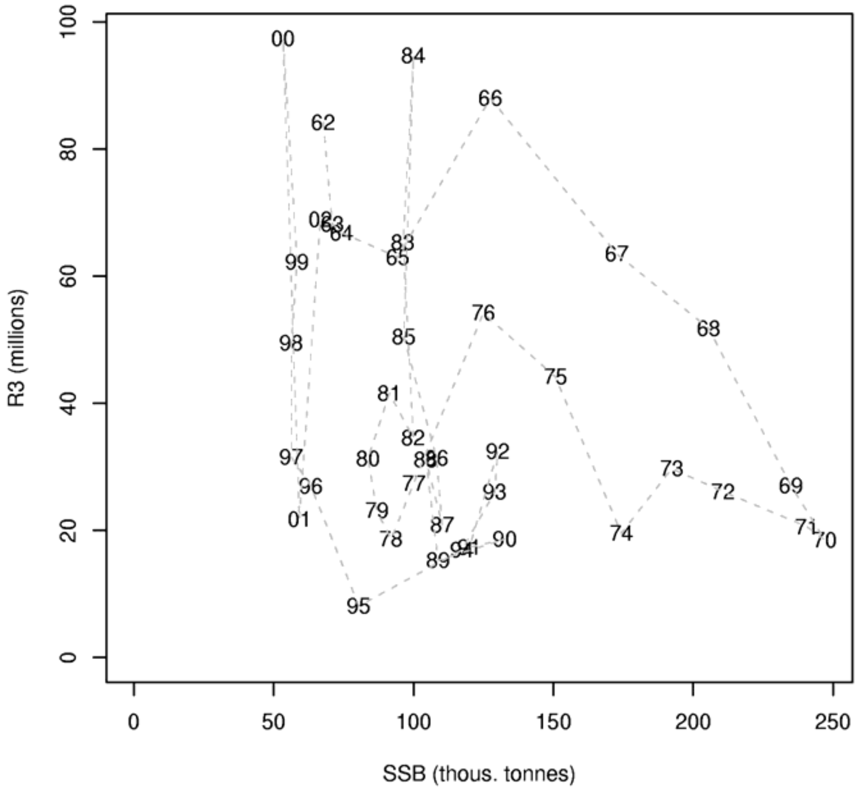


Figure 3.2.7.18. Saithe in Va. Scatter of stock and recruitment pairs.

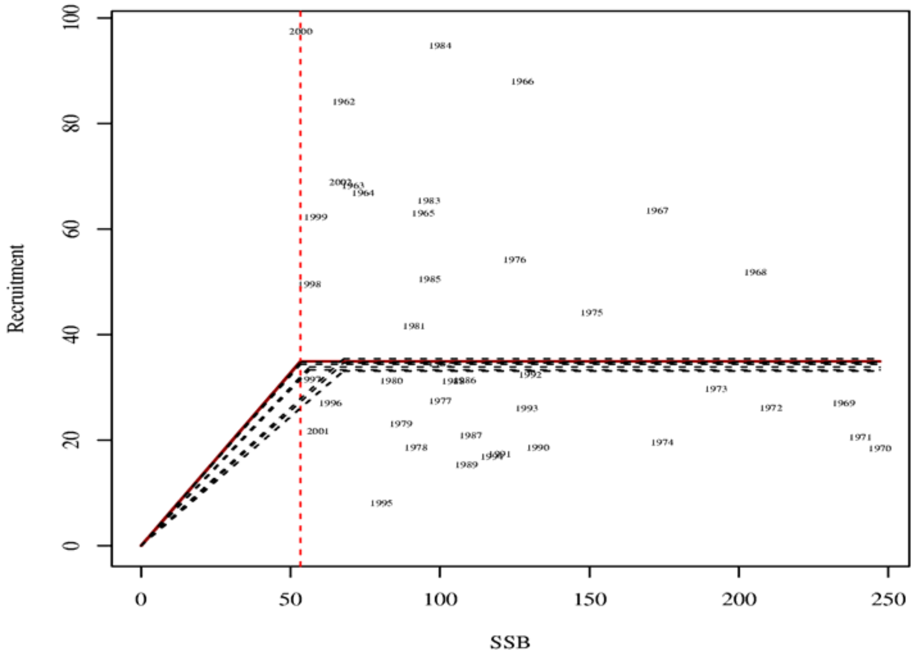


Figure 3.2.7.19. Saithe in Va. Hockeystick/segmented regression of stock and recruitment pairs.

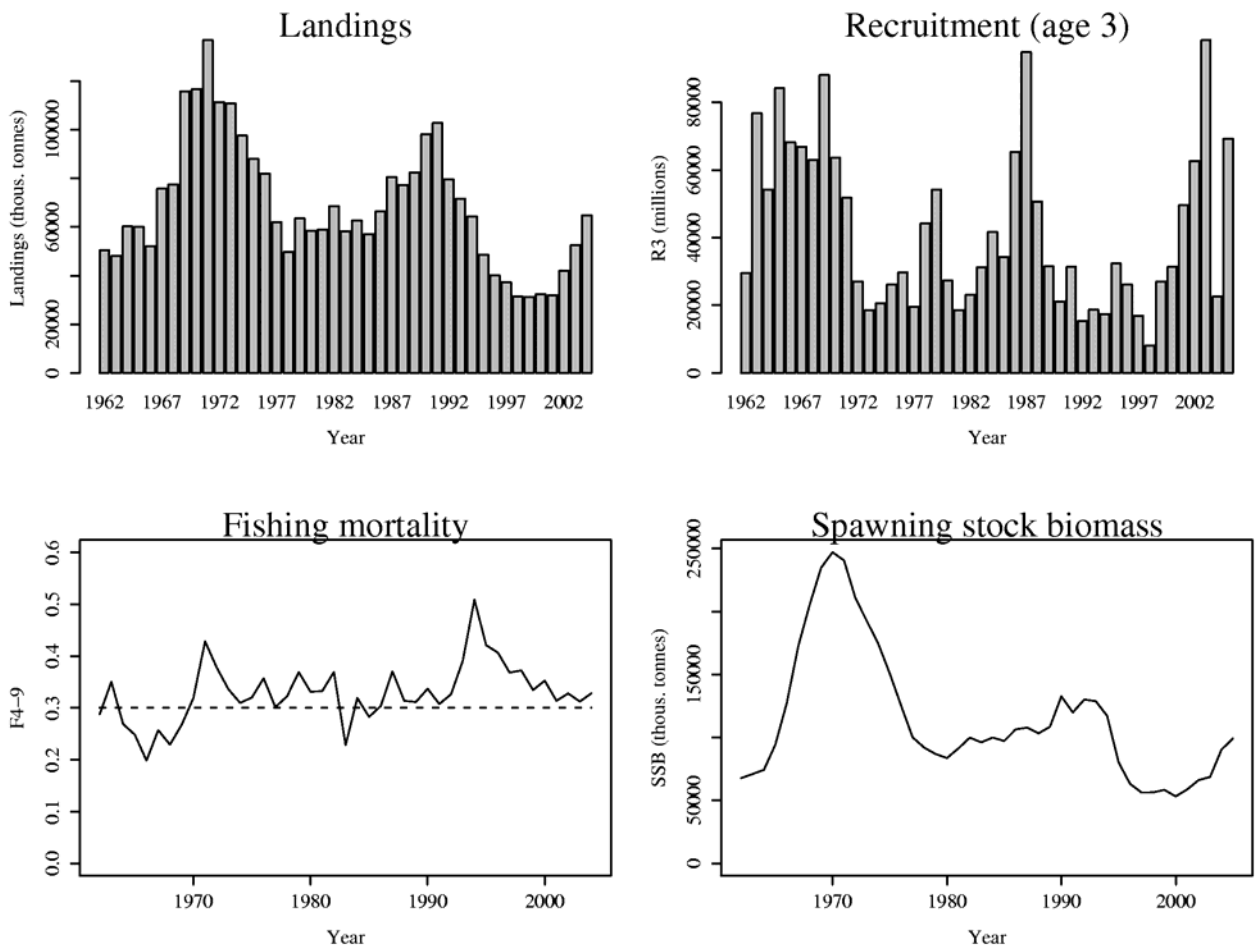


Figure 3.2.8.1. Saithe in Va. Stock summary plot.

3.3 Icelandic cod

3.3.1 Summary

3.3.1.1 Input data

- The total reported landings in 2004 were 223 thos. tonnes compared to 220 estimated by the working group.
- The landings at age in 2004 were in good accordance with last years projections.
- Mean weight at age both in landings and survey were observed around 3-5% lower than predicted by the working group last year. Around 10% decrease observed in mw@age in last two years.
- Total biomass survey index was observed about 16% lower compared to last year but with somwhat lower measurment error (CV).

3.3.1.2 Assessment models

- Several assessment models were applied as in recent years, all giving similar results. The results from the AD-Model builder statistical Catch at Age Model (AD-CAM), as in previous years, was adopted as a point estimate for forward projections. This year the AD-CAM model was run with a slightly reduced shrinkage on fishing mortalities in recent years compared to last year assessment.

3.3.1.3 Changes in assessment results

- In present assessment the estimated reference biomass (B4+) in the beginning of 2005 is 760 thous. tonnes compared to 785 thous. tonnes in last years assessment. The refernce biomass in 2004 was estimated at 854 thous. tonnes in last year's assessment, the same value as in the current assessment.
- The year classes 2000-2003 were estimated 198, 68, 171 and 153 millions respectively in last years assessment compared to 193, 69, 168 and 133 in the current assessment.
- The situation now with 3 of the 4 recent year classes estimated poor (2001, 2003 and 2004) raises questions about the size of the spawning stock in 2009 - 2010 when those year classes will become a large part of the spawning stock.

3.3.1.4 Comments

- Medium term projections based on current HCR indicate that the refernce biomass (B4+) will most likely stay around the same level in coming years but a moderate increase in SSB is seen.
- The situation now with 3 of the 4 recent year classes estimated poor (2001, 2003 and 2004) raises questions about the size of the spawning stock in 2009 - 2010 when those year classes will become a large part of the spawning stock.

3.3.2 Input data

3.3.2.1 Fisheries dependent data

3.3.2.1.1 Catch: Landings, discards and misreporting

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 1990-2000 all year classes entering the fishable stock were 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. With increasing effort 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 202 000 tonnes in 2003 and the recorded landings in 2004 were 223 000 tonnes.

An extensive project with the objective to estimate discard for some main species in the Icelandic fishery has been conducted since 2001 (Pálsson et al 2002). The estimated cod discard in 2004 amounted to 1227 metric tons, 0.60% of landings, slightly more than in 2003 and considerably less than in 2001(1.8%) and 2002.

The by-catch of cod in the blue whiting pelagic trawl fishery within the Icelandic EEZ is estimated to have been around 1000 tonnes in 2004 (Pálsson 2005. An analysis of by-catch in the Icelandic blue whiting fishery. Fisheries Research 73:135-146 and draft of 2004 results "by-catchBlueWhiting2004draft.doc" in Relevants reorts). This by-catch is included in the estimated annual landings for 2004.

Misreporting is not regarded as a major problem in this fishery but no analytical assessment is available to support that general perspective. Production figures from Processing plants seem to be in "good" coherence with landings figures according verbal statements from the Fisheries Directorate.

3.3.2.1.2 Sampling intensity

The data samples comprising the age-length keys for 2004 are given in the following table:

Gear	Area	Season	No. length samples	No. length measured	No. age samples	No. aged
Longline	South	Jan.-May	90	17618	11	538
Gillnet	South	Jan.-May	144	18024	8	393
Handlines	South	Jan.-May	6	1076	0	0
Danish seine	South	Jan.-May	35	7120	2	99
Bottom trawl	South	Jan.-May	74	12404	27	1337
Longline	North	Jan.-May	82	18415	10	477
Gillnet	North	Jan.-May	45	6839	3	144
Handlines	North	Jan.-May	4	769	1	50
Danish seine	North	Jan.-May	4	376	0	0
Bottom trawl	North	Jan.-May	185	38636	40	1967
Longline	South	June-Dec.	59	11281	7	327
Gillnet	South	June-Dec.	20	2752	3	111
Handlines	South	June-Dec.	27	5202	1	50
Danish seine	South	June-Dec.	14	2439	4	179
Bottom trawl	South	June-Dec.	32	5022	16	774
Longline	North	June-Dec.	180	38427	16	798
Gillnet	North	June-Dec.	3	380	0	0
Handlines	North	June-Dec.	81	16757	8	399
Danish seine	North	June-Dec.	18	2932	2	100
Bottom trawl	North	June-Dec.	266	50191	63	3132
Total			**1369**	**256660**	**222**	**10875**

3.3.2.1.3 Landings in numbers by age

The total landings-at-age data is given in Table 3.3.3.and Figure 3.3.4. In 2004 age 7 and younger accounted for about 93% of the landings in number. The age composition of the landings in 2004 are good coherence with last years prediction reflecting the relatively good year classes from 1997-2000.

3.3.2.1.4 Mean weight at age in the landings

The mean weights at age were high in 1994 to 1997 but were around the long term average in 1998-2002. In 2003 about 6% decreased was observed for age groups 3-7 compared to 2002. The observed mean weights at age in 2004 were about 4-6% lower for age groups 5-7 compared to 2003 and around 1% for age group 4. The observed mean weights in 2004 for age groups 5-8 are 8-13% below the last 20 years average and age groups 9-10 around 20% below. The mean weights at age in the landings are shown in table 3.3.5 and figure 3.3.7. The weights at age in the landings are used to calculate the "reference biomass" B4+ used by the Harvest Control Rule.

3.3.2.1.5 Logbooks

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 a decrease in effort was observed for trawlers and gillnetters and has been at a about the same level since then. By longliners an increase in effort is observed since 2003. CPUE for gillnets has been decreasing since 1997 reflecting the decreased proportion of older fish in the stock.An increase has been observed in bottom trawl in 2001- 2003 but the CPUE in 2004 is observed about the same as in 2003. By longliners and a slight decrease in CPUE was observed in 2003 compared to 2002 but increased again in 2004. 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. 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.

3.3.2.2 Fisheries independent data

3.3.2.2.1 Survey abundance indices

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.

3.3.2.2.2 Mean weight 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 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 justification is that 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 at age for the older fish are poorly estimated from survey data.

The mean weight at age used for calculation of spawning stock biomass are shown in table 3.3.6. and figure 3.3.8.

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 1985-2005.

3.3.2.2.3 Maturity at age in survey

In assessments prior to 2004 maturity data from the commercial catch period January-May were used for estimation of maturity at age in the spawning stock. As pointed out in last years report 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 proportion mature at age for the youngest fish. It was also noted in last years report that landings data showed increase in proportion mature at age in recent years, especially for age group 4, which were not observed in the survey data. Because of this observation and to respond to last years Technical Minutes a detailed data analysis was conducted this spring with the objective to scrutinise this discrepancies (WD-23). The results conforme the working group view that inadequate sampling and low quality maturity data from landings are the main explanation for the observed discrepancies. In spite of the fact that landings data are inadequate to estimate maturity at age analysis of all available data show some changes in maturation ogives in recent years. L_{50} has decreased slightly and the maturation ogive become steeper in recent years.

The observed maturity at age from the spring survey for age groups 3-9 are used for estimation of the spawning stock biomass while for age 10 and older, values from catches are used. The resulting numbers are shown in table 3.3.7. figure 3.3.6.

As the survey data are only available back to 1985 maturity at age weights in the spawning stock prior 1985 were estimated using the relationship between the maturity at age in the catches to the weights of mature fish in the survey in 1985-2005.

3.3.2.3 Analysis of input data

The Shepherd Nicholson model, using landings at age data, gives a CV of 0.2 for age groups 4-10. Catch curves for year classes 1983-1998 are presented in figure 3.3.5.

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.

The Shepherd Nicholson model gives a CV of 0.24 for age groups 2-9 for the survey indices. Catch curves based on the spring survey indices for year classes 1981-2001 are presented in figure 3.3.12.

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.

In figure 3.3.14 the relationships between the survey indices and estimated stock in numbers for age groups 1-9 using 1985-2002 data are presented. This is a period were the VPA has converged and the relatively high correlations observed for most age groups indicate a good consistency between catch-at-age data and survey data. Figure 3.3.15 shows the same relationship on logscale.

3.3.3 Assessment

3.3.3.1 Exploratory analysis

In the current report results from five different models are presented: **XSA**, **TSA** (Time Series analysis developed by G. Guðmundsson)**, ADAPT, X-CAM** (Statistical catch at age model written in Excel by E. Hjörleifsson) 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.

The AD-CAM model was now ran with same settings as last year (AC-base) but also with changes in the random walk term that limits the interannual changes in fishing mortality between years(AC-base-rs). After the changes interannual changes in log of fishing mortality between years are modelled as multivariate normal with correlation between ages i and j set to $\rho^{\alpha|(i-2)^k-(j-2)^k|}$ where ρ is the correlation coefficient. The original formulation was to set the correlation between ages i and j to $\rho^{|(i-j\ |}$ but that formulation indicates that adjacent age groups of older fish are more related to each other than adjacent age groups of young fish. The values of the parameters are α=4.3 , k=0.3 and ρ=0.8 meaning considerable positive correlation between age groups. As before the standard deviation of changes in log(F) is decreasing with age.

Implementing the correlation makes the random walk term less restrictive than the old setting. The changes were introduced last year after looking at standard error and correlation of log(F) back in time but were not used that year when the most recent survey was considered to be with unusually high catchability (as for example seen by high CV). Catchability in this years survey seems normal and therefore this change in the random walk term was incorporated. The labelling AC-base-rs means Adcam-base-reduced-shrinkage and indicates that those changes affect the results in some way like reduction of shrinkage.

Correlation of residuals in the survey are modelled as multivariate normal with correlation between ages i and j calculated by $\rho^{|(i-j|}$. Investigation of residuals indicated that the residuals of age 1 and 2 should not be correlated with the other age groups and that change was implemented. The correlation coefficient ρ was estimated to by 0.38 for the March survey.

The five different assessment models were run all using the same datasets, catch in number at age, Table 3.3.3, and survey indices, Table 3.3.8, expect for TSA using weighted geometric mean of North and South areas indices, Table 3.3.9. All models used the assumption that catchability in the survey is dependent on stock size for the youngest age groups.

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 2005 spring survey indices were moved three months back in time i.e. to end of December 2004. 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 **0.65.**

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) (see also WD#33). The results from corresponding retrospective analysis are presented in Figures 3.3.16-17. The terminal reference fishing mortality based on this run is **0.58**.

ADAPT

The ADAPT type model model estimates the survivors in the beginning of the assessment years an backcalculates from there using Popes equation. On the right side the fishing mortality of the oldest age is the weighted mean of the fishing mortality of the two agegroups next to it. The recruitment model, the survey tuning model and the prognosis module are the same as in the ADCAM model and the model does stock estimation, recruitment estimates and prognosis in the same run.

The estimated fishing mortality rates in the final year and stock in numbers in 2005 are presented 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 **0.60**.

X-CAM

A fixed separable CAEGIAN type of model using c@age for the years 1985-2004, ages 3-11 (age 11 as a plus group) and indices@age from spring survey for ages 1-9. Same lamda weight applied to each source of information and a yield penality added.

The estimated fishing mortality rates in 2004 and stock in numbers in 2005 are presented in Table 3.3.13 and Figures 3.3.19-3.3.20. 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 **0.50**.

AD-CAM

The input parameters settings of the AC-base-rs run, are presented in Table 3.3.12 along with the resulting residuals. 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 **0.60**.

3.3.3.2 Final assessment

Comparison of the retrospective results from the five models (Figure 3.3.16-17) show that the all the models show relatively good consistency looking at the reference fishable biomass (4+) although the pattern observed using the AD-CAM with reduced shrinkage model are slightly more consistence than observed from the other models. The retrospective pattern of the reference fishing mortalities show more inconsistence pattern indicating that the average F of age groups 5-10 might be inappropriate for latest years

Residuals by year and age group from the various models are presented in figure 3.3.18. All models expect for TSA show positive blocks in survey residuals in 1998 when catchabilty in survey is assumed to have been exceptionally high. In the TSA model catchabilty is estimated and partly corrected for and also different weightings are used for combining North and South indices.

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 2005 from the different models are presented. The estimated stock in weight (4+) in the beginning of 2005 from the three models used are very similar or in the range of 730-784 thous. tonnes. These models also show similar fishing mortality pattern but X-CAM estimate somewhat lower F values for the older age groups.

Resulting terminal reference fishing mortalities are also very similar or in the range 0.50-0.67, the lowest value from the X-CAM which is reflecting the difference in the older ages. The estimated stock in numbers in the beginning of 2005 from all models are well within one standard error of the AD-CAM (AC-base_rs) results (Figure 3.3.24).

For the last two years the NWWG has 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 AD-CAM run with a slightly reduced shrinkage on fishing mortalities in recent years (AC-base_rs) was considered the most appropriate to use (see justifictaions above). 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.

The estimated biomass(4+) in 2005 from the AD-CAM model is 760 thous. tonnes with standard error of 39. 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, dropped markedly in 1995-1997 due to restriction of the cod quota but then rose to another peak in 1999-2001. In recent years the reference fishing mortalities are estimated to have been around 0.60.

3.3.3.3 Short term projections

3.3.3.3.1 Input data to the short-term prediction

Prior to 2004 the catch weights at age had been predicted from the weight at age of the same yerarclass in the previous year and predicted size of the capelin stock. This regression had given reasonable results for some years but had led to overestimation of the weights in some recent years, due to reduced availability of capelin and/or overestimation of the capelin stock. Last year the weights at age were therefore predicted from the most recent data points which are the survey weights in the assessment year (Prediction of the capelin stock size was anyway not available last year). Most of the difference between survey weights and catch weights in the same year has to do with selection but difference between survey weights and catch weights the following year has capelin dependent growth included. Analysis of the residuals of the regression models used last year (WD-30) show that for the assesment year no obvious pattern is observed in the residuals but for the following year an overestimation is observed in the most recent years. This is explained by the fact that the mean weight at age has been decreasing in last two years but the linear model assumes average growth. In Working Document 30 a result from sensitivity analysis of using various models or methods to predict mean weight at age in the catches are presented. The results indicate little in gain in predicting power or resulting advice compared to the simple approach of using last years observation for the mean weight at age in the catches in the assessment year and the following year. On the basis of this analysis and that no informations are available about the capelin stock size next winter the working group decided to use mean weight at age in the catches in 2004 for 2005 and onwards and the survey weights in 2005 for stock and SSB weights in 2006 and onwards.

The exploitation pattern used for the short-term predictions was taken as the average of the years 2002–2004.

Based on the reported landings in the first month of the 2004/2005 fishing year and an assumption of the use of harvest control rule for the coming fishing year the expected catch in 2005 will be a around 205000t corresponding to F=0.51. A yield constraint is used for this stock since the yield forecasts based on TAC have historically been relatively good.

The results from the AD-CAM model were used for recruitment prediction. The size of the year classes 2000–2004 as estimated by the various models give all very similar estimates, see Table 3.3.13.

3.3.3.3.2 Short-term prediction results

Input data to the short term prediction and results from projections up to the year 2008 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 2005/2006 fishing year will be 198 000t. The SSB will increase to about 275 000 t in 2006 and the resulting reference fishing mortality is about 0.50. The estimated age distribution of the catches and SSB in 2006 are shown in figure 3.3.23B.

3.3.3.4 Long term predictions

3.3.3.4.1 Long-term prediction input

Average exploitation pattern for the last three years and mean weight at age and maturity at age over the years 1985–2004 has been used as input (Table 3.3.25).

3.3.3.4.2 Long-term prediction results and biological reference points

The biological reference values for F_{max} and $F_{0.1}$ are 0.32 and 0.14 respectively. Yield per recruit at the F_{max}- is 1.82 kg. (Figure 3.3.25 Table 3.3.26).

In Figure 3.3.26 the spawning stock recruitment relationship is shown with 3 curves fitted to it i.e segmented regression curve, Ricker curve with estimated timetrend in Rmax and Ricker curvewith no trend in Rmax. The point of maximum recruitment in the Ricker curve is probably close to Bmsy and is put in Figure 3.3.30 for reference.

A plot of the spawning stock biomass and recruitment is given in Figure 3.3.26. When using the period 1955–2000, the reference point F_{med} is estimated around 0.62.

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.

3.3.3.5 Reference points and management strategies (HCR)

A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year was set as a fraction (25%) of the "available biomass" which is computed as the biomass of age 4 and older fish B(4+), averaged over two adjacent calendar years. In the long term, this corresponds to a fishing mortality of about 0.4.

ICES considers the 1995 harvest control rule to be consistent with the precautionary approach.

In spring 2000 the Icelandic government introduced an amendment to the catch rule, limiting inter-annual changes in catches to 30 000 t. Limited studies, using a similar approach as when the initial catch rule was adopted were the basis for this amendment. ICES has not evaluated the amendment. The 30 000 t stabilizer was in effect in the fishing years 2000/2001 and 2001/2002, but not thereafter.

The SG on Precautionary Reference Points for Advice on Fishery Management (SGPRP – February 2003) suggested a candidate for 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.

3.3.3.6 Medium term simulations

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 figures 3.3.27-30. The results indicate that the catchable biomass 4+ will most likely stay around the same level in coming years

3.3.3.7 Harvest control rule scenarios

Medium term simulations were performed looking at 3 different HCR. All of the HCR are implemented as proportin of reference biomass which is the estimated number at age 4 and older in the beginning of the year multiplied by the weights at age in the catches the same year. The scenarios investigated are.

1. The currently implemented HCR where the TAC the next fishing year is 25% of the mean of the reference biomass in the beginning of the current year and the beginning of next calendar year. In addition interannual changes in TAC are limited to 30 kT.
2. The proposed HCR by the "long term committee" where the TAC for next fishing year is the mean of last fishing years TAC and 22% of the reference biomass in the beginning of the current year.
3. In their work the long term commitee used as criterion to maximize the current value of the revenue from the fisheries. The results indicated that ratios from 19 to 23% of the reference biomass gave optimal results. Therfore 20% of the reference biomass was one of the scenarios investigated.

Figure 3.3.30 shows the development of the spawning stock according to the 3 HCR. They indicates that the currently adopted HCR will most likely not lead to any increase in the SSB in the period but the rules taking lower proportion of the stock will lead to some increase. Figure 3.3.29 show the TAC from the three scenarios and show that most likely the TAC will not change much in the period. The difference in spawning stock between the scenarios is close to the difference in catches at the yield per recruit curve is relatively flat and thesimulation is not for long enough period for improved recruitment at larger spawning stock to affect the results.

3.3.4 Management considerations

3.3.4.1 Management measures

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 was in a reviewing process in 2001-2004 by a group of scientists appointed by the Ministry of Fisheries. This group delivered a final report to the Minister in May 2004. The report has not been published and is only available in icelandic. Based on simulation work the group recommended a new HCR using the average of last years TAC and 22% of the estimated reference biomass (B4+) in the assessment year. This HCR has not been adopted.

3.3.4.2 Technical management measures

- A quick area closure system is in force allowing inspectors to close fishing areas for maximum two weeks if the proportion of 55 cm cod or smaller exceeds 25% in numbers. If the same area has been closed two times or more consequently, the Ministry of Fisheries, on the basis of an advice from the MRI, can close the area more permanently by specific directive. Numerious areas are closed temporarily or permanently for all fisheries or specific gears for protecting juveniles, or for social-political reasons.

- The minimum allowed mesh size in codend of bottom trawl and Danish seine is 135 mm.
- For the gillnet fishery both minimum and maximum mesh-sizes are restricted. Since autumn 2004 the maximum allowed mesh-size in the gillnet fishery is 8 inches. The objective of this measure is to decrease the effort directed towards bigger spawners.
- Since 1995 the main cod spawning areas are closed for all fisheries for 2-3 weeks during the spawning season with the objective to decrease the disturbance on the spawning grounds during spawning and thereby increase the probability of successful spawning.

3.3.4.3 Evaluation of management measures

Since the implementation of the catch rule in 1995 realised reference fishing mortalities have been in the range of 0.51-0.77, in last three years 0.60-0.66. 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 8 and younger fish account for 96% of the fishable biomass(4+) in 2005. The age composition of the spawning stock is highly skewed. Spawners at age 9 and younger will constitute to about 96% of the spawning stock biomass in 2006. 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 effects of technical measures have not been evaluated expect for preliminary evaluation on the effectiveness of the quick closure system. The results indicated that the relatively small areas closed for short time do most likely not contribute much to protection of juveniles. On the other hand, several consecutive quick closures often lead to closures of larger areas for longer time and force the fleet to operate in other areas.

3.3.4.4 Comments on the assessment

The current assessment and last three years assessments are more consistent with previous years assessments compared to the assessments in 1998-2000 were substantial overestimation was observed. As in three 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 2004 was estimated at 854 thous. tonnes in last year's assessment, the same value as in the current assessment.

Prior to 2004 the catch weights at age had been predicted from the weight at age of the same yerarclass in the previous year and predicted size of the capelin stock. In last two years no information has been available about the size of the capelin stock in the assessment year for predictions. This regression had given reasonable results for some years but had led to overestimation of the weights in some recent years, due to reduced availability of capelin and/or overestimation of the capelin stock. Last year the weights at age were therefore predicted from the most recent data points which are the survey weights in the assessment year. As nothing is known about the stock size of capelin this year, and regression models used last year assumed average growth, in this years assessment the same weights at age for 2005 and 2007 were taken as in 2004. Around 10% reductions in mean weights at age have been observed in last two years.

The year classes 2000-2003 were estimated 198, 68, 171 and 153 millions respectively in last years assessment compared to 193, 69, 168 and 133 in the current assessment.

The situation now with 3 of the 4 recent year classes estimated poor (2001, 2003 and 2004) raises questions about the size of the spawning stock in 2009 - 2010 when those year classes will become a large part of the spawning stock.

3.3.5 Assessment deficiencies, data gaps and research priorities

No serious assessment deficiencies or data gaps have been revealed for stock in recent years. The relatively high positive residuals in 1998 survey data and overestimation of the stock in 1998-2000 still remain unexplained although the retrospective pattern of the models used for assessing the stock in recent years are not showing serious deviations in these years.

Several research projects are conducted at the MRI dealing with cod reflecting the research priorities. Among others, projects are ongoing dealing with following: population structure with respect to management, the effect of fisheries on life history trades, the potential effects of capelin catches on yield of cod.

3.3.6 Ecosystem considerations

3.3.6.1 Ecosystem effect on the stock

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

3.3.6.2 Fishery effect on the ecosystem

To be added

3.3.6.3 Technical interactions

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 in recent 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.

3.3.7 Icelandic cod (Quality handbook)

3.3.7.1 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.

3.3.7.2 Fisheries dependent data

3.3.7.2.1 Sampling protocol

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").

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.

Mean weights at age

Mean weight at age in the landings is calculated with the catch in numbers. Before 1993 weighting of cod was relatively uncommon so length-weight relationships were based on little data. Since 1994 weighting has been much more extensive but currently all fishes sampled for otolith are weighted and length-weight relationships can be calculated from current data. The mean weights at age in the landings are shown in table 3.3.5 and figure 3.3.7.

Mean weight at age have been shown to correlate well with the size of the capelin stock and capelin stock size has been used as a predictor of weights in the landings since 1991. In 1981-1982 weights were low following collapse of the capelin stock and were also relatively low in 1990-1991 when the capelin stock was small. 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.

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

3.3.7.2.2 Catch rate and effort data (log books)

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.

3.3.7.3 Fisheries independent data

3.3.7.3.1 Survey description

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.

3.3.7.4 Assessment input data

3.3.7.4.1 Survey abundance indices

3.3.7.4.2 Mean weight at age

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.

3.3.7.5 Stock assessment model

3.3.7.5.1 Present input data

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).

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.

3.3.7.5.2 Predictions

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).

3.3.7.5.3 Present model setup

ADCAM

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 Rmax 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 maturity at age backwards in time from the observations from the catches.
- Migrations for specified years in specified ages are estimated (specify which year and which ages).
- 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 separately for each age in the survey (change from last year when it was also a 2^{nd} order polynomial) Correlation of residuals of different age groups 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 (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 must be specified.

Some non-traditional of the assessment model are.

- Rmax decrease by 0.9% per year from 1955 to 1995 so predicted recruitment in 1995 is expected to be 67% of what it was in 1995 for the same spawning size of the spawning 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 spawning 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.

Table 3.3.1 Nominal catch (tonnes) of Cod in Division Va, by countries, 1997-2004 as officially reported to ICES

Table 3.3.2. Cod at Iceland. Division Va. Landings (tonnes), effort, cpue and percentage changes in effort and cpue in the period 1991-2004 (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	110757	176645.9	75	627	84
1994	65213	82757.61	35	788	106
1995	55656	65400.71	28	851	114
1996	63749	63749	27	1000	134
1997	81202	74840.55	32	1085	146
1998	108424	84905.25	36	1277	171
1999	123140	119206.2	51	1033	139
2000	102094	124809.3	53	818	110
2001	96624	108322.9	46	892	120
2002	85741	82127.39	35	1044	140
2003	86992	76780.23	33	1133	152
2004	94041	76456.1	33	1230	152

Gillnet

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	58948	11101	100	5.31	100
1992	59712	10720	97	5.57	105
1993	56350	11270	102	5.00	94
1994	39821	8028	72	4.96	93
1995	31182	5423	49	5.75	108
1996	40807	6447	58	6.33	119
1997	45919	6458	58	7.11	134
1998	51004	8543	77	5.97	112
1999	47137	9446	85	4.99	94
2000	48018	9921	89	4.84	91
2001	53600	13333	120	4.02	76
2002	44162	11096	100	3.98	75
2003	37498	10474	94	3.58	67
2004	37296	11166	101	3.34	63

Long line

Year	Catch	Effort	Effort % changes	Cpue	Cpue % changes
1991	44711	2009	100	22	100
1992	42301	2017	100	21	94
1993	45938	2162	108	21	96
1994	35990	1633	81	22	99
1995	44584	1724	86	26	116
1996	39770	1476	73	27	121
1997	31276	830	41	38	169
1998	37244	979	49	38	171
1999	52658	1536	76	34	154
2000	49869	1706	85	29	131
2001	47120	1794	89	26	118
2002	42153	1401	70	30	135
2003	44662	1598	80	28	126
2004	57480	1838	91	31	141

Table 3.3.3 Cod at Iceland. Observed catch in numbers by year and age (millions) 1955-2004 and predicted for 2005-2007.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	4.790	25.164	46.566	28.287	10.541	5.224	2.467	25.182	2.101	1.202	1.668	0.665
1956	6.709	17.265	31.030	27.793	14.389	4.261	3.429	2.128	16.820	1.552	1.522	1.545
1957	13.240	21.278	17.515	24.569	17.634	12.296	3.568	2.169	1.171	6.822	0.512	1.089
1958	25.237	30.742	14.298	10.859	15.997	15.822	12.021	2.003	2.125	0.771	3.508	0.723
1959	18.394	37.650	23.901	7.682	5.883	8.791	13.003	7.683	0.914	0.990	0.218	1.287
1960	14.830	28.642	27.968	14.120	8.387	6.089	6.393	11.600	3.526	0.692	0.183	0.510
1961	16.507	21.808	19.488	15.034	7.900	6.925	3.969	3.211	6.756	1.202	0.089	0.425
1962	13.514	28.526	18.924	14.650	12.045	4.276	8.809	2.664	1.883	2.988	0.405	0.324
1963	18.507	28.466	19.664	11.314	15.682	7.704	2.724	6.508	1.657	1.030	1.372	0.246
1964	19.287	28.845	18.712	11.620	7.936	18.032	5.040	1.437	2.670	0.655	0.370	1.025
1965	21.658	29.586	24.783	11.706	9.334	6.394	11.122	1.477	0.823	0.489	0.118	0.489
1966	17.910	30.649	20.006	13.872	5.942	7.586	2.320	5.583	0.407	0.363	0.299	0.311
1967	25.945	27.941	24.322	11.320	8.751	2.595	5.490	1.392	1.998	0.109	0.030	0.106
1968	11.933	47.311	22.344	16.277	15.590	7.059	1.571	2.506	0.512	0.659	0.047	0.098
1969	11.149	23.925	45.445	17.397	12.559	14.811	1.590	0.475	0.340	0.064	0.024	0.021
1970	9.876	47.210	23.607	25.451	15.196	12.261	14.469	0.567	0.207	0.147	0.035	0.050
1971	13.060	35.856	45.577	21.135	17.340	10.924	6.001	4.210	0.237	0.069	0.038	0.020
1972	8.973	29.574	30.918	22.855	11.097	9.784	10.538	3.938	1.242	0.119	0.031	0.001
1973	36.538	25.542	27.391	17.045	12.721	3.685	4.718	5.809	1.134	0.282	0.007	0.001
1974	14.846	61.826	21.824	14.413	8.974	6.216	1.647	2.530	1.765	0.334	0.062	0.028
1975	29.301	29.489	44.138	12.088	9.628	3.691	2.051	0.752	0.891	0.416	0.060	0.046
1976	23.578	39.790	21.092	24.395	5.803	5.343	1.297	0.633	0.205	0.155	0.065	0.029
1977	2.614	42.659	32.465	12.162	13.017	2.809	1.773	0.421	0.086	0.024	0.006	0.002
1978	5.999	16.287	43.931	17.626	8.729	4.119	0.978	0.348	0.119	0.048	0.015	0.027
1979	7.186	28.427	13.772	34.443	14.130	4.426	1.432	0.350	0.168	0.043	0.024	0.004
1980	4.348	28.530	32.500	15.119	27.090	7.847	2.228	0.646	0.246	0.099	0.025	0.004
1981	2.118	13.297	39.195	23.247	12.710	26.455	4.804	1.677	0.582	0.228	0.053	0.068
1982	3.285	20.812	24.462	28.351	14.012	7.666	11.517	1.912	0.327	0.094	0.043	0.011
1983	3.554	10.910	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	0.044
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	0.009	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	9.429	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	3.458	7.707	25.394	20.167	5.893	3.856	2.951	0.500	0.196	0.055	0.033	0.013
1999	2.525	19.554	15.226	24.622	12.966	2.795	1.489	0.748	0.140	0.046	0.010	0.005
2000	10.493	6.581	29.080	11.227	11.390	5.714	1.104	0.567	0.314	0.074	0.022	0.006
2001	11.338	25.040	9.311	19.471	5.620	3.929	2.017	0.452	0.202	0.118	0.013	0.009
2002	5.934	18.482	24.297	6.874	8.943	2.227	1.353	0.689	0.123	0.040	0.041	0.002
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
2004	1.743	18.960	24.540	16.974	9.728	2.682	2.006	0.477	0.125	0.062	0.014	0.005
2005	3.888	5.743	22.411	15.872	10.286	5.477	0.820	0.708	0.106	0.066	0.020	0.004
2006	2.780	13.171	7.301	17.915	10.443	5.519	2.502	0.346	0.249	0.043	0.025	0.008
2007	2.324	10.492	18.735	6.570	13.341	6.381	2.885	1.213	0.141	0.115	0.019	0.012

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

Age	Fprop	Mprop
3	0.085	0.250
4	0.180	0.250
5	0.248	0.250
6	0.296	0.250
7	0.382	0.250
8	0.437	0.250
9	0.477	0.250
10	0.477	0.250
11	0.477	0.250
12	0.477	0.250
13	0.477	0.250
14	0.477	0.250

Table 3.3.5 Cod at Iceland. Division Va. Observed mean weight at age in the landings(g) 1955-2004 and predicted for 2005-2007 (gray shaded area) .

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	827	1307	2157	3617	4638	5657	6635	6168	8746	8829	10086	14584
1956	1080	1600	2190	3280	4650	5630	6180	6970	6830	9290	10965	12954
1957	1140	1710	2520	3200	4560	5960	7170	7260	8300	8290	10350	13174
1958	1210	1810	3120	4510	5000	5940	6640	8290	8510	8840	9360	13097
1959	1110	1950	2930	4520	5520	6170	6610	7130	8510	8670	9980	11276
1960	1060	1720	2920	4640	5660	6550	6910	7140	7970	10240	10100	12871
1961	1020	1670	2700	4330	5530	6310	6930	7310	7500	8510	9840	14550
1962	990	1610	2610	3900	5720	6660	6750	7060	7540	8280	10900	12826
1963	1250	1650	2640	3800	5110	6920	7840	7610	8230	9100	9920	11553
1964	1210	1750	2640	4020	5450	6460	8000	9940	9210	10940	12670	15900
1965	1020	1530	2570	4090	5410	6400	7120	8600	12310	10460	10190	17220
1966	1170	1680	2590	4180	5730	6900	7830	8580	9090	14230	14090	17924
1967	1120	1820	2660	4067	5560	7790	7840	8430	9090	10090	14240	16412
1968	1170	1590	2680	3930	5040	5910	7510	8480	10750	11580	14640	16011
1969	1100	1810	2480	3770	5040	5860	7000	8350	8720	10080	11430	13144
1970	990	1450	2440	3770	4860	5590	6260	8370	10490	12310	14590	21777
1971	1255	1783	2579	3623	4898	6301	7684	9345	10921	12767	14521	17235
1972	1255	1783	2579	3623	4898	6301	7684	9345	10921	12767	14521	17235
1973	1030	1420	2470	3600	4900	6110	6670	6750	7430	7950	10170	17000
1974	1050	1710	2430	3820	5240	6660	7150	7760	8190	9780	12380	14700
1975	1100	1770	2780	3760	5450	6690	7570	8580	8810	9780	10090	11000
1976	1350	1780	2650	4100	5070	6730	8250	9610	11540	11430	14060	16180
1977	1259	1911	2856	4069	5777	6636	7685	9730	11703	14394	17456	24116
1978	1289	1833	2929	3955	5726	6806	9041	10865	13068	11982	19062	21284
1979	1408	1956	2642	3999	5548	6754	8299	9312	13130	13418	13540	20072
1980	1392	1862	2733	3768	5259	6981	8037	10731	12301	17281	14893	19069
1981	1180	1651	2260	3293	4483	5821	7739	9422	11374	12784	12514	19069
1982	1006	1550	2246	3104	4258	5386	6682	9141	11963	14226	17287	16590
1983	1095	1599	2275	3021	4096	5481	7049	8128	11009	13972	15882	18498
1984	1288	1725	2596	3581	4371	5798	7456	9851	11052	14338	15273	16660
1985	1407	1971	2576	3650	4976	6372	8207	10320	12197	14683	16175	19050
1986	1459	1961	2844	3593	4635	6155	7503	9084	10356	15283	14540	15017
1987	1316	1956	2686	3894	4716	6257	7368	9243	10697	10622	15894	12592
1988	1438	1805	2576	3519	4930	6001	7144	8822	9977	11732	14156	13042
1989	1186	1813	2590	3915	5210	6892	8035	9831	11986	10003	12611	16045
1990	1290	1704	2383	3034	4624	6521	8888	10592	10993	14570	15732	17290
1991	1309	1899	2475	3159	3792	5680	7242	9804	9754	14344	14172	20200
1992	1289	1768	2469	3292	4394	5582	6830	8127	12679	13410	15715	11267
1993	1392	1887	2772	3762	4930	6054	7450	8641	10901	12517	14742	16874
1994	1443	2063	2562	3659	5117	6262	7719	8896	10847	12874	14742	17470
1995	1348	1959	2920	3625	5176	6416	7916	10273	11022	11407	13098	15182
1996	1457	1930	3132	4141	4922	6009	7406	9772	10539	13503	13689	16194
1997	1484	1877	2878	4028	5402	6386	7344	8537	10797	11533	10428	12788
1998	1230	1750	2458	3559	5213	7737	7837	9304	10759	14903	16651	18666
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	8769	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	13804
2004	1254	1769	2317	3302	4262	5389	5874	7394	10780	11563	13814	12954
2005	1254	1769	2317	3302	4262	5389	5874	7394	10780	11563	13814	12954
2006	1254	1769	2317	3302	4262	5389	5874	7394	10780	11563	13814	12954
2007	1254	1769	2317	3302	4262	5389	5874	7394	10780	11563	13814	12954

Table 3.3.6. Cod at Iceland. Division Va. Mean weight at age in the spawning stock(g) 1955-2005 and predicred for 2006-2007.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	645	1019	1833	3183	4128	5657	6635	6168	8746	8829	10086	14584
1956	645	1248	1862	2886	4138	5630	6180	6970	6830	9290	10965	12954
1957	645	1334	2142	2816	4058	5960	7170	7260	8300	8290	10350	13174
1958	645	1412	2652	3969	4450	5940	6640	8290	8510	8840	9360	13097
1959	645	1521	2490	3978	4913	6170	6610	7130	8510	8670	9980	11276
1960	645	1342	2482	4083	5037	6550	6910	7140	7970	10240	10100	12871
1961	645	1303	2295	3810	4922	6310	6930	7310	750	8510	9840	14550
1962	645	1256	2218	3432	5091	6660	6750	7060	7540	8280	10900	12826
1963	645	1287	2244	3344	4548	6920	7840	7610	8230	9100	9920	11553
1964	645	1365	2244	3538	4850	6460	8000	9940	9210	10940	12670	15900
1965	645	1193	2184	3599	4815	6400	7120	8600	12310	10460	10190	17220
1966	645	1310	2202	3678	5100	6900	7830	8580	9090	14230	14090	17924
1967	645	1420	2261	3579	4948	7790	7840	8430	9090	10090	14240	16412
1968	645	1240	2278	3458	4486	5910	7510	8480	10750	11580	14640	16011
1969	645	1412	2108	3318	4486	5860	7000	8350	8720	10080	11430	13144
1970	645	1131	2074	3318	4325	5590	6260	8370	10490	12310	14590	21777
1971	645	1391	2192	3188	4359	6301	7684	9345	10921	12767	14521	17235
1972	645	1391	2192	3188	4359	6301	7684	9345	10921	12767	14521	17235
1973	645	1108	2100	3168	4361	6110	6670	6750	7430	7950	10170	17000
1974	645	1334	2066	3362	4664	6660	7150	7760	8190	9780	12380	14700
1975	645	1381	2363	3309	4850	6690	7570	8580	8810	9780	10090	11000
1976	645	1388	2252	3608	4512	6730	8250	9610	11540	11430	14060	16180
1977	645	1491	2428	3581	5142	6636	7685	9730	11703	14394	17456	24116
1978	645	1430	2490	3480	5096	6806	9041	10865	13068	11982	19062	21284
1979	645	1526	2246	3519	4938	6754	8299	9312	13130	13418	13540	20072
1980	645	1452	2323	3316	4681	6981	8037	10731	12301	17281	14893	19069
1981	645	1288	1921	2898	3990	5821	7739	9422	11374	12784	12514	19069
1982	645	1209	1909	2732	3790	5386	6682	9141	11963	14226	17287	16590
1983	645	1247	1934	2658	3645	5481	7049	8128	11009	13972	15882	18498
1984	645	1346	2207	3151	3890	5798	7456	9851	11052	14338	15273	16660
1985	485	1375	1750	2709	3454	6372	8207	10320	12197	14683	16175	19050
1986	758	1597	2882	3246	4581	6155	7503	9084	10356	15283	14540	15017
1987	576	1584	2423	3522	4905	6257	7368	9243	10697	10622	15894	12592
1988	610	1475	2261	3277	4398	6001	7144	8822	9977	11732	14156	13042
1989	673	1494	2338	3429	4686	6892	8035	9831	11986	10003	12611	16045
1990	563	1035	2170	2798	4422	6521	8888	10592	10993	14570	15732	17290
1991	686	1283	2039	2747	3397	5680	7242	9804	9754	14344	14172	20200
1992	619	1336	2094	3029	3753	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
2004	590	1453	2099	3057	3757	5389	5874	7394	10780	11563	13814	12954
2005	557	1119	1897	2963	3874	5389	5874	7394	10780	11563	13814	12954
2006	557	1119	1897	2963	3874	5389	5874	7394	10780	11563	13814	12954
2007	557	1119	1897	2963	3874	5389	5874	7394	10780	11563	13814	12954

Table 3.3.7. Cod at Iceland. Division Va. Maturity at age from 1955-2005 and predicted for 2006-2007.

Year/age	3	4	5	6	7	8	9	10	11	12	13	14
1955	0.02	0.02	0.03	0.18	0.58	0.78	0.83	0.96	1.00	1.00	1.00	1.00
1956	0.02	0.03	0.03	0.11	0.58	0.78	0.82	0.98	0.98	1.00	1.00	1.00
1957	0.02	0.03	0.04	0.10	0.55	0.80	0.84	0.99	1.00	1.00	1.00	1.00
1958	0.02	0.03	0.09	0.52	0.68	0.80	0.83	1.00	1.00	1.00	1.00	1.00
1959	0.02	0.03	0.07	0.54	0.77	0.82	0.83	0.99	1.00	1.00	1.00	1.00
1960	0.02	0.03	0.07	0.58	0.78	0.83	0.83	0.99	1.00	1.00	1.00	1.00
1961	0.02	0.03	0.05	0.45	0.77	0.82	0.83	0.99	0.99	1.00	1.00	1.00
1962	0.02	0.03	0.05	0.28	0.79	0.83	0.83	0.99	0.99	1.00	1.00	1.00
1963	0.02	0.03	0.05	0.24	0.71	0.83	0.85	1.00	1.00	1.00	1.00	1.00
1964	0.02	0.03	0.05	0.33	0.76	0.83	0.85	1.00	1.00	1.00	1.00	1.00
1965	0.02	0.03	0.05	0.35	0.75	0.83	0.84	1.00	1.00	1.00	1.00	1.00
1966	0.02	0.03	0.05	0.39	0.79	0.85	0.85	1.00	1.00	1.00	1.00	1.00
1967	0.02	0.03	0.05	0.34	0.77	0.84	0.85	1.00	1.00	1.00	1.00	1.00
1968	0.02	0.03	0.05	0.29	0.68	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1969	0.02	0.03	0.04	0.23	0.68	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1970	0.02	0.02	0.04	0.23	0.64	0.77	0.82	1.00	1.00	1.00	1.00	1.00
1971	0.02	0.03	0.04	0.07	0.66	0.71	0.77	0.98	0.99	0.98	0.99	1.00
1972	0.02	0.02	0.04	0.11	0.45	0.77	0.81	0.98	0.99	0.98	0.99	1.00
1973	0.02	0.03	0.16	0.38	0.70	0.80	0.83	1.00	1.00	1.00	1.00	1.00
1974	0.02	0.03	0.09	0.35	0.64	0.79	0.82	0.99	1.00	1.00	1.00	1.00
1975	0.02	0.04	0.12	0.29	0.72	0.81	0.84	1.00	1.00	1.00	1.00	1.00
1976	0.03	0.03	0.09	0.25	0.41	0.80	0.84	1.00	1.00	1.00	1.00	1.00
1977	0.02	0.02	0.06	0.38	0.74	0.82	0.84	1.00	1.00	1.00	1.00	1.00
1978	0.03	0.03	0.05	0.19	0.74	0.82	0.84	1.00	1.00	1.00	1.00	1.00
1979	0.02	0.02	0.05	0.28	0.64	0.79	0.84	0.92	1.00	1.00	1.00	1.00
1980	0.03	0.02	0.05	0.23	0.65	0.78	0.83	0.98	1.00	0.96	1.00	1.00
1981	0.02	0.02	0.03	0.09	0.45	0.75	0.81	0.96	0.99	1.00	1.00	1.00
1982	0.02	0.03	0.04	0.07	0.30	0.71	0.82	0.97	1.00	1.00	1.00	1.00
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	0.99	1.00	1.00	1.00	1.00
2005	0.01	0.11	0.28	0.50	0.79	0.81	0.95	0.99	1.00	1.00	1.00	1.00
2006	0.00	0.06	0.25	0.52	0.76	0.82	0.88	0.99	1.00	1.00	1.00	1.00
2007	0.00	0.06	0.25	0.52	0.76	0.82	0.88	0.99	1.00	1.00	1.00	1.00

Table 3.3.8. CPUE from bottom trawl survey 1985-2005 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	64.30	22.57	14.86	4.85	3.21	1.52	0.30	0.30	0.10
1986	15.08	60.56	95.56	22.43	21.23	26.36	6.64	2.48	0.83	0.74	0.27	0.07	0.06
1987	3.65	28.86	103.10	82.03	21.08	12.22	12.02	2.57	0.90	0.40	0.45	0.23	0.15
1988	3.44	7.36	71.69	101.61	66.75	7.81	5.88	6.14	0.58	0.25	0.11	0.12	0.05
1989	4.04	16.45	21.97	77.70	67.59	34.20	4.20	1.45	1.14	0.24	0.17	0.06	0.01
1990	5.56	11.79	26.15	14.07	26.97	32.38	14.22	1.51	0.53	0.42	0.13	0.00	0.04
1991	3.95	16.27	17.93	30.17	15.24	18.09	20.93	4.23	0.80	0.32	0.24	0.00	0.11
1992	0.72	17.13	33.26	18.87	16.27	6.54	5.70	5.11	1.29	0.22	0.03	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
2005	2.56	14.62	39.03	9.70	43.40	22.93	10.86	5.66	0.93	0.83	0.23	0.18	0.03

Table 3.3.9 CPUE from bottom trawl survey 1985-2005 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	16190	14655	9669	4479	2056	1325
1986	8130	7447	10572	3023	877	386
1987	27505	5408	5278	4257	1193	336
1988	34442	20690	3722	2103	1828	282
1989	26633	22989	16532	2016	653	370
1990	3346	10316	16267	6309	739	270
1991	10229	5205	8893	10308	2072	392
1992	7596	5405	2893	2843	2685	695
1993	15487	5494	4642	935	877	552
1994	12346	7990	2778	1375	311	247
1995	4157	9384	8299	1742	755	164
1996	13054	4894	7140	6267	1587	506
1997	18433	8884	4100	3699	2549	257
1998	5283	13445	10541	2520	1792	1170
1999	13167	4334	11249	5077	1183	463
2000	2786	10131	3863	3513	2073	257
2001	14553	1845	6502	1361	781	397
2002	16914	14890	3602	3232	726	312
2003	12962	10806	8700	2047	1247	335
2004	22054	13284	11685	5876	1315	632
2005	3184	12891	10946	4604	2176	436

Table 3.3.10 . XSA Tuning diagnostic.

Lowestoft VPA Version 3.1

17/04/2005 17:43

Extended Survivors Analysis

"ICELANDIC COD (Div. Va); data from 1971-2004"

CPUE data from file codvarnt.dat

Catch data for 33 years. 1972 to 2004. Ages 0 to 14.

Fleet,		First, year,	Last, year,	First, age ,	Last, age	Alpha,	Beta
SMB. Tot	,	1984,	2004,	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 17 iterations

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

Fishing mortalities

Age,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004
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,	.076,	.036,	.022,	.023,	.042,	.066,	.076,	.037,	.022,	.028
4,	.199,	.143,	.148,	.129,	.178,	.147,	.221,	.171,	.130,	.145
5,	.360,	.246,	.247,	.358,	.404,	.437,	.319,	.346,	.305,	.307
6,	.372,	.489,	.372,	.509,	.714,	.596,	.594,	.413,	.455,	.427
7,	.534,	.506,	.619,	.659,	.736,	.887,	.689,	.607,	.590,	.493
8,	.523,	.602,	.711,	.791,	.778,	.881,	.921,	.653,	.681,	.770
9,	.426,	.581,	.768,	.986,	.840,	.838,	.940,	1.011,	.804,	.804
10,	.615,	.564,	.836,	.956,	.735,	.949,	1.068,	1.053,	.972,	1.072
11,	.652,	.560,	.821,	1.006,	.793,	.813,	1.166,	1.006,	.818,	1.013
12,	.752,	.631,	.412,	1.137,	.687,	1.517,	.859,	.765,	.841,	.838
13,	1.174,	.763,	.944,	1.327,	.635,	.861,	1.441,	.861,	1.098,	1.148
14,	.805,	.636,	.763,	1.120,	.719,	1.049,	1.146,	.931,	.941,	1.029

Table 3.3.10 (Cont'd)1

XSA population numbers (Thousands)

YEAR	AGE 0	1	2	3	4	5	6	7	8	9
1995	3.02E+05	1.31E+05	2.04E+05	1.62E+05	5.57E+04	6.16E+04	4.65E+04	1.10E+04	4.33E+03	9.98E+02
1996	1.24E+05	2.47E+05	1.07E+05	1.67E+05	1.23E+05	3.73E+04	3.52E+04	2.62E+04	5.27E+03	2.10E+03
1997	3.32E+05	1.01E+05	2.02E+05	8.78E+04	1.32E+05	8.74E+04	2.39E+04	1.77E+04	1.29E+04	2.36E+03
1998	3.11E+05	2.72E+05	8.30E+04	1.66E+05	7.03E+04	9.32E+04	5.59E+04	1.35E+04	7.80E+03	5.20E+03
1999	3.30E+05	2.55E+05	2.23E+05	6.79E+04	1.33E+05	5.06E+04	5.33E+04	2.75E+04	5.71E+03	2.89E+03
2000	3.54E+05	2.70E+05	2.09E+05	1.82E+05	5.33E+04	9.08E+04	2.76E+04	2.14E+04	1.08E+04	2.15E+03
2001	1.29E+05	2.90E+05	2.21E+05	1.71E+05	1.40E+05	3.77E+04	4.80E+04	1.25E+04	7.21E+03	3.66E+03
2002	3.24E+05	1.06E+05	2.37E+05	1.81E+05	1.30E+05	9.18E+04	2.24E+04	2.17E+04	5.13E+03	2.35E+03
2003	2.68E+05	2.65E+05	8.67E+04	1.94E+05	1.43E+05	8.94E+04	5.32E+04	1.22E+04	9.68E+03	2.19E+03
2004	2.18E+05	2.20E+05	2.17E+05	7.10E+04	1.56E+05	1.03E+05	5.40E+04	2.76E+04	5.52E+03	4.01E+03

Estimated population abundance at 1st Jan 2005

, 0.00E+00, 1.78E+05, 1.80E+05, 1.78E+05, 5.65E+04, 1.10E+05, 6.18E+04, 2.88E+04, 1.38E+04, 2.09E+03,

Taper weighted geometric mean of the VPA populations:

, 2.86E+05, 2.37E+05, 1.98E+05, 1.61E+05, 1.28E+05, 8.30E+04, 4.59E+04, 2.14E+04, 8.85E+03, 3.46E+03,

Standard error of the weighted Log(VPA populations) :

, .4266, .4239, .4384, .4391, .4106, .4103, .4505, .5098, .5865, .7022,

YEAR	AGE 10	11	12	13	14
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	9.16E+01	6.69E+01	4.35E+01
1998	8.98E+02	3.42E+02	8.95E+01	4.96E+01	2.13E+01
1999	1.59E+03	2.83E+02	1.02E+02	2.35E+01	1.08E+01
2000	1.02E+03	6.23E+02	1.05E+02	4.21E+01	1.02E+01
2001	7.61E+02	3.24E+02	2.26E+02	1.88E+01	1.46E+01
2002	1.17E+03	2.14E+02	8.27E+01	7.85E+01	3.65E+00
2003	7.00E+02	3.34E+02	6.41E+01	3.15E+01	2.72E+01
2004	8.01E+02	2.17E+02	1.21E+02	2.27E+01	8.60E+00

Estimated population abundance at 1st Jan 2005

, 1.47E+03, 2.25E+02, 6.45E+01, 4.28E+01, 5.88E+00,

Taper weighted geometric mean of the VPA populations:

, 1.31E+03, 4.96E+02, 1.87E+02, 6.86E+01, 2.26E+01,

Standard error of the weighted Log(VPA populations) :

, .7627, .7548, .7086, .7286, 1.1336,

1

Log catchability residuals.

Fleet : SMB. Tot

Age	1984
0	-.16
1	.12
2	.08
3	.29
4	.15
5	.28
6	.64
7	.28
8	.62

Table 3.3.10 (Cont'd)1

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
0	.31	.37	-.12	.22	-.17	-.15	-.25	-.30	.30	-.18
1	-.02	.09	.07	.04	.13	-.24	-.04	-.04	-.21	.12
2	-.14	.09	.37	.35	-.01	.03	-.13	.00	-.09	-.24
3	-.22	-.25	.05	.39	.04	.05	.06	-.08	-.05	-.09
4	-.03	-.12	-.10	.00	-.08	.20	-.15	.07	-.18	.13
5	.05	.08	-.54	.19	-.17	.11	-.18	.00	-.30	.04
6	-.27	.06	.24	-.21	.02	.14	-.17	-.31	-.12	-.16
7	-.29	-.15	.55	-.03	-.33	-.23	-.14	-.07	-.43	-.01
8	-.48	-.09	-.37	.54	.12	.13	-.35	-.32	.05	-.08

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	-.30	.08	-.04	-.02	.35	.08	-.08	.13	.08	-.14
1	-.13	-.01	.14	.10	.07	-.12	.11	-.03	-.04	-.12
2	.07	.01	-.14	-.15	.14	-.04	-.03	-.03	-.12	-.05
3	-.14	.20	.06	.03	-.19	-.11	.00	-.11	.10	-.03
4	.24	-.03	.41	-.03	-.06	-.40	.04	-.01	-.06	.01
5	.12	.08	.32	.19	-.20	-.15	-.15	-.02	.23	.01
6	.28	.20	.18	.00	-.06	-.41	-.05	-.18	.26	-.07
7	.57	.22	.49	.00	-.07	-.41	-.35	.17	.22	.00
8	.28	-.47	.43	.18	-.47	-.57	-.22	.26	.64	.16

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

Age	5	6	7	8
Mean Log q	-7.9131	-7.8184	-7.8027	-7.8804
S.E(Log q)	.2086	.2442	.3019	.3825

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	.45	4.283	11.63	.76	21	.22	-10.68
1	.53	7.789	10.64	.94	21	.12	-9.21
2	.62	4.718	9.85	.89	21	.16	-8.48
3	.62	4.468	9.59	.88	21	.16	-8.19
4	.68	3.419	9.16	.86	21	.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	.86	1.475	8.38	.85	21	.17	-7.91
6	.86	1.364	8.22	.83	21	.21	-7.82
7	.95	.363	7.91	.72	21	.29	-7.80
8	.98	.116	7.90	.61	21	.38	-7.88

1

Fleet disaggregated estimates of survivors :

Age 0 Catchability dependent on age and year class strength

Year class = 2004

SMB. Tot

Age	0
Survivors	154776.
Raw Weights	11.111

Table 3.3.10 (Cont'd)1

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	154776.,	.300,	.000,	.00,	1,	.666,	.000
P shrinkage mean ,	236723.,	.42,,,,				.334,	.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
178352.,	.24,	.25,	2,	1.002,	.000

Age 1 Catchability dependent on age and year class strength

Year class = 2003

SMB. Tot

Age,	1,	0,
Survivors,	159063.,	194185.,
Raw Weights,	11.111,	11.111,

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	175749.,	.212,	.100,	.47,	2,	.810,	.000
P shrinkage mean ,	198107.,	.44,,,,				.190,	.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
179787.,	.19,	.07,	3,	.385,	.000

1

Age 2 Catchability dependent on age and year class strength

Year class = 2002

SMB. Tot

Age,	2,	1,	0,
Survivors,	170016.,	171745.,	202180.,
Raw Weights,	11.111,	11.111,	11.111,

Fleet,	Estimated, Survivors,	Int, s.e,	Ext, s.e,	Var, Ratio,	N,	Scaled, Weights,	Estimated F
SMB. Tot ,	180733.,	.173,	.056,	.32,	3,	.865,	.000
P shrinkage mean ,	160899.,	.44,,,,				.135,	.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
177926.,	.16,	.05,	4,	.306,	.000

Table 3.3.10 (Cont'd)1

```
 Age  3   Catchability dependent on age and year class strength

 Year class = 2001

 SMB. Tot
        Age,         3,          2,          1,          0,
  Survivors,    54771.,     50353.,     54986.,     51988.,
 Raw Weights,    10.810,     10.810,     10.810,     10.810,




 Fleet,                   Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot              ,     52989.,   .150,       .021,    .14,   4,  .813,     .029

   P shrinkage mean  ,    127657.,    .41,,,,                        .112,     .012

   F shrinkage mean  ,     34144.,    .50,,,,                        .075,     .045

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     56549.,       .14,      .14,    6,   1.053,   .028


1
 Age  4   Catchability dependent on age and year class strength

 Year class = 2000

 SMB. Tot
        Age,         4,          3,          2,          1,          0,
  Survivors,   110886.,    122087.,    107332.,    123024.,    119221.,
 Raw Weights,     9.615,      9.406,      9.406,      9.406,      9.406,




 Fleet,                   Estimated,    Int,       Ext,    Var,    N, Scaled,
Estimated
      ,                   Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot              ,    116314.,   .134,       .027,    .20,   5,  .826,     .138

   P shrinkage mean  ,     82956.,    .41,,,,                        .104,     .188

   F shrinkage mean  ,     89916.,    .50,,,,                        .070,     .175

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
    110296.,       .12,      .06,    7,    .454,   .145


      1
 Age  5   Catchability constant w.r.t. time and dependent on age

 Year class = 1999

 SMB. Tot
        Age,         5,          4,          3,          2,          1,          0,
  Survivors,    62503.,     57933.,     55504.,     60016.,     54955.,     87450.,
 Raw Weights,     8.174,      7.180,      6.919,      6.919,      6.919,      6.919,
```

Table 3.3.10 (Cont'd)1

```
 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     62192.,   .123,       .070,    .57,   6,  .915,     .305

   F shrinkage mean  ,     57783.,    .50,,,,                        .085,     .325

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     61804.,       .12,      .06,    7,    .512,   .307


1
 Age  6   Catchability constant w.r.t. time and dependent on age

 Year class = 1998

 SMB. Tot
   Age,         6,           5,           4,           3,           2,           1,    0,
   Survivors,    26911.,     36123.,     28500.,     28783.,     27642.,     30992.,
28285.,
 Raw Weights,     7.249,      5.343,      4.501,      4.171,      4.171,      4.171,
4.171,


 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     29428.,   .116,       .040,    .34,   7,  .894,     .420

   F shrinkage mean  ,     24212.,    .50,,,,                        .106,     .491

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
     28826.,       .12,      .04,    8,    .364,   .427


1
 Age  7   Catchability constant w.r.t. time and dependent on age

 Year class = 1997

 SMB. Tot
     Age,         7,           6,           5,           4,           3,           2,     1,
0,
   Survivors,    13803.,     17892.,     13512.,     14380.,     12331.,     15884.,
15216.,     13212.,
 Raw Weights,     6.399,      4.305,      3.046,      2.443,      2.288,      2.288,
2.288,      2.288,


 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot            ,     14551.,   .117,       .043,    .36,   8,  .864,     .473

   F shrinkage mean  ,      9939.,    .50,,,,                        .136,     .634

 Weighted prediction :

     Survivors,        Int,      Ext,    N,    Var,     F
     at end of year,   s.e,      s.e,     ,   Ratio,
         13815.,       .12,      .06,    9,    .509,   .493
```

Table 3.3.10 (Cont'd)1

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

 Year class = 1996

 SMB. Tot
        Age,         8,          7,          6,          5,          4,          3,
2,          1,          0,
   Survivors,     2448.,      2606.,      1753.,      1804.,      1397.,      1738.,
1807.,      2398.,      2277.,
 Raw Weights,     3.022,      2.690,      1.888,      1.372,      1.185,      1.137,
1.137,      1.137,      1.137,



 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,      2081.,   .121,       .070,    .58,   9,  .786,     .773

   F shrinkage mean  ,      2136.,    .50,,,,                         .214,     .759

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      2093.,       .14,      .06,   10,    .410,   .770


1
 Age  9   Catchability constant w.r.t. time and dependent on age

 Year class = 1995

 SMB. Tot
        Age,         9,          8,          7,          6,          5,          4,
3,          2,          1,          0,
   Survivors,        0.,      2778.,      1743.,      1397.,      1271.,      1381.,
1513.,      1281.,      1450.,      1090.,
 Raw Weights,      .000,      1.478,      1.293,       .757,       .489,       .409,
.400,       .400,       .400,       .400,



 Fleet,                 Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                 Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,      1695.,   .133,       .109,    .82,   9,  .601,     .728

   F shrinkage mean  ,      1186.,    .50,,,,                         .399,     .928

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
      1470.,       .21,      .11,   10,    .510,   .804


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

 Year class = 1994

 SMB. Tot
        Age,        10,          9,          8,          7,          6,          5,
4,          3,          2,          1,          0,
   Survivors,        0.,         0.,       292.,       159.,       148.,       183.,
218.,       239.,       226.,       198.,       187.,
 Raw Weights,      .000,       .000,       .520,       .420,       .245,       .164,
.144,       .141,       .141,       .141,       .141,
```

Table 3.3.10 (Cont'd)1

```
 Fleet,                    Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                    Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,         206.,   .133,       .088,    .66,   9,  .339,    1.131

   F shrinkage mean  ,         235.,    .50,,,,                          .661,    1.043

 Weighted prediction :

 Survivors,         Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
       225.,       .33,      .06,   10,    .181,  1.072


1
 Age 11   Catchability constant w.r.t. time and dependent on age

 Year class = 1993

 SMB. Tot
         Age,          11,
   Survivors,          0.,
 Raw Weights,        .000,


        Age,         10,          9,          8,          7,          6,          5,          4,          3,
2,          1,          0,
   Survivors,        0.,         0.,        52.,        43.,        61.,        78.,        97.,        79.,
69.,        72.,        87.,
 Raw Weights,      .000,       .000,       .130,       .086,       .045,       .031,       .027,       .026,
.026,       .026,       .026,


 Fleet,                    Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                    Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,          60.,   .147,       .091,    .62,   9,  .095,    1.060

   F shrinkage mean  ,          65.,    .50,,,,                          .905,    1.008

 Weighted prediction :

 Survivors,         Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        64.,       .45,      .04,   10,    .081,  1.013


1
 Age 12   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1992

 SMB. Tot
         Age,          12,          11,
   Survivors,          0.,          0.,
 Raw Weights,        .000,        .000,


         Age,          10,           9,           8,           7,           6,           5,
4,           3,           2,           1,           0,
   Survivors,          0.,          0.,         24.,         40.,         43.,         59.,
41.,         37.,         34.,         35.,         32.,
 Raw Weights,        .000,        .000,        .070,        .054,        .035,        .027,
.023,        .022,        .022,        .022,        .022,
```

Table 3.3.10 (Cont'd)1

```
 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,        36.,   .128,       .092,    .72,   9,  .069,     .946

   F shrinkage mean  ,         43.,    .50,,,,                        .931,     .830

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
        43.,       .47,      .07,   10,    .145,   .838

1
 Age 13   Catchability constant w.r.t. time and age (fixed at the value for age) 11

 Year class = 1991

 SMB. Tot
         Age,        13,         12,         11,
   Survivors,        0.,         0.,         0.,
 Raw Weights,      .000,       .000,       .000,


         Age,        10,          9,          8,          7,          6,          5,
4,          3,          2,          1,          0,
   Survivors,        0.,         0.,         4.,         6.,         7.,         6.,
7.,         5.,         5.,         6.,         5.,
 Raw Weights,      .000,       .000,       .022,       .019,       .014,       .011,
.009,       .008,       .008,       .008,       .008,


 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,         5.,   .122,       .083,    .68,   9,  .026,    1.206

   F shrinkage mean  ,          6.,    .50,,,,                        .974,    1.147

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
         6.,       .49,      .03,   10,    .063,  1.148

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

 Year class = 1990

 SMB. Tot
         Age,        14,         13,         12,         11,
   Survivors,        0.,         0.,         0.,         0.,
 Raw Weights,      .000,       .000,       .000,       .000,


         Age,        10,          9,          8,          7,          6,          5,
4,          3,          2,          1,          0,
   Survivors,        0.,         0.,         3.,         4.,         3.,         3.,
3.,         2.,         3.,         2.,         2.,
 Raw Weights,      .000,       .000,       .009,       .007,       .005,       .003,
.002,       .002,       .002,       .002,       .002,


 Fleet,                  Estimated,    Int,       Ext,    Var,    N, Scaled,  Estimated
      ,                  Survivors,    s.e,       s.e,   Ratio,    , Weights,    F
 SMB. Tot             ,         3.,   .133,       .066,    .50,   9,  .009,     .916

   F shrinkage mean  ,          3.,    .50,,,,                        .991,    1.030

 Weighted prediction :

 Survivors,        Int,      Ext,    N,    Var,     F
 at end of year,   s.e,      s.e,     ,   Ratio,
         3.,       .50,      .06,   10,    .123,  1.029
```

Table 3.3.11. Cod at Iceland. Division Va. TSA-results

Input data and estimated parameters:

Data: Catch at age 1971–2004 and spring trawl survey indices (weighted geometric of North and South) 1985–2005.

Estimated stock in numbers and total biomass:

Year/age	4	5	6	7	8	9	10	11	BIOM(4-11)
1984	182237.	75881.	40239.	18360.	13944.	5069.	995.	1016.	875.4
1985	110343.	121037.	44363.	19424.	7755.	4779.	1771.	352.	899.1
1986	106953.	67935.	66696.	20699.	7858.	2870.	1688.	611.	830.1
1987	239403.	69108.	31477.	26907.	7051.	2430.	857.	508.	978.7
1988	220133.	142439.	32715.	11749.	8404.	2024.	679.	238.	1010.6
1989	137731.	142698.	69975.	11765.	3482.	1846.	463.	161.	999.8
1990	64265.	85572.	102504.	31314.	4412.	1127.	591.	145.	815.9
1991	101938.	41429.	43842.	44370.	11637.	1510.	372.	192.	685.4
1992	78221.	60480.	19943.	16135.	14409.	3635.	444.	105.	534.4
1993	131852.	43074.	26016.	6642.	4666.	4336.	1130.	133.	570.6
1994	103140.	78640.	20753.	9864.	2192.	1269.	1104.	290.	577.1
1995	56223.	62800.	46011.	10534.	4260.	840.	485.	426.	558.5
1996	119100.	37760.	35379.	25367.	5132.	1988.	386.	218.	671.1
1997	131980.	84443.	23633.	17738.	12220.	2234.	856.	164.	785.3
1998	68585.	92758.	53601.	13030.	7749.	4853.	828.	317.	715.8
1999	127332.	48916.	52784.	26576.	5483.	2784.	1519.	261.	721.5
2000	51858.	86013.	26587.	21594.	10649.	2064.	1039.	561.	574.8
2001	141366.	36284.	45974.	11912.	7730.	3656.	702.	348.	686.8
2002	131803.	93463.	21072.	21111.	4737.	2658.	1194.	229.	743.3
2003	134386.	90514.	54238.	11387.	9540.	1938.	984.	441.	772.7
2004	150726.	95256.	54539.	28053.	5354.	4046.	772.	396.	849.4
2005	49951.	106097.	56796.	29155.	13360.	2193.	1576.	304.	745.7

Standard deviation of stock estimate:

2004	6934.	5661.	3453.	1874.	329.	288.	72.	45.	35.3
2005	5493.	5748.	4539.	2696.	1423.	266.	232.	49.	42.4

Estimated fishing mortality rates:

Year/age	4	5	6	7	8	9	10	11	FBAR(5-10)
1984	0.209	0.331	0.528	0.660	0.870	0.851	0.839	0.843	0.680
1985	0.283	0.396	0.561	0.705	0.794	0.839	0.864	0.868	0.693
1986	0.237	0.560	0.708	0.877	0.972	1.005	1.000	1.012	0.854
1987	0.314	0.545	0.776	0.962	1.048	1.075	1.080	1.092	0.914
1988	0.233	0.501	0.817	1.014	1.289	1.269	1.234	1.231	1.021
1989	0.271	0.480	0.590	0.757	0.910	0.904	0.918	0.939	0.760
1990	0.238	0.462	0.637	0.790	0.870	0.907	0.919	0.930	0.764
1991	0.322	0.530	0.774	0.913	0.960	1.020	1.052	1.041	0.875
1992	0.395	0.644	0.896	1.017	1.000	0.965	1.004	1.037	0.921
1993	0.317	0.526	0.768	0.909	1.083	1.157	1.157	1.149	0.933
1994	0.285	0.336	0.477	0.638	0.756	0.755	0.748	0.748	0.619
1995	0.197	0.358	0.395	0.519	0.562	0.577	0.600	0.609	0.502
1996	0.144	0.266	0.462	0.527	0.615	0.632	0.642	0.641	0.524
1997	0.150	0.254	0.392	0.584	0.701	0.754	0.756	0.752	0.574
1998	0.138	0.357	0.501	0.652	0.756	0.879	0.858	0.839	0.667
1999	0.191	0.409	0.679	0.714	0.775	0.782	0.789	0.814	0.691
2000	0.153	0.426	0.602	0.817	0.869	0.877	0.895	0.908	0.748
2001	0.214	0.326	0.575	0.704	0.862	0.905	0.904	0.895	0.713
2002	0.176	0.344	0.400	0.583	0.663	0.782	0.783	0.764	0.593
2003	0.144	0.307	0.459	0.546	0.647	0.709	0.703	0.694	0.562
2004	0.151	0.317	0.426	0.542	0.693	0.743	0.732	0.709	0.575

Standard deviations of log(F):

2004	0.09	0.09	0.09	0.09	0.10	0.12	0.12	0.12	0.076

Table 3.3.11 (Continued)

Standardized catch prediction errors:

Year/age	4	5	6	7	8	9	10	11
1985	0.83	-0.02	1.57	0.09	1.10	-1.29	0.60	0.57
1986	0.00	0.63	1.47	1.76	0.64	1.40	-0.78	0.44
1987	1.81	1.02	-0.90	0.66	0.23	0.46	0.99	-0.35
1988	-0.92	1.47	2.03	-1.22	0.49	0.33	0.42	2.02
1989	-1.15	-0.49	0.94	0.29	-1.10	-2.38	-1.32	-0.16
1990	-0.53	-1.64	-0.39	1.55	1.60	0.49	0.60	1.33
1991	0.96	1.27	-0.49	0.72	0.12	0.90	0.80	0.52
1992	1.28	1.30	1.38	-0.83	-1.08	-0.71	-0.36	-1.04
1993	0.25	-1.00	0.49	-0.73	-1.41	-0.10	2.53	2.14
1994	0.31	-0.29	-0.74	0.21	1.58	-0.83	-0.49	1.41
1995	-0.55	-1.53	-0.96	-0.68	-1.36	-1.56	-1.19	-0.90
1996	-0.10	-1.32	-1.30	0.34	0.07	0.27	1.19	-0.43
1997	-0.57	0.10	-0.53	-1.06	0.93	0.14	0.88	1.44
1998	-0.27	0.29	1.99	0.73	-1.41	0.56	-0.08	0.03
1999	1.17	1.66	1.21	1.39	-0.41	-1.89	-2.06	-1.46
2000	0.16	1.72	1.30	-0.51	0.42	-0.08	-0.15	-0.14
2001	-0.01	0.31	0.69	0.28	-1.42	0.03	0.89	0.24
2002	-0.92	-1.11	0.36	-0.32	0.47	0.01	0.82	0.45
2003	-0.80	-0.97	-1.34	1.26	0.45	2.39	-0.37	-0.34
2004	0.10	0.42	-0.85	-1.61	1.65	1.28	1.88	-0.81

SELECTIVITY

0.027 0.058 0.155 0.214 0.214 0.214 0.000 0.000

SKEWNESS AND KURTOSIS

2.078 -1.740

VARIANCE AT AGE

0.6388 1.1599 1.3316 0.9048 1.0777 1.2810 1.2360 1.0368

VARIANCE AT YEAR

0.8385 1.1064 0.8706 1.6570 1.3984 1.3088 0.6298 1.1015 1.8528 0.7770

CORRELATION WITHIN COHORTS 0.38

CORRELATION WITHIN AGES AND YEARS 0.35 0.03

Table 3.3.11 (Cont'd)1

Standardized prediction errors of cpue:

Year/age	4	5	6	7	8	9
1985	1.24	-0.23	1.69	1.29	1.42	0.69
1986	-0.98	-0.57	-0.37	-0.31	-1.25	-0.38
1987	-0.17	-0.86	-0.77	-0.15	0.26	-0.11
1988	0.48	1.63	-0.55	-0.42	0.69	-0.30
1989	1.43	1.00	2.47	0.88	0.24	-0.10
1990	-0.97	-0.92	-0.62	1.99	1.16	1.24
1991	0.31	2.30	-0.28	1.52	0.42	1.37
1992	0.97	-0.46	-0.30	-1.12	-0.32	0.09
1993	0.81	0.84	0.76	-0.93	-0.39	-0.54
1994	-0.62	-0.42	-1.06	-1.13	-0.65	-0.32
1995	-0.38	-0.37	0.18	-0.50	-0.16	0.03
1996	0.86	0.92	-0.97	1.66	2.09	1.11
1997	-0.08	-0.15	-0.36	-1.23	-0.12	-1.95
1998	-0.11	-0.52	0.40	-0.45	-0.86	-0.11
1999	0.68	-0.23	-0.60	-0.04	-0.26	-1.56
2000	0.53	0.67	-0.02	-1.31	0.28	-0.96
2001	-0.39	-0.41	-0.45	-1.17	-1.82	-0.91
2002	0.52	1.25	2.27	0.30	0.74	-0.27
2003	-0.47	-0.07	-0.62	1.64	0.13	1.08
2004	1.67	0.90	0.59	0.69	2.33	0.46
2005	0.80	-0.48	0.22	-0.59	-0.22	0.47

```
SKEWNESS AND KURTOSIS
3.777  -0.045

 VARIANCE AT AGE
0.6756    0.8444    1.0170    1.1757    1.0515    0.7950

 VARIANCE AT YEAR
 .5723    0.7202    0.3894    0.9345    1.9024    1.7223
1.7417    0.6171    0.8490    0.7087

CORRELATION WITHIN COHORTS    0.12

CORRELATION WITHIN AGES AND YEARS    0.36  -0.07
```

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 2004 and survey data from 1985 – 2005. 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	0.4013	-25.240	2.242	-1.000	-1.000	-1.000
2	0.2	0.1548	-20.726	1.997	-1.000	-1.000	-1.000
3	0.2	0.2070	-17.570	1.776	0.154	0.054	0.172
4	0.2	0.2106	-15.009	1.603	0.504	0.216	0.099
5	0.2	0.1809	-12.147	1.388	0.789	0.442	0.113
6	0.2	0.1422	-7.710	1.000	0.978	0.656	0.123
7	0.2	0.1692	-7.584	1.000	1.220	0.841	0.083
8	0.2	0.2034	-7.542	1.000	1.432	1.008	0.106
9	0.2	0.2285	-7.624	1.000	1.479	1.118	0.160
10	0.2	0.2312	-7.583	1.000	1.538	1.183	0.156
11	0.2	-1.0000	-1.000	-1.000	1.481	1.091	0.197
12	0.2	-1.0000	-1.000	-1.000	1.321	1.079	0.198
13	0.2	-1.0000	-1.000	-1.000	1.000	1.000	0.252
14	0.2	-1.0000	-1.000	-1.000	1.000	1.000	0.252

Table 3.3.12 (Continued)

Residuals:

Log(Cay-observed/Cay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
3	0.02	0.06	-0.07	-0.04	-0.09	0.00	0.04	-0.10	0.11	0.02
4	0.08	-0.04	0.05	-0.03	0.02	-0.05	0.02	0.04	0.02	0.10
5	-0.04	0.01	0.02	-0.03	0.06	-0.04	-0.05	0.02	-0.08	-0.05
6	0.05	-0.01	-0.07	0.07	-0.04	0.00	-0.03	0.02	-0.02	-0.08
7	-0.05	0.07	0.03	-0.04	0.00	0.01	0.04	0.04	-0.03	-0.02
8	-0.01	-0.02	0.01	0.03	-0.07	0.05	-0.04	-0.01	-0.06	0.03
9	-0.06	0.05	-0.01	0.07	-0.14	-0.04	0.06	-0.02	0.03	-0.09
10	0.06	-0.09	0.05	0.01	-0.04	-0.10	-0.03	-0.02	0.21	-0.06
11	0.02	0.04	-0.16	0.22	0.00	0.14	-0.13	-0.32	0.24	0.20
12	-0.15	0.02	-0.05	0.01	0.23	0.05	0.18	-0.33	-0.09	0.24
13	0.20	-0.26	0.06	0.24	0.00	-0.08	-0.24	-0.24	-0.41	0.24
14	0.21	0.08	-0.12	0.06	-0.60	0.05	0.07	-0.05	0.21	-0.15

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
3	0.12	0.00	-0.06	-0.08	-0.03	0.06	0.08	0.00	-0.09	0.01
4	-0.01	-0.03	0.00	-0.06	0.01	-0.09	0.05	0.01	-0.02	0.00
5	0.03	-0.06	-0.01	0.03	0.03	0.05	-0.04	0.00	-0.01	0.04
6	-0.01	0.03	-0.04	0.03	0.01	0.00	0.00	0.00	-0.01	-0.02
7	-0.01	0.02	-0.05	0.01	0.03	-0.01	0.01	-0.02	0.08	-0.08
8	-0.06	0.02	0.09	-0.08	-0.01	0.04	-0.10	0.00	-0.01	0.10
9	-0.05	0.05	0.08	0.10	-0.11	0.02	0.03	-0.09	0.10	0.01
10	-0.13	0.08	0.10	0.02	-0.07	-0.05	0.12	0.10	-0.15	0.13
11	-0.07	-0.15	0.19	0.04	-0.08	0.04	0.01	0.14	0.04	-0.17
12	0.33	-0.16	-0.31	0.12	-0.17	0.09	0.09	-0.14	0.07	0.02
13	0.51	0.29	-0.08	0.08	-0.19	-0.04	-0.18	0.19	0.06	0.14
14	0.29	0.01	0.10	-0.30	-0.37	0.00	0.01	-0.47	0.23	-0.14

Table 3.3.12 (Continued)

Log(Uay-observed/Uay-predicted)

Year/age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
1	-0.13	0.23	0.29	-0.13	0.16	-0.19	-0.11	-0.28	-0.26	0.25
2	0.05	-0.01	0.02	0.03	0.04	0.08	-0.21	0.01	-0.03	-0.14
3	0.08	-0.16	0.05	0.21	0.23	0.00	0.01	-0.11	0.05	-0.04
4	0.19	-0.13	-0.17	0.08	0.24	-0.02	0.04	0.02	-0.03	0.01
5	0.08	-0.05	-0.01	-0.04	0.09	-0.08	0.11	-0.07	0.01	-0.09
6	0.16	0.02	-0.02	-0.18	0.07	-0.07	0.04	-0.05	-0.01	-0.17
7	0.23	-0.06	0.04	0.06	-0.07	0.01	0.08	-0.07	-0.13	-0.08
8	0.13	-0.15	-0.03	0.23	-0.08	-0.09	-0.09	-0.07	-0.10	-0.17
9	0.18	-0.14	-0.04	-0.09	0.07	-0.02	0.13	-0.07	-0.14	-0.12
10	0.26	-0.06	-0.01	-0.10	0.04	0.05	0.16	0.00	-0.19	-0.09

Year/age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	-0.18	-0.30	0.08	-0.07	-0.05	0.37	0.04	-0.07	0.14	0.14	-0.09
2	0.07	-0.07	-0.01	0.15	0.06	0.04	-0.06	0.06	0.02	-0.01	-0.03
3	-0.14	0.02	0.04	-0.11	-0.05	0.07	-0.06	0.00	-0.06	-0.03	-0.02
4	-0.09	-0.09	0.11	0.03	0.01	-0.15	-0.10	-0.03	-0.05	0.04	-0.04
5	0.06	0.08	-0.02	0.23	-0.03	-0.04	-0.28	-0.01	-0.05	-0.02	-0.02
6	0.02	-0.01	0.00	0.16	0.05	-0.08	-0.08	-0.04	-0.06	0.06	0.01
7	-0.09	0.15	-0.01	0.08	0.03	-0.09	-0.17	-0.06	-0.03	0.05	-0.07
8	-0.04	0.24	0.14	0.11	0.01	0.00	-0.30	-0.13	0.04	0.14	-0.03
9	-0.03	0.13	-0.20	0.23	-0.01	-0.15	-0.20	-0.23	0.18	0.25	0.08
10	-0.20	0.02	-0.01	0.25	0.01	-0.17	0.00	-0.12	-0.29	0.22	0.11

Table 3.3.13 Comparison of the results from the variuos methods.

Estimated fishing mortality rate in 2004:

Age	XSA	TSA	A-C_base	AC_base_rs	ADAPT	X-CAM
3	0.03		0.03	0.03	0.03	0.04
4	0.14	0.15	0.15	0.15	0.14	0.16
5	0.31	0.32	0.33	0.30	0.34	0.30
6	0.43	0.43	0.47	0.43	0.43	0.44
7	0.49	0.54	0.56	0.58	0.46	0.55
8	0.77	0.69	0.77	0.69	0.82	0.60
9	0.80	0.74	0.81	0.76	0.61	0.59
10	1.07	0.73	1.06	0.82	0.94	0.54
11	1.01	0.71	0.87	0.73	1.27	0.45
12	0.84		0.88	0.73	3.95	
13	1.15		1.02	0.67	2.52	
14	1.03		1.02	0.67	1.06	
F(5-10)	**0.65**	**0.58**	**0.67**	**0.60**	**0.60**	**0.50**

Estimated stock in numbers (millions) in 2005:

Age	XSA	TSA	A-C_base	AC_base_rs	ADAPT	X-CAM
3	177.926	154.000	167.500	167.992	172.529	170.266
4	56.549	49.951	54.134	54.735	54.034	51.477
5	110.296	106.097	109.072	108.630	115.936	107.658
6	61.804	56.796	53.265	56.436	55.683	56.171
7	28.826	29.155	26.242	29.151	28.408	28.828
8	13.815	13.360	12.739	13.509	15.135	14.071
9	2.093	2.193	1.812	1.882	1.900	2.078
10	1.47	1.576	1.430	1.534	2.171	1.929
11	0.225	0.304	0.189	0.247	0.277	1.037
12	0.064		0.088	0.153	0.044	
13	0.043		0.037	0.049	0.001	
14	0.006		0.007	0.010	0.001	

Recruitment:

Yearcl.	XSA	TSA	A-C_base	AC_base_rs	ADAPT	X-CAM
2000	194	184	193	193	203	196
2001	71	68	68	69	68	65
2002	178	154	168	168	173	170
2003	147	123	135	133	138	127
2004	120	100	112	110	116	99

Estimated stock in weight (4+, Thous. tonnes) in 1990-2005

Year	XSA	TSA	A-C_base	AC_base_rs	ADAPT	X-CAM
1991	711	685	678	698	711	718
1992	554	534	537	547	554	563
1993	588	571	572	590	588	581
1994	585	577	581	575	585	576
1995	563	559	556	553	562	560
1996	688	671	659	669	687	670
1997	804	785	785	785	803	799
1998	737	716	716	719	737	735
1999	746	722	720	729	749	736
2000	595	575	578	583	598	583
2001	697	687	688	694	706	688
2002	744	743	733	746	754	742
2003	781	773	743	767	776	770
2004	872	849	826	854	876	864
2005	**784**	**746**	**730**	**760**	**781**	**762**

Table 3.3.14 Cod at Iceland. Division Va. Resulting fishing mortality 1955-2004 using final F from AD-CAM using catch at age and spring trawl survey indices and predicted for 2005-2007.

Year/age	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
3	0.04	0.05	0.08	0.11	0.09	0.10	0.09	0.11	0.13	0.13	0.12
4	0.17	0.18	0.21	0.25	0.23	0.23	0.22	0.25	0.28	0.29	0.28
5	0.25	0.25	0.27	0.30	0.28	0.29	0.26	0.28	0.33	0.37	0.38
6	0.27	0.26	0.27	0.29	0.26	0.29	0.26	0.26	0.31	0.36	0.40
7	0.30	0.29	0.30	0.32	0.30	0.34	0.33	0.35	0.38	0.43	0.47
8	0.30	0.30	0.33	0.37	0.34	0.40	0.40	0.42	0.49	0.57	0.60
9	0.28	0.30	0.33	0.40	0.35	0.43	0.42	0.47	0.59	0.74	0.74
10	0.33	0.34	0.36	0.44	0.40	0.48	0.46	0.51	0.65	0.81	0.85
11	0.33	0.36	0.37	0.44	0.38	0.48	0.44	0.49	0.63	0.83	0.88
12	0.31	0.34	0.33	0.39	0.32	0.39	0.35	0.38	0.46	0.61	0.65
13	0.33	0.33	0.30	0.33	0.23	0.27	0.23	0.24	0.29	0.39	0.43
14	0.33	0.33	0.30	0.33	0.23	0.27	0.23	0.24	0.29	0.39	0.43
F_{5-10}	**0.29**	**0.29**	**0.31**	**0.35**	**0.32**	**0.37**	**0.35**	**0.38**	**0.46**	**0.55**	**0.58**

Year/age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	0.09	0.08	0.08	0.06	0.07	0.09	0.09	0.12	0.11	0.11	0.07
4	0.25	0.23	0.25	0.23	0.27	0.31	0.30	0.32	0.32	0.31	0.26
5	0.34	0.30	0.34	0.32	0.39	0.48	0.48	0.49	0.50	0.50	0.43
6	0.38	0.34	0.41	0.35	0.43	0.53	0.55	0.56	0.58	0.60	0.55
7	0.49	0.48	0.58	0.50	0.55	0.62	0.65	0.67	0.70	0.72	0.70
8	0.62	0.61	0.76	0.61	0.65	0.72	0.73	0.75	0.83	0.88	0.85
9	0.78	0.75	1.04	0.72	0.76	0.80	0.79	0.80	0.92	1.02	0.95
10	0.92	0.88	1.20	0.84	0.89	0.96	0.96	0.95	1.06	1.13	1.01
11	1.01	0.93	1.36	0.87	0.95	1.04	1.06	1.04	1.18	1.25	1.06
12	0.79	0.72	1.08	0.72	0.80	0.89	0.92	0.90	1.03	1.11	0.95
13	0.53	0.46	0.74	0.44	0.52	0.58	0.60	0.59	0.70	0.78	0.66
14	0.53	0.46	0.74	0.44	0.52	0.58	0.60	0.59	0.70	0.78	0.66
F_{5-10}	**0.59**	**0.56**	**0.72**	**0.56**	**0.61**	**0.69**	**0.69**	**0.70**	**0.76**	**0.81**	**0.75**

Year/age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.04	0.05	0.06	0.06
4	0.20	0.17	0.17	0.17	0.18	0.19	0.18	0.20	0.23	0.26	0.27
5	0.33	0.28	0.27	0.31	0.35	0.39	0.38	0.38	0.42	0.52	0.55
6	0.43	0.35	0.34	0.39	0.49	0.56	0.55	0.53	0.58	0.71	0.81
7	0.61	0.53	0.50	0.54	0.65	0.70	0.71	0.67	0.72	0.83	0.91
8	0.72	0.60	0.57	0.62	0.82	0.90	0.88	0.81	0.84	0.96	1.06
9	0.73	0.55	0.50	0.56	0.85	0.96	0.92	0.76	0.77	0.88	1.00
10	0.74	0.55	0.49	0.55	0.82	0.87	0.86	0.71	0.71	0.78	0.86
11	0.70	0.48	0.42	0.47	0.75	0.75	0.74	0.60	0.60	0.66	0.75
12	0.63	0.45	0.39	0.44	0.70	0.68	0.68	0.57	0.57	0.63	0.71
13	0.41	0.28	0.25	0.29	0.52	0.52	0.53	0.44	0.45	0.50	0.58
14	0.41	0.28	0.25	0.29	0.52	0.52	0.53	0.44	0.45	0.50	0.58
F_{5-10}	**0.59**	**0.48**	**0.45**	**0.49**	**0.66**	**0.73**	**0.72**	**0.64**	**0.67**	**0.78**	**0.87**

Table 3.3.14 (Continued)

Year/age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.05	0.04	0.05	0.09	0.10	0.14	0.09	0.06	0.04	0.03	0.03
4	0.26	0.24	0.25	0.30	0.32	0.31	0.24	0.20	0.16	0.15	0.16
5	0.52	0.46	0.47	0.56	0.59	0.55	0.38	0.32	0.28	0.27	0.33
6	0.79	0.65	0.66	0.81	0.86	0.80	0.53	0.42	0.41	0.42	0.51
7	0.92	0.80	0.79	0.89	0.93	0.89	0.68	0.57	0.56	0.59	0.67
8	1.11	0.90	0.86	0.95	1.01	1.04	0.77	0.63	0.63	0.67	0.78
9	1.09	0.80	0.75	0.85	0.90	1.03	0.72	0.56	0.58	0.66	0.83
10	0.95	0.73	0.69	0.78	0.82	0.95	0.71	0.58	0.60	0.69	0.85
11	0.88	0.65	0.62	0.71	0.74	0.89	0.64	0.52	0.54	0.63	0.80
12	0.84	0.64	0.61	0.70	0.73	0.87	0.65	0.53	0.55	0.63	0.79
13	0.73	0.52	0.50	0.59	0.62	0.78	0.55	0.44	0.46	0.54	0.72
14	0.73	0.52	0.50	0.59	0.62	0.78	0.55	0.44	0.46	0.54	0.72
F_{5-10}	**0.90**	**0.72**	**0.70**	**0.81**	**0.85**	**0.88**	**0.63**	**0.51**	**0.51**	**0.55**	**0.66**

Year/age	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	0.05	0.06	0.06	0.04	0.03	0.03	0.03	0.02	0.02
4	0.18	0.19	0.19	0.16	0.15	0.15	0.13	0.11	0.12
5	0.39	0.40	0.38	0.33	0.30	0.30	0.26	0.23	0.23
6	0.64	0.62	0.58	0.47	0.44	0.43	0.37	0.33	0.34
7	0.75	0.76	0.72	0.62	0.58	0.58	0.49	0.44	0.45
8	0.87	0.89	0.88	0.75	0.69	0.69	0.59	0.53	0.54
9	0.93	0.97	1.00	0.86	0.75	0.76	0.65	0.59	0.59
10	0.93	0.98	1.03	0.92	0.82	0.82	0.70	0.64	0.64
11	0.87	0.92	0.98	0.85	0.74	0.73	0.63	0.58	0.58
12	0.85	0.91	0.96	0.84	0.74	0.73	0.63	0.57	0.58
13	0.78	0.85	0.92	0.78	0.67	0.67	0.58	0.53	0.53
14	0.78	0.85	0.92	0.78	0.67	0.67	0.58	0.53	0.53
F_{5-10}	**0.75**	**0.77**	**0.76**	**0.66**	**0.60**	**0.60**	**0.51**	**0.46**	**0.47**

Table 3.3.15. Cod at Iceland. Division Va. Resulting Stock in numbers in 1955- 2005 using final F from AD-CAM using catch at age and spring trawl survey indices and predicted for 2006-2007.

Year/age	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
3	152.031	152.871	170.674	220.658	289.039	154.437	192.870	128.979	177.607	204.024	216.450
4	217.709	119.588	118.943	128.845	161.140	216.112	114.335	143.766	94.452	127.737	147.311
5	212.057	150.345	81.606	78.562	82.287	104.500	140.159	74.749	91.852	58.278	78.234
6	115.459	134.824	95.914	50.819	47.563	50.806	63.724	88.549	46.181	54.178	32.892
7	36.023	71.830	85.220	59.846	31.111	30.134	31.076	40.166	55.703	27.763	30.934
8	24.544	21.796	44.008	51.660	35.451	18.896	17.599	18.230	23.259	31.099	14.720
9	12.928	14.825	13.171	35.185	51.747	20.633	10.397	23.609	9.770	11.645	14.399
10	87.267	7.972	9.036	7.773	19.357	37.523	11.011	5.604	12.122	4.451	4.550
11	9.169	51.603	4.629	5.140	4.100	10.632	19.073	5.695	2.747	5.202	1.621
12	7.776	5.422	29.578	2.631	2.699	2.289	5.412	10.058	2.864	1.204	1.849
13	8.083	4.671	3.171	17.360	1.463	1.602	1.274	3.123	5.640	1.477	0.536
14	2.627	4.779	2.736	1.923	10.260	0.951	1.000	0.831	2.012	3.470	0.820

Year/age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	229.213	320.419	171.957	247.888	180.588	188.700	139.121	273.239	179.152	260.994	368.245
4	157.041	170.803	242.968	130.390	191.946	138.052	141.407	104.347	198.656	130.944	191.759
5	90.779	99.785	111.218	155.453	84.638	120.033	82.963	85.611	61.999	117.550	78.659
6	43.591	52.833	60.325	64.699	92.210	46.955	60.853	42.038	43.003	30.816	58.250
7	17.990	24.363	30.846	32.929	37.181	49.306	22.544	28.630	19.568	19.804	13.836
8	15.810	9.015	12.296	41.289	32.968	17.546	21.693	9.637	12.021	7.959	7.874
9	6.601	6.949	4.012	4.685	18.409	14.095	23.254	8.560	3.711	4.283	2.690
10	5.599	2.475	2.689	1.166	1.870	7.048	5.173	8.621	3.151	1.209	1.262
11	1.594	1.834	0.842	0.662	0.413	0.627	2.209	1.620	2.718	0.897	0.320
12	0.551	0.477	0.593	0.177	0.227	0.131	0.182	0.626	0.468	0.684	0.210
13	0.787	0.206	0.189	0.165	0.071	0.083	0.044	0.060	0.208	0.137	0.185
14	0.287	0.378	0.106	0.074	0.086	0.035	0.038	0.020	0.027	0.084	0.051

Year/age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	143.281	226.891	244.004	139.718	140.723	131.992	233.367	138.837	137.859	333.541	264.919
4	282.145	113.789	180.769	194.214	111.216	112.627	105.126	186.640	109.372	107.326	256.729
5	121.262	190.020	78.295	124.769	133.485	76.359	76.093	72.017	125.112	71.131	67.590
6	41.984	71.411	117.470	48.728	75.220	76.799	42.152	42.783	40.502	67.246	34.788
7	27.461	22.397	41.034	71.792	27.112	37.771	35.992	19.823	20.644	18.624	26.975
8	5.651	12.219	10.846	20.320	47.180	11.601	15.351	14.534	8.266	8.263	6.673
9	2.748	2.249	5.477	5.036	8.943	17.008	3.861	5.189	5.307	2.934	2.594
10	0.853	1.086	1.066	2.729	2.359	3.120	5.314	1.257	1.988	2.007	0.994
11	0.376	0.333	0.513	0.534	1.293	0.850	1.067	1.843	0.507	0.803	0.756
12	0.090	0.153	0.168	0.276	0.273	0.499	0.329	0.418	0.829	0.228	0.339
13	0.066	0.039	0.080	0.093	0.145	0.111	0.208	0.137	0.194	0.384	0.100
14	0.078	0.036	0.024	0.051	0.057	0.070	0.055	0.100	0.072	0.102	0.191

Table 3.3.15 (Continued)

Year/age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	175.580	87.482	130.763	104.636	173.493	136.831	76.146	152.412	167.068	85.317	161.210
4	205.192	137.149	68.756	101.809	78.590	128.172	97.572	57.045	117.337	131.945	68.074
5	160.068	129.745	88.125	43.812	61.623	46.666	76.612	62.651	38.355	81.768	93.334
6	31.826	77.722	100.559	45.163	20.477	27.879	22.008	42.737	37.313	23.725	50.938
7	12.637	11.819	33.074	42.537	16.470	7.068	10.284	10.598	22.926	20.305	12.801
8	8.908	4.113	4.363	12.276	14.342	5.334	2.375	4.267	4.887	10.696	9.246
9	1.883	2.408	1.371	1.510	3.875	4.272	1.549	0.902	1.866	2.140	4.472
10	0.779	0.519	0.882	0.530	0.529	1.286	1.243	0.616	0.422	0.859	0.905
11	0.345	0.246	0.205	0.361	0.199	0.191	0.408	0.502	0.283	0.189	0.352
12	0.293	0.118	0.106	0.091	0.145	0.078	0.064	0.176	0.245	0.135	0.083
13	0.137	0.103	0.051	0.047	0.037	0.058	0.027	0.027	0.085	0.116	0.059
14	0.046	0.054	0.050	0.025	0.021	0.016	0.022	0.013	0.015	0.044	0.055

Year/age	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	66.553	180.462	170.038	167.823	192.960	68.734	167.992	132.769	109.838
4	128.219	52.064	139.429	130.735	132.063	153.762	54.735	134.627	106.192
5	47.678	87.597	35.369	94.283	90.807	93.350	108.630	38.686	98.348
6	55.094	26.365	48.312	19.754	55.537	54.976	56.436	69.055	25.103
7	24.930	23.788	11.584	22.160	10.076	29.327	29.151	31.924	40.443
8	5.368	9.655	9.136	4.625	9.726	4.603	13.509	14.623	16.772
9	3.453	1.847	3.251	3.116	1.785	3.985	1.882	6.143	7.031
10	1.595	1.116	0.574	0.981	1.078	0.687	1.534	0.803	2.792
11	0.317	0.518	0.343	0.167	0.321	0.389	0.247	0.622	0.348
12	0.130	0.109	0.168	0.105	0.059	0.126	0.153	0.107	0.286
13	0.031	0.045	0.036	0.053	0.037	0.023	0.049	0.067	0.049
14	0.024	0.012	0.016	0.012	0.020	0.016	0.010	0.023	0.032

Table 3.3.16 Cod at Iceland. Division Va. Resulting SSB in 1955-2004 using final F from AD-CAM using catch at age and spring trawl survey indices an predicted for 2005-2007.

Year/age	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
3	1.7663	1.7744	1.9759	2.5474	3.3435	1.7850	2.2305	1.4894	2.0477	2.3531	2.4974
4	4.5025	3.4347	3.7754	4.6337	6.4833	6.8782	3.4022	4.1066	2.7473	4.0928	3.9709
5	11.4598	8.2603	6.6807	15.8146	12.7209	15.1361	15.2071	7.0594	8.6761	5.4449	6.6481
6	58.3346	38.0549	23.7070	91.5427	89.2498	104.4409	96.1835	75.1355	31.7730	53.9174	35.3756
7	72.7125	146.0349	161.0081	152.6781	100.1435	99.2372	98.8915	134.7926	146.9844	82.6733	88.8738
8	90.4271	79.9348	173.1575	198.7622	146.6177	81.7435	72.6026	80.0368	102.9932	123.0429	56.8986
9	59.4426	61.9275	64.7027	153.3266	229.4944	92.2202	46.8261	101.1967	46.7556	52.8646	57.5648
10	420.8665	43.9678	51.9290	49.6990	107.4344	200.9836	60.8876	29.1703	64.4781	28.5930	24.8253
11	65.3148	277.1684	30.7072	33.6638	27.6504	64.2528	10.9208	32.0505	15.9604	30.6107	12.4781
12	56.3370	40.8085	198.9962	18.3953	19.0938	18.5457	37.0766	66.1321	19.8871	9.3695	13.4638
13	66.3969	41.5285	27.0557	132.3080	12.4439	13.5246	10.6960	28.8859	46.4410	14.7914	4.2420
14	31.2100	50.2048	29.7204	20.5112	98.5987	10.2341	12.4188	9.0411	19.2984	43.6063	10.9645
Total	**938.771**	**793.099**	**773.416**	**873.883**	**853.274**	**708.982**	**467.343**	**569.097**	**508.042**	**451.360**	**317.803**

Year/age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	2.651	3.711	1.992	2.876	2.093	2.183	1.610	3.651	2.177	3.173	5.617
4	4.861	6.199	6.854	4.703	4.525	4.319	4.076	2.907	7.371	5.694	6.284
5	7.862	10.152	11.292	12.374	6.216	8.223	5.375	24.695	9.151	27.528	13.032
6	53.667	55.493	51.389	41.743	58.237	8.997	16.603	40.943	40.132	23.303	42.955
7	57.229	73.587	72.050	79.039	79.812	105.951	32.818	64.141	42.265	49.573	18.484
8	67.127	43.092	39.637	141.352	101.882	54.242	72.963	32.267	41.825	27.838	27.676
9	28.761	30.770	14.724	18.644	62.401	54.241	94.231	30.936	13.305	15.890	11.291
10	29.517	13.054	12.231	6.211	9.728	38.795	28.468	34.973	13.896	5.761	7.121
11	8.525	10.182	4.500	3.629	2.621	3.949	13.752	6.940	12.064	4.132	2.116
12	5.128	3.240	3.899	1.206	1.815	1.023	1.402	3.076	2.663	3.754	1.449
13	8.180	2.237	1.852	1.447	0.769	0.866	0.454	0.435	1.750	0.906	1.809
14	3.794	4.741	1.138	0.748	1.398	0.430	0.468	0.241	0.270	0.610	0.579
Total	**277.301**	**256.459**	**221.558**	**313.972**	**331.496**	**283.220**	**272.220**	**245.204**	**186.868**	**168.162**	**138.413**

Year/age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	1.666	3.472	2.838	2.223	1.637	1.697	2.715	1.613	0.000	0.239	0.289
4	9.272	3.750	5.344	5.459	2.904	3.128	3.623	5.532	2.882	3.577	12.154
5	15.485	21.829	8.283	12.011	6.705	4.778	5.994	7.300	34.711	25.570	12.631
6	48.125	40.871	100.154	30.846	16.148	10.998	10.492	18.532	36.250	66.403	32.986
7	78.956	65.472	101.003	169.904	35.979	30.949	25.150	25.168	25.544	40.364	43.597
8	21.263	49.855	42.966	79.935	137.089	28.273	28.817	34.921	25.558	23.355	22.069
9	11.947	12.456	28.523	24.604	35.546	55.648	11.923	18.342	16.396	12.938	8.811
10	5.544	8.632	6.861	20.964	13.752	17.298	26.703	7.972	13.931	11.521	5.805
11	3.000	3.286	5.247	4.991	9.655	6.771	7.743	14.110	4.421	5.697	5.272
12	0.917	1.408	1.777	3.545	2.383	4.889	3.165	4.122	8.823	2.462	2.442
13	0.907	0.625	0.915	1.143	1.348	1.434	2.434	1.610	2.412	4.187	1.143
14	1.480	0.639	0.413	0.806	0.800	0.870	0.745	1.284	1.056	1.145	1.732
Total	**198.562**	**212.295**	**304.323**	**356.431**	**263.946**	**166.733**	**129.503**	**140.509**	**171.985**	**197.457**	**148.931**

Table 3.3. 16 (Continued)

Year/age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	0.609	0.446	0.418	0.000	0.203	0.546	0.487	0.537	0.215	0.326	0.000
4	7.970	4.665	0.776	6.472	5.844	13.347	16.887	9.334	5.892	6.093	5.822
5	68.046	36.535	25.103	11.018	28.078	23.868	50.630	49.592	15.762	40.534	38.684
6	40.117	77.699	96.193	34.276	18.368	31.439	35.317	60.342	55.415	31.683	66.663
7	16.651	25.064	59.748	62.388	33.543	13.624	23.910	27.331	48.861	55.461	32.994
8	21.398	11.872	14.787	34.550	44.889	15.642	9.271	15.581	15.577	38.120	39.308
9	7.135	7.949	6.594	4.731	14.633	15.579	5.624	4.466	8.109	8.770	18.166
10	3.928	3.401	6.293	2.867	2.769	6.514	6.394	4.568	2.943	4.675	4.938
11	2.100	2.063	1.601	2.387	1.683	1.296	3.053	4.112	2.195	1.440	2.459
12	1.796	0.746	1.094	0.888	1.312	0.609	0.576	1.480	2.393	1.004	0.804
13	1.297	0.830	0.601	0.479	0.412	0.557	0.286	0.278	0.860	0.889	0.665
14	0.399	0.639	0.651	0.368	0.171	0.181	0.277	0.147	0.179	0.411	0.697
Total	**171.445**	**171.910**	**213.860**	**160.424**	**151.904**	**123.202**	**152.713**	**177.768**	**158.402**	**189.407**	**211.202**

Year/age	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	0.538	0.102	0.425	0.802	0.530	0.000	0.535	0.281	0.232
4	7.620	4.218	8.541	16.509	7.530	7.864	6.077	8.985	7.086
5	18.999	35.879	16.540	60.121	38.701	42.529	52.036	16.408	41.689
6	67.038	30.769	61.429	33.432	72.645	77.177	70.540	92.182	33.476
7	45.801	44.718	25.949	50.231	27.819	52.669	70.419	75.669	95.693
8	18.545	31.832	28.623	18.556	27.485	14.686	43.556	48.591	55.598
9	12.644	8.630	12.455	8.440	6.098	12.675	7.318	22.706	25.911
10	9.590	5.999	2.984	5.307	5.437	3.230	7.637	4.141	14.348
11	2.210	3.246	1.790	1.106	1.891	2.812	1.868	4.848	2.704
12	1.032	0.752	0.964	0.897	0.424	0.973	1.245	0.895	2.389
13	0.302	0.380	0.248	0.311	0.312	0.219	0.492	0.681	0.504
14	0.235	0.127	0.136	0.131	0.188	0.140	0.090	0.217	0.308
Total	**184.555**	**166.651**	**160.084**	**195.843**	**189.061**	**214.974**	**261.814**	**275.605**	**279.936**

Table 3.3.17. Cod at Iceland. Division Va. Resulting stock weight in 1955-2004 using final F from AD-CAM using catch at age and spring trawl survey indices and predicted for 2005-2007.

Year/age	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
3	125.730	165.101	194.568	266.996	320.833	163.703	196.727	127.689	222.009	246.869	220.779
4	284.546	191.341	203.393	233.209	314.223	371.713	190.939	231.463	155.846	223.540	225.386
5	457.407	329.256	205.646	245.113	241.101	305.140	378.429	195.096	242.490	153.853	201.061
6	417.615	442.223	306.925	229.194	214.983	235.738	275.923	345.340	175.487	217.797	134.529
7	167.074	334.008	388.603	299.231	171.731	170.556	171.850	229.747	284.642	151.311	167.350
8	138.847	122.713	262.288	306.858	218.733	123.771	111.050	121.409	160.954	200.898	94.206
9	85.778	91.617	94.434	233.629	342.045	142.574	72.051	159.361	76.599	93.158	102.519
10	538.263	55.563	65.601	64.441	138.015	267.912	80.490	39.563	92.246	44.239	39.129
11	80.192	352.450	38.422	43.745	34.890	84.734	143.044	42.943	22.606	47.909	19.951
12	68.657	50.369	245.199	23.257	23.398	23.443	46.055	83.276	26.062	13.169	19.342
13	81.521	51.213	32.818	162.485	14.601	16.183	12.532	34.041	55.950	18.716	5.463
14	38.319	61.913	36.050	25.189	115.691	12.246	14.551	10.655	23.250	55.176	14.121
4+	**2358.220**	**2082.665**	**1879.378**	**1866.352**	**1829.409**	**1754.008**	**1496.914**	**1492.895**	**1316.132**	**1219.767**	**1023.057**

Year/age	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
3	268.179	358.869	201.190	272.677	178.782	236.819	174.597	281.436	188.110	287.093	497.131
4	263.829	310.861	386.319	236.006	278.322	246.147	252.129	148.173	339.702	231.771	341.331
5	235.117	265.427	298.064	385.523	206.518	309.565	213.963	211.460	150.657	326.789	208.446
6	182.210	214.873	237.076	243.916	347.631	170.118	220.472	151.335	164.273	115.867	238.826
7	103.083	135.458	155.463	165.960	180.698	241.502	110.419	140.287	102.534	107.930	70.147
8	109.086	70.225	72.669	241.952	184.292	110.555	136.686	58.885	80.059	53.245	52.992
9	51.686	54.477	30.130	32.795	115.239	108.304	178.685	57.095	26.533	32.425	22.196
10	48.038	20.867	22.799	9.735	15.650	65.866	48.341	58.192	24.454	10.377	12.123
11	14.487	16.669	9.050	5.777	4.334	6.852	24.121	12.040	22.263	7.900	3.695
12	7.840	4.810	6.870	1.784	2.797	1.671	2.323	4.978	4.578	6.690	2.396
13	11.084	2.929	2.770	1.881	1.034	1.212	0.642	0.607	2.569	1.379	2.604
14	5.141	6.208	1.702	0.972	1.880	0.597	0.657	0.336	0.397	0.928	0.833
4+	**1031.599**	**1102.804**	**1222.914**	**1326.301**	**1338.394**	**1262.388**	**1188.437**	**843.386**	**918.016**	**895.302**	**955.589**

Year/age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
3	180.391	292.462	343.558	194.487	166.053	132.784	255.537	178.822	193.968	486.636	348.633
4	539.179	208.575	353.584	361.626	183.618	174.572	168.096	321.954	215.572	210.466	502.162
5	346.324	556.569	206.854	340.994	301.676	171.503	173.112	186.956	322.289	202.298	181.547
6	170.834	282.429	469.763	183.607	247.699	238.384	127.342	153.207	147.832	241.616	135.463
7	158.643	128.245	227.654	377.555	121.542	160.830	147.422	86.647	102.726	86.320	127.216
8	37.499	83.165	73.256	141.853	274.632	62.482	84.137	84.270	52.668	50.858	41.751
9	21.117	20.332	45.455	40.478	69.210	113.649	27.213	38.688	43.552	22.016	19.110
10	8.295	11.794	9.923	29.285	22.230	28.524	43.194	12.384	20.515	18.235	9.191
11	4.400	4.352	6.736	6.564	14.703	10.170	11.744	20.371	6.180	8.315	8.086
12	1.303	1.835	2.254	4.774	3.492	7.101	4.603	5.994	12.173	3.489	3.599
13	1.160	0.752	1.083	1.382	1.819	1.927	3.296	2.087	3.137	5.582	1.588
14	1.892	0.769	0.489	0.974	1.080	1.169	1.008	1.665	1.374	1.526	2.406
4+	**1290.646**	**1298.816**	**1397.050**	**1489.093**	**1241.701**	**970.313**	**791.166**	**914.224**	**928.017**	**850.722**	**1032.117**

Table 3.3.17 (Continued)

Year/age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
3	252.484	103.753	168.684	136.969	223.632	190.469	109.878	205.451	243.418	126.610	198.288
4	370.372	248.651	117.160	193.335	138.946	241.861	201.291	111.751	226.460	247.661	119.130
5	412.335	336.040	210.002	108.434	152.146	129.359	196.279	182.940	120.127	235.329	229.415
6	111.994	304.282	305.096	142.670	67.410	104.882	80.528	154.921	154.512	95.566	181.289
7	62.298	61.575	152.933	161.300	72.370	34.848	52.623	54.857	112.844	109.686	66.731
8	53.457	28.350	28.448	69.729	80.056	32.294	14.870	27.375	29.367	68.305	71.537
9	13.456	19.346	12.186	10.937	26.467	31.824	11.955	7.137	13.818	15.716	35.045
10	6.873	5.104	9.339	5.191	4.296	11.116	11.056	6.327	4.122	7.331	8.418
11	3.442	2.952	2.258	3.521	2.521	2.087	4.430	5.528	2.982	2.043	3.792
12	3.438	1.177	1.539	1.303	1.949	0.971	0.825	2.003	3.311	1.561	1.232
13	1.934	1.302	0.801	0.666	0.581	0.849	0.392	0.360	1.159	1.212	0.984
14	0.595	0.862	0.868	0.512	0.241	0.275	0.378	0.190	0.235	0.560	1.031
4+	**1040.194**	**1009.641**	**840.630**	**697.599**	**546.984**	**590.364**	**574.627**	**553.391**	**668.939**	**784.969**	**718.603**

Year/age	1999	2000	2001	2002	2003	2004	2005	2006	2007
3	82.592	236.044	254.887	217.163	242.358	86.193	211.577	166.492	137.737
4	220.024	92.778	285.829	251.796	235.865	272.005	94.772	238.155	187.854
5	115.667	204.102	93.692	250.415	219.570	216.292	252.472	89.635	227.873
6	189.688	85.738	164.890	72.695	194.546	181.532	186.225	228.018	82.890
7	117.669	111.565	55.209	104.594	44.928	124.993	124.098	136.060	172.370
8	34.100	56.909	59.455	29.457	48.998	24.808	72.685	78.802	90.386
9	30.148	14.427	24.448	24.334	10.683	23.409	11.023	36.084	41.298
10	15.864	10.269	5.201	8.834	8.463	5.081	11.329	5.939	20.641
11	3.511	5.302	3.007	1.746	2.826	4.195	2.659	6.709	3.752
12	1.627	1.218	1.604	1.408	0.634	1.451	1.769	1.237	3.311
13	0.461	0.599	0.404	0.474	0.451	0.317	0.682	0.920	0.682
14	0.358	0.201	0.221	0.200	0.272	0.202	0.125	0.293	0.418
4+	**729.117**	**583.107**	**693.960**	**745.953**	**767.236**	**854.285**	**757.839**	**821.853**	**831.475**

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), Harvest Ratio and total biomass ('000 tonnes).

Year	Landings	F5-10	SSB	Recruitment	Bio4+	SSB	Recruitment	Harvest Ratio
1955	538	0.29	939	221	2358	939	221	0.23
1956	481	0.29	793	289	2083	793	289	0.23
1957	452	0.31	773	154	1879	773	154	0.24
1958	509	0.35	874	193	1866	874	193	0.27
1959	453	0.32	853	129	1829	853	129	0.25
1960	465	0.37	709	178	1754	709	178	0.27
1961	375	0.35	467	204	1497	467	204	0.25
1962	387	0.38	569	216	1493	569	216	0.26
1963	410	0.46	508	229	1316	508	229	0.31
1964	434	0.55	451	320	1220	451	320	0.36
1965	394	0.58	318	172	1023	318	172	0.38
1966	357	0.59	277	248	1032	277	248	0.35
1967	345	0.56	256	181	1103	256	181	0.31
1968	381	0.72	222	189	1223	222	189	0.31
1969	406	0.56	314	139	1326	314	139	0.31
1970	471	0.61	331	273	1338	331	273	0.35
1971	453	0.69	283	179	1262	283	179	0.36
1972	399	0.69	272	261	1188	272	261	0.34
1973	383	0.70	245	368	843	245	368	0.45
1974	375	0.76	187	143	918	187	143	0.41
1975	371	0.81	168	227	895	168	227	0.41
1976	348	0.75	138	244	956	138	244	0.36
1977	340	0.59	199	140	1291	199	140	0.26
1978	330	0.48	212	141	1299	212	141	0.25
1979	368	0.45	304	132	1397	304	132	0.26
1980	434	0.49	356	233	1489	356	233	0.29
1981	469	0.66	264	139	1242	264	139	0.38
1982	388	0.73	167	138	970	167	138	0.40
1983	300	0.72	130	334	791	130	334	0.38
1984	284	0.64	141	265	914	141	265	0.31
1985	325	0.67	172	176	928	172	176	0.35
1986	369	0.78	197	87	851	197	87	0.43
1987	392	0.87	149	131	1032	149	131	0.38
1988	378	0.90	171	105	1040	171	105	0.36
1989	356	0.72	172	173	1010	172	173	0.35
1990	335	0.70	214	137	841	214	137	0.40
1991	309	0.81	160	76	698	160	76	0.44
1992	268	0.85	152	152	547	152	152	0.49
1993	252	0.88	123	167	590	123	167	0.43
1994	179	0.63	153	85	575	153	85	0.31
1995	169	0.51	178	161	553	178	161	0.31
1996	182	0.51	158	67	669	158	67	0.27
1997	203	0.55	189	180	785	189	180	0.26
1998	243	0.66	211	170	719	211	170	0.34
1999	260	0.75	185	168	729	185	168	0.36
2000	236	0.77	167	193	583	167	193	0.40
2001	235	0.76	160	69	694	160	69	0.34
2002	209	0.66	196	168	746	196	168	0.28
2003	202	0.60	189	133	767	189	133	0.26
2004	223	0.60	215	110	854	215	110	0.26
Mean	348	0.61	305	180	1100	305	180	0.33

Table 3.3.19. Short term prediction (Management option table)

Calculations were performed with the spreadsheet: codpr2005.xls
Input data:

Sexual maturity at spawning time:

age\year	2004	2005	2006	2007
3	0.00	0.01	0.00	0.00
4	0.04	0.11	0.06	0.06
5	0.25	0.28	0.25	0.25
6	0.55	0.50	0.52	0.52
7	0.63	0.79	0.76	0.76
8	0.84	0.81	0.82	0.82
9	0.82	0.95	0.88	0.88
10	0.99	0.99	0.99	0.99
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	2004	2005	2006	2007
3	0.59	0.557	0.557	0.557
4	1.453	1.119	1.119	1.119
5	2.099	1.897	1.897	1.897
6	3.057	2.963	2.963	2.963
7	3.757	3.874	3.874	3.874
8	5.389	5.389	5.389	5.389
9	5.874	5.874	5.874	5.874
10	7.394	7.394	7.394	7.394
11	10.78	10.78	10.780	10.780
12	11.563	11.563	11.563	11.563
13	13.814	13.814	13.814	13.814
14	12.954	12.954	12.954	12.954

Mean weights in the catch

age\year	2004	2005	2006	2007
3	1.254	1.254	1.254	1.254
4	1.769	1.769	1.769	1.769
5	2.317	2.317	2.317	2.317
6	3.302	3.302	3.302	3.302
7	4.262	4.262	4.262	4.262
8	5.389	5.389	5.389	5.389
9	5.874	5.874	5.874	5.874
10	7.394	7.394	7.394	7.394
11	10.780	10.780	10.780	10.780
12	11.563	11.563	11.563	11.563
13	13.814	13.814	13.814	13.814
14	12.955	12.955	12.955	12.955

Table 3.3.19 (Continued)

Selection pattern from a AD-CAM:

age\year	1999	2000	2001	2002	2003	2004	02-04	Used
3	0.061	0.075	0.082	0.060	0.045	0.046	0.051	0.051
4	0.241	0.243	0.250	0.249	0.246	0.247	0.247	0.247
5	0.523	0.514	0.500	0.499	0.505	0.507	0.504	0.504
6	0.853	0.810	0.758	0.717	0.733	0.727	0.725	0.725
7	0.998	0.985	0.940	0.945	0.975	0.962	0.960	0.960
8	1.155	1.156	1.145	1.140	1.157	1.162	1.153	1.153
9	1.239	1.260	1.306	1.306	1.261	1.263	1.278	1.278
10	1.233	1.275	1.351	1.393	1.369	1.378	1.380	1.380
11	1.154	1.202	1.286	1.291	1.233	1.228	1.252	1.195
12	1.131	1.180	1.258	1.274	1.230	1.227	1.245	1.195
13	1.042	1.106	1.198	1.186	1.118	1.114	1.141	1.195
14	1.042	1.106	1.198	1.186	1.118	1.114	1.141	1.195
Ave(5-10)	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Natural Mortality

age\year	2004	2005	2006	2007	2008
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	2005	2006	2007	2008	F	M
3	167.992	133.00	110.00	153.00	0.085	0.250
4	54.735				0.180	0.250
5	108.630				0.248	0.250
6	56.436				0.296	0.250
7	29.151				0.382	0.250
8	13.509				0.437	0.250
9	1.882				0.477	0.250
10	1.534				0.477	0.250
11	0.247				0.477	0.250
12	0.153				0.477	0.250
13	0.049				0.477	0.250
14	0.010				0.477	0.250

Table 3.3.19 (Continued)

Prognosis - Summary

Catch, '000 tonnes

	2001	2002	2003	2004	2005	2006	2007	2008
Opt1	235	209	202	223	205	170	170	170
Opt2	235	209	202	223	205	198	207	205
Opt3	235	209	202	223	205	180	180	180
Opt4	235	209	202	223	205	200	200	200
Opt5	235	209	202	223	205	220	220	220

Average fishing mortality of 5-10 years old

	2001	2002	2003	2004	2005	2006	2007	2008
Opt1	0.76	0.66	0.60	0.60	0.508	0.385	0.348	0.319
Opt2	0.76	0.66	0.60	0.60	0.508	0.460	0.465	0.456
Opt3	0.76	0.66	0.60	0.60	0.508	0.412	0.380	0.354
Opt4	0.76	0.66	0.60	0.60	0.508	0.467	0.449	0.437
Opt5	0.76	0.66	0.60	0.60	0.508	0.524	0.527	0.540

Fishable stock, 4+ in '000 tonnes at the beginnig of the year

	2001	2002	2003	2004	2005	2006	2007	2008
Opt1	694	746	767	854	760	823	864	886
Opt2	694	746	767	854	760	823	833	811
Opt3	694	746	767	854	760	823	853	863
Opt4	694	746	767	854	760	823	830	816
Opt5	694	746	767	854	760	823	808	769

Spawning stock in '000 at the time of spawning

	2001	2002	2003	2004	2005	2006	2007	2008
Opt1	160	196	189	215	262	283	310	347
Opt2	160	196	189	215	262	276	281	289
Opt3	160	196	189	215	262	281	301	329
Opt4	160	196	189	215	262	276	281	294
Opt5	160	196	189	215	262	270	262	259

Prognosis - Summary table (nwwg2005)

2005				2006				2007				2008			
TAC	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*	*TAC*	*4+ stofn 4+ stock*	*Hr. stofn Sp. stock*	*F (5-10)*
205	760	262	0.508	170	823	283	0.385	170	864	310	0.348	170	886	347	0.319
				198	823	276	0.460	207	833	281	0.465	205	811	289	0.456
				180	823	281	0.412	180	853	301	0.380	180	863	329	0.354
				200	823	276	0.467	200	830	281	0.449	200	816	294	0.437
				220	823	270	0.524	220	808	262	0.527	220	769	259	0.540

The shaded option corresponds to the harvest control rule.

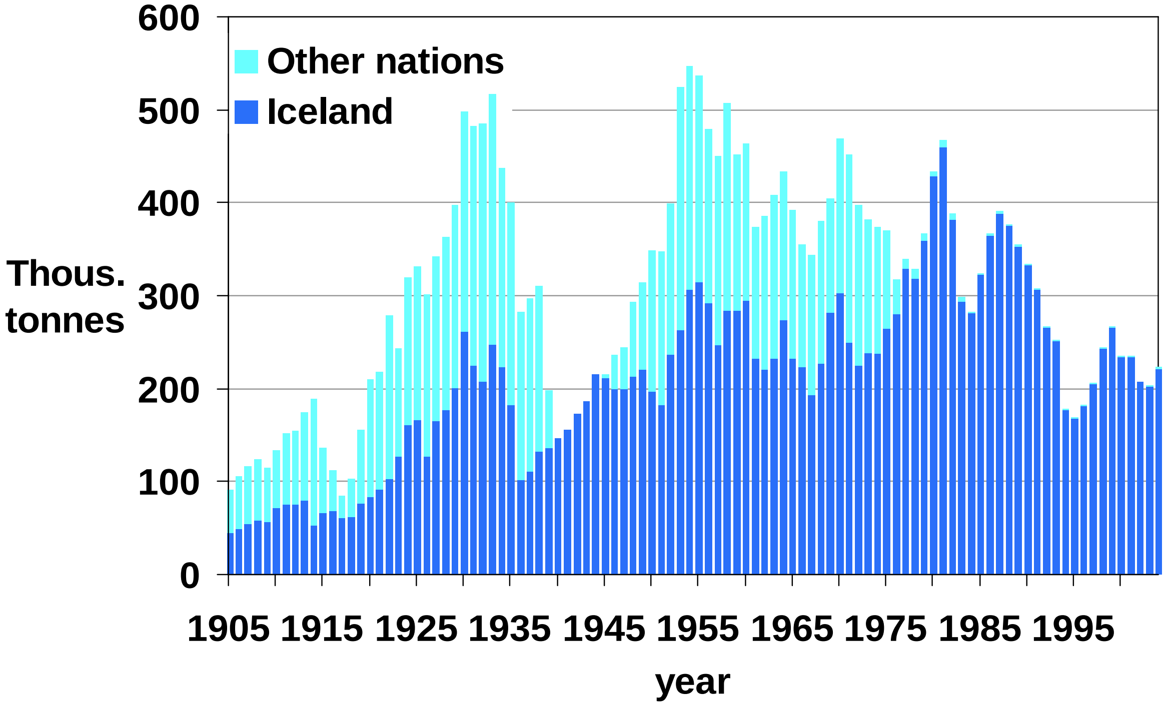


Figure 3.3.1 Cod at Iceland Division Va. Landings since 1905.

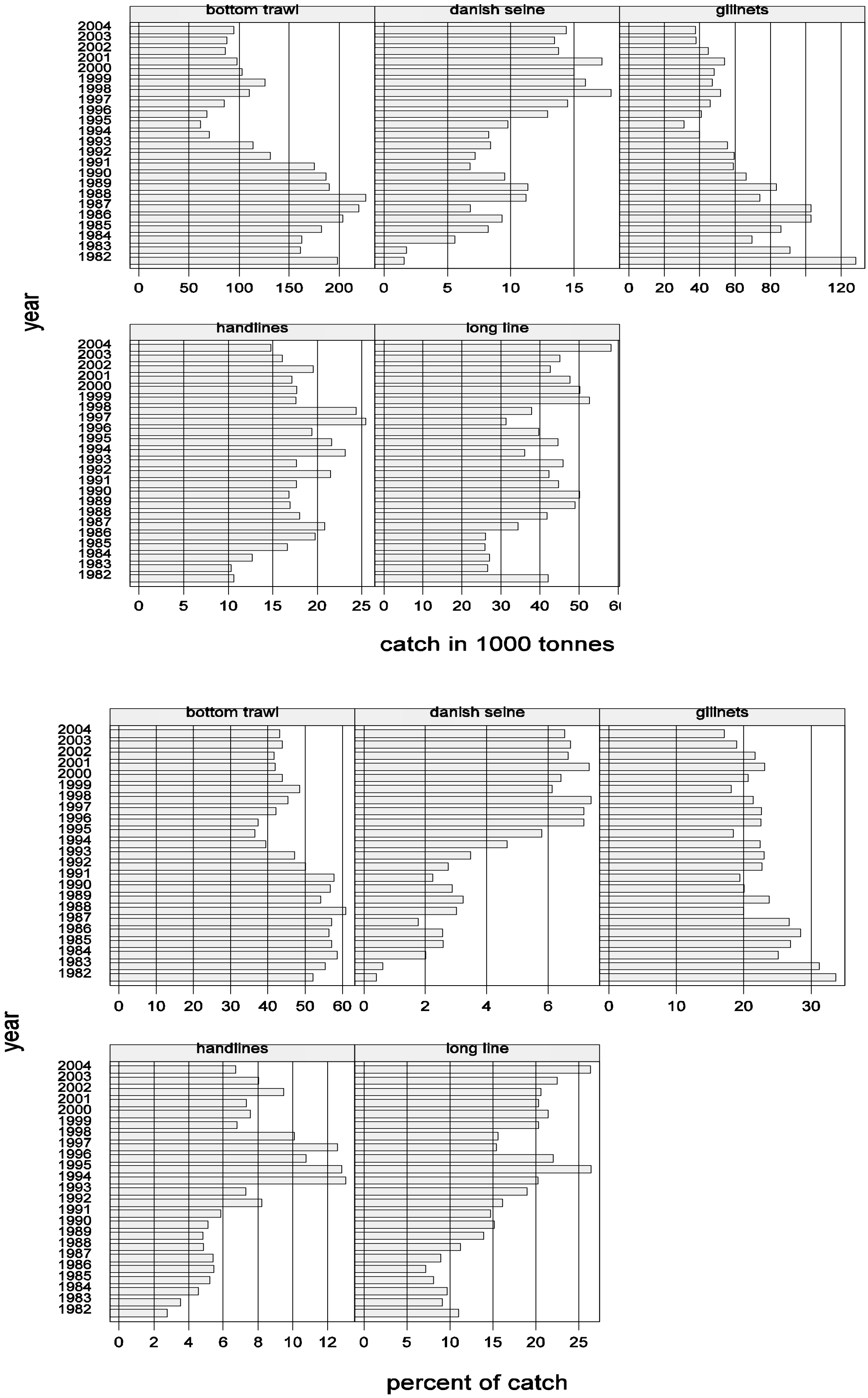


Figure 3.3.2 Landings by gear and year. Upper pictures in tonnes and lower in percentages.

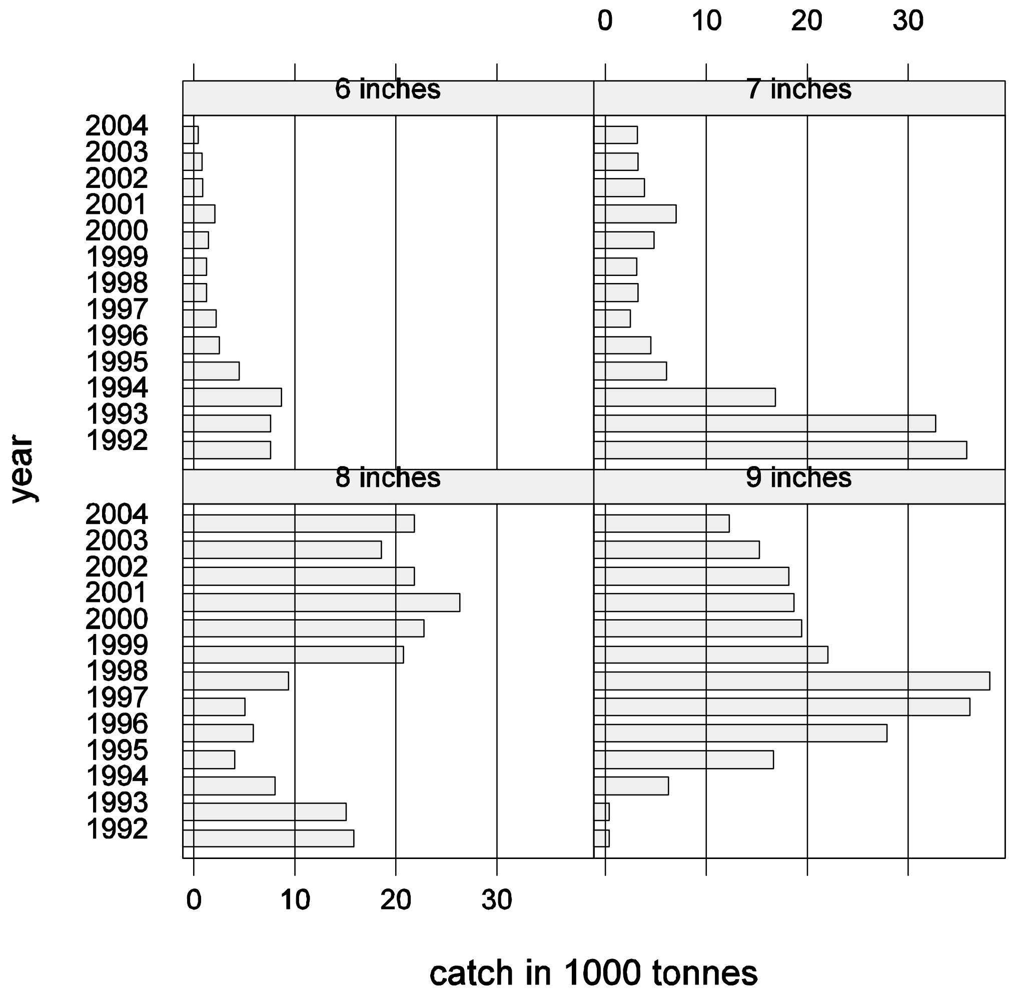


Figure 3.3.3.. Cod in division Va. Gillnet landings by mesh size and year.

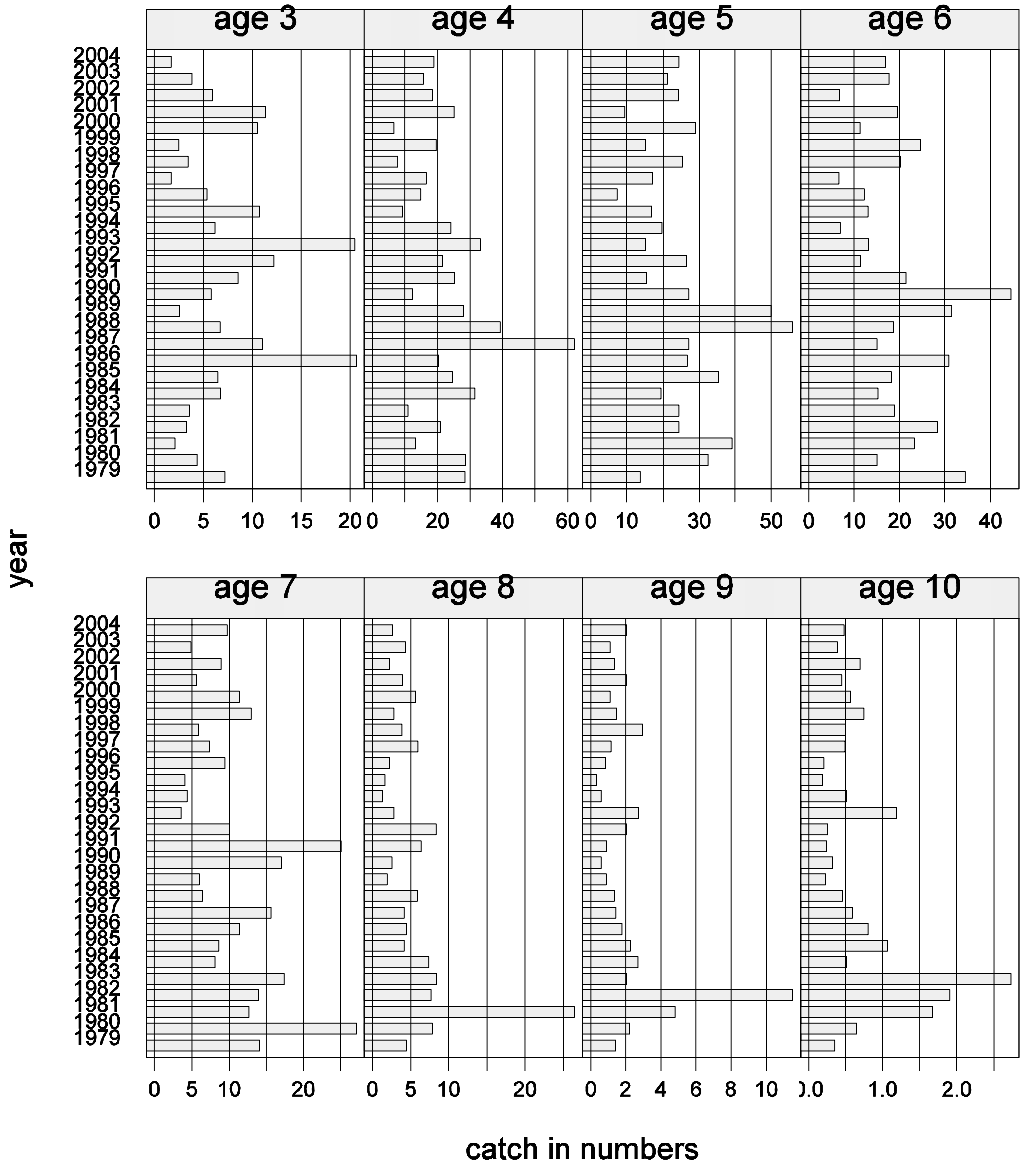


Figure 3.3.4 . Cod in division Va. Catch in numbers by year and age.

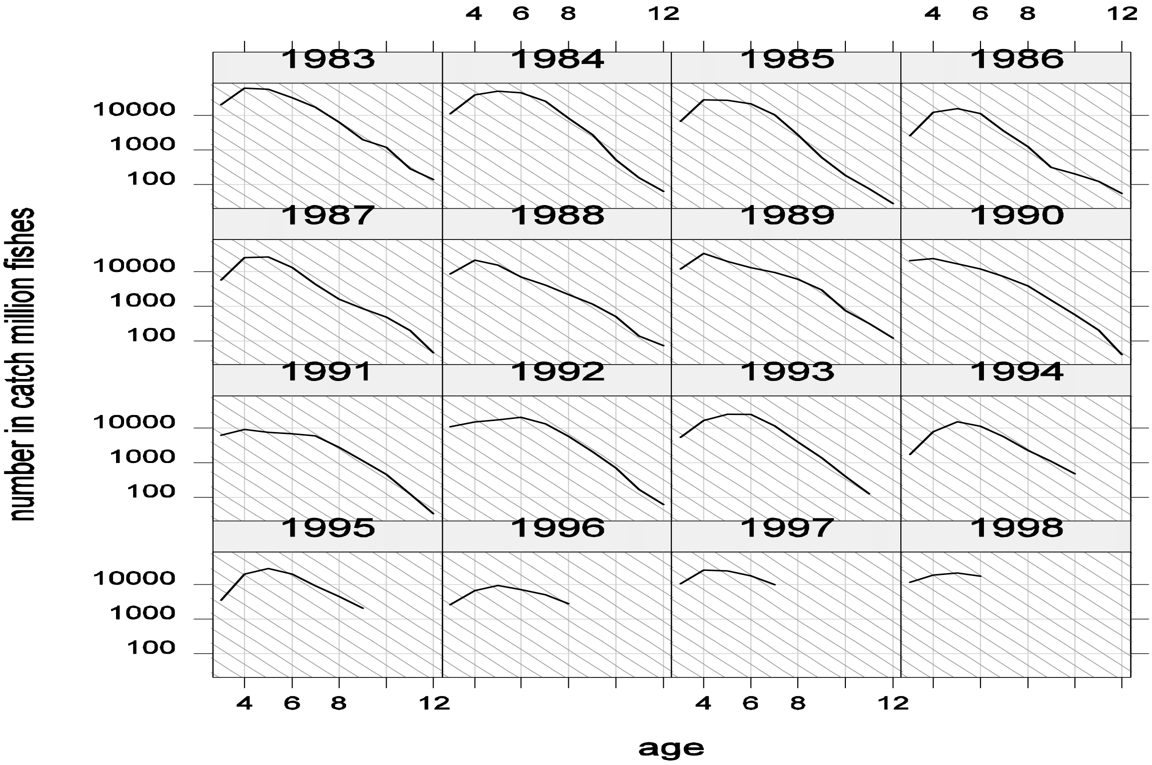


Figure 3.3.5. Icelandic cod. Catch curves. Grey lines show Z = 1.

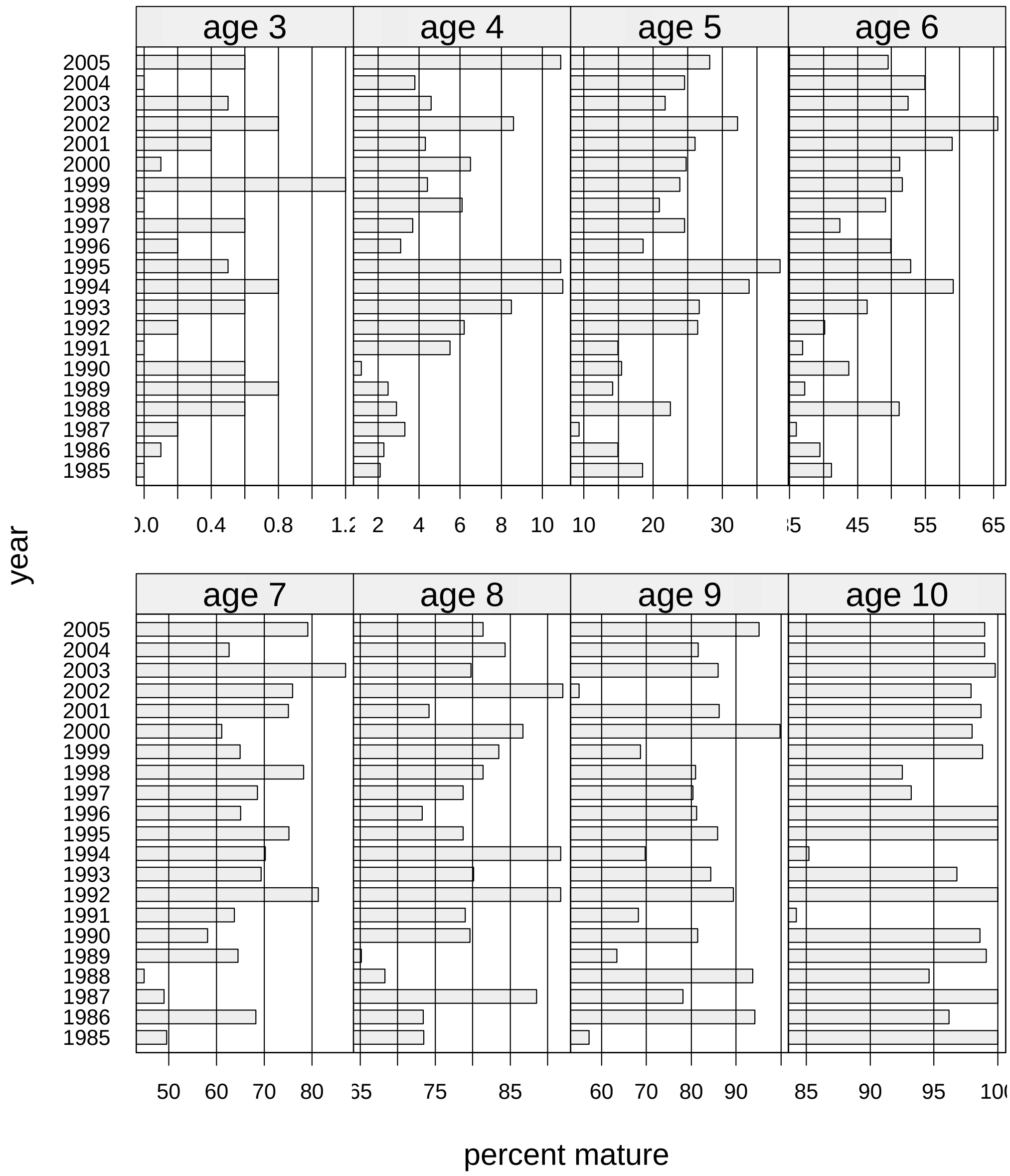


Figure 3.3.6. Cod. Sexual maturity at age in the spring survey.

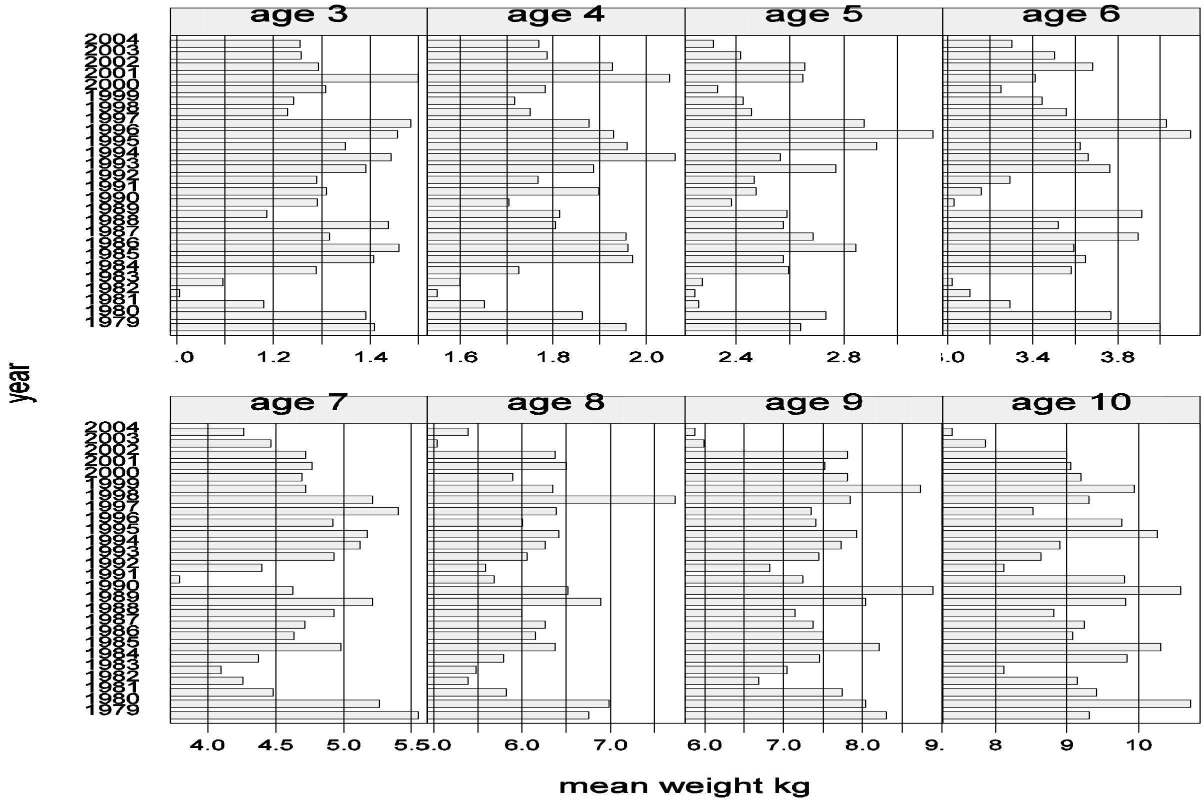


Figure 3.3.7 Cod in division Va. Mean weight at age in the catches.

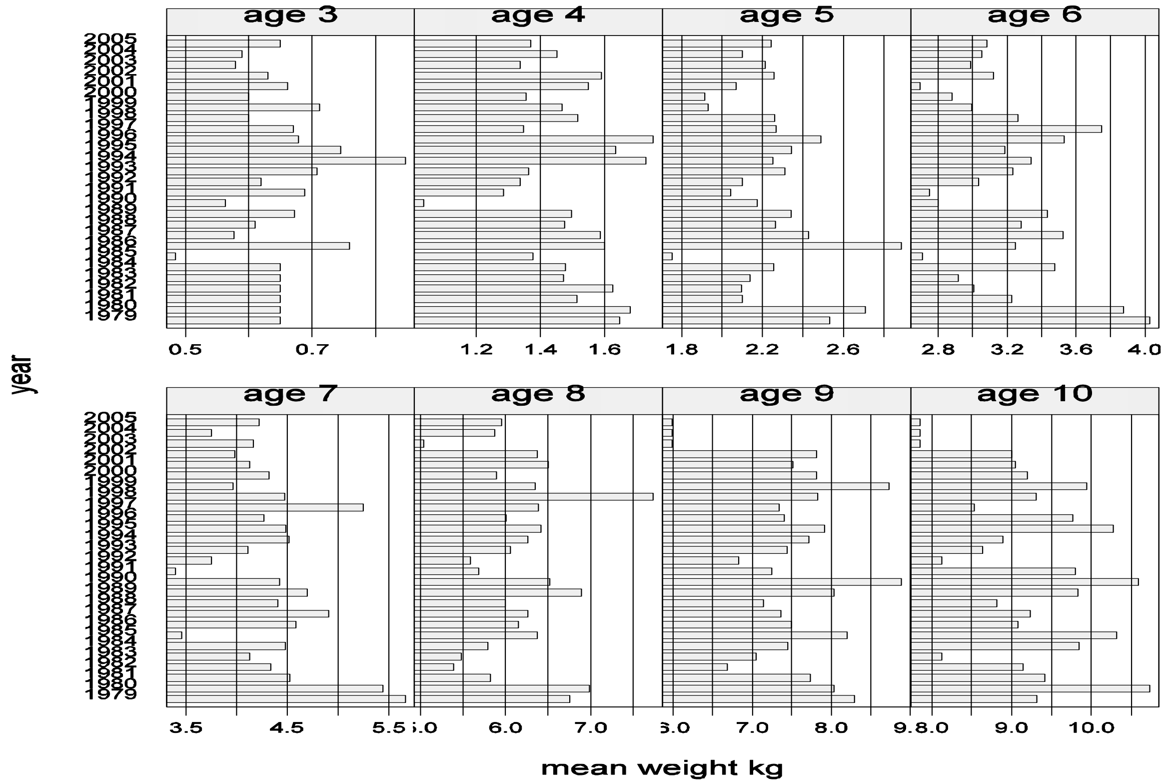


Figure 3.3.8 Cod in division Va. Mean weight at age in the SSB.

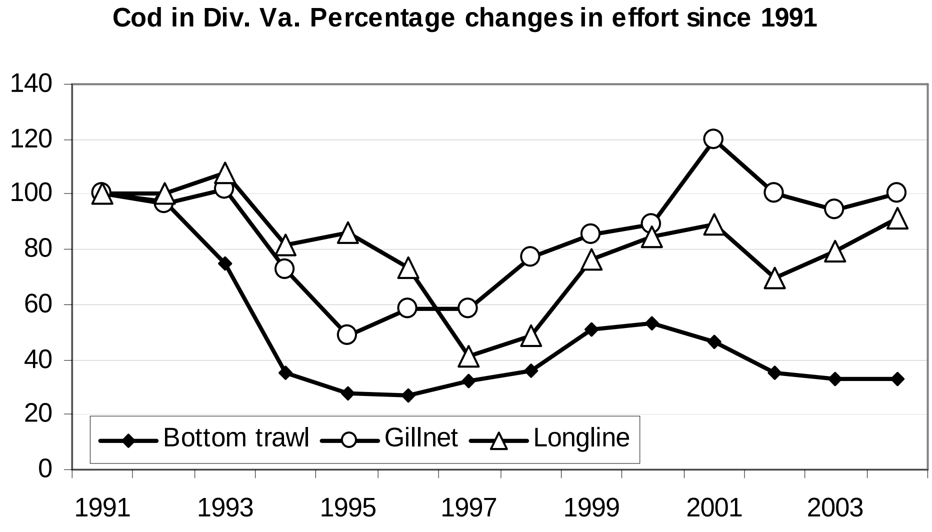


Figure 3.3.9.A. Cod at Iceland Division Va. Percentages changes in effort for the main geras since 1991.

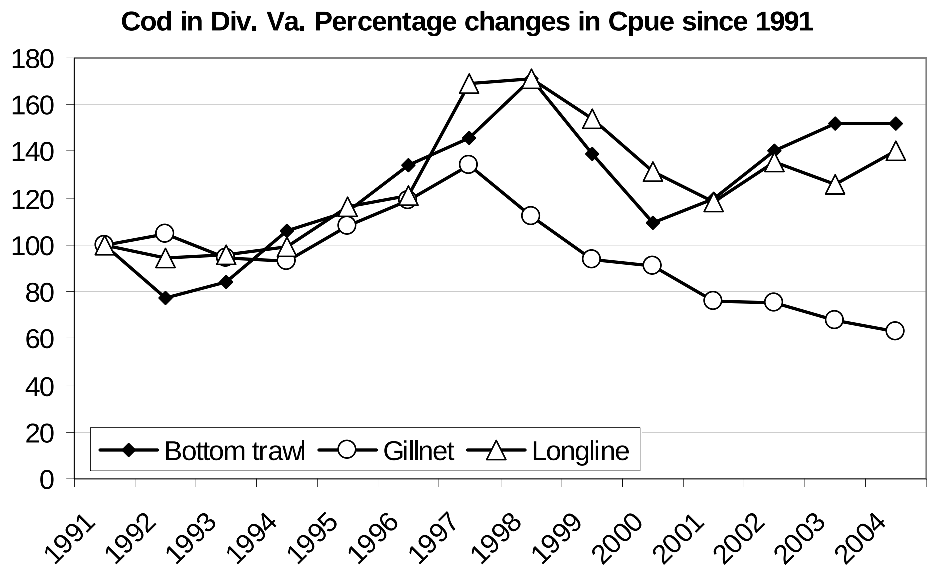


Figure 3.3.9.B. Cod at Iceland Division Va. Percentages changes in cpue for the main gears since 1991.

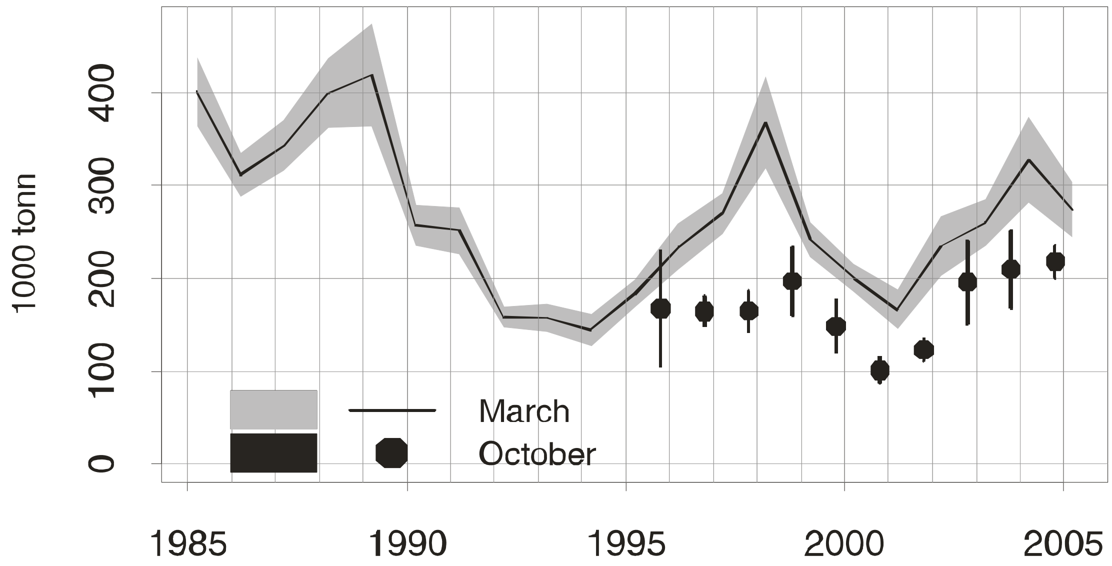


Figure 3.3.10. Cod in division Va. Total biomass index from the spring groundfish survey 1985-2005 and from the autumn survey 1996-2004.

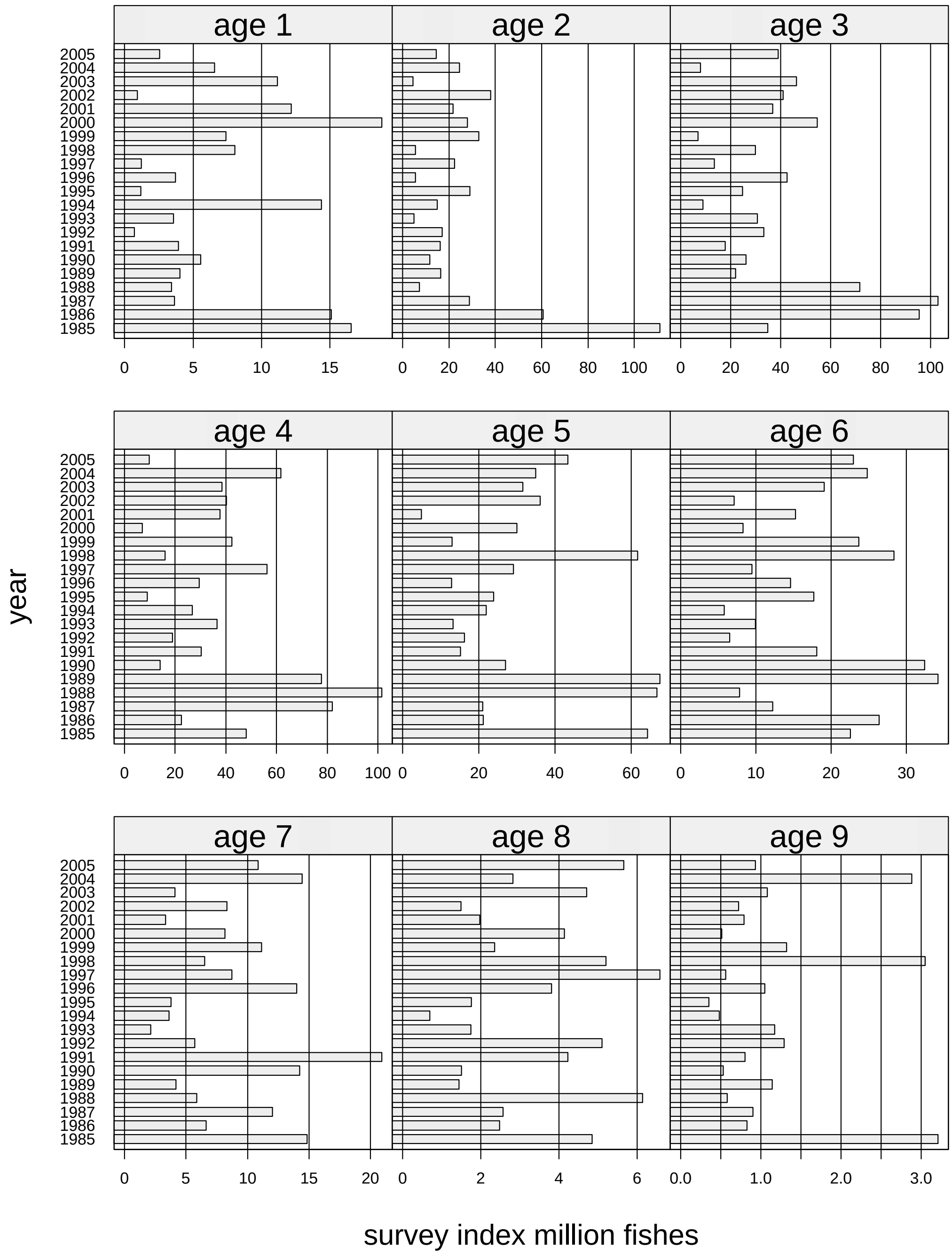


Figure 3.3.11. Cod in division Va. Survey indices from the March survey. Numbers by year and age.

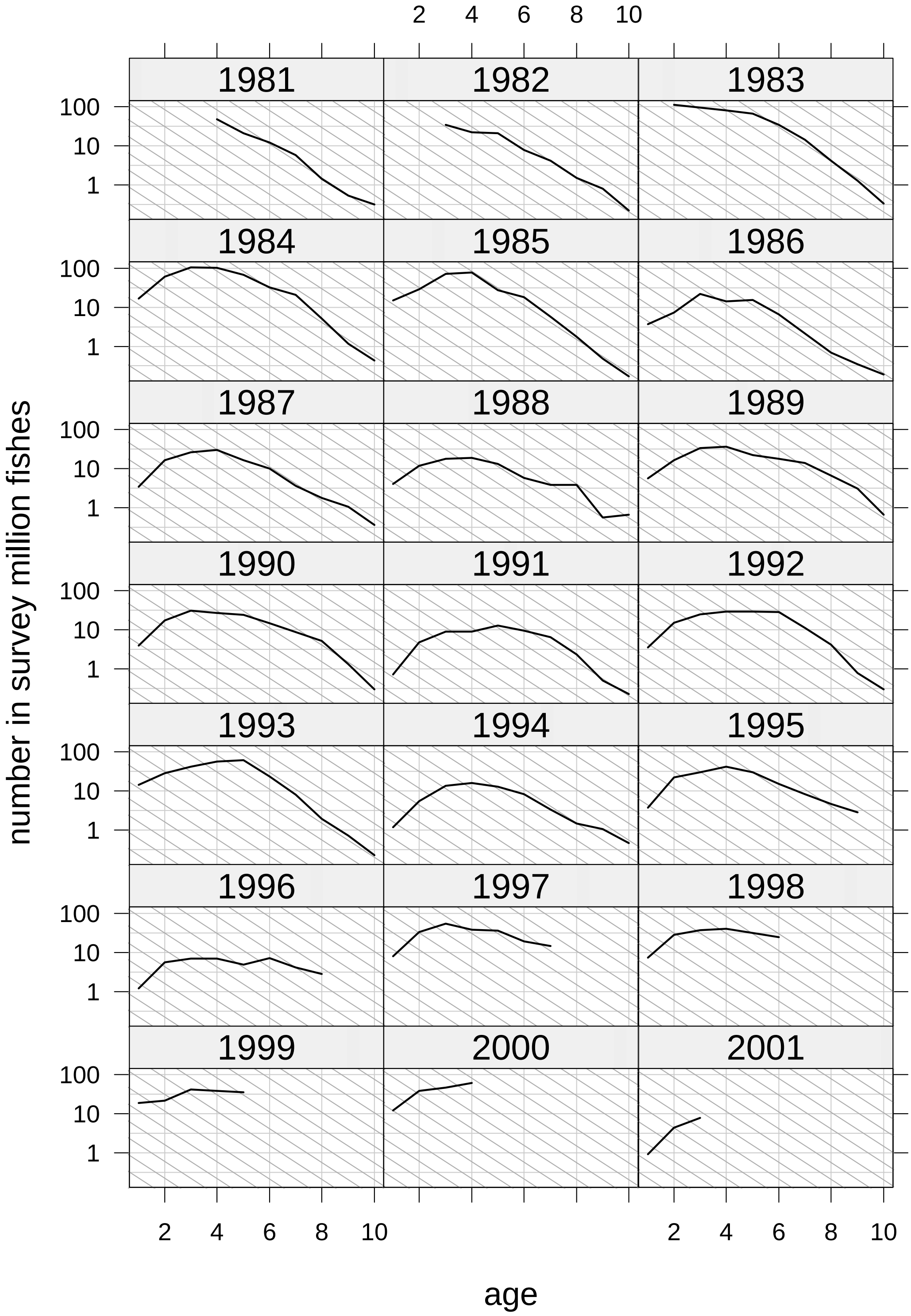


Figure 3.3.12. Cod in division Va. Catchcurves from the survey. The grey lines show Z=1

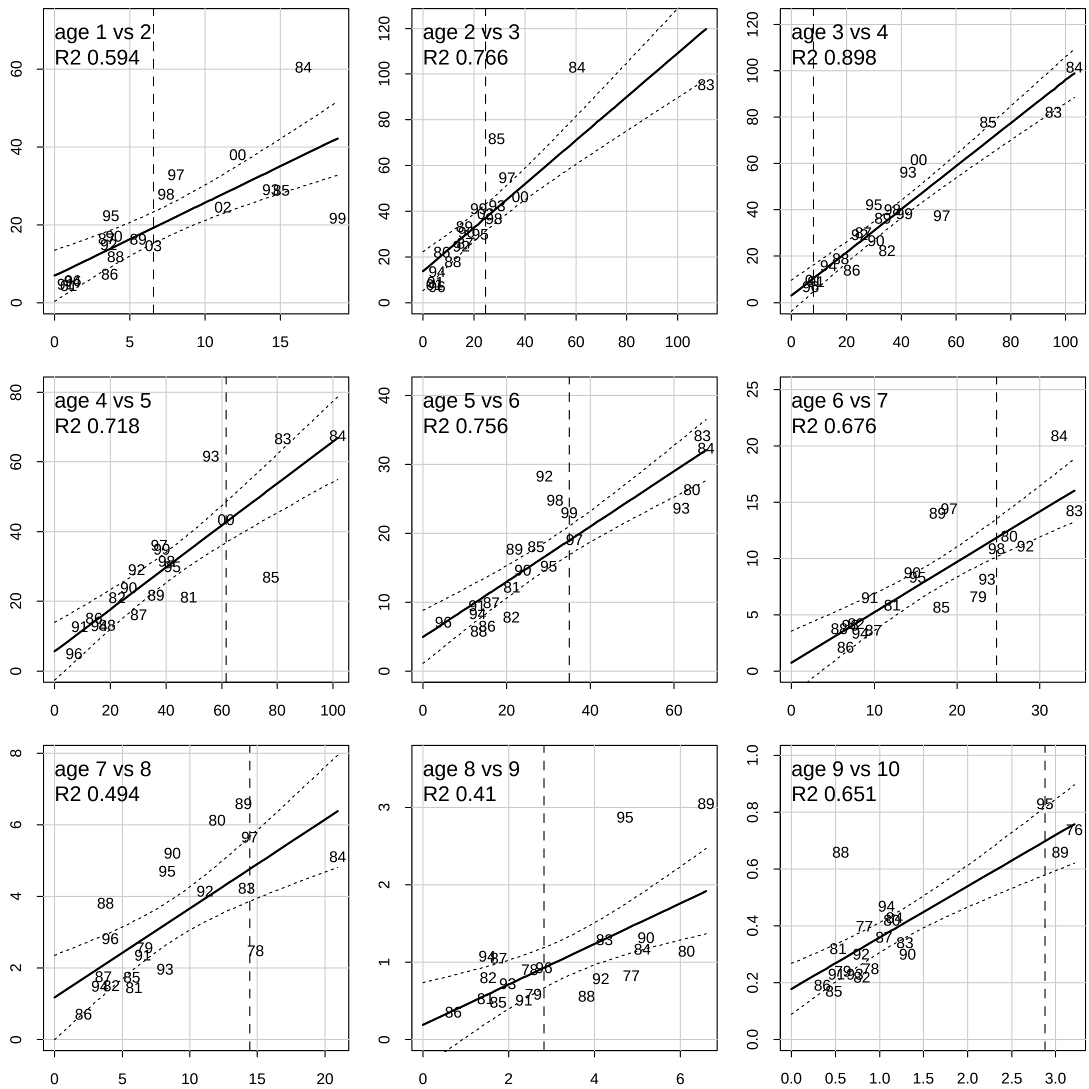


Figure 3.3.13. Cod in division Va. Indices from the groundfish survey vs. index of the same year class in survey a year later.

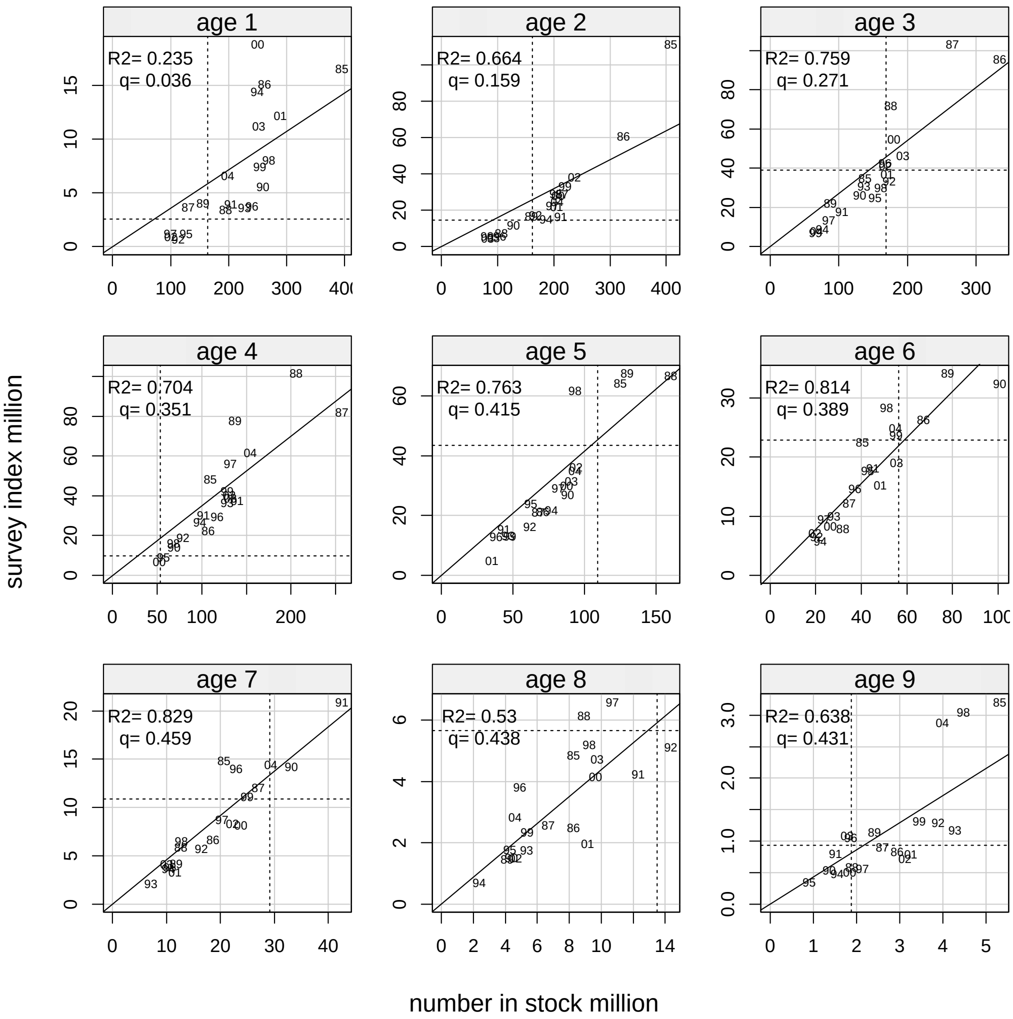


Figure 3.3.14. Cod in division Va. Survey indices vs. number in stock. Line fitted on original scale using 1985-2002 data.

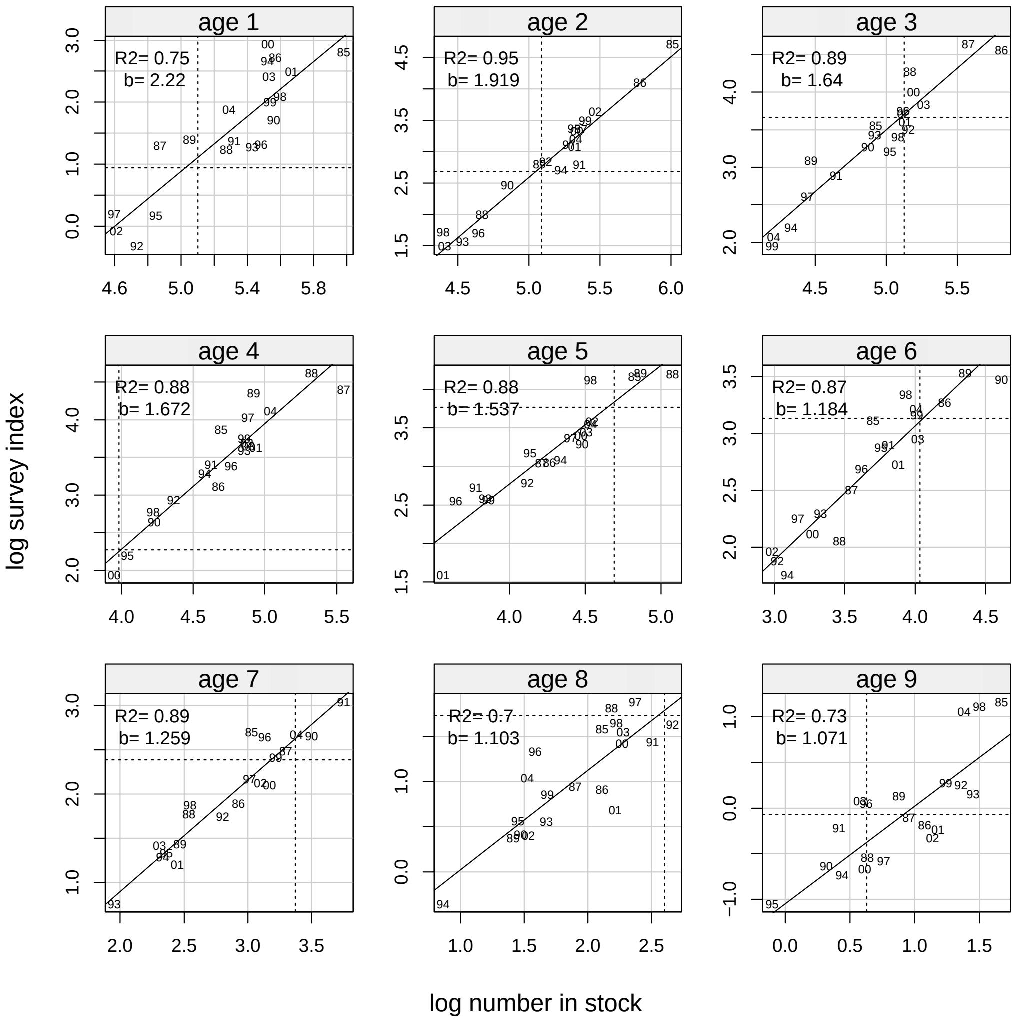


Figure 3.3.15. Cod in division Va. Survey indices vs. number in stock. Line fitted on logscale (power curve) using 1985-2002 data.

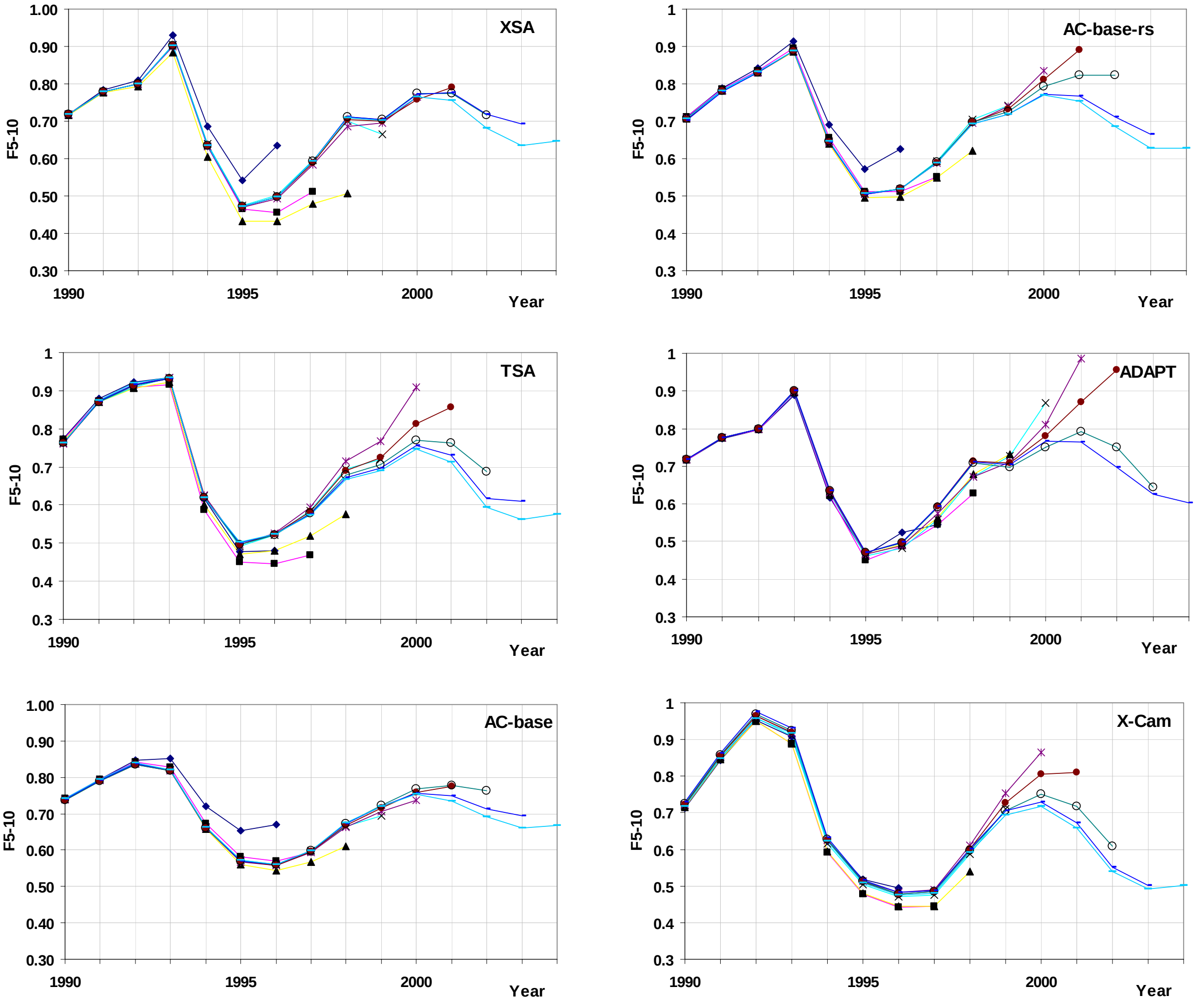


Figure 3.3.16. Retrospective pattern from assessment runs. The figures show mean fishing mortality of ages 5 to 10.

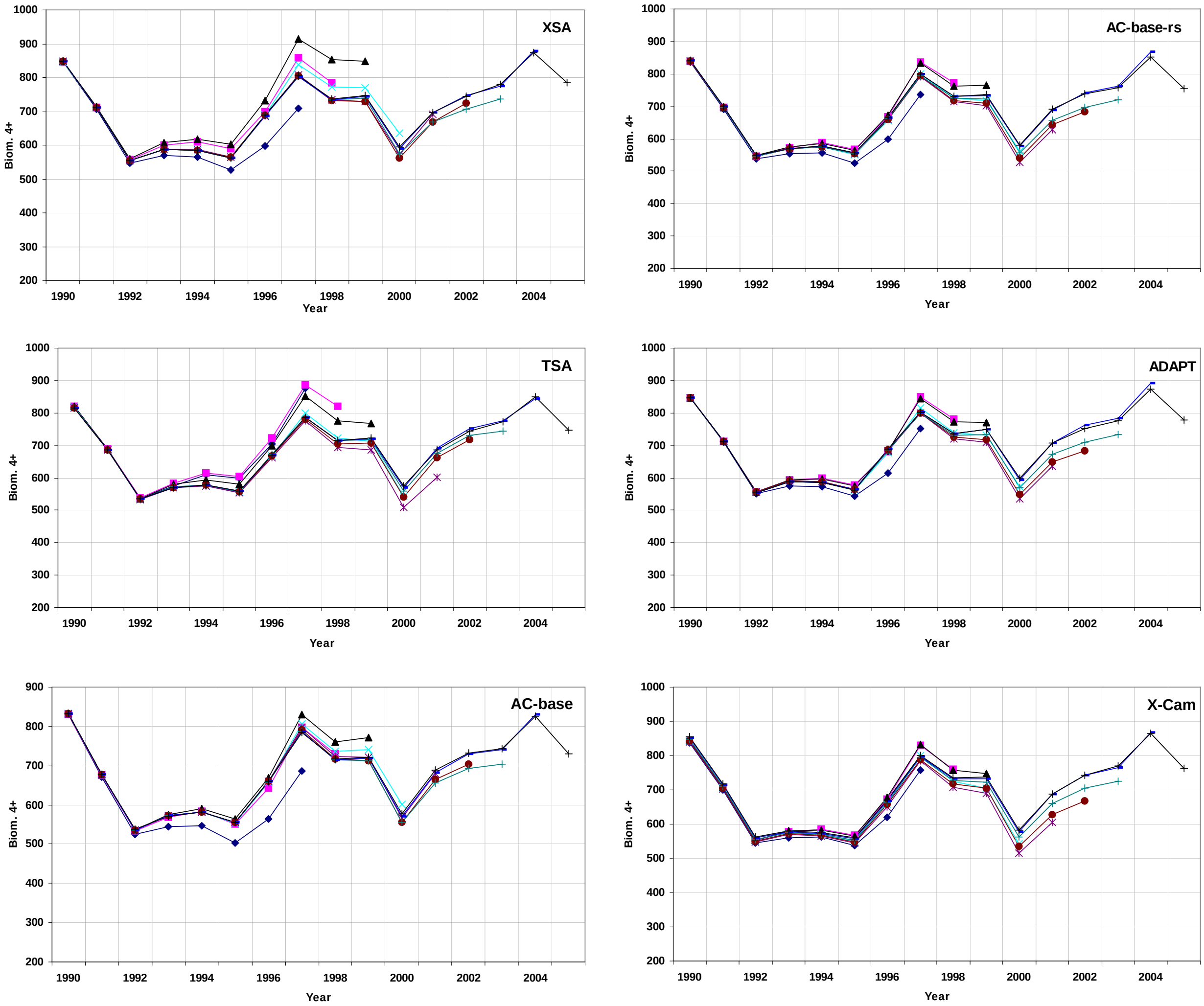


Figure 3.3.17. Retrospective patterns from assessment runs. The figures show number of age 4 and older multiplied by the weight in the catches.

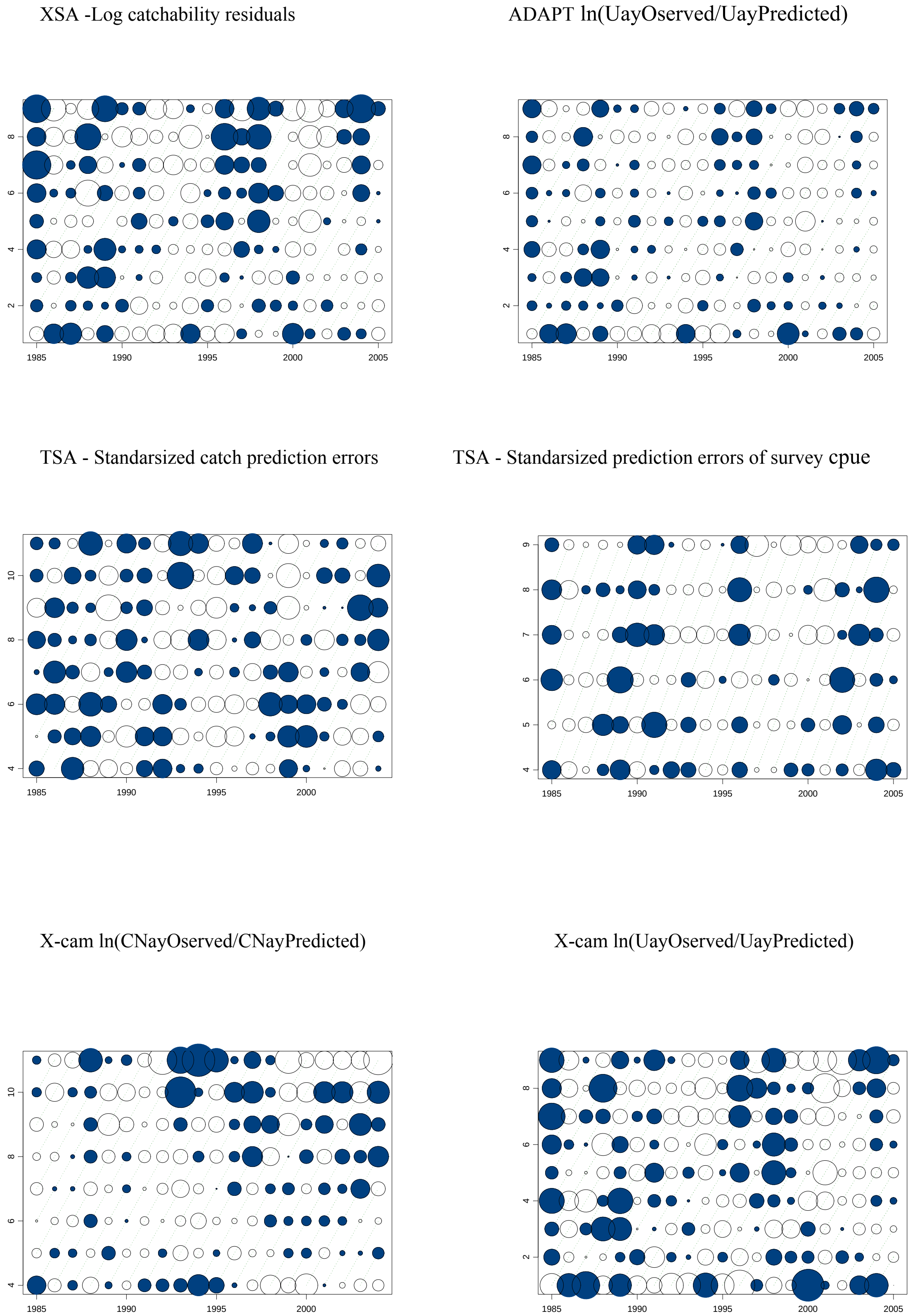
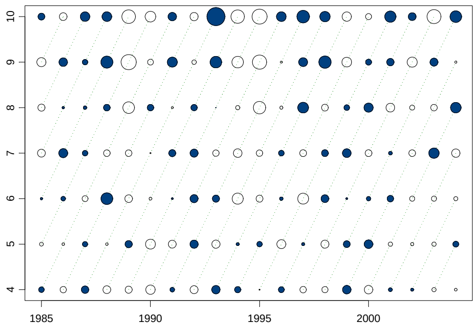
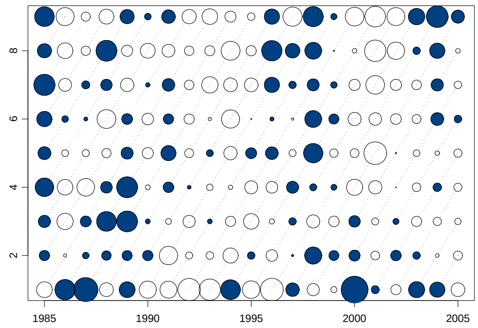


Figure 3.3.18. Residuals by year and age group from the various models. Solid symbols indicate positive values, open symbols indicate negative values. Bubble area is proportional to magnitude.

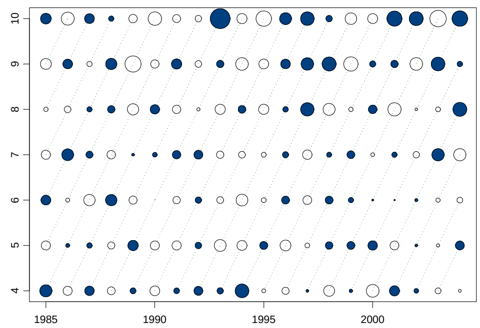
AC-base ln(CNayOserved/CNayPredicted)



AC-base ln(UayOserved/UayPredicted)



AC-base.rs. ln(CNayOserved/CNayPredicted)



AC-base.rs. ln(UayOserved/UayPredicted)

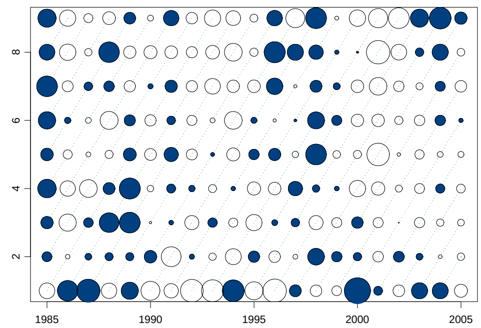


Figure 3.3.18 (Continued)

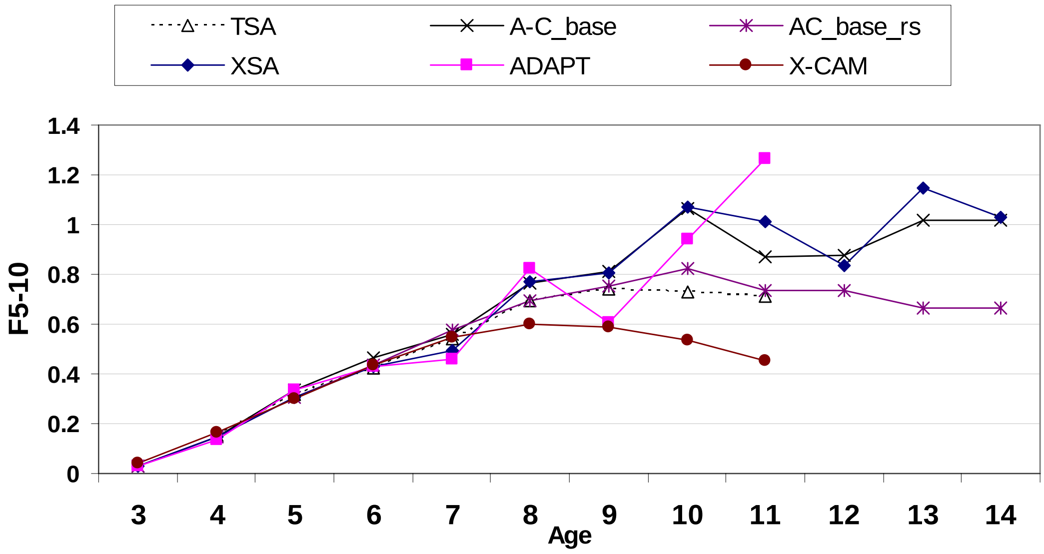


Figure 3.3.19. Comparison of estimated fishing mortalities in 2004 from different assessment runs.

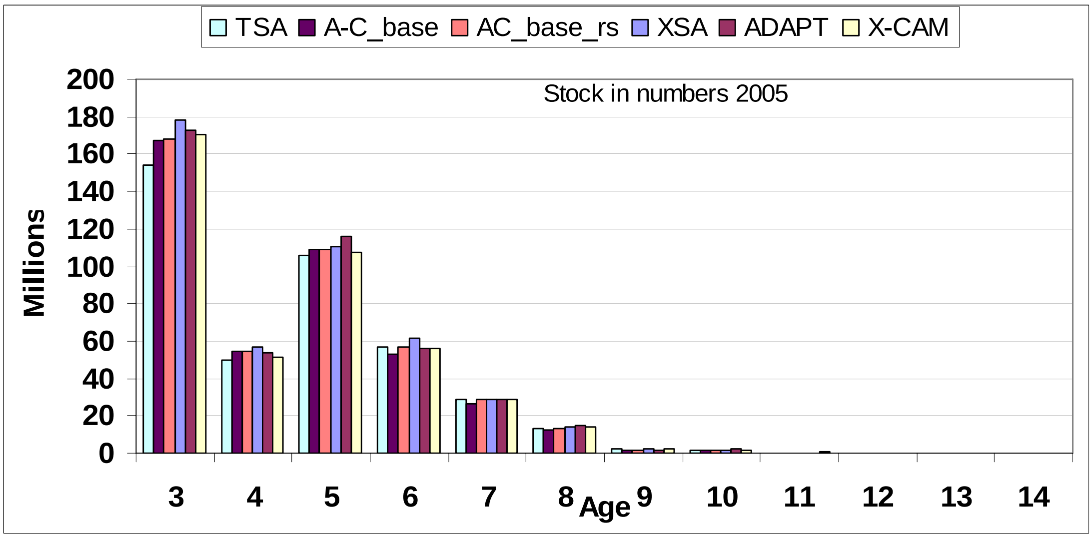


Figure 3.3.20. Comparison of estimated stock in numbers in 2005 from different assessment runs.

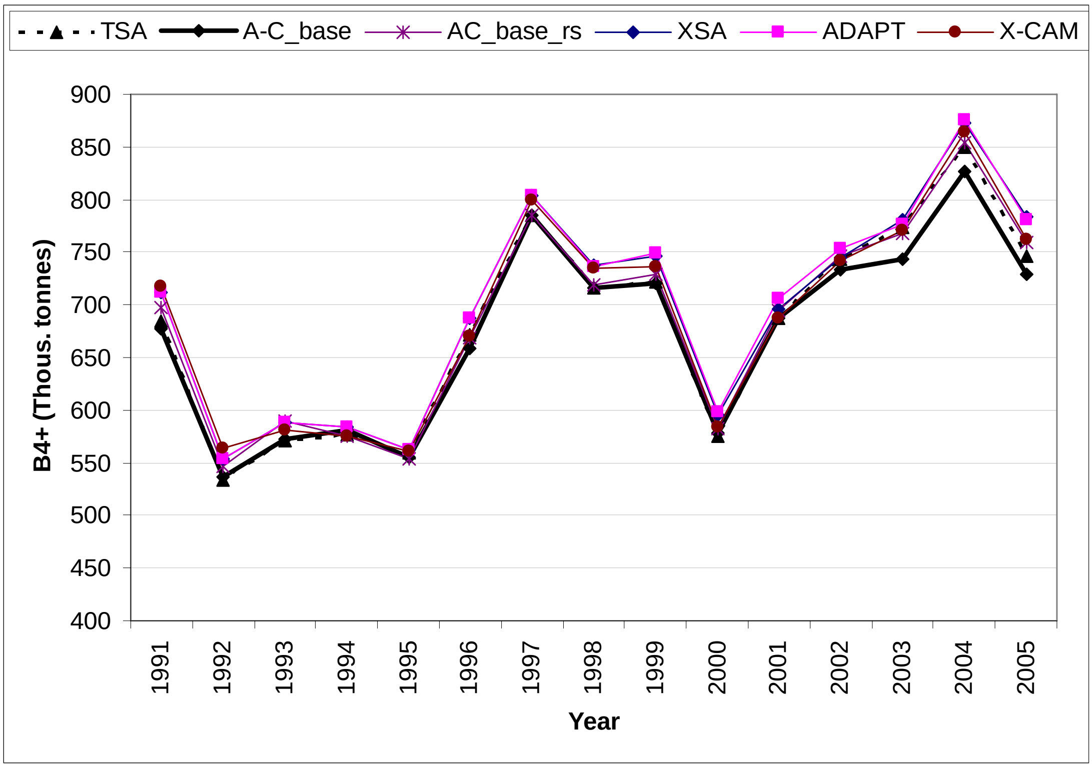


Figure 3.3.21. Estimated 4+ biomass from the various assessment models.

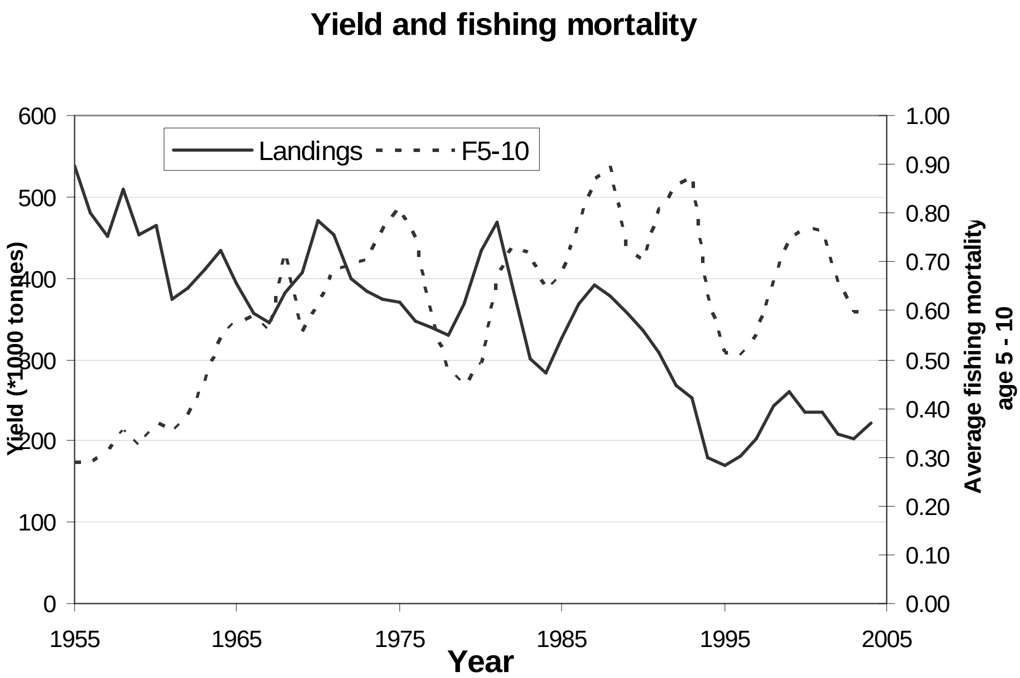


Figure 3.3.22A. Yield and fishing mortality

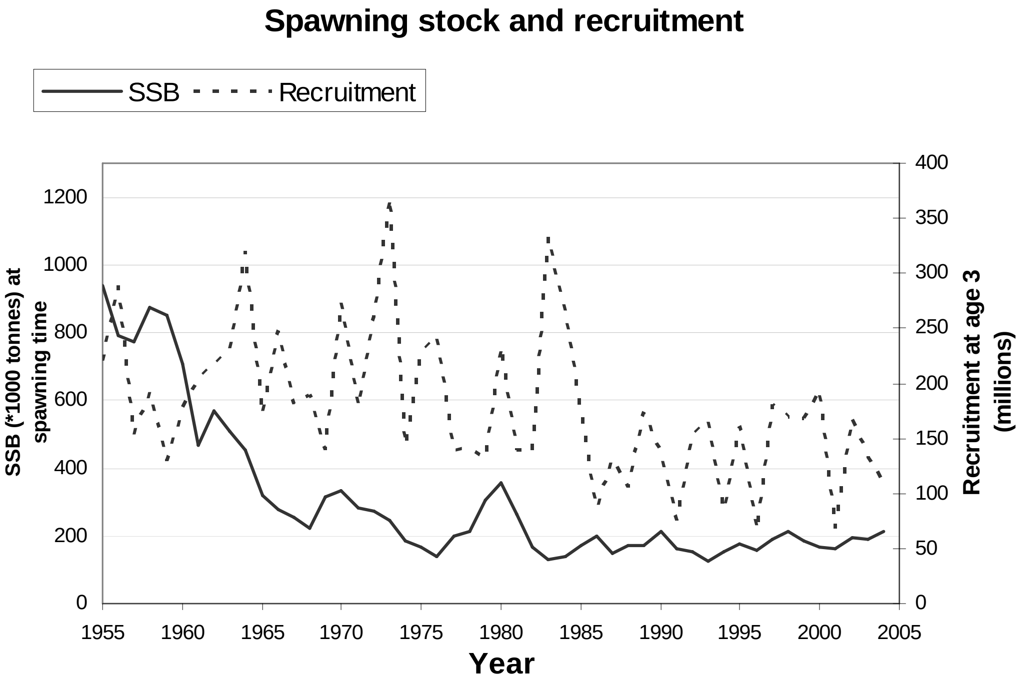


Figure 3.3.22B. Spawning stock and recruitment.

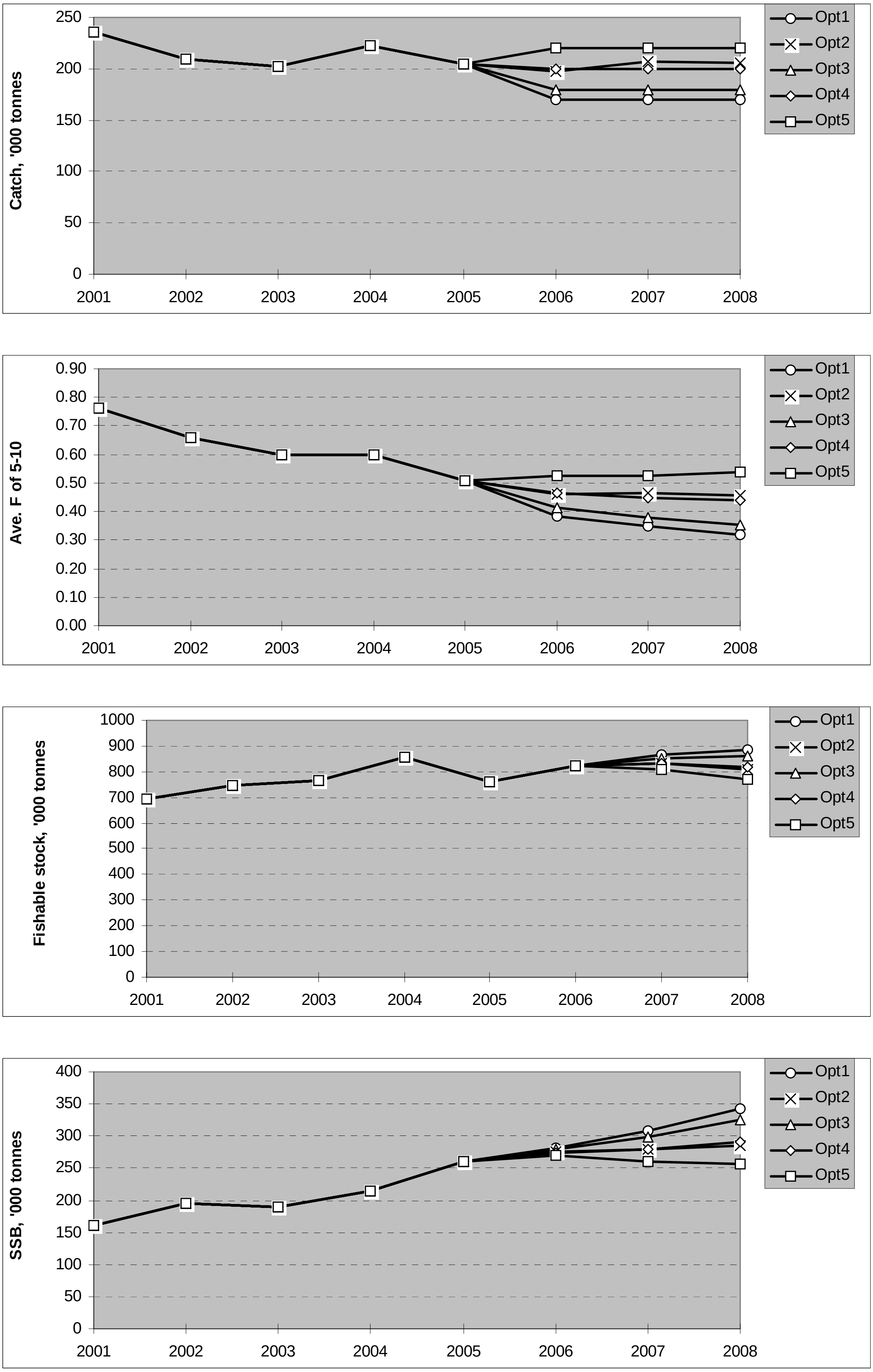
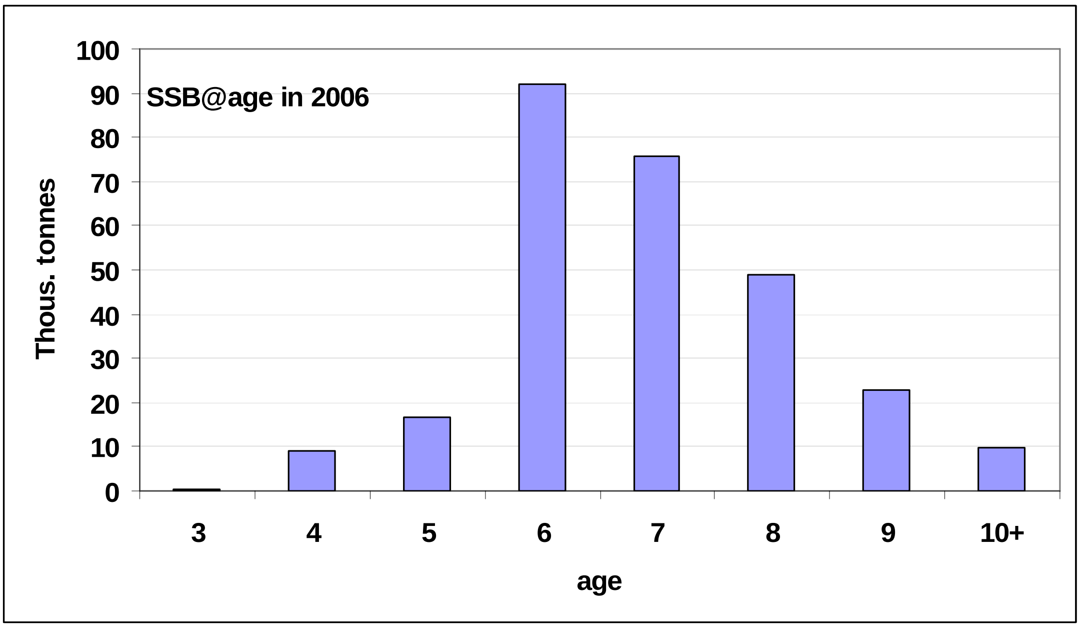


Figure 3.3.23A. Results of different management options.



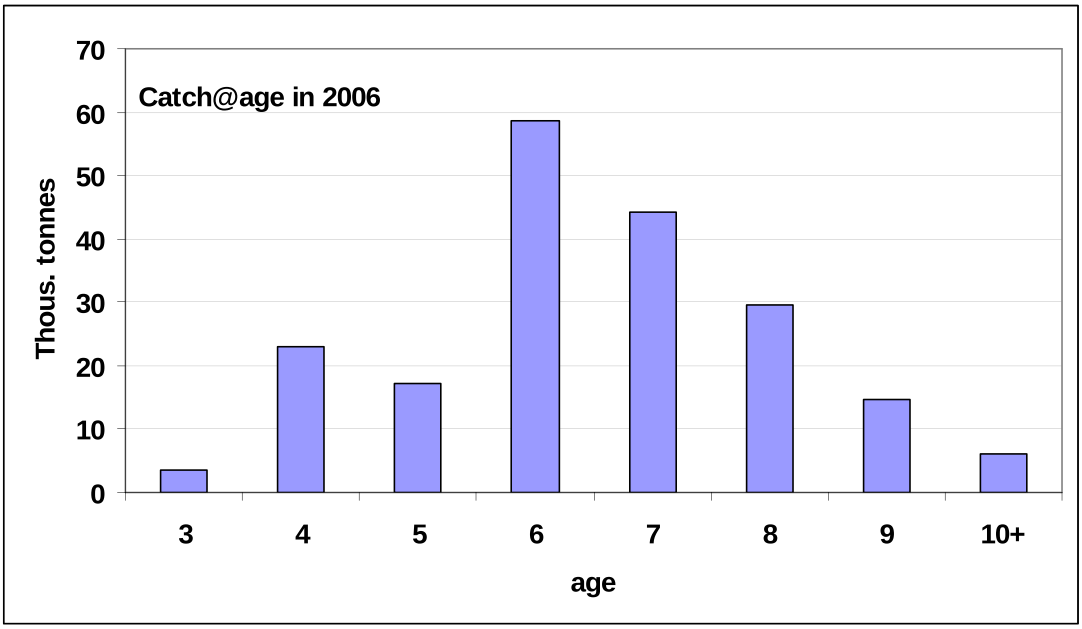


Figure 3.3.23B. Estimed age composition of the SSB and the catches in 2006.

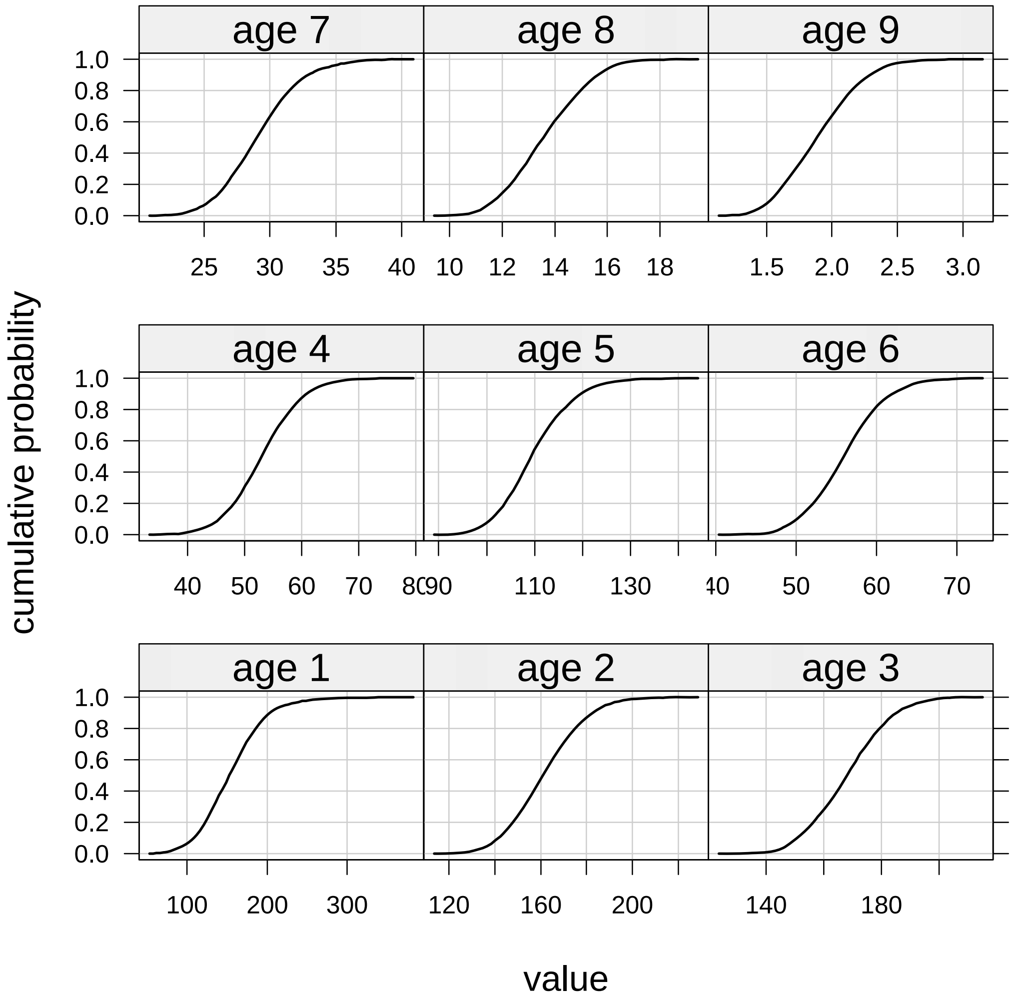


Figure 3.3.24.. Cod in division Va. Cumulative probability distribution of number in stock at the start of 2005.

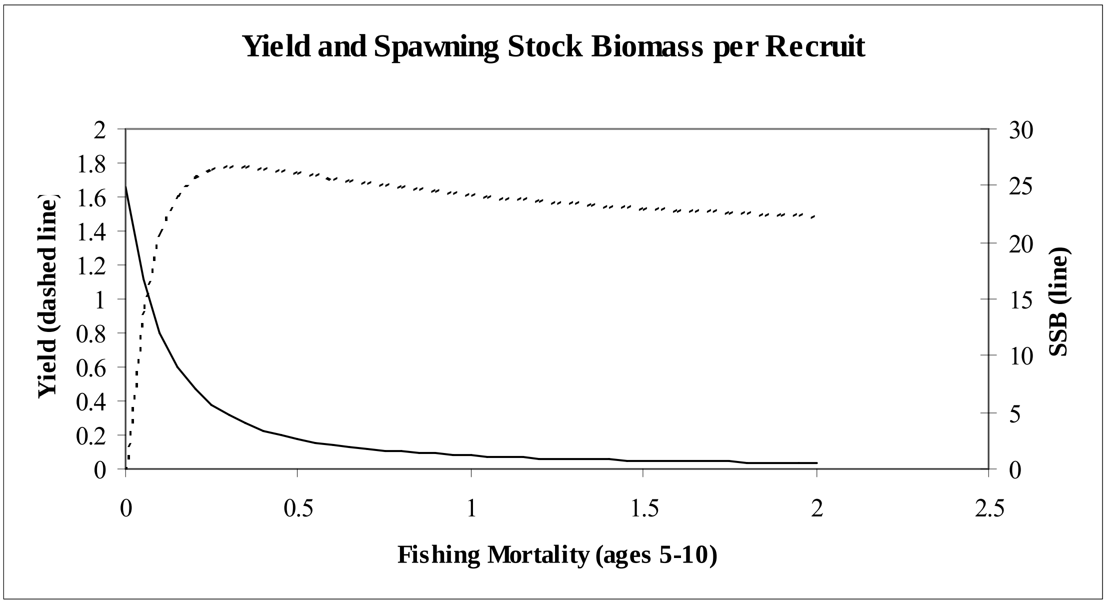


Figure 3.3.25 Yield per recruit

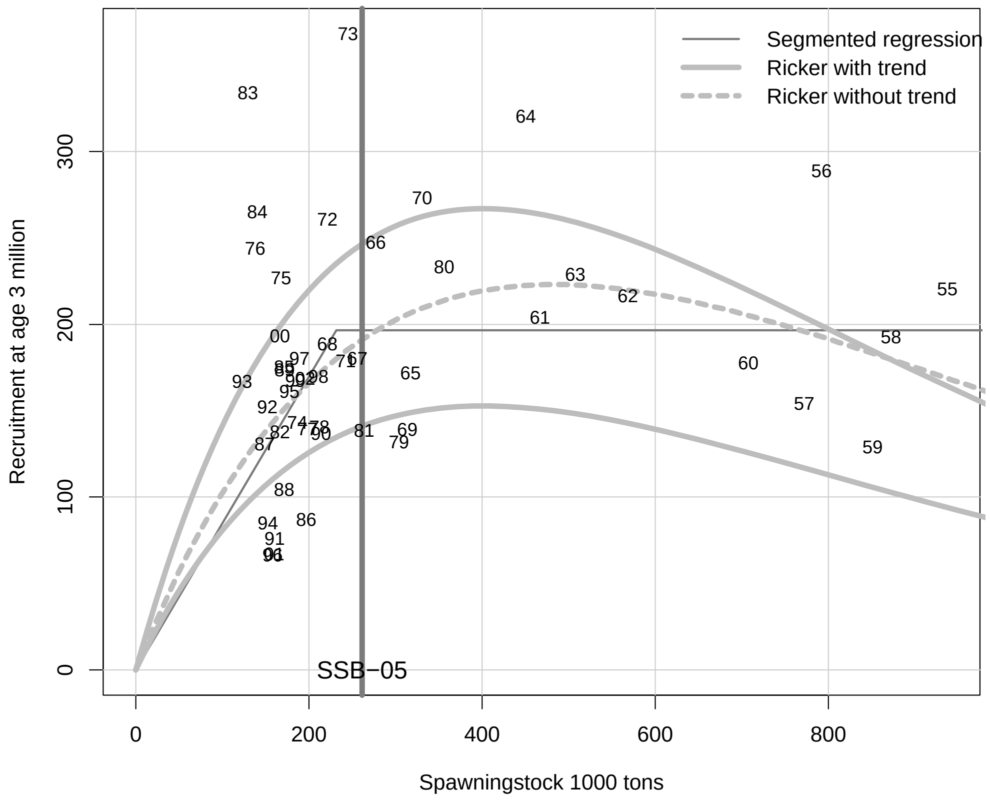


Figure 3.3.26 Spawning stock biomass and recruitment at age 3

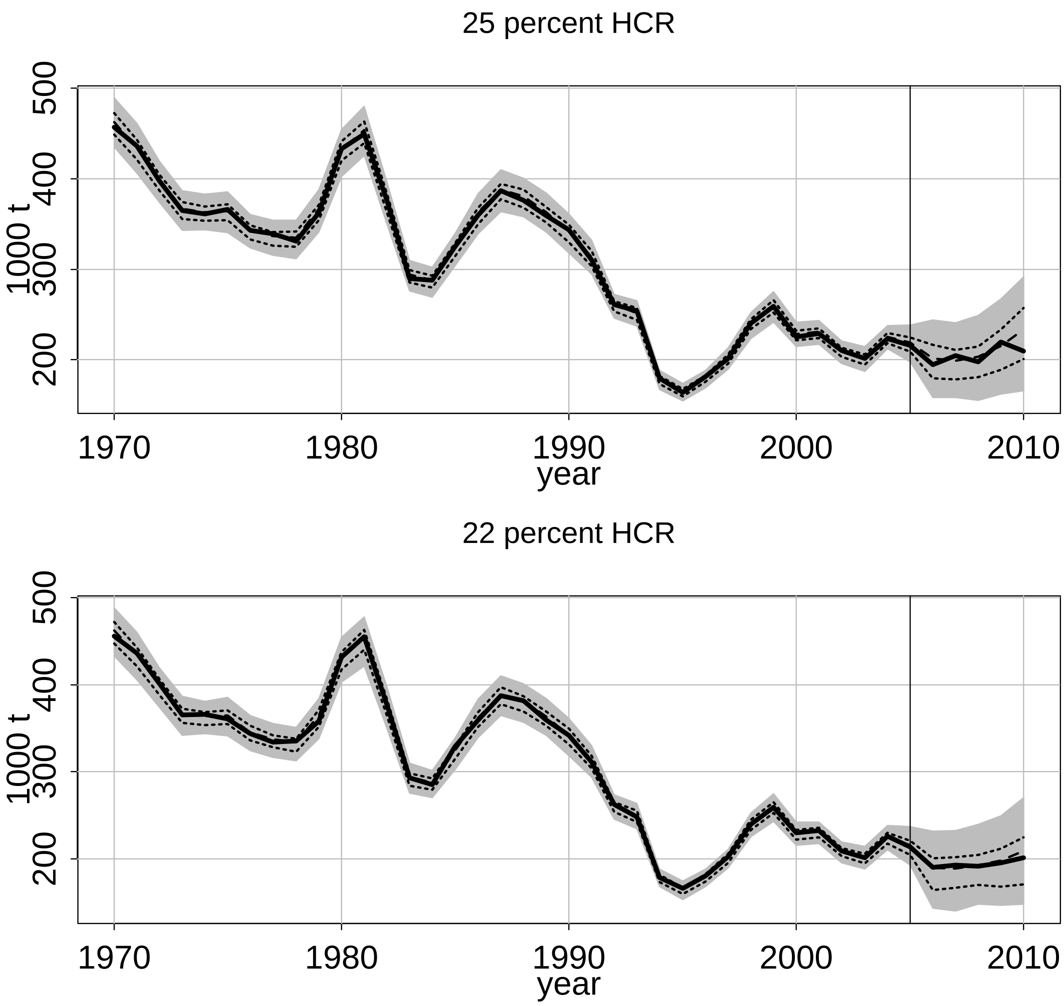


Figure 3.2.27. Cod in division Va. Yield estimate and medium term prognosis according to the ammended catchrule and a 22 persent HCR. Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

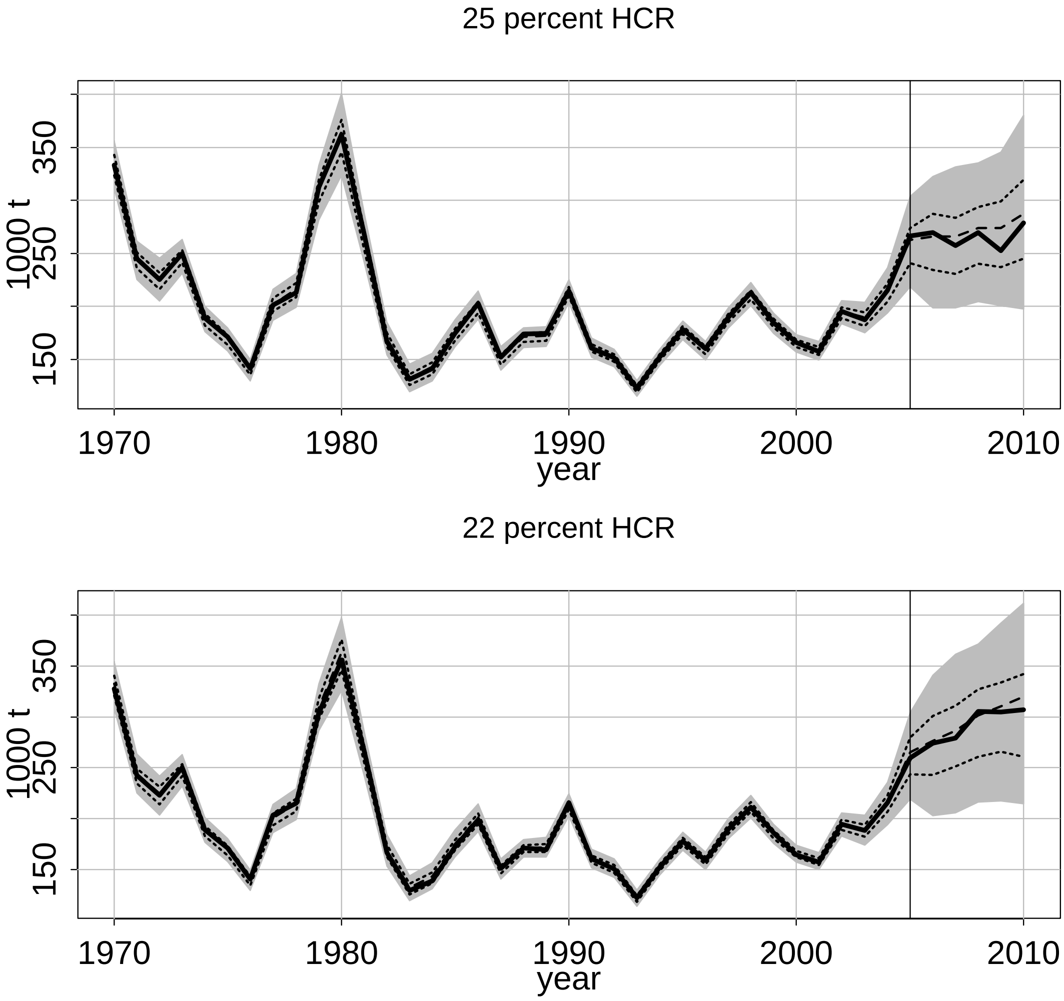


Figure 3.2.28. Cod in division Va. SSB estimate and medium term prognosis according to the ammended catchrule and 22 percent HCR. Shaded are shows 90% percentile distribution and the dotted line represent the 50% percentile.

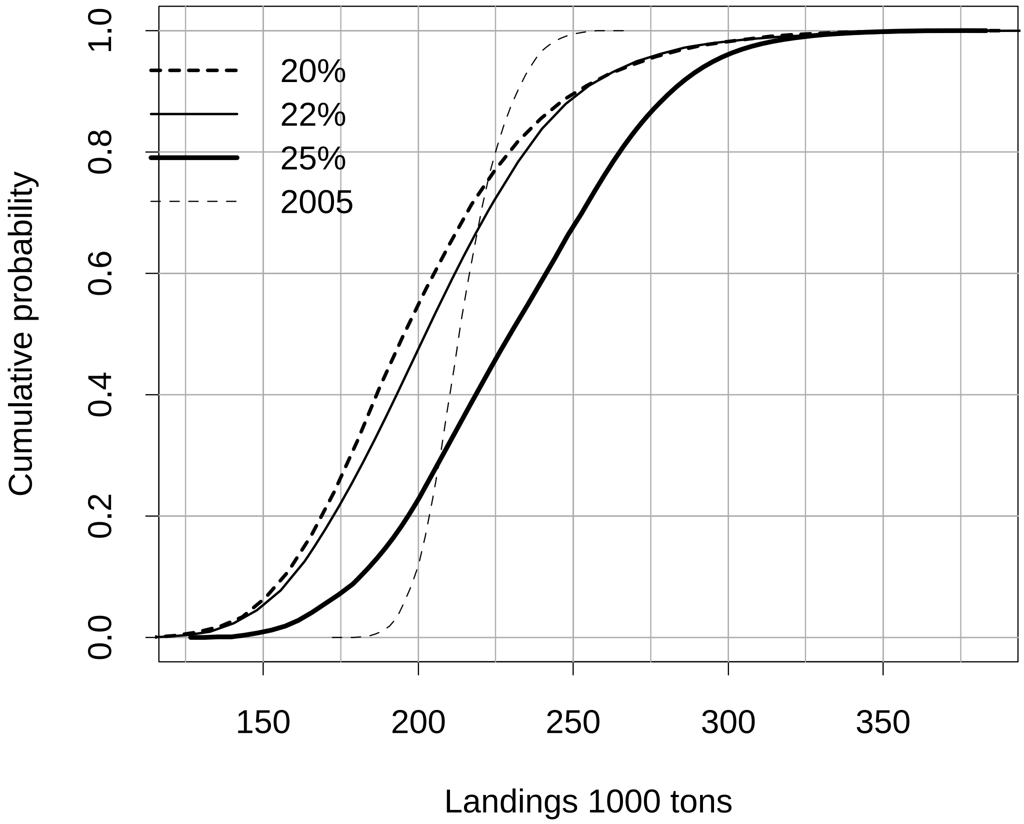


Figure 3.2.29. Cod in division Va.. Cod in division Va. Cumulative probability distribution of the expected landings in the year 2010 according to three different harvestitng ratios (HCR).

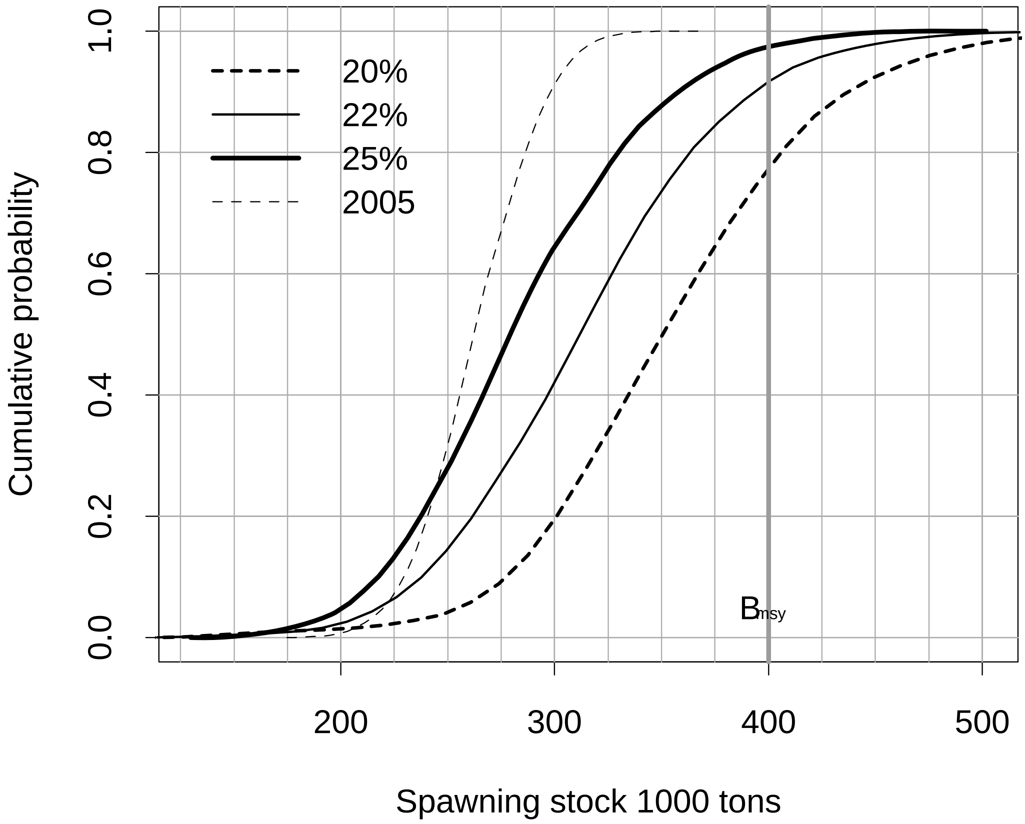


Figure 3.2.30. Cod in division Va. Cumulative probability distribution of the estimated size of the spawning stock in 2010 according to three different harvestitng ratios (HCR).

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 5 of 7 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.

This years assessment is in line with last years assessment indicating very good recruitment in recent years and increasing stock size. The main difference from last year are more emphasis on the Icelandic autumn survey and somewhat contradictory results from assessment based on that survey and the Icelandic March survey used for assessment of the stock in recent years. Also problems with high proportion of the estimated landings in 2006 coming from a very big year class from 2003 are highlighted.

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 84 000 tonnes highest in 2004 . 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 2004 were 84 500 tonnes, increasing from 60 500 tonnes in 2003. In last year the forecasted landings for the year 2003 were 80 000 tonnes but the year before the forecast for the assessment year was higher than the landings.

In 2004, 60% of landings were by demersal trawl, 10% by Danish seine, 28% by long line and 2% by gillnets. The share of each gear is similar to what is was in 2003 (figure 3.4.2.2).

In recent years increasing percentage of the catches have been taken north of Iceland. (figures 3.4.2.3 and 3.4.5.11).

Discard larger problem in the Icelandic haddock fisheries than in other demersal fisheries off Iceland. The discards have been estimated to be up to 50% of number caught and 22% of landings in 1997. In recent years discard of haddock has decreased, mostly due to reduced spatial overlap of the fisheries and recruitment. In 2004 the discards are estimated to be 3.1% of landings and 7% by number (Anon 2005). Discards estimates are not used in calculations of catch in numbers by age.

3.4.3 Catch at age

Catch at age for 2004 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 2004 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	11751	1496	77	30	1399
South	Jan-May	Gillnet	583	137	7	3	139
South	Jan-May	Danish seine	3835	249	26	5	349
South	Jan-May	Bottom trawl	22977	1893	142	39	999
South	June-Dec	Long line	5979	295	42	6	299
South	June-Dec	Gillnet	811	147	7	3	150
South	June-Dec	Danish seine	1623	146	9	3	100
South	June-Dec	Bottom trawl	17150	1679	105	34	1100
North	Jan-May	Long line	5570	355	42	8	300
North	Jan-May	Danish seine	509	0	3	0	0
North	Jan-May	Bottom trawl	9174	1093	49	22	648
North	June-Dec	Long line	12186	697	92	14	600
North	June-Dec	Gillnet	311	50	2	1	50
North	June-Dec	Danish seine	3203	99	24	2	100
North	June-Dec	Bottom trawl	33173	2005	207	41	749

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 similar results.

The table below shows catch at age in 2004 in percent of number compared to last years prediction. Some discrepancies may be seen, with less than predicted catch of age 4 but more of most other agegroups.

AGE	2	3	4	5	6	7	8	9
Forecast %	3.6	6.5	38	32.5	15.4	3.1	0.4	0.5
Catch %	2.5	7.6	32.7	35.4	16.1	3.6	1	1

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 so that year class did last for a long time in the fisheries. . Figure 3.4.3.1 indicates that CV in these data is low. Shephard Nicholson model gives a CV of 22% 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 1982–2005 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. Most of the recent year classes are large and weights at age have dropped in recent years. The weight at age of those year classes is though still above what is was for the 1990 and 1995 year classes. Exception is the very big year class 2003, where the weight at age is similar to what it was for the 1990 year class. Lower fishing mortality could compensate for density dependent growth as the fishery tends to remove the largest individuals of each age group affecting mean weight at age of the survivors.

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 from the catches in January - May is used 1980 to 1984.

In tables 3.4.4.1 to 3.4.4.3 values used in prediction are highlighted.

3.4.5 Survey and cpue data.

Haddock is one of the most abundant fishes in the Icelandic groundfish surveys in March and October, 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 groundfish surveys in March and October is shown in figure 3.4.5.2. Both surveys show much increase in recent years, but the change occurred earlier and more rapidly in the March survey than in the October survey and the indices from the October survey were not as low in 2000 and 2001 as in March. Look at the catch curves and the Hjörleifsson Pálsson plot (figures 3.4.5.6 and 3.4.5.4) suggests the March 2003 survey to be an outlier for year classes 1998 and 1999 and the measurement error of the 2003 indices is fairly high. The two most recent March and October surveys have been characterized by high indices with relatively low CV (figure 3.4.5.2) indicating high abundance and even distribution of haddock. This is also supported by the median indices calculated as the proportion of stations where haddock is found, times the median of the haddock catch at those stations (figure 3.4.5.3) but they have increased much in both surveys. In short, looking at the total biomass both the surveys show much increase in recent year although the increase in the March survey has been more.

Age disaggregated indices from both the surveys (figure 3.4.5.14 and tables 3.4.5.1 and 3.4.5.2) indicate 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 2004 year class seems to be about average.

In figures 3.4.5.8 and 3.4.5.9 indices from the surveys are plotted against stock estimate using the SPALY run from last year (see section 3.4.6), tuning with age disaggregated indices (age 1-9) from the March survey. The plot for the March survey includes regression lines based on all data until 2002 and r2 in the fit of those lines included. The regression line for the autumn survey is on the other hand based on all data points. The figures shows that the survey indices have been a good indicator of stock size and the relationship between survey indices and number in stock is close to linear for all age groups. The figures do though indicate that ages 4 and 5 in the March survey in 2003 are outliers and that the most recent estimate (shown as intersection of dashed lines) is below prediction according to the March survey. Figure 3.4.5.9 does on the other hand indicates that indices from the autumn survey fit well with results from the SPALY run.

The surveys indicate that in some of recent years increasing proportion of the incoming year classes has been in the northern part of the survey area (figures 3.5.5.10, 3.4.5.11 and 3.4.5.12) where fishing effort has been relatively small. There used to be shrimp fishery in many fjords off the north coast but it stopped in 1996 -1997 due to collapse of the shrimp stocks. Reduced spatial overlap between recruiting year classes and the fishery in recent years can explain why discards have reduced and recent year classes have progressively become stronger in every new survey (Björnsson and Jónsson 2004).

CPUE from the commercial fleet is shown in figure 3.4.5.14. The CPUE indices are calculated from records where more than 50% of the catch is haddock and also from all records where haddock were caught. They show an increase in recent years for bottom trawl and longlines which are the most important fishing gear. (It must be noted that the longline data are only comparable from 2000 onwards). The change in CPUE is though much less than observed in the surveys and Danish seine and gillnets do not show any increase in recent years. Figure 3.4.5.15 shows then the effort calculated by dividing the total catch for each gear by the CPUE indices, both based on records where more than 50% of the catch was haddock and all records where some haddock was found. The figure shows increase in effort in recent year which is not in line with decreasing fishing mortality that the assessment predicts.

The discrepancy between CPUE from commercial fleets and survey indices from 2003 to 2005 is of interest and needs some clarification.

- Large part of the increase in the haddock abundance indices in recent years is in the area north of Iceland where fishing effort is small
- The method used here before to calculate effort for figure 3.4.5.15 is conceptually wrong.
- 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.

To look at the spatial aspect, the proportion of the catch and the survey index of fishable haddock in the March survey were compared, showing the the fishery does not quite follow change in spatial location of the stock (figure 3.4.5.11). Also an attempt was made to calculate the number and the proportion of fishable haddock (>42cm) caught in bottom trawl by multiplying the number caught per hour in each statistical square in the survey in March by the number of hours towed in that square the same year. The method is described in Björnsson and Jónsson (2004). The results are shown in figures 3.4.5.16 and 3.4.5.17. Figure 3.4.5.16 indicates that number caught, calculated in this way are not very far from official catch in numbers and Figure 3.4.5.17 that fishing mortality (by bottom trawl) might have been reducing in recent years.

3.4.6 Stock Assessment and recruitment estimates

Last years assessment was based on a number of different models and settings but the final run selected for prediction was based on a model called ADCAM using age disaggregated indices from the groundfish survey in March.

This year similar procedure was used Most of the model were run on age disaggregated indices from the groundfish survey in March but a number of runs were made using indices from the autumn survey and the main changes from last year was more thorough look at indices from the autumn survey which has now been conducted for 10 years. As before an emphasis was put on letting more than one person do an assessment. Results from the TSA assessments are described in working paper #33.

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 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 prediction 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 years assessment results from 4 different models TSA, XSA, ADAPT 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. In the former table estimated Tac for the year 2006 assuming F4-7 =0.47 in 2006 and 96 000 TAC constraint in 2005 is shown for some of the models.

Summary of results from different assessment models.

	F4-7 2004	Biomass 3+ 2005	Std. Err in 3+ bio	N7-2005	N6-2005	N5-2005	F 2005 96kt	Tac 2006
XSA March survey 2-9	0.376	334		13.7	42.6	102.3		
XSA March survey 1-9	0.408	314		13.2	37.1	91.0		
TSA March survey*	0.410	276	24	13.3	35.3	72.3		
TSA autumn survey	0.520	202	16	10.1	27.7	42.0		
TSA March survey var*	0.486	231	20	10.4	26.7	61.0		
Adapt March survey	0.439	277	30	10.2	32.7	81.5	0.418	139
Last years spaly	0.438	278	25	11.6	33.7	78.5	0.412	141
Adapt Autumn survey 1-9	0.530	219	31	8.8	28.9	61.8	0.545	99
Adcam Autumn surve 1-9	0.549	219	25	10.7	28.5	55.4	0.655	99
Last years assessment		267						

In addition to the stock assessment models two models estimating only recruitment were used, i.e a timeseries model from Gudmundur Gudmundsson (WD#33) and RCT3 based were used. The results of the recruitment models are shown in the table below.

Recruitment age 2 (million)

YEAR CLASS	RTC3 MARCH SURVEY	ADAPT AUTUMNSURVEY	XSA MARCH SURVEY	ADCAM SPALY	ADAPT	ADCAM AUTUMNSURVEY	TSA MARCH SURVEY	TSA OCT SURVEY
2000	180	152		182	188	141		
2001	54	40	58.4	48	49	42		43
2002	196	154	223	207	208	155	202	142
2003	371	308	442	481	483	314	4889	297
2004	90	58*		112	95	57*		

***numbers are geometric mean**

As may be seen the results vary widely. The main difference is though not between models but between the tuning series with models using the March survey giving more optimistic estimates than models using the autumn survey. Last years assessment also showed wide range of stock estimates and runs based on the autumns survey indicated smaller stock than runs based on the March survey.

Many signs indicate that recruitment of haddock has been well above average since 1998 and that fishing mortality has reduced in last years (models based on the autumns survey predict increase from 2003 – 2004). 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. Also the weight of inertia terms might be increased when there is suspicion that the most recent survey is an outlier as was the case in the 2003 assessment when the 2003 March survey was an outlier (figures 3.4.5.2 and 3.4.5.4). .

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.

Some further analysis were made to investigate if something more than increased number in stock could be causing the rapid increase in survey indices in recent years and why assessment based on the March and October survey give so different results. The ADCAM model was used in most of those exercises but TSA was also used for one test.

1. The TSA model indicates that catchability in the March survey might have increased in recent years. Allowing change in catchability of the survey between 2002 and 2003 leads to significant reduction in the log-likelihood (working paper #33) and predicted increased catchability in the survey. This change leads to substantial reduction in estimate of biomass of age 3+ from 278 to 230 as seen in the table above.
2. The Adcam run was made, using the March survey only using data from 1995 – 2005 which is the time period that the autumn survey has been conducted. The stock estimates did not change much. Skipping the years 1996 – 2001 was also investigated ,not changing much.
3. Area dependent catchability was a factor that was investigated by dividing the abundance indices between north and south and adding the indices using an estimated catchability factor $I_{tot,a} = I_{N,a} + q_a I_s$. The results from the exercise did not help in explaining data discrepancies and the estimated factors q_q did not show any consistent pattern with age. More work is though needed in this area.
4. In Björnsson and Jónsson (2004) modelling of the unreported mortality of ages 1 to 3 caused by the fisheries is described predicting reduction in unreported mortality in recent years.

5. Figure 3.4.6.1 indicates that the SPALY run does not follow the March survey (predicted biomass below observed one) and the same may be seen in the residual plot figure 3.4.6.3. In March 2005 the observed survey biomass is 15% above the predicted one. The model run based on the autumn survey shows even more discrepancy in recent years (figure 3.4.6.6 and 3.4.6.7). At the same time the CV in the autumn survey has been very low (figure 3.4.5.2). There are therefore indications that models runs based on the autumn survey might be underestimating the stock. Similar catchability increase as could have occurred in the March survey can though not be excluded. Graphic stock assessment using figure 3.4.5.8 would give results close to the the SPALY run.

The ADCAM used as SPALY model last year is a statistical catch at age model written in AD-model builder (described in working paper 33 in 2002) was used. (Other models using the same data gave similar results) 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 0.82 to be compared with estimated CV of the survey indices 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 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 $\rho|i\text{-}j|$. where ρ is the estimated correlation coefficient
- Catchability in survey was independent of stock size for all ages. (See figures 3.4.5.7 and 3.4.5.8 for justification)
- 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 log(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.

The results from the SPALY ADCAM run are shown in Figures 3.4.6.1 to 3.4.6.4 and results from the same run based on the autumn survey are shown in figures 3.4.5.6 and 3.4.5.7. Figure 3.4.6.4 shows large blocks in the survey. There are 2 possible explanations for those year blocks

- Large abundance of haddock in a survey leads to subsampling 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 in the survey but in ADCAM the correlation between residuals of different agegroups in the March survey 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 as it would do if the correlation was 0 (in the autumn survey the estimate is 0.28 so the effect is less). Modelling of the correlation of survey residuals explains most of the differences between results from ADCAM and TSA and from XSA (see table above).

Figure 3.4.6.5 shows the residuals in catch at age from the SPALY. 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. The standard error of stock estimates based on the autumn survey is proportionally larger as the series is shorter and the models seem to estimate higher CV for the autumn survey than for the March survey.

3.4.7 Prediction of catch and biomass

3.4.7.1 Input data

The input data for the prediction are shown in tables 3.4.4.1 to 3.4.4.3 and tables 3.4.6.3 and 3.4.6.4 as shaded lines.

For the short-term catch prediction and stock biomass calculations, the mean weight at age 3–8 in the catches in 2005 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 2006 the procedure was repeated. For the youngest age groups the mean of last 3 years was used. The big year class from 2003 has not been seen in the catches before but the surveys indicate that mean weight at age is low for this year class. This year class will appear in the catches in 2006 but the reduction in mean weight at age in stock is not expected to affect the weight at age in the catches much, as for age 3 they are mostly determined by selection .

For the stock weights, survey weights for the year 2005 were used for that year but for the year 2006 mean weight at age was predicted from the mean weight of the same year class in the survey in 2005.

The exploitation pattern was taken as the mean exploitation pattern from 2000–2004.

Maturity was taken to be the mean of the 2003-2005 values.

Stock in number in the year 2006 and recruitment in 2006 – 2007 were obtained from the ADCAM model based on the March survey and the same model was used for prediction. Predictions based on stock in number from runs based on the autumn survey are also presented to see the effect of given TAC on the fishing mortality .

A TAC constraint of 96 000 tonnes was used for the year 2005. The estimate was the sum of the TAC for the fishing year starting September 1st 2004 that was remaining in the beginning of 2005 and 36% of the estimated TAC for the fishing year 2004-2005 but 36% of the TAC for the fishing year 2003-2004 was taken in the year 2004 (all years were one too low. In the prognosis last year a TAC constraint of 80 000 t was used for the year 2004 while the landings are now estimated to be 84 000 tonnes

Stochastic short term prognosis were done using the ADCAM model. The proposed Fpa 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.

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 was the mean from 1980 - 2003. Input data for long term yield per recruit are given in table 3.4.7.1.

3.4.7.2 Biological reference points

The yield per recruit is shown in table 3.4.7.2. and figure 3.4.7.1

Compared to the estimated fishing mortality of F4–7=0.52 for 2003, Fmax=0.44 and F0.1=0.16.

Yield per recruit at Fmax corresponds to 0.88kg. (Table 3.4.7.2). Mean weights as in the most recent years would give lower yield per recruit.

A plot of spawning stock biomass and recruitment from 1981- 2004 is shown in Figure 3.4.6.1 and a plot of recruitment vs. spawning stock in figure 3.4.7.3.

In the year 2000 the working group proposed provisional Fpa set to the Fmed value of 0.47 and this value has been used as Ftarget since then. Since 1986 F4–7 has exceeded Fmax and for only 4 years since 1960 has F4–7 been lower than Fpa.

The SGPRP proposed Bloss as candidate for Bpa 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 2005 and 2/3rd within the calendar year 2006. The TAC for the next fishing year will therefore be 1/3rd of the landings in 2006 plus 2/3rd of the advice for 2006.

3.4.7.3 Projection of catch and biomass

Results from short term prediction are shown in tables 3.4.7.3 to 3.4.7.5.

At the beginning of 2005, the biomass of age 3+ is predicted to be 278 000 t with a spawning stock of 182 000 t according to the SPALY run. Same model based on the autumn survey gives . B3+2005= 217 000 t and SSB2005 = 144 000 t.

With a catch of 96 000 t in 2005, fishing mortality is estimated to be 0.41 and at the start of 2006 the biomass of age 3+ is predicted to be 411 000 t and the spawning stock 253 000 tonnes. For comparison the model based on the autumn survey predicts F2005=0.54, $B3+_{2006}$ = 280,000 tons and SSB_{2006} = 174 000 tons.

The predictions based on March survey results indicate that the catches will be well above 100 000 tonnes for at least the next 5 years if the F=0.47 will be used as target F. F=0.47 leads to 139 000 tons for the calendar year 2006 if the SPALY run from last year is used but 93 000 tons if numbers in stock are based on the same model using the autumn survey.

Figures 3.4.7.4 and 3.4.7.5 show the output of the short term prognosis including errors in mean weight at age and assessment errors, assuming F4-7=0.47 after 2005. They indicate considerably less landings according to the autumn survey but the uncertainity does also seem to be proportionally more as indicated by standard error of stock estimates which are higher.

3.4.8 Management considerations

For more than a decade fishing mortality on haddock was high with F4–7 between 0.6 and 0.8 since 1986. The advice last years has been based on the provisionally proposed F med that is 0.47.

The short term predictions do not show much advantage in terms of total yield in reducing fishing mortality as may also be seen by the yield per recruit plot (figure 3.4.7.1). 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.

Prediction using the SPALY run indicate that F=0.47 will lead to a catch of 141 000 tonnes for the calendar year 2006 which is more than has been caught before (figure 3.4.1.1). Of this catch 32 kt are estimated to come from the very big 2003 year class and 32 kt of the big 2002 year class. Relatively slow growth of year class 2003 means that fishermen will try to avoid it in 2006 transferring the fishing pressure on the older age groups. The size of those large recruiting year classes is also very uncertain and models based on the autumn survey are not as optimistic about the state of the stock, especially size of those year classes. Assessment based on the autum survey indicate that landings of 140 kt in 2006 will lead to unacceptably fishing mortality (table 3.4.7.7) but landings in the neighbourhood of 100 kt would lead to F=0.47.

As described in Björnsson and Jónsson (2004) 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 neprops 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 and Fmax is considerably less than the same number based on models ignoring those effects.

As described in section 3.4.3 discard of small haddock by the fisheries has often been a problem but has been reduced in recent years due favourable spatial distribution of recruits compared to the fisheries. Discard might though increase in 2005 and 2006 when the strong 2002 and 2003 year class will be caught.

The working group recommends that the results of Björnsson and Jónsson (2004) are an indication that the optimal target fishing mortality for this stock might be considerabley lower than 0.47. Also basing the TAC on a selection pattern different from the selection by the fisheries (having lower weight on ages 2 - 4) should be considerd to reduce effort when strong year classes are entering the fishery. Selection pattern used for setting TAC does not need to be the selection pattern of the fisheries.

The following list summarizes some of the points mentioned in sections 3.4.6 to 3.4.8.

1) Stock estimated based on the March survey (SPALY run) is an overestimate

- Strange residuals in the 2003 survey, too rapid increase of the stock from 2002 to 2003
- Results from model runs allowing permantent change in catchability between 2002 and 2003 showing significant increase (WD #33).
- Area or stocksize dependent catchability possible. Stock size is outside range of data.
- CPUE not showing same increase as survey. Effort increasing in recent years ?? (Figures 3.4.5.14 and 3.4.5.15)

2) F=0.47 from SPALY run not advisable

- 31 kt landings estimated from a large year class that will mostly be below minimum landing size
- Unreported mortality a problem and F=0.47 is too high as target F. (Björnsson and Jónsson 2004)
- Assessment based on the suvey might be overestimating the stock. (underestimation in not impossible)

3) Stock estimate based on autumn survey is an underestimate

- Residuals in assessment positive figures (3.4.6.6 ,3.4.6.7)
- Retros showing pattern of increasing stock size. (WD #33)

- Autum survey fits spaly assessment well (figure 3.4.5.5)

3.4.9 Comments on the assessment

The current assessment was done using only groundfish surveys 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 F4–7=0.438 in 2004 which is a little increase from 2003 when F4–7 is now estimated to have been 0.428 (last years estimate for 2003 was 0.52)

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 to 2005 March survey. The biomass of age 3+ at the start of 2005 is now predicted to be 278 000 t (SSB 182 000 t) but was predicted to be 267 000 t (SSB 195 000 t) in last years assessment. (If same maturity at age had been used last year as this year the SSB last year would have been 177 000 tonnes)

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 TSA using the same tuning data. Results based on the autumn survey indicate considerably smaller stock.

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 seen in recent decades. Data from the early 1960's when the landings exceeded 100 kt for a number of years (figure 3.4.2.1) do though indicate that similar year class might have been seen in that period.

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	2004
Belgium		
Faroe Islands	833	1035
Iceland	59970	83791
Norway	30	9
UK	51	
Total	60884	84835

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
2004	1356	4154	17937	19402	8801	1957	539	538

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
2004	575	979	1235	1574	2048	2799	3167	3082
2005	569	887	1383	1662	2069	2527	3177	3423
2006	569	885	1275	1787	2163	2546	2981	3433

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
1985	35	244	567	1187	1673	2372	2768	3199	3334
1986	35	239	671	1134	1944	2400	3192	3295	3731
1987	31	162	550	1216	1825	2605	3031	3644	3838
1988	37	176	456	974	1831	2697	3104	3483	3321
1989	26	182	440	886	1510	2382	3011	3502	3198
1990	29	184	456	839	1234	1966	2677	3055	3269
1991	31	176	500	1002	1406	1885	2498	3757	3656
1992	28	157	503	894	1365	1892	2326	2938	3684
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
1997	50	173	423	818	1224	1426	1917	2397	3694
1998	41	202	404	742	1232	1738	2015	2333	3081
1999	34	205	479	719	1198	1967	2381	2798	2929
2000	29	179	552	888	1167	1777	2620	2924	3155
2001	36	188	487	1052	1433	1502	2165	2758	
2002	63	172	474	891	1465	1955	2143	1998	3662
2003	40	230	412	801	1268	1873	3139	2343	3301
2004	34	176	556	807	1282	1690	2454	3236	2942
2005	40	153	448	920	1188	1564	2128	2808	2550
2006	38	186	394	826	1335	1669	2133	2604	3256

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
2005	0	2.4	23	56.2	75.3	92.7	93.6	96.8	100
2006	0	4.1	31.2	60.5	81.7	91.9	96	98.9	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
2005	58.37	693.04	288.21	44.97	156.93	57.32	15.75	3.34	0.32	0.27

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
2004	196.89	716.82	323.19	48.18	142.49	62.11	14.93	3.2	0.67	0.4	0.0

Table 3.4.6.1 Haddock in division Va. Summary table from the SPALY run using the March survey for tuning.

year	Recruitment million atage 2	Biomass 3+ 1000 tons	SSB 1000 tons	Landings 1000 tons	F_{4-7}	Yield/SSB
1979	79	163	96	59	0.537	0.617
1980	37	192	116	51	0.442	0.439
1981	10	204	139	63	0.487	0.457
1982	42	179	136	69	0.457	0.504
1983	30	144	109	65	0.49	0.591
1984	19	111	81	48	0.506	0.593
1985	42	99	63	50	0.564	0.792
1986	88	92	55	47	0.708	0.853
1987	166	105	44	40	0.659	0.91
1988	44	153	67	54	0.662	0.804
1989	25	169	100	63	0.631	0.625
1990	24	143	110	67	0.613	0.61
1991	81	118	87	55	0.625	0.628
1992	168	103	65	47	0.698	0.724
1993	36	128	69	49	0.693	0.702
1994	39	124	80	59	0.686	0.734
1995	71	118	81	60	0.675	0.746
1996	36	105	68	57	0.698	0.839
1997	99	86	58	44	0.655	0.765
1998	16	95	63	41	0.679	0.662
1999	51	87	61	45	0.725	0.738
2000	123	86	59	42	0.679	0.707
2001	157	113	67	40	0.557	0.586
2002	182	168	98	50	0.502	0.516
2003	49	218	147	61	0.428	0.413
2004	207	251	181	84	0.438	0.466
2005	481	278	182	**96**	0.412	**0.520**

Table 3.4.6.2 Haddock in division Va. Summary table from the SPALY run using the autumn survey for tuning.

YEAR	RECRUITMENT MILLION AT AGE 2	BIOMASS 3+ 1000 TONS	SSB 1000 TONS	LANDINGS 1000 TONS	F_{4-7}	YIELD/SSB
1979	81	163	96	59	0.534	0.615
1980	36	192	116	51	0.443	0.44
1981	10	204	139	63	0.488	0.453
1982	41	179	136	69	0.457	0.507
1983	30	144	109	65	0.491	0.596
1984	20	110	80	48	0.515	0.6
1985	41	98	63	50	0.572	0.794
1986	87	91	54	47	0.716	0.87
1987	167	103	43	40	0.665	0.93
1988	46	152	66	54	0.665	0.818
1989	26	168	99	63	0.627	0.636
1990	22	143	110	67	0.61	0.609
1991	79	118	87	55	0.625	0.632
1992	168	102	65	47	0.7	0.723
1993	38	127	69	49	0.694	0.71
1994	39	124	80	59	0.686	0.738
1995	70	118	80	60	0.679	0.75
1996	36	105	68	57	0.696	0.838
1997	101	86	58	44	0.648	0.759
1998	16	96	63	41	0.668	0.651
1999	49	88	62	45	0.711	0.726
2000	121	87	60	42	0.667	0.7
2001	145	113	67	40	0.554	0.597
2002	140	162	95	50	0.511	0.526
2003	42	195	135	61	0.448	0.452
2004	155	214	157	84	0.491	0.535
2005	314	217	144	**96**	0.549	0.66

Table 3.4.6.3 Haddock in division Va. Number in stock from the SPALY run using the March survey. The shaded numbers are input for prediction.

YEAR/AGE	1	2	3	4	5	6	7	8	9
1979	45.4	78.9	120.2	26.7	20.1	21.2	3.2	0.8	0.1
1980	11.8	37.1	64.4	96.2	18.4	10.8	8.7	1.1	0.3
1981	51.7	9.7	30	51.5	68.9	11	5	3.4	0.4
1982	37	42.3	7.9	24	37.4	40.8	4.5	1.8	1.1
1983	22.9	30.3	34.6	6.3	17	21.7	19.4	1.7	0.6
1984	51.9	18.7	24.8	27.6	3.9	9.7	9.1	8.1	0.5
1985	107.1	42.5	15.3	19.5	17.9	2.1	3.9	3.9	2.7
1986	203.3	87.7	34.5	11.1	11.5	9	0.8	1.6	1.2
1987	53.7	166.4	71.5	24.8	5.9	5	2.8	0.3	0.5
1988	30.4	44	134.5	52.2	13.6	2.4	1.9	1.1	0.1
1989	28.8	24.9	35.8	100.7	29.1	5.9	0.9	0.7	0.3
1990	98.9	23.6	20.3	26.9	60.9	14.8	1.9	0.3	0.2
1991	204.7	81	18.9	14.5	15.6	29	5.8	0.7	0.1
1992	44	167.6	64.2	14.2	8.4	7.1	11.4	2.1	0.2
1993	48.2	36	134.8	46.1	7.8	3.5	2.5	3.9	0.6
1994	86.5	39.4	29.3	99.6	26	3.3	1.3	0.8	1.2
1995	44.1	70.8	32	21.2	58	11.1	1.2	0.4	0.2
1996	121.2	36.1	56	21.3	12.3	26.3	4	0.4	0.1
1997	20	99.3	28.5	37.5	11	6	9.4	1.2	0.1
1998	61.7	16.4	80	19.9	20.2	4.7	2.5	3.1	0.3
1999	149.7	50.5	13.2	58	10.5	8.8	1.7	0.9	0.9
2000	191.8	122.6	40.4	9.5	32.4	4.1	3	0.6	0.3
2001	222.8	157	98.3	27.5	5.6	14.5	1.4	1	0.2
2002	59.3	182.4	126.6	70.4	16.3	3.1	6.3	0.5	0.3
2003	253.3	48.5	148.3	94.1	43.2	8.8	1.5	2.3	0.1
2004	588	207.4	39.5	115.5	62.5	23.8	4.6	0.6	0.7
2005	137	481.4	168.6	28.6	78.4	33.7	11.6	2	0.2
2006	74.8	112.2	390.6	125.8	19	45.3	17.3	5.1	0.7
2007	74.8	61.2	90.9	287.8	80.8	10.4	21.8	7	1.6

Table 3.4.6.4 Haddock in division Va. Fishing mortality from the SPALY run using the March survey.

YEAR/AGE	1	2	3	4	5	6	7	8	9
1979	0	0.004	0.022	0.174	0.423	0.691	0.859	0.859	0.859
1980	0	0.014	0.023	0.133	0.312	0.574	0.747	0.869	0.869
1981	0	0.004	0.021	0.12	0.325	0.701	0.803	0.884	0.884
1982	0	0.002	0.034	0.146	0.346	0.542	0.792	0.912	0.912
1983	0	0.001	0.025	0.259	0.365	0.662	0.675	0.917	0.917
1984	0	0.004	0.038	0.236	0.428	0.718	0.643	0.914	0.914
1985	0	0.009	0.12	0.33	0.489	0.744	0.692	0.952	0.952
1986	0	0.003	0.129	0.441	0.642	0.961	0.789	0.973	0.973
1987	0	0.013	0.115	0.404	0.684	0.774	0.774	0.98	0.98
1988	0	0.004	0.089	0.385	0.638	0.817	0.808	0.998	0.998
1989	0	0.005	0.086	0.303	0.478	0.902	0.842	1.011	1.011
1990	0	0.019	0.134	0.347	0.542	0.732	0.831	1.008	1.008
1991	0	0.032	0.088	0.348	0.592	0.736	0.823	1.013	1.013
1992	0	0.018	0.131	0.405	0.681	0.838	0.867	1.02	1.02
1993	0	0.008	0.102	0.374	0.652	0.802	0.943	1.022	1.022
1994	0	0.009	0.123	0.342	0.646	0.795	0.962	1.035	1.035
1995	0	0.034	0.206	0.342	0.589	0.822	0.948	1.069	1.069
1996	0	0.035	0.201	0.463	0.521	0.827	0.979	1.08	1.08
1997	0	0.016	0.161	0.416	0.643	0.658	0.903	1.073	1.073
1998	0	0.015	0.121	0.437	0.631	0.794	0.853	1.068	1.068
1999	0	0.023	0.134	0.383	0.746	0.88	0.893	1.058	1.058
2000	0	0.021	0.185	0.332	0.601	0.839	0.946	1.053	1.053
2001	0	0.015	0.133	0.324	0.386	0.631	0.885	1.042	1.042
2002	0	0.007	0.097	0.289	0.414	0.504	0.799	1.04	1.04
2003	0	0.006	0.05	0.209	0.395	0.454	0.656	1.052	1.052
2004	0	0.007	0.121	0.187	0.417	0.523	0.626	1.123	1.123
2005	0	0.009	0.093	0.213	0.349	0.466	0.619	0.837	0.837
2006	0	0.01	0.106	0.243	0.399	0.532	0.707	0.955	0.955

Table 3.4.6.5 Haddock in division Va. Number in stock from the ADCAM run using the autumn survey. The shaded numbers are input for prediction

YEAR/AGE	1	2	3	4	5	6	7	8	9
1979	43.9	80.6	119.8	26.8	20.1	21.2	3.2	0.8	0.1
1980	11.9	35.9	65.7	96	18.4	10.7	8.7	1.1	0.3
1981	50.3	9.7	29	52.6	68.7	11	4.9	3.4	0.4
1982	36.8	41.2	7.9	23.2	38.2	40.6	4.5	1.8	1.2
1983	24.2	30.1	33.6	6.3	16.4	22.3	19.3	1.7	0.6
1984	50.2	19.8	24.6	26.8	4	9.2	9.5	8	0.5
1985	106.1	41.1	16.2	19.4	17.2	2.1	3.5	4.1	2.7
1986	203.4	86.9	33.4	11.8	11.4	8.6	0.8	1.4	1.3
1987	56.1	166.5	70.9	23.9	6.2	4.9	2.6	0.3	0.4
1988	31.9	45.9	134.7	51.6	12.9	2.6	1.8	1	0.1
1989	26.9	26.1	37.5	100.8	28.5	5.6	1	0.7	0.3
1990	96.6	22	21.3	28.2	60.7	14.3	1.9	0.3	0.2
1991	205.3	79.1	17.6	15.3	16.3	28.7	5.6	0.7	0.1
1992	45.8	168.1	62.7	13.2	8.9	7.4	11.2	2	0.2
1993	47.9	37.5	135.2	44.9	7.2	3.6	2.6	3.8	0.6
1994	85.9	39.2	30.5	99.9	25.3	3	1.3	0.8	1.1
1995	43.8	70.3	31.8	22.1	57.7	11	1.1	0.4	0.2
1996	123.7	35.9	55.6	21.1	12.8	26.3	4	0.3	0.1
1997	19.9	101.2	28.3	37.3	11.1	6.2	9.5	1.2	0.1
1998	59.8	16.3	81.6	19.7	20.4	4.8	2.6	3.2	0.3
1999	147.4	49	13.1	59.2	10.5	9	1.8	0.9	0.9
2000	176.6	120.7	39.2	9.4	33.2	4.1	3.2	0.6	0.3
2001	171.3	144.6	96.7	26.7	5.5	14.8	1.5	1.1	0.2
2002	51.1	140.2	116.4	69.1	15.8	3.1	6.4	0.5	0.3
2003	189.3	41.8	113.8	85.8	42	8.5	1.5	2.3	0.2
2004	383.5	155	34	87.3	55.7	22.8	4.3	0.6	0.7
2005	69.5	314	125.7	24.1	55.3	28.5	10.8	1.8	0.1
2006	69.5	56.9	253.7	90.5	14.7	28.4	12.6	3.9	0.5
2007	69.5	56.9	46	186	57.4	8.1	13.7	5.1	1.3

Table 3.4.7.1 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 3.4.7.2 Haddock in division Va. Output from yield per recruit.

F-reference points:

	FISH MORT	YIELD/R	SSB/R
	Ages 4-7		
Average last 3 years	0.562	0.882	1.406
Fmax	0.441	0.887	1.684
F0.1	0.161	0.779	3.282
Fmed	0.617	0.879	1.311

Table 3.4.7.3 Haddock in division Va. Output from short term prediction using results from the SPALY model (ADCAM) based on the March survey . Tac constraint of 96 000 tonnes for 2005.

2005				
B3+	SSB	Fmult	F4-7	Landings
278	182	0.94	0.412	96

2006					2007	
B3+	SSB	Fmult	F4-7	Landings	B3+	SSB
411	253	0.2	0.088	31	566	410
411	253	0.3	0.131	45	553	399
411	253	0.4	0.175	59	541	388
411	253	0.5	0.219	73	529	378
411	253	0.6	0.263	86	517	368
411	253	0.7	0.307	98	506	359
411	253	0.8	0.351	110	496	350
411	253	0.9	0.394	122	485	341
411	253	1	0.438	133	476	333
411	253	1.1	0.482	144	466	325
411	253	1.2	0.526	155	457	318
411	253	1.3	0.57	165	448	310
411	253	1.4	0.614	174	440	303
411	253	1.5	0.657	184	431	296
411	253	1.6	0.701	193	423	290
411	253	1.7	0.745	202	416	283
411	253	1.8	0.789	211	408	277
411	253	1.9	0.833	219	401	271
411	253	2	0.877	227	394	266

Table 3.4.7.4 Haddock in division Va. Output from short term prediction using results from the SPALY model (ADCAM) based on the Autumn survey . Tac constraint of 96 000 tonnes for 2005.

2005				
B3+	SSB	F mult	F4-7	landings
217	144	1.119	0.549	96

2006					2007	
B3+	SSB	F mult	F4-7	Landings	B3+	SSB
280	174	0.2	0.098	24	374	275
280	174	0.3	0.147	35	364	267
280	174	0.4	0.196	46	355	259
280	174	0.5	0.245	56	346	251
280	174	0.6	0.295	66	337	244
280	174	0.7	0.344	75	329	236
280	174	0.8	0.393	84	321	230
280	174	0.9	0.442	93	313	223
280	174	1	0.491	102	306	217
280	174	1.1	0.54	110	299	211
280	174	1.2	0.589	118	292	205
280	174	1.3	0.638	125	285	200
280	174	1.4	0.687	132	279	195
280	174	1.5	0.736	139	273	190
280	174	1.6	0.785	146	267	185
280	174	1.7	0.835	153	261	180
280	174	1.8	0.884	159	256	176
280	174	1.9	0.933	165	250	172
280	174	2	0.982	171	245	168

Table 3.4.7.5 Haddock in division Va. Output from short term prediction using results from the SPALY model (ADCAM) based on the Autumn survey . Tac constraint of 96 000 tonnes for 2005. The shaded row indicates the TAC for 2006 from the SPALY run based on the March survey and F_{2006}=0.47

	2006			2007			2008		
Tac	SSB	B3+	F4-7	SSB	F4-7	bio307	SSB	bio308	F
90	174	280	0.424	226	0.334	316	255	316	0.292
95	174	280	0.452	222	0.363	311	247	307	0.324
100	174	280	0.481	218	0.393	307	239	298	0.358
105	174	280	0.511	215	0.425	303	231	289	0.396
110	174	280	0.542	211	0.46	298	224	280	0.438
115	174	280	0.573	207	0.496	294	216	271	0.485
120	174	280	0.605	204	0.535	290	208	262	0.538
125	174	280	0.638	200	0.576	285	200	252	0.598
130	174	280	0.671	196	0.62	281	192	243	0.666
135	174	280	0.706	193	0.667	277	184	234	0.743
140	174	280	0.741	189	0.717	272	176	225	0.834

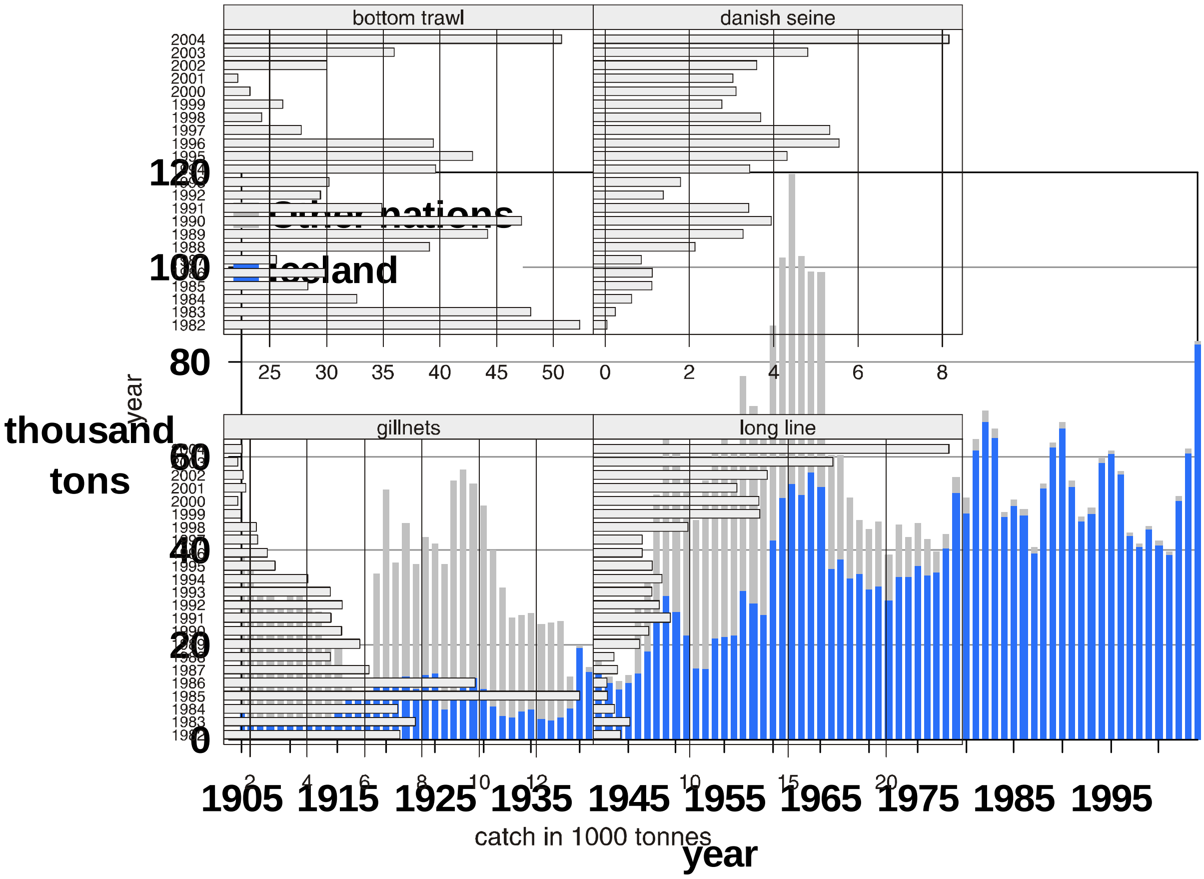


Figure 3.4.2.1 Haddock Division VA. Nominal landings (tonnes) 1905 – 2004.

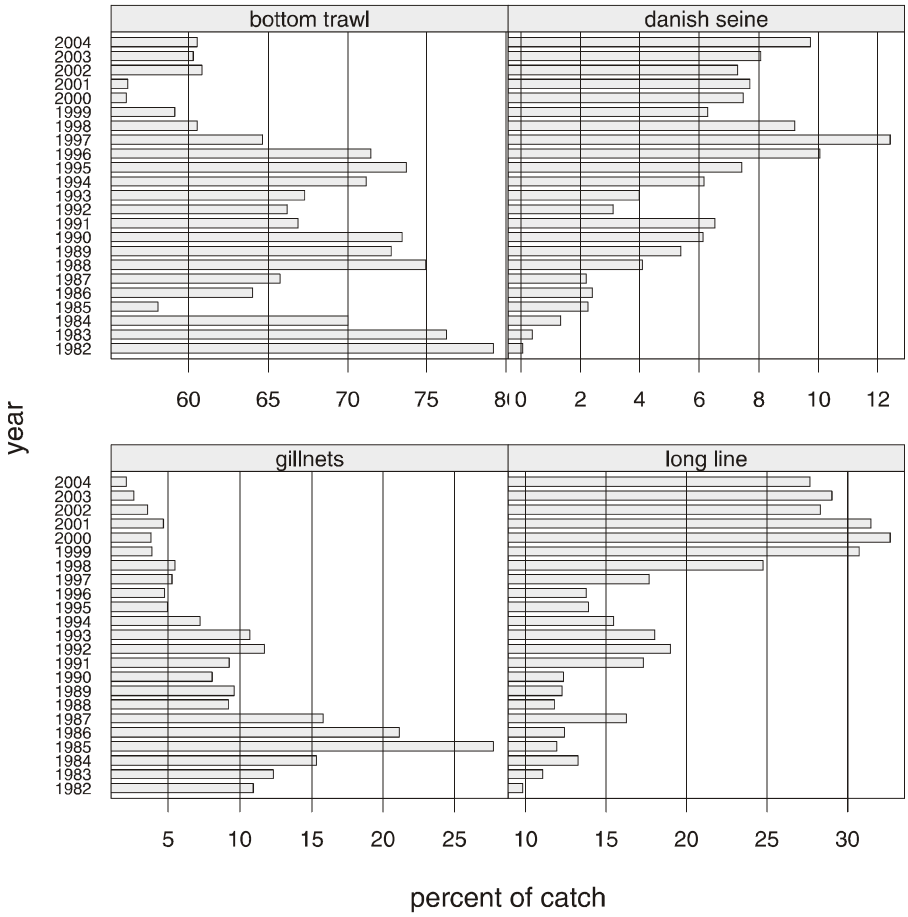


Figure 3.4.2.2 Haddock Division VA. Landings in percent of total by gear and year. The upper picture shows landings in tons and the lower percent of total.

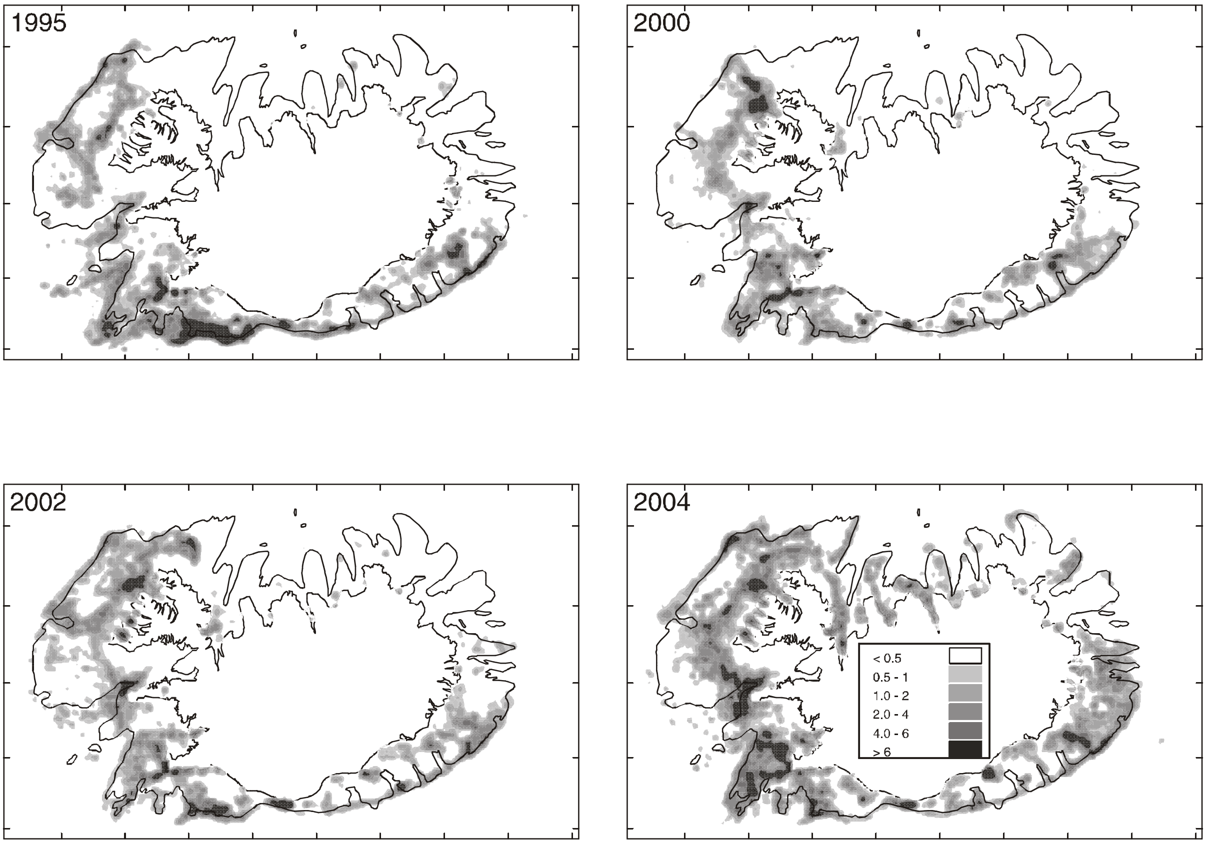


Figure 3.4.2.3 Haddock Division VA. Spatial distribution af landings. The legend show tonnes per square mile. .

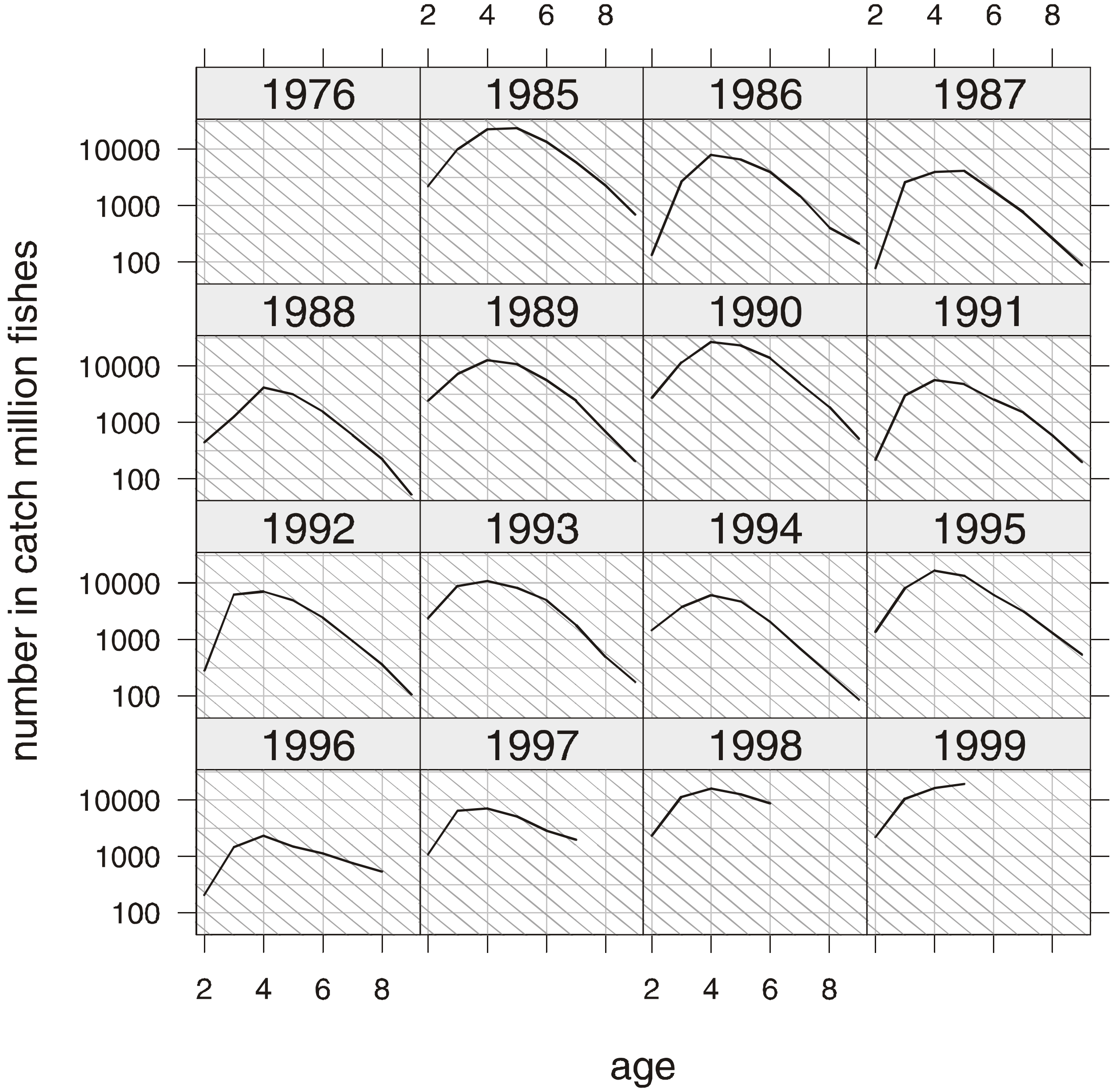


Figure 3.4.3.1. Haddock in division Va. Age disaggregated catch in numbers plotted on log scale. The grey lines show Z = 1.

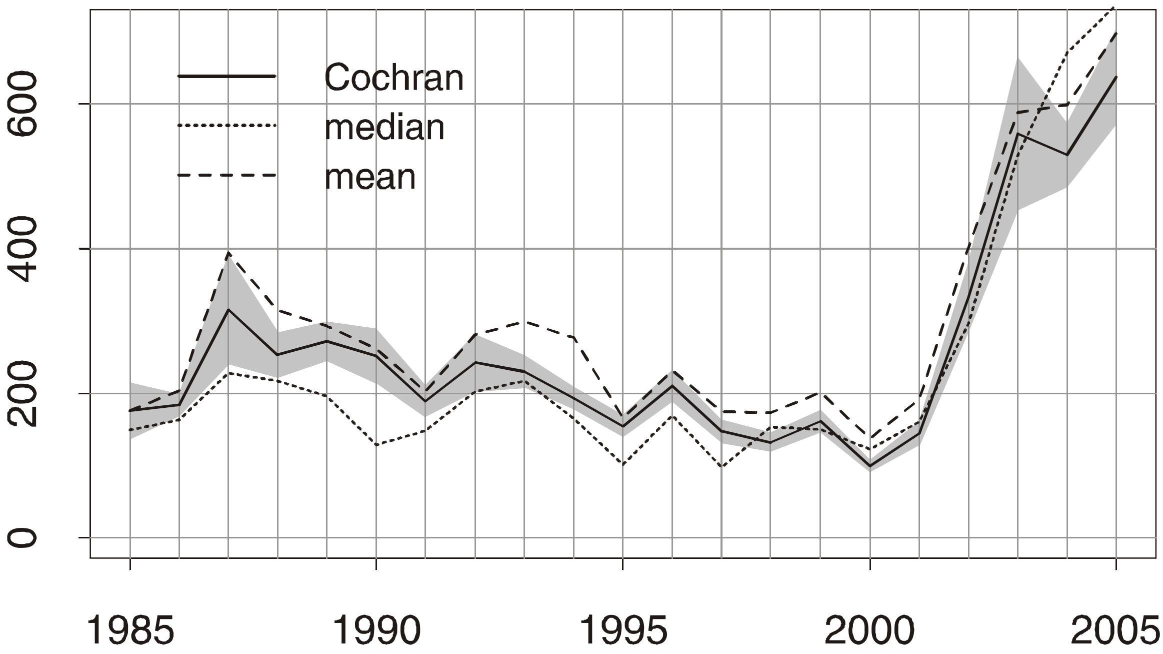


Figure 3.4.5.1. Haddock in division va. Total biomass index from the groundfish survey. 1000 tonnes. The shaded area shows show the standard error in the estimate of the indices. Indices based on unweighed mean of all stations and number of stations with haddock times median of the haddock catch at those stations are shown for comparison.

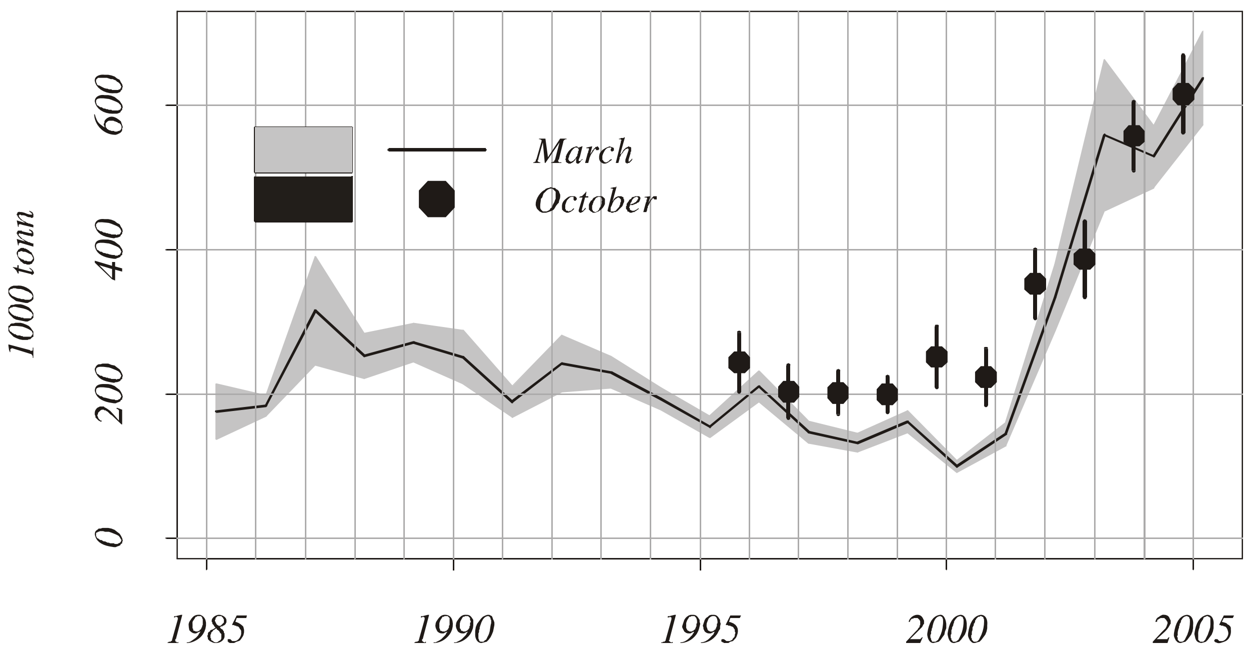


Figure 3.4.5.2 Icelandic haddock. Total biomass indices from the groundfish surveys in March (lines and shading) and the groundfish survey in October vertical segments. The standard error in the estimate of the indices is shown in the figure.

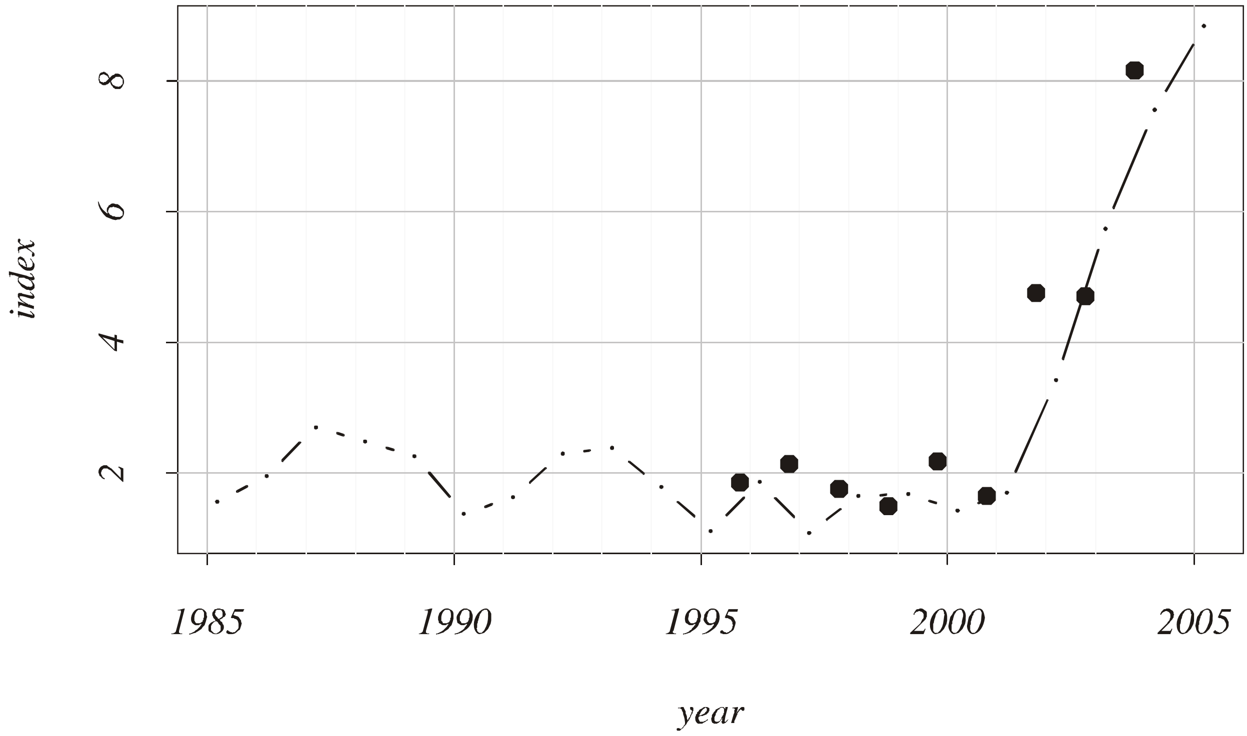


Figure 3.4.5.3 Icelandic haddock. Median indices from the groundfish survey in March and the autumn survey. The index is calculated as the number of stations where haddock is caught times median of the haddock catch at those stations are shown for comparison. The line show the March survey and the dots the autumn survey.

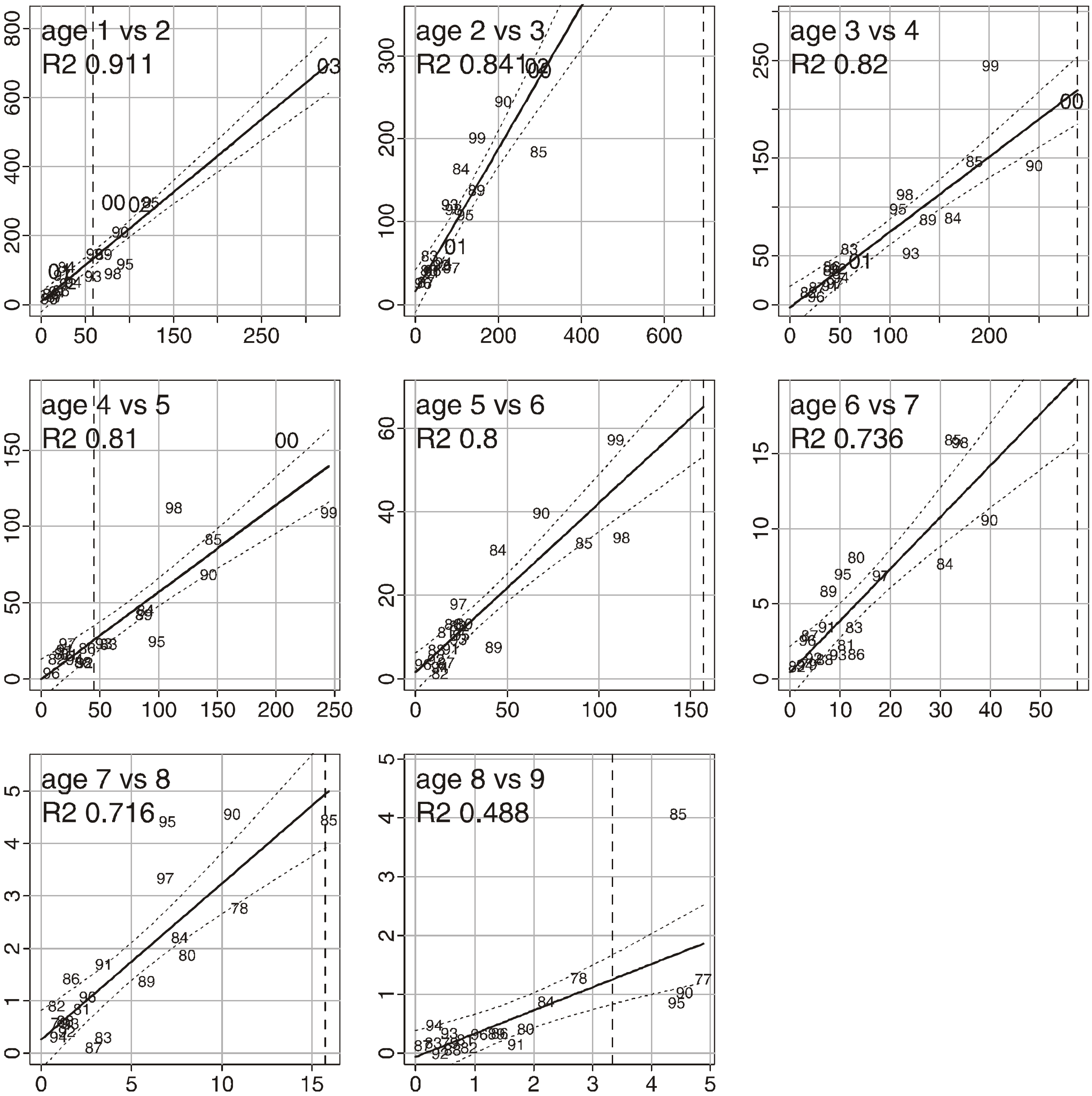


Figure 3.4.5.4 Haddock in division Va. Indices from March survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values.

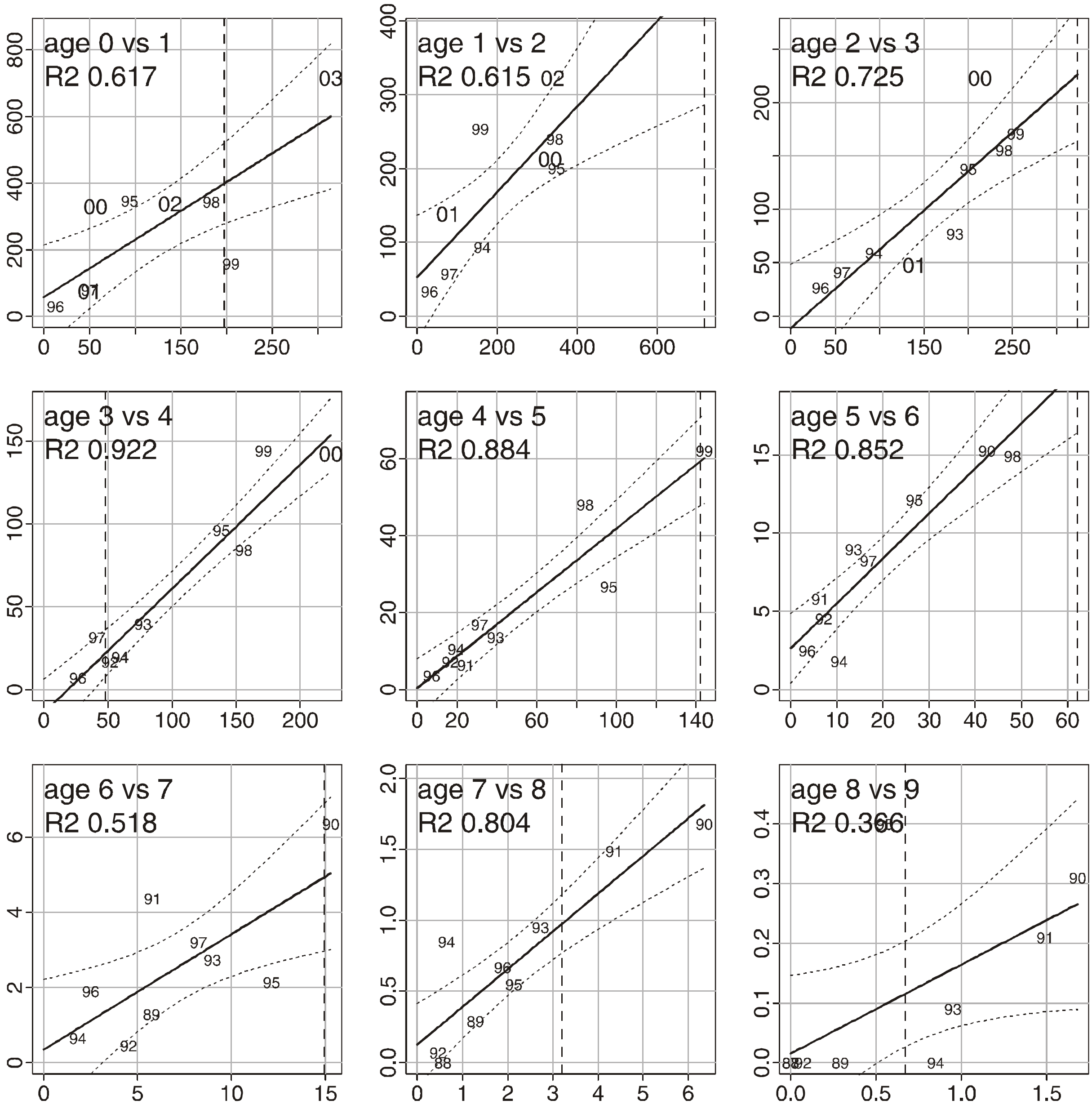


Figure 3.4.5.5 Haddock in division Va. Indices from October survey plotted against indices of the same year class one year earlier. The letters in the figure are year classes. The dashed vertical lines show the most recent values. .

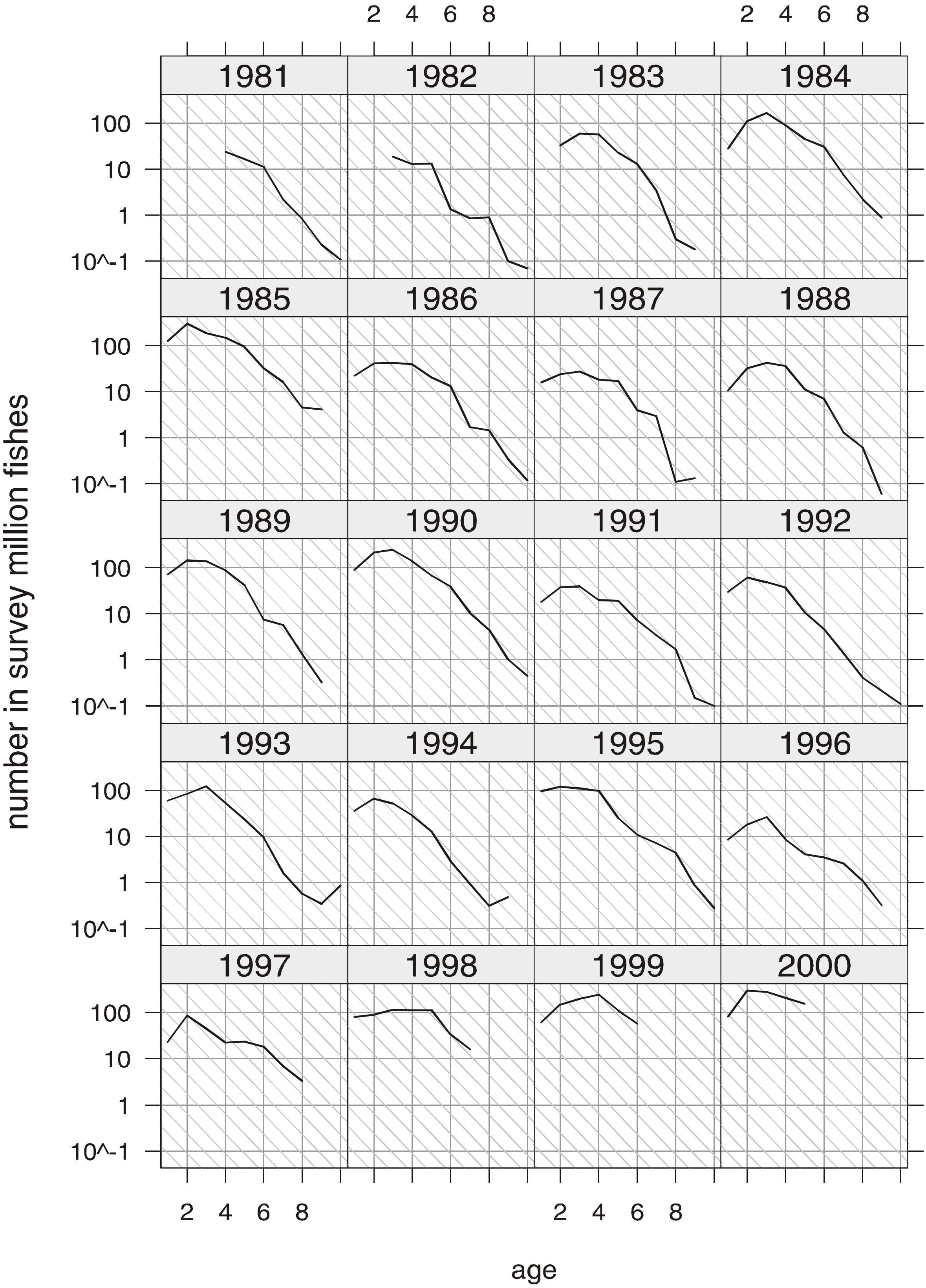


Figure 3.4.5.6. Catchcurves from the groundfish survey in March. Grey lines show Z=1.

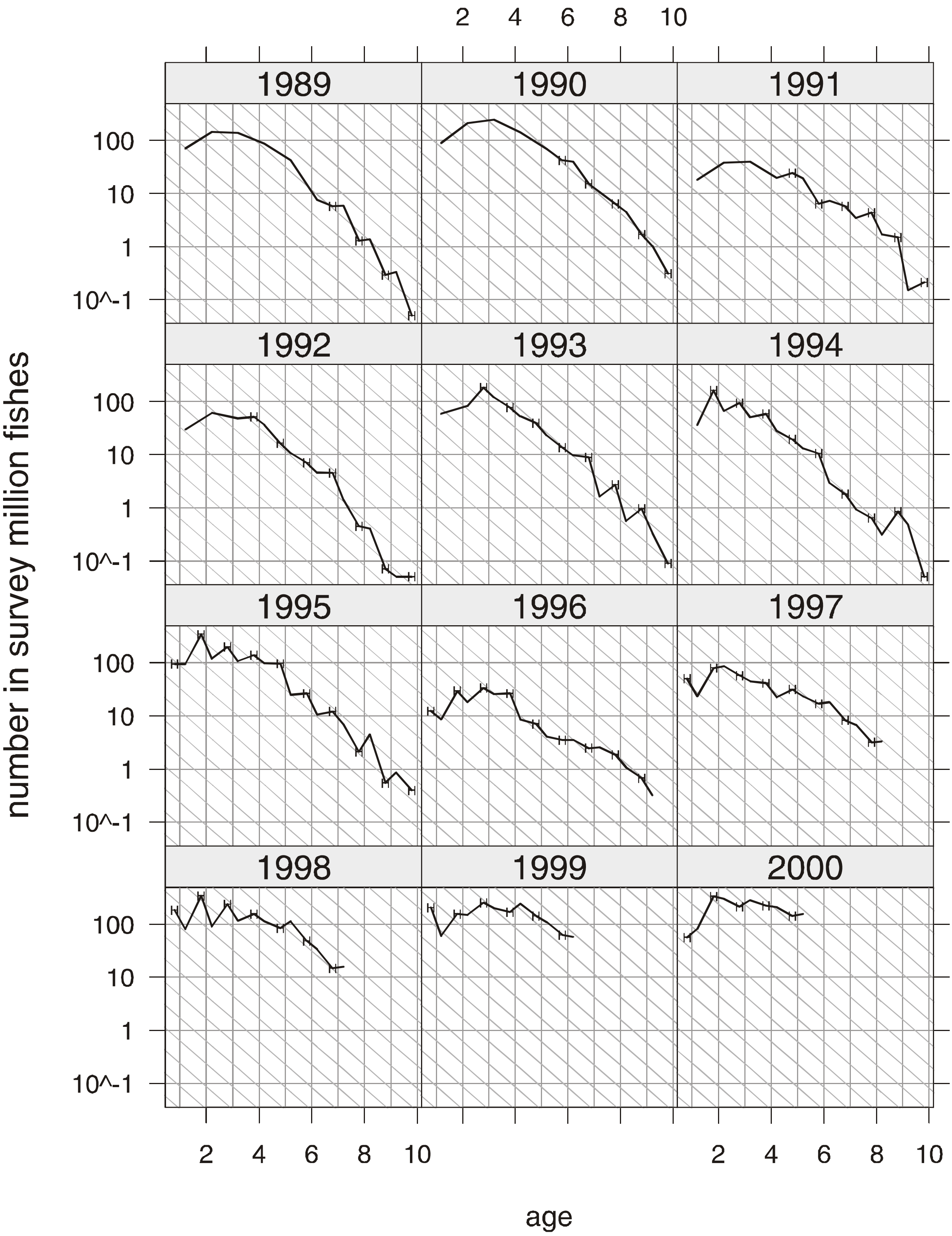


Figure 3.4.5.7. Catchcurves from the groundfish surveys in March and October. Grey lines show Z=1. Points from the autumn survey are labelled "H".

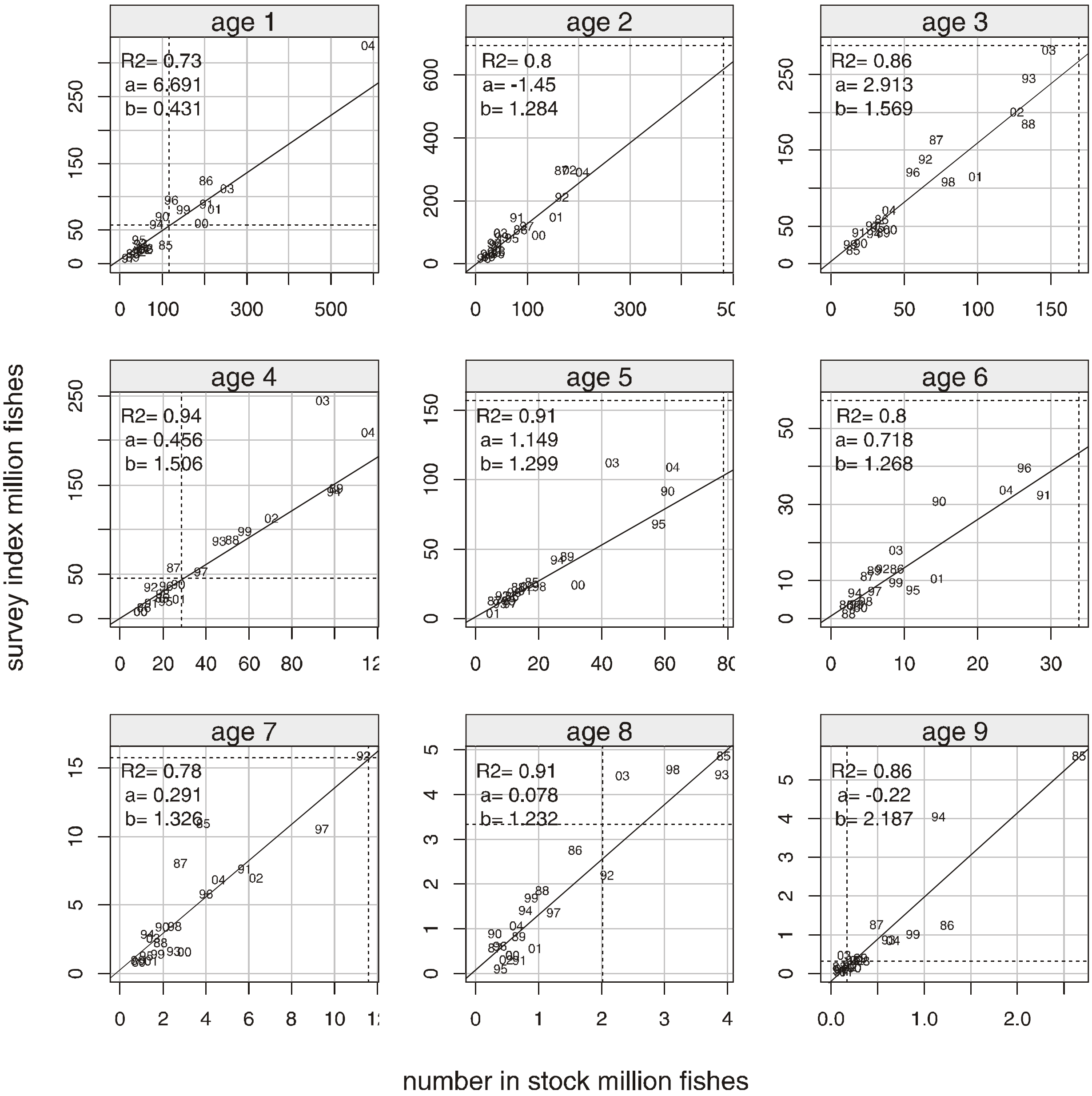


Figure 3.4.5.8 Icelandic haddock. Abundance indices from the March survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses the data until 2001. Dashed lines show most recent estimates..

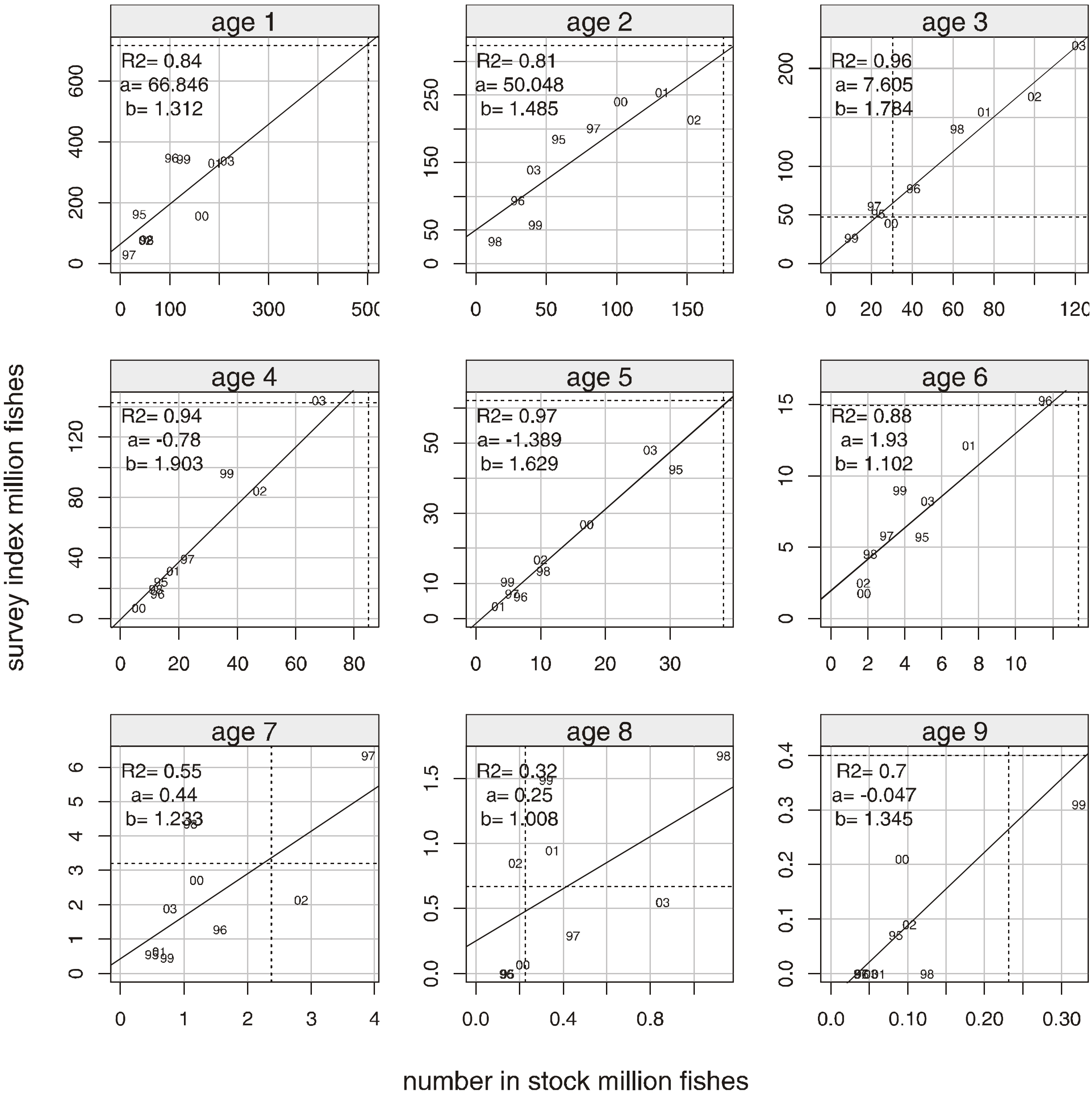


Figure 3.4.5.9 Icelandic haddock. Abundance indices from the October survey vs. number in stock according to the SPALY run from last year. Line fitted through origin on original scale. . The fitted line uses all the data as the assessment is not using the autumn survey.

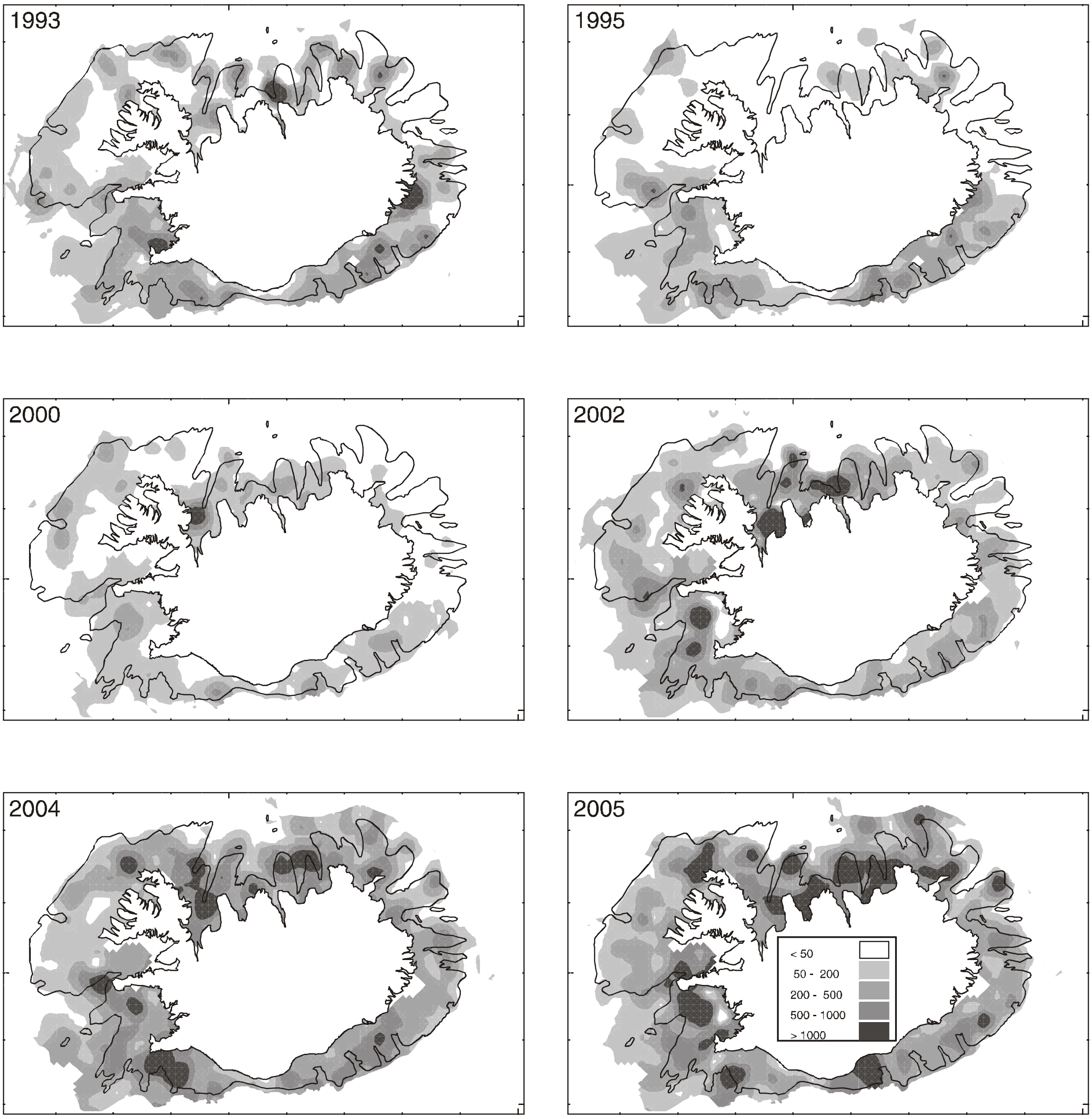


Figure 3.4.5.10. Spatial distribution of haddock in the groundfish survey in March. The legend show kg per hour towed.

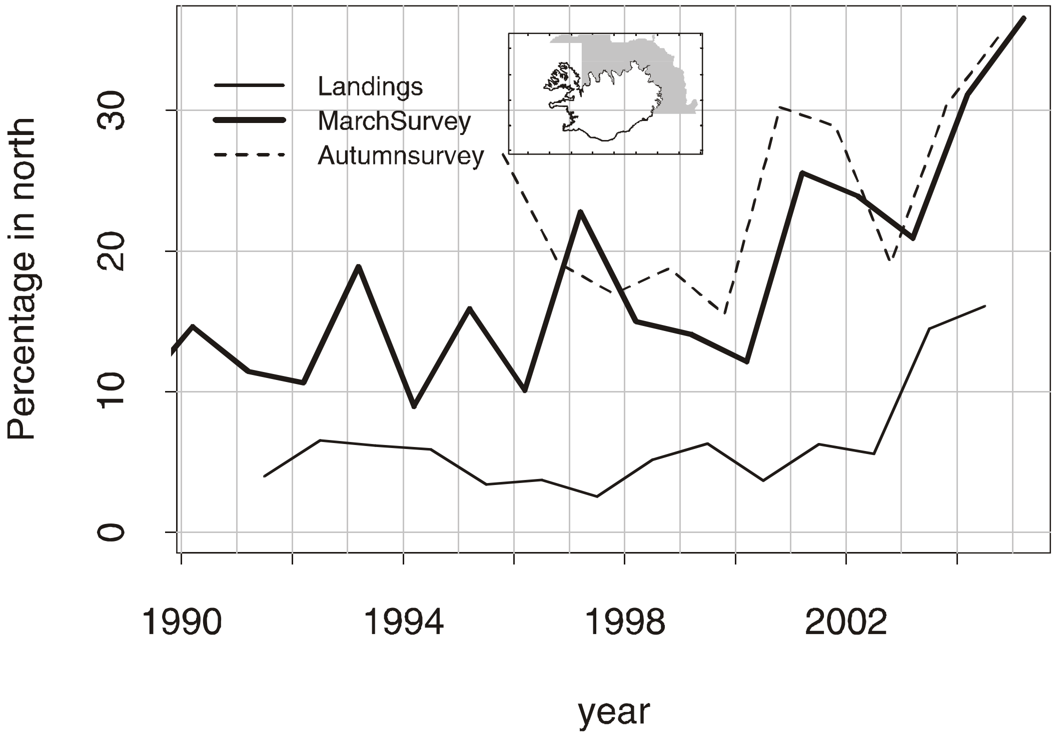


Figure 3.4.5.11. Proportion of the landings and the biomass of 42cm and older haddock that is in the north area. The figure shows the northern area.

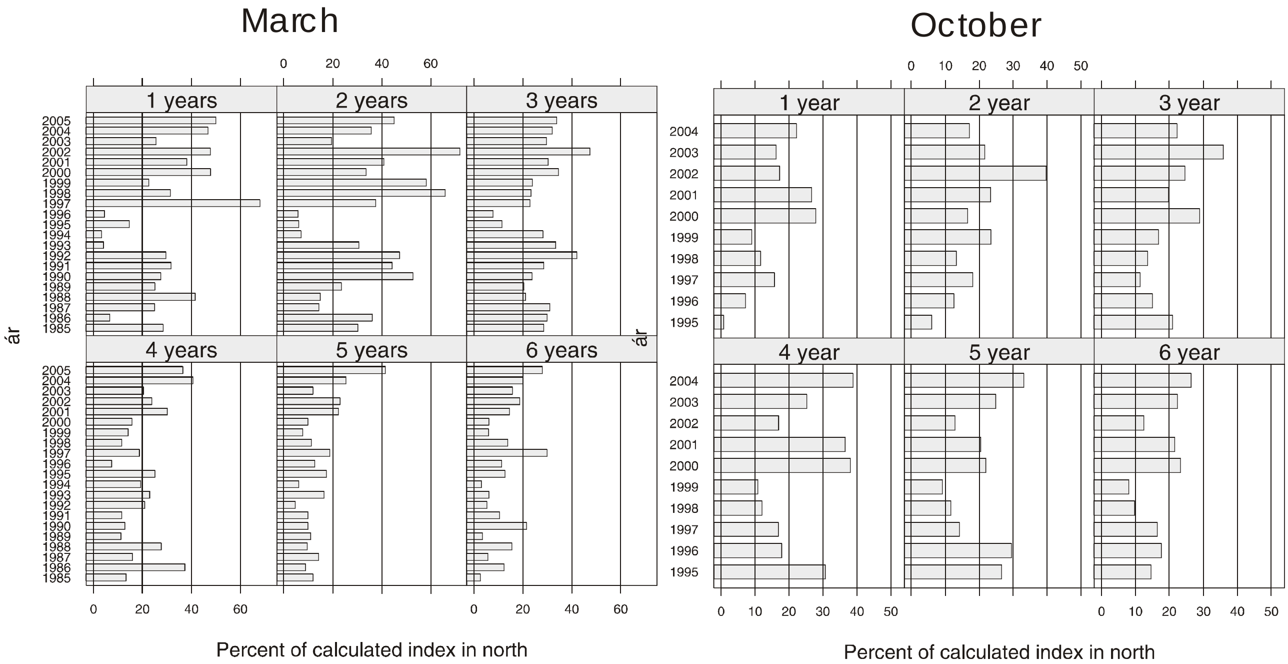


Figure 3.4.5.12. Proportion of each age group in the northern area in March and October. .

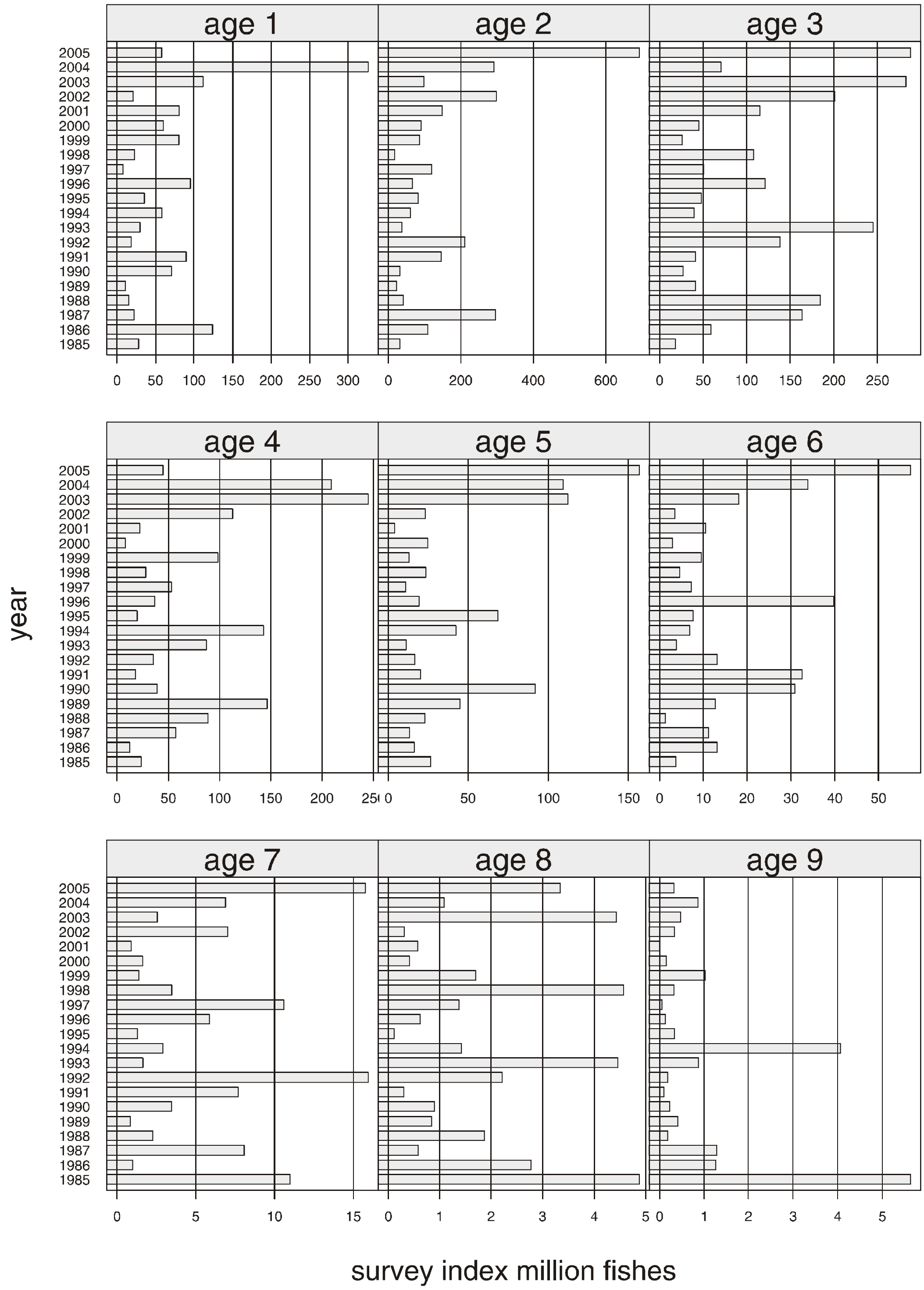


Figure 3.4.5.13. Age disaggregated survey indices for haddock. The figure shows indices from the groundfish survey in March.

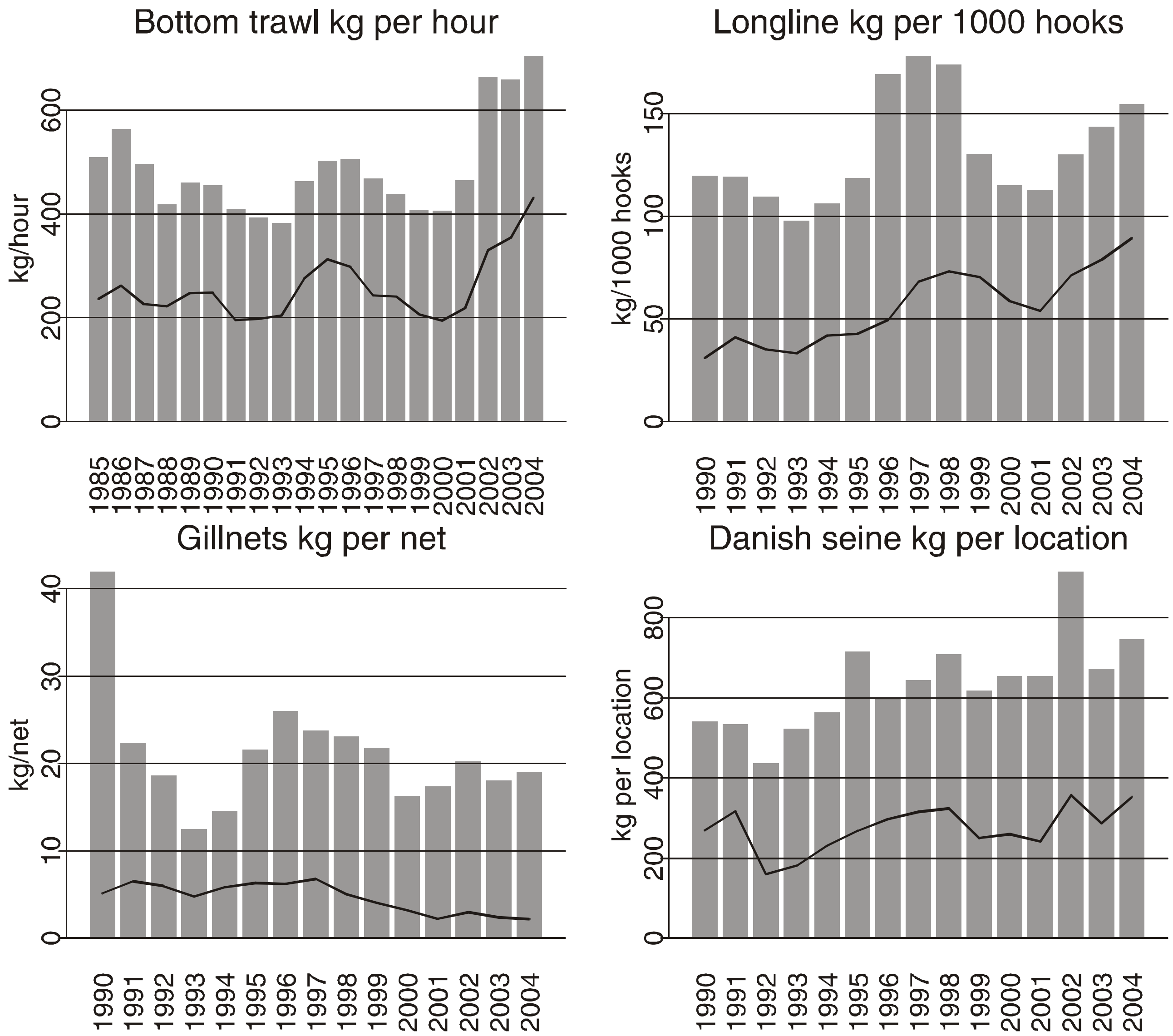


Figure 3.4.5.14. Catch per unit effort in the most important gear types. The figure is based on locations where more than 50% of the catch is haddock. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return log-books but later all vessels were required to return logbooks.

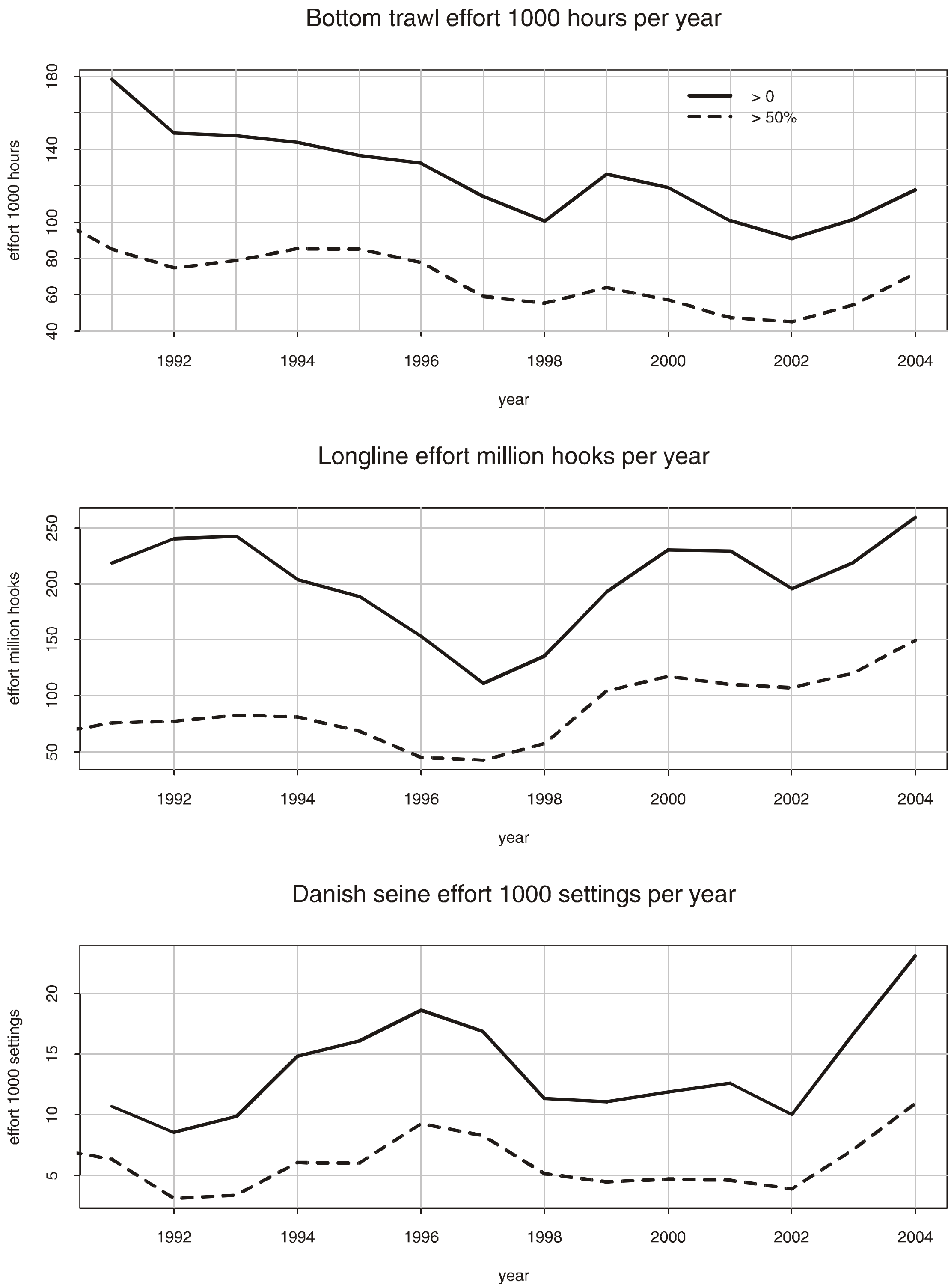


Figure 3.4.5.15. Effort towards haddock. The effort is calculated as the ratio of the total landings for the gear and the CPUE based on records where haddock was more than 50% of the registered catch.

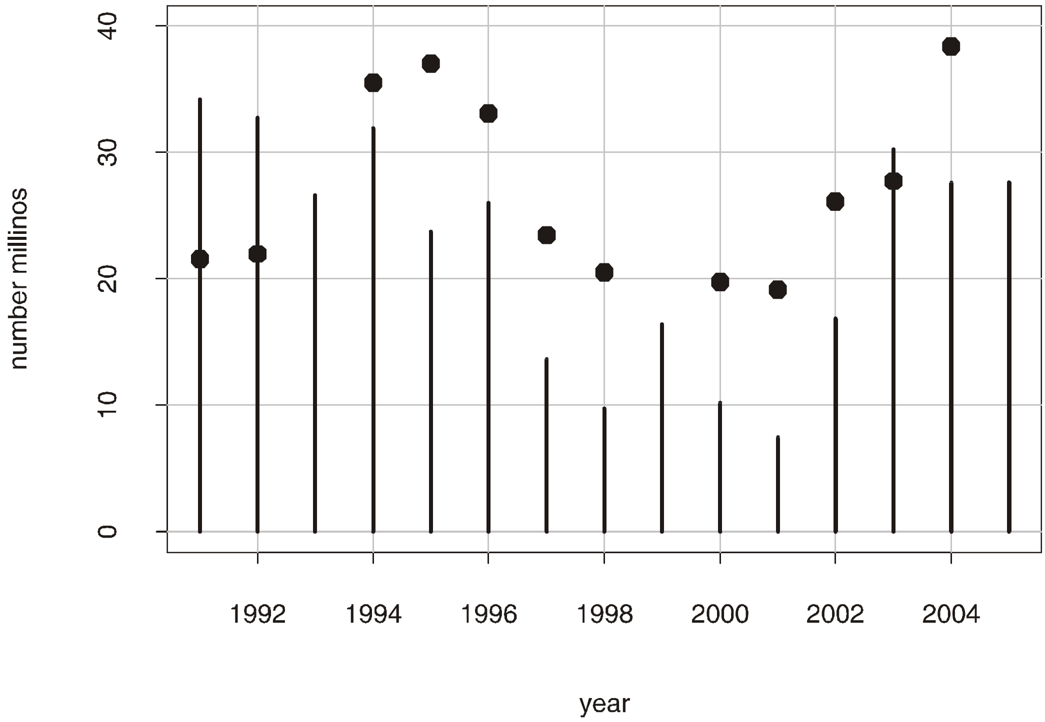


Figure 3.4.5.16. Number of haddock caught. The number is calculated by multiplying the mean number of 42cm and larger haddock per hour in the groundfish survey in March in each statistical square (1/2x1degree) by the trawling effort in that square. Catch in number for bottom trawl is shown for comparison (the dots).

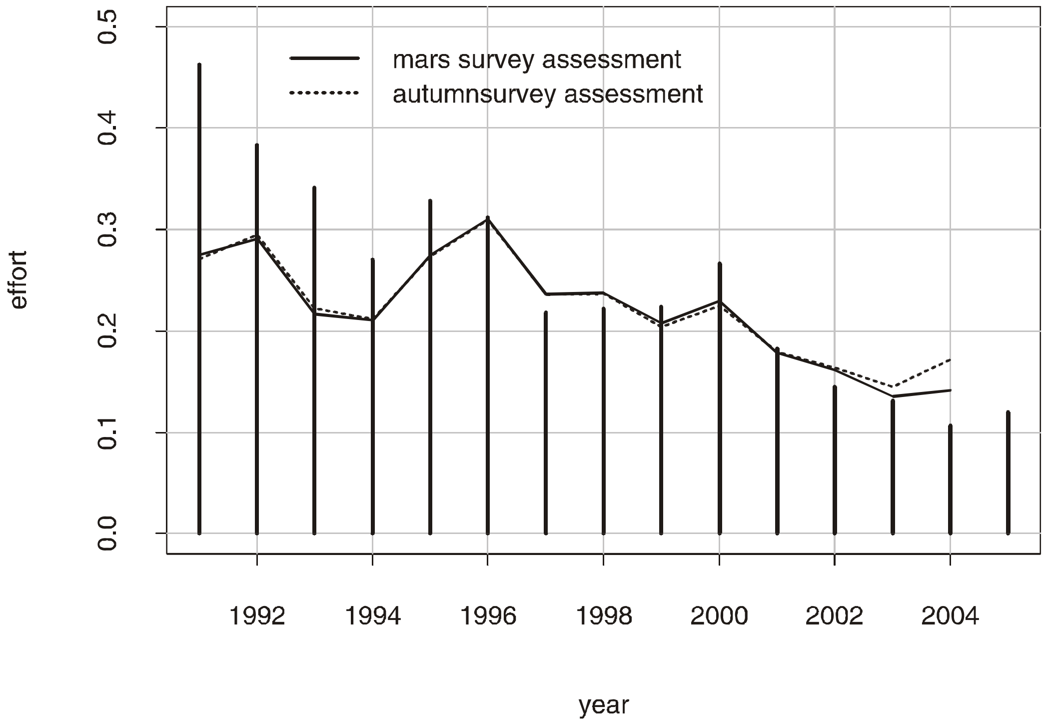


Figure 3.4.5.17. Index of proportion of haddock larger than 42cm caught by bottom trawl each in each year. The index is calculated by dividing the total number caught as shown in figure 3.4.15 by the abundance index from the survey. Proportion of age 4 and older caught according to assessment is shown for comparison

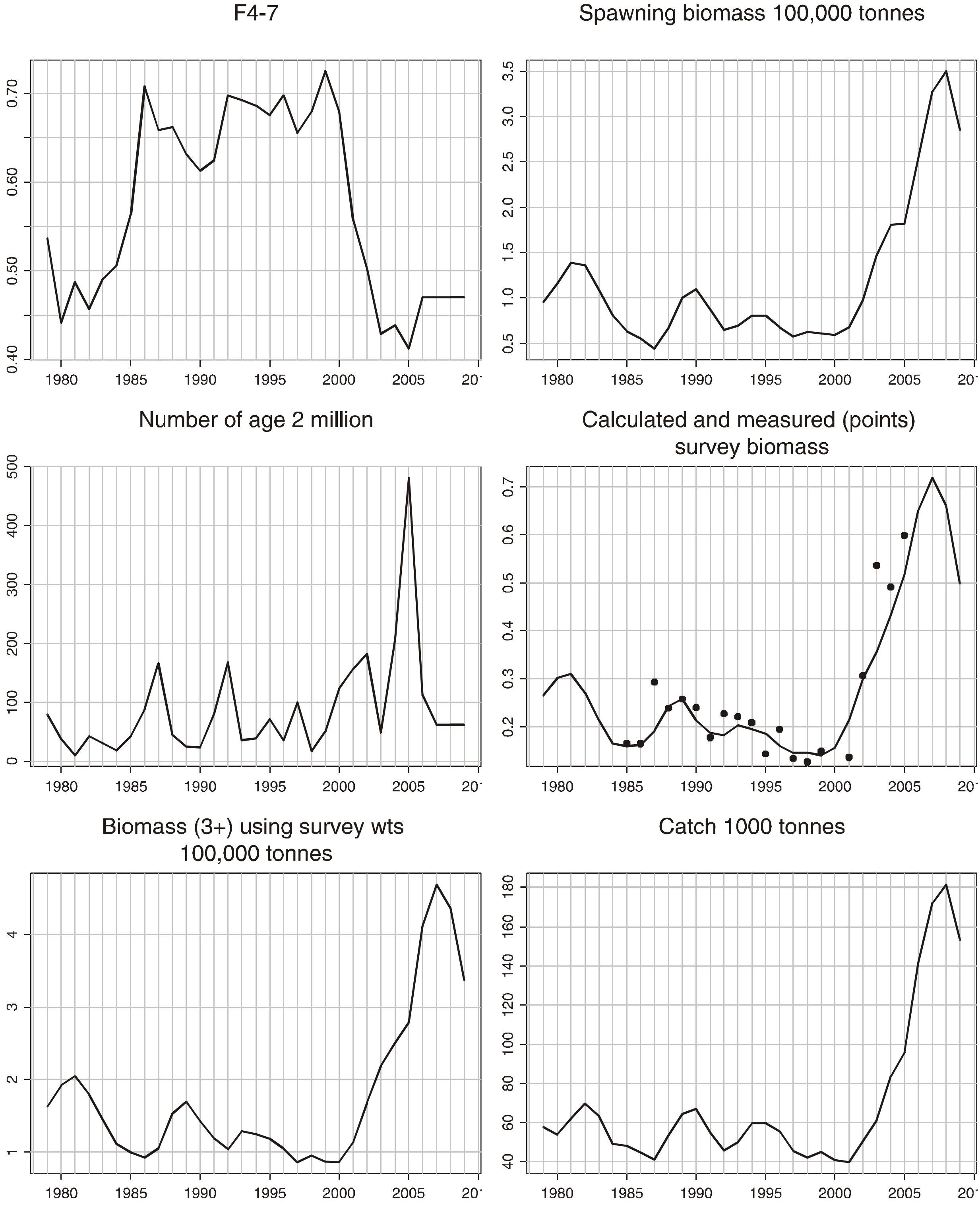


Figure 3.4.6.1. Haddock in division Va. Summary plots from the SPALY run using the March survey

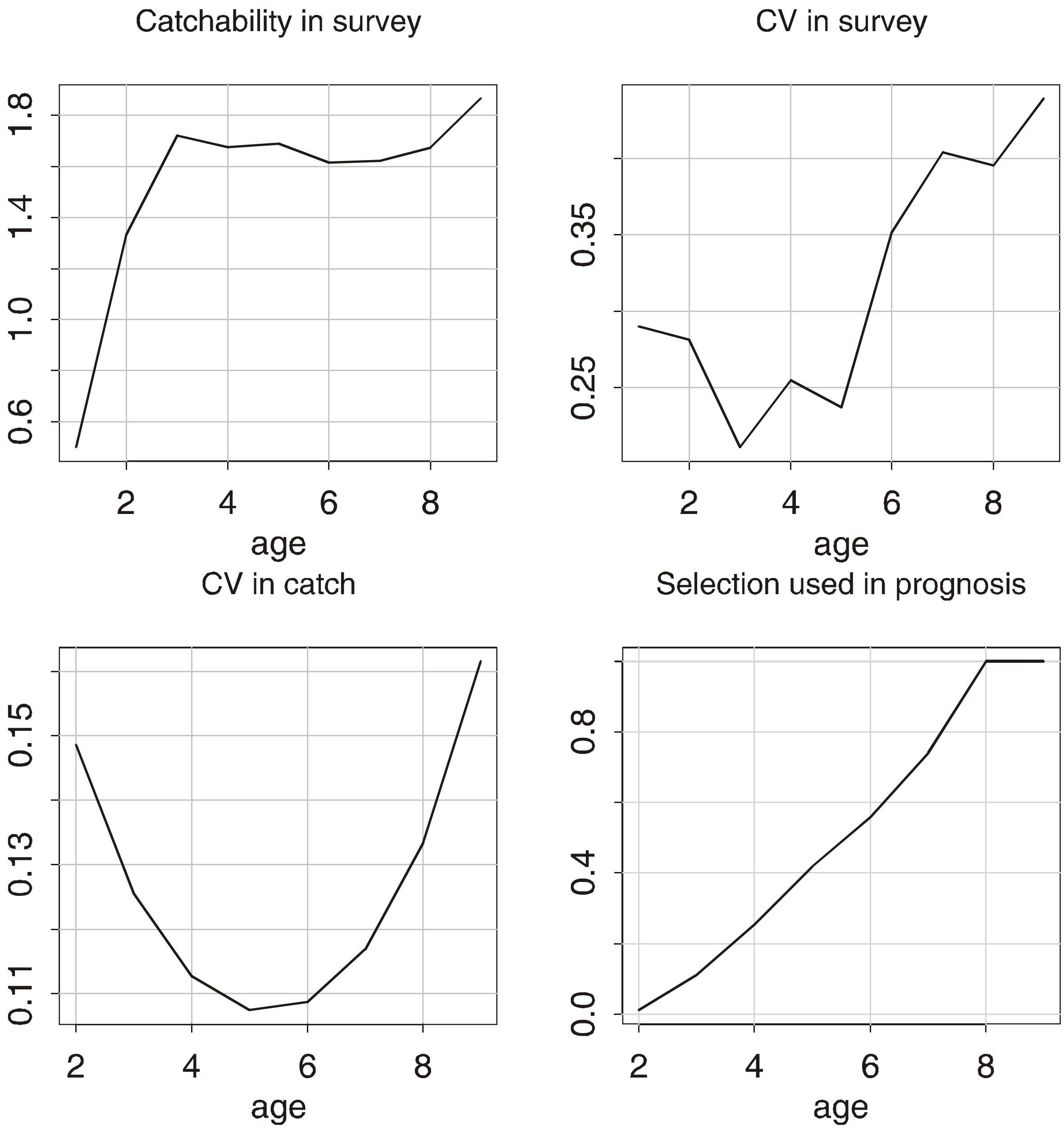


Figure 3.4.6.2. Haddock in division Va. SPALY model based on the March survey. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

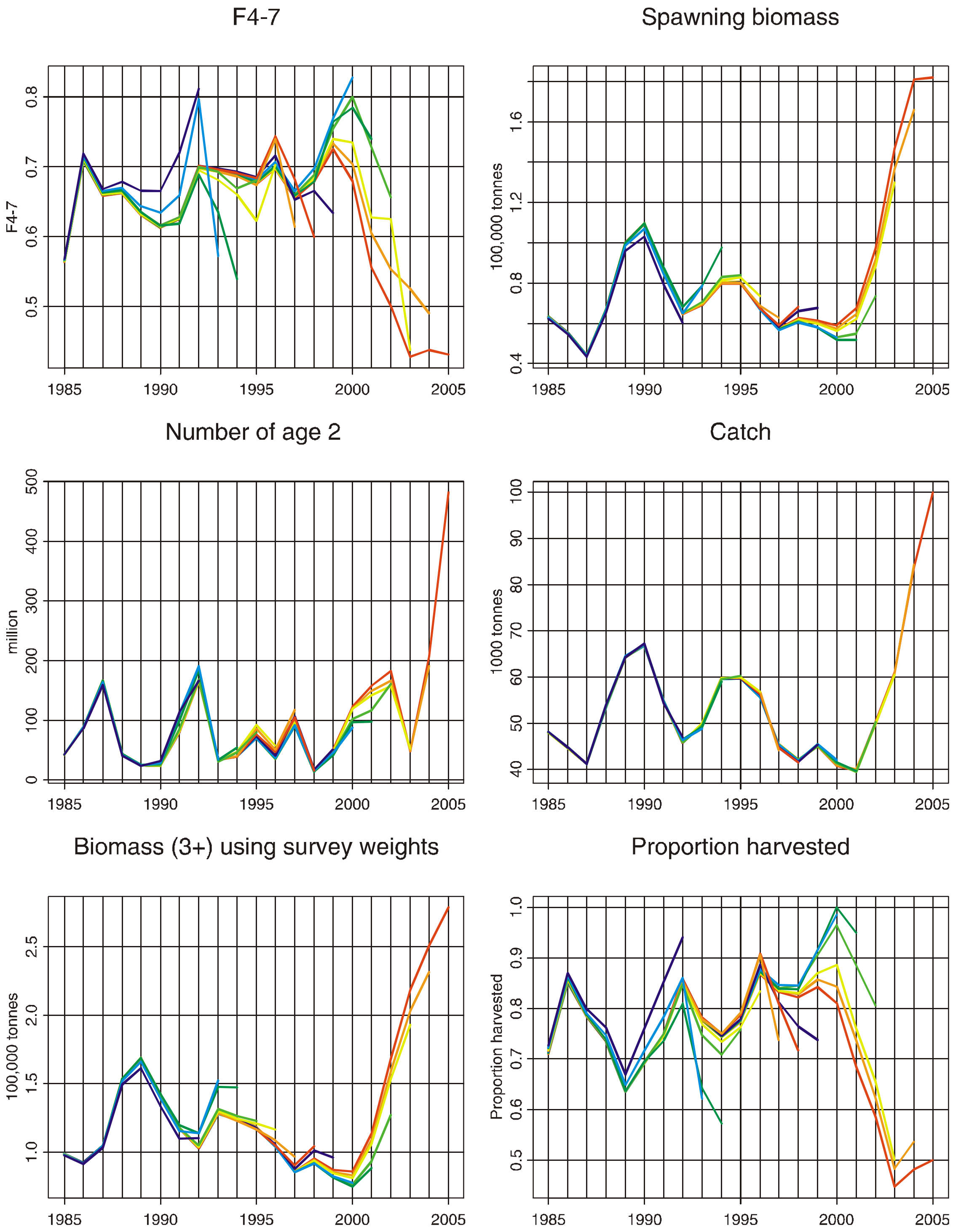


Figure 3.4.6.3 Haddock in division Va. Retrospective pattern from the ADCAM run using indices from age 1 to 9.

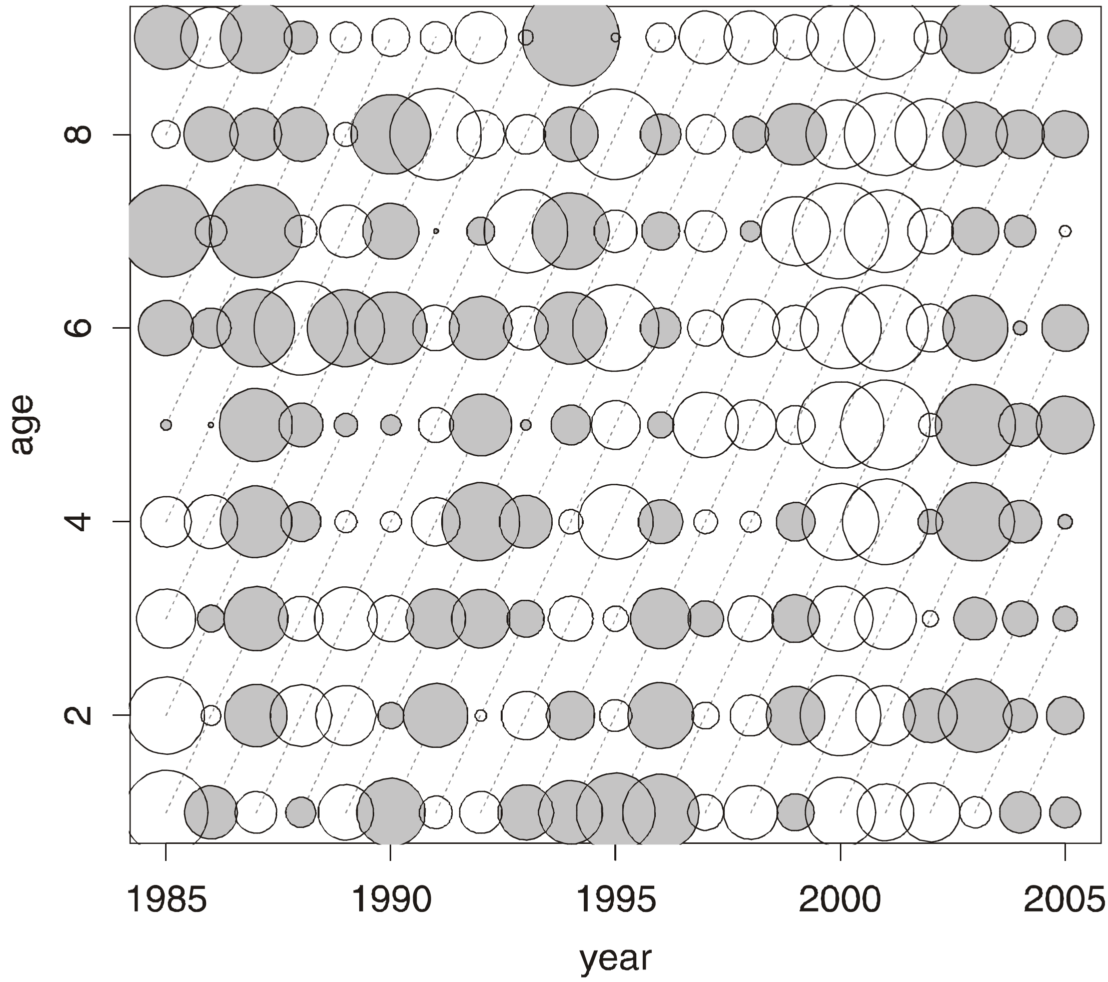


Figure 3.4.6.4 Residuals from the fit to survey data . $\frac{\log(I_{ay}+\varepsilon_{age})}{\log(I_{ay}+\varepsilon_{age})}$ Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles

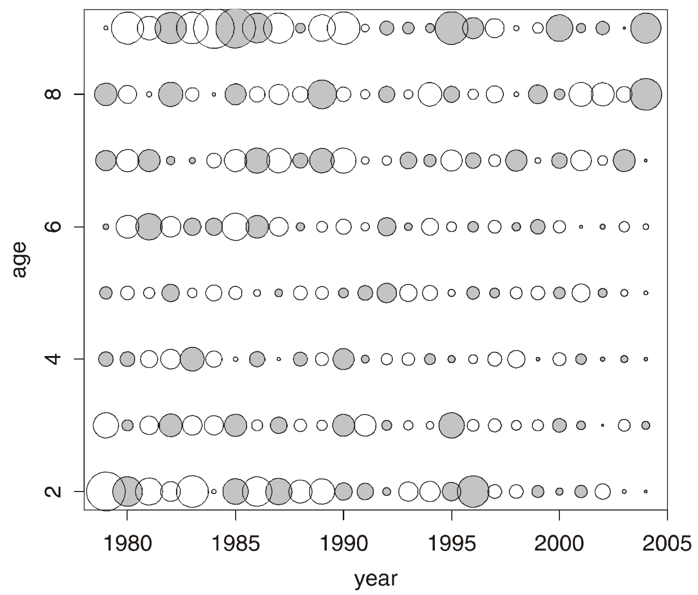


Figure 3.4.6.5 Haddock in division Va. Residuals from the model fit to catch at age data using the selected AD-cam model. .

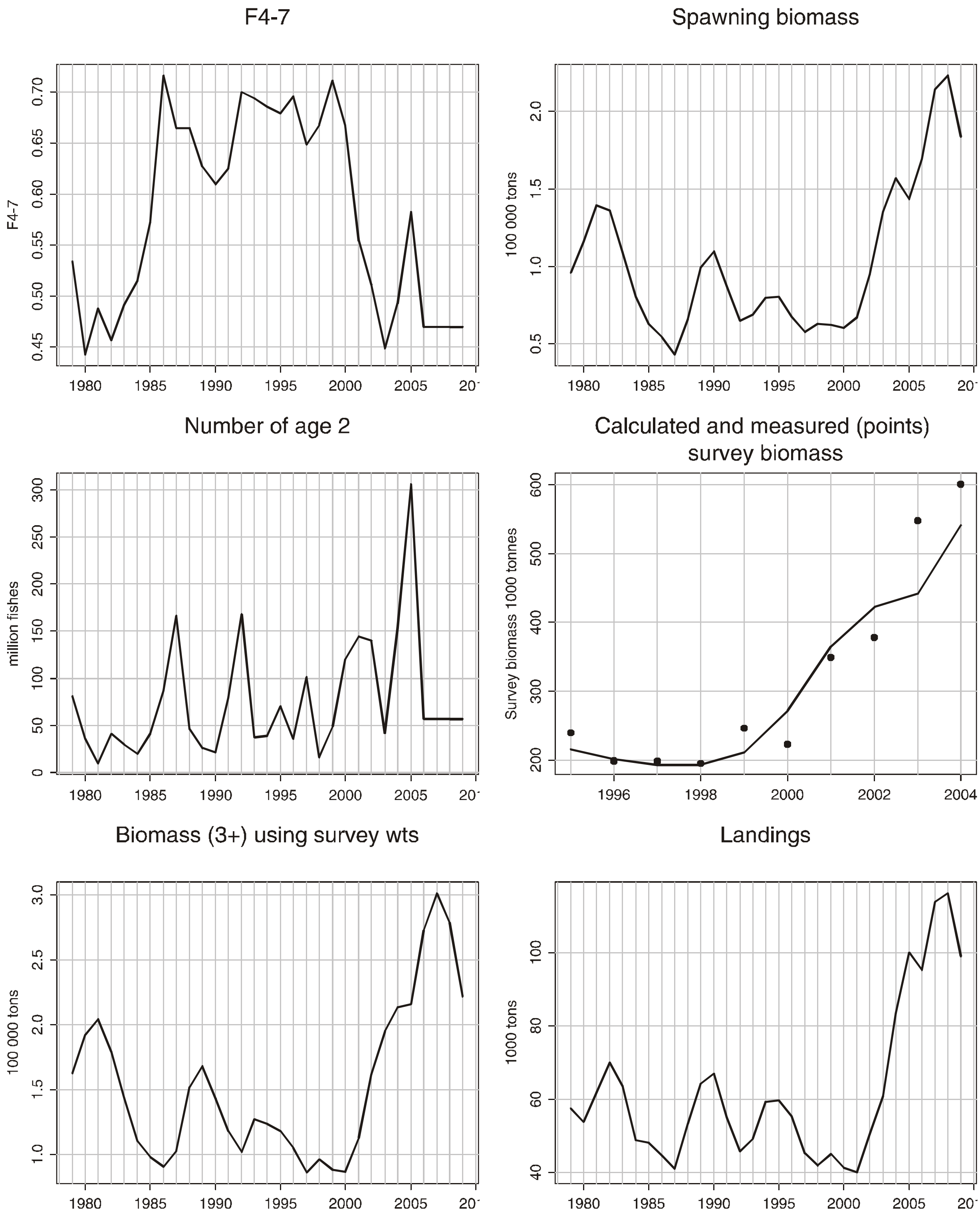


Figure 3.4.6.6. Haddock in division Va. Summary plots from the ADCAM run using the Autumn survey

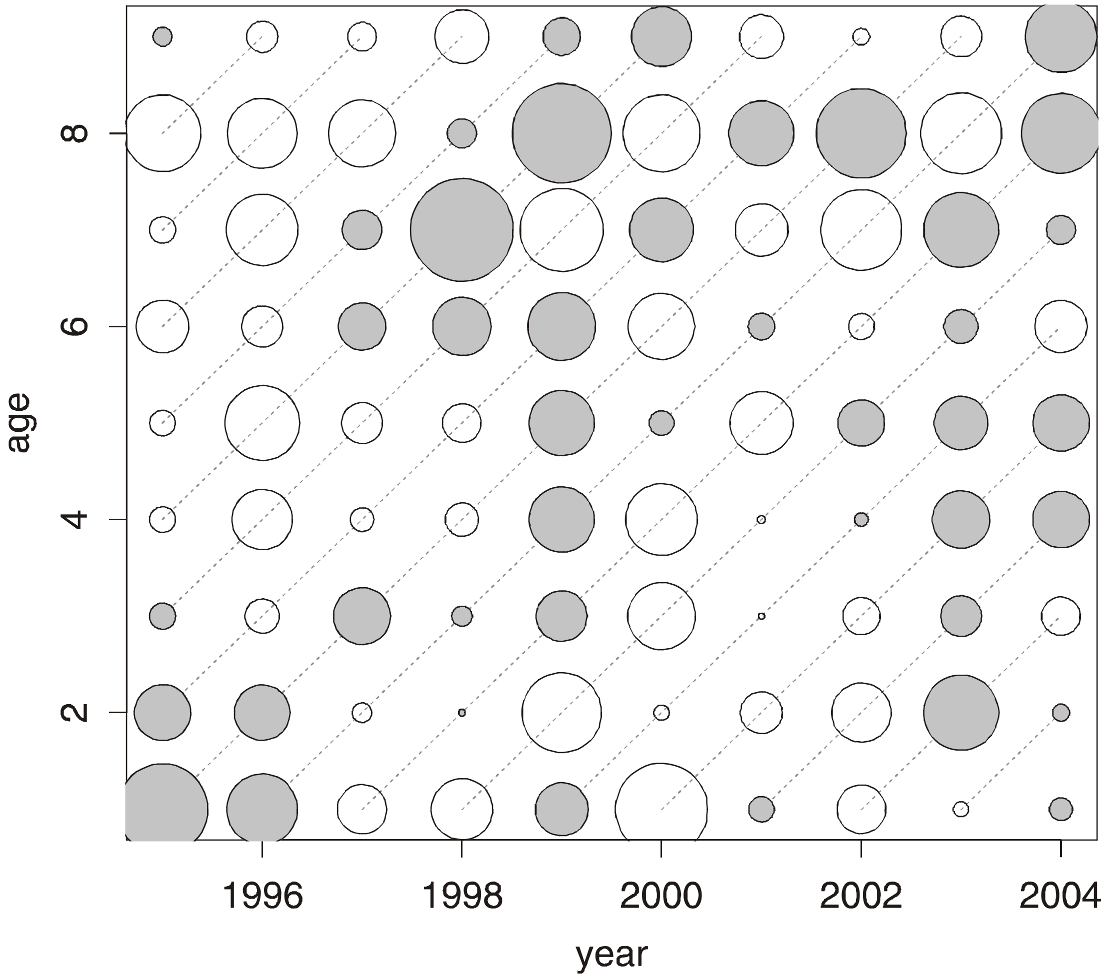


Figure 3.4.6.7 Residuals from the fit to survey data . $\frac{\log(I_{ay} + \boldsymbol{\varepsilon}_{age})}{\log(I_{ay} + \boldsymbol{\varepsilon}_{age})}$ from ADCAM run based on the autumn survey. Coloured circles indicate positive residuals (observed > modelled). The largest circle corresponds to a value of 0.78 and residuals are proportional to the area of the circles

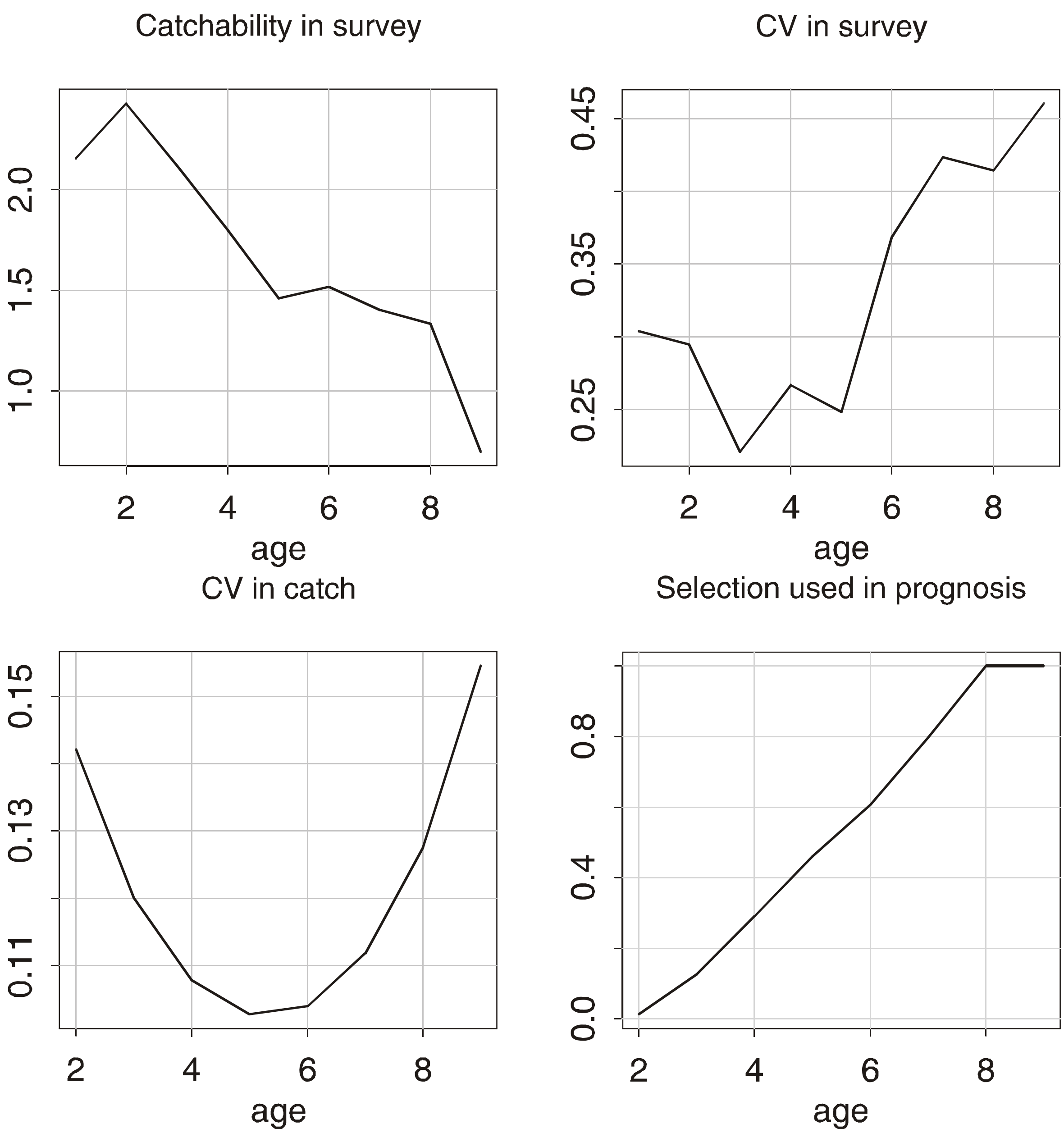


Figure 3.4.6.8. Haddock in division Va. ADCAM model based on the autumn survey. Model estimate of selection pattern and variance in survey and in the catch. Selection used in prognosis is the mean of last 5 years.

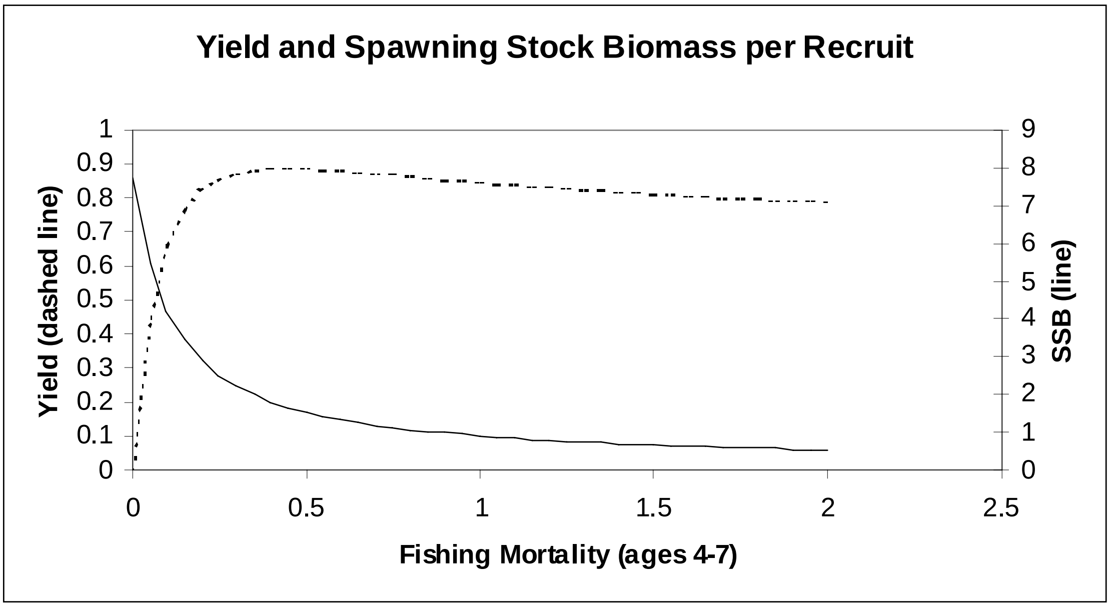


Figure 3.4.7.1 Haddock in division Va. Yield per recruit.

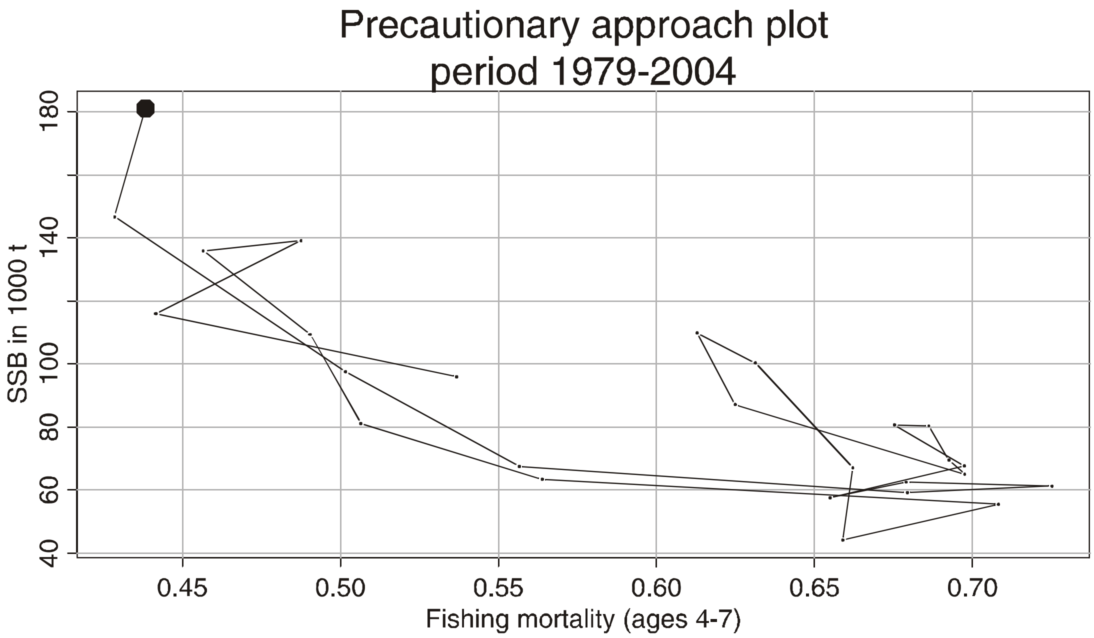


Figure 3.4.7.2 Haddock in division Va. Spawning stock vs. fishing mortality.

Figure 3.4.7.3 Haddock in division Va. Spawning stock vs. recruitment. . The labels in the figure show year classes.

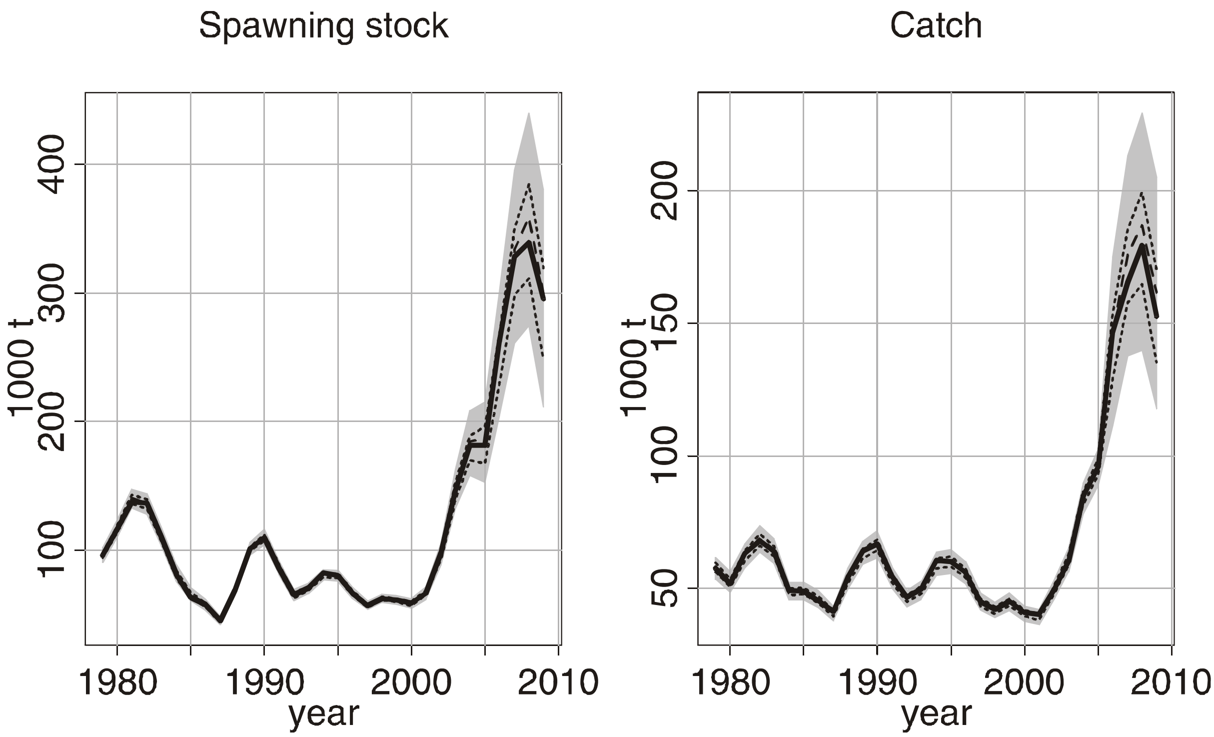


Figure 3.4.7.4 Haddock in division Va. Cumulative probability profiles of landings, and SSB according to the SPALY run based on the March survey. F=0.47 and 15%CV in assessment after

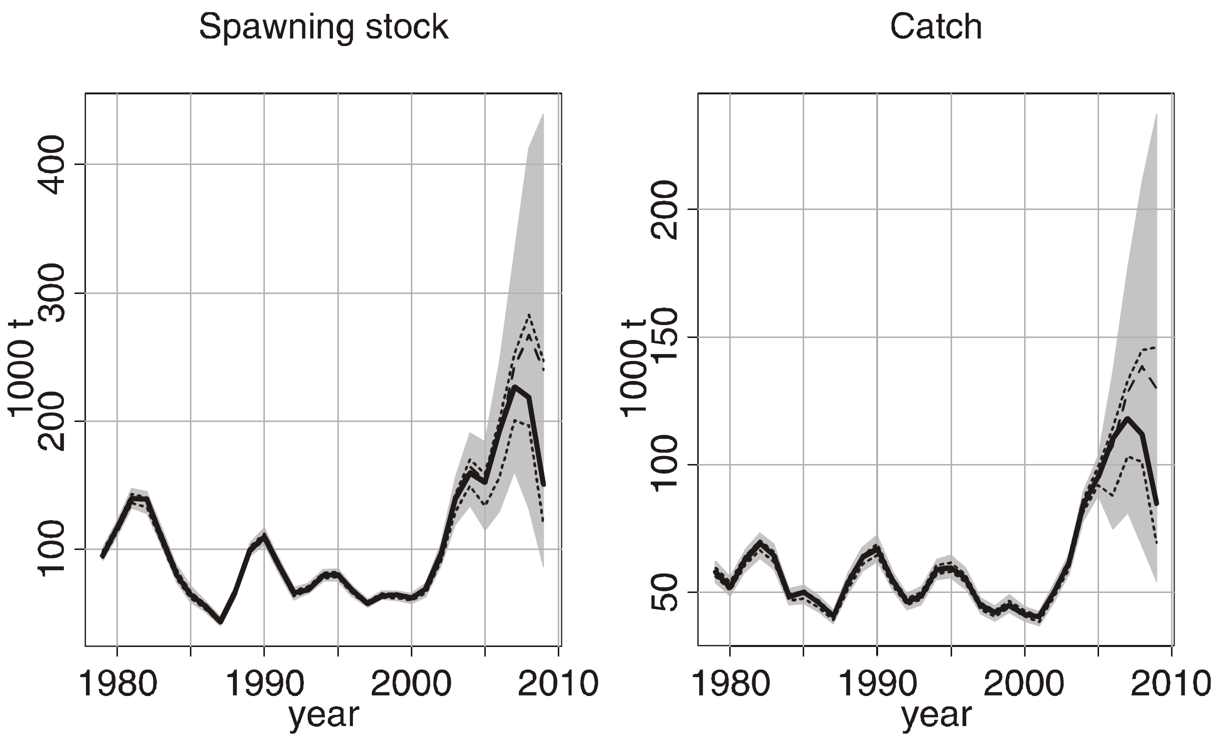


Figure 3.4.7.5 Haddock in division Va. Cumulative probability profiles of landings, and SSB according to the ADCAM run based on the Autumn survey. F=0.47 and 15%CV in assessment after

3.5 Icelandic summer spawning herring

This stock was assessed by the NPBWWG working group in 2004. The final assessment in 2004 was made by the assessment tool AMCI.

The herring fishery on Icelandic summer spawning herring started in late 18th century. The catches were low and until early 1960's the fishery was only autumn fishery. Year-round fishing started in early 1960s which lead to a high exploitation rate and a corresponding decline in stock biomass. This decline coincided with poor recruitment that could also have been influenced by cold environmental conditions during the late 1960s. The stock size of the Icelandic summer spawning herring declined from about 300 thous. t in the early 1960s to about 10 thous. t in the early 1970s. At the end of 1971 a moratorium on fishing the stock was accepted. It is estimated that at that time, the whole stock of 12 thous. t was overwintering in two schools southeast of Iceland. This very small spawning stock produced a relatively strong year class (1971) which became the basis of the recovery of the stock. The fishery was reopened in 1975 and then both seasonal restriction, September-December, and a minimum landing size of 27 cm were implemented. When the fishery started again it took place southeast of Iceland. Since the late 1970s the advice has been fishing at $F_{0.1}$, which has been followed by the Icelandic authorities.

3.5.1 Fishery

The landings of Icelandic summer-spawning herring by fishing season from 1983 - 2004 are given in Table 3.5.1.1 and in Figure 3.5.1.1. No discards were reported for the 2004/2005 season. The fishery started in September and terminated in January. The total landings were about 126 000 tonnes. Overview of geographical distribution of the catches is given in Figure 3.5.1.2. Since the fishing season 1997/98 there has been a fishery for herring both west and east of Iceland, which is unusual compared with earlier years when the fishable stock was found only south and east of Iceland.

In the fishing season 2004/05 a small part of the Norwegian spring spawning herring stock was mixed with the Icelandic summer spawning herring stock east of Iceland. Based on port inspections, it was estimated to be about 1200 t of NSSH mixed with the summer spawning herring.

3.5.2 Fleets and fishing grounds

Until 1990, the herring fishery took place during the last three months of the calendar year, but from 1990-2002 and in 2005 the autumn fishery has continued until January or early February of the following year. In 2003 the season was further extended to the end of April and in the summers of 2002 and 2003 an experimental fishery for spawning herring with a catch of about 5 000 t each year was conducted at the south coast. In 1994 the fishery started in September. Therefore, all references to the years 1990-1993 imply seasons starting in October of that year, but after that in September. Landings, catches and recommended TACs since 1984 are given in thous. tonnes in Table 3.5.1.1.

About 70% of the catch in 2004/05 was taken with traditional purse-seines and about 30% with pelagic trawls. The pelagic trawl fishery started in 1993/94, reached a peak in the fishing season 2002/03, but has declined since then (see Figure 3.5.2.1). Since the fishing season 1998/99, high proportion of the catches was taken west of Iceland. The ratio reached a peak in the fishing season 2002/03 but has declined since then and in the fishing season 2004/05 the main fishing grounds were southeast and east of Iceland.

In the fishing season 2003/04, area closures were common as small herring was frequently present in the catches (less than 27 cm), but in the fishing season 2004/05 there was only one area closure.

3.5.3 Catch in numbers, weight at age and maturity

Data from samples taken from purse seine and pelagic trawl were used to calculate catch in numbers at age for total landings in 2004. The catches of the Icelandic summer spawners in numbers at age for the period 1981- 2004 are given in Table 3.5.3.1.

Mean weight at age and proportion mature are derived from the same samples and are given in Tables 3.5.3.2 and 3.5.3.3. The weights from the catch are used as the weights for the stock. The sampling level is considered inadequate, since only 3204 scales were taken for age determination from catches in all of the 2004/05 season.

In 2000/01 the strong 1994 and 1996 year classes were most abundant in the catch, but in 2001/02 the 1996 year class was the most abundant. In 2002/03 the 1998 and 1999 year classes were the most common in the catch followed by the 1996 and 1994 year classes. In 2003/04 the very strong year classes of 1999 and 2000 dominated in the catches with 42% and 35% in numbers respectively. In 2004/05 these same year classes dominated the catches. Last year it was predicted that 35% of the catches in numbers would be of the 2000 year class, but 32% were caught. The 1999 year class was 34% of the catches which is almost the same as predicted. About 11% of the catches were from the 2001 year class, which had been predicted to be about 6% of the catches in numbers.

3.5.4 Acoustic survey

The Icelandic summer-spawning herring stock has been monitored by annual acoustic surveys since 1974 (Table 3.5.4.1). These surveys have been conducted in October-December or January. The survey area variates in terms of areas as the survey is focused on the adult and incoming year classes. The surveyed area is decided based on all available information on the distribution of the stock, including information from the fishery. The latest survey was conducted in late January 2005 at the west and east coast of Iceland, At that time the herring fishery had finished. On the traditional fishing grounds off the east coast the survey recorded about 355 000 t of which 246 000 t were adult herring, 27 cm and larger. A total of 367 000 t were estimated on the grounds off the west coast of which 287 000 t were adult herring. The total estimate of the adult stock was therefore 533 000 t. Figure 3.5.4.1 shows the total estimated biomass of 4 year and older herring in the acoustic survey since 1987.

Samples for age determination were taken in the acoustic survey. Only 13 samples were taken, 4 in the west and 9 in the east (Table 3.5.4.2). The total number of scales were 1212. Length distributions from the surveys in 1987-2004 are shown in Figure 3.5.4.2. It can be seen from this figure that the number of herring recorded in surveys in the last years have increased Based on these samples age disaggregated indices were made. According to these indices the 1999-2002 year classes and are considered strong (Table 3.5.4.1).

Due to discrepancy between age readers in the past it was decided to reage all scales from the survey samples as well as in the catches. Based on these new age readings a new survey indices were calculated. The comparison between new and the old indices are shown in Figure 3.5.4.3 . On the basis of the reread scales from the survey samples, new age disaggregated acoustic survey indices have been calculated. There were some differences between the old and new derived indices in the years 1990, 1995, 1996, 1998 and 2000 in the youngest age groups. To check the consiquences of these revised indices, the tuning series was used on the spaly setting and data from last year. The results of the test gave nearly same results as when using the old indices and therefore it was decided to replace the new indices with the old ones.

Since 1987 there have not been any major changes in the survey design which could suggest changes in the catchability of the survey in recent years. However, the WG noted that the survey time is variable with respect to the fishing season, but the effects of such changes have not been evaluated. It was discussed that timing of the survey might have an effect on the catchability due to avoidance reaction of the fish.

3.5.5 Data exploration

In last year's report (ICES CM 2004/ACFM:24) it was pointed out that there were discrepancies in the catch and survey datasets, which made it difficult to assess the stock. One cause of the problem was suggested to be wrong age reading. It was stated that a project was ongoing at MRI, where all scales are being reread back to 1992. Rereading scales from samples taken in the surveys has been done, but the work on data from the catches was not completed prior to the meeting.

3.5.5.1 Analysis of catch at age in commercial data and in the acoustic survey

Using catch data from 1981 catch curves were plotted (Figures 3.5.5.1.1). From them it can be seen that the total mortality sign is around 0.4 provided that effort has been the same the whole time. It can also be seen, that in later years the fish is fully recruited to the fishery at younger ages. Last year a Shepherd-Nicholson model was run for the catch data by using data from the years 1981-2003 and ages 2-15. The CV was estimated at 0.40, 0.45, 0.53 and 0.48 when using ages 4-11, 4-12, 3-12 and 3-11 respectively.

Catch curves were also plotted using the age disaggregated survey indices (Figure 3.5.5.1.2). Like last year they are a somewhat difficult to interpret. The lines are still zig-zagged which can be caused by inadequate sampling in the survey (Table 3.5.4.2). But the mortality sign could be somewhere around 0.4 in the most abundant age age groups, provided that the catchability at age is the same. A comparison between ages in the survey was made by fitting a line through the origin (Figure 3.5.5.1.3) and the correlation from the regression tabulated (Table 3.5.5.4.1). Based on those indices ages 2-10 (at the end of the year) could be considered as reliable age disaggregated indices in assessment.

3.5.5.2 Data exploration with different assessment models

In 2004 the final assessment was made with AMCI 2.3a.

<u>Input data available:</u>

- c@a, years 1981-2004, age groups 2-12
- U@a, years 1981-2004, age groups 2-10, timing of the survey is at the end of the year.
- Natural mortality is M=0.1 for all age groups
- Proportion of M before spawning is set to 0.5
- Proportion of F before spawning is set to 0.

In order to explore the data this year, numeous assessment tools were used and note thus taken of the technical minutes from spring 2004 about exploring the effect of using fewer ages in the fit. It was noted that the assessment in 2004 had a strong retrospective behaviour. The assessment tools and the exercises performed are listed in the table below.

ASSESSMENT MODEL	EXERCISES PERFORMED
AMCI 2.3a	c@a 1981-2004, ages 2-12+ u@a 1987-2004 First analysis was with the same settings as last year. Then age 2 skipped both from c@a and u@a and more gain allowed on selection for ages 3,4 and 5.
NFT Adapt 2.2.2	c@a 1981-2004, ages 2-12 u@a 1988-2005, different age ranges used in the tuning like 3-4, 3-9, 3-11, 4-8, 4-11
TSA	Uses only c@a 1986-2004 and ages 4-12. Uses u@a 1987-2004 & ages 3-7 First fixed M=0.1. Then estimates M. M = 0.1 + θ*p, P=proportion of annual catch, caught by pelagic trawl, θ estimated.
XSA	c@a 1978-2004, ages 2-15 u@a 1987-2004, tried to use different age groups in the tuning and different shrinkage as well.
Cohort analysis	c@a 1981-2004, ages 3-11, F2004 = average F 2002-2003
Camera (a separable model)	c@a 1981-2004, u@a 1987-2004, different age groups used in the tuning, like 3-4 and 4-9
Adapt in AD Model builder	c@a 1981-2004, ages 2-12 u@a 1988-2005, ages 3-12 Catchability fixed from age 8 onwards, CV estimated for each agegroup in the survey

3.5.5.3 Comparisons between models

There is inconsistency between the catch at age data and the survey data. There is a consistent pattern in nearly all the runs that were done. All the models, except when using only the catch at age data, showed retrospectivly that the Fs are underestimated in the terminal year and the fishable stock (SSB) overstimated. Some of the models had difficulties in finding solutions.

The NFT Adapt had difficulties in finding a solution when excluding age 3. It took AMCI a long time finding a solution indicating an overparametrized model. All of the models showed increasing trend in the spawning stock, but at different levels. The Cohort analysis gave the most pessimistic and one of the NFT runs the most optimistic state of the stock. The cohort analysis gave F of about 0.47 (equal to F_{max}) but all of the backward running VPA models gave the fishing mortality in the last year close to 0.2, which is thought to be contradictory to what is seen in the catch curves. All of the models, except the Cohort analysis and the TSA when estimating the M, showed a retrospective pattern like the one in Figure 3.5.5.3.1, indicating that they have been underestimating F and overestimating the spawning stock in the last years. As the TSA, when estimating M, was not considered better then when M was kept fixed it was excluded from further analysis. The retrospective plot from the Cohort analysis is shown in Figure 3.5.5.3.2. The least retrospective pattern in % of the models which were tuned with the survey indices was given by the Camera model (21%), when using ages 3-4 in the tuning (Figure 3.5.5.3.3). As the working group could not find any acceptable solution to resolve the conflicting signals from the catch and survey data, or choose between different models runs, it was decided to give summary for 3 models to illustrate the range of the outcomes. Further details of different runs are given in Working document **36.**

3.5.6 Assessment

A benchmark assessment was meant to be made for this stock this year. The group could not come up with one "final" assessment this year. There are obvious data discrepancies between the catch and the survey data, which needs to be analyzed further. In order to show the range of the results it was thus decided to go ahead with three alternatives, showing the range of the results. Fistly, the Cohort analysis, showing the most pessimistic view of the status, the Camera model (which gave relatively lowest retrospective biased estimate), and the AMCI (spaly from last year) which gave the most optimistic view of the stock. . The retrospective pattern in the Camera model gave on average 21% underestimation of terminal Fs in recent 5 years it was decided to raise the Fs from the Camera model by 21% and run those on a traditional VPA. This approach was applied in 1998 and 1999 with the Icelandic saithe when the retrospective pattern of Icelandic saithe showed similar behaviour (resulting in improved assessment- see the quality control sheet). The resulting F_{5-10} by the Camera model in 2004, bias corrected, is 0.33. The spawning stock is considered to be 517 thous. tonnes in 2004 and 576 thous. tonnes in 2005. Fishing mortalities and stock numbers from the VPA run with the biased corrected F from the Camera run are given in Tables 3.5.6.1 and 3.5.6.2 respectively. A summary is given in Table 3.5.6.3. The summary for the other runs in terms of different Fs and SSB in 2005 are given in the textable below.

MODEL	F5-1	F7+	WF5+	SSB2005
AMCI - SPALY	0.215	0.215	0.215	650
CAMERA, bias corrected	0.334	0.380	0.281	576
Cohort analysis	0.573	0.61	0.47	324

3.5.7 Short term prediction

As the mean weight at age has not shown any trend in last years it was decided to use average weights from 2002-2004. Proportion mature was also derived using the same average. There have not been any major changes in past years in the selection pattern. Therefore, selection for the prognosis was estimated as the mean selection from 2000-2002 was used. Proportion of M before spawning is 0.5 and proportion of F before spawning is 0. Year class strengths are taken from the model for yea class 2001 and older but a geometric mean is used for 2002 year class. The input data are shown in Table 3.5.7.1 and the results from the run in Table 3.5.7.2. In the past the stock has been managed at F0.22-0.23. Fishing at 0.22 (= $F_{0.1}$) would correspond to a catch of 118 thousand tonnes in 2005/06 season, based on the CAMERA model. However, corresponding catches using AMCI (spaly) are 133 thous. tonnes and 68 thous. tonnes using cohort analysis as a basis for the predictions (Table 3.5.7.2). Applying a TAC of 118 given the worst case senario (cohort analysis) would results in F=0.47 and the SSB in 2006 would be around 315 thous. tonnes in 2006, compared with 324 thous. tonnes in 2005. This would respond to F in 2005 being close to F_{max} (=0.48).

3.5.8 Medium term predictions

No medium term predictions were performed.

3.5.9 Management consideration

Since the late 70s the Icelandic summer-spawning herring stock has been managed at levels corresponding fairly closely to fishing at $\mathbf{F}_{0.1}$. Although the stock has been fished well above $\mathbf{F}_{0.1}$ due to biased assessments, it does not seem to have resulted in a decline in the stock. Even though the current status of the stock is highly uncertain it is considered to be in a relatively good shape.

3.5.10 Comments on the PA reference points

The Working Group points out that managing this stock at an exploitation rate at or above $\mathbf{F}_{0.1}$ has been successful in the past, despite biased assessments. Thus the Northern Pelagic and Blue Whiting Fisheries Working Group agreed in 1998 with the SGPAFM on using $\mathbf{F}_{pa}= \mathbf{F}_{0.1}=$ 0.22, $\mathbf{B}_{pa}= \mathbf{B}_{lim} * e^{1.645\sigma}=$ 300 000 t where $\mathbf{B}_{lim}=$ 200 000 t. The Study Group on Precautionary Reference Points for Advice on Fishery Management met in February 2003 and concluded that it was not considered relevant to change the $\mathbf{B}_{lim}$ from 200 000 t. The WG did not have time to recalculate refrerence points during the meeting.

The fishing mortality has since 1990 been on the average 0.322 or approximately 40% higher than the intended target of F0.1=0.23. This is despite the fact that the managers have followed the scientific advice and restricted quotas with the aim of fishing at the intended target. During this time period the SSB has remained above Blim. As there is an aggreed management strategy that have been applied since the fishery was reopend after it collapsed in late 1960's, it is proposed to use $F_{0.1}$ = $\mathbf{F}_{pa}$ as F_{target}.

3.5.11 Comments to the assessment

As has been pointed out, there is a large uncertainty regarding the assessment of the stock this year and the assessment has been biased . However, in light of the acoustic assessment survey results this year the state of the stock is considered good.

Table 3.5.1.1 Icelandic summer spawners. Landings, catches and recommended TACs in thousand tonnes.

Year	Landings	Catches	Recommended TACs
1972	0.31	0.31	
1973	0.254	0.254	
1974	1.275	1.275	
1975	13.28	13.28	
1976	17.168	17.168	
1977	28.925	28.925	
1978	37.333	37.333	
1979	45.072	45.072	
1980	53.268	53.268	
1981	39.544	39.544	
1982	56.528	56.528	
1983	58.867	58.867	
1984	50.304	50.304	
1985	49.368	49.368	
1986	65.5	65.5	65
1987	73	73	70
1988	92.8	92.8	100
1989	97.3	101	90
1990/1991	101.6	105.1	90
1991/1992	98.5	109.5	79
1992/1993	106.7	108.5	86
1993/1994	101.5	102.7	90
1994/1995	132	134	120
1995/1996	125	125.9	110
1996/1997	95.9	95.9	100
1997/1998	64.7	64.7	100
1998/1999	87	87	90
1999/2000	92.9	92.9	100
2000/2001	100.3	100.3	110
2001/2002	95.3	95.3	125
2002/2003	92.7	93.6	105
2003/2004	125.2	125.2	110
2004/2005*	125.7	125.7	110

***Preliminary**

Table 3.5.3.1 Icelandic summer spawners. Catch in numbers (millions) and total catch in weight (thous. tonnes). 1982 refers to season 1982/1983.

AGE/YEAR	1981	1982	1983	1984	1985	1986	1987	1988
2	2.283	0.454	1.475	0.421	0.112	0.100	0.029	0.879
3	4.629	19.187	22.499	18.015	12.872	8.172	3.144	4.757
4	16.771	28.109	151.718	32.244	24.659	33.938	44.590	41.331
5	12.126	38.280	30.285	141.354	21.656	23.452	60.285	99.366
6	36.871	16.623	21.599	17.043	85.210	20.681	20.622	69.331
7	41.917	38.308	8.667	7.113	11.903	77.629	19.751	22.955
8	7.299	43.770	14.065	3.916	5.740	18.252	46.240	20.131
9	4.863	6.813	13.713	4.113	2.336	10.986	15.232	32.201
10	13.416	6.633	3.728	4.517	4.363	8.594	13.963	12.349
11	1.032	10.457	2.381	1.828	4.053	9.675	10.179	10.250
12	0.884	2.354	3.436	0.202	2.773	7.183	13.216	7.378
13	0.760	0.594	0.554	0.255	0.975	3.682	6.224	7.284
14	0.101	0.075	0.100	0.260	0.480	2.918	4.723	4.807
15	0.062	0.211	0.003	0.003	0.581	1.788	2.280	1.957
Catch	39.544	56.528	58.867	50.304	49.368	65.500	75.439	92.828

AGE/YEAR	1989	1990	1991	1992	1993	1994	1995	1996
2	3.974	11.009	35.869	12.006	0.869	6.225	7.411	1.100
3	22.628	14.345	92.758	79.782	35.560	110.079	26.221	18.723
4	26.649	57.024	51.047	131.543	170.106	99.377	159.170	45.304
5	77.824	34.347	87.606	43.787	87.363	150.310	86.940	92.948
6	188.654	77.819	33.436	56.083	25.146	90.824	105.542	69.878
7	43.114	152.236	54.840	41.932	28.802	23.926	74.326	86.261
8	8.116	32.265	109.418	36.224	18.306	20.809	20.076	37.447
9	5.897	8.713	9.251	44.765	24.268	19.164	13.797	13.207
10	7.292	4.432	3.796	9.244	14.318	17.973	8.873	6.854
11	4.780	4.287	2.634	2.259	3.639	16.222	9.140	4.012
12	3.449	2.517	1.826	0.582	0.878	2.955	7.079	1.672
13	1.410	1.226	0.516	0.305	0.300	1.433	2.376	4.179
14	0.844	1.019	0.262	0.203	0.200	0.345	0.927	1.672
15	0.348	0.610	0.298	0.102	0.100	0.345	0.124	0.100
Catch	101.000	105.097	109.489	108.504	102.741	134.003	125.851	95.882

AGE/YEAR	1997	1998	1999	2000	2001	2002	2003	2004
2	9.323	16.161	0.629	7.958	10.206	14.149	23.470	8.135
3	27.072	37.787	43.537	52.921	23.944	70.982	235.988	62.763
4	28.397	151.853	65.871	131.153	76.666	78.395	283.519	179.547
5	29.451	42.833	145.127	44.334	107.849	43.905	50.527	194.951
6	42.267	19.872	24.653	102.925	46.646	57.266	25.898	52.092
7	35.285	30.280	20.614	10.962	51.585	21.433	24.010	20.852
8	28.506	22.572	25.853	9.312	18.504	42.272	11.330	15.784
9	21.828	32.779	21.163	17.218	11.356	9.668	9.743	7.494
10	8.160	14.366	14.436	9.471	7.933	4.632	1.429	9.186
11	3.815	4.802	6.973	7.610	8.547	6.429	3.750	3.320
12	1.696	2.199	2.164	1.930	5.090	7.839	3.479	4.020
13	6.570	1.084	2.426	5.199	4.346	9.738	1.743	10.070
14	1.378	5.081	0.473	0.552	1.611	4.478	1.272	0.176
15	1.802	3.036	0.961	0.166	0.864	4.537	0.816	1.417
Catch	64.682	86.998	92.896	100.332	95.278	93.601	125.2	125.7

Table 3.5.3.2 Icelandic summer spawners. Weight at age (g).

AGE/YEAR	1981	1982	1983	1984	1985	1986	1987	1988
2	61	65	59	49	53	60	60	75
3	141	141	132	131	146	140	168	157
4	190	186	180	189	219	200	200	221
5	246	217	218	217	266	252	240	239
6	269	274	260	245	285	282	278	271
7	298	293	309	277	315	298	304	298
8	330	323	329	315	335	320	325	319
9	356	354	356	322	365	334	339	334
10	368	385	370	351	388	373	356	354
11	405	389	407	334	400	380	378	352
12	382	400	437	362	453	394	400	371
13	400	394	459	446	469	408	404	390
14	400	390	430	417	433	405	424	408
15	400	420	472	392	447	439	430	437

AGE/YEAR	1989	1990	1991	1992	1993	1994	1995	1996
2	63	75	74	63	74	67	69	78
3	130	119	139	144	150	135	129	140
4	206	198	188	190	212	204	178	166
5	246	244	228	232	245	249	236	208
6	261	273	267	276	288	269	276	258
7	290	286	292	317	330	302	292	294
8	331	309	303	334	358	336	314	312
9	338	329	325	346	373	368	349	324
10	352	351	343	364	387	379	374	360
11	369	369	348	392	401	398	381	349
12	389	387	369	444	425	387	400	388
13	380	422	388	399	387	421	409	403
14	434	408	404	419	414	402	438	385
15	409	436	396	428	420	390	469	420

AGE/YEAR	1997	1998	1999	2000	2001	2002	2003	2004
2	62	78	64	58	78	80	66	80
3	137	147	143	158	140	149	149	140
4	197	184	211	214	217	202	183	196
5	234	213	236	256	242	245	225	227
6	270	246	268	284	281	275	255	258
7	299	286	300	326	294	311	283	288
8	323	314	318	333	309	325	328	311
9	342	341	349	366	339	347	347	319
10	358	351	347	383	350	383	328	326
11	363	354	377	402	367	390	368	336
12	373	350	359	405	375	402	387	358
13	412	372	403	422	403	442	385	378
14	394	400	408	406	426	463	380	397
15	429	437	445	444	425	453	430	397

Table 3.5.3.3 Icelandic summer spawners. Proportion mature at age.

AGE/YEAR	1981	1982	1983	1984	1985	1986	1987	1988
2	0.000	0.020	0.000	0.000	0.000	0.000	0.000	0.000
3	0.030	0.050	0.000	0.010	0.000	0.030	0.010	0.045
4	0.650	0.850	0.640	0.820	0.900	0.890	0.870	0.900
5	0.990	1.000	1.000	1.000	1.000	1.000	1.000	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

AGE/YEAR	1989	1990	1991	1992	1993	1994	1995	1996
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.060	0.000	0.013	0.020	0.049	0.054	0.157	0.049
4	0.930	0.780	0.720	0.930	0.999	1.000	0.982	0.990
5	1.000	1.000	1.000	1.000	1.000	0.992	0.998	1.000
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

AGE/YEAR	1997	1998	1999	2000	2001	2002	2003	2004
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.160	0.265	0.074	0.279	0.101	0.190	0.286	0.201
4	0.925	0.935	0.879	0.831	0.981	0.734	0.795	0.987
5	0.989	0.995	0.977	0.992	0.997	0.898	0.962	0.999
6	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
7	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
8	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
12	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
13	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
14	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.5.4.1 Recalculated acoustic estimates (in millions) of the Icelandic summer spawning herring, 1987-2004. No survey in 1994.

					AGE										
year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1987	116	401	858	308	57	33	70	37	24	18	24	10	4	5	
1988	636	201	233	381	188	46	26	33	17	10	9	5	3	5	
1989	139	655	179	279	593	180	22	22	13	10	2	-1	-1	-1	
1990	404	132	259	94	191	514	79	38	9	13	-1	-1	-1	-1	
1991	598	1050	355	320	90	138	257	21	10	-1	9	-1	-1	1	
1992	268	831	730	159	131	54	96	97	25	1	1	3	-1	-1	
1993	302	505	883	496	67	58	106	49	36	-1	4	18	-1	-1	
1994	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	
1995	217	134	762	278	385	177	98	49	16	29	48	4	-1	-1	
1996	33	271	134	469	270	326	217	93	55	39	30	53	19	13	
1997	292	602	81	57	287	156	203	106	35	27	14	36	14	12	
1998	100	256	1082	103	52	135	71	102	54	17	14	3	4	9	
1999	516	839	239	606	88	43	166	90	121	78	22	4	11	-1	
2000	190	967	1316	191	482	34	16	38	14	15	15	2	3	-1	
2001	1048	287	217	260	161	346	62	57	38	46	38	21	4	-1	
2002	1732	1919	553	206	262	153	276	99	48	55	19	24	24	1	
2003	1115	1435	2058	331	109	101	39	46	7	6	8	11	-1	2	
2004	2417	714	1022	1047	171	62	44	11	24	13	-1	2	11	-1	

Table 3.5.4.2. Number of scales by ages taken in the annual acoustic surveys in the seasons 1987/1988-2004/2005. In 2000 seven samples were used from the fishery.

					AGE											NO. OF SAMPLES		
year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total	Total	West	East
1987	11	59	246	156	37	28	58	33	22	16	23	10	5	8	712	8	1	7
1988	229	78	181	424	178	69	50	77	42	29	23	13	7	12	1412	18	5	10
1989	38	245	96	132	225	35	2	2	3	3	2				783	8		8
1990	418	229	303	90	131	257	28	6	3	8					1473	15		15
1991	414	439	127	127	33	48	84	5	3	0	2	0	0	1	1283	15		15
1992	122	513	289	68	73	28	38	34	6	2	2	6	0	0	1181	12		12
1993	63	285	343	129	13	15	7	14	11	0	1	3	0	0	884	9		9
1994															0			
1995	183	90	471	162	209	107	38	18	8	14	18	2	0	0	1320	14	9	5
1996	24	150	88	351	141	137	87	32	15	10	7	14	4	2	1062	11	4	7
1997	101	249	50	36	159	95	122	62	21	13	8	15	8	5	944	14	7	7
1998	130	216	777	72	31	65	59	86	37	22	17	5	6	11	1534	17	10	7
1999	116	227	72	144	17	13	26	26	27	10	8	2	1		689	7	3	4
2000	116	249	332	87	166	10	7	21	8	14	11	3	1	0	1025	14	10	4
2001	61	56	130	114	62	136	25	24	17	21	17	10	3	0	676	9	4	5
2002	520	705	258	104	130	74	128	46	26	25	13	15	10	1	2055	22	12	10
2003	126	301	415	88	35	32	15	17	3	4	4	6	1	1	1048	13	8	5
2004	304	159	284	326	70	29	17	5	8	4	0	3	3		1212	13	4	9

Table 3.5.5.4.1 Within survey consistency, correlation of N at age a in year y with N at age a+1 in year y+1 over the fishing seasons 1987/1988-2004/2005.

A	A+1	R
2	3	**.88**
3	4	**.92**
4	5	**.95**
5	6	**.93**
6	7	**.98**
7	8	**.93**
8	9	**.83**
9	10	**.81**

Table 3.5.6.1 Icelandic summer spawning herring. Estimated parameters from the Camera run.

INDEX	NAME	VALUE	STD
1	logsel	-4.523	0.901
2	logsel	-1.908	0.766
3	logsel	-0.702	0.766
4	logsel	-0.402	0.766
5	logsel	-0.282	0.964
6	logsel	-0.177	0.982
7	logsel	-0.103	1.002
8	Sfull	8.000	14697.000
9	logvarL	0.000	58095.000
10	logvarR	0.000	58095.000
11	a50	8.000	14697.000
12	deltaA	7.000	18520.000
13	logPopAgeOne	6.796	0.817
14	logPopAgeOne	5.599	0.907
15	logPopAgeOne	5.751	0.907
16	logPopAgeOne	6.203	0.889
17	logPopAgeOne	6.656	0.687
18	logPopAgeOne	5.908	0.620
19	logPopAgeOne	5.393	0.623
20	logPopAgeOne	6.227	0.611
21	logPopAgeOne	5.813	0.616
22	logPopAgeOne	7.006	0.563
23	logPopAgeOne	7.053	0.546
24	logPopAgeOne	6.487	0.660
25	logPopAgeOne	6.717	0.647
26	logPopAgeOne	5.481	0.619
27	logPopAgeOne	5.434	0.628
28	logPopAgeOne	6.744	0.596
29	logPopAgeOne	5.940	0.646
30	logPopAgeOne	6.966	0.624
31	logPopAgeOne	6.239	0.679
32	logPopAgeOne	6.238	0.705
33	logPopAgeOne	7.658	0.713
34	logPopAgeOne	7.477	0.766
35	logPopAgeOne	7.071	1.058
36	logPopAgeOne	7.803	3.233
37	logPopYearOne	5.338	0.936
38	logPopYearOne	5.294	1.057
39	logPopYearOne	4.731	1.219
40	logPopYearOne	5.335	1.481
41	logPopYearOne	5.312	1.541
42	logPopYearOne	3.957	1.725
43	logPopYearOne	2.972	1.862
44	logPopYearOne	3.504	2.140
45	logPopYearOne	2.000	0.016
46	logPopYearOne	2.000	0.002
47	logPopYearOne	2.000	0.003
48	logPopYearOne	2.000	0.004
49	logFullF	-1.480	0.939
50	logFullF	-1.106	0.943
51	logFullF	-1.076	0.917
52	logFullF	-1.393	0.909
53	logFullF	-1.657	0.902
54	logFullF	-1.442	0.879
55	logFullF	-1.403	0.874
56	logFullF	-1.001	0.860
57	logFullF	-0.800	0.875
58	logFullF	-0.674	0.883
59	logFullF	-0.564	0.850
60	logFullF	-0.693	0.821
61	logFullF	-1.034	0.820
62	logFullF	-0.599	0.772
63	logFullF	-0.530	0.776
64	logFullF	-0.697	0.802
65	logFullF	-0.924	0.821
66	logFullF	-0.667	0.799
67	logFullF	-0.768	0.842
68	logFullF	-0.770	0.863
69	logFullF	-0.758	0.932
70	logFullF	-0.912	0.981
71	logFullF	-0.870	1.027
72	logFullF	-1.138	1.113
73	logqjus	0.066	0.388
74	logqjus	0.298	0.411
75	Fbar	0.200	0.156
76	Fbar	0.290	0.227
77	Fbar	0.299	0.228
78	Fbar	0.218	0.167
79	Fbar	0.167	0.127
80	Fbar	0.208	0.152
81	Fbar	0.216	0.156
82	Fbar	0.323	0.230
83	Fbar	0.394	0.281
84	Fbar	0.448	0.318
85	Fbar	0.499	0.337
86	Fbar	0.439	0.289
87	Fbar	0.312	0.208
88	Fbar	0.482	0.299
89	Fbar	0.517	0.318
90	Fbar	0.437	0.283
91	Fbar	0.348	0.235
92	Fbar	0.451	0.292
93	Fbar	0.407	0.285
94	Fbar	0.407	0.295
95	Fbar	0.411	0.334
96	Fbar	0.353	0.304
97	Fbar	0.368	0.338
98	Fbar	0.281	0.285
99	FSB	312.300	112.280
100	FSB	354.050	126.280
101	FSB	349.360	131.300
102	FSB	334.830	128.010
103	FSB	424.210	147.130
104	FSB	456.720	141.500
105	FSB	473.430	143.060
106	FSB	469.490	135.900
107	FSB	408.270	122.380
108	FSB	418.300	115.160
109	FSB	468.910	120.880
110	FSB	516.890	135.350
111	FSB	593.170	152.230
112	FSB	573.440	154.510
113	FSB	466.550	137.820
114	FSB	401.660	116.820
115	FSB	390.060	120.330
116	FSB	434.800	135.280
117	FSB	457.110	157.840
118	FSB	495.360	193.620
119	FSB	595.170	260.460
120	FSB	772.240	382.940
121	FSB	858.540	467.980

122	FSB	1052.300	931.450
123	FSB	1125.600	1297.500
124	SSB	217.160	108.470
125	SSB	223.340	107.100
126	SSB	254.110	109.950
127	SSB	266.750	124.890
128	SSB	312.490	145.260
129	SSB	331.360	139.320
130	SSB	389.380	138.690
131	SSB	395.390	134.440
132	SSB	329.320	119.010
133	SSB	282.840	102.770
134	SSB	234.870	90.498
135	SSB	318.570	112.490
136	SSB	448.930	145.140
137	SSB	461.850	146.970
138	SSB	425.340	134.480
139	SSB	308.590	108.640
140	SSB	275.740	101.670
141	SSB	307.470	110.530
142	SSB	288.270	114.230
143	SSB	383.590	159.600
144	SSB	367.100	177.350
145	SSB	372.890	206.620
146	SSB	550.590	321.390
147	SSB	682.020	452.190
148	SSB	786.480	638.070

Table 3.5.6.1. Icelandic summer spawning herring. Fishing mortality (F) from a VPA run with bias corrected F from a Camera run.

Run title : Sumargotssild i 5a.

At 2/05/2005 20:50

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,
AGE							
2,	.0143,	.0039,	.0131,	.0027,	.0020,	.0071,	.0009,
3,	.0618,	.0954,	.0698,	.0217,	.0257,	.1166,	.1012,
4,	.1311,	.1608,	.1650,	.0981,	.1592,	.2578,	.2178,
5,	.1246,	.2376,	.2822,	.1231,	.3004,	.2298,	.3604,
6,	.1101,	.1913,	.3249,	.2469,	.2211,	.2467,	.1753,
7,	.3015,	.1254,	.1785,	.3178,	.3875,	.1539,	.1075,
8,	.3292,	.2963,	.1877,	.1469,	.5636,	.2136,	.0868,
9,	.7120,	.2001,	.3347,	.1274,	.1781,	.3047,	.0802,
10,	.4924,	.4129,	.1558,	.3611,	.2289,	.1255,	.1391,
11,	.4264,	.2426,	.5833,	.1133,	.4689,	.1077,	.0753,
12,	.5234,	.3269,	.5579,	.7502,	.3591,	.2454,	.0107,
13,	.0424,	.0630,	.0010,	2.1893,	1.7353,	.1194,	.0231,
14,	.7222,	.1646,	.2830,	.1154,	2.0086,	2.0195,	.0681,
15,	.2280,	.3310,	.3410,	.2280,	.3310,	.3410,	.2480,
FBAR 4-13,	.3193,	.2257,	.2771,	.4474,	.4602,	.2005,	.1276,

Table 8 Fishing mortality (F) at age

YEAR,	1985,	1986,	1987,	1988,	1989,	1990,	1991,	1992,	1993,	1994,
AGE										
2,	.0001,	.0002,	.0001,	.0019,	.0103,	.0130,	.0343,	.0200,	.0013,	.0219,
3,	.0315,	.0079,	.0059,	.0168,	.0563,	.0422,	.1300,	.0896,	.0685,	.1947,
4,	.1755,	.0979,	.0488,	.0896,	.1110,	.1757,	.1853,	.2451,	.2493,	.2469,
5,	.1992,	.2251,	.2254,	.1314,	.2168,	.1828,	.3938,	.2144,	.2280,	.3233,
6,	.3412,	.2646,	.2813,	.3869,	.3483,	.3111,	.2430,	.4176,	.1647,	.3480,
7,	.1601,	.5257,	.3848,	.5089,	.3925,	.4639,	.3342,	.4788,	.3486,	.2084,
8,	.1067,	.3477,	.6069,	.7489,	.3007,	.5062,	.6316,	.3421,	.3519,	.4048,
9,	.0616,	.2717,	.4830,	1.0225,	.4490,	.5367,	.2348,	.5085,	.3594,	.6668,
10,	.1030,	.2984,	.5753,	.8094,	.5925,	.6349,	.4191,	.3454,	.2675,	.4367,
11,	.1602,	.3083,	.6051,	.9910,	.7625,	.7438,	.8707,	.4191,	.1981,	.4835,
12,	.1404,	.4148,	.7833,	1.0889,	.9941,	1.0899,	.7333,	.4161,	.2535,	.2188,
13,	.0593,	.2497,	.6756,	1.2773,	.5415,	1.1032,	.5960,	.2238,	.3483,	.7309,
14,	.0499,	.2252,	.5128,	1.7006,	.4059,	.8499,	.6489,	.4381,	.2007,	.7503,
15,	.1910,	.2360,	.2460,	.3670,	.4490,	.5100,	.5690,	.5000,	.3560,	.5490,
FBAR 4-13,	.1507,	.3004,	.4669,	.7055,	.4709,	.5748,	.4642,	.3611,	.2769,	.4068,

Table 3.5.6.1 (cont.) . Icelandic summer spawning herring. Fishing mortality (F) from a VPA run with bias corrected F from a Camera run

Run title : Sumargotssild i 5a.

At 2/05/2005 20:50

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	FBAR **-**
AGE											
2,	.0293,	.0014,	.0260,	.0277,	.0017,	.0159,	.0065,	.0093,	.0187,	.0042,	.0107,
3,	.1090,	.0866,	.0377,	.1256,	.0874,	.1703,	.0548,	.0511,	.1889,	.0575,	.0992,
4,	.4199,	.2479,	.1644,	.2718,	.2976,	.3615,	.3520,	.2277,	.2629,	.1922,	.2276,
5,	.3156,	.4106,	.2258,	.3530,	.3998,	.2981,	.5031,	.3108,	.2011,	.2594,	.2571,
6,	.3512,	.3996,	.2949,	.2094,	.3138,	.4861,	.5161,	.4841,	.2714,	.2925,	.3493,
7,	.4718,	.4775,	.3207,	.3168,	.3104,	.2001,	.4260,	.4204,	.3409,	.3248,	.3620,
8,	.2419,	.4092,	.2535,	.3110,	.4329,	.2008,	.5312,	.6541,	.3645,	.3497,	.4561,
9,	.4548,	.2219,	.3942,	.4559,	.4740,	.5084,	.3557,	.5189,	.2691,	.3878,	.3919,
10,	.6639,	.3804,	.1859,	.4329,	.3305,	.3570,	.4119,	.2142,	.1182,	.3878,	.2401,
11,	.3680,	.6367,	.3352,	.1427,	.3436,	.2592,	.5571,	.6085,	.2403,	.3878,	.4122,
12,	.3569,	.0945,	.5383,	.2927,	.0795,	.1343,	.2468,	1.3898,	.6943,	.3878,	.8240,
13,	.2450,	.3284,	.5597,	.6992,	.5341,	.2476,	.4411,	.8887,	1.3503,	.3878,	.8756,
14,	1.4506,	.2433,	.1530,	1.0182,	.6698,	.1960,	.1013,	.9902,	.2330,	.3878,	.5370,
15,	.5880,	.4980,	.3970,	.5130,	.4640,	.4630,	.4680,	.4020,	.4190,	.3878,	.4029,
FBAR 4-13,	.3889,	.3607,	.3273,	.3485,	.3516,	.3053,	.4341,	.5717,	.4113,	.3358,	

Table 3.5.6.2. Icelandic summer spawning herring. Stock in numbers from a VPA run with bias corrected F from a Camera run.

Run title : Sumargotssild i 5a.

At 2/05/2005 20:50

Traditional vpa using file input for terminal F

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

YEAR	1978	1979	1980	1981	1982	1983	1984
AGE							
2	195234	247870	253514	879637	237697	218814	481929
3	395140	174151	223399	226397	793758	214645	196589
4	435789	336107	143234	188506	200452	699982	172847
5	124108	345884	258960	109891	154634	154685	489421
6	87975	99146	246793	176711	87915	103611	111224
7	159046	71302	74094	161359	124908	63772	73256
8	27097	106455	56916	56085	106253	76714	49473
9	13032	17641	71626	42685	43817	54717	56064
10	4349	5786	13067	46375	34004	33178	36504
11	2793	2405	3464	10118	29243	24473	26480
12	1027	1650	1707	1749	8175	16556	19882
13	430	551	1077	884	748	5165	11720
14	51	373	468	973	90	119	4148
15	262	22	286	319	785	11	14
TOTAL	1446336	1409343	1348605	1901690	1822477	1666445	1729552

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

YEAR	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
AGE										
2	1210325	622121	330863	480806	407548	894372	1117819	635605	722314	301264
3	435667	1095040	562823	299350	434216	364986	798795	977348	563706	652750
4	160766	381972	983064	506274	266340	371389	316619	634678	808539	476270
5	125795	122055	313379	847133	418826	215679	281906	238026	449459	570189
6	308844	93267	88183	226344	672140	305105	162546	172052	173815	323777
7	84458	198662	64771	60229	139094	429317	202269	115350	102538	133397
8	59528	65118	106265	39887	32763	84996	244267	131021	64661	65474
9	41044	48410	41617	52407	17068	21947	46358	117525	84208	41152
10	46821	34919	33381	23231	17056	9857	11611	33167	63956	53188
11	28741	38220	23444	16991	9357	8534	4727	6909	21246	44286
12	22223	22157	25407	11583	5707	3950	3670	1791	4111	15770
13	17798	17475	13242	10504	3528	1911	1202	1595	1069	2887
14	10363	15178	12318	6097	2650	1857	574	599	1154	683
15	3506	8920	10964	6674	1007	1598	718	271	350	854
TOTAL	2555878	2763514	2609722	2587509	2427298	2715500	3193080	3065939	3061125	2681942

Table 3.5.6.2 (cont.). Icelandic summer spawning herring. Stock in numbers from a VPA run with bias corrected F from a Camera run.

Run title : Sumargotssild i 5a.

At 2/05/2005 20:50

Traditional vpa using file input for terminal F

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

YEAR,	1995,	1996,	1997,	1998,	1999,	2000,	2001,	2002,	2003,	2004,	2005,	GMST 78-**	AMST 78-**
AGE													
2,	269591,	849677,	381320,	620688,	392688,	529361,	1663903,	1604302,	1328478,	2039570,	0,	512381,	621971,
3,	266677,	236892,	767773,	336170,	546259,	354720,	471420,	1495858,	1438180,	1179744,	1837744,	435629,	515381,
4,	486136,	216390,	196559,	668977,	268287,	452909,	270717,	403802,	1286045,	1077287,	1007828,	350435,	401864,
5,	336650,	289056,	152810,	150890,	461255,	180279,	285479,	172271,	290976,	894671,	804323,	249334,	289949,
6,	373392,	222164,	173471,	110318,	95923,	279826,	121073,	156192,	114238,	215323,	624565,	169991,	198872,
7,	206857,	237798,	134800,	116873,	80957,	63415,	155726,	65388,	87096,	78798,	145422,	115898,	132786,
8,	97993,	116776,	133473,	88512,	77035,	53703,	46974,	92031,	38857,	56043,	51526,	74100,	83179,
9,	39523,	69617,	70178,	93724,	58682,	45211,	39753,	24987,	43296,	24419,	35745,	44219,	50120,
10,	19114,	22693,	50457,	42813,	53755,	33054,	24606,	25205,	13456,	29933,	14993,	25723,	30886,
11,	31099,	8905,	14037,	37909,	25128,	34951,	20930,	14747,	18410,	10818,	18378,	14835,	19566,
12,	24709,	19476,	4263,	9084,	29741,	16126,	24405,	10849,	7261,	13099,	6642,	8055,	12231,
13,	11465,	15647,	16034,	2252,	6134,	24855,	12758,	17253,	2446,	3281,	8043,	4201,	7927,
14,	1258,	8119,	10195,	8290,	1012,	3253,	17556,	7427,	6419,	573,	2015,	1795,	4592,
15,	292,	267,	5760,	7916,	2710,	469,	2420,	14355,	2496,	4601,	352,	783,	2830,
TOTAL,	2164755,	2313476,	2111130,	2294415,	2099567,	2072133,	3157720,	4104666,	4677655,	5628161,	4557576,		

Table 3.5.6.3. Icelandic summer spawning herring. Summary table from a VPA run with bias corrected F from a Camera run.

Run title : Sumargotssild i 5a. ,

At 2/05/2005 20:50

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

,	RECRUITS, Age 2	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4-13,	WF 5-15,
1978,	195234,	273977,	182997,	37333,	.2040,	1.0000,	.3193,	0.226
1979,	247870,	281535,	205735,	45072,	.2191,	1.0000,	.2257,	0.228
1980,	253514,	275695,	220155,	53268,	.2420,	1.0000,	.2771,	0.283
1981,	879637,	300156,	192997,	39544,	.2049,	1.0000,	.4474,	0.236
1982,	237697,	337175,	199866,	56528,	.2828,	1.0000,	.4602,	0.352
1983,	218814,	323993,	225884,	58867,	.2606,	1.0000,	.2005,	0.217
1984,	481929,	305223,	237829,	50304,	.2115,	1.0000,	.1276,	0.251
1985,	1210325,	400376,	255746,	49368,	.1930,	1.0000,	.1507,	0.223
1986,	622121,	473531,	265769,	65500,	.2465,	1.0000,	.3004,	0.351
1987,	330863,	525185,	367560,	75439,	.2052,	1.0000,	.4669,	0.376
1988,	480806,	534693,	420899,	92828,	.2205,	1.0000,	.7055,	0.297
1989,	407548,	487255,	384817,	101000,	.2625,	1.0000,	.4709,	0.321
1990,	894372,	487001,	342306,	105097,	.3070,	1.0000,	.5748,	0.377
1991,	1117819,	516850,	292982,	109489,	.3737,	1.0000,	.4642,	0.413
1992,	635605,	541702,	337684,	108504,	.3213,	1.0000,	.3611,	0.364
1993,	722314,	593303,	437262,	102741,	.2350,	1.0000,	.2769,	0.251
1994,	301264,	557784,	431208,	134003,	.3108,	1.0000,	.4068,	0.343
1995,	269591,	461551,	392108,	125851,	.3210,	1.0000,	.3889,	0.362
1996,	849677,	410009,	296945,	95882,	.3229,	1.0000,	.3607,	0.403
1997,	381320,	395922,	266545,	64395,	.2416,	1.0000,	.3273,	0.287
1998,	620688,	412708,	304252,	86999,	.2859,	1.0000,	.3485,	0.335
1999,	392688,	407155,	285343,	92896,	.3256,	1.0000,	.3516,	0.375
2000,	529361,	409077,	305935,	100332,	.3280,	1.0000,	.3053,	0.362
2001,	1663903,	470139,	264885,	95278,	.3597,	.9992,	.4341,	0.462
2002,	1604302,	613730,	265495,	93601,	.3526,	.9992,	.5717,	0.478
2003,	1328478,	703194,	393903,	125233,	.3179,	1.0006,	.4113,	0.259
2004,	2039570,	892517,	516614,	125716,	.2433,	1.0290,	.3358,	0.281
Arith. Mean ,	700641,	458942,	307175,	84854,	.2740		.3730,	
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),				

Table 3.5.7.1. Prognosis input.

	N 2005	SELP	PMAT	W	M
2	600	0.027	0	75	0.1
3	600	0.237	0.223	146	0.1
4	1007.828	0.807	0.789	194	0.1
5	804.323	1	0.952	232	0.1
6	624.565	1.000	1	263	0.1
7	145.422	1.000	1	294	0.1
8	51.526	1.000	1	321	0.1
9	35.745	1.000	1	338	0.1
10	14.993	1.000	1	346	0.1
11	18.378	1.000	1	365	0.1
12	6.642	1.000	1	382	0.1
13	8.043	1.000	1	402	0.1
14	2.015	1.000	1	413	0.1
15	0.352	1.000	1	427	0.1

Table 3.5.7.2. Icelandic summer spawning herring. Summary table for 3 differnt runs.

MODEL	F5-10	F7+	WF5+	SSB2005	C2005*	SSB 2006
AMCI - SPALY	0.215	0.215	0.215	650	134	679
CAMERA, bias corrected	0.334	0.380	0.281	576	118	591
Cohort analysis	0.573	0.61	0.47	324	68	356

*** Forward calculation based on $F_{0.1}$=0.22**

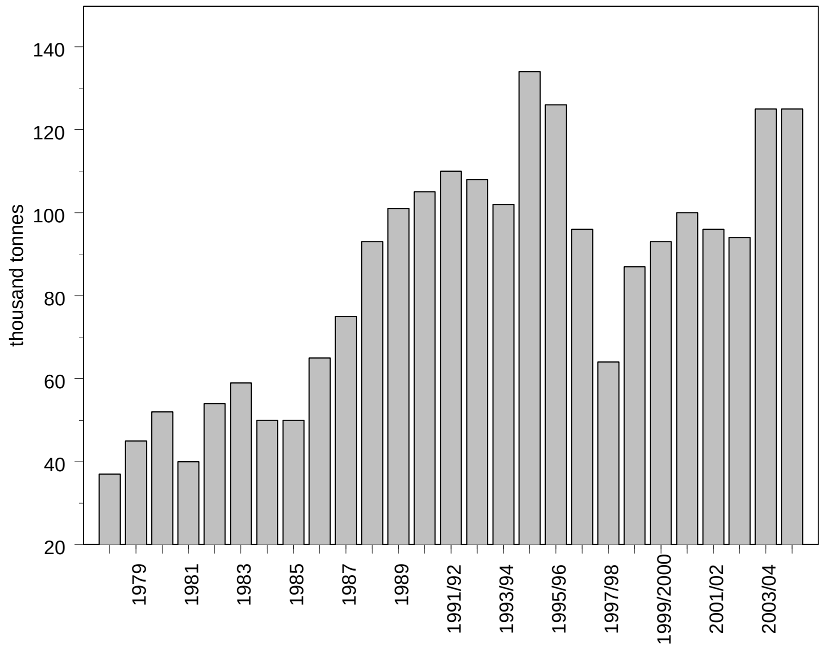


Figure 3.5.1.1. Total catch (in thousand tonnes) of the icelandic summer spawning herring in 1978/79-2004/05.

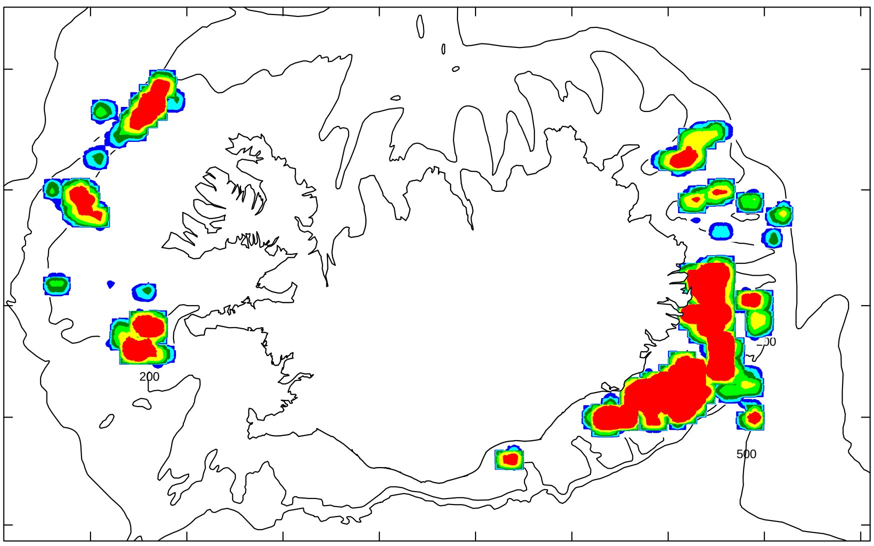


Figure. 3.5.1.2 Distribution of the catches of the icelandic summer spawning herring in the fishing season 2004/05 based on data from logbooks.

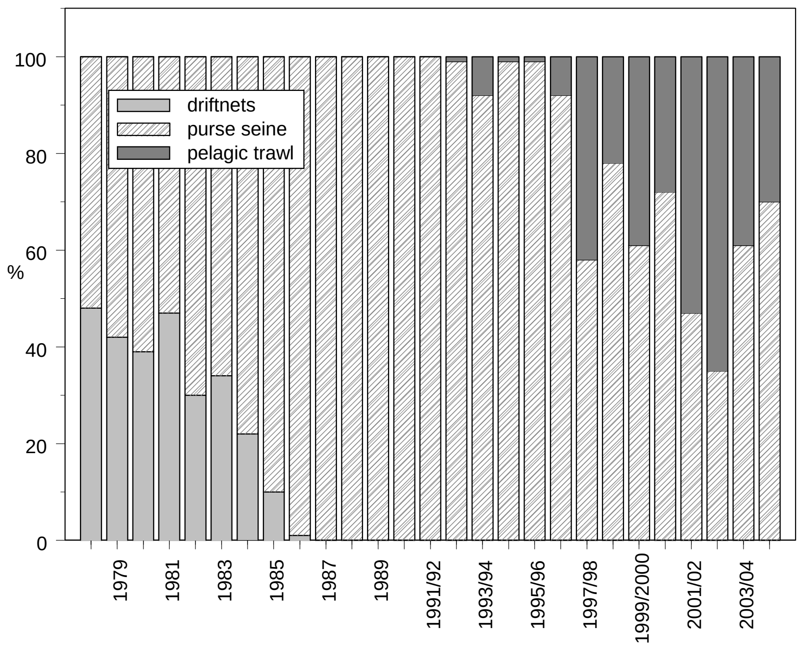


Figure 3.5.2.1. Proportion of the catches of the icelandic summer spawning herring in 1978/79-2004/05 taken by gears.

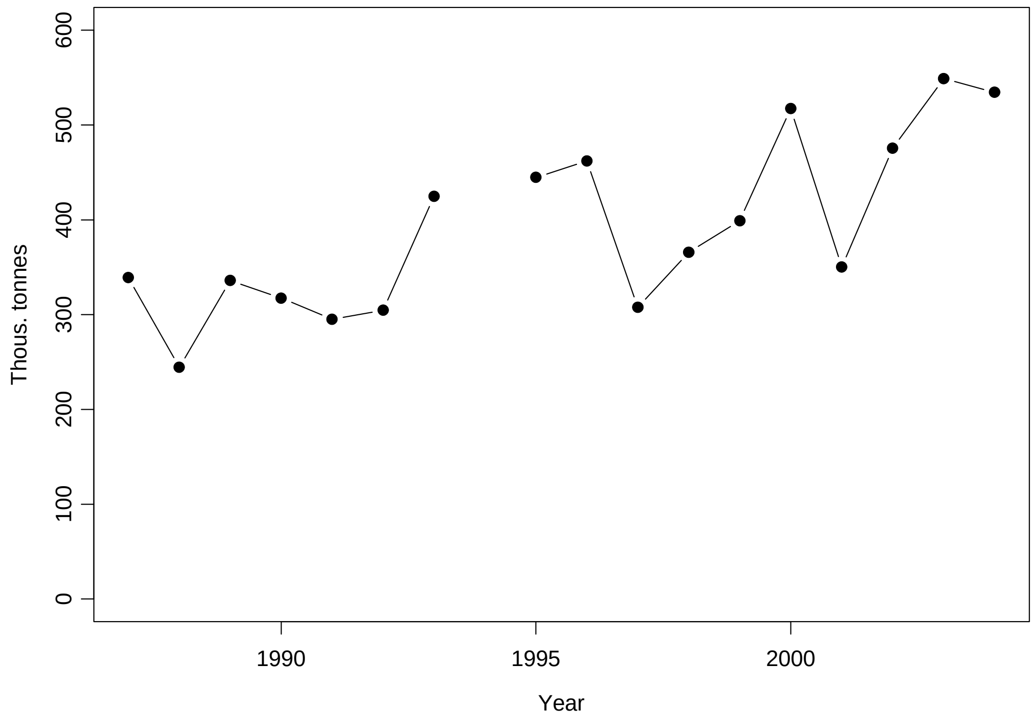


Figure 3.5.4.1 Totalbiomass from the survey for ages 4 and older in the years

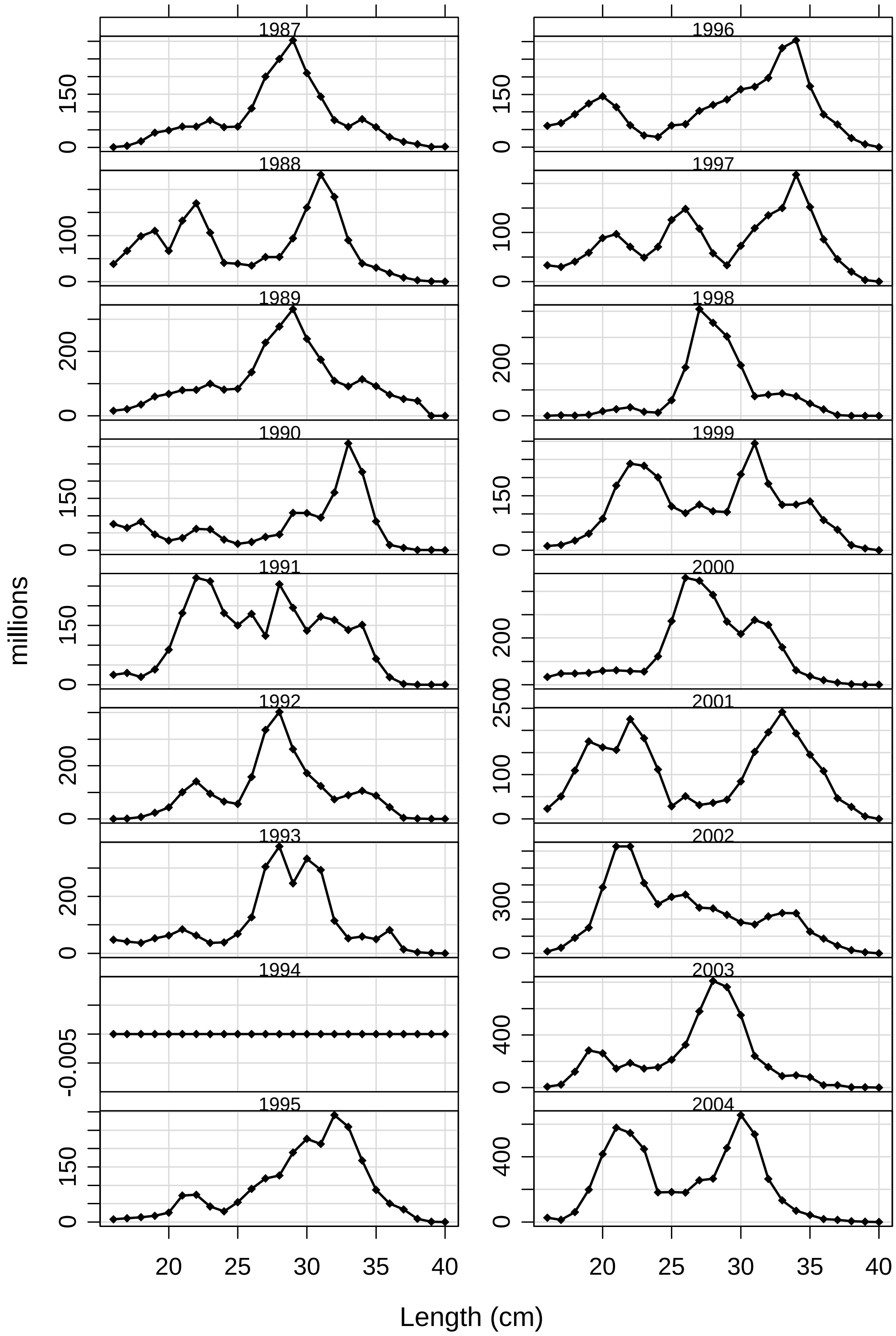


Figure 3.5.4.2 . Length distributions of icelandic summer spawning herring from acoustic surveys 1987-2004. Free scale on y-axis. Only lengths > 15 cm used. No survey in 1994

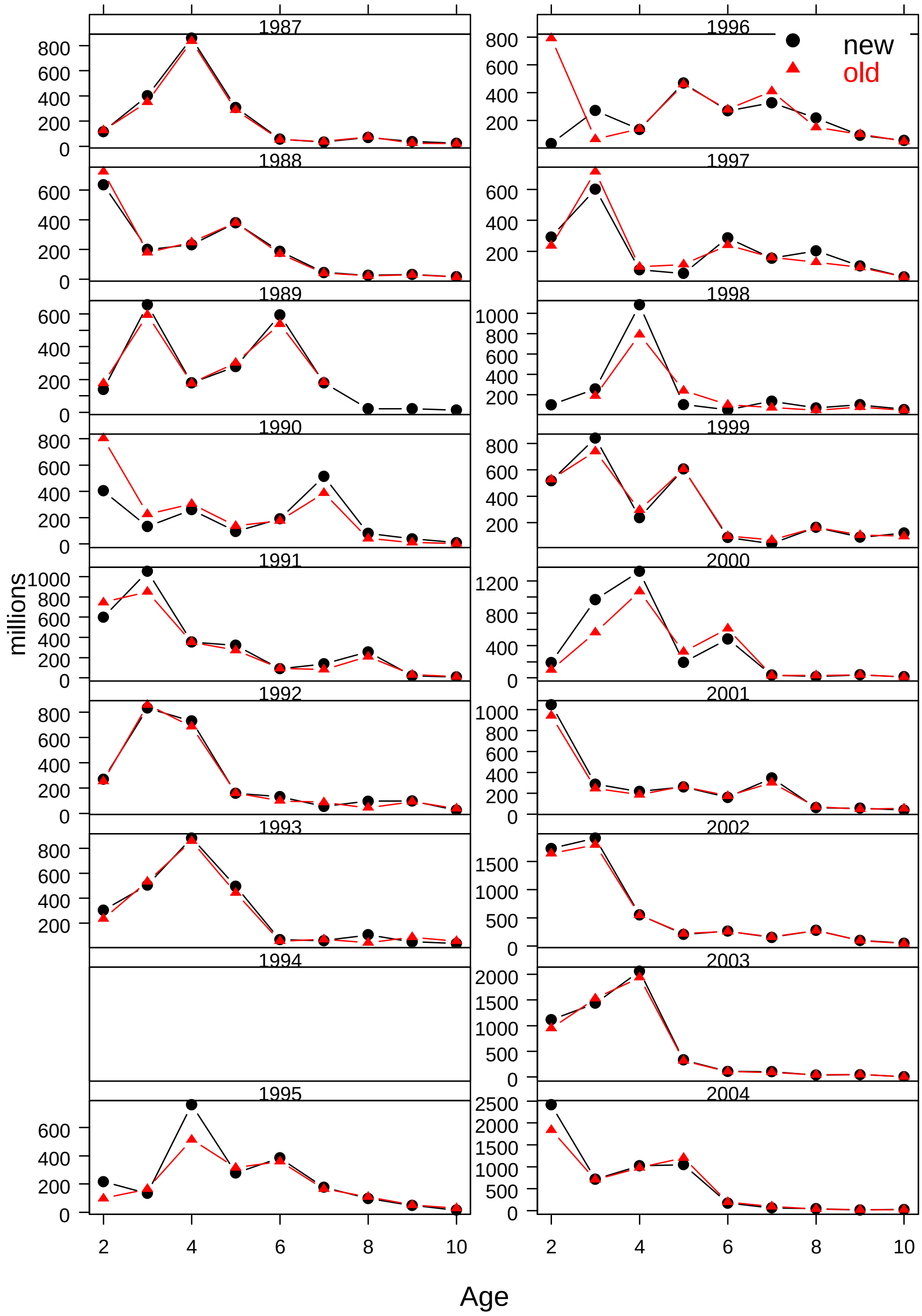


Figure 3.5.4.3 Age disaggregated indices (ages 2-10) for icelandic summer spawning herring from annual acoustic surveys in the seasons 1987/88-2004/05. Lines with triangles denote old indices and lines with bullets recalulated indices.

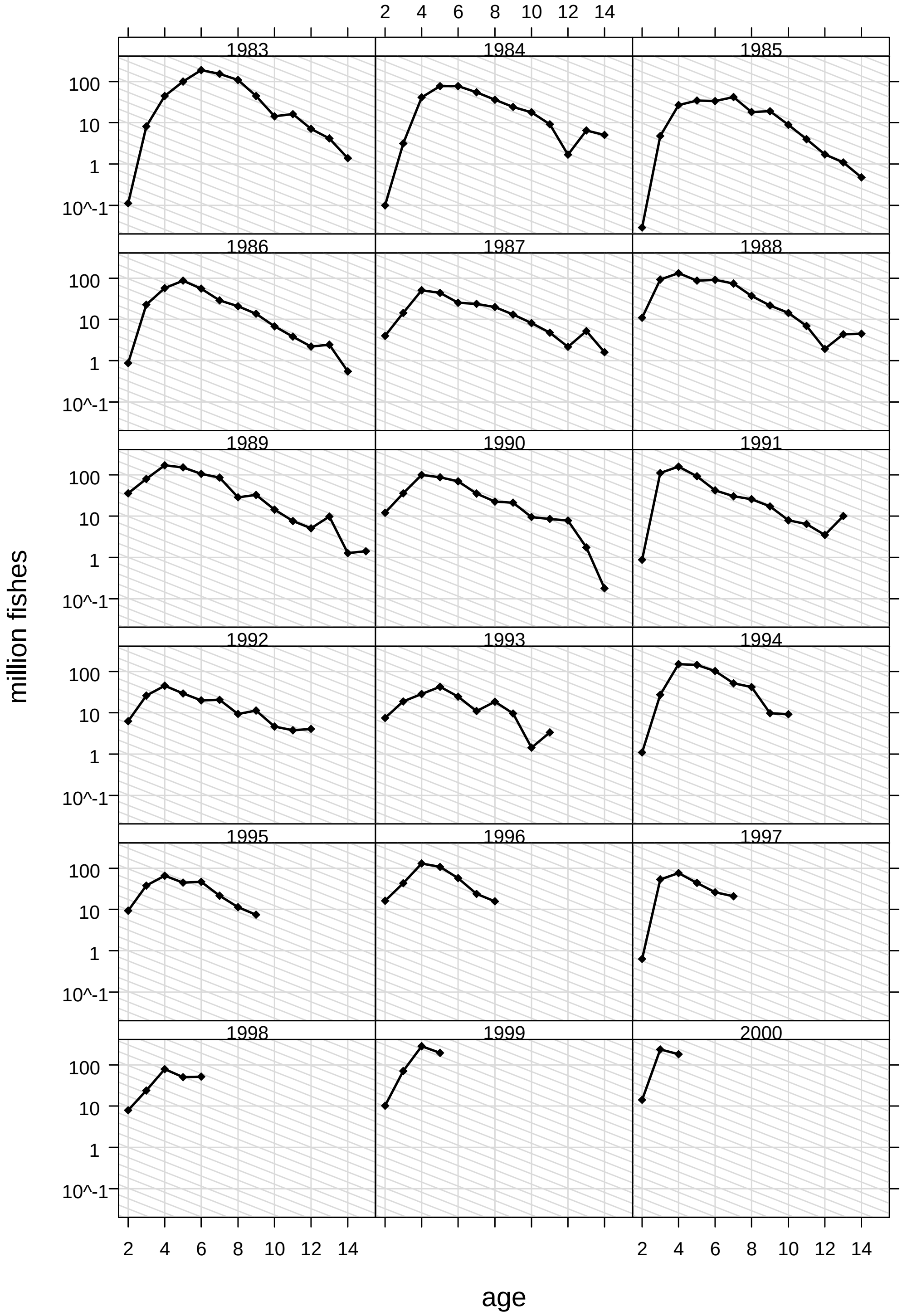


Figure 3.5.5.1.1. Catchcurves by yearclasses and years. Grey lines correspond to Z=0.4

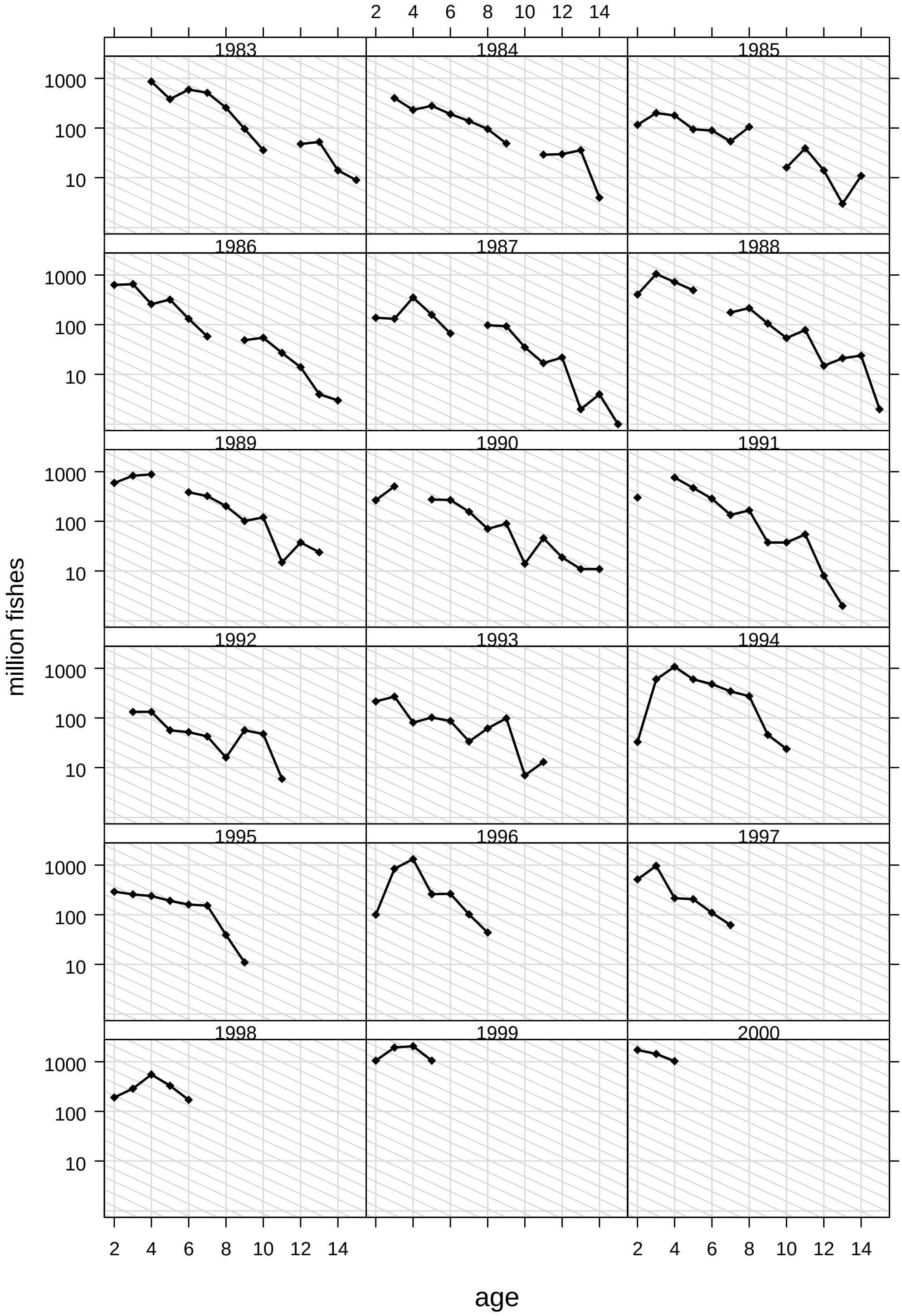


Figure 3.5.5.1.2. Catchcurves for the year classes 1983-2000 by age for icelandic summer spawning herring made from survey data in the seasons 1987/88-2004/05. Grey lines correspond to Z=0.4.

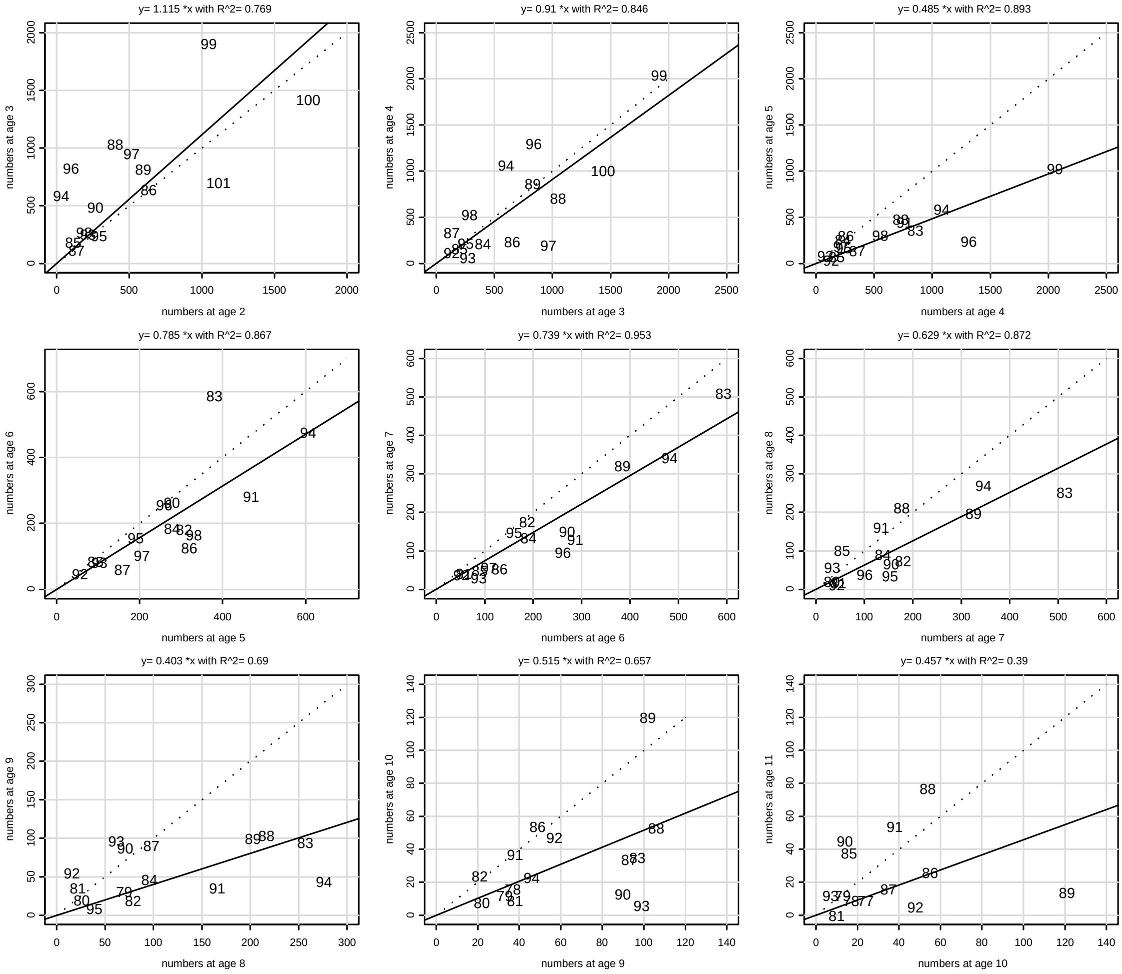


Figure 3.5.5.1.3. Comparison between ages in the survey. Yearclasses are denoted in the graphs.

Solid line is the fitted line through origin and dotted line is line with slope 1.

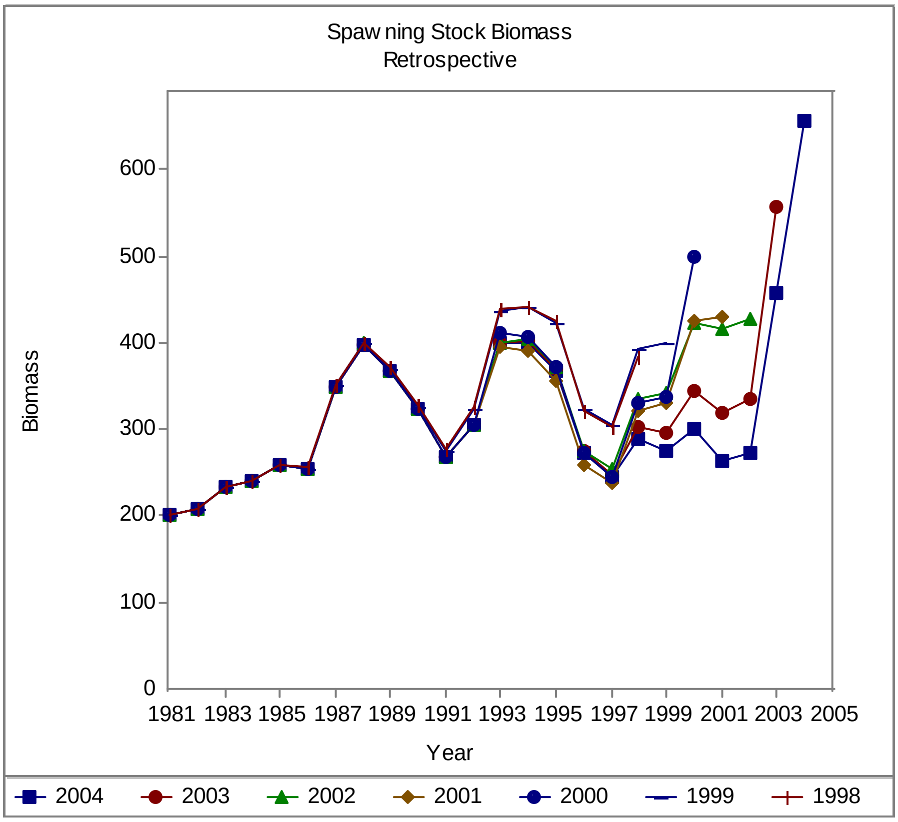
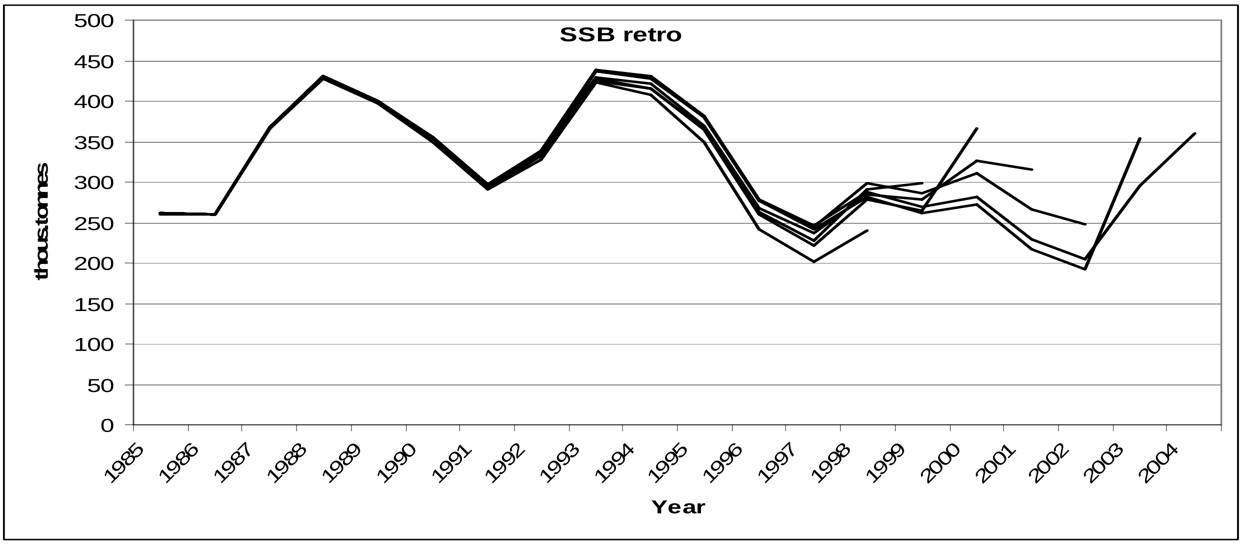


Figure 3.5.5.3.1. A retrospective plot of SSB for one of the models run, showing the bias in the assessment.



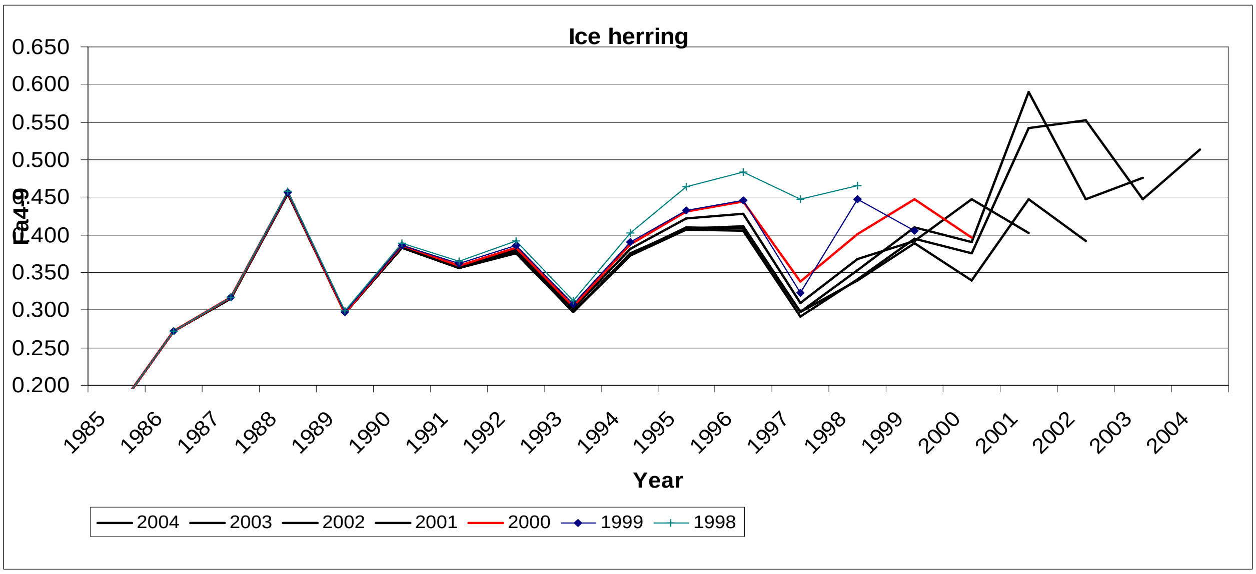


Figure 3.5.5.3.2. A retrospective plot from a Cohort analysis.

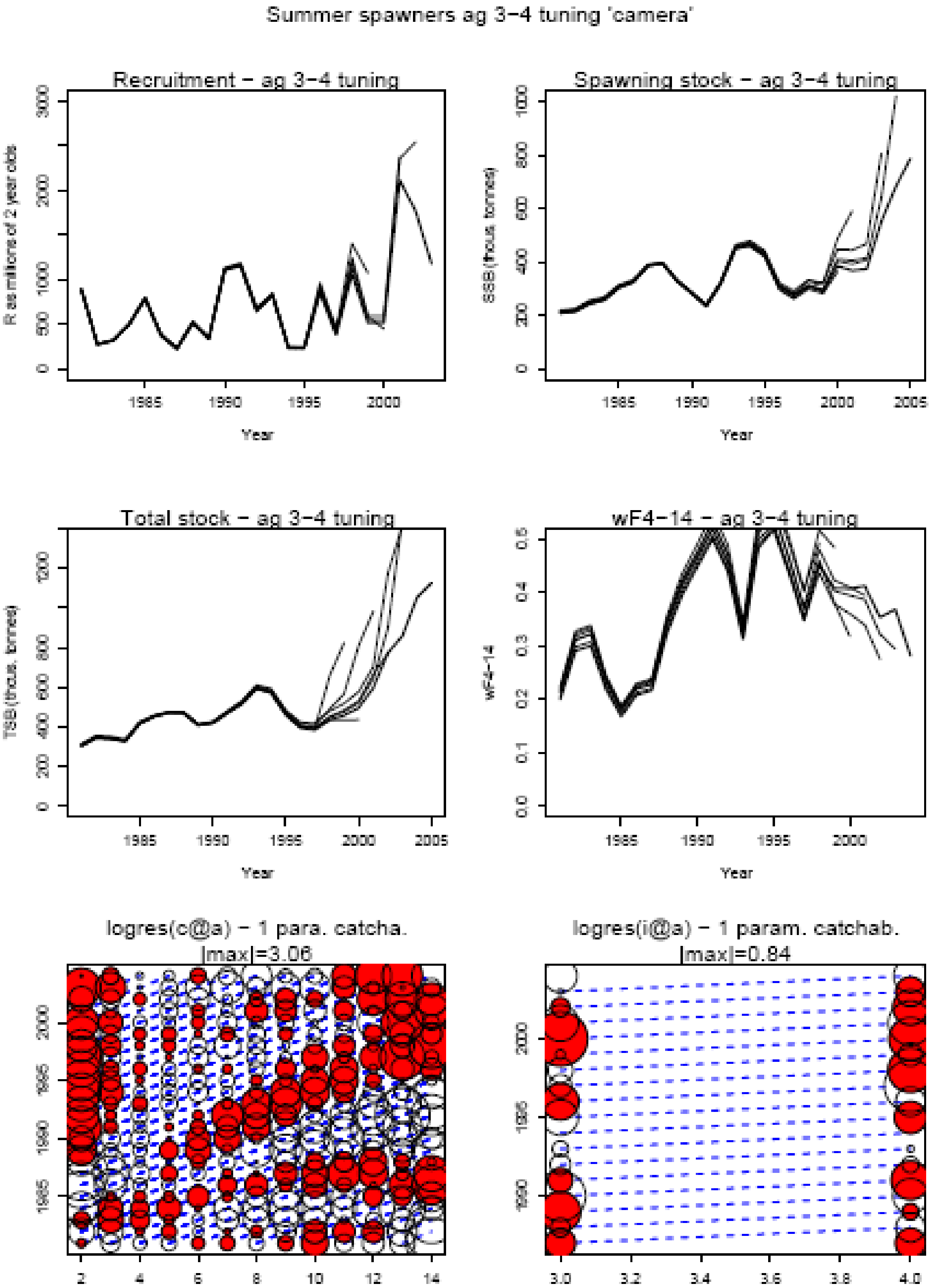


Figure 3.5.5.3.3. Diagnostic plot from a Camera run, with age 3-4 in the tuning fleet.

4 Overview on fisheries and their management in Greenland waters.

4.1 Ecosystem considerations

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 for some fish stocks as indicated from the surveys might be a response of the stock to such favourable environmental conditions (WD 1/2005). As has been observed with the Icelandic cod stock another important interaction is between cod and shrimp and a historic large shrimp biomass is in West Greenland water in present time would make feeding conditions optimal (Hvingel 2004).

4.2 Description of the fisheries

Fisheries targeting living marine resources off Greenland can be divided into inshore and off-shore 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 1700 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.

4.2.1 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.

4.2.2 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.

4.3 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.

4.4 Description of the most important commercial fishery resources - except mammals

4.4.1 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.

4.4.2 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.

4.4.3 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.

4.4.4 Squids

The status of squids in Greenland water is unknown.

4.4.5 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.

4.4.6 Redfish

4.4.7 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 compoent 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.

4.4.8 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.

4.4.9 Capelin;

Advice on demersal stocks under mixed fisheries consideration

4.5 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.

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

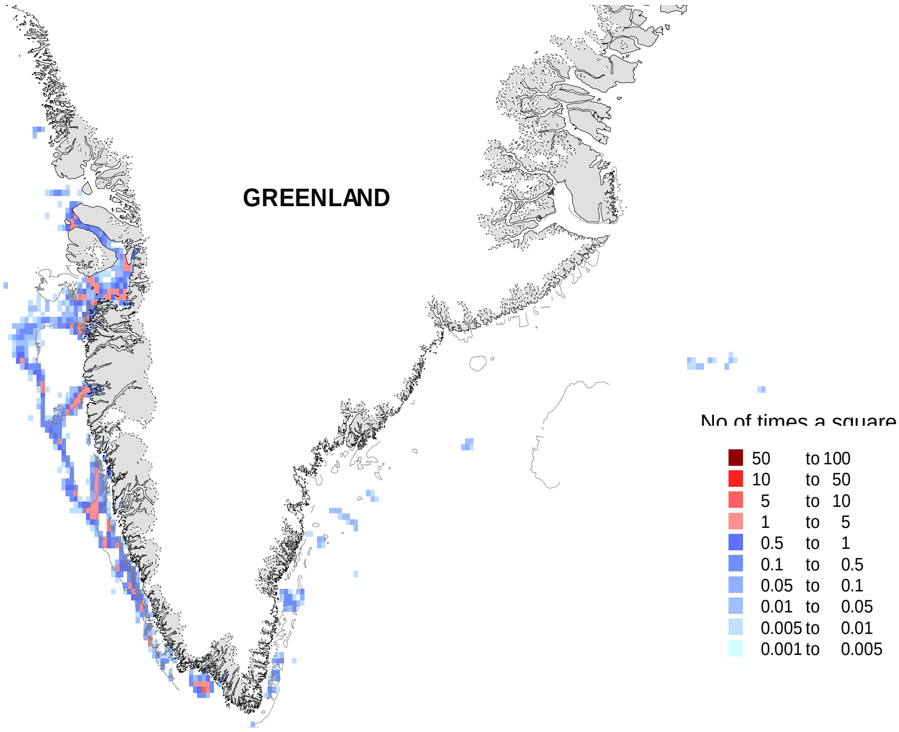
OFFSHORE:	VESSELS	TONNES	DICARD
Capelin	70	117838	0
G.halibut	26	8026	10
A.Halibut	10	248	0
Shrimp	28	7349	11
S. mentella Pel.	35	10680	11
Redfish sp.	2	106	0
S.Marinus	19	366	0
Roundn. grenadier	19	104	6
Wolffish	3	10	0
Mixed quota	3	485	1

West Greenland

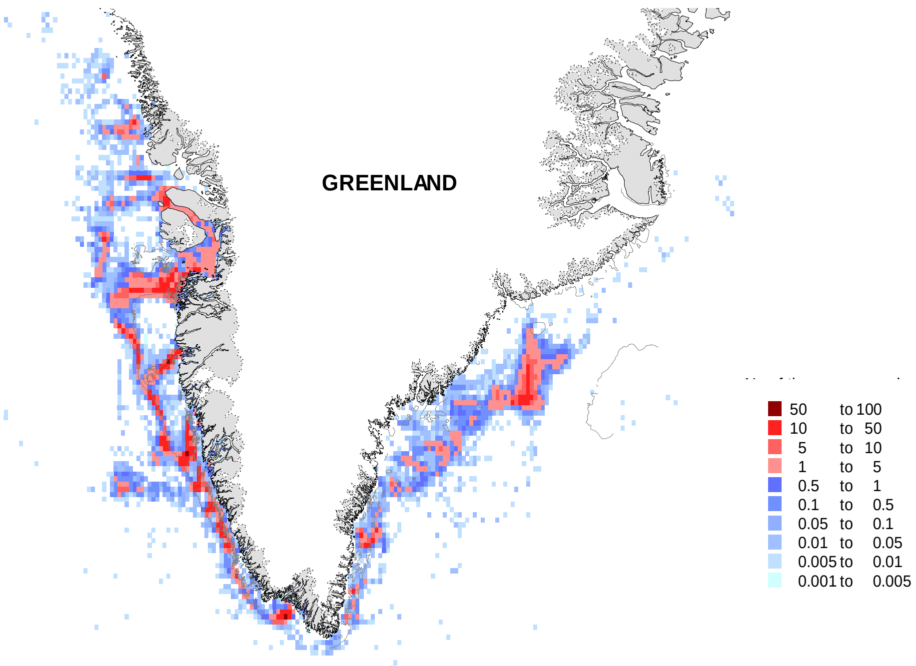
OFFSHORE:	VESSELS	TONNES	DICARD
G.halibut	17	9502	18
A.halibut	1	20	0
Shrimp	20	58623	9
Redfish sp.	14	2349	0
Roundn. grenadier	7	46	30
Cod	10	728	0
Inshore:			
Snow crab	12	2802	41
Scallops	4	2215	0

***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 -offshore

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. 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 (Storr-Paulsen et al. 2004). 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.

5.1.1 Historic assessment

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 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 catch data were available to update the assessment on an annually basis. Information on the historic VPA is available in ICES 2001/Assess:20. Due to a strong recruiting yearclass (2003) there have been some attempts to make an analytic assesment for the offshore cod in 2005.

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 22000 t and exceeded the level of 120 000 t in 1931. The next 10 years landings were fluctuating in the range of 60 000 –130 000 t (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 270 000 t. In 1962 the offshore landings culminated with landings of 440 000 t. After this historic high, landings decreased sharply by 90 % to 46 000 t in 1974 and even further down in 1977. The level of 40 000 t was only exceeded during the periods 1982–83 and 1988–1990. 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 125 000 t by more than 65 %, 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 until 2003. In 2004, the officially reported landings amounted to 357 t all caught in East Greenland. From total offshore landings, 10 t or less than 3 % was reported as by-catch in other fisheries. No reports on discards have been available. Anecdotal information indicates that catches of close to 1 000 t have been caught in East Greenland water although not registered in 2004.

Age-1 and partly age 2 cod is believed to be caught as by-catch in the shrimp fishery at West and East Greenland waters, however no official registrations are available on this subject.

Logbook information about commercial catches and effort has been available from 1990-2004 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. In 2004, 3 vessels had in periods cod as main target all ships derived from the Faroe Island, and 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. 1/2005. 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. 1/2005).

Stock abundance indices

Table 5.1.4 lists abundance and biomass indices for West and East Greenland, respectively and then combined for the years 1982–2004. 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 2004 survey results confirmed the severely depleted status of the SSB, although they represent the highest stock size in 14 years (less than 6% of the abundance in 1987) and indicates a significant recovery signal as especially one strong year class (2003) has been registered in the survey. The total abundance and biomass indices amounted to 50 million individuals and 39 000 t, respectively, were 64 % of the stock in numbers were distributed off West Greenland but only 16 % of the biomass.

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 1 814 individual age determinations. The year class 2003 was as 0-group by far the largest in the time series and at age one in 2004 is assessed as the second strongest year class and is estimated to amount to 70 % of the strongest year class 1984 at age 1. 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 fourth strongest year class in West Greenland since 1982 and thus to provide some recovery potential in the next few years. 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.

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 1982–2004. They reveal pronounced area and temperature effects. Age groups 3–10 years off East Greenland were found to be significant longer in average 15% 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 2004 values for East and West Greenland indicate a stable length frequency for all age classes. Mean weight at age can be obtained from regression $f(x)= 0.00895x^{3.00589}$, X=length in cm, the equation has been determined on the basis of historic measurements.

5.1.2.2 Results of the Greenland groundfish survey off West Greenland

Since 1988, the Greenland Institute of Natural Resources has conducted an annual stratified random trawl survey at West Greenland. The main purpose of the survey is to evaluate the biomass and abundance of the Northern shrimp (*Pandalus borealis*), but since 1992 data on fish species have been included. The survey covers the offshore areas at West Greenland between 59º15'N and 72º30'N and the inshore area of Disko Bay from the 3 mile limit down to the 600 m. (Figure 5.1.8). The survey area is divided into NAFO divisions and further subdivided into five depth strata (50-100, 101-150, 151-200, 201-400 and 401-600 m) on the basis of depth contour lines.

It is conducted with a 722 GRT trawler, equipped with a 3000/20-mesh Skjervøy with a twin cod end. Stratified abundance and biomass estimates are calculated from catch-per-tow data using the strata area as weighting factor (Cochran, 1977). The catchability coefficient is 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.

Stock abundance indices

The biomass indices for cod were in the survey estimated to be between 4000-7000 t in the period 1988-1990. In 1992 the biomass decreased by more than 95 % to only 250 t and remained at this low level until recent years. Since 2001 a slight improvement was detected in the biomass index and in 2004 the biomass level was estimated to be close to 2400 t (Table 5.1.8 and 5.1.9). Abundance was estimated to be 6.5 millions individuals, which is the highest number in the time series (1992-2004), and this is mainly caused by a high abundance of age 2 cod.

Age composition

Age disaggregated abundance indices are listed in Table 5.1.10 and indicates that more year-classes is occurring, although there still is a dominance of age group 2 contributing to 43 % of the total abundance. In 2004, age length keys were determined on the basis of 392 otoliths.

5.1.3 Biological sampling of commercial catches

Due to the low landings from the offshore component of cod off Greenland, there were since 1993 no catch samples available to calculate the catch, maturity and mean weight at age.

The working group strongly recommends to conducting sampling of commercial catches from the Greenland offshore areas with the purpose to improve the assesment.

5.1.4 Stock assessment (offshore component)

The strong 2003 year class at age 1 as indicated from the German survey requires an analytical approach to estimate its abundance in relation to historic year class strengths. As stated in section 5.1.3 no catch samples have been available. The historic recordings of catches do include landings only, discards information have not been available.

The approach preferred by the working group is based on survey indices from 2005 simulated from the 2004 survey indices at ages 2-8 by applying survey mean Zs by age (1982 to 2004). Regressions between the converged part of the historic VPA values (1982-1989) and the corresponding survey indices were used to scale the survey indices in 2005 to absolute stock size estimates for age groups 2-8.

For age group 2 (year class 2003), which was estimated to be the second highest in the survey time series, a simple linear regression was applied. The 1985 year class was at age 2 at a similar very high survey level as the 2003 year class. For this reason, the estimation of the year class 2003 at age 2 is based on an average between the VPA estimate for the 1985 year class at age 2 and the value derived from the linear regression between the survey and VPA at the given survey size.

As the older age groups (3-8) all are indicated as low abundant by the survey results, a log-log transformation between survey estimates and VPA was used to convert the survey estimates by means of linear regressions

All regressions used to estimate the stock size in number in 2005 are shown in figure 5.1.9).

5.1.4.1 Short term predictions

Input data-short term

- Stock size: Start population estimates was estimated as explained in section 5.1.4.
- Recruitment at age 1 in 2005-2007: 1983-1992 geometric mean from the rerun XSA = 6.765 million, representing 4 % of the long term average mean 1955-1992.
- Natural mortality in 2005-2007: usual standard input M=0.2 for ages 1-4 and M=0.3 for ages=>5 to account for the arbitrary emigration to Iceland.
- Maturity: A strong trend of maturation at age was apparent in the survey records to earlier ages, probably because of positive temperature effects. As the survey estimates were not taken in spawning time but in autumn, historic standard values were adopted in the present calculations, without knowledge of their origin. However, such maturity ogive implies a very late maturation (age50%=6) compared to the recent survey results offshore (age 50%=2).
- Mean weight at age in the stock in 2005-2007: mean 2002-2004 survey weights at ages 1-8 were used as the fish seem to have profited from recent high temperatures.
- Mean weight at age in the landings in 2005-2007: in absence of direct landing samples mean weight at age in the stock was used for ages 1-2 and 4-8. The mean weight at age 3 was adjusted for the effect of higher mean weights at age in the commercial landings during 1982-1992, were both weights at ages from commercial landings and the survey catches were available. On average, the weights at age 3 in the landings were 39 % higher than the survey estimates during that period. The survey mean weight at age 3 in 2002-2004 was increased by 39 % resulting in a value of 0.938 kg. For ages 4 and older the comparison between mean weights in the surveys and commercial catches did not reveal significant differences.
- Mean weight at age in the discards in 2005-2007: in absence of observations mean weight at age in discards are not considered.
- The fishery in the interim projection year 2005 is assumed as status quo compared to 2004 resulting in an exploitation rate at Fref=0.02.
- Exploitation patterns of landings in 2005-2007: Relative Fs are used as inputs based on average exploitation pattern by age 1 to 8 in 1990-1992 which is scaled to the average Fref over ages 5 to 8, amounting to 0.9054. The variation is over years and ages is shown in Figure 5.1.9. The exploitation pattern does not take into account the increased size at age 3 which should result in an increased selection in short term. However, as the selection of age 3 is low, this effect should not result in a major change in the projections of landings and SSB.

Input parameters for the short term prediction are given in Table 5.1.11.

Results- short term

Single option results and the management options are given in Table 5.1.12 and 5.1.13. It can be seen in the management option table that any significant fishing will lead to a reduction in the spawning stock until 2007 (Figure 5.1.11)

As the result of the short predictions is very sensitive to the survival rate of the strong 2003 year class, any discards would affect this projection significantly.

5.1.4.2 Medium term predictions

Medium term predictions are giving for the 2003 year class only and was projected for 10 years under a no fishing scenario in order to illustrate its development in terms of SSB

Input data-medium term

Input parameters and results are given Table 5.1.14 and are identical to the short term parameters except the mean weight, which are the survey mean weights at age over 1982-2004 to account for historic variation in medium term The emigration is accounted for as the usual M=0.3 for ages>=5..

Results-medium term

The 2003 year class was estimated to about 92 million fish. The resulting medium term SSB projections are sensitive to its future emigration behaviour, for which insufficient information exists as based from preceding year classes. Considering a no fishing scenario, the resulting SSB from the year class 2003 will peak during 2010-2013 in the order of 90.000 t (Figure 5.1.12), representing the double compared with SSB from the early 1970s to the early 1990s (low stock period) but only 10 % compared with the SSB estimated from 1955-70 (high stock period).

5.1.4.3 Long term predictions

Input data- long term

- Natural mortality: The usual standard input M=0.2 for ages 1-4 were used and M=0.3 for ages=>5 to account for emigration to Iceland.
- Maturity: Same input as for the short term predictions.
- Mean weight at age in the stock and landings: long term mean 1955-1992 weights at ages 1-11 were used, the oldest age being a plus group.
- Exploitation pattern: Same input as for the short term predictions.

Results- long term

The result of the long term prediction is very sensitive to discard mortality, not included in the calculations, any discards would affect the projection. Input data to the Y/R model are given in Table 5.1.15.

The yield per recruit trajectory reveals a poor defined and relatively high Fmax= 0.69 (Figure 5.1.13), mainly because of the increased natural mortality for ages 5+ to account for emigration to Iceland. The F0.1 is low and amounts to F=0.25.

5.1.5 State of the stock (offshore component)

The historic XSA in combination with recent survey results and predictions scenarios confirm that the SSB remains severely depleted, in short term projection until 2008.

Mortality rates derived from the survey and low landings imply that the recent exploitation rate is very low.

Recruitment has been slightly increased since 1997 and the 2003 year class is estimated to range in the order of 40 % of the last strong 1984 year class, maps on the geographic distribution patterns of the 2 year classes are visualized in figure 5.1.16. The strong 2003 year class implies a recovery potential of SSB.

5.1.6 Management considerations

There is strong evidence for a significant increase in the cod stock abundance in medium term, not only from a single strong recruiting year class but also from increased growth rates and earlier maturation probably enhanced by continued favourable environmental conditions.

The working group notes that there exist no management objectives for the exploitation of the Greenland cod. No direct fishing should take place on the stock and maximum protection of juvenile cod is required to increase the recovery potential of the stock. Given the fishing possibilities of the stock, a recovery plan urgently needs to be developed. Such multi-annual harvest plan needs to account not only the stock dynamics but also needs to incorporate the ecological interaction with the shrimp stock and its exploitation as well as temperature effects. Until such a recovery plan is effective,

5.1.7 Comments on the assessment

The assessment of the recruitment strength and dynamics must be considered uncertain as it is based on a single year survey estimate and discard rates in the shrimp fishery remain unknown as well as no catch at age information are available. However, the state of the cod stock in terms of biomass will remain very low until 2008. A significant part of the earlier strong 1984 year class was observed to have migrated to Iceland when ready for first spawning (Storr-Paulsen et al.). If the 2003 year class will show a similar homing migration is uncertain as environmental conditions as well as optimal feeding conditions might influence the migration behaviour.

5.1.8 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:15.

ICES 1996 Report of the North Western Working Group. ICES CM 1996/Assess:15.

ICES 2001 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.

Hvingel, C. 2004. An assessment of the shrimp stock in Denmark Strait/off East Greenland. NAFO SCR Doc. 04/81.

Jónsson, J. 1959. Icelandic cod investigations in Southwest and Southeast Greenland waters, 1957. Annls. Biol. 14: 115-118.

Meyer, A. 1963. Greenland cod, German investigations, 1961. Annls. Biol. 18: 114-118.

Rätz, H.-J. 2005. Groundfish survey results for cod off Greenland (offshore component) 1982-2004. Working document 1, ICES North Western Working Group 2005.

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. 2005. Cod stock investigations off West Greenland. Working document 6, ICES North Western Working Group 2005.

Storr-Paulsen, M., Wieland K., Hovgård H. and Rätz H-J. 2004. Stock structure of Atlantic cod (*Gadus morhua*) in West Greenland waters: implications of transport and migration ICES Journal of Marine Science. 61: 972-982

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: 61-76.5.1.1 Cod off Greenland (offshore component)

Table 5.1.1 Nominal catch (t) of Cod in NAFO Sub-area 1, 1988-2004 as officially reported to ICES.

COUNTRY	1988	1989	1990	1991	1992	1993
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
Japan	10	-	-	-	-	-
Norway	7	2	948	-	-	-
UK	927	3780	1.631	-	-	-
Total	59.653	108.826	68.961	20.335	5.723	1.924
WG estimate	62.653 [2]	111.567 [3]	98.474 [4]	-	-	-

COUNTRY	1994	1995	1996	1997	1998	1999
Faroe Islands	-	-	-	-		
Germany	-	-	-	-		
Greenland	2.115	1.710	948	904	319	622
Japan	-	-	-	-		
Norway	-	-	-	-		
UK	-	-	-	-		
Togo	2.115	1.710				
Total	-	-	948	904	319	622
WG estimate			-	-	-	-

COUNTRY	2000	2001	2002[1]	2003[1]	2004[1]
Faroe Islands					
Germany					
Greenland	764	1680	3698	3989	4948
Japan					
Norway				693 [5]	
UK					
Togo				533 [5]	
Total	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, 1988-2004 as officially reported to ICES.

COUNTRY	1988	1989	1990	1991	1992	1993
Faroe Islands	12	40	-	-	-	-
Germany	12.049	10.613	26.419	8.434	5.893	164
Greenland	345	3.715	4.442	6.677	1.283	241
Iceland	9	-	-	-	22	-
Norway	-	-	17	828	1.032	122
Russia		-	-	-	126	
UK (Engl. and Wales)	-	1.158	2.365	5.333	2.532	-
UK (Scotland)	-	135	93	528	463	163
United Kingdom	-	-	-	-	-	46
Total	12.415	15.661	33.336	21.800	11.351	-
WG estimate	9.457 [1]	14.669 [2]	33.513 [3]	21.818 [4]	-	736

COUNTRY	1994	1995	1996	1997	1998	1999
Faroe Islands	1	-	-	-	-	6
Germany	24	22	5	39	128	13
Greenland	73	29	5	32	37 [5]	+ [5]
Iceland	-	1	-	-		-
Norway	14	+	1	-	+	2
Portugal					31	-
UK (E/W/NI)	-	232	181	284	149	95
United Kingdom	296					
Total	408	284	192	355	345	116
WG estimate	-	-	-	-	-	-

COUNTRY	2000	2001	2002[5]	2003[5]	2004
Faroe Islands					329
Germany	3	92	5	1	
Greenland		4	232	78	23
Iceland	-	210			
Norway	- [5]	43	13		5
Portugal	-	278			
UK (E/W/NI)	149	129			
United Kingdom			34		
Total	152	756	284	79	357
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 – 2004 as used by the Working Group, inshore and offshore by NAFO division 1B and 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.

COD	INSHORE			OFFSHORE			TOTAL
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*
2004	1316	116	4948*	369	27	396*	5344*

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.

	ABUNDANCE					BIOMASS				
YEAR	WEST	EAST	TOTAL	CI	Spawn.	WEST	EAST	TOTAL	CI	Spawn.
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
2004	31607	17540	49147	58	20976	6284	32392	38676	38	34429

Table 5.1.5 Cod off West Greenland (offshore component), German survey. Age disaggregate abundance indices (1000), 1982-2004. *) 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
2004	31	24115	5316	803	588	584	142	9	0	0	0	0	31588

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
2004	190	4227	2008	712	1019	3975	2559	1933	738	130	44	0	17535

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
2004	221	28342	7324	1515	1607	4559	2701	1942	738	130	44	0	49123

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	WESTGR.	CI
1991	0	0	10	6	10	337	481	*	*	(846)	51
1992	0	0	4	16	37	243	345	0	8	653	49
1993	0	0	2	0	16	54	135	286	18	512	68
1994	0	10	0	0	41	87	0	6	0	144	47
1995	0	0	0	40	11	380	44	62	39	578	55
1996	0	0	0	0	0	46	68	87	107	308	55
1997	0	0	0	0	7	31	0	0	0	38	68
1998	0	0	0	4	0	0	26	26	3	59	54
1999	0	12	20	90	46	16	23	6	0	213	29
2000	0	186	399	270	167	71	58	9	189	1349	23
2001	0	0	26	236	69	110	448	305	313	1508	26
2002	0	0	13	69	134	78	3294	114	457	4158	50
2003	0	112	380	1356	39	351	727	214	211	3391	22
2004	0	0	197	37	115	379	2630	1538	1610	6507	29

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	WESTGR.	CI
1990	2	13	*	75	3	83	9005	*	*	(9180)	65
1991	0	0	7	2	15	151	310	*	*	(485)	44
1992	0	0	3	20	34	75	118	0	2	251	45
1993	0	0	2	0	5	25	39	124	5	200	70
1994	0	3	0	0	9	38	0	1	0	51	46
1995	0	0	0	5	1	120	23	3	4	155	63
1996	0	0	0	0	0	15	23	27	49	113	51
1997	0	0	0	0	2	53	0	0	0	55	76
1998	0	0	0	1	0	0	47	50	3	101	56
1999	0	1	5	23	5	1	17	1	0	53	47
2000	0	51	99	76	54	21	9	2	46	357	23
2001	0	0	15	125	30	56	178	98	100	603	23
2002	0	0	13	54	74	41	1489	42	150	1863	46
2003	0	18	111	315	8	264	453	118	46	1332	26
2004	0	0	496	46	7	176	680	685	305	2394	28

Table 5.1.10 Cod off Greenland (offshore component), Greenland survey. Age disaggregate abundance indices (1000) for West Greenland, 1992-2004.

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
2004	1215	2812	1205	786	382	71	33	0	6504

Table 5.1.11 Greenland cod offshore component. Short term input parameters.

2005					LANDINGS	LANDINGS	DISCARD	DISCARD
age	stock	M	maturity	weight	exploitation	weight	exploitation	weight
1	6765	0.2000	0.0000	0.077	0.0000	0.077	0.0000	0.000
2	91541	0.2000	0.0000	0.317	0.0000	0.317	0.0000	0.000
3	11445	0.2000	0.0100	0.675	0.1783	0.938	0.0000	0.000
4	2261	0.2000	0.0400	1.439	0.4767	1.439	0.0000	0.000
5	1109	0.3000	0.1500	2.216	0.6719	2.216	0.0000	0.000
6	1675	0.3000	0.4600	3.066	0.9454	3.066	0.0000	0.000
7	886	0.3000	0.7900	4.038	1.1554	4.038	0.0000	0.000
8	931	0.3000	0.9400	4.946	1.2273	4.946	0.0000	0.000

2006					landings	landings	discard	discard
age	stock	M	maturity	weight	exploitation	weight	exploitation	weight
1	6765	0.2000	0.0000	0.077	0.0000	0.077	0.0000	0.000
2		0.2000	0.0000	0.317	0.0000	0.317	0.0000	0.000
3		0.2000	0.0100	0.675	0.1783	0.938	0.0000	0.000
4		0.2000	0.0400	1.439	0.4767	1.439	0.0000	0.000
5		0.3000	0.1500	2.216	0.6719	2.216	0.0000	0.000
6		0.3000	0.4600	3.066	0.9454	3.066	0.0000	0.000
7		0.3000	0.7900	4.038	1.1554	4.038	0.0000	0.000
8		0.3000	0.9400	4.946	1.2273	4.946	0.0000	0.000

2007					landings	landings	discard	discard
age	stock	M	maturity	weight	exploitation	weight	exploitation	weight
1	6765	0.2000	0.0000	0.077	0.0000	0.077	0.0000	0.000
2		0.2000	0.0000	0.317	0.0000	0.317	0.0000	0.000
3		0.2000	0.0100	0.675	0.1783	0.938	0.0000	0.000
4		0.2000	0.0400	1.439	0.4767	1.439	0.0000	0.000
5		0.3000	0.1500	2.216	0.6719	2.216	0.0000	0.000
6		0.3000	0.4600	3.066	0.9454	3.066	0.0000	0.000
7		0.3000	0.7900	4.038	1.1554	4.038	0.0000	0.000
8		0.3000	0.9400	4.946	1.2273	4.946	0.0000	0.000

Table 5.1.12 Greenland cod offshore component. Single option short term prediction under status quo condition in landings.

2005	**F-**	**0.02**	**REFERENCE**	**0.0200**				**1**					
age	absolute	absolute	absolute F	catch in	catch in	landings	landings	discards	discards	stock size	stock	sp. stock	SSB (t)
1	0.0000	0.0000	0.0000	0	0	0	0	0	0	6765	521	0	0
2	0.0000	0.0000	0.0000	0	0	0	0	0	0	91541	29018	0	0
3	0.0036	0.0036	0.0000	37	35	37	35	0	0	11445	7725	114	77
4	0.0095	0.0095	0.0000	19	27	19	27	0	0	2261	3254	90	130
5	0.0134	0.0134	0.0000	13	29	13	29	0	0	1109	2458	166	368
6	0.0189	0.0189	0.0000	27	83	27	83	0	0	1675	5136	771	2364
7	0.0231	0.0231	0.0000	17	69	17	69	0	0	886	3578	700	2827
8	0.0245	0.0245	0.0000	19	94	19	94	0	0	931	4605	875	4328
				132	337	132	337	0	0	116613	56295	2716	10094
2006	F-factor:	0.02	reference	0.0200				1 January					
age	absolute	absolute	absolute F	catch in	catch in	landings	landings	discards	discards	stock size	stock	sp. stock	SSB (t)
1	0.0000	0.0000	0.0000	0	0	0	0	0	0	6765	521	0	0
2	0.0000	0.0000	0.0000	0	0	0	0	0	0	5539	1756	0	0
3	0.0036	0.0036	0.0000	244	229	244	229	0	0	74947	50589	749	506
4	0.0095	0.0095	0.0000	80	115	80	115	0	0	9337	13436	373	537
5	0.0134	0.0134	0.0000	21	47	21	47	0	0	1834	4064	275	609
6	0.0189	0.0189	0.0000	13	40	13	40	0	0	811	2487	373	1144
7	0.0231	0.0231	0.0000	24	97	24	97	0	0	1218	4918	962	3885
8	0.0245	0.0245	0.0000	13	64	13	64	0	0	641	3170	603	2982
				395	592	395	592	0	0	101765	80941	4008	9663
2007	F-factor:	0.02	reference	0.0200				1 January					
age	absolute	absolute	absolute F	catch in	catch in	landings	landings	discards	discards	stock size	stock	sp. stock	SSB (t)
1	0.0000	0.0000	0.0000	0	0	0	0	0	0	6765	521	0	0
2	0.0000	0.0000	0.0000	0	0	0	0	0	0	5539	1756	0	0
3	0.0036	0.0036	0.0000	15	14	15	14	0	0	4535	3061	45	30
4	0.0095	0.0095	0.0000	524	754	524	754	0	0	61141	87982	2446	3520
5	0.0134	0.0134	0.0000	87	193	87	193	0	0	7572	16780	1136	2517
6	0.0189	0.0189	0.0000	22	67	22	67	0	0	1341	4112	617	1892
7	0.0231	0.0231	0.0000	12	48	12	48	0	0	590	2382	466	1882
8	0.0245	0.0245	0.0000	18	89	18	89	0	0	882	4362	829	4100
				678	1165	678	1165	0	0	89327	120956	6501	13941

Table 5.1.13 Greenland cod offshore component. Management option table under status quo in the interim year 2005.

2005							2006							2007	
F-factor	reference	stock	sp.	catch in	landings	discard	F-factor	reference	stock	SSB (t)	catch (t)	landings	discard	stock	SSB (t)
0.0200	0.02	56295	10094	337	337	0	0.0000	0.0000	80941	9663	0	0	0	121630	14131
							0.1000	0.1000	80941	9663	2895	2895	0	118309	13195
							0.2000	0.2000	80941	9663	5636	5636	0	115131	12339
							0.3000	0.3000	80941	9663	8233	8233	0	112107	11559
							0.4000	0.4000	80941	9663	10692	10692	0	109215	10836
							0.5000	0.5000	80941	9663	13033	13033	0	106439	10178
							0.6000	0.6000	80941	9663	15255	15255	0	103795	9576
							0.7000	0.7000	80941	9663	17370	17370	0	101255	9024
							0.8000	0.8000	80941	9663	19392	19392	0	98815	8513
							0.9000	0.9000	80941	9663	21324	21324	0	96466	8044
							1.0000	1.0000	80941	9663	23164	23164	0	94209	7606
							1.1000	1.1000	80941	9663	24941	24941	0	92038	7205
							1.2000	1.2000	80941	9663	26637	26637	0	89946	6834
							1.3000	1.3000	80941	9663	28262	28262	0	87928	6495
							1.4000	1.4000	80941	9663	29821	29821	0	85979	6172
							1.5000	1.5000	80941	9663	31329	31329	0	84091	5875

Table 5.1.14 Greenland cod offshore component. Input parameters and resulting stock in number and SSB from the medium term projection of the year class 2003.

AGE	YEAR	M	MEAN WEIGHT (KG)	MATURITY	N (1000)	SSB (T) PROJECTED
2	2005	0.2	0.226	0	91541	0
3	2006	0.2	0.61	0.01	74947	457
4	2007	0.2	1.319	0.04	61361	3237
5	2008	0.3	2.125	0.15	50238	16013
6	2009	0.3	2.986	0.46	37217	51120
7	2010	0.3	3.887	0.79	27571	84663
8	2011	0.3	4.818	0.94	20425	92503
9	2012	0.3	6.173	1	15131	93404
10	2013	0.3	7.34	1	11209	82274

Table 5.1.15 Greenland cod offshore component. Input parameters for the long term predictions in the Y/R model.

AGE MIN	AGE GROUP	STOCK WEIGHT	CATCH WEIGHT	MATURITY	F	M	STOCK NUMBER
1	1	0.064	0.064	0.0000	0.0000	0.20	1
age max	2	0.226	0.226	0.0000	0.0000	0.20	
11	3	0.815	0.815	0.0100	0.1783	0.20	
Fref	4	1.255	1.255	0.0400	0.4767	0.20	
1.0000	5	1.863	1.863	0.1500	0.6719	0.30	
	6	2.549	2.549	0.4600	0.9454	0.30	
	7	3.295	3.295	0.7900	1.1554	0.30	
	8	4.157	4.157	0.9400	1.2273	0.30	
	9	4.967	4.967	1.0000	1.3020	0.30	
	10	5.836	5.836	1.0000	1.0779	0.30	
	11	6.823	6.823	1.0000	1.0779	0.30	

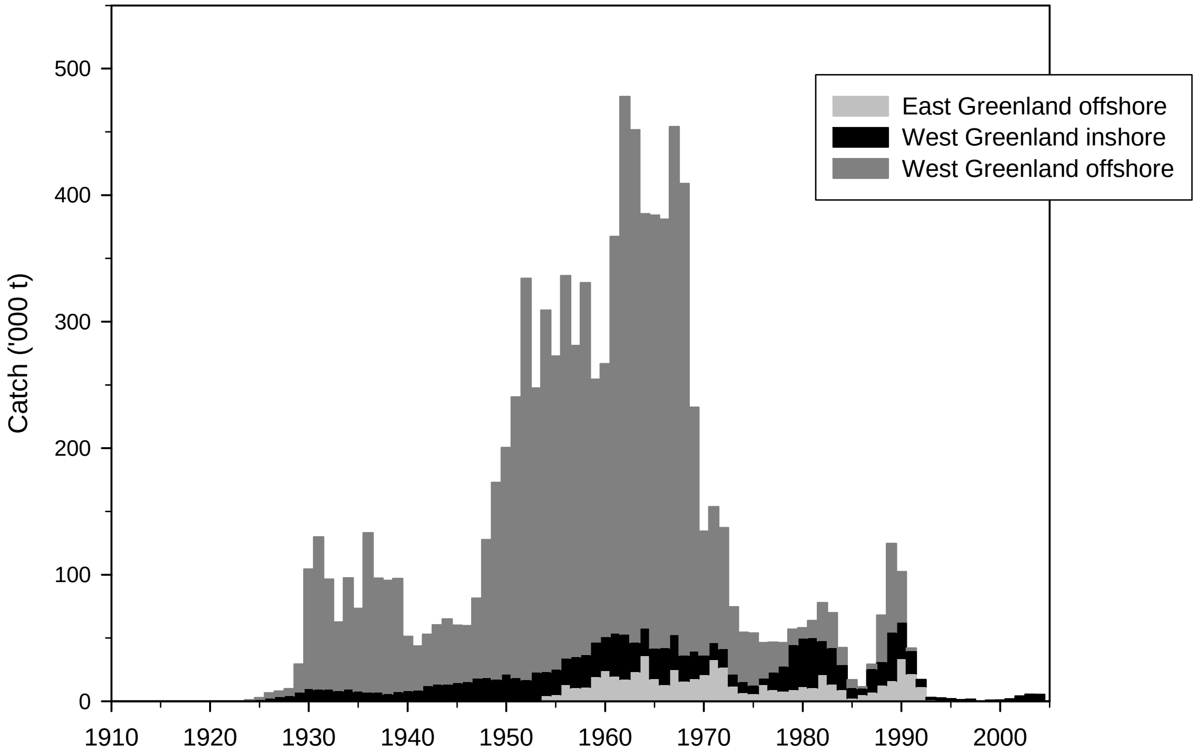


Figure 5.1.1 Cod off Greenland. Catches 1911-2004 as used by the Working Group, inshore and offshore by West and East Greenland (Horsted 1994,2000).

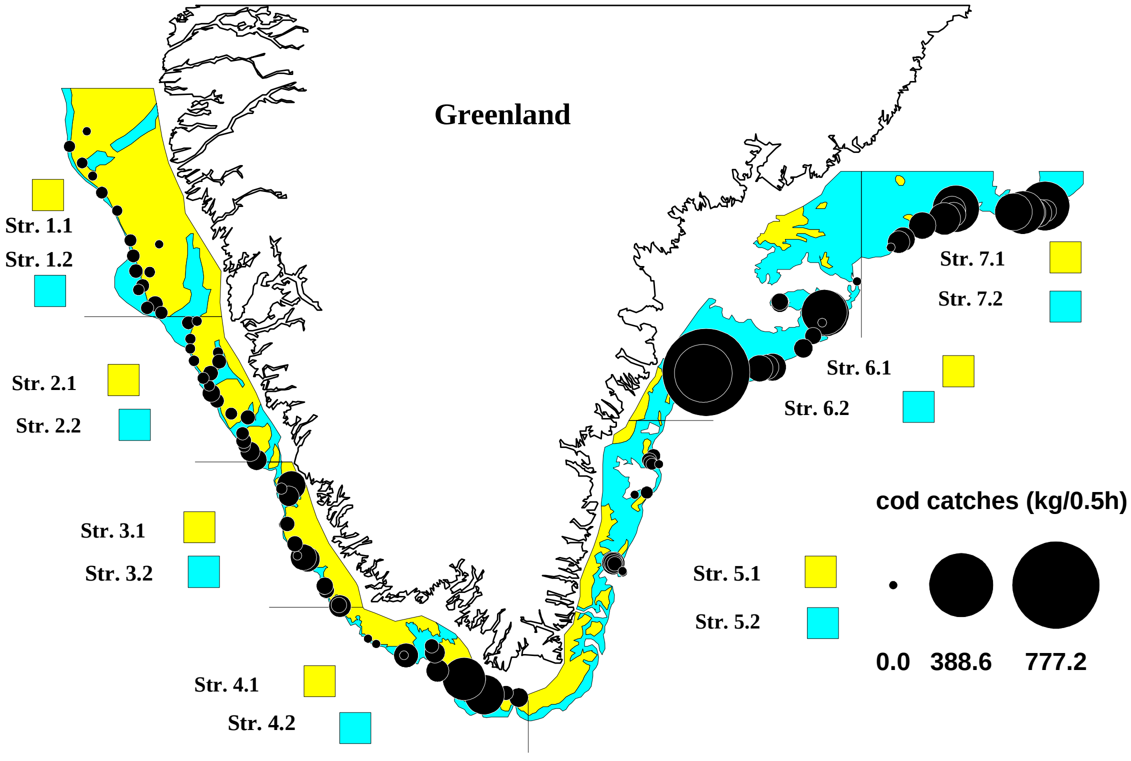


Figure 5.1.2 Cod off Greenland (offshore component), German survey. Survey area, stratification and position of hauls carried out in 2004.

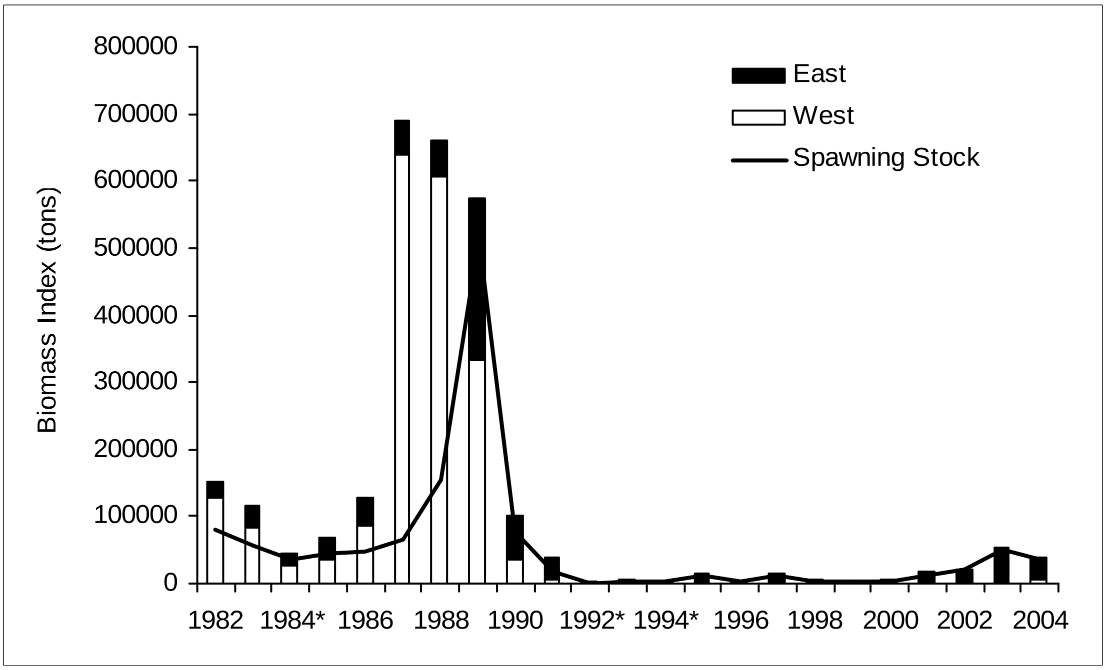


Figure 5.1.3 **Cod off Greenland (offshore component), German survey. Aggregated survey biomass indices for West and East Greenland and spawning stock biomass, 1982-2004. *)incomplete survey coverage.**

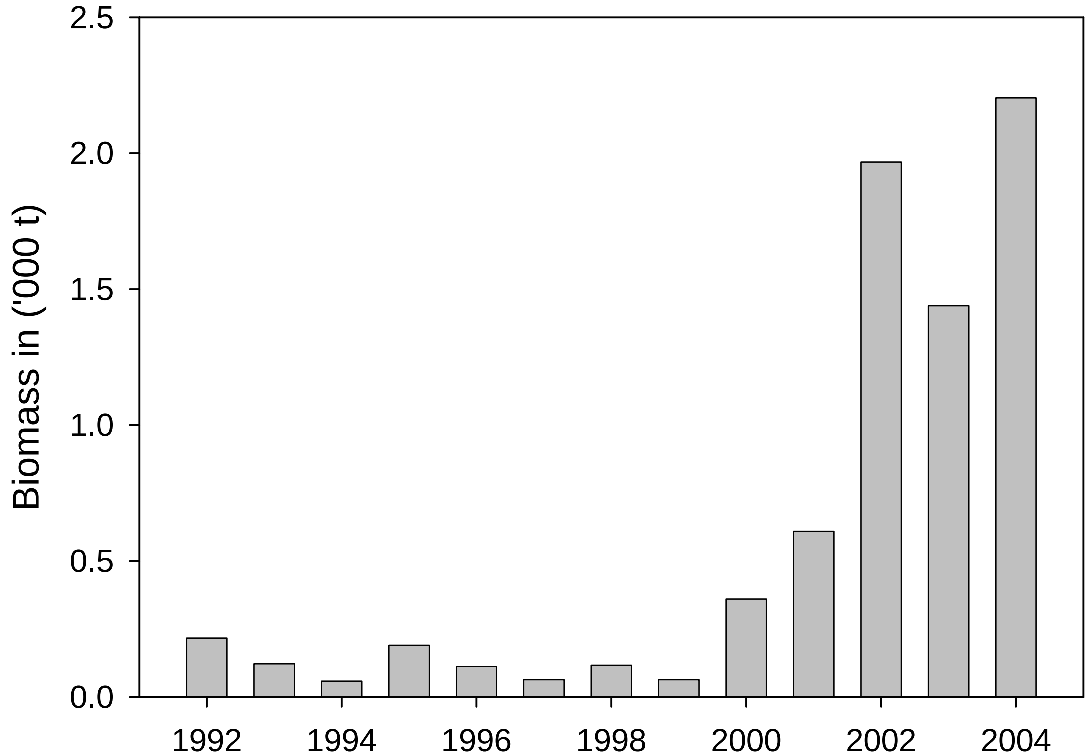


Figure 5.1.4 **Cod off Greenland (offshore component), Greenland survey. Aggregated survey biomass indices for West Greenland, 1992-2004.**

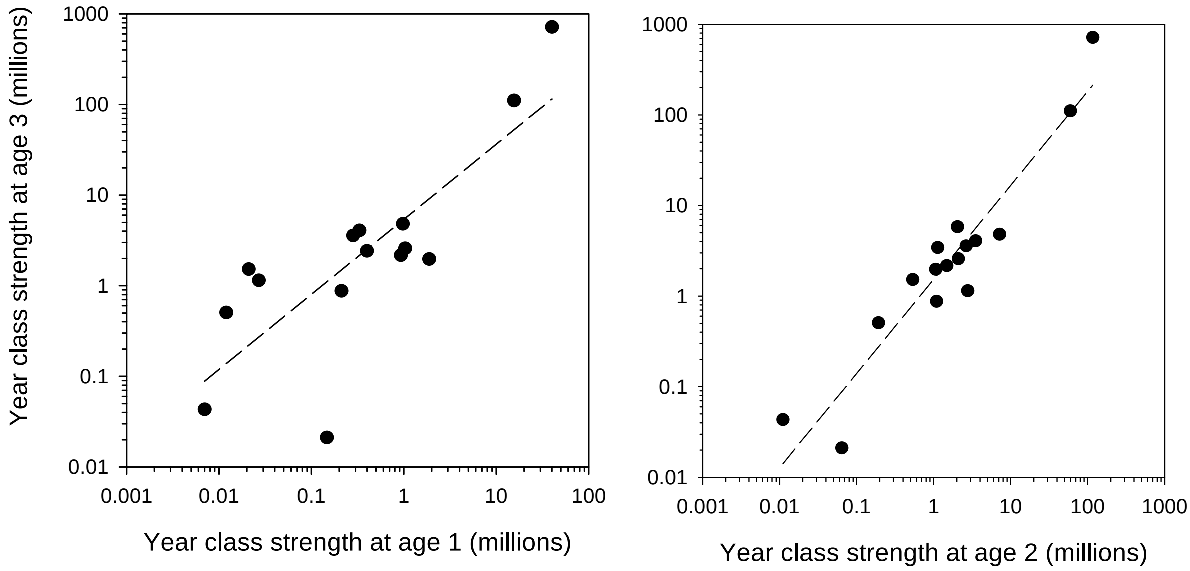


Figure 5.1.5 Comparison of survey estimates of abundance at age 3 in a given year with age 1 two years earlier (r^2= 0.64) and with age 2 one year earlier (r^2= 0.90) for East and West Greenland offshore cod. Years with incomplete coverage off East Greenland omitted. Data derived from the German survey.

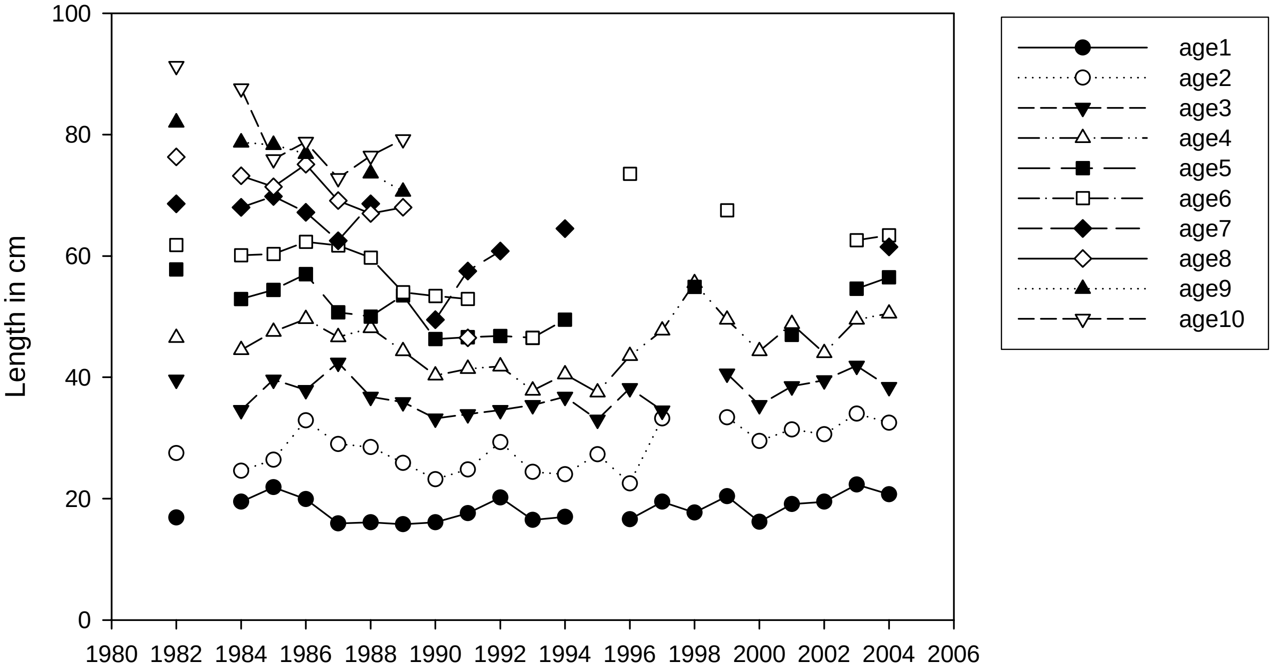


Figure 5.1.6 Weighted mean length at age 1-10 years 1982, 1984-2004 sampled in West Greenland. Data derived from German survey.

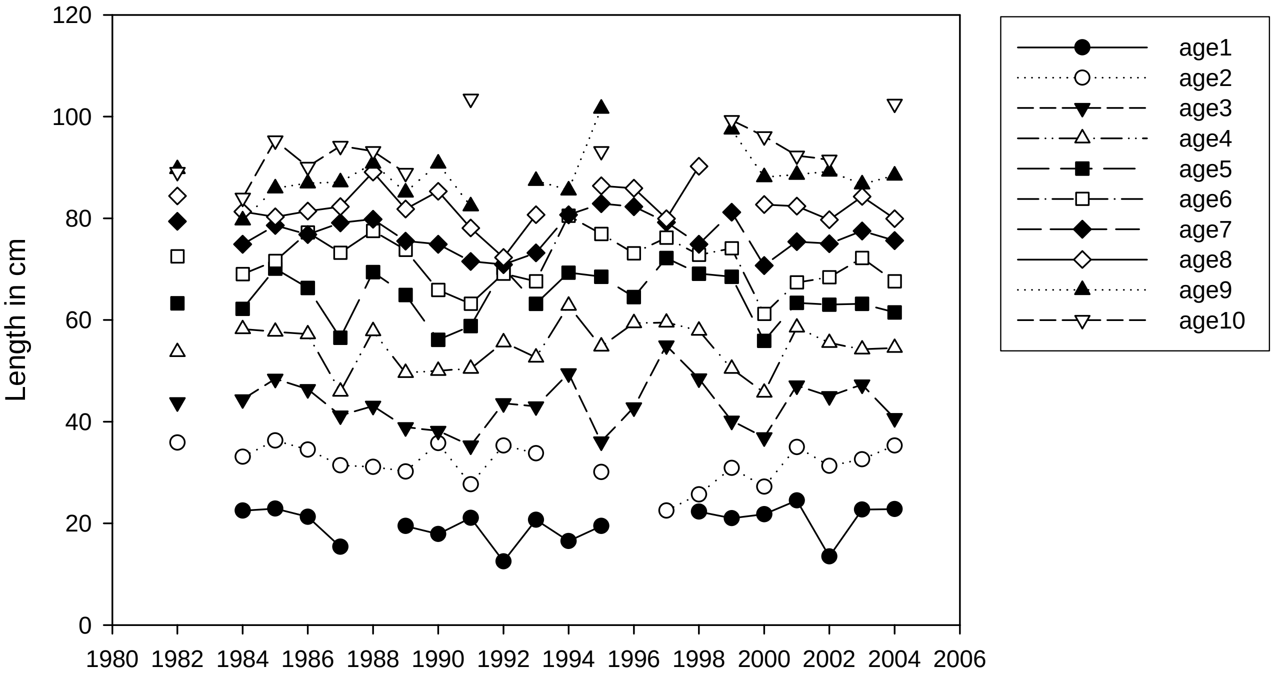


Figure 5.1.7 Weighted mean length at age 1-10 years 1982, 1984-2004 sampled in East Greenland. Data derived from German survey.

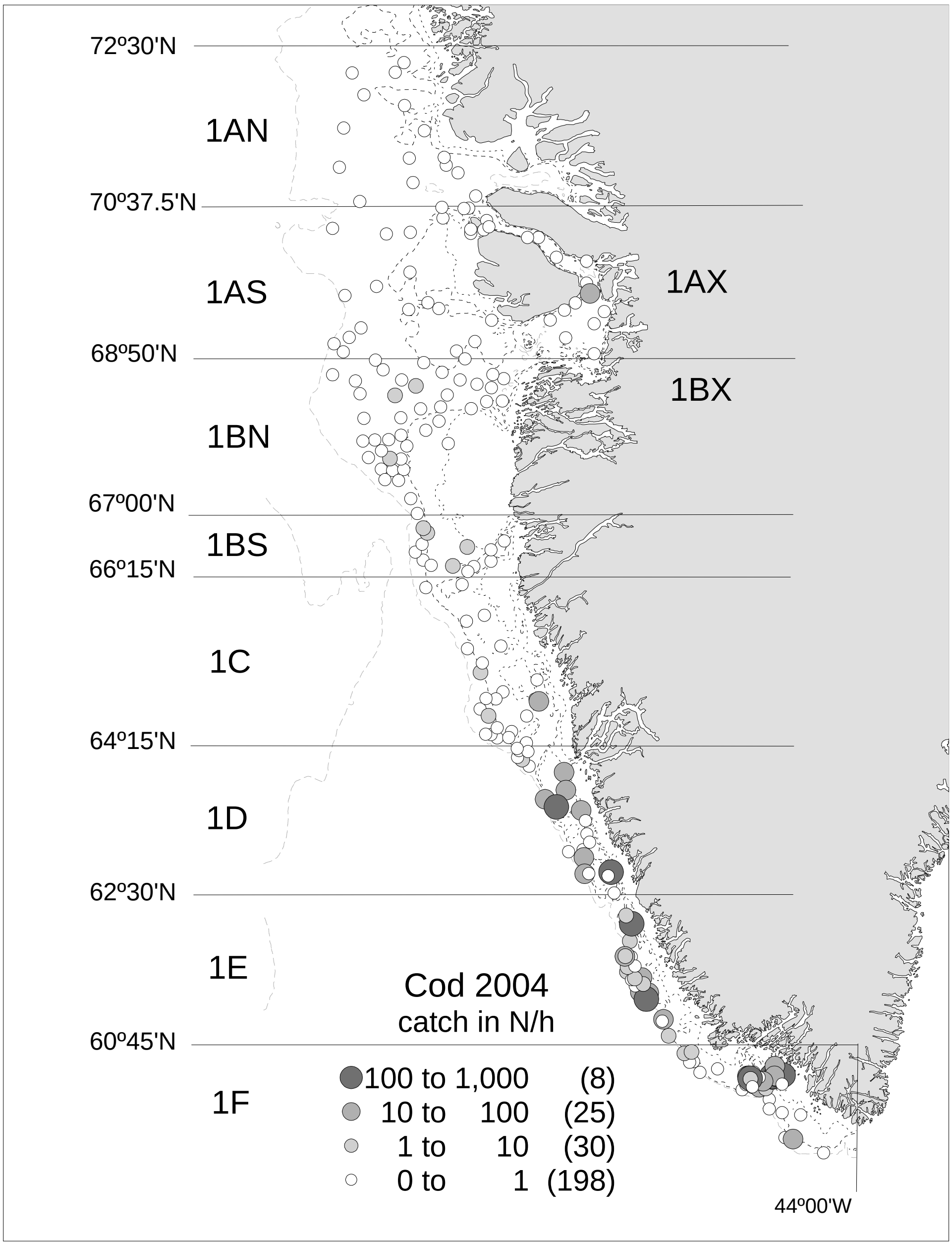


Figure 5.1.8 Number of cod /hour trawl off Greenland (offshore component), Greenland survey. Survey area, stratification and position of hauls carried out in 2004.

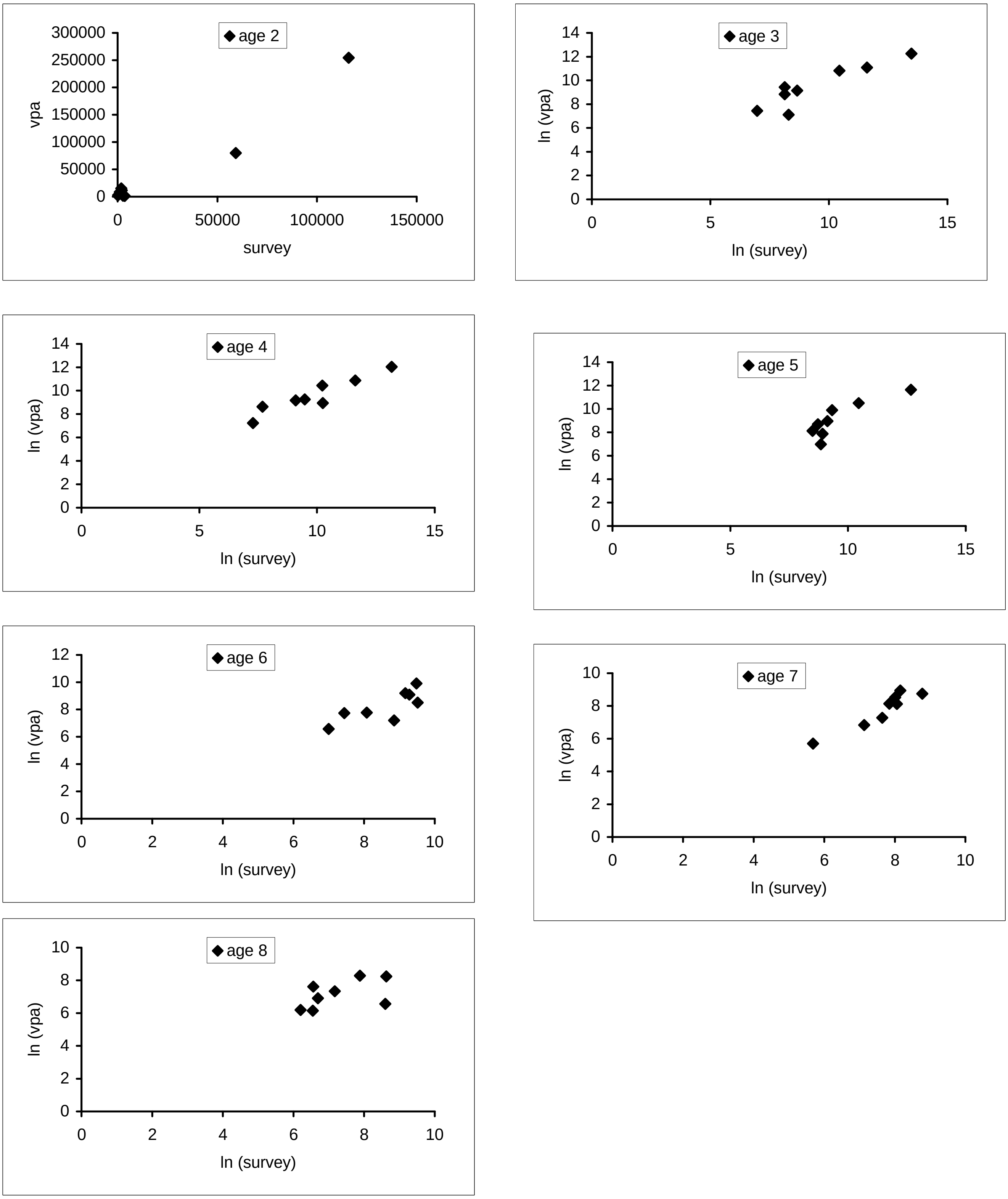


Figure 5.1.9 The relation between the survey estimates and VPA for age group 2-8 in the time-frame 1982-1989. For age group 2 a linear regression is used for the rest of the age group a log-log regression .

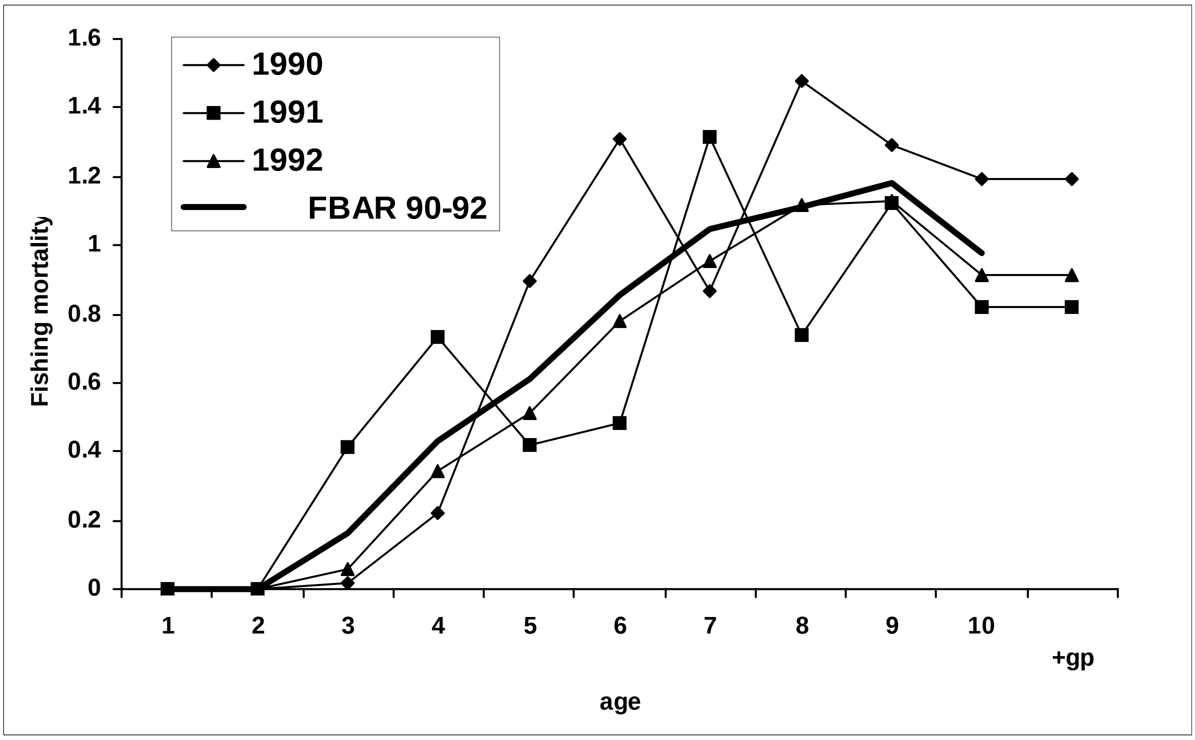


Figure 5.1.10 Greenland cod offshore component. Exploitation patterns in 1990-92 and the average FBAR. Discards in 2005-2007 are not included in the calculation due to lack of information.

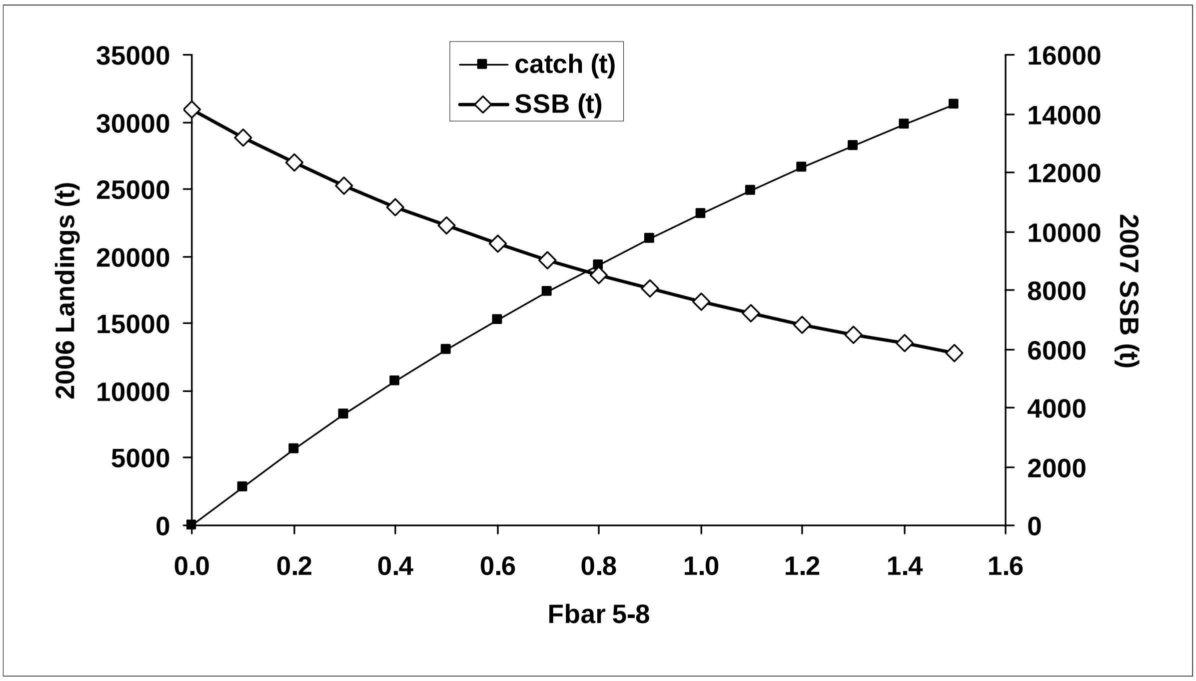


Figure 5.1.11 Greenland cod offshore component. Trajectories of SSB in 2007 and landings in 2006 as a function of fishing mortality.

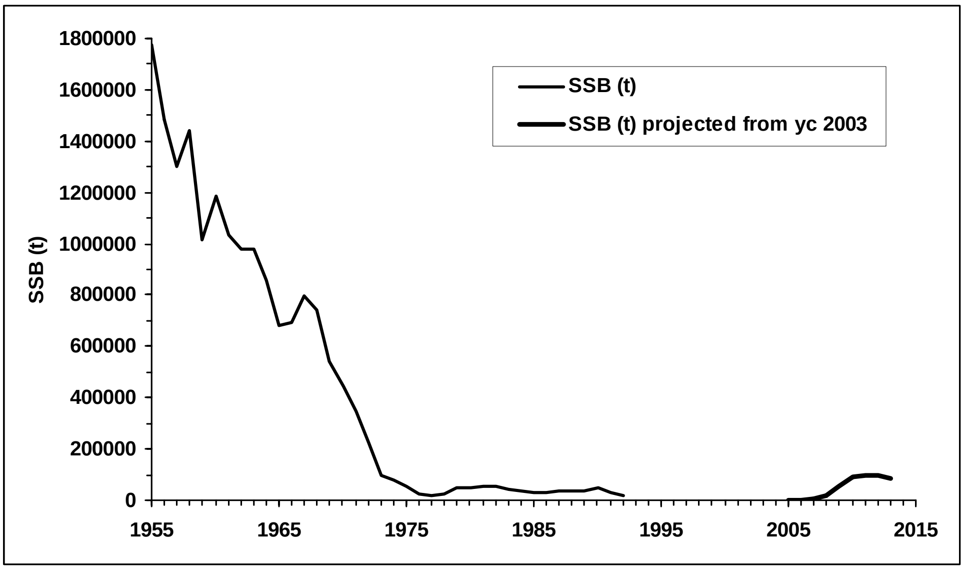


Figure 5.1.12 Greenland cod offshore component. Medium term projection of SSB from the year class 2003 in comparison with the historic SSB trajectory.

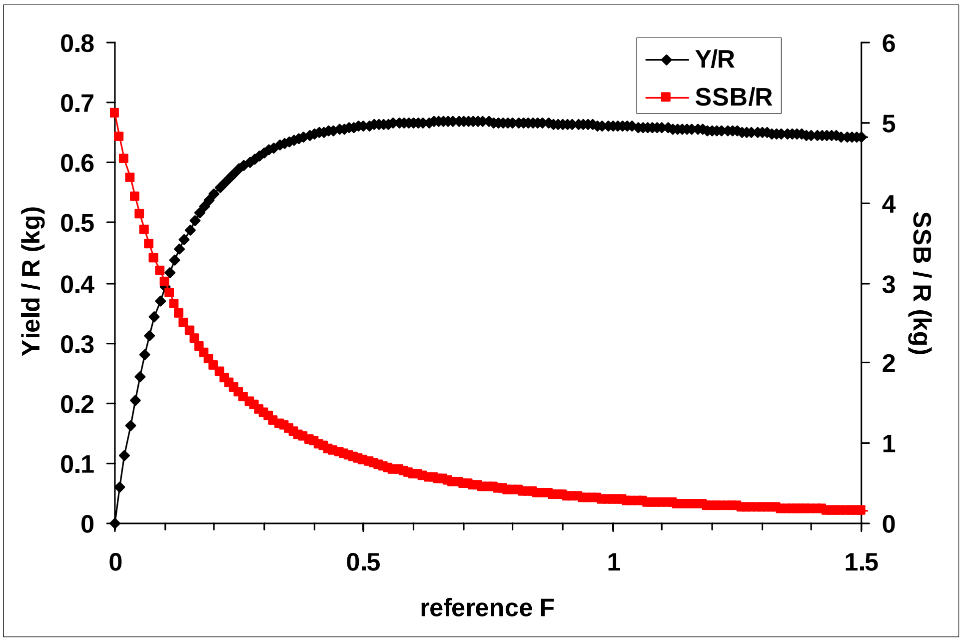


Figure 5.1.13 Greenland cod offshore component. Yield per recruit, input parameters are given in Table X1. F0.1=0.25, Fmax=0.69.

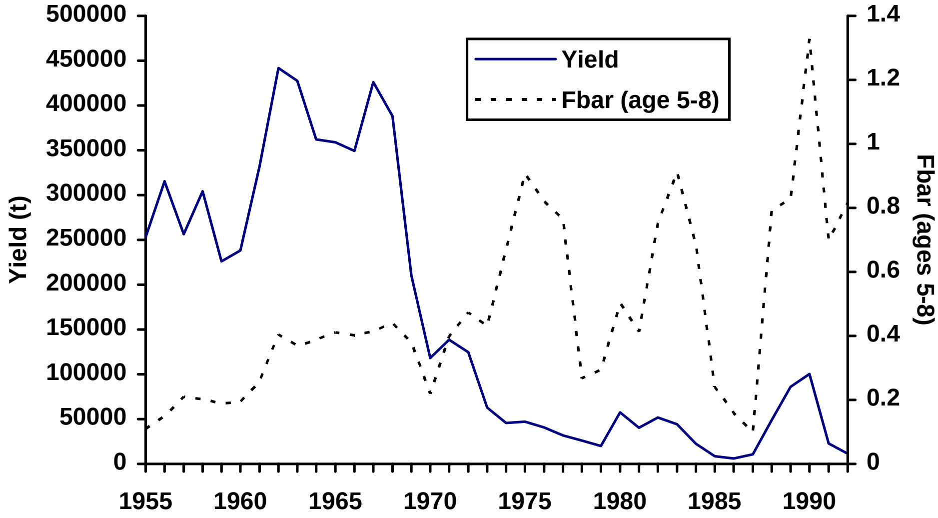


Figure 5.1.14 **Greenland cod (offshore component). Trends in yield and fishing mortality.**

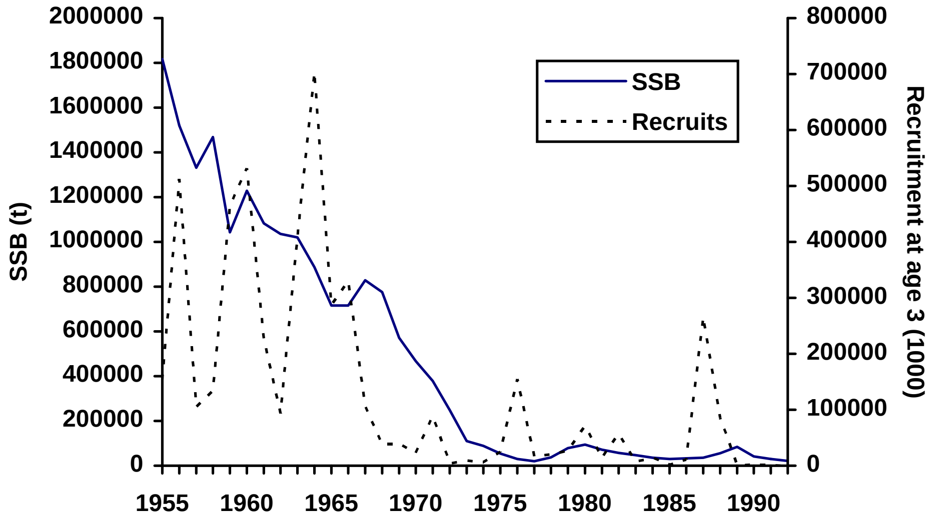


Figure 5.1.15 **Greenland cod (offshore component). Trends in spawning stock biomass (SSB) and recruitment.**

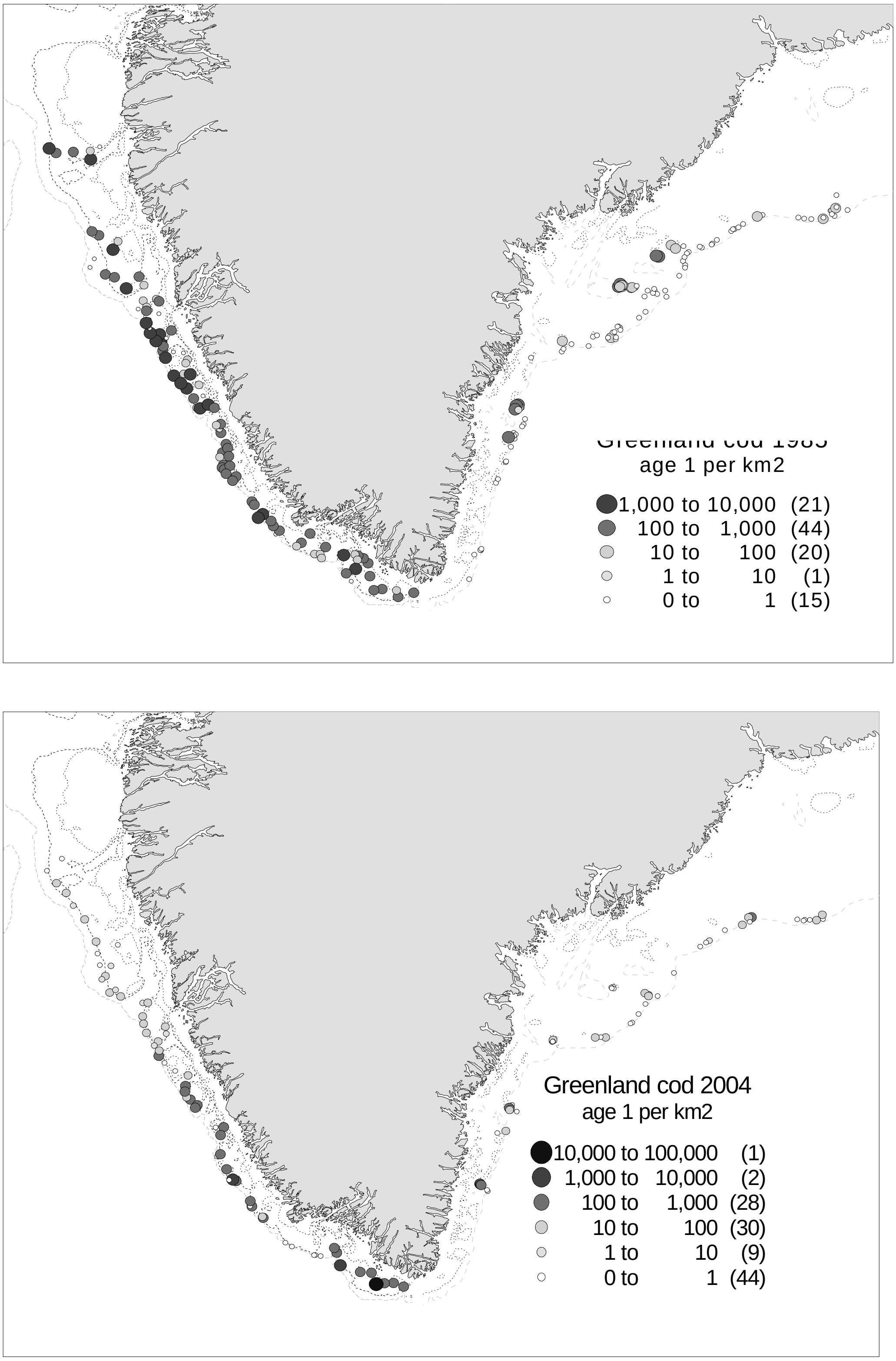


Figure 5.1.16 Comparison between the distribution 1984 and 2003 year class as age group 1 from the German ground fish survey.

5.2 Cod off Greenland (Inshore component)

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 fisheries (Inshore component)

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 –2004. In the same period the inshore landings have been fluctuating between 500-5 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 2004 are close to 5000t where NAFO division 1B is accounting for approximately 1/4 of the total inshore landings (table 5.2.1). Besides 785t have been transshipped from local inshore areas to foreign vessels, the main part from NAFO division 1B (Table 5.2.1.). The increased inshore landings the last two years could be a conscience of the transhipment taking place in NAFO division 1B.

A commercial pound net CPUE series is available between 1992-1999. The mean catch per pound net setting decreased from 804 t in 1994 to 284 in 1999. No commercial effort data from 2000 to 2002 and catch at age data in 1997-1998 and 2000-2001 have been available to the working group.

5.2.2 Survey (Inshore component)

5.2.2.1 Results of the 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 6/2005. No survey took place in 2001, in 2004 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 2004 indicate a decrease of the recruitment index in division 1B compared to the relative large value from 2002 and below average (1985-2004). The recruitment index for division 1D increased some for age group 2 but is still considered at a very low level.

5.2.3 Biological sampling of commercial landings

The commercial catches were according to the Greenland catch statistic at 4948 t in 2004 witch corresponds to a small decrease at 5% compared to 2003. 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 were more than 50% of the catches are taken. Catch-at-age and weight-at-age are showed in Table 5.2.1 and 5.2.2) indicates some inconsistency in 2003, and in 2004 the average weight was on the measured fish 0.78kg and for nearly all age groups above average.

5.2.4 Assessment of the stock

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 2002-2004 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 2002 as an exploratory tool to estimate the likely historical stock and exploitation dynamics. Insufficient data it was not accepted by the working group for assesment purpose (ICES CM 2003/ACFM:24, WD XX) and the model was not updated this year.

5.2.5 Status of the stock

The exploitation rate of the stock is unknown as no logbook information is available. However, a logbooks system has been implemented in 2005 for vessels larger than 30 feet only. 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.

5.2.6 Biological reference points

No specific values can be put forward as reference points due to the depleted state of the stocks.

5.2.7 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 were 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 2005). [1]Including 1258t transshipped from local inshore fishers to foreign vessels.[2] Including 2608 t fished in unknown waters

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]
2004	535	1316	242	116	47	84	4948[2]

Table 5.2.2 Catch at age (abundance in millions) 1985-2004, 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
2004			0.417	1.093	1.241	1.018	0.065	0.010	0.002

Table 5.2.3 Weight at age in landing 1985-2004, 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			0.98	1.26	2.01	2.77	3.18	5.02	6.14
2004			0.83	1.01	1.24	1.72	2.51	3.77	3.6

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 1987-2004.

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
2004	9.6	39.55	11.42	4.22

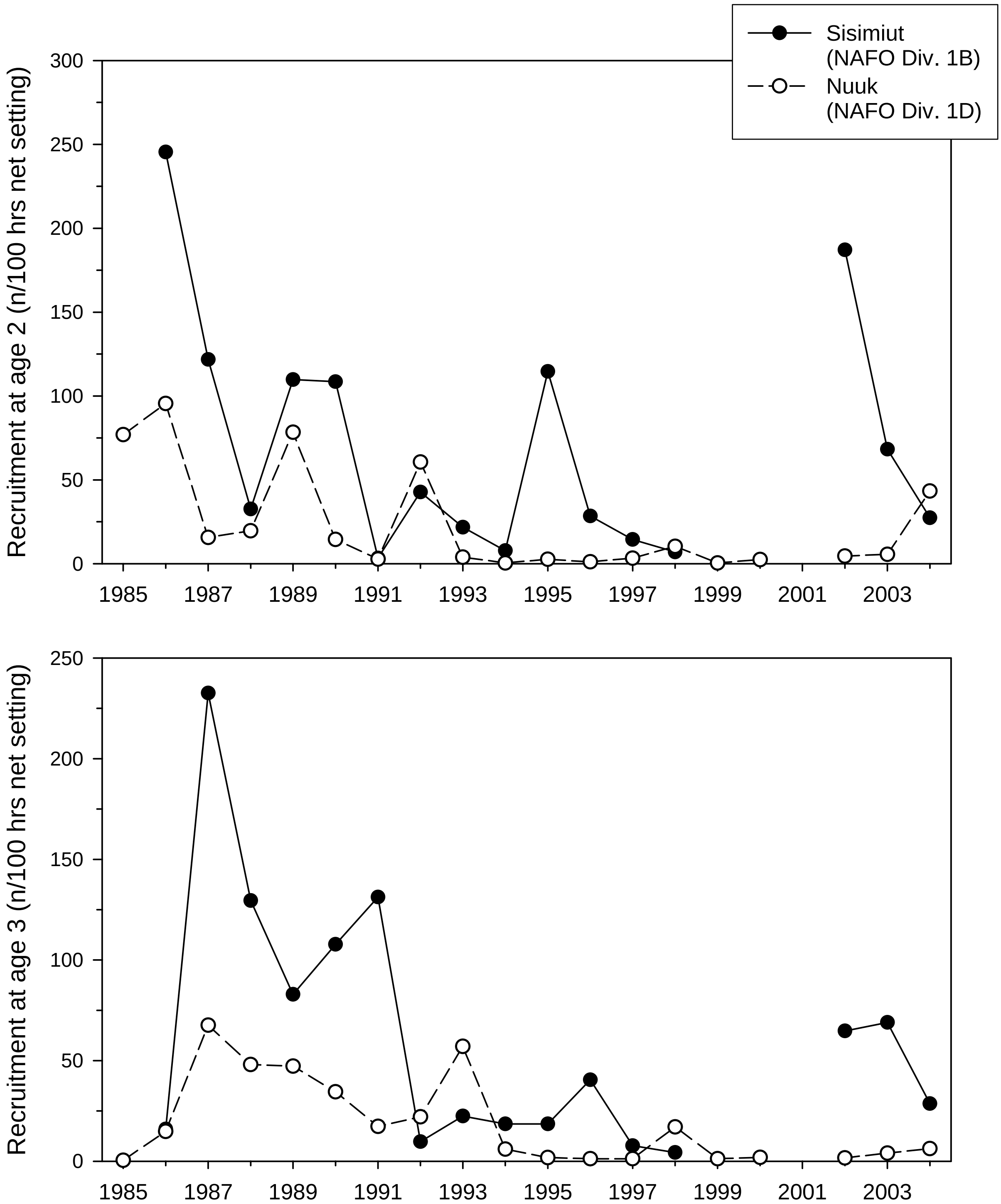


Figure 5.2.1. Recruitment index of age 2 and 3 cod in the inshore gillnet survey in NAFO division 1B and 1D between 1985 and 2004.

6 Greenland Halibut in Subareas V, VI, XII, and XIV

Greenland halibut in ICES Subareas V, XII and XIV are assessed as one stock unit. New information on catches at Hatton Bank (XIIb and VIb) were made available to the group this year. Therefore catches from this area are tabled in the report, although it is recognised that there is at present no information on stock affinity for the Greenland halibut at Hatton Bank in relation to the main stock complex in areas V, XIIa and XIV.

6.1 Excecutive summary

There have been no changes in **input data** to the assessment this year: current surveys have continued and sampling intensity and coverage remains also unchanged. For the second time no age readings of otoliths were available from the main fishing areas.

It was not possible to conduct either **ASPIC** or **age-disaggregated models**. The assessment relies entirely on indices from surveys and the fishery.

Indices from the different divisions within the entire distribution area of Greenland halibut are less conflicting as it was in former years.

The logic behind the catch advice is apparently initiated from elaborations in the **technical minutes**; the logic assumes that the development in landings and effort has been similar in the remaining two fishing areas Vb and XIVb which is not the case.

6.2 Landings, Fisheries, Fleet and Stock Perception

Landings

Total annual landings in Divisions Va, Vb, and Subareas VI, XII and XIV are presented for the years 1981–2004 in Tables 6.1.1–6.1.6 and since 1961 in Figure 6.1.1. Catches taken within the Icelandic EEZ in Division XIVb have historically been registrated in Division Va. 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 a record high of about 61 000 t in 1989. Since then landings have decreased markedly to a low in 1998-99, followed by an increase to about 30 000 t in 2003. Landings decreased to about 28 000 t in 2004. Landings not officially reported to ICES have been included in the assessment.

Landings in Icelandic waters have historically predominated the total landings in areas V+XIV. In the year 1989 with record high landings Iceland took 97% of the total . Since then fisheries developed in Div. XIVb and Vb and these areas have increased their share of the total landings and have in the past decade varied from about 20% to 50%. From 2003 to 2004 landings increased in XIV and decreased in V.

Fisheries and fleets

In 2004 quotas in Greenland and Icelandic EEZ’s were not fully utilized (about 70%) 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 2004. Table 6.1.6 describes the Working Group’s best landing estimates for the year 2004 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 since 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. In 2004 most of the landings derived from the southern area. 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.

Since 1996 a Greenland halibut has been taken as bycatch in the Spanish trawl fishery in the Hatton Bank area of Division VIb. Further a Norwegian longline fishery has been developing in the deeper waters of the western continental slope of the same area since 2000 (deeper than 1 000m) also stretching into Div. XIIb. Landings in table 6.1.5-6.1.6 derives from the Hatton Bank area. This fishery is considered to be in a period of learning.

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). The mandatory use of sorting grids operated since 2000 is expected to have reduced these bycatches.

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°-69° 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.

Greenland halibut in Hatton Bank (Divisions VIb and XIIb) have until now not been considered in the current stock definition. Recent investigations in the Hatton Bank area (both VIb and XIIb) show that Greenland halibut in the area have sizes comparable to the exploited stock in V and XIV and catches are dominated by old females (Hareide et al 2002, Fossen 2003, 2004, WD 17). Spawning has been reported in the area in spring and maturity studies conducted (histological examinations of ovaries) from September indicate spawning to occur in the following autumn/winter (Tuene et al 2002). Considering the oceanic current system in this area it is likely that eggs and larvae will be transported out of the Hatton Bank area. Early development studies of Greenland halibut have shown an egg development phase of nearly two moths before hatching (2 dg C) (Stene et al 1999). Further the larval drift period is long, indicating settling after at least 5-6 months (results from the Barents Sea ,e.g Ådlandsvik et al 2004). Greenland halibut eggs have been described to be pelagic untill gastrulation (6-26 days after spawning) and then sink to deeper water masses. They are then transported bathypelagic (Ådlandsvik et al 2004). A model simulation made on anglerfish originating from the Hatton Bank area (Hislop et al 2001) show that anglerfish are likely to drift westwards towards Faroe Islands and Iceland. Keeping this in mind it is possible that Greenland halibut eggs and larvae originating from the Hatton Bank area may drift into the waters around Faroe Island, Iceland and East Greenland indicating a different stock perception than the current.

6.3 Trends in Effort and CPUE

Division Va

Indices of CPUE for the Icelandic trawl fleet directed at Greenland halibut for the period 1985–2004 (Table 6.2.1, Fig. 6.2.1) were estimated from a GLM 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 (Fig. 6.2.2.), but stabilised in 1995–1997. Catch rates increased until 1999-2001 and has since decreased continuously to a record low in 2004. The derived effort has increased from a low in 1998 to a level similar to that prior to 1998. The directly measured effort from logbook information covering the entire fishery, suggest an effort pattern with a more pronounced maximum in 1996 and further that effort was stable from 2003 to 2004. (Fig. 6.2.1).

Division Vb

Information from logbooks from the Faroese otterboard trawl fleet (>1000 hp) was available for the years 1991-2004 (Table 6.2.1, Fig. 6.2.3). 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. 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. CPUE decreased drastically in the early period by more than 50 % coinciding with a significant increase in effort. Since 1994 CPUE has been slightly decreasing reaching a record low in 2004.

Division XIVb

For Division XIVb, logbook data was available from both Greenland and foreign fleets. In the time series a variable proportion of all logbooks have been available for analysis (on average 40%, in 2004 75%). 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 1991–2004 were standardised in the same way as described for fleets in Va and so was effort (Table 6.2.1, Fig.6.2.4). CPUE increased significantly from 1992 to 1998, from about 125 kg/hr to more than 400 kg/hr. CPUE declined significantly from 1998 to 2001 and again from 2002 to 2004. Effort has increased considerably in the time series. The fishery in XIVb is relatively new and annual catches have increased from below 500 tons before 1991 to 10 000 t in 2004. 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 main fleet (nation) components, show that for all fleets apart from the German, that CPUE decreased from 2002 to 2004. (Fig. 6.2.5). The German fleet, which takes the main part of the catches in XIV, have had stable catch rates since 1999.

The CPUE series from Divisions Va, Vb and XIVb do not develop similar in the period where time series are comparable. (Fig.6.2.1-6.2.4). This might indicate different population 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 to the fishery.

Divisions VI and XIIb

In recent years a fishery has been developing in divisions VIb and XIIb in the Hatton Bank area. Limited fleet information is available (ref to deep sea wg). Norway has been targeting Greenland halibut in the Hatton Bank area using longlines since 2000 (Hareide et al 2002). Catches are reported in both VIb and XIIb. Unstandardised catch rates (kg/1000 hooks) based on available logbooks do not show any consistent patterns. Average catch per 1000 hooks has varied between 33 (1999) and 234 (2003) (Fossen 2004). Greenland halibut has been reported as bycatchs from the Spanish fleet since 1998 (WD17). Unstandardised CPUE series indicate that Greenland halibut catches are low compared to V and XIV; between 10 and 90 kg / h in VIb and below 14 kg/h in XIIb (WD17). In addition to the fishery in the Hatton bank area Greenland halibut has also been caught in the Reykjanes Ridge area of area XII. (Table 6.1.5-6.1.6).

6.4 Catch-at-age

Otoliths have been sampled from the Icelandic fishery in 2004 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. 6.3.1 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 2004 distribution do obviously not differ form the long-term average. Fig. 6.3.2. and 6.3.3 show length compositions of catches in XIVb from German and Norwegian trawl and longline fisheries, respectively. Most distribution are stable from year to year, only the Norwegian trawl fishery in 2004 catches smaller fish than previous years.

6.5 Weight-at-age

Due to lack of age-readings as described in Sec. 6.3 no weight-at-age is provided.

6.6 Maturity-at-age

Due to lack of age-readings as described in Sec. 6.3 no maturity-at-age is provided.

6.7 Survey information

Division Va

An October groundfish survey in Icelandic waters (Fig. 6.6.1), 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. Since 2001 the fishable biomass of Greenland halibut (fish of length equal to or greater than 50 cm) has decreased significantly (Figure 6.6.2). Abundance indices of smaller fish (<50 cm) indicated signs of improved recruitment in 1998 and 1999, but a significant decrease in abundance of 40-60cm fish has been seen since 2002 (Fig. 6.6.2-6.6.3). The decrease in biomass and abundance in 2004 has occurred for the entire surveyed area (Fig.6.6.1)

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 (Fig. 6.6.4). The survey is designed as an exploratory fishery where the skipper decides haul location; the survey is limited to the Faroe Plateau within the period 28 May to 10 June. Depth and area coverage has varied substantially in time and as both location and depth have a considerable effect on catch rates (cpue increases by depth), it was decided to analyse the catch rates from the survey similar to a commercial fleet, i.e. by means of a GLM. The GLM takes into account the area (as shown in Fig. 6.6.4) and depth. Usually the total number of hauls has been around 40, except in 1995 and 2003 when only about 24 stations were taken. Although the unstandardised catch rates (arith. mean in Fig. 6.6.5) show a sharp decline in the time series, the standardised catch rates have been stable since 1996. The discrepancy between the unstandardised and standardised catch rates is partly due to the survey moving to shallower depth over time.

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 (Fig. 6.6.6). No survey took place in 2001. In 2004 a total of 51 of the planned 70 stations were hauled. Total estimated biomass in 2004 was estimated at 16 000 t, which is a slight increase from 2003 (14 000 t). (Fig. 6.6.7). Compared to the period 1999-2001, biomass estimates for the period 2002-2004 is somewhat lower, although not significant at the 5% level. The deep-water survey is mainly catching Greenland halibut in the length range 30-70cm (Fig. 6.6.8). Abundance estimates by age show that catches mainly consist of 4-8 year olds. From the short time series available it is not possible to identify consistent strong cohorts . (Fig. 6.6.8).

SURVEY /DIVISION	NO HAULS IN 2004 (PLANNED HAULS)	DEPTH RANGE (M)	COVERAGE (KM^2)
Va	150 (150)	500-1300	130 000
Vb	42 (40)	400-500	3 300
XIVb	51 (70)	400-1500	37 000

6.8 Stock Assessment

Age-disaggregated CPUE values for age groups 7–12 from the Icelandic trawling fleet operating in Division Va have in former times been used for an 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.

A stock-production model approach, ASPIC, have been performed from 2000 to 2002, 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 were available. Attempts was made to fit the model to catch and effort data, but the model did not fit any of the indices satisfactory. Therefore ASPIC most be considered a poor performer of the recent biomass dynamics that the CPUE and survey indices are considered to reflect.

6.8.1 Summary of the various observation data

A number of indices from surveys and from the commercial fishery are available as indicators for the biomass development.

The surveys in Va and XIV are considered to cover the adult stock distribution in the two division adequately, while the survey/exploratory fishery in Vb has an insufficient coverage of the stock component in Vb due to the survey design.

The main fishing grounds are covered well by the logbook data in Va and XIV, while in Vb the logbook information does not include the principal fleet, gill netters, that covers other areas within Vb. The fleet behaviour is likely influenced by a number of factors, such as weather conditions and sea ice in the northwestern areas. Therefore CPUE series is considered less qualified as biomass indicators than surveys.

- **Div. Va:** The fall groundfish survey in Va (1996-2003) indicate a decline in biomass in the last three years for all sizes of fish and in all surveyed areas. Icelandic trawl CPUE (1985-2003) show that catch rates in 1993-2004 are less than half that observed in 1985-1989. CPUE declined in the last three years and are currently 1/4 of that in 1985. Effort has increased significantly since 1998.
- **Div. Vb:** Catch rates from an exploratory fishery/survey (1995-2004) shows stable catch rates since 1996. Faroese trawl CPUE (1991-2004) show a slight but continuous decrease in catch rates since 1994, following a significant decrease in the early years.
- **Div. XIVb:** The Greenland survey in XIV have signs of slight increasing biomass index since 2002, but compared to an earlier period (1998-2000) recent estimates are lower. Trawl CPUE’s from the various fleets in XIVb show an overall stable pattern since 1993, but a decrease in the last two years. Among the main fleets in the area, the German fleet accounting for 70% of catches have maintained catch rates stable in recent years, while Norwegian, Greenland and Faroese trawlers decreased their catch rates.

6.8.2 State of the stock

The present state of the stock cannot be evaluated in with regard to biological reference points. All indices, however, suggest that present biomass is low compared to historic levels. CPUE indices from Division Va suggest a low biomass in recent years compared to the mid-1980s, and survey indices support a declining trend in the past two years. (Fig. 6.2.1 and 6.6.2). In Div Vb indices suggest a decreasing biomass being at a low level (Fig. 6.2.3 and 6.6.8). In Div. XIVb indices suggest that biomass is low in recent years compared to the period 1996-98 (Fig. 6.6.5 and 6.2.4). There are no signs of strong year classes entering the stock from survey information (Fig. 6.6.3 and 6.6.6).

6.8.3 Biological reference points

No biological reference points is adopted.

6.9 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 since 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.

6.10 Comments on the Assessment

The assessment relies on a number of indices from surveys and the commercial fishery in absence of material to age-disaggregate the catches. As the stock dynamics as well as stock structure in the entire distribution areas is not fully understood, input to stock production models (i.e. ASPIC) are not easily selected. In order to improve the quality of the assessment of the stock, age-disaggregation of catches must therefore be recommenced. This will require that the main labs must continue sampling otoliths from Greenland halibut and put higher priority to age-reading work.

Given the likely poor state of the stock, it is proposed that effort should be reduced to the lowest observed in the time-series (1998), at which time the stock increased. The landings at that time were around 20 000 t. In order to allow the stock to rebuild the catch in the total areas should be less than 20 000 t in 2005.

References

Fossen, I. 2004. Norwegian Commercial Fisheries on demersal species in the Hatton bank area during 2003. Working Group document presented at the WG Deep in 2004.

Fossen, I. 2003. Norwegian Commercial Fisheries on Hatton bank during 2002. Working Group document presented at the WG Deep in 2003.

Hareide, N. -R., Fossen, I. and Dyb, J. E. 2002. Results from Norwegian Commercial and exploratory fisheries on Hatton Bank in 2001. ICES Working doc. to WGDeep. April 2002. 5p + figs and tabs

Hislop, J. R. G., A. Gallego, M. R. Heath, F. M. Kennedy, S. A. Reeves and P. J. Wright. 2001. A synthesis of the early life history of anglerfish, *Lophius Piscatorius (Linnaeu*s, *175*6) in northern British waters. ICES Journal of Marine Science, 58, 70-86.

Stene, A., A. C. Gundersen, P. Solemdal, K.H. Nederaas & O.T. Albert. 1999. Early development of Northeast Arctic Greenland halibut (*Reinhardtius hippoglossoides*). Northwest Atlantic Fisheries Science, 25: 171-178.

Tuene, S. Gundersen, A.C., Emblem, W., Fossen, I., Boje, J. Steingrund, P. & Ofstad, L.H. 2002 a. Maturation and occurrence of atresia in oocytes of Greenland halibut (*Reinhardtius hippoglossoides* W.) in the waters of East Greenland, Faroe Islands and Hatton Bank. Pp. 39-71. *In*: Gundersen, A.C. (ed.) Reproduction of West-Nordic Greenland halibut. Studies reflecting on maturity, fecundity, spawning, and TEP. TemaNord Fisheries, 2002 (519): 323p.

Table 6.1.1 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Sub-areas V, VI, XII and XIV 1981-2004, as officially reported to ICES and estimated by WG

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
Spain									89
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 9	20,449

Country	1999 [1]	2000 [1]	2001 [1]	2002 [1]	2003 [1]	2004 [1]
Denmark		-	0	0	0	0
Faroe Islands	3,884	-	0	0	0	1,860
France	-	21	25	20	33	0
Germany	3,082	3,271	2,807	2,148	2,948	6,906
Greenland	200	1,740	1,553	0 0	0	1,420
Iceland	11,180	14,537	16,590	2,277	20,371	15,478
Ireland		-	7			
Norway	1,187	1,272	1,483	1,328	1,114	1,250
Poland						206
Portugal			6			0
Russia	138	183	186	44 0	0	265
Spain		8	10	0 0	0	256
UK (Engl. and Wales)	261	370	227	71 0	0	
UK (Scotland)	69	121	130	157 0	0	
United Kingdom	-	-		239	1,205	20
Total	20,001	21,523	23,024	6,284	25,671	27,660
Working Group estimate	20,371	26,839	28,021	30,574	31,133	27,788

1) Provisional data

Table 6.1.2 GREENLAND HALIBUT. Nominal landings (tonnes) by countries, in Division Va 1981-2004, as officially reported to ICES and estimated by WG.

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]	2004 [1]
Faroe Islands	9					
Germany	13	22	50	31	23	10
Greenland	[1]					
Iceland	11,087	14,507	2,310 [4]	2,277	20,371	15,478
Norway			6			
UK (E/W/I)	26	73	50	21		
UK Scottland	3	5	12	16		
UK				37	21	10
Total	11,138	14,607	2,428	2,382	20,415	15,497
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 landings (tonnes) by countries, in Division Vb 1981-2004 as officially reported to ICES and estimated by WG.

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]	2004 [1]
Denmark						
Faroe Islands	3873					1,717
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	128
Total	4057	288	280 2	259	232	1,845
Working Group estimate	2694 [2]	5092 [3]	3,951	2,694	2,426	1,845

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 landings (tonnes) by countries, in Sub-area XIV 1981-2004, as officially reported to ICES and estimated by WG.

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]	2004 [1]
Denmark						
Faroe Islands	2					143
Germany	3047	3243	2,750	2,117	2,925	6,896
Greenland	200 [1,4]	1740 [8]	1,553 [9]			1,420
Iceland	93	30	14,280			
Ireland			7			
Norway	1100	1162 [1]	1,424	1,280	1,112	1,131
Poland						205
Portugal			6			
Russia	138	183	186	44		264
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	10,059
Working Group estimate	5376 [11]	6588 [5]	6,588 [6]	6,750 #	8,017	

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 landings (tonnes) by countries in Sub-area XII, as officially reported to the ICES and estimated by WG

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]
Faroe Islands		47							
Norway	2								119
Poland									1
Spain 2	2	42	67	137	299	102	28	35	86
Total	2	47							120
WG estimate	4	89	67	137	299	102	28	35	206

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 6.1.6 GREENLAND HALIBUT. Nominal landings (tonnes) by countries in Division VIb, as officially reported to the ICES and estimated by WG.

Country	1996	1997	1998	1999	2000	2001	2002	2003 [1]	2004 [1]
Faroe Islands									
Norway							21	26	
Poland									1
Russia									1
Spain [2]			22	88	20	350	1367	214	170
UK									10
Total	0	0	22	88	20	350	1388	240	182
WG estimate									

[1] Provisional data

[2] Based on estimates by observers onboard vessels

Table 6.1.7. 2004 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.					0	23
Greenland					0	
Iceland	170	13,914	1,393	1	15,478	20371
Norway					0	
UK (E/W/NI)					0	
UK (Scotland)					0	
UK					21	21
Total	170	13,914	1,393	1	15,478	20,415

Vb	Long line	Trawl	Gill Net	Unknown	SUM	"Official"
Faroe Islands				1,717	1,717	
France						33
Germany Fed. Rep.						
Norway						2
UK (England & Wales)						
UK (Scotland)						
United Kingdom						197
Total	0	0	0	1,717	1,717	232

VI	Long line	Trawl	Gill Net	Unknown	SUM	SUM
Faroe Islands					0	
Total	0	0	0	0	0	0

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		143			143	
EU (GER)		6,896			6,896	2,925
Greenland		1,420			1,420	
Iceland (outside 200 EEZ)					0	
Norway (inside 200 EEZ)	586	545			1,131	1,112
Norway (outside 200 EEZ)					0	
Russia					0	
Ireland					0	
UK (England & Wales)					0	
UK (Scotland)					0	
United Kingdom					0	987
Total	586	9,004	0	0	9,590	5,024

Summary of catch by gear	Long line	Trawl	Gill Net	Unknown	SUM	SUM
	756	22,918	1,393	1,718	**26,785**	25,671

Table 6.2.1. CPUE indices of trawler fleets in Div Va, Vb and XIVb as derived from GLM r

area	year	cpue(t/hr)	% change in CPUE between years	landings	derived effort	% change in effort between years
Iceland Va	1985	1.000		29,197	29	
	1986	0.915	-8	31,027	34	16
	1987	0.884	-3	44,659	51	49
	1988	0.967	9	49,379	51	1
	1989	0.918	-5	59,049	64	26
	1990	0.752	-18	37,308	50	-23
	1991	0.763	1	35,413	46	-6
	1992	0.656	-14	31,978	49	5
	1993	0.509	-22	34,134	67	38
	1994	0.412	-19	28,608	69	3
	1995	0.314	-24	27,391	87	25
	1996	0.260	-17	22,073	85	-2
	1997	0.289	11	16,792	58	-32
	1998	0.466	61	10,595	23	-61
	1999	0.535	15	11,138	21	-8
	2000	0.589	10	14,607	25	19
	2001	0.613	4	16,755	27	10
	2002	0.466	-24	19,714	42	55
	2003	0.324	-30	20,415	63	49
	2004	0.243	-25	15,477	64	1
Greenland, XIVb	1991	0.12		875	7	
	1992	0.12	-7	1,176	10	44
	1993	0.34	197	2,249	7	-36
	1994	0.25	-27	3,125	12	91
	1995	0.30	20	5,077	17	35
	1996	0.39	29	7,283	19	11
	1997	0.43	10	8,558	20	7
	1998	0.43	1	5,940	14	-31
	1999	0.33	-24	5,376	16	19
	2000	0.29	-12	6,958	24	47
	2001	0.25	-12	7,216	29	18
	2002	0.34	33	6,750	20	-30
	2003	0.32	-4	8,017	25	23
	2004	0.28	-15	9,854	36	44
Faroe Islands, Vb	1991	0.25		1,662	7	
	1992	0.27	9	2,269	8	26
	1993	0.20	-24	4,434	22	157
	1994	0.13	-35	5,225	39	80
	1995	0.14	5	3,832	27	-30
	1996	0.14	2	6,469	45	65
	1997	0.14	-6	4,870	36	-20
	1998	0.11	-19	3,825	35	-3
	1999	0.11	4	4,265	38	7
	2000	0.13	17	5,079	38	2
	2001	0.12	-12	3,245	28	-27
	2002	0.11	-8	2,694	25	-9
	2003	0.13	23	2,426	18	-33
	2004	0.10	-25	1,771	18	-28

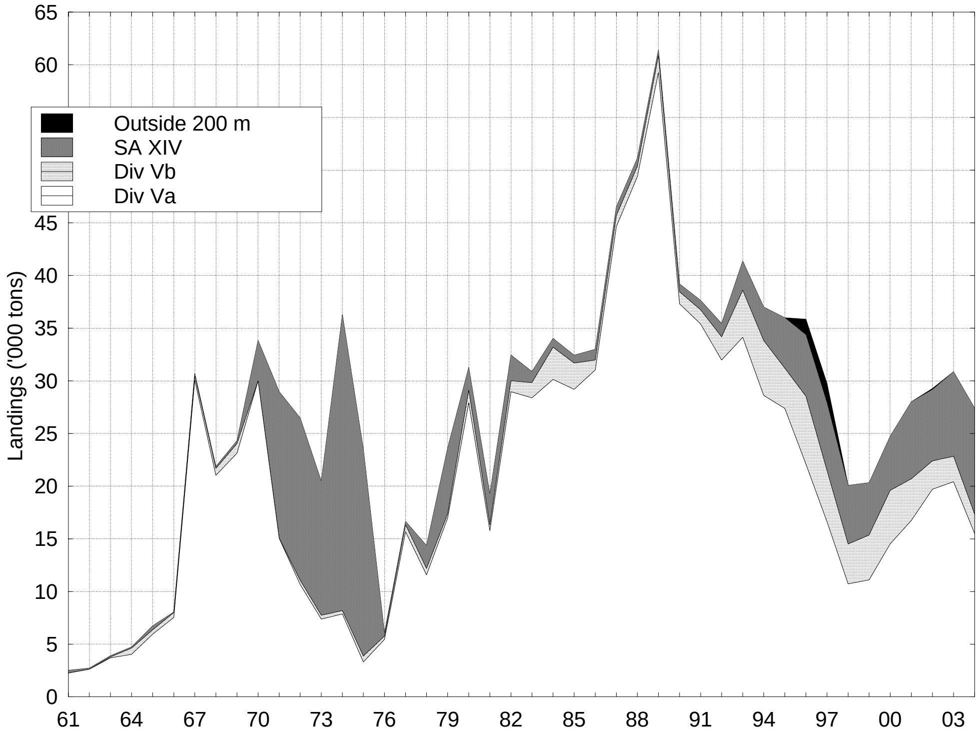
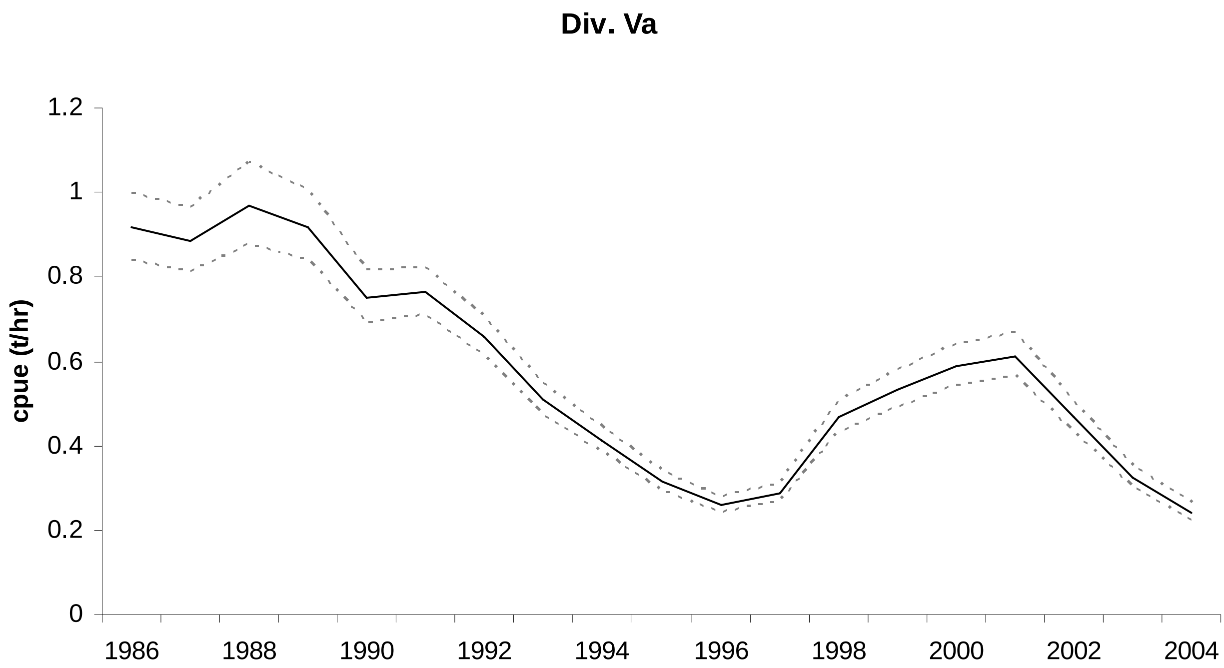


Figure. 6.1.1. Landings of Greenland halibut in Divisions Va, Vb and Subarea XIV. As the landings within Icelandic waters, since 1976, have not officially been separated and reported according to the defined ICES statistical areas, they are set under area Va by the North Western Working Group.



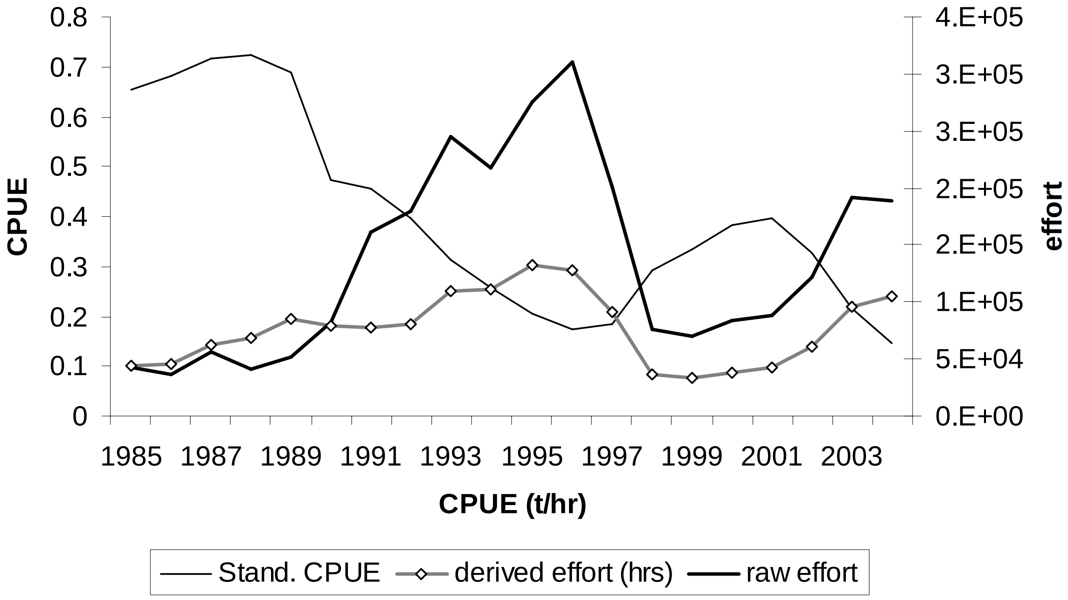


Figure 6.2.1 Upper:Standardised CPUE from the Icelandic trawler fleet. 95% CI indicated. Lower: Stand. CPUE and effort derived from GLM and effort summarized from logbooks (raw effort).

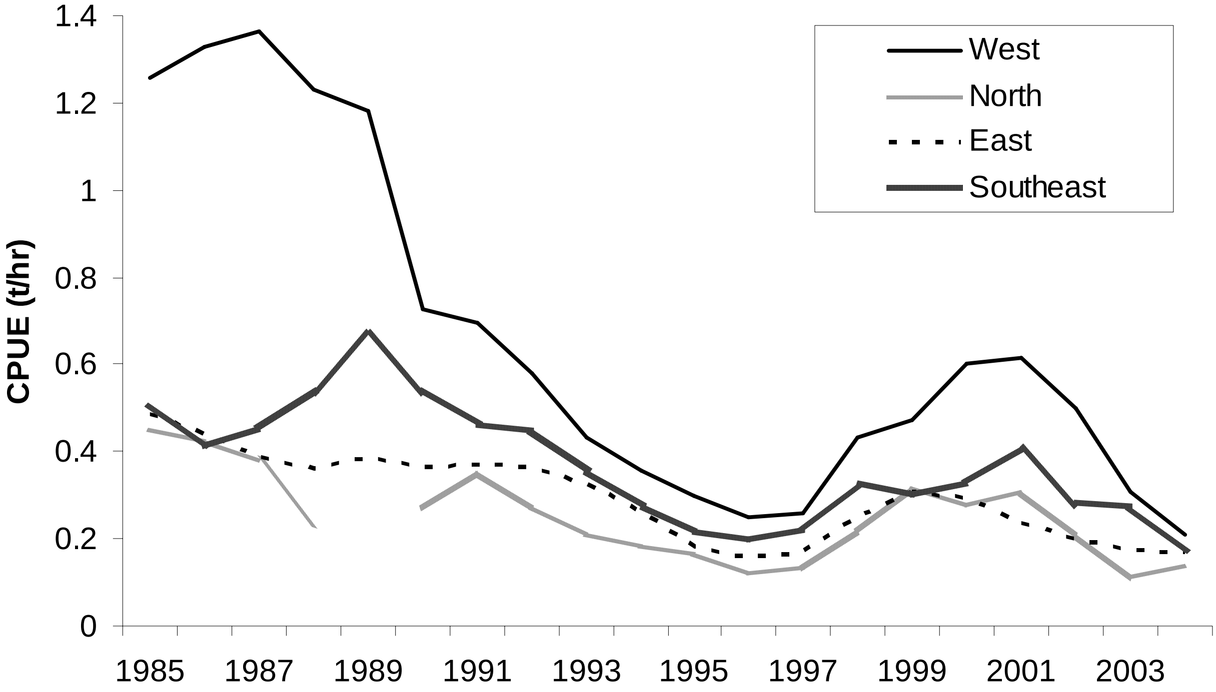


Figure 6.2.2. Standardised CPUE series from Icelandic trawlers from 4 areas around Iceland.

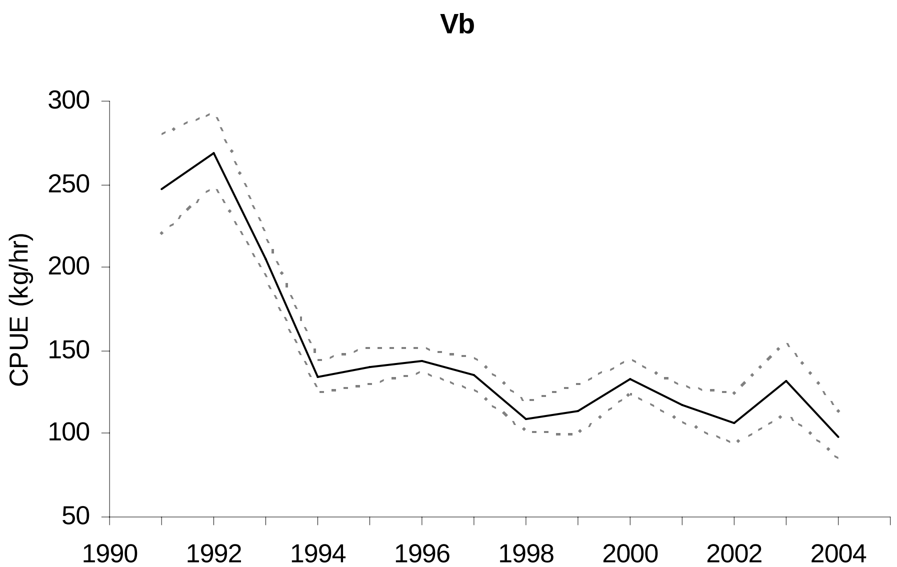


Figure 6.2.3. Standardised CPUE from the Faroese trawler fleet. 95% CI indicated.

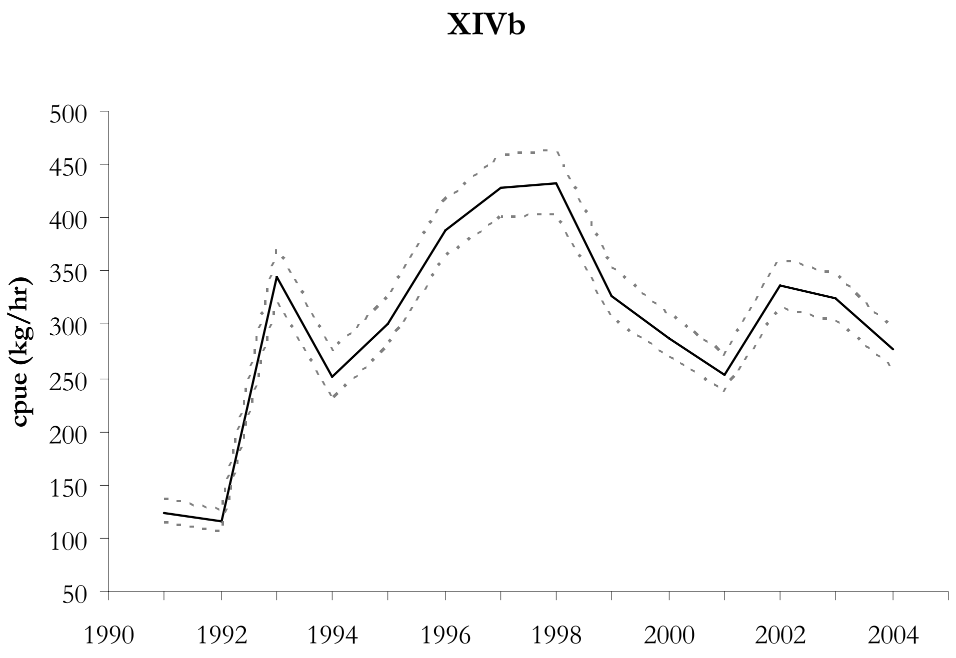


Figure 6.2.4. Standardised CPUE from trawler fleets in XIVb. 95% CI indicated.

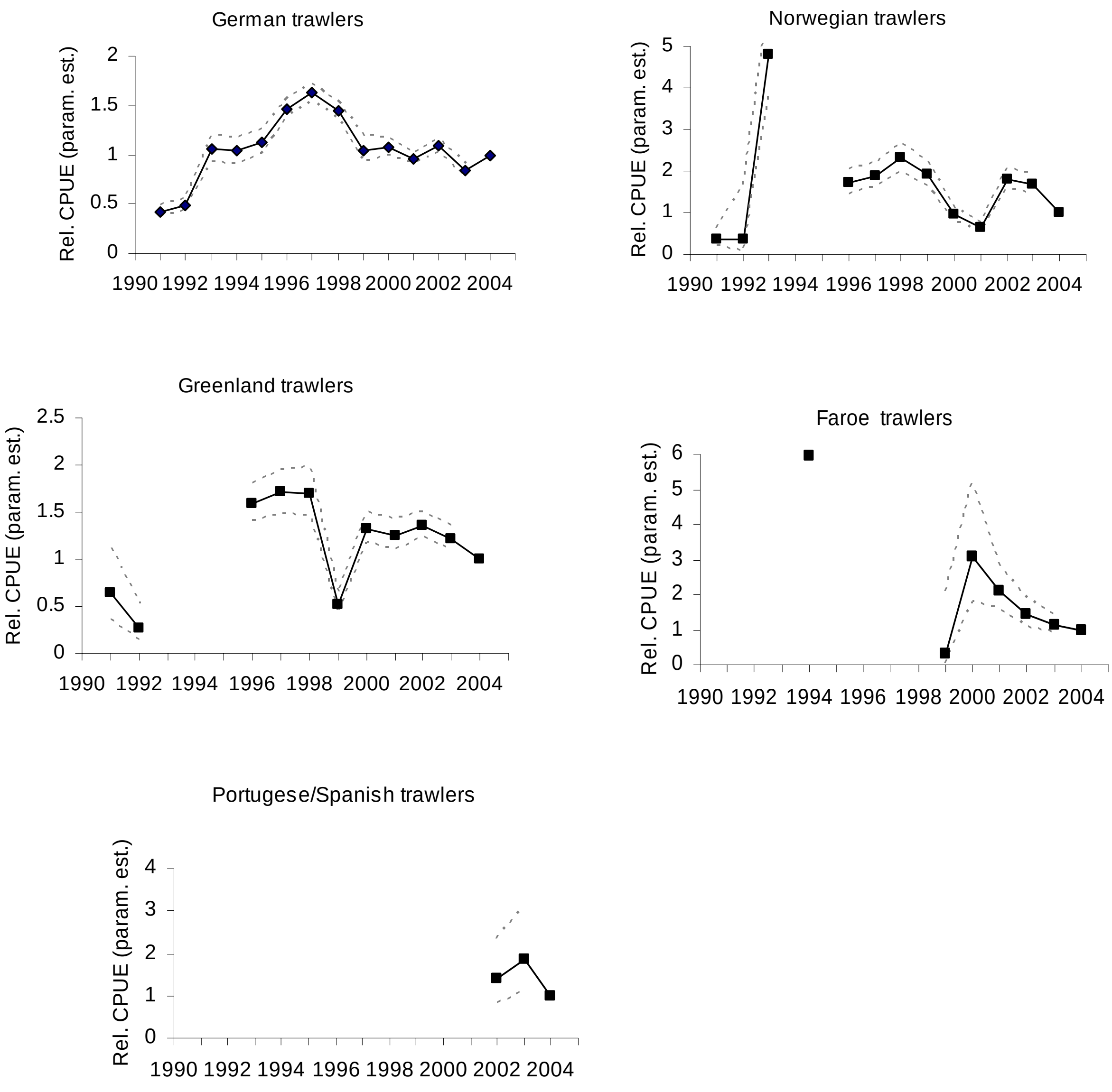


Figure. 6.2.5. Standardised CPUE series from the main fleets in Div. XIVb . 95% CI indicated

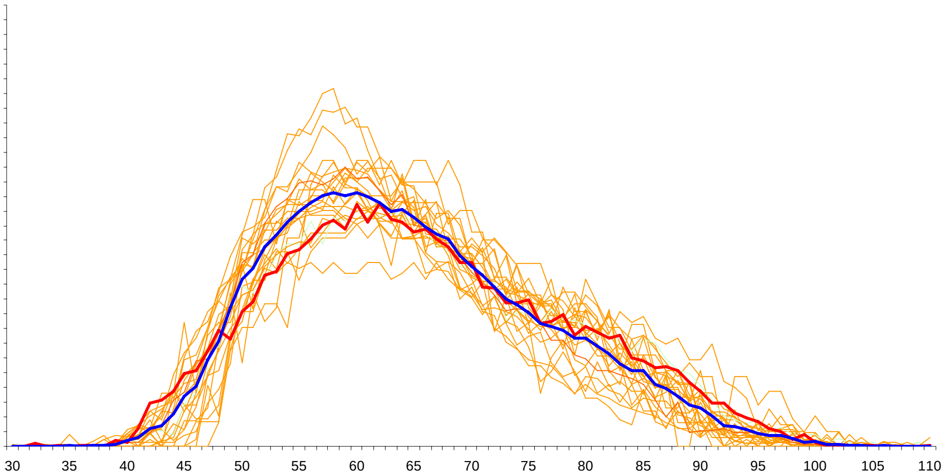
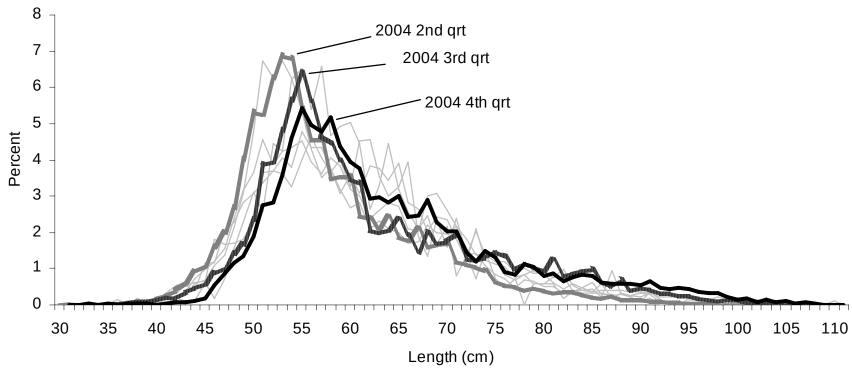


Figure 6.3.1 Length distributions from the commercial trawlfishery in the western fishing grounds of Iceland (Va) in the years 1985 – 2004. The thin solid line is average of 1985-2004 and the thick solid line is 2004 distribution



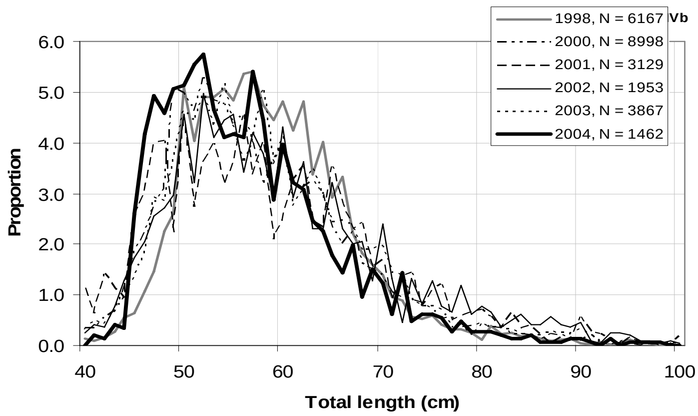


Figure 6.3.2. Length distributions from the commercial trawlfishery in East Greenland (XIVb) . Upper: German trawl fishery 1999-2004 with indication of 2004. Lower: Norwegian trawl fishery 1998-2004.

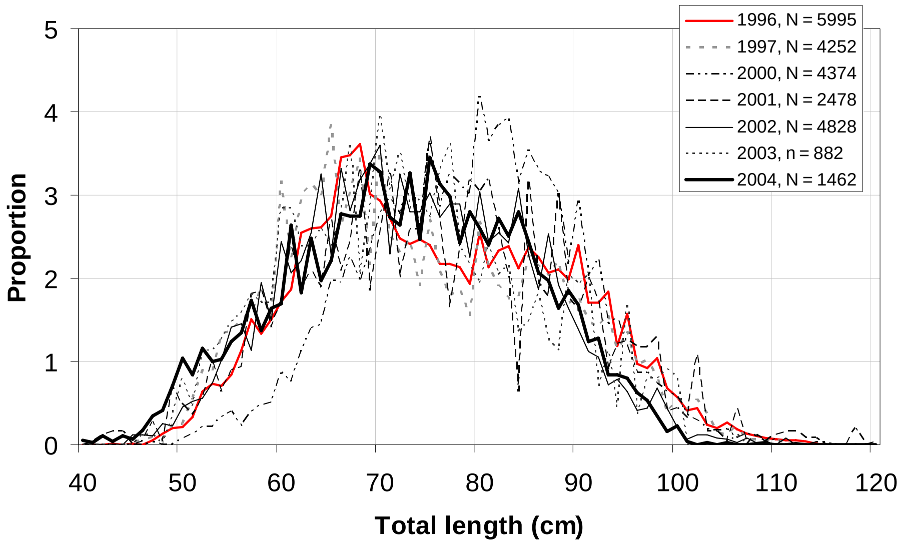


Figure 6.3.3. Length distributions from commercial longline fishery in East Greenland (XIVb) by Norway 1996-2004.

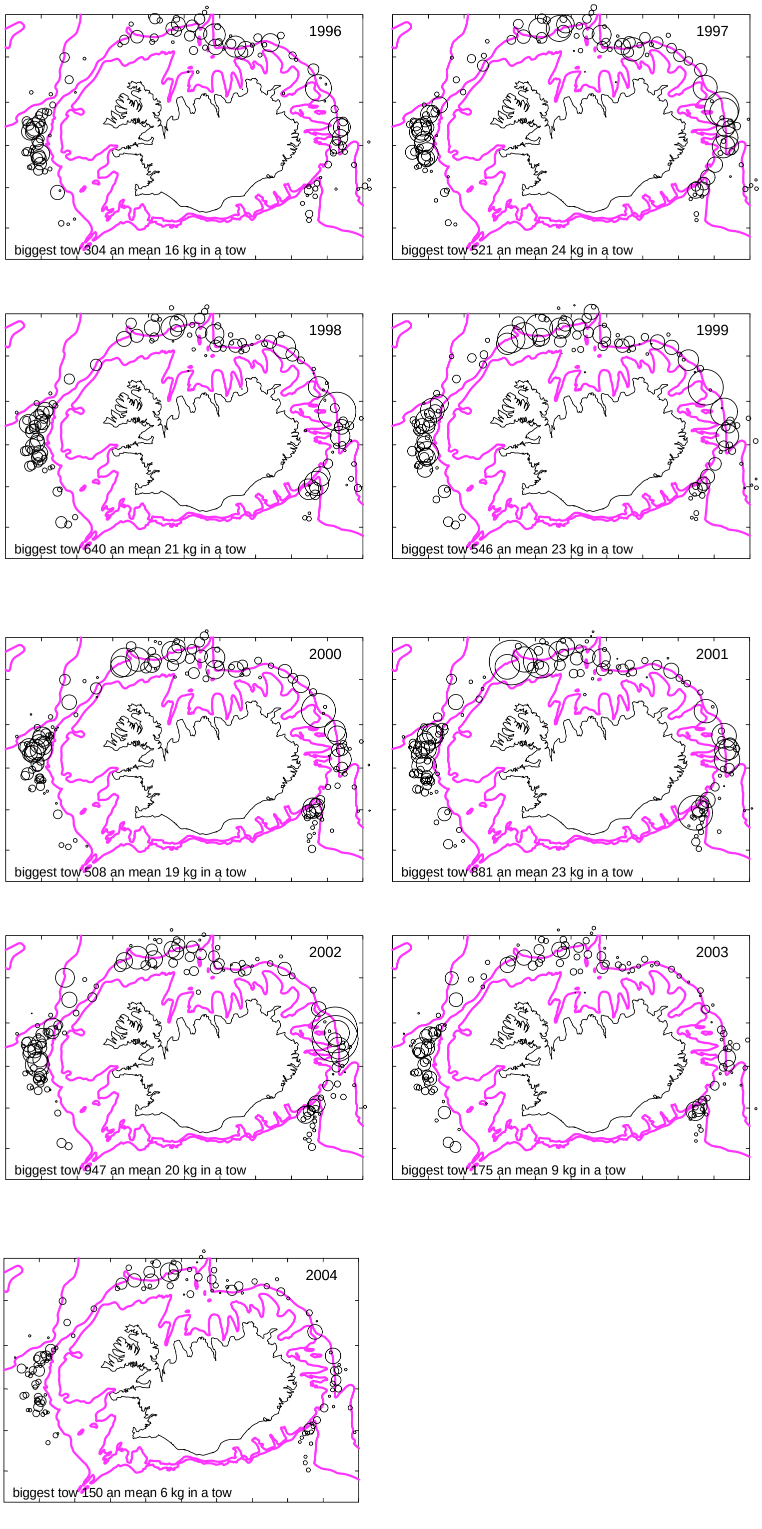


Figure 6.6.1. Distribution of catches from the Icelandic fall survey 1996-2004.

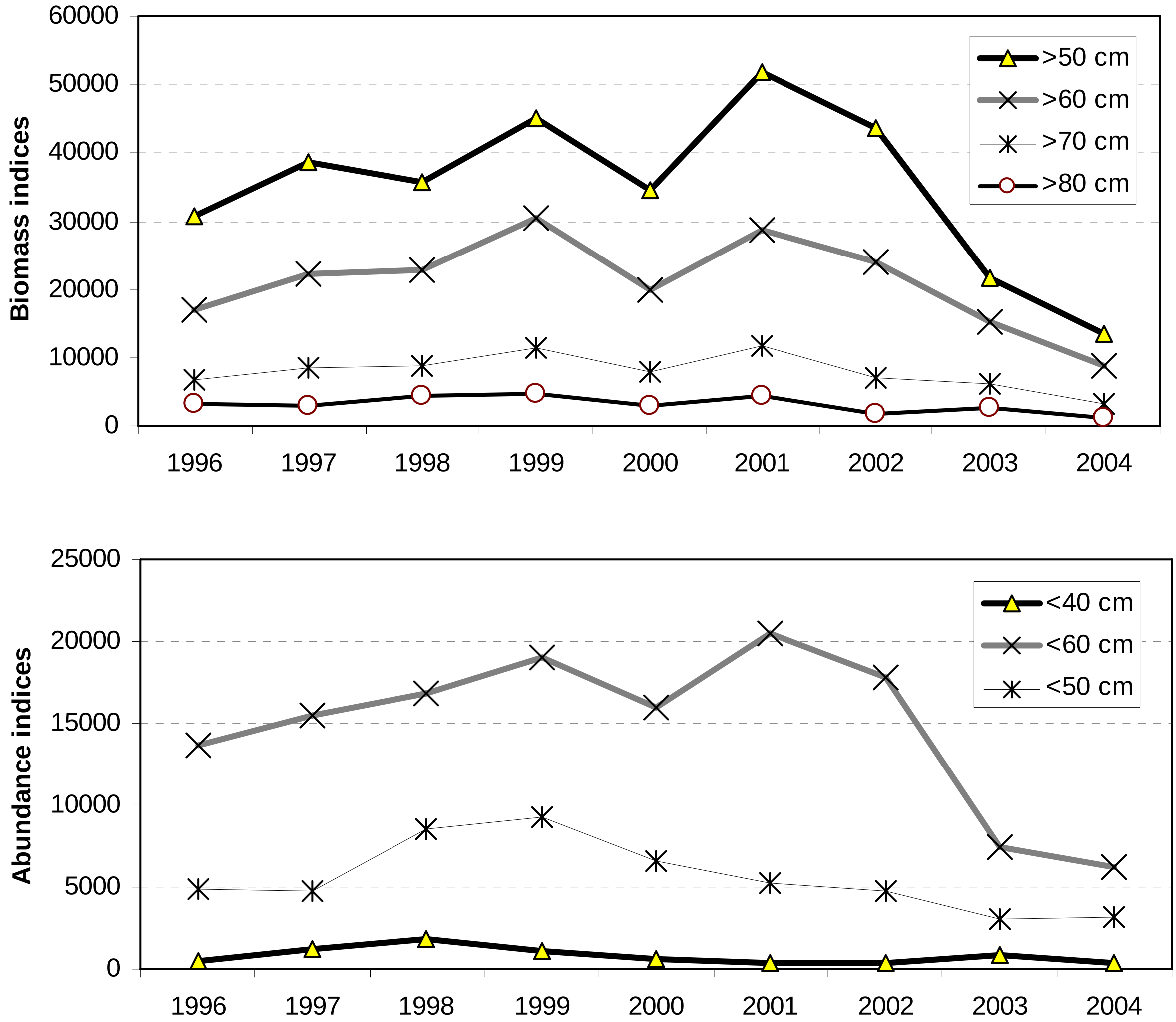


Figure 6.6.2. Greenland halibut in Icelandic fall groundfish survey; UPPER: biomass indices of lengths larger than indicated and ,LOWER: abundance indices by length smaller than indicated.

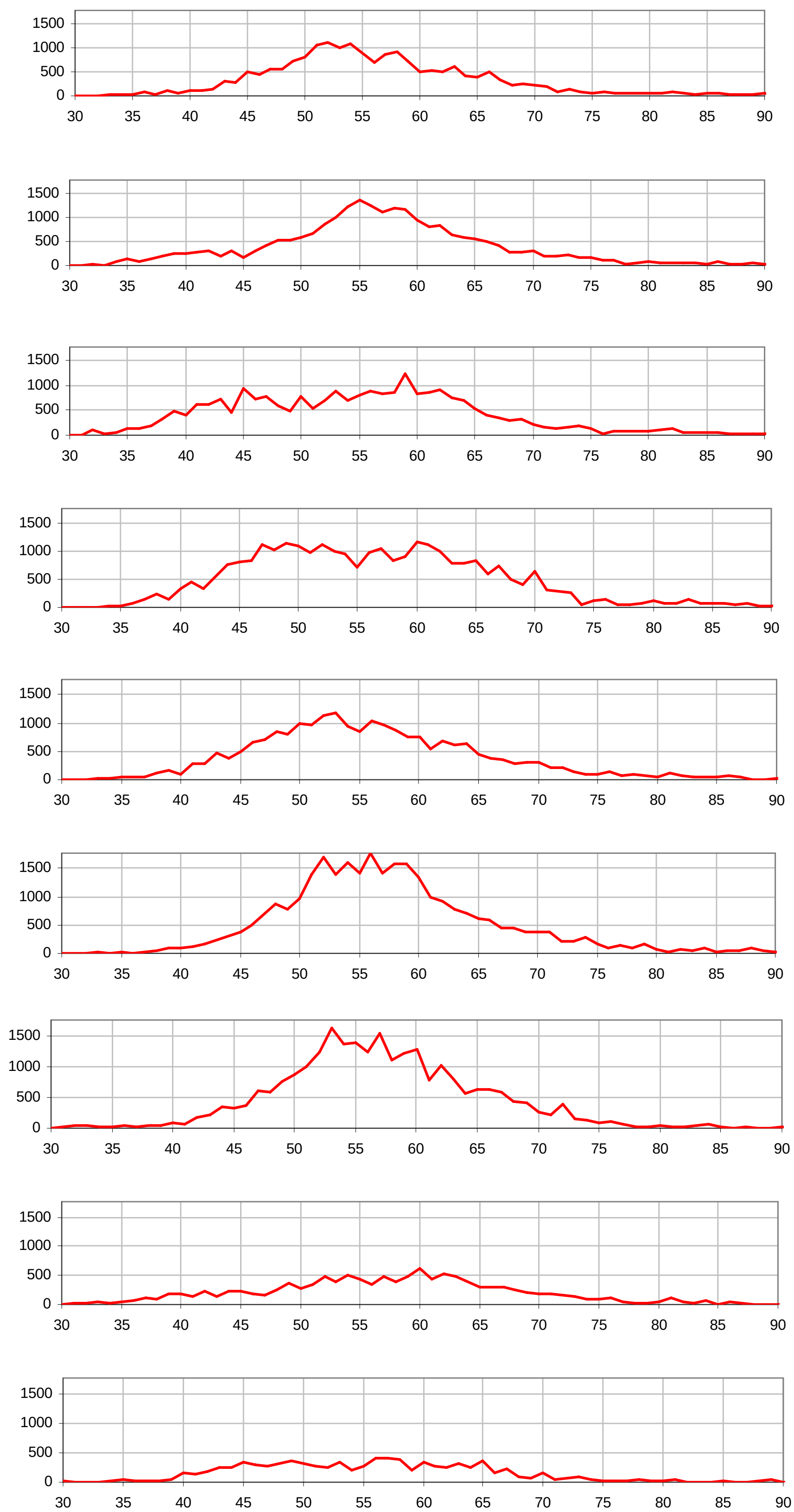


Figure 6.6.3. Abundance indices by length for the Icelandic fall survey.

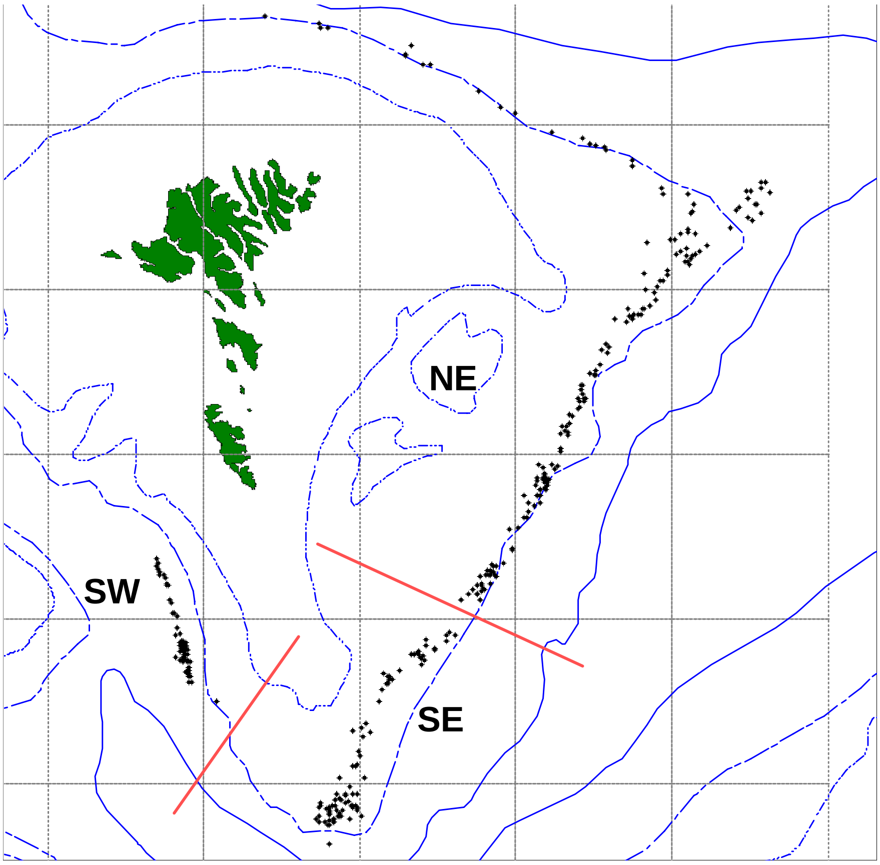


Figure 6.6.4. Hauls conducted by the Faroese deep-water survey in 1995-2004; area separation indicated for use in GLM procedure.

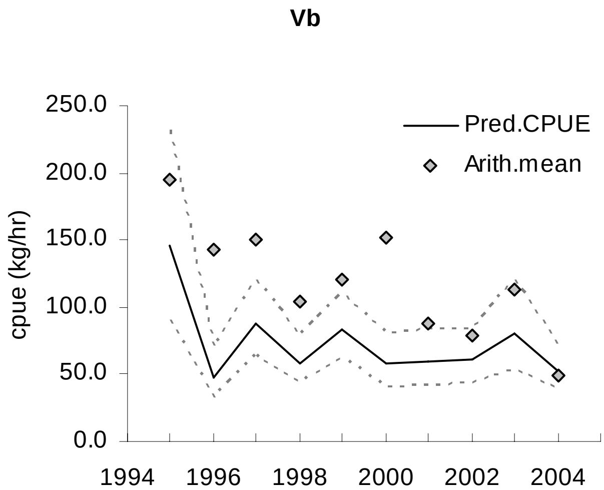


Figure 6.6.5. CPUE from Faroese deep-water survey. Predicted CPUE is estimates from a GLM taking into account area (Fig.6.6.7) and depth of survey. Arith.mean is mean of raw CPUE.

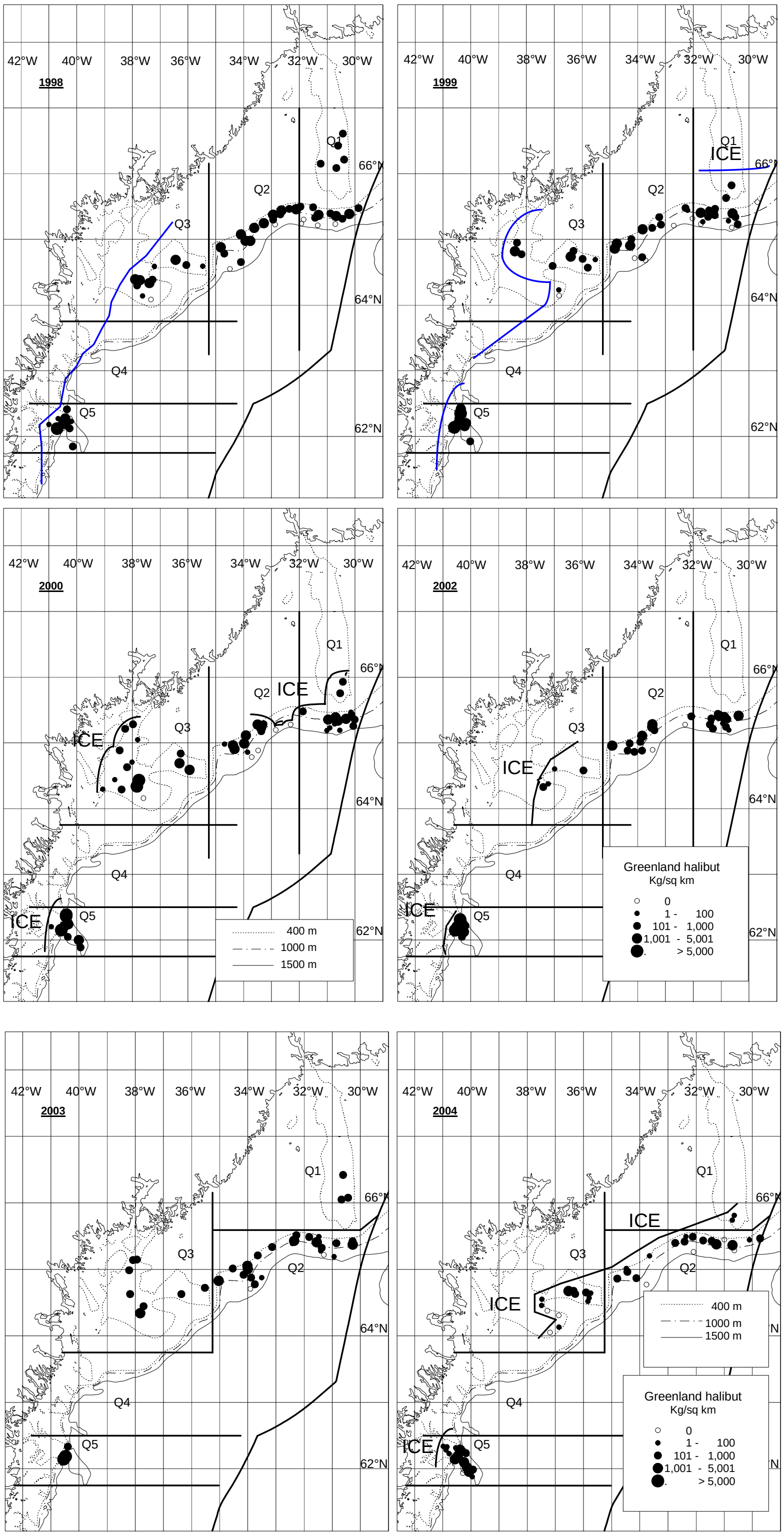


Figure 6.6.6. Distribution of catches of Greenland halibut at East Greenland in 1998 – 2002 in the Greenland deep-water survey.

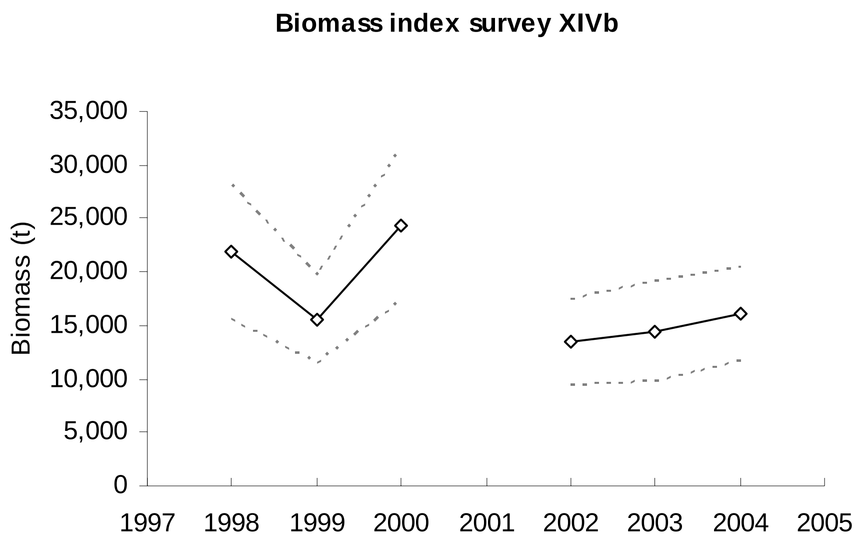
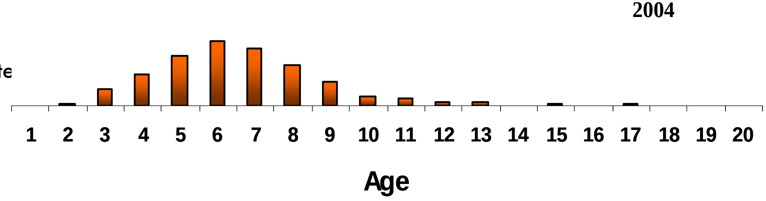
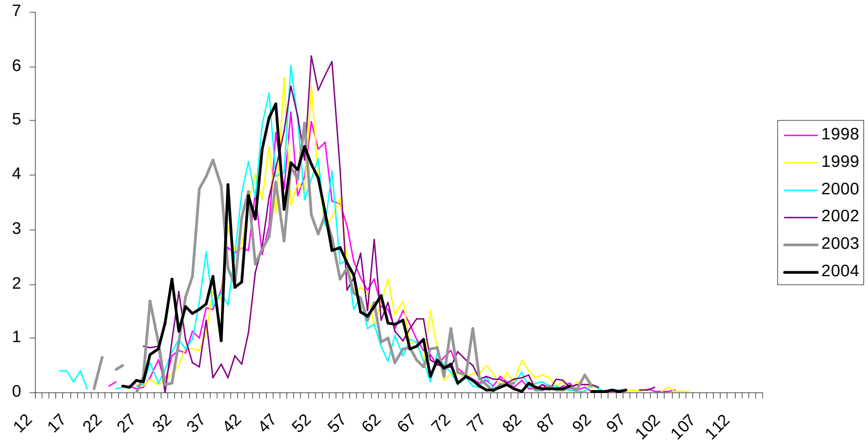


Figure 6.6.7. Estimated Biomass (t) in div. XIVb from the Greenland deep-water trawl survey with 95% CI indicated.





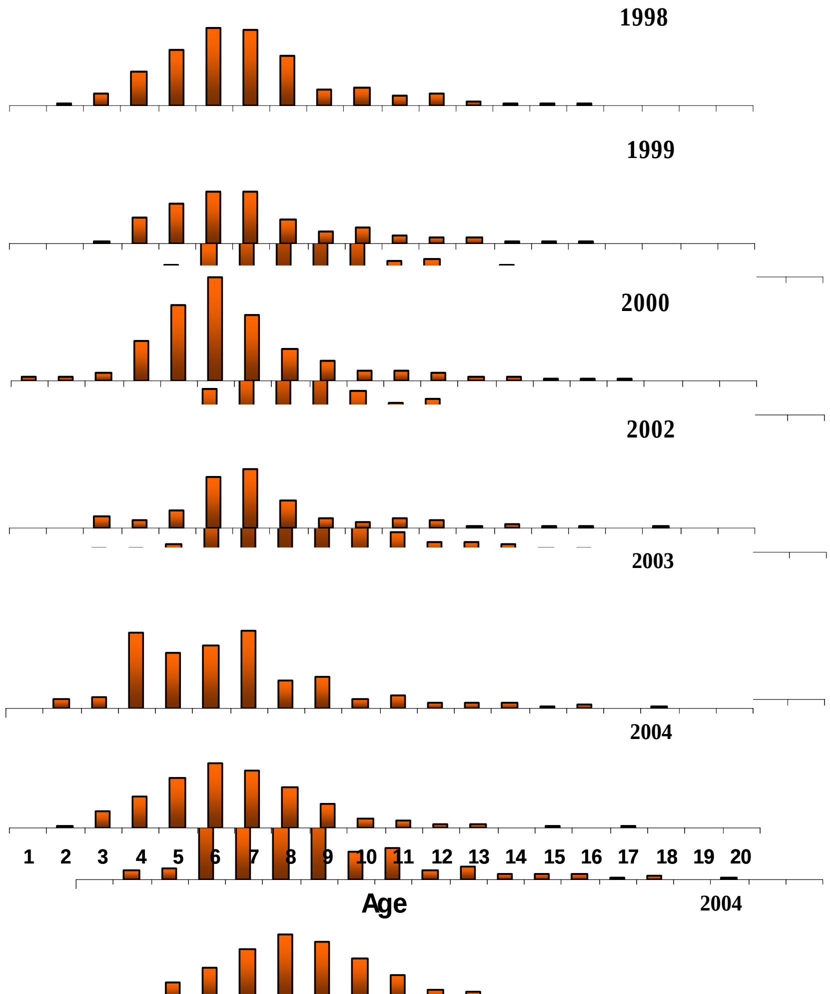


Fig.6.6.8. Greenland deep-water survey in Div. XIVb. Upper: Length frequencies in survey 1998-2004; Lower: Abundance estimates by age.

7 Redfish in Subareas V, VI, XII and XIV

This chapter deals with redfish of the genus *Sebastes* in general, therefore the Group provides information on the redfish fisheries in Sub-areas V, VI, XII and XIV (chapter 7.1), the abundance and distribution of juveniles (chapter 7.2), discards and by-catches (chapter 7.3). Chapters 7.4 and 7.5 deal with the stock identity of *S. mentella* and related special requests.

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 Sub-areas 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 two small areas south of Iceland at depths of 150-250 m. The landings of *S. viviparus* decreased from 1,160 t in 1994 to 2 t in 2004.

7.1 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). Only preliminary official landings data were provided by NEAFC. Detailed descriptions of the fisheries are given in the respective chapters: *S. marinus* in chapter 8.1, demersal *S. mentella* in chapter 9.1 and pelagic *S. mentella* in chapter 10.1.

Information from various sources, are used to split demersal landings into species (see WD30 of NWWG2004). In Division Va, if no direct information is 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 demersal *S. mentella*, depending whether they are fishing west or east of the redfish line (see WD30 of NNWG2004 for further details).

The pelagic *S. mentella* fishery in Division Va has in recent years moved more northwards, and in some years, it merged with the demersal *S. mentella* fishery on the redfish line in June/July. When the pelagic *S. mentella* crossed the redfish line, it was recorded as demersal *S. mentella* and caught with bottom trawls resulting in increased landings in 2003 (see chapter 10.1.2.4). Furthermore, the fraction of demersal *S. mentella* catches taken by pelagic trawls has been varying since 1993, based on log-book data, ranging between 0% in 2004 and 23% in 1994 (average 12%). WD07 was presented where the proposal was made that all catches taken by pelagic trawl should be reported as pelagic *S. mentella*, and catches taken by bottom trawls as catches of demersal *S. mentella* to improve the catch statistics and to prevent overexploitation of *S. mentella* in the overlapping areas of pelagic and demersal fisheries for *S. mentella*. Since ACFM concluded to maintain the current advisory units, this proposal was not considered further by the Working Group.

7.2 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* off East Greenland are 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 Magnússon and Jóhannesson (1997) describe 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 CM 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. In 2004, a minor increase in abundance was observed.

7.3 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 West Greenland. This fishery expanded to East Greenland in the beginning of the 1980s and was mainly conducted on the shallower part of the Dohrn Bank and on the continental shelf from 65°N to 60°N. Observer samples from the Greenland Fishery Licence Control showed that redfish is by-catch in the shrimp fishery off Greenland. No information was available in recent years to quantify the by-catch and about the length distribution of the fish caught. The amount of by-catches of juvenile redfish in the shrimp fishery, however, is expected to be considerably high. Since 1st October 2000, sorting grids with 22 mm bar spacing have been mandatory to reduce the bycatches. The documentation of the effect of sorting grids on the by-catches is needed in order to estimate the by-catch of young redfish in the shrimp fishery.

In late 1980's, Iceland introduced a sorting grid with a bar spacing of 22 mm in the shrimp fishery to reduce the by-catch of juveniles in the shrimp fishery north of Iceland. This was partly done to avoid redfish juveniles as a by-catch in the fishery, but also juveniles of other species. Since the large year-classes of *S. marinus* disappeared out of the shrimp fishing area, there in the early 1990's, observers report small redfish as being negligible in the Icelandic shrimp fishery.

7.4 Special Requests

Special request 1.a) from NEAFC (ToR c) of this Group), regarding the stock identity of *S. mentella*, is dealt with in chapter 7.1, whereas request 1.b) (contained in ToR d) of this Group) to “provide quantitative information to allow spatial and temporal limitations in catches and other measures to avoid disproportionate exploitation rate of any one component, especially to prevent local depletion” is dealt with in chapter 10.3.

Detailed descriptions of the fishery of different nations are given in chapters 8 for *S. marinus*, 9 for demersal *S. mentella*, and 10 for pelagic *S. mentella*, based on various working documents.

7.5 Stock identity and management units of *S. mentella*

After the "Study Group on Stock Identity and Management Units of Redfishes" (SGSIMUR, 31 Aug-3 Sep 2004, Bergen, Norway), dealing with the stock structure of demersal and pelagic *S. mentella*, the NWWG met from 6-10 Sep 2004 (Bergen, Norway) to a) assess the status of and provide catch options for 2005 for the stocks of redfish in Subareas V, XII and XIV, (…); 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".

ACFM concluded to maintain the current advisory units until more information becomes available: a demersal unit on the continental shelf in ICES Divisions Va, Vb, and XIV and a pelagic unit in the Irminger Sea and adjacent areas (V, VI, XII, and XIV)." This latter unit also includes pelagic redfish in the NAFO Convention Area. A schematic illustration of the horizontal and vertical distribution of redfish in these areas is given in Figure 7.1.1.

Two working documents, dealing with the stock structure of *S. mentella* (ToR c) were sumitted to the NWWG in 2005. The working group did not have sufficient expertise to thoroughly review the scientific content of these papers. What follows is a summary of the content of these papers: 1) WD08 presents Russian biological, ecological and parasitological studies that indicate no substantial exchange between the investigated components of *S. mentella* as they relatively stably dwell in different oceanic biotopes, mesopelagic and mesobenthal depths. According to this working document, just minor exchange is possible between these components in the direction from the pelagic Irminger Sea to the slope of Iceland. 2) WD32 describes genetic analyses that resulted in allelic richness that was statistically significant lower at shallow waters when compared to the depth. Values of individual admixture proportions originating in either the shallow or the depth habitats were calculated using a model based Bayesian method. Catch-depth was plotted against these values and a clear signal emerged. Two clusters segregated according to both the depth and admixture proportions indicating depth as barrier to gene-flow within the Irminger Sea. The authors conclude that the structure described is genuine and observed differences cannot be attributed to different life-cycle stages.

Recent underwater tagging experiments showed that *S. mentella* tagged in the pelagic fisheries areas southwest off Iceland were recaptured in shelf areas in Division Va (WD25), and vice versa. According to the few recaptures obtained so far, some degree of mixure of pelagic and demersal *S. mentella* in these areas is very likely.

For the abovementioned reasons, the Group continues to provide fishery and survey information for the pelagic *S. mentella* unit in the Irminger Sea and adjacent waters (chapter 10), separated from the demersal *S. mentella* (chapter 9). The *S. marinus* on the continental shelves of ICES Divisions Va, Vb and Sub-areas VI and XIV is dealt with in chapter 8.

Table 7.2.1 REDFISH. Nominal landings (tonnes) by countries, in Division Va 1998-2004, as officially reported to ICES.

COUNTRY	1998	1999	2000	2001	2002	2003	2004*
Faroe Islands	280	255					
Germany	284	428	513	844	467	1,105	620
Greenland	-*	-*	-*	-*	3,341*		
Iceland	108,380	81,430	95,118	48,970	63,247	67,997	70,167
Norway	-	18	36	26*	16*	19	9
UK (E/W/NI)	-	542	734	1,037	432	...	…
UK (Scotland)	-	149	70	114	272	...	…
United Kingdom					704	1,081	1,008
Total	108,944	82,822					71,803

***Preliminary.**

Table 7.2.2 REDFISH. Nominal landings (tonnes) by countries, in Division Vb 1998-2004, as officially reported to ICES.

COUNTRY	1998	1999	2000	2001	2002	2003	2004*
Faroe Islands	6,484	6,191					
France	110*		250	189	221	262	
Germany	-	207	79	88	2	19	+
Greenland	-*	-*	-*	-*	13*		
Iceland	-	-	-	54	35	-	
Ireland	-	-	-	1	-		
Norway	39	37	41	24*	30*	31	19
Portugal							15
Russia	-	-	12	-	-	-	3
UK (E/W/NI)	4	15	111	92	120	...	…
UK (Scotland)	27	46	142	116	89	...	…
United Kingdom					409	89	152
Total	6,664						189

***Preliminary.**

Table 7.2.3 REDFISH. Nominal landings (tonnes) by countries, in Sub-area VI 1998-2004, as officially reported to ICES.

COUNTRY	1998	1999	2000	2001	2002	2003	2004*
Estonia	-	-	-	+	-	-	1
Faroe Islands	-	44					
France	297*		269	188	97	113	
Germany	1	+	+	1	-	-	1
Ireland	10	34	54	47	26		
Norway	3	8	11	5*	9*	7	2
Portugal	1	-	-	-	-	-	
Russia	-	243	461	88	19	94[1]	
Spain	-	38	16	4	784		
UK (E/W/NI)	12	4	20	44	7	...	…
UK (Scotland)	364	762	405	485	376	...	…
United Kingdom						950	517
Total	688						521

Preliminary. [1]Reported as *S. mentella.

Table 7.2.4 REDFISH. Nominal landings (tonnes) by countries, in Sub-area XII 1998-2004, as officially reported to ICES.

COUNTRY	1998	1999	2000	2001	2002	2003	2004*
Estonia	3,968	2,108	4,000	-	-	-	
Faroe Islands	1,793	528					
France	3*	-*	+	+	-	1	
Germany	9,746	8,204	1,128	3,833	3,032	565	313
Greenland	1,180*	1,188*	124*	740*	-*		
Iceland	1,311	5,072	3,121	11,679	5,745	-	14,266
Latvia	-	-	-	-	1,061	371	+
Lithuania	-	-	-	-	-	14,321	
Norway	602	2,040	2,200	878*	1,094*	3,111	1,858
Poland	-	-	-	-	1	-	
Portugal	-	-	-	387	878	504[1]	1,727
Russia	89	7,698	9,243	4,509	6,090	2,430[2]	812[2]
Spain	2,231	1,723	576	1,332	854		
UK (E/W/NI)	+	187	-	-	+	...	…
UK (Scotland)	-	1	+	-	4	...	…
United Kingdom						1	+
Total	20,923	28,749					18,976

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 1998-2004, as officially reported to ICES.

COUNTRY	1998	1999	2000	2001	2002	2003	2004*
Estonia	-	-	3,811	599	-	-	
Faroe Islands	47	2					
Germany	9,709	8,935	7,840	6,758	9,576	7,050	2,336
Greenland	296*	3,152*	3,545*	2,587*	1,171*		
Iceland	6,441	23,770[1]	17,999	31,786	41,805	43,063[2]	123
Norway	525	3,253	3,699	4,258*	4,215*	5,073	6,964
Poland	-	-	-	-	-	141[4]	2,011
Portugal	4,133	4,302	4,154	2,116	2,208	2,116[3]	2,693
Russia	25,748	16,652	14,851	23,851	25,309	28,687[4]	31,381[4]
Spain	4,660	4,175	2,657	4,982	-		
UK (E/W/NI)	43	68	45	179	16	...	…
UK (Scotland)	-	-	-	-	17	...	…
United Kingdom						378	338
Total	51,602	64,309					45,846

Preliminary. [1]Note Excluding 58 t reported as area unknown . [2]Oceanic redfish. [3]Reported as V/XII/XIV. [4]Reported as *S. mentella.

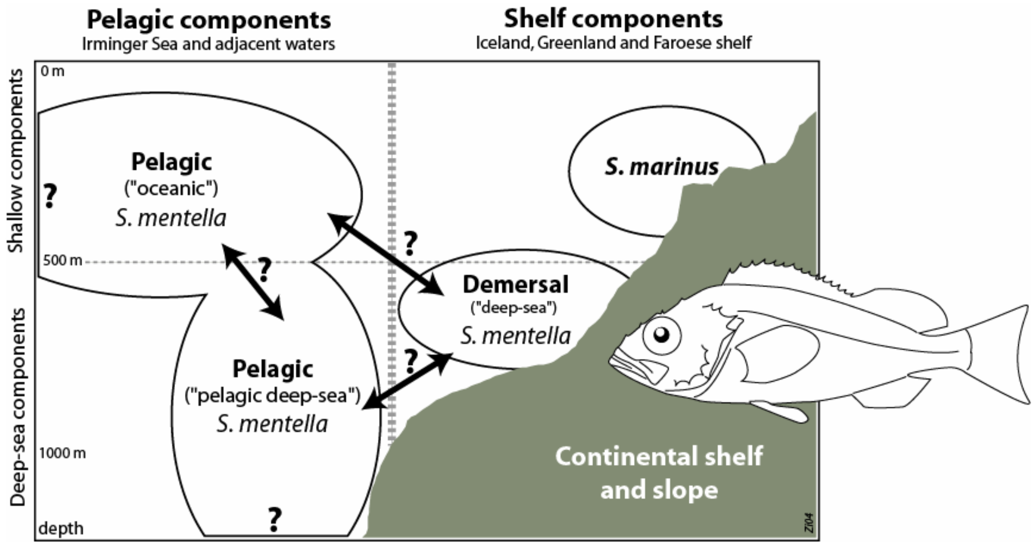


Figure 7.1.1 Possible relationship between redfish occurrences in the Irminger Sea and adjacent waters.

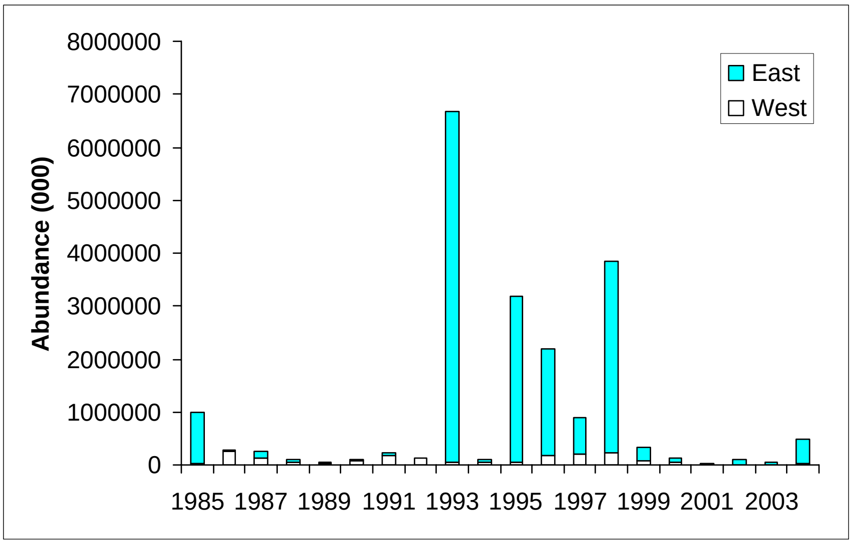


Figure 7.3.1 Survey abundance indices of juvenile *Sebastes* spp. (<17 cm) from the German groundfish survey conducted on the continental shelves off East and West Greenland 1985-2004.

8 Sebastes Marinus

Sebastes marinus in ICES sub-areas 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 have decreased by more than 70% 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 and to 33 500 t in 2004. The majority of the *S. marinus* catch is taken in ICES 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 32 000 and 49 000 t, with the lowest landings in 2004 and the highest in 2002. The landings decreased in 2003 by about 12 000 t from the previous year and to 36 500 t and continued to decrease in 2004 to 32 000 t. Between 90-95% of the annual *S. marinus* catch in Division Va is 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 2004, 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 discards, it is believed that there are no significant discards of *S. marinus* in the redfish fishery due to area closures of important nursery grounds west of Iceland.

In Division Vb, landings dropped gradually from 1985 to 1999 from 9 000 t to 1 500 t and has, since then, remained at that level (Table 8.1.1). The majority of the *S. marinus* caught in sub-Division Vb is taken by pair- and single trawlers (vessels larger than 1000 HP).

Annual landings from sub-area VI increased from 1978 to 1987 followed by a gradual decrease to 1992 (Table 8.1.1). In the 1995-2004 period, annual landings have ranged between 400 and 800 t.

Annual landings from sub-area XIV have been more variable than in the other areas (Table 8.1.1). After the landings reached a record high of 31 000 t in 1982 the *S. marinus* fishery drastically reduced within the next three years (the landings from XIV are about 2 000 t in 1985). During the period 1985-1994 the annual landings from sub-area XIV varied between 600 and 4 200 t but since 1995 there has been little or no directed fishery for *S. marinus*. In recent years, landings have been 200 t or less and is mainly taken as by-catch in the shrimp fishery.

8.1.1 Biological data form the fishery

The table below shows the fishery related sampling by gear type and Divisions.

Area	Nation	Gear	Landings	Samples	Fish measured
Va	Iceland	Bottom trawl	31,473	219	34,806
Va	Germany/UK	Bottom trawl	6		
Va	Faeroe	Longline	237		
Va	Norway	Longline	22		
Vb	Faeroe	Bottom trawl/gillnets	948	12	106
Vb	Various	Bottom trawl	191		
XIV	Various	Bottom trawl	103		
VI	Various	Bottom trawl	519		

The length distributions from the Icelandic commercial trawler fleet in 1989-2004 show that the majority of the fish caught range between 30 and 45 cm (Figure 8.1.3). From 2000 to 2004 the modes of the length distribution were around 35 cm whereas the modes in 1997-1999 were around 37 cm.

Catch-at-age data from the Icelandic fishery in Division Va shows that the 1985-year class dominated the catches from 1995-2002 (Figure 8.2.4 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 and 2004 contributing about 27% of the total catch in weight in both years. The average total mortality (Z), estimated from this 10-year series of catch-at-age data (Figure 8.1.5) is about 0.25 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 2005a). A fairly good agreement (about 60%) between readers was, however, obtained for ages 11-20 years when allowing for ±1 year tolerance.

Length distribution from the Faeroes commercial catches for 2001-2004 indicates that the fish caught are on average larger than 40 cm with modes between 40 cm and 45 cm (Figure 8.1.6).

No length data from the catches have been available for several years in Divisions XIV and VI.

8.2 Assessment data

8.2.1 CPUE

CPUE indices for the Icelandic trawl fleet for the period 1985-2004 were estimated from a GLM multiplicative model where data was summarised for each vessel by ICES statistical square, month and year. The model takes, therefore, into account changes in the Icelandic trawl catches due to vessel, area, month, and year effects. All hauls at depths above 500 m with *S. marinus* exceeding 50% of the total catch (assumed to be the directed fishery towards the species), 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 2002-2004. The index in 2004 was 6% higher than the highest value in the series in 1987. Effort towards *S. marinus* has decreased considerable from 1986 to 2004 (Figure 8.2.1).

Un-standardized CPUE of the Faeroes otterboard (OB) trawlers 1991-2004 gradually declined to a record low in 1997 but has since then gradually increased and was 84% of the 1991 value in 2004 (Figure 8.2.2). OB trawlers conduct mixed fishery and direct their fishery to some extent towards *S. marinus*. Un-standardised CPUE from the Faeroes CUBA pair-trawler fleet, where *S. marinus* is mainly caught as bycatch in the saithe fishery, was fairly stable between 1991 to 1998, but gradually decreased from 1999 to a record low in 2002 (Figure 8.2.2). CPUE increased in 2003 and 2004 and the CPUE was in 2004 the second highest recorded. Effort has in recent years increased both for the CUBA and OB trawlers.

8.2.2 Survey data

Figure 8.3.2 shows total biomass index from the Icelandic spring and autumn groundfish surveys in 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 selection curve (Figure 8.2.4) 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 8.2.5 shows this index of fishable biomass. 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 values in 2004 and 2005 are about 60% of the highest observed value. The total indices were on the other hand used in the BORMICON model (see below). 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 few large hauls (Table 8.2.1). This estimate of the fishable biomass could be used as a proxy for the SSB. Figure 8.2.6 shows the proportion of mature *S. marinus* in the commercial catches 1995-2004 as a function of length. The estimated length at which 50% fish became mature (L_{50}) was estimated 33.2 cm, which is about 2 cm lower than the L_{50} of the catchability curve.

Length distributions from the Icelandic groundfish surveys show that the peak (Figure 8.2.7), 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 8.1.4). There is no indication of recruitment after 1990-year class, that is fish less than 12 cm. However, a large amount of fish between 25 and 30 cm was observed in the 2005 survey, but not observed previously as smaller fish. This could therefore be a recruiting fish coming from East Greenland (Figure 8.2.11).

In Division Vb, CPUE of *S. marinus* were available from the Faeroes spring groundfish survey from 1994 to 2005 (Figure 8.2.8). 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 2004, CPUE increased and was about 40% of what it was in 1996 (Figure 8.2.8).

From 1985 to 2004, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm are illustrated in Figures 8.2.9 and 8.2.10. 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 an increased number of adults off East Greenland. Between 2003 and 2004 the biomass decreased and abundance increased slightly. The length frequencies from the German groundfish survey are illustrated in Figure 8.2.11. 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) . 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 2005. 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 2005 run is shown in Figure 8.2.12.

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 8.2.12-8.2.17 and compared to the results from two previous years in Figure 8.2.18. As may be seen the estimate on catchable biomass for 2005 is similar to the ones estimated in 2002 and 2003, although a little higher, with the difference probably driven by the high survey indices 2004 (Figure 8.2.16). Furthermore, the results for 2005 are similar to the one presented in Björnsson and Sigurdsson (2003), where they used data until 2000.

Figure 8.2.17 shows residuals from the model fit to the survey data, demonstrating large positive residuals in some years, most notably 1993, 1999, and 2003-2005. The large positive residuals for 22-37 cm fish observed in 2003-2005 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 8.2.13). 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.

The estimation of L_{50} in the selection pattern of the commercial fleet was estimated 32.4 cm, which is the lowest value estimated (Table 8.2.2) It is not known whether the changes of selection in the fishery is related to model misspecification or recruitment.

Different catch options were tested in the simulations for a fixed catch. As may be seen in Figures 8.2.13, the catchable biomass will decrease in next 5 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. The BORMICON model and available survey information 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 5 years. It is expected that those year classes will dominate the catches in the next few years. There is no indication of new, strong year classes since the 1990-year class, that is fish smaller than 12 cm. However, in the 2005 survey, a large number of fish at lengths between 25 and 30 cm was observed. The BORMICON model estimated the exploitation rate to amount to F=0.16. In Vb, survey indices do not indicate improved situation in the area, but CPUE indices from the commercial fleet has increased. In sub-Division XIV, the adult fish is severely depleted, but there are signs of improved recruitment (Figure 8.2.11). No information are available on exploitation rate in Divisions Vb and XIV.

In summary, the Icelandic groundfish survey shows 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

Results from the short term prediction is given in Table 8.2.3. 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 4 years would provide a fishable stock size above current biomass level at the end of that period and total biomass similar to current level (Table 8.2.3). 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

The biological reference points are given in Table 8.2.4.

F_{max} was calculated by following one year class of million fishes for 50 years through the fisheries calculating total yield from the year class as function of fishing mortality of fully recruited fish. From the plot of yield vs. fishing mortality F_{max} and $F_{0.1}$ were estimated. In the model the selection of the fisheries is length based so only the largest individuals of recruiting year classes are caught, reducing mean weight of the survivors, more as fishing mortality is increased. This is to be contrasted with age based yield per recruit where the same weights at age are assumed in the landings independent of the fishing mortality even when the catch weights are much higher hand the mean weight in the stock. Those effects can be seen in Figure 8.2.12 where the model estimates L_{inf} = 60cm while the removal of the largest individuals of recruiting year classes let it look like L_{inf}=40cm. This difference leads to estimates of F_{max} that are considerably lower than F_{max} from age based assessment.

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 SSB a little and lead to fishing mortality close to $\mathbf{F_{max}}$.

S. marinus is mainly caught in Division Va, and the relative state of the stock can be assessed through survey index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max} /5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been close to U_{pa} during the last years (Figure 8.2.5). The survey index series is only available from 1985 (Table 8.2.5).

8.4 Comment on the assessment

The basis for advise and the relative state of the stock is based on projection derived from the analytical BORMICON model and survey index series.

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 Faeroes fishing grounds in Vb. The largest specimens are found in Subdivision Vb and therefore the year classes from 1985 and 1990 might still not have entered into that area. This might explain the inconsistency between different indicators on the status of the stock.

Table 8.1.1 Official landings (in tonnes) of *S. marinus*, by area, 1978-2004 as officially reported to ICES.

	Area				
Year	Va	Vb	VI	XIV	Total
1978	31,300	2,039	313	15,477	49,129
1979	56,616	4,805	6	15,787	77,214
1980	62,052	4,920	2	22,203	89,177
1981	75,828	2,538	3	23,608	101,977
1982	97,899	1,810	28	30,692	130,429
1983	87,412	3,394	60	15,636	106,502
1984	84,766	6,228	86	5,040	96,120
1985	67,312	9,194	245	2,117	78,868
1986	67,772	6,300	288	2,988	77,348
1987	69,212	6,143	576	1,196	77,127
1988	80,472	5,020	533	3,964	89,989
1989	51,852	4,140	373	685	57,050
1990	63,156	2,407	382	687	66,632
1991	49,677	2,140	292	4,255	56,364
1992	51,464	3,460	40	746	55,710
1993	45,890	2,621	101	1,738	50,350
1994	38,669	2,274	129	1,443	42,515
1995	41,516	2,581	606	62	44,765
1996	33,558	2,316	664	59	36,597
1997	36,342	2,839	542	37	39,761
1998	36,771	2,565	379	109	39,825
1999	39,824	1,436	773	7	42,040
2000	41,187	1,498	776	89	43,550
2001	35,067	1,631	535	93	37,326
2002	48,570	1,941	392	189	51,092
2003	36,577	1,459	968	215	39,220
2004[1)]	31,738	1,139	519	103	33,498

1) Provisional

Table 8.1.2 ***S. marinus*****. Landings in Va in weight (tonnes) by age 1995-2004. Highlighted are the 1985- and 1990-yearclasses. 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	2004
7	62	0	33	24	7	40	122	130	201	243
8	374	355	230	285	367	64	137	911	211	924
9	1,596	814	481	598	1,643	852	393	767	1,368	522
10	9,436	3,652	1,037	1,214	1,247	4,308	1,615	842	1,122	2,249
11	2,719	9,007	2,698	1,135	1,840	1,894	**7,725**	3,189	1,198	820
12	1,319	2,074	11,559	3,258	2,643	2,277	1,799	**11,069**	3,955	956
13	3,534	1,302	2,822	12,552	2,309	1,703	1,973	3,096	**9,777**	2,066
14	5,671	1,458	1,369	2,086	15,583	2,375	1,246	2,631	2,362	**8,705**
15	5,971	4,374	3,134	2,039	1,143	14,878	835	1,855	1,979	2,134
16	1,730	5,599	3,662	2,410	1,309	1,777	**11,629**	3,028	1,218	1,632
17	852	923	3,033	3,408	1,849	1,184	520	**12,041**	2,267	839
18	368	383	900	2,046	2,699	1,624	783	2,097	**6,427**	1,361
19	1,134	264	644	1,015	2,272	2,427	1,063	1,173	761	**5,060**
20	1,144	336	945	726	1,205	2,191	1,792	661	410	1,135
21	503	1,200	450	521	482	544	965	1,409	604	233
22	677	1,022	524	390	222	447	418	1,027	791	482
23	1,427	795	689	425	345	270	435	741	755	537
24	664	0	590	662	223	64	168	362	379	610
25	762	0	752	515	936	393	130	294	303	270
26	365	0	271	399	279	340	125	185	75	129
27	350	0	136	425	650	193	291	83	83	220
28	725	0	204	359	230	528	203	297	27	104
29	0	0	150	54	107	371	153	499	106	116
30	133	0	30	225	231	441	374	174	197	188
Total	41,516	33,558	36,343	36,771	39,821	41,186	34,894	48,561	36,576	31,535

Table 8.2.1 Index on fishable stock of *S. marinus* in the Icelandic groundfish survey 1985-2005 divided by depth intervals.

			Depth Intervals			
Year	< 100m	100-200m	200-400m	400-500m	0 - 400m	Total
1985	7.0	90.7	139.7	23.6	237.4	261.1
1986	2.0	86.1	179.9	12.1	268.0	280.1
1987	2.0	123.8	150.2	10.0	276.0	286.0
1988	1.1	94.6	110.1	4.0	205.8	209.7
1989	1.1	101.4	117.8	10.9	220.2	231.1
1990	2.3	67.9	81.0	22.2	151.2	173.4
1991	1.7	75.9	52.6	8.3	130.3	138.6
1992	1.2	62.2	58.5	9.4	121.9	131.3
1993	0.7	47.5	50.2	16.6	98.4	115.0
1994	0.5	57.7	51.4	1.3	109.6	110.9
1995	0.3	36.0	44.6	11.2	81.0	92.1
1996	0.8	44.3	76.5	21.1	121.5	142.6
1997	1.0	60.3	71.5	33.6	132.7	166.4
1998	1.6	56.9	71.2	2.7	129.7	132.4
1999	0.7	55.5	107.3	44.4	163.6	207.9
2000	2.0	46.7	68.5	8.1	117.2	125.4
2001	1.6	33.1	66.6	5.8	101.2	107.0
2002	1.8	64.0	74.2	11.4	140.1	151.4
2003	8.7	60.2	107.5	28.8	176.4	205.2
2004	7.9	57.2	91.6	102.3	156.7	259.0
2005	9.4	42.3	112.3	37.6	164.1	201.7

Table 8.2.2 Results of the BORMICON model. BASE CASE, estimated value of L_{50}. in the selection pattern of the commercial fleet

Year	<1998	1998	1999	2000	2001	2002	2003	2004
L_{50}	33.85	34.49	34.30	33.92	33.65	34.14	32.81	32.40

Table 8.2.3 *S. marinus* in Division Va. Output from short term prediction using results from the BORMICON model, where the annual landings after 2004 is set to 30 000 t. The table gives the SSB (the same as the catchable biomass), total biomass and landings in thousands tons F_{20} is the fishing mortality at age 20.

Year	SSB	F_{20}	Total biomass	Landings
2004	183.3	0.175	340.5	31.5
2005	195.9	0.184	349.0	35.0
2006	205.2	0.175	352.2	35.0
2007	215.1	0.167	353.2	35.0
2008	225.1	0.159	352.3	35.0
2009	233.2	0.153	349.5	35.0

Table 8.2.4 Biological reference points for *S. marinus* in Division Va.

Parameters	Estimation
F_{max}	0.16
$F_{0.1}$	0.09
SSB	183 000 t
Yield per rectruit	250 g

Table 8.2.5 Index in thousands of total biomass of *S. marinus* from the groundfish survey in March 1985-2005 and CV of the estimates.

YEAR	INDEX	CV
1985	331	0.094
1986	372	0.134
1987	348	0.115
1988	270	0.101
1989	335	0.153
1990	297	0.327
1991	200	0.106
1992	171	0.094
1993	202	0.144
1994	189	0.125
1995	163	0.139
1996	230	0.209
1997	282	0.318
1998	230	0.158
1999	381	0.204
2000	264	0.201
2001	222	0.153
2002	259	0.122
2003	409	0.188
2004	457	0.310
2005	345	0.136

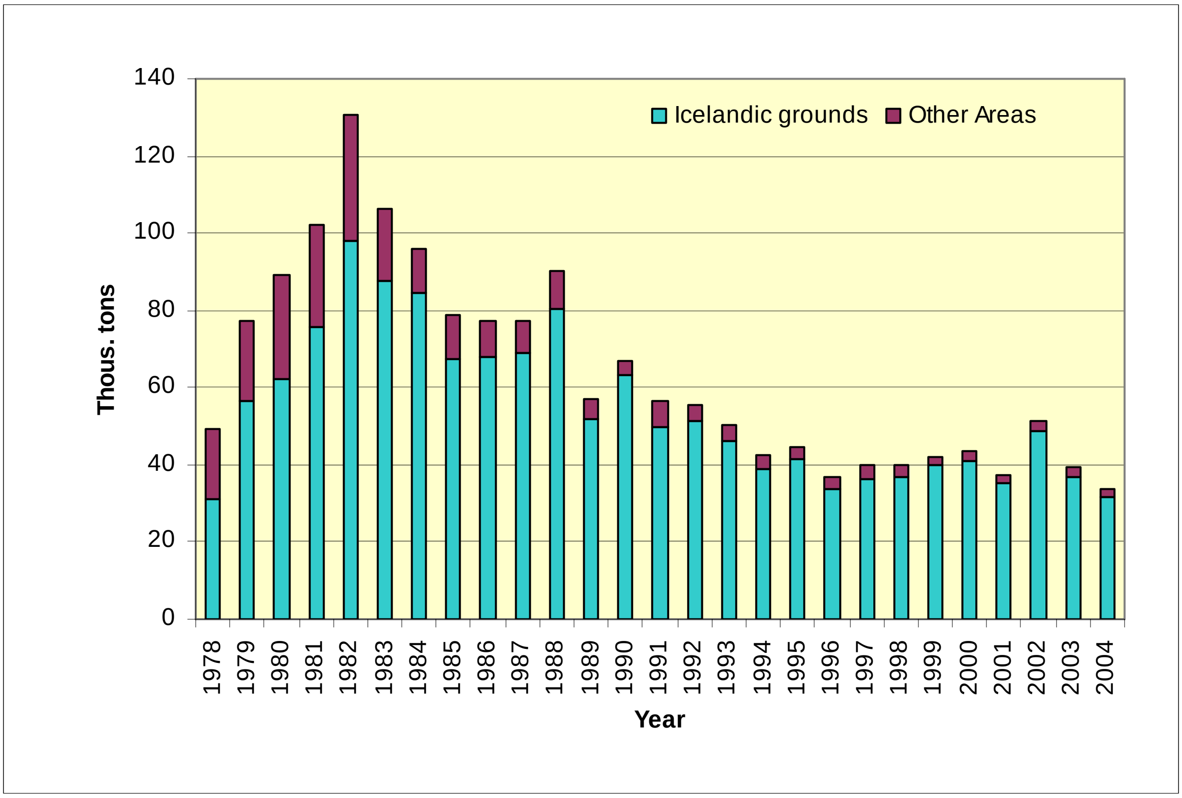


Figure 8.1.1 ***Sebastes marinus*****. Nominal landings in tonnes in ICES Division Va and in other areas (landing statistics for ICES Divisions Vb, VI and XIV combined) 1978-2004. Landings statistics for 2004 are provisional.**

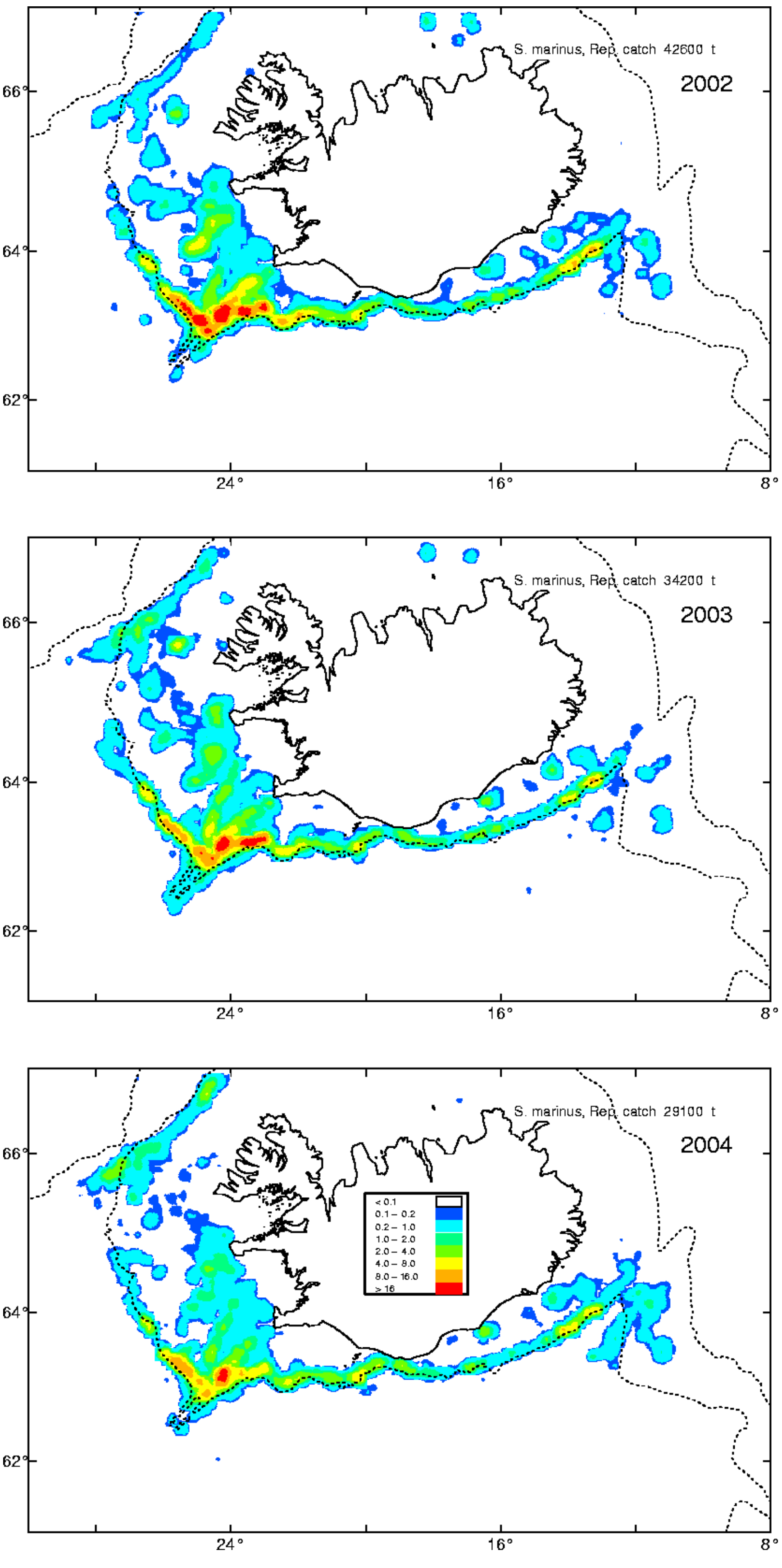


Figure 8.1.2 **Geographical distribution of *S. marinus* catches in Division Va 2002-2004.**

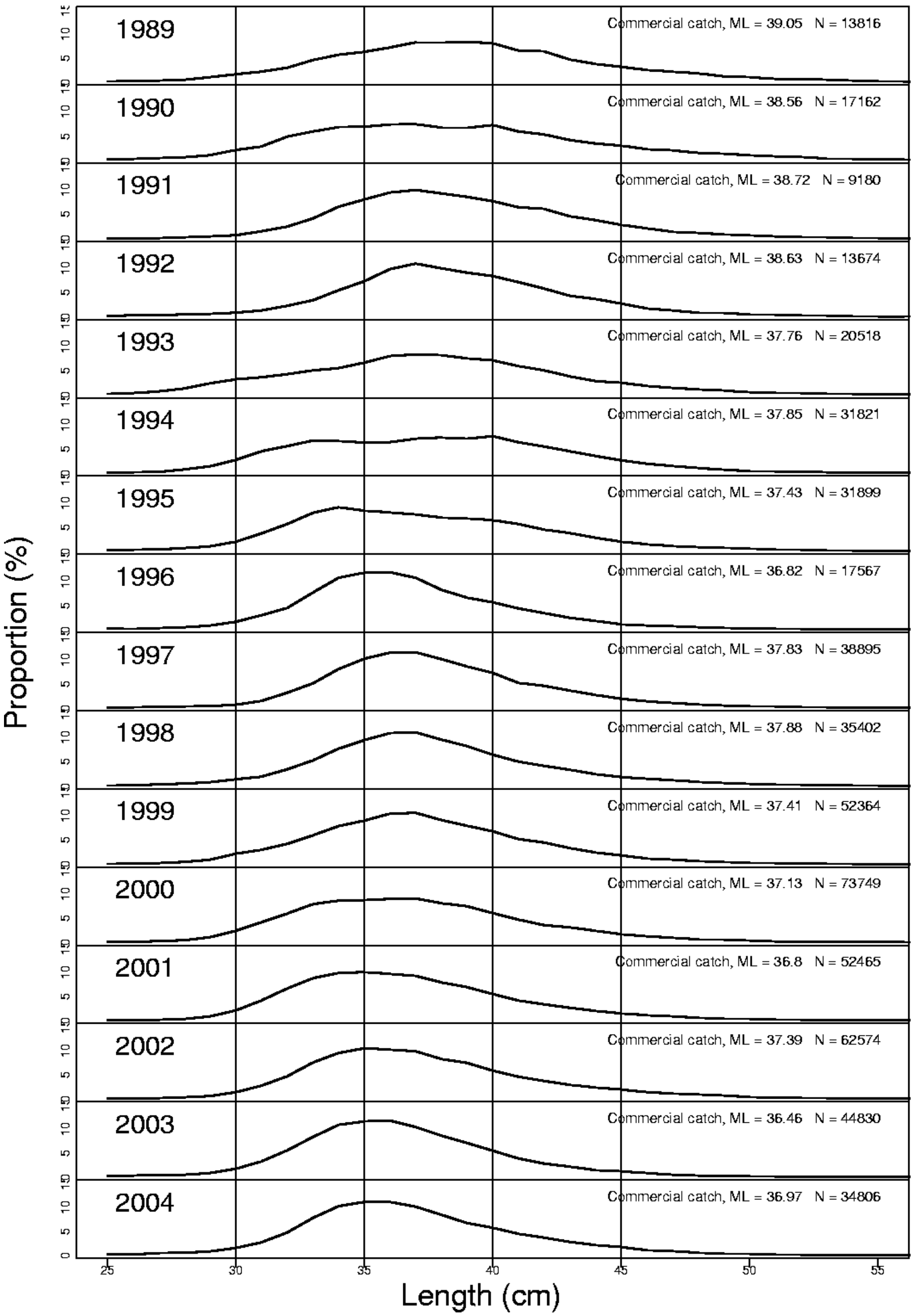


Figure 8.1.3 **Length distribution of *S. marinus* in the commercial landings of the Icelandic bottom trawl fleet 1989-2004.**

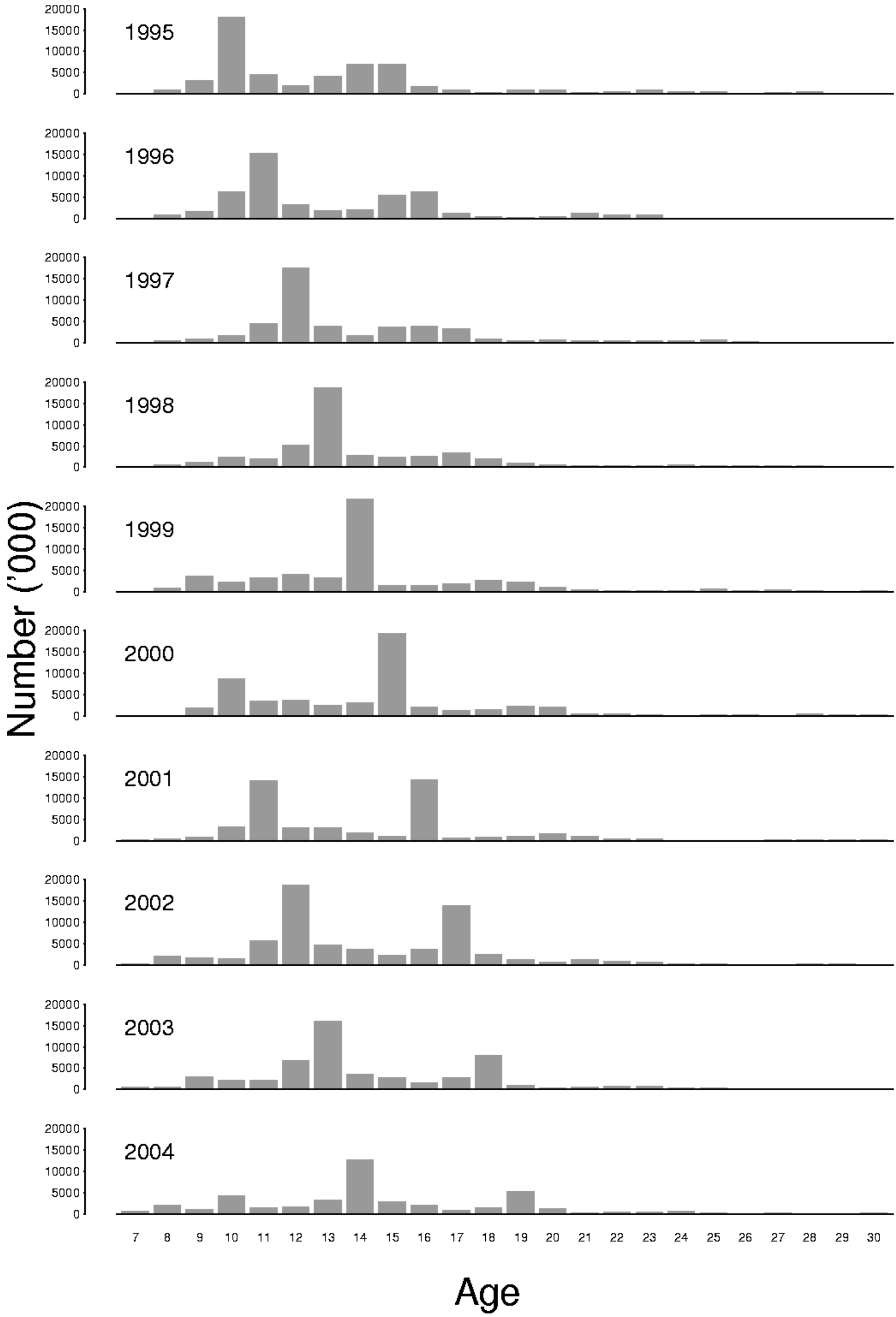


Figure 8.1.4 ***S. marinus.*** **Catch-at-age in numbers in ICES Subdivision Va 1995-2004.**

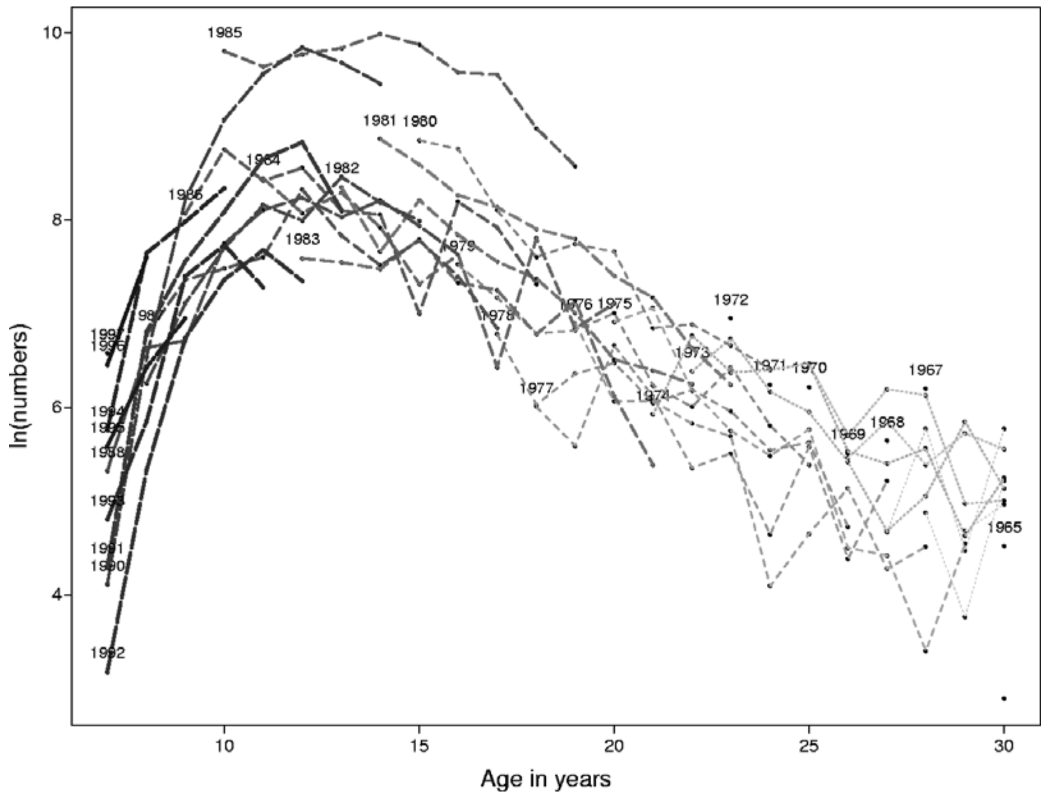


Figure 8.1.5 ***S. marinus.*** **Catch curve based on the catch-at-age data in ICES Division Va 1995-2004.**

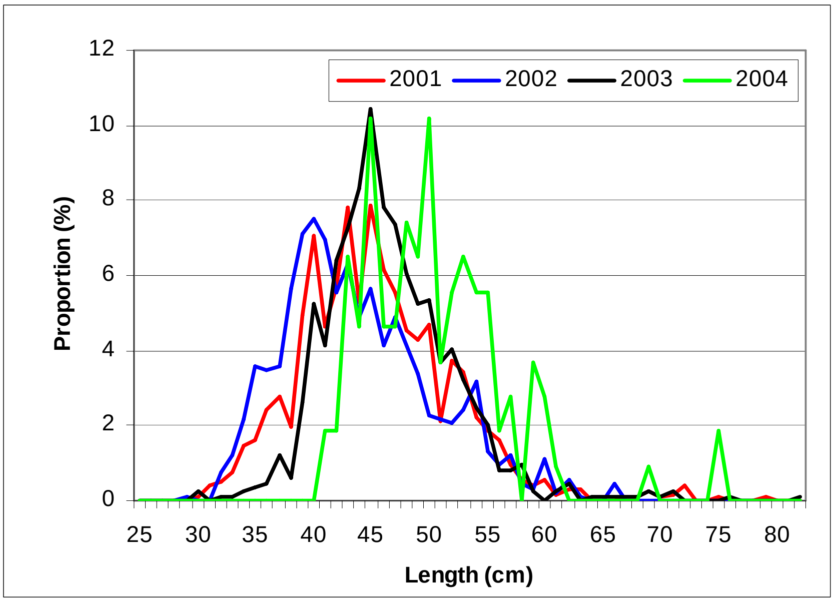
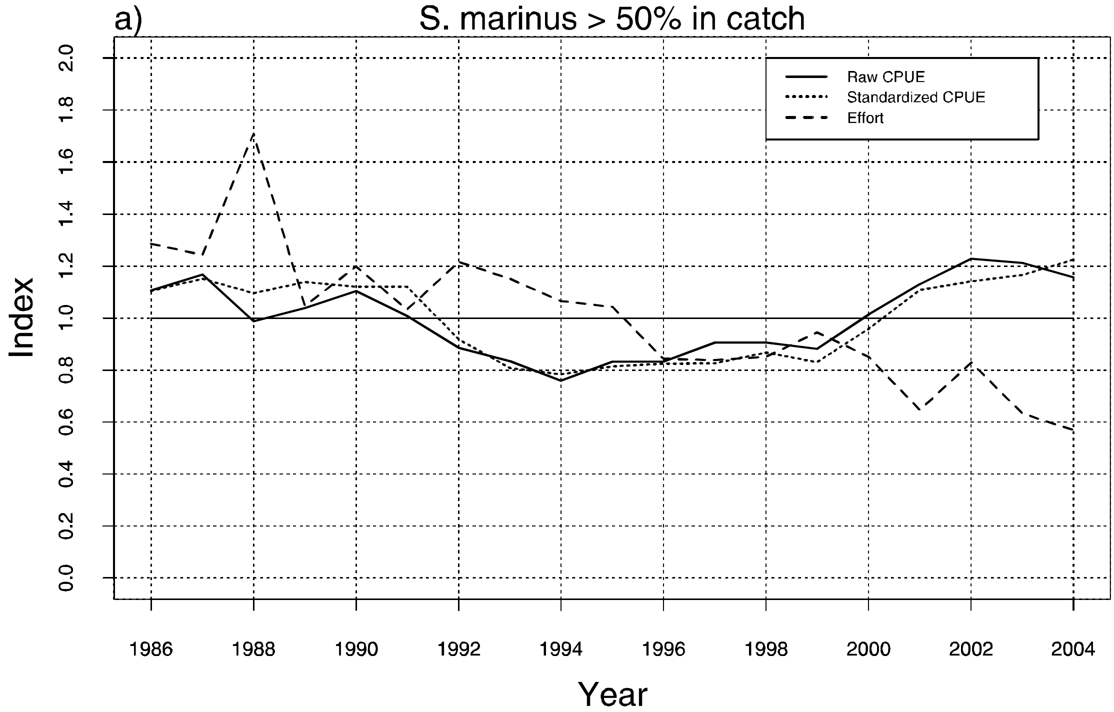


Figure 8.1.6 ***S. marinus.*** **Length distribution from Faroese catches in 2001-2004.**



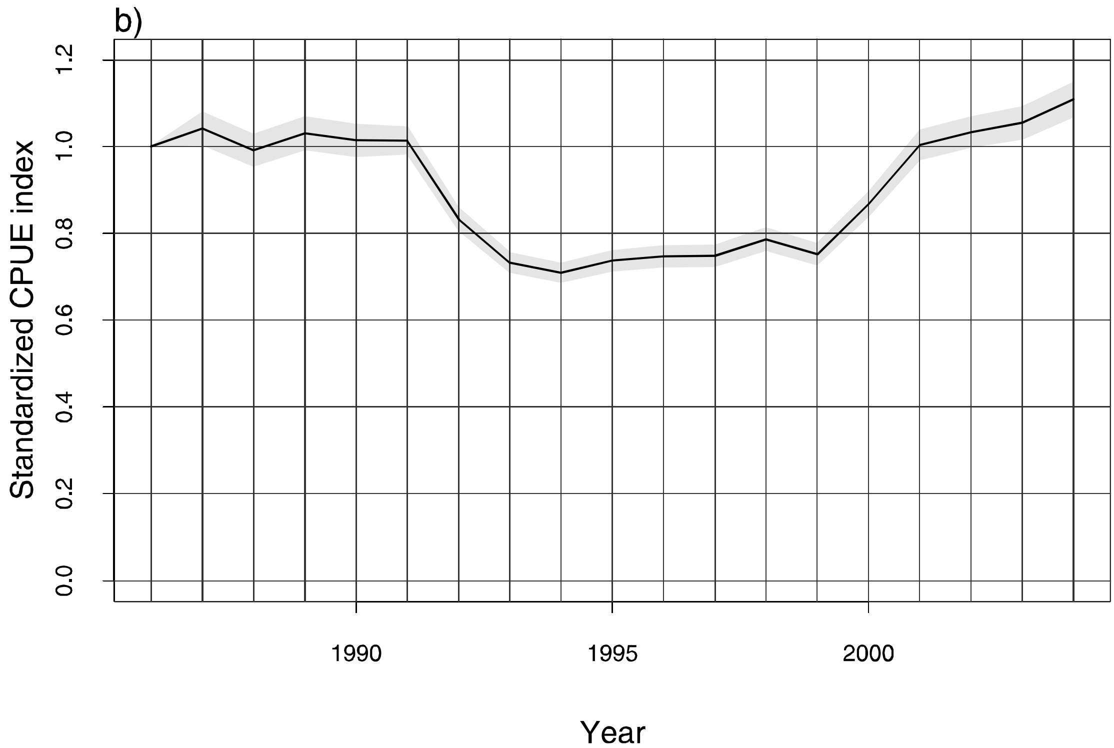


Figure 8.2.1 **CPUE indices, relative to 1986, of demersal *S. mentella* from Icelandic bottom-trawl fishery in Division Va. The CPUE indices are based on a GLM model, based on data from-log-books and where at least 50% of the total catch in each tow was demersal *S. mentella. Also shown is the fishing effort index..***

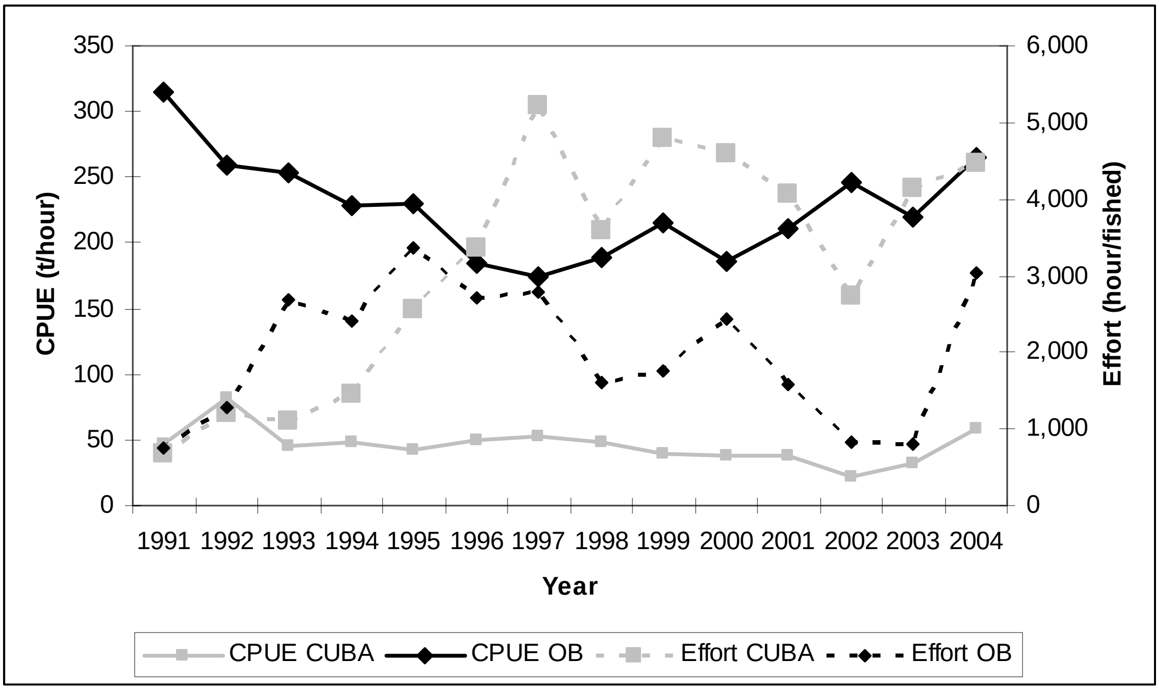


Figure 8.2.2 CPUE (solid lines) and effort (dotted lines) from the Faroese CUBA pair-trawlers (grey) and otterboard trawlers (black) in ICES Division Vb 1991-2004.

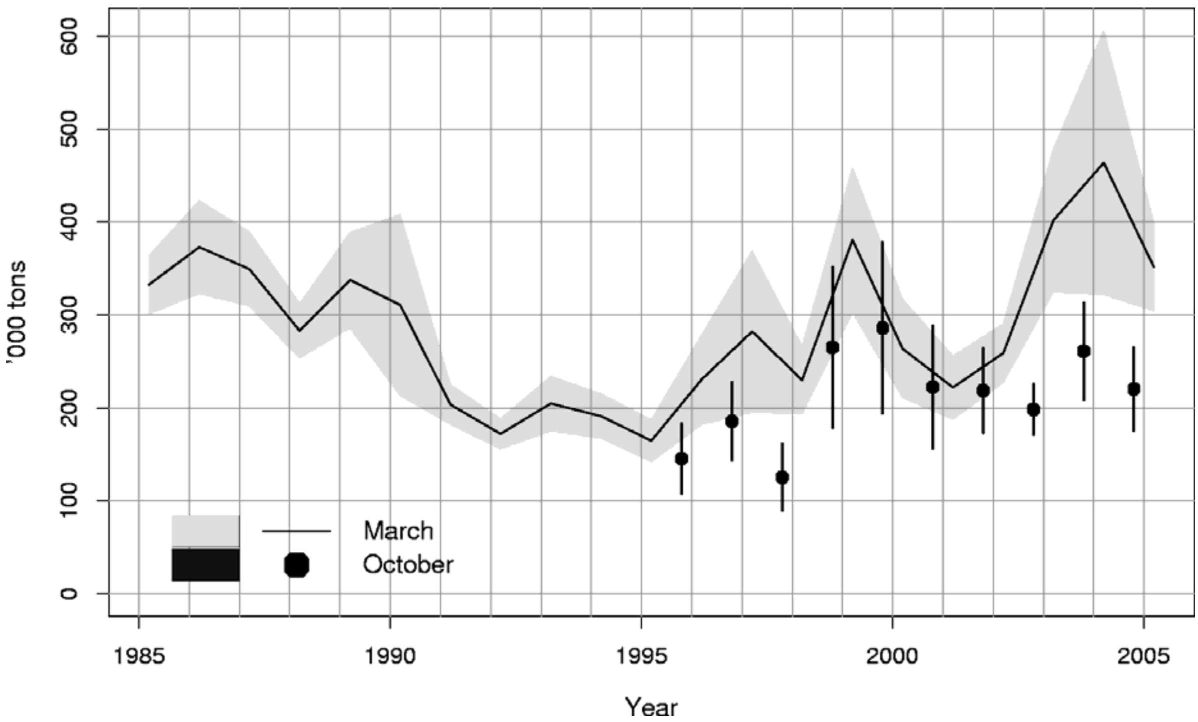


Figure 8.2.3 Total biomass indices from the grounfish surveys in March 1985-2005 (line) and October 1996-2004 (points). The shaded area and the vertical bar show ±1 standard error in the estimate of the indices.

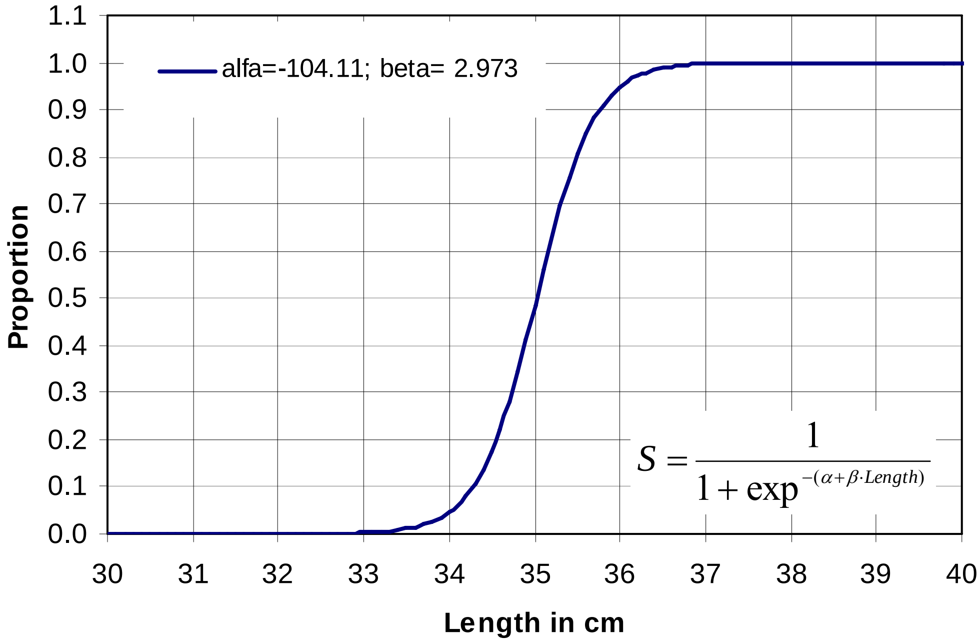


Figure 8.2.4 Selection pattern of *S. marinus* from the spring groundfish survey used to estimate the abundance of the fishable stock abundance. L_{50} = 35 cm.

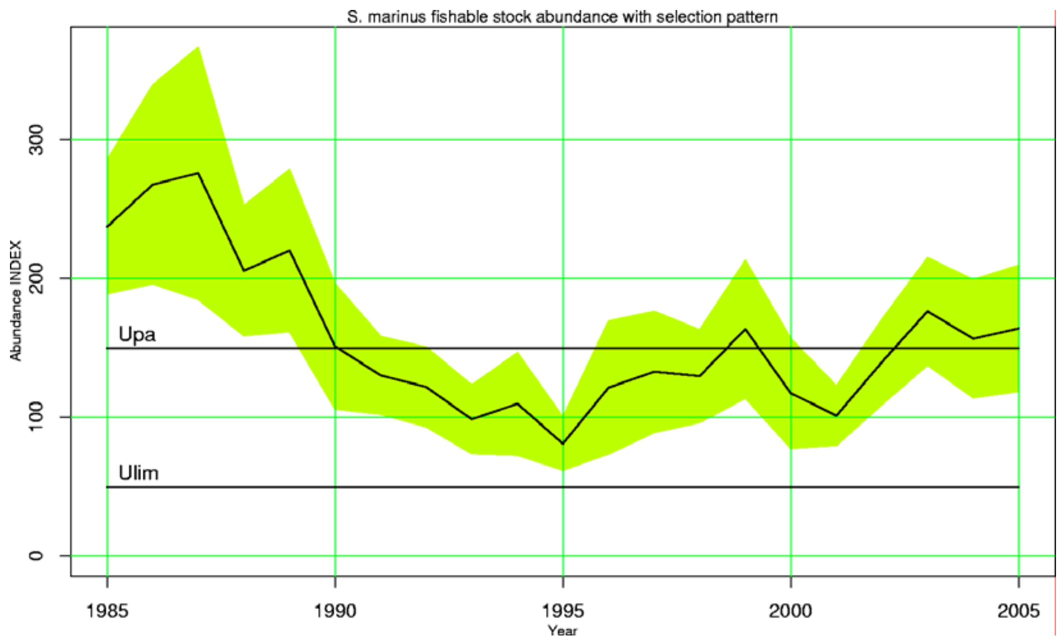


Figure 8.2.5 Index on fishable stock of *S. marinus* from Icelandic groundfish survey 1985-2005 and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

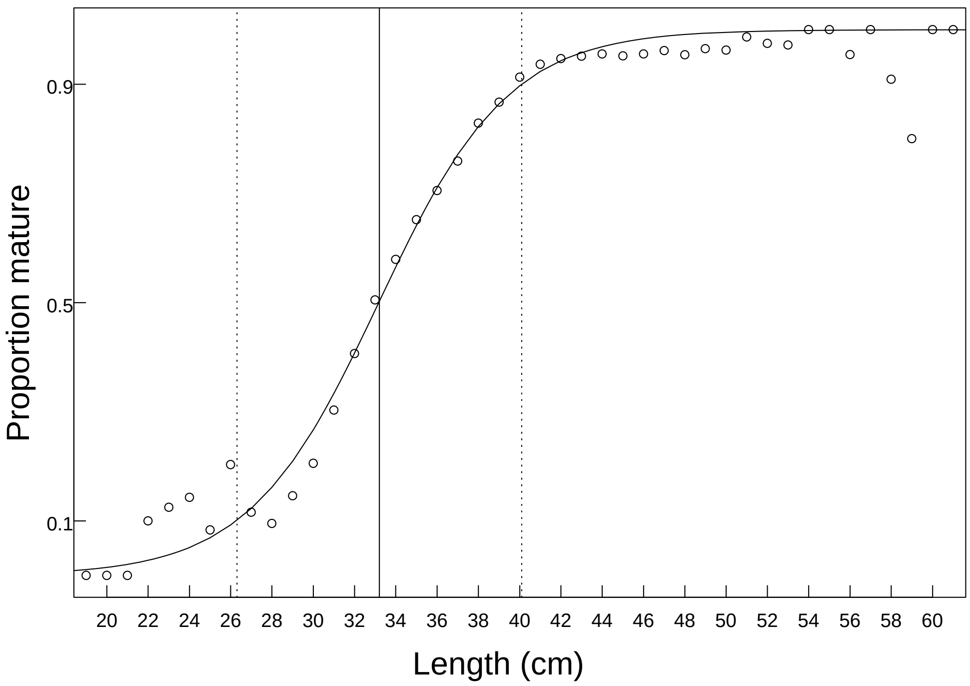


Figure 8.2.6 **The proportion of mature *S. marinus* as a function of length from the commercial catch in Va 1995-2004 (all data pooled). The data points show the observed proportion mature and the lines the fitted maturity. The solid vertical lines indicates the point where 50% of the fish mature and the two dotted lines indicates the 10% and 90% probability of being mature.**

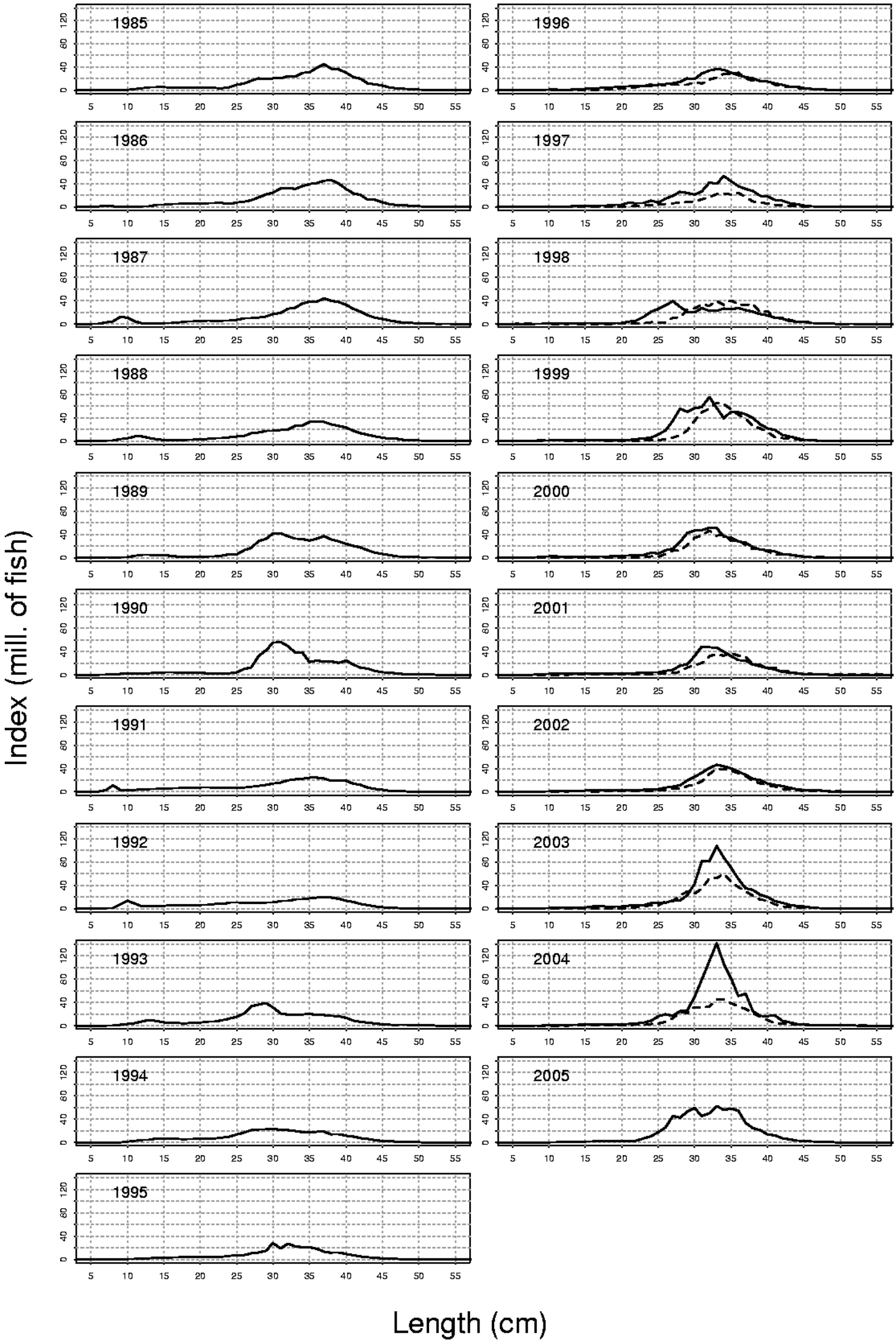


Figure 8.2.7 Length distribution of *S. marinus* in the bottom trawl surveys in March 1996--2004 (solid line) and in October 1996-2005 (broken lines) conducted in Icelandic waters.

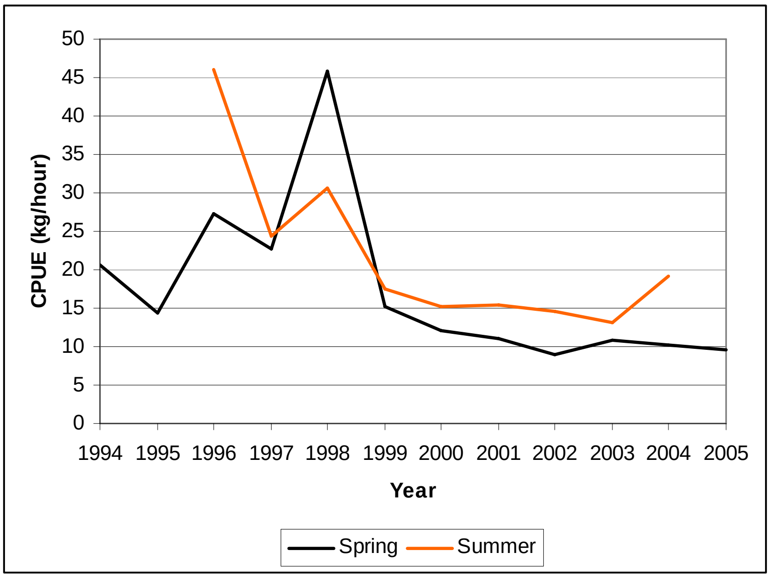


Figure 8.2.8 CPUE of *S.marinus* in the Faeroes spring groundfish survey 1994-2005 and the summer groundfish survey 1996-2004 in ICES Division Vb.

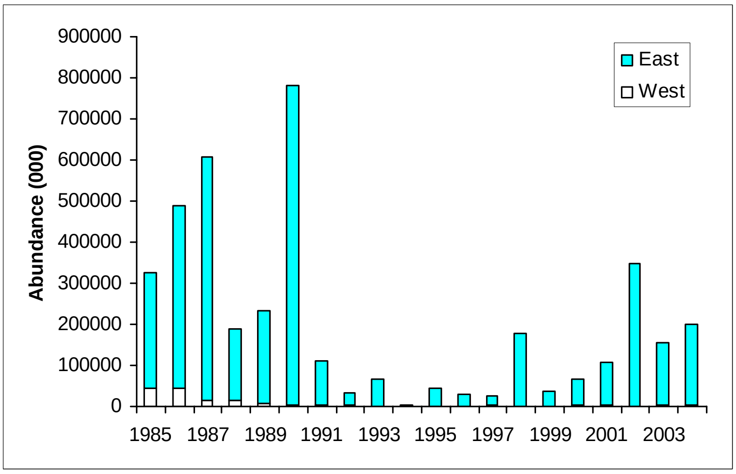


Figure 8.2.9 *S. marinus* (≥17 cm). Survey abundance indices for East and West Greenland from the German groundfish survey 1985-2004.

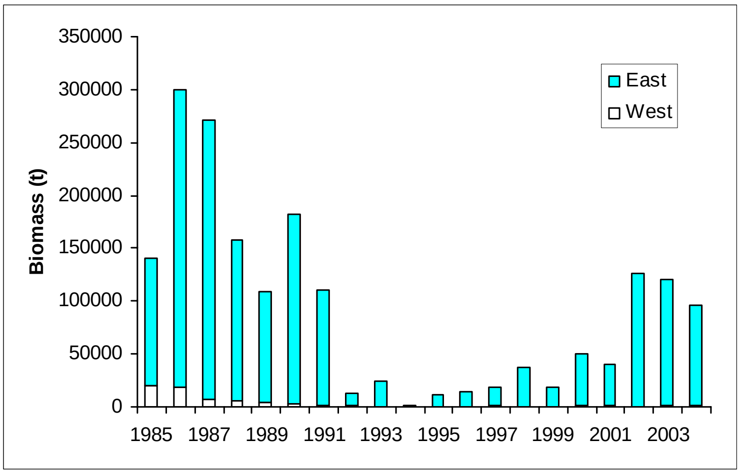


Figure 8.2.10 *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland from the German groundfish survey1985-2004.

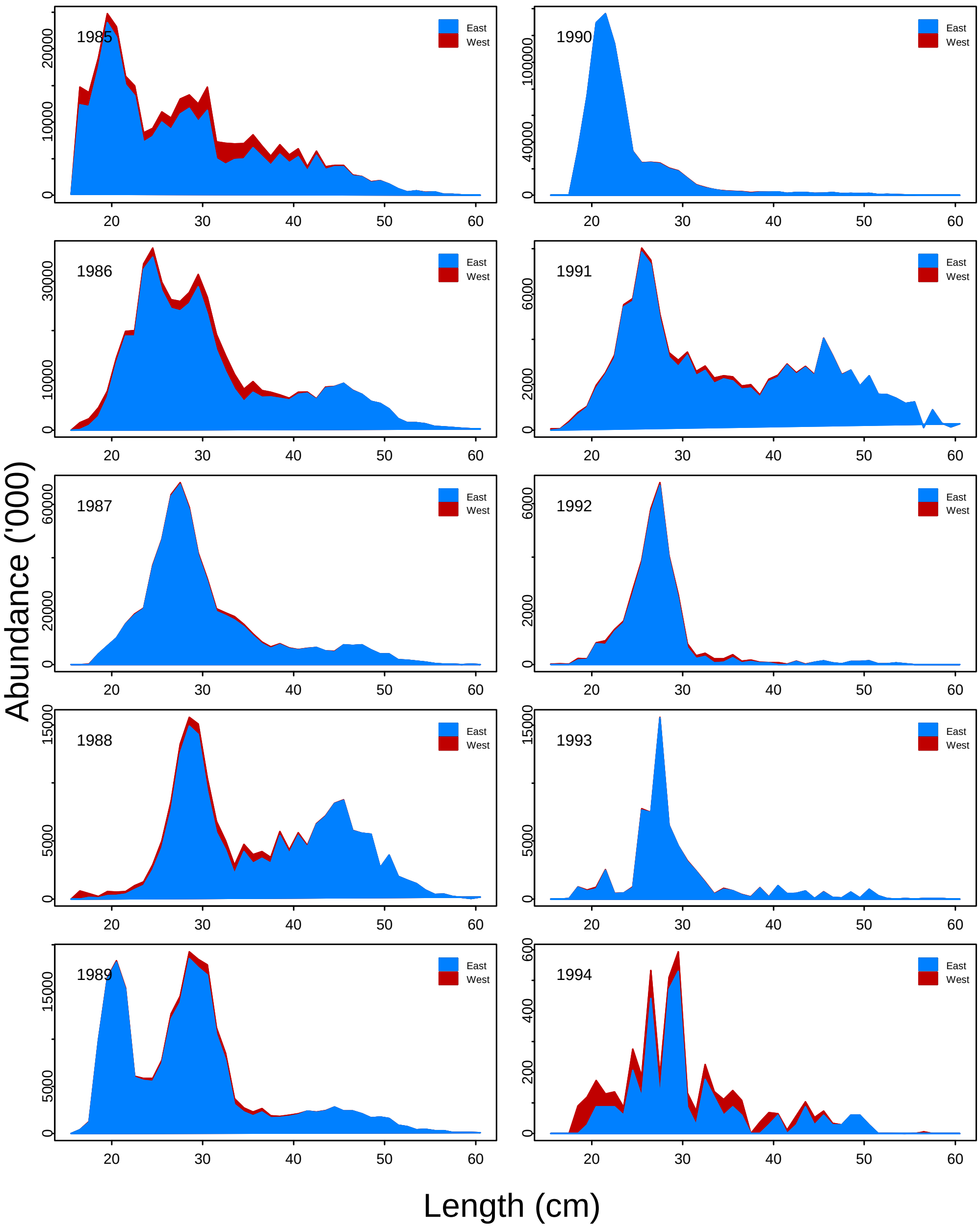


Figure 8.2.11 *S. marinus* (>17 cm). Length frequencies for East and West Greenland 1985-1994.

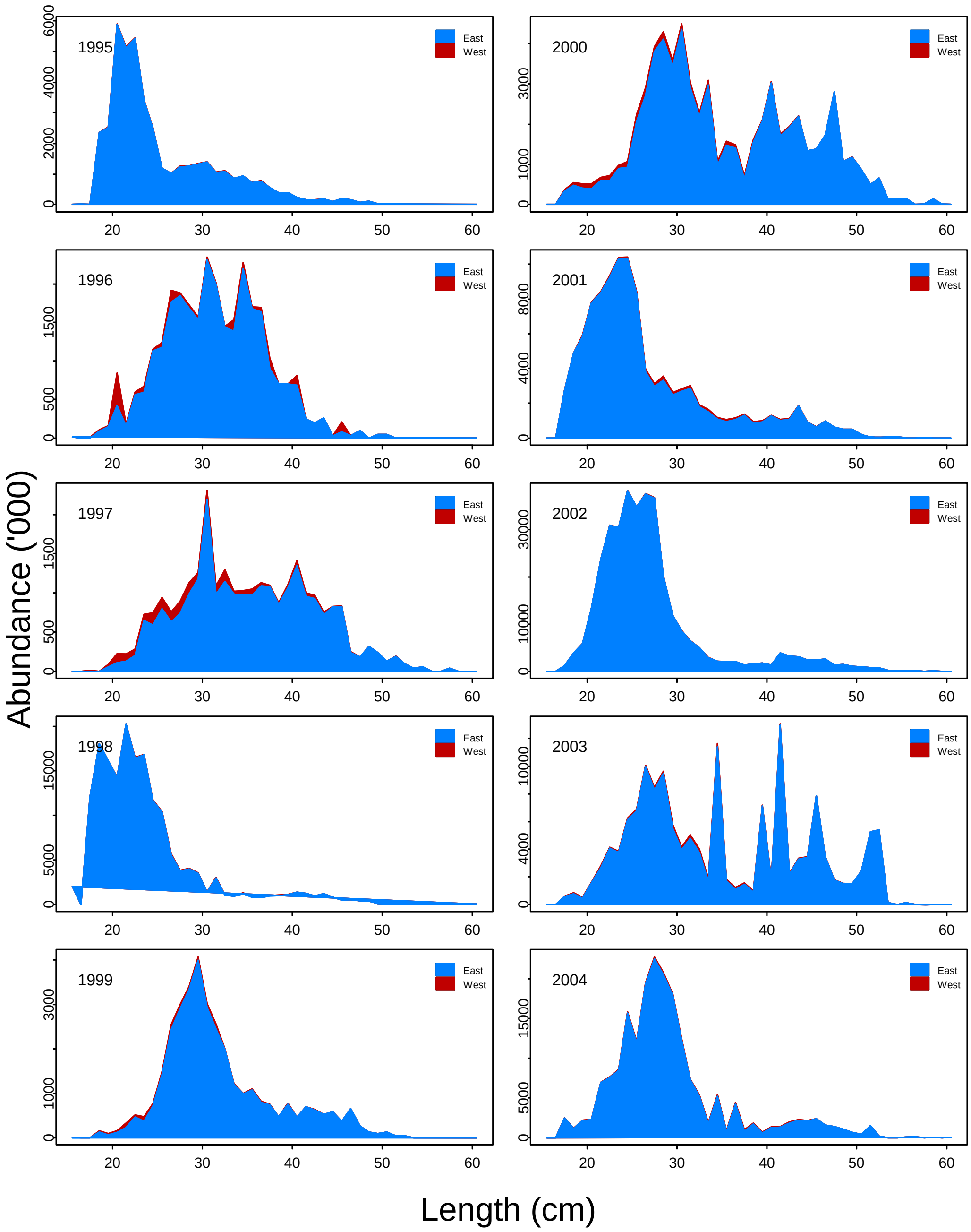


Figure 8.2.11 **Continued.** ***S. marinus*** **(>17 cm). Length frequencies for East and West Greenland 1995-2004.**

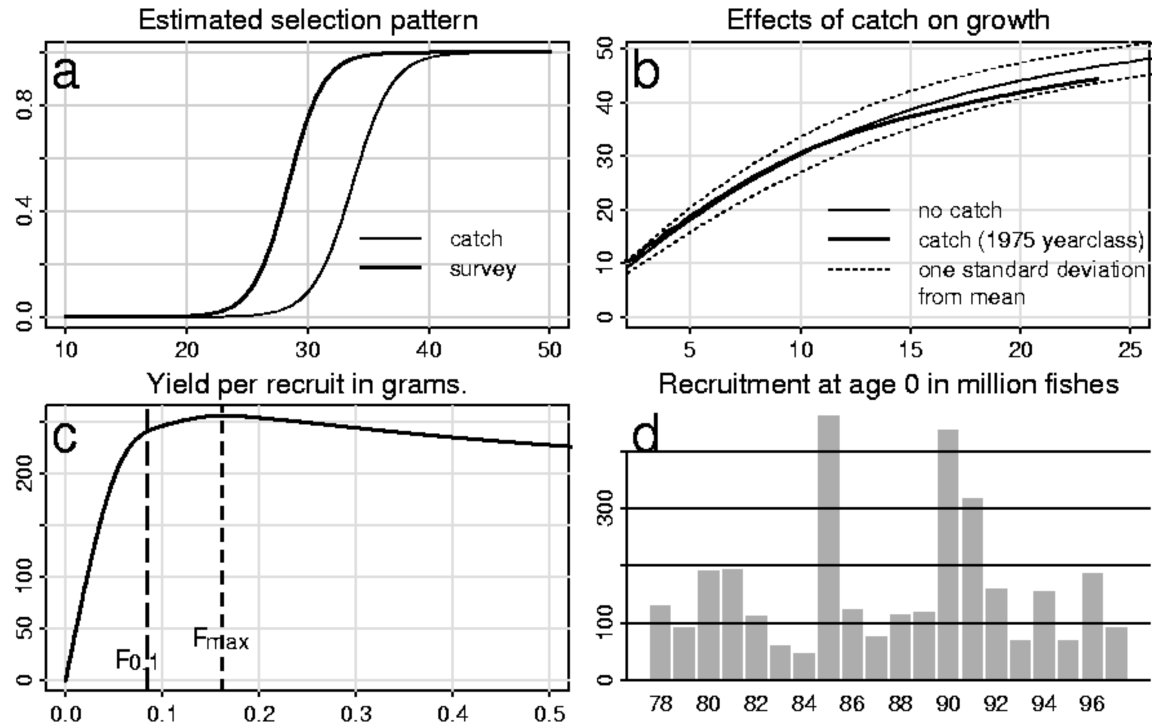


Figure 8.2.12 Results from the BORMICON model-BASE CASE, using catch data from ICES Division Va. a) Estimated selection pattern of the commercial fleet and the survey, b) Mean length (the Figure also demonstrates the effect of catch on length-at-age), c) Yield-per-recruit, and d) Estimated recruitment at age 0.

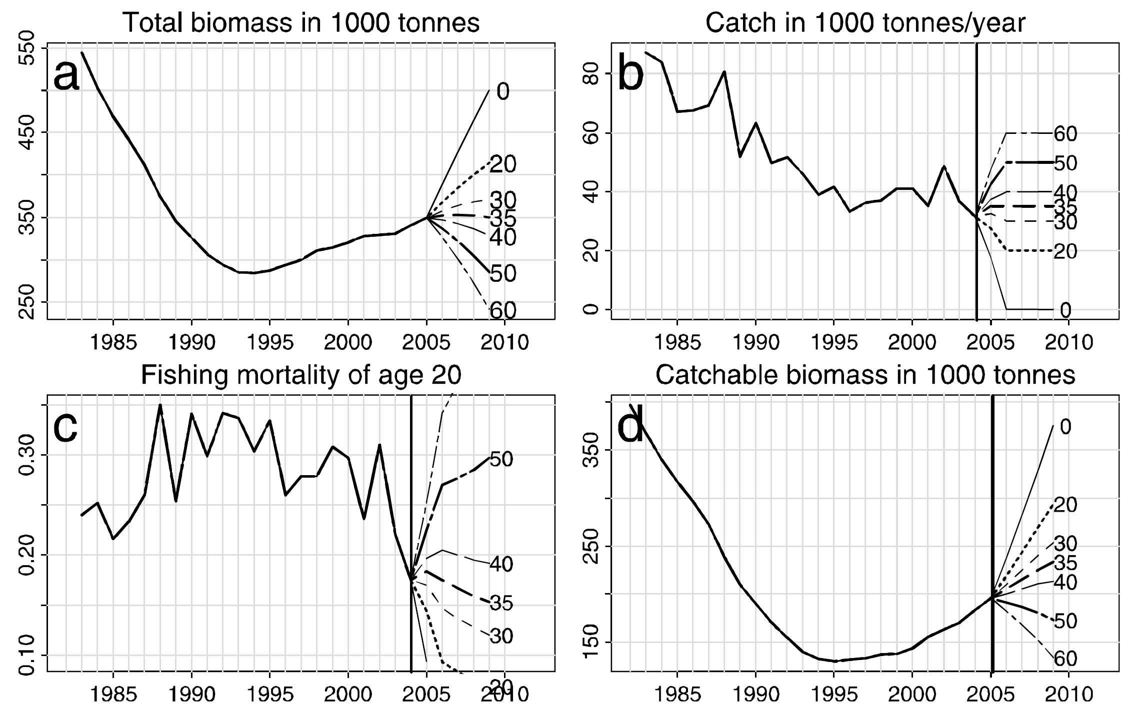


Figure 8.2.13 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different catch options (0-60 000 t) after 2004.

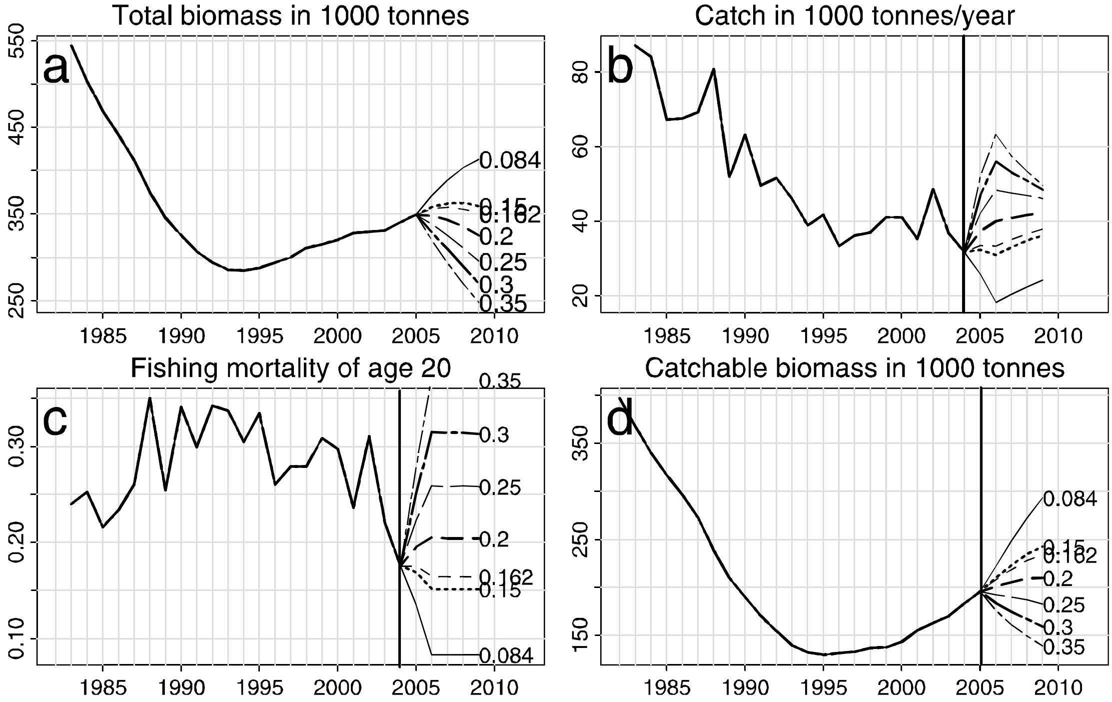


Figure 8.2.14 Results from the BASE CASE run, using catch data from ICES Division Va. The Figures show the development of biomass and F, using different effort after 2004.

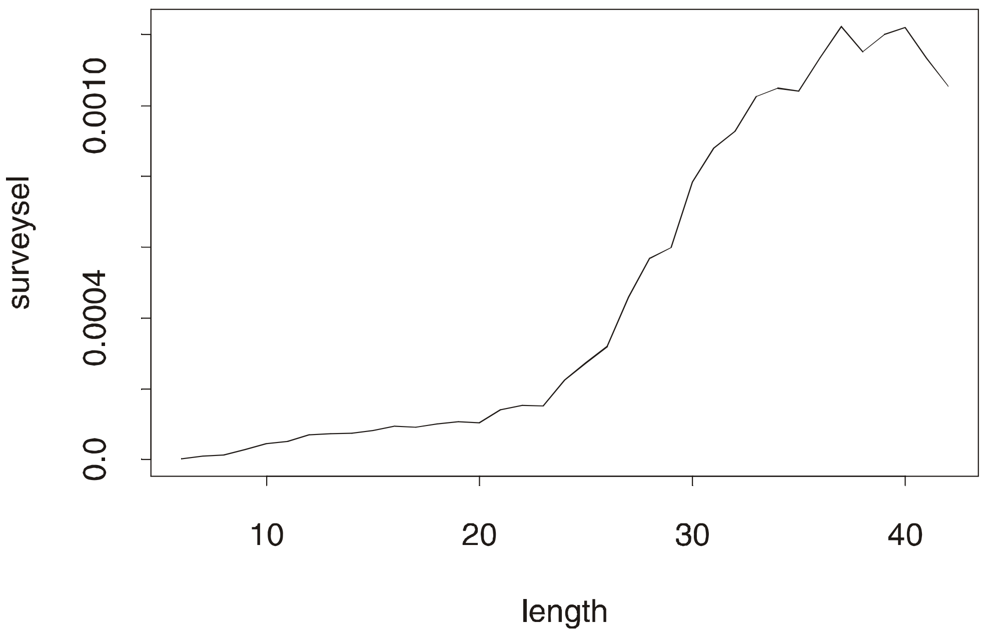


Figure 8.2.15 Estimated selection pattern as a function of length from the BASE CASE for *S. marinus* in the Icelandic groundfish survey.

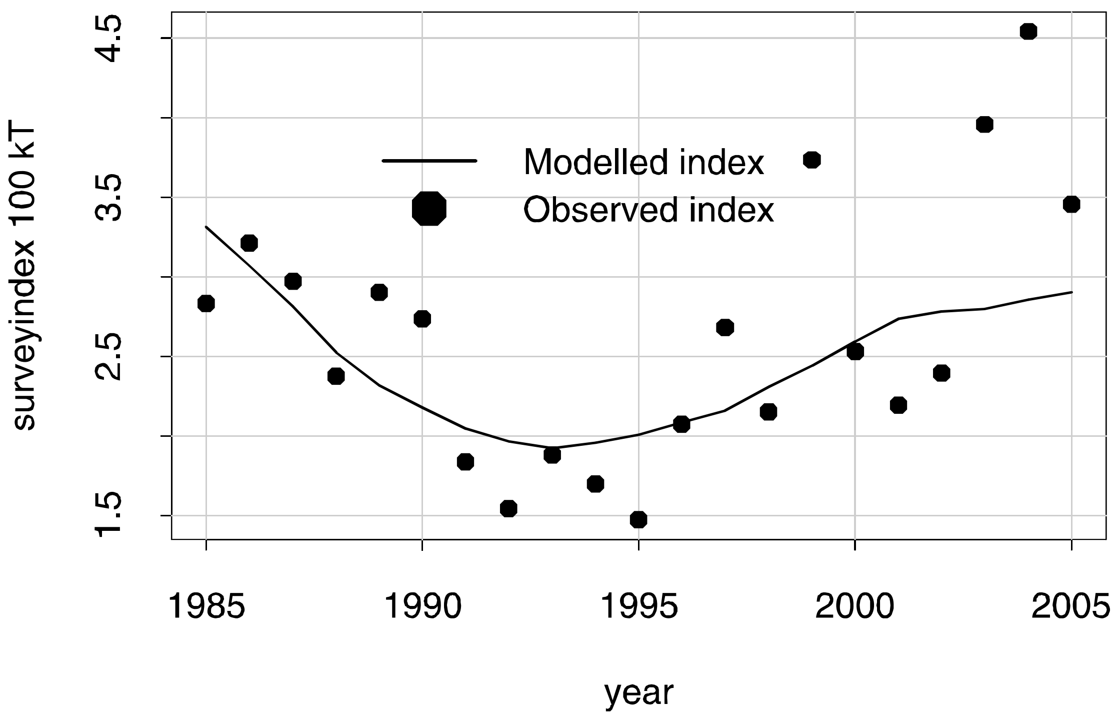


Figure 8.2.16 Results from the BASE CASE run, using only catch data from ICES Division Va. The Figure show comparison of observed and modelled survey biomass (total biomass).

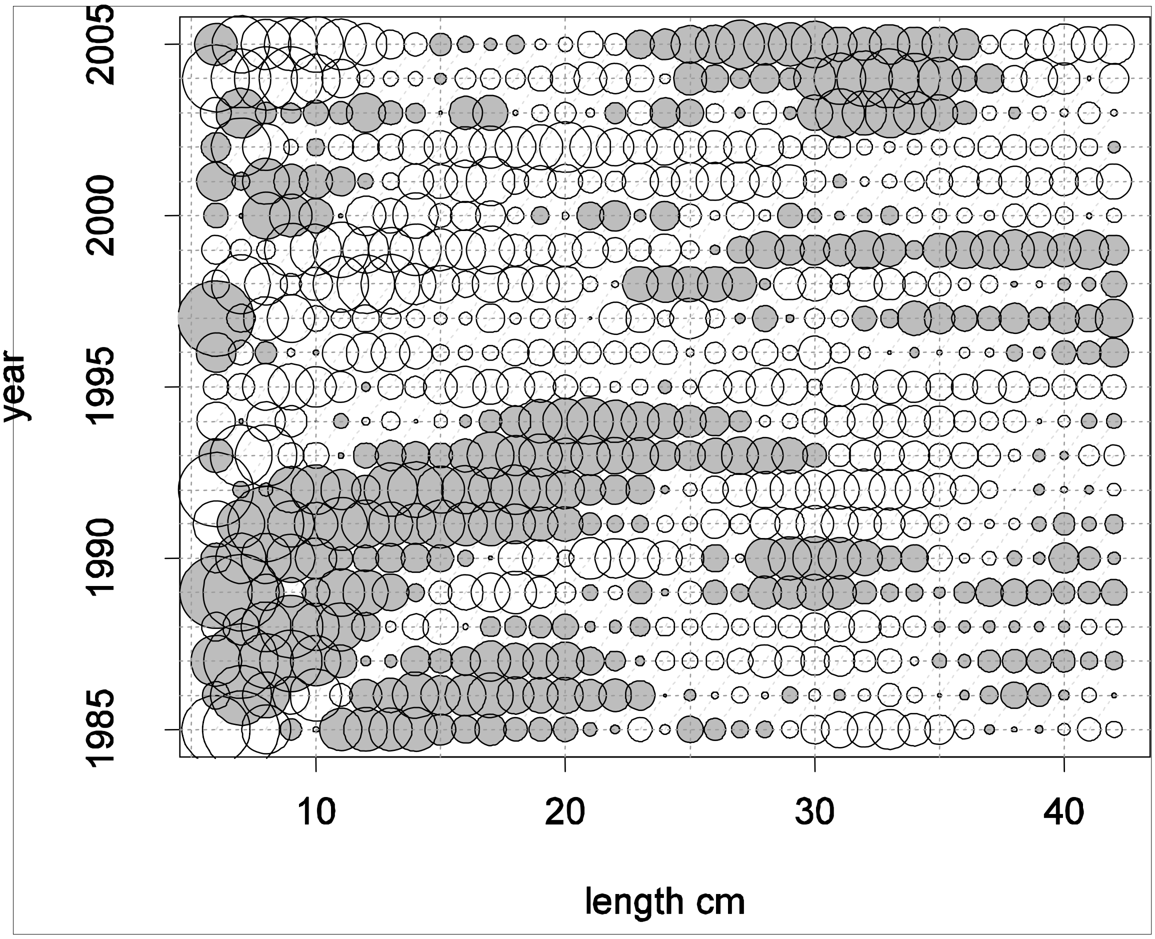


Figure 8.2.17 Results from the BASE CASE run, using catch data from ICES Division Va. Residuals from fit to survey data log(Isur/Imod). The shaded circles show positive residuals (survey results exceed model prediction).

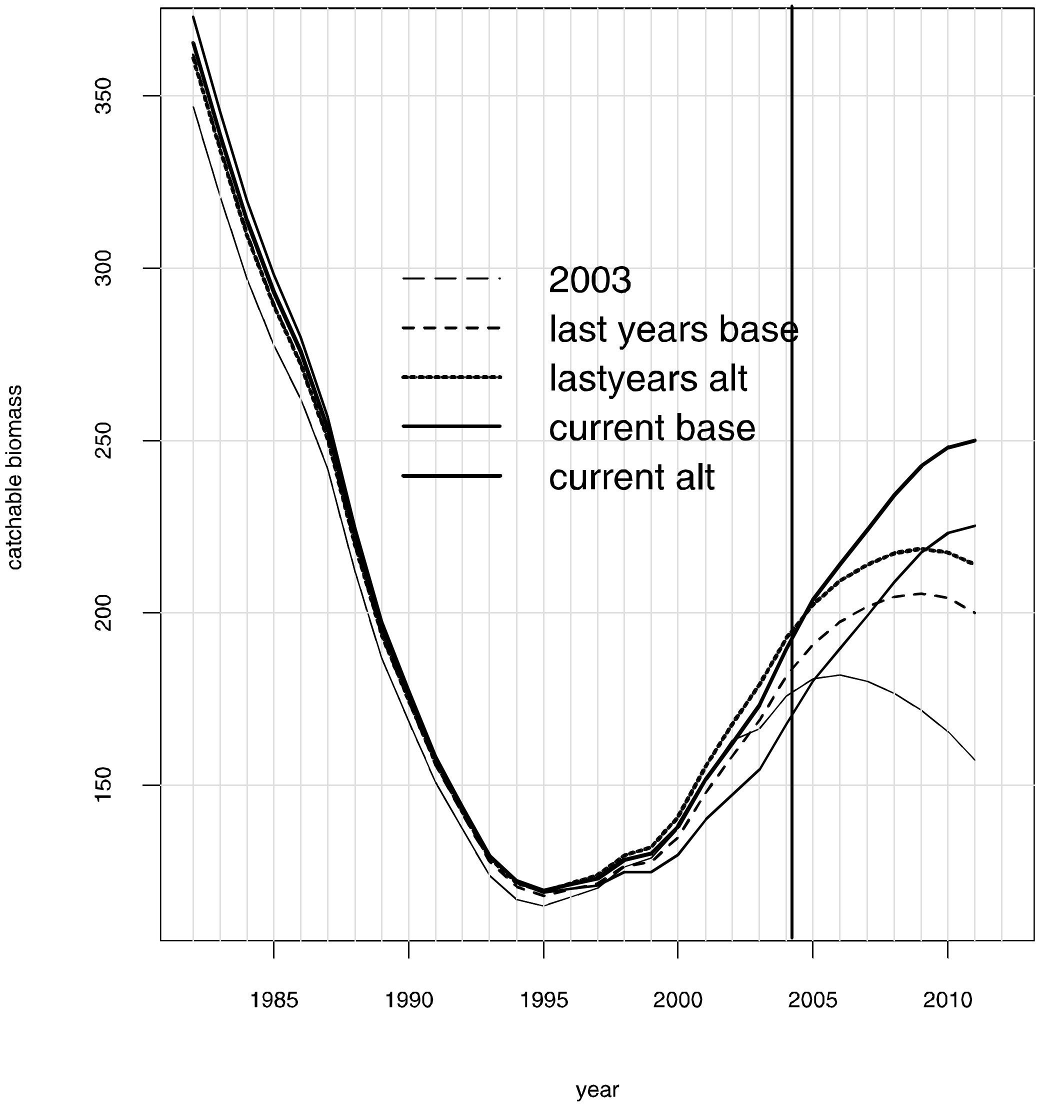


Figure 8.2.18 Comparison of catchable biomass (in thousand tonnes) using the data obtained now and last year, for same settings. Results are obtained using only the catch history from ICES Division Va.

9 DEMERSAL *SEBASTES MENTELLA* ON THE CONTINENTAL SHELF

Demersal *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 (pelagic *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 demersal *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 2001 and 2002 annual landings were 24 000 t. Landings in 2003 increased by about 7 000 t from 2002 and was mainly due to increased landings from Va. Landings in 2004 were 22 000 t, which was the lowest landings recorded since 1978.

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. Landings in 2003 increased by an amount of 10 000 t and to 28 500 t, but decreased again in 2004 to 18 000 t (Table 9.1.1 and Figure 9.1.1). Most of the catches are taken by bottom trawlers along the shelf west, southwest, and southeast of Iceland at depths between 500 and 800 m (Figure 9.1.2). The fraction of demersal *S. mentella* catches taken by pelagic trawls has been varying since 1993, ranging between 0% in 2004 and 23% in 1994 (average 12%). The catches in the third and fourth quarter of the year decreased considerable in 2001 and 2002 compared with earlier years (Figure 9.1.3). The reason for this decrease seems to be associated with decreased effort at that time of the year. The catch pattern by month changed considerably in 2003. The catches peaked in July, which was unusual compared with other years (Figure 9.1.3). This pattern is probably associated with the pelagic *S. mentella* fishery within the Icelandic EEZ (see Figure 10.1.3). The pelagic *S. mentella* fishery has in recent years moved more northwards, and in 2003 it merged with the demersal *S. mentella* fishery on the redfish line in July (Figure 10.1.4). When the pelagic *S. mentella* crossed the redfish line it was recorded as demersal *S. mentella* and caught with bottom trawls resulting in increased landings in 2003 (Figures 10.1.5 and 10.1.6). The catches in the third and fourth quarter of 2004 are similar as in 2001 and 2002. Length distributions of demersal *S. mentella* from the bottom trawl fishery show an increase in the number of small fish in the catch 1994-2003 compared to 1989-1993 (Figure 9.1.4). A peak of about 32 cm in 1994 can been followed by approximately 1 cm annual growth in 1996-2002. The fish caught in 2004 peaked around 37 cm and are on average bigger than in 2003.

In Division Vb, landings of demersal *S. mentella* were 4 000 t in 2004, which is a considerable increase compared to 2002 and 2003 (Table 9.1.1 and Figure 9.1.1). The record high was reported in 1986 as 15 000 t. Length distributions from the landings in 2001-2003 indicate that the fish caught are on average larger than 40 cm (Figure 9.1.5).

In Subarea VI, the annual landings varied between 200 t and 1 100 t in 1978-2000 (Table 9.1.1 and Figure 9.1.1). The landings from VI in 2004 were negligible and only 6 t were landed, which is the lowest recorded since 1978.

In Subarea XIV, the annual demersal *S. mentella* landings have 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 in 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 9.1.6). There was very little demersal *S. mentella* fishery in XIV in 2003 and 2004, and 348 t and 38 t were landed from that area, respectively.

The table below shows the 2004 biological sampling from the catch and landings of demersal *S. mentella* from the continental selves divided by ICES Division and nation. No biological samples were taken in sub-area XIV in 2004.

Area	Nation	Landings	Nos. samples	Nos. fish measured
Va	Iceland	17,883	110	18,687
Vb	Faeroe Islands	3,931	16	3,166

9.2 Assessment

9.2.1 CPUE indices

Data used to estimate CPUE for demersal *S. mentella* in Division Va 1986-2004 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 (generalized linear models). 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 9.1.7). From 1995 to 2000, CPUE slightly increased annually, but has since then been fairly stable. From 1991 to 1994, when CPUE decreased, the fishing effort increased drastically. From 1995 effort decreased between 10% and 20% each year to 2001. Since 2001 the effort has varied. ICES recommended 25% annual reduction in fishing effort during the same time period. Effort increased by about 12% between 2001 and 2002, by about 40% between 2002 and 2003, but decreased by about 35% between 2003 and 2004.

Non-standardized CPUE indices in Division Vb for demersal *S. mentella* were obtained from the Faeroese otterboard (OB) trawlers > 1000 HP towing deeper than 450 m and where dermersal *S. mentella* composed at least 70% of the total catch in each tow. The OB trawlers have in recent years landed about 50% of the total demersal *S. mentella* landings from Vb. CPUE for the OB trawlers decreased from 500 kg/hour in 1991 to of 300 kg/hour in 1993 and has, since then, been at this level (Figure 9.1.8). Fishing effort decreased between 2001 and 2003, but increased in 2004.

Non-standardized CPUE data from Division XIV were available from 1998 to 2002 when the German fleet fished for *S. mentella* by Germany along the continental slope of East Greenland. CPUE decreased between 1998 and 1999, but increased since then annually. No CPUE and effort data were available from sub-area XIV in 2003 and 2004, as there was no effort exerted by the German fleet.

9.2.2 Survey indices

The German survey conducted on the continental shelf of West and East Greenland since 1985 cover only the distribution of juvenile demersal *S. mentella* (recruits). The results indicate that juveniles are most abundant off East Greenland, while a negligible part of juveniles is distributed off West Greenland (Figure 9.2.1). Figure 9.2.1 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 and biomass in 2003 and 2004 further recruiting year-classes (Figures 9.2.2 and 9.2.3). The juveniles observed at East and West Greenland will probably recruit to some extent to the demersal stock on the shelves of Greenland, Iceland and Faeroes Islands and partly to the pelagic stock as well (Stransky 2000). Juvenile demersal *S. mentella* are not observed in the spring and autumn surveys in Icelandic waters and in the surveys conducted in Faeroese waters.

The Greenland halibut survey conducted on the continental shelf and slope of East Greenland 1998-2004 covers depths from 400 m down to 1 500 m (WD 11). Although relatively short survey series the trends in abundance and biomass have varied with the highest estimates in 1999 and lowest in 2002 (Figure 9.2.4). The highest densities are at depth stratum 401-600 m with the remaining densities at depth stratum 600-800 m. The length distribution in 2002-2004 are dominated by 20-25 cm fish (Figure 9.2.4) and length increases both by depth and from north to south.

The Icelandic autumn survey on the continental shelf and slope in Va 2000-2004, covering depths down to 1200 m, shows that the fishable biomass index of demersal *S. mentella* increased between 2000 and 2001, but since then there has been a considerable decrease (Figure 9.2.5). Note the large measurement error in 2001. This large measurement error is caused by one tow accounting for a large part of the total amount caught. The biomass index in 2003 was the lowest measured, but the index increased in 2004 and was similar as it was in 2002. Because there may high variance in the estimates and because the time series of the survey is short, it may be difficult use such data to explain any trend in biomass in the short term. The length of the demersal *S. mentella* in the autumn survey is between 30 and 47 cm with a modes ranging between 36-39 cm (Figure 9.2.6).

The Faeroes summer survey in Division Vb shows up to five-fold decrease in the catch rate from 1996 to 2004 or from about 10 kg/hour to about 2 kg/h (except in 1999 when the catches were over 10 kg/h) (Figure 9.2.7). The spring survey in the same area has varied more between 1994 and 2005 ranging between 2 kg/h and 6 kg/h (Figure 9.2.7). However, the surveys are mainly designed for species inhabiting depths down to 500 m and do not cover the entire vertical distribution of demersal *S. mentella*.

9.3 State of the stock

The Group concludes that the state of the stock is stable on a low level. With information at hand, current exploitation rates can not be evaluated for the demersal *S. mentella* sub-areas V and XIV.

The fishable biomass index of *S. mentella* in Va from the Icelandic autumn survey shows that the biomass index for 2002-2004 has been relatively stable on a lower level than in earlier years. In Division Vb, there is no reliable survey information available on fishable biomass. In sub-area XIV, the Greenlandic survey designed for Greenland halibut suggests stable demersal *S. mentella* biomass in survey period 1998-2004. Standardised CPUE indices in Division Va show a reduction from highs in the late 1980s, but there is an indication that the stock has started a slow recovery since the middle of 1990s, when CPUE was close to 50% of the maximum. The CPUE index has been increasing since 1995. In Division Vb development in CPUE resembles that in Division Va, i.e., the CPUE have stabilised close to the 50% of the maximum in the time series.

Recently, good recruitment has been observed on the East Greenland shelf (growth of about 2cm/yr) which is assumed to contribute to both the demersal and pelagic stock at unknown shares.

9.4 Biological reference points

There are no biological reference points for the species. Previous reference points established were based upon commercial CPUE indices, but are now considered to be unreliable indicators of stock size. ICES has withdrawn these reference points.

9.5 Management considerations

S. mentella is a slow growing, late maturing deep-sea species and is therefore considered vulnerable to overexploitation and advice has to be conservative.

The CPUE has been stable on a low level during recent years. It is, however, not known to what extent CPUE series reflect change in stock status of demersal *S. mentella*. The fishery is focusing on aggregations.

The landings decreased in Division Va between 2003 and 2004 by about 10 000 t and were considerable lower than the set quota of 22 000 t. The likely explanation for this decrease in the demersal *S. mentella* fishery and not fishing out the set quota is due to decreased effort. .

It should be noted that Icelandic authorities give a joint quota for *S. marinus* and *S. mentella*. The working group reiterates its recommendation 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.

Bycatches of juvenile demersal *S. mentella* in the shrimp fishery off East Greenland can not be quantified at present but are assumed to be considerably high (see chapter 7.3). The Working Group recommends, however, a maximum protection of the juveniles in Division XIV.

Table 9.1.1 Nominal landings (tonnes) of demersal *S. mentella* on the continental shelf and slopes 1978-2004, divided by ICES Division.

	ICES Division					
Year	Va	Vb	VI	XII	XIV	Total
1978	3 902	7 767	18	0	5 403	17 090
1979	7 694	7 869	819	0	5 131	21 513
1980	10 197	5 119	1 109	0	10 406	26 831
1981	19 689	4 607	1 008	0	19 391	44 695
1982	18 492	7 631	626	0	12 140	38 889
1983	37 115	5 990	396	0	15 207	58 708
1984	24 493	7 704	609	0	9 126	41 932
1985	24 768	10 560	247	0	9 376	44 951
1986	18 898	15 176	242	0	12 138	46 454
1987	19 293	11 395	478	0	6 407	37 573
1988	14 290	10 488	590	0	6 065	31 433
1989	40 269	10 928	424	0	2 284	53 905
1990	28 429	9 330	348	0	6 097	44 204
1991	47 651	12 897	273	0	7 057	67 879
1992	43 414	12 533	134	0	7 022	63 103
1993	51 221	7 801	346	0	14 828	74 196
1994	56 720	6 899	642	0	19 305	83 566
1995	48 708	5 670	536	0	819	55 733
1996	34 741	5 337	1 048	0	730	41 856
1997	37 876	4 558	419	0	199	43 051
1998	33 125	4 089	298	3	1 376	38 890
1999	28 590	5 294	243	0	865	34 992
2000	31 393	4 841	885	0	986	38 105
2001	17 230	4 696	36	0	927	23 889
2002	19 045	2 552	20	0	1 903	23 520
2003	28 478	2 114	197	0	348	31 137
2004[1)]	17,584	3 931	6	0	38	21 559

1) Provisional

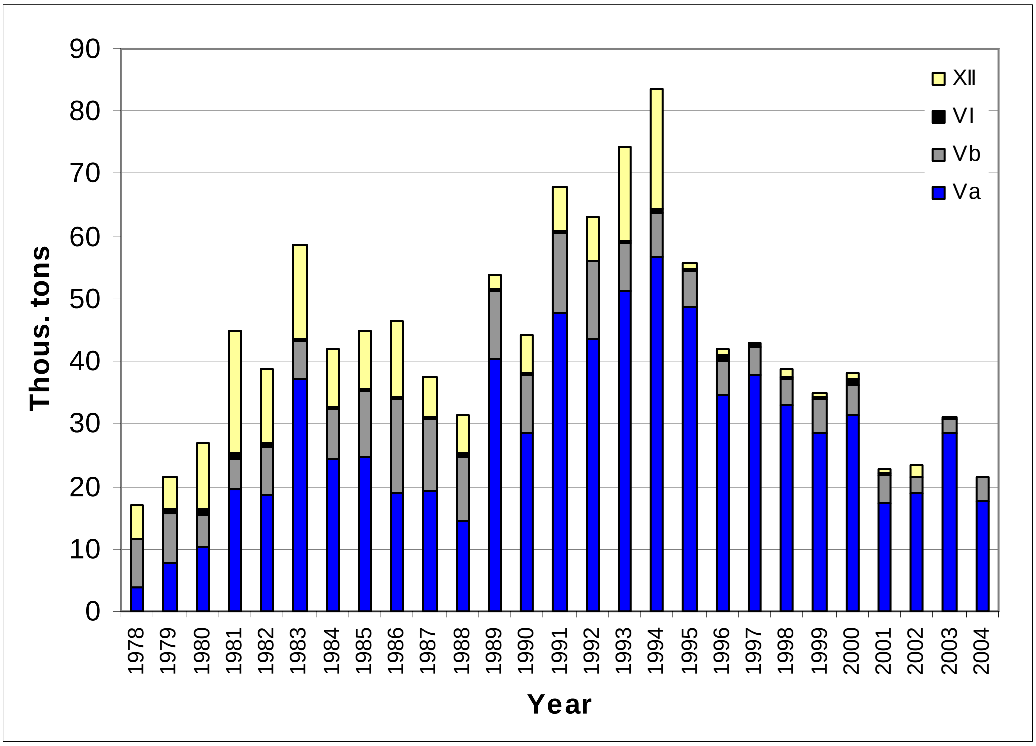


Figure 9.1.1 Nominal landings of demersal *S. mentella* (in tonnes) from ICES Divisions Va, Vb, VI and XIV 1978-2004.

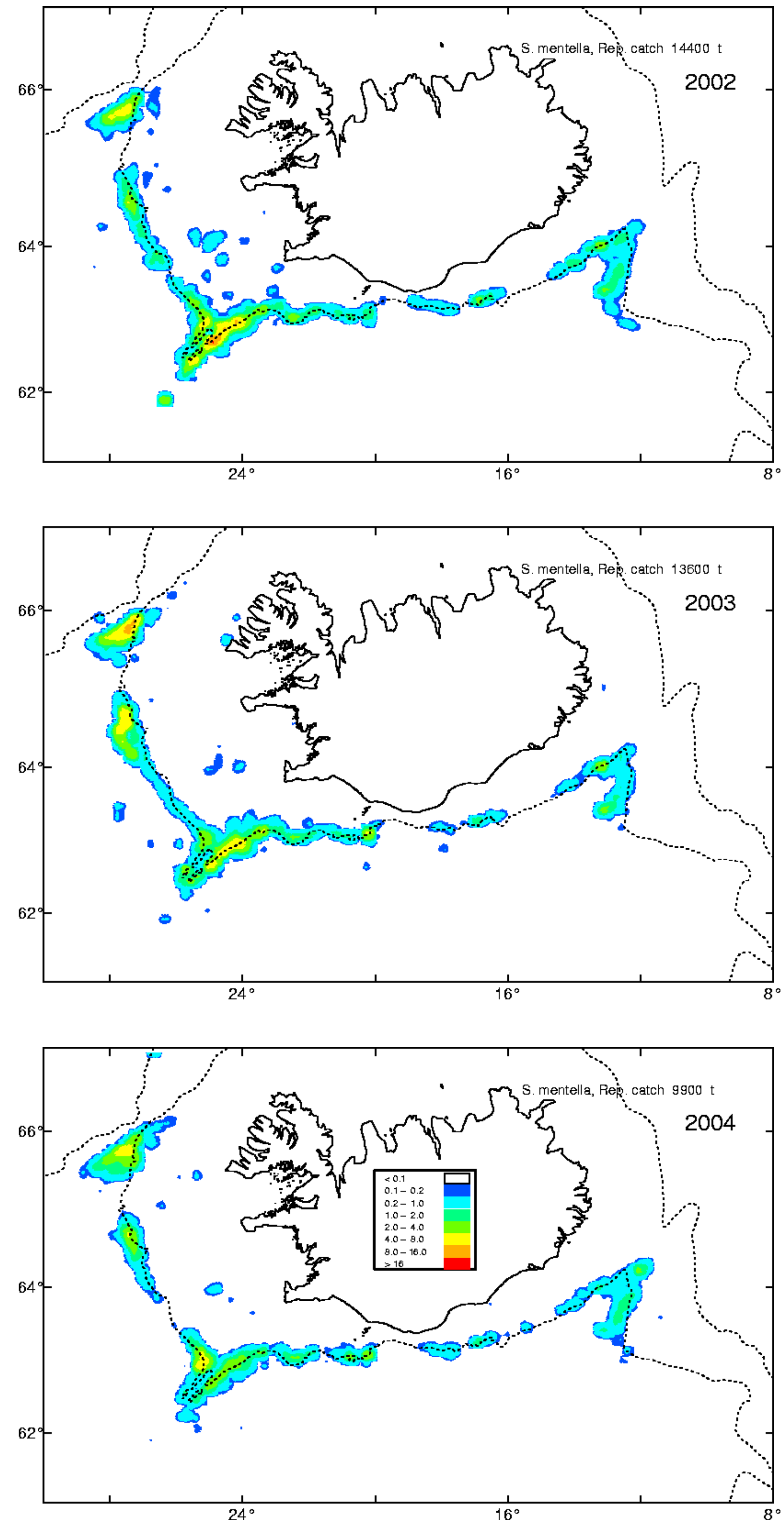


Figure 9.1.2 **Geographical location of the demersal *S. mentella* catches in Icelandic waters 2002-2004 as reported in log-books of the Icelandic bottom trawl fleet. The dotted line represents the 1000 m isobaths.**

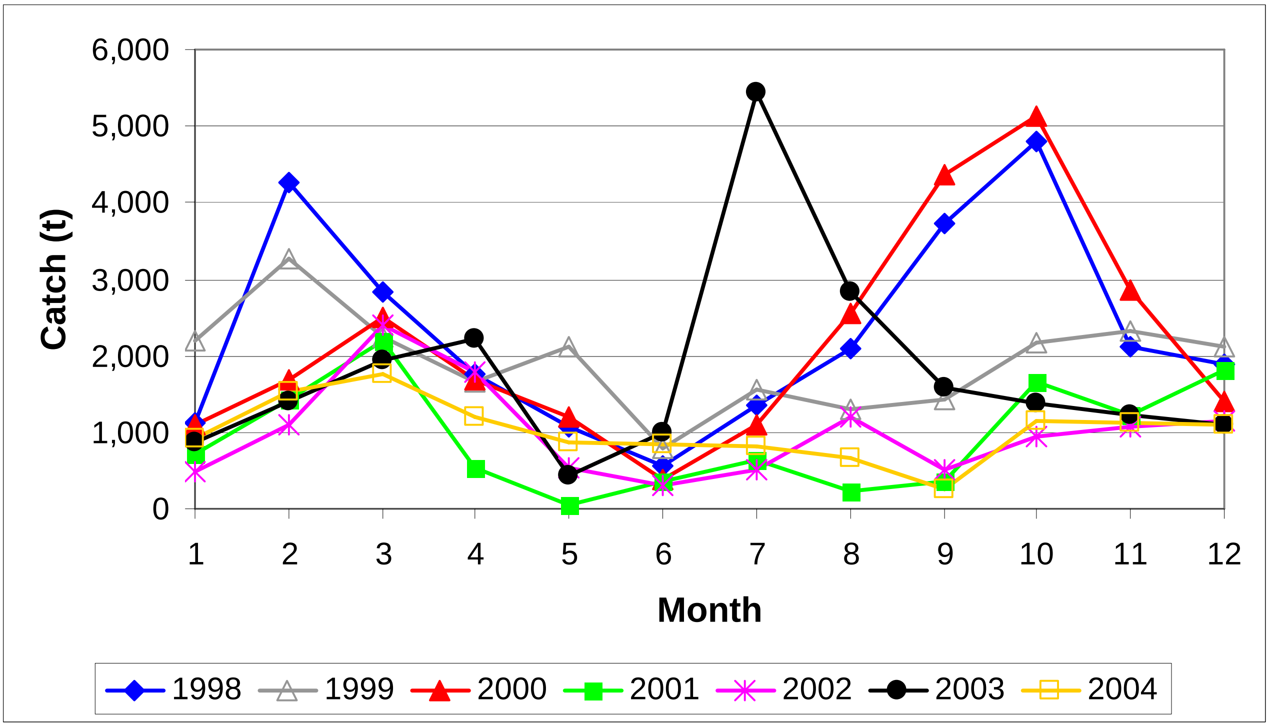


Figure 9.1.3 Nominal landings of demersal *S. mentella* (in tonnes) in Icelandic waters (ICES Division Va) of the Icelandic bottom trawl fleet 1998-2004, divided by month.

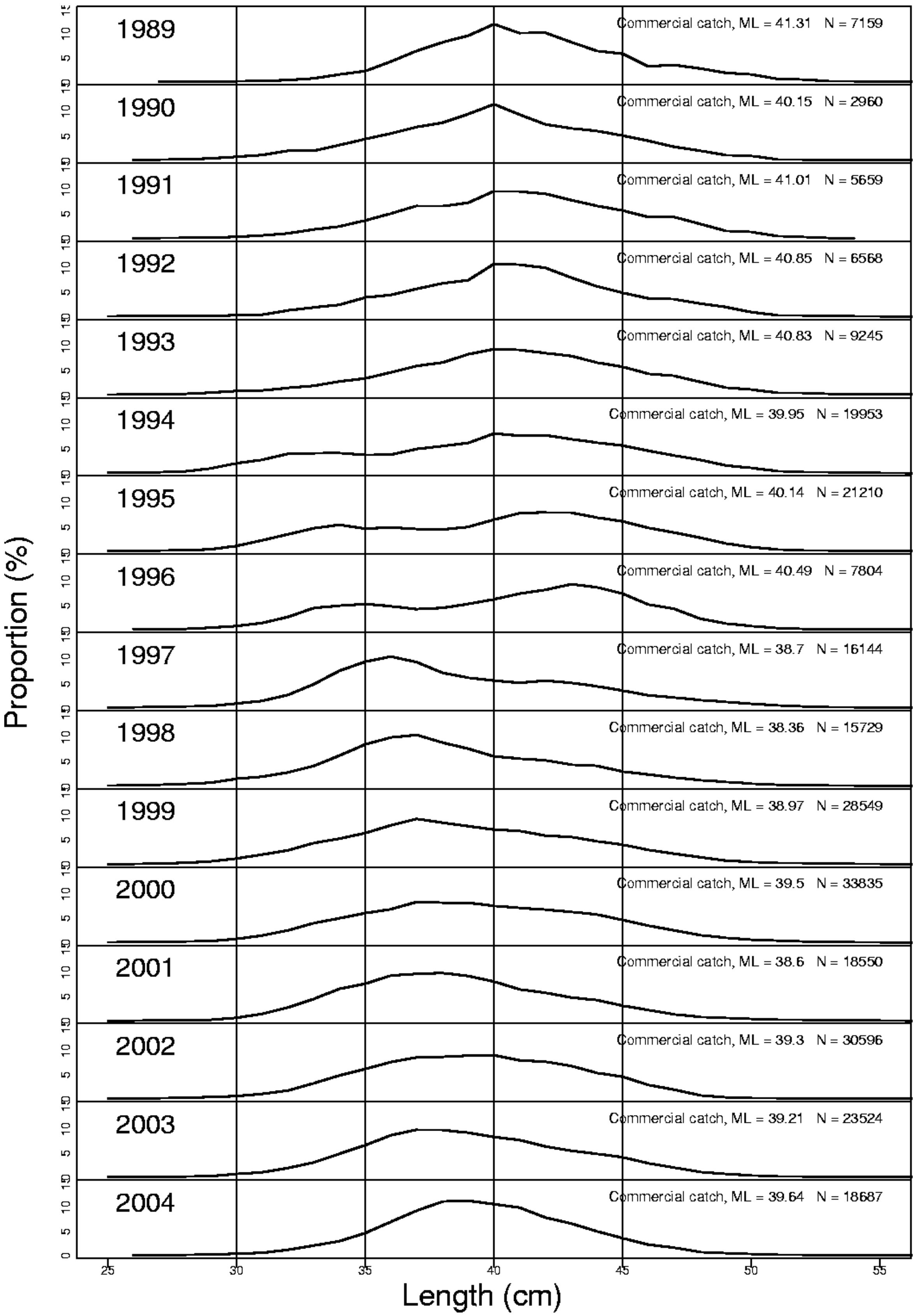


Figure 9.1.4 Length distributions of demersal *S. mentella* from the Icelandic bottom trawl catch and landings in Division Va 1989-2004.

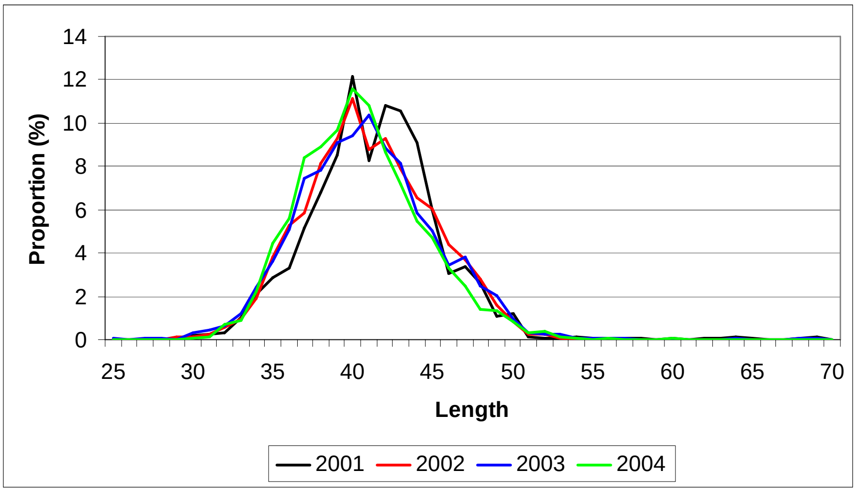


Figure 9.1.5 Length distribution of demersal *S. mentella* from landings of the Faeroese fleet in Division Vb 2001-2004.

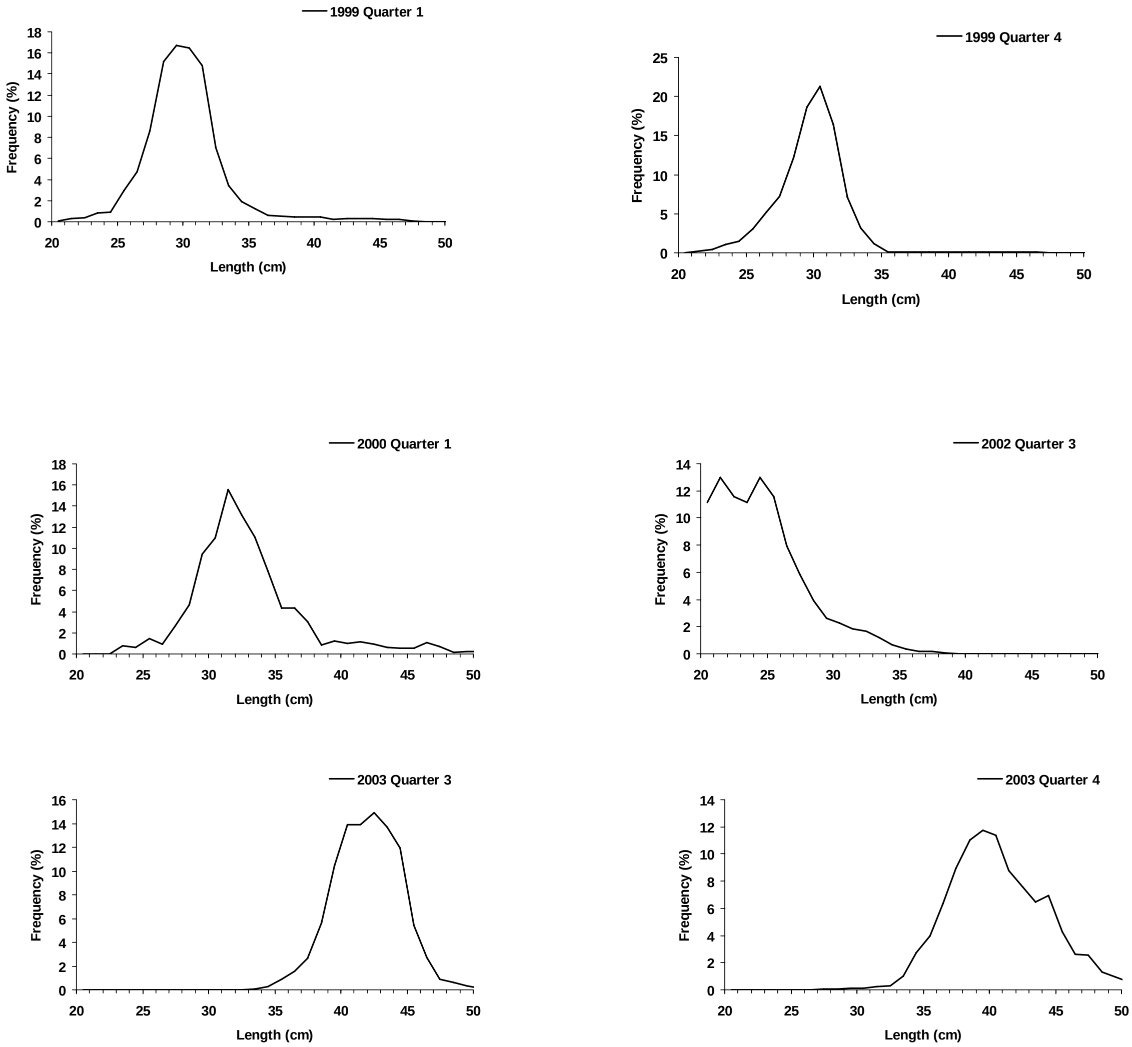


Figure 9.1.6 Length distribution of demersal *S. mentella* of the German commercial landings in Division XIV 1999-2003, divided by quarters.

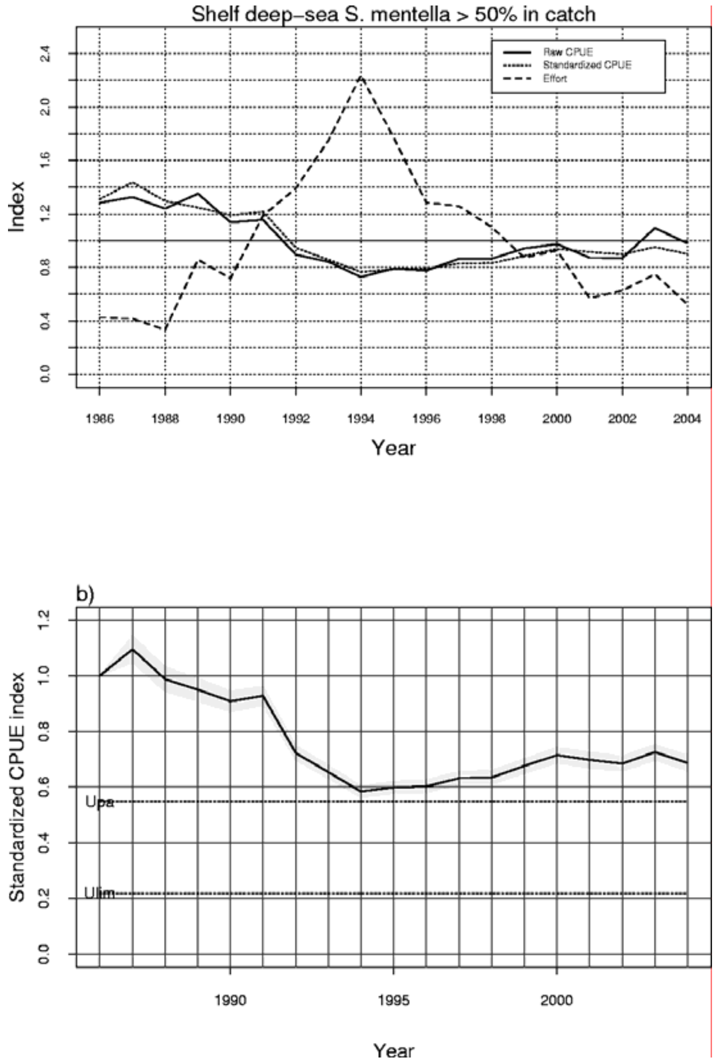


Figure 9.1.7 CPUE indices, relative to 1986, of demersal *S. mentella* from the Icelandic bottom trawl fishery in Division Va. The CPUE indices are based on a GLM model, based on data from log-books and where at least 50% of the total catch in each tow was demersal *S. mentella*. Also shown is the fishing effort.

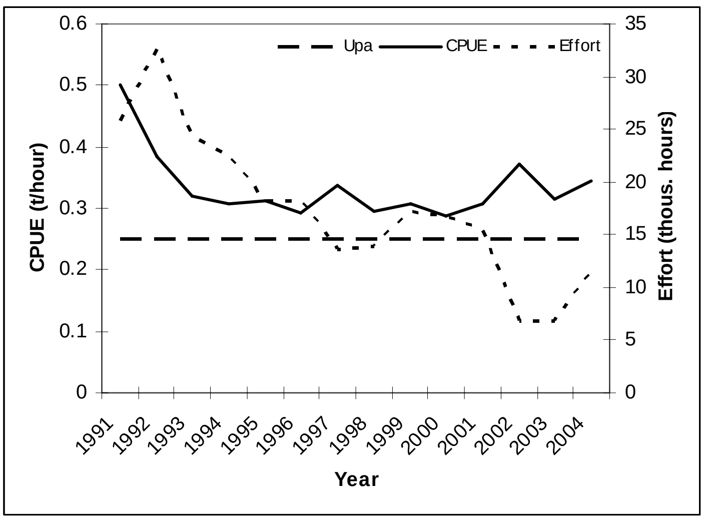


Figure 9.1.8 Demersal *S. mentella..* CPUE (t/hour) and fishing effort (in thousands hours) from the Faeroese CUBA fleet 1991-2004 and where 70% of the total catch was demersal *S. mentella .*

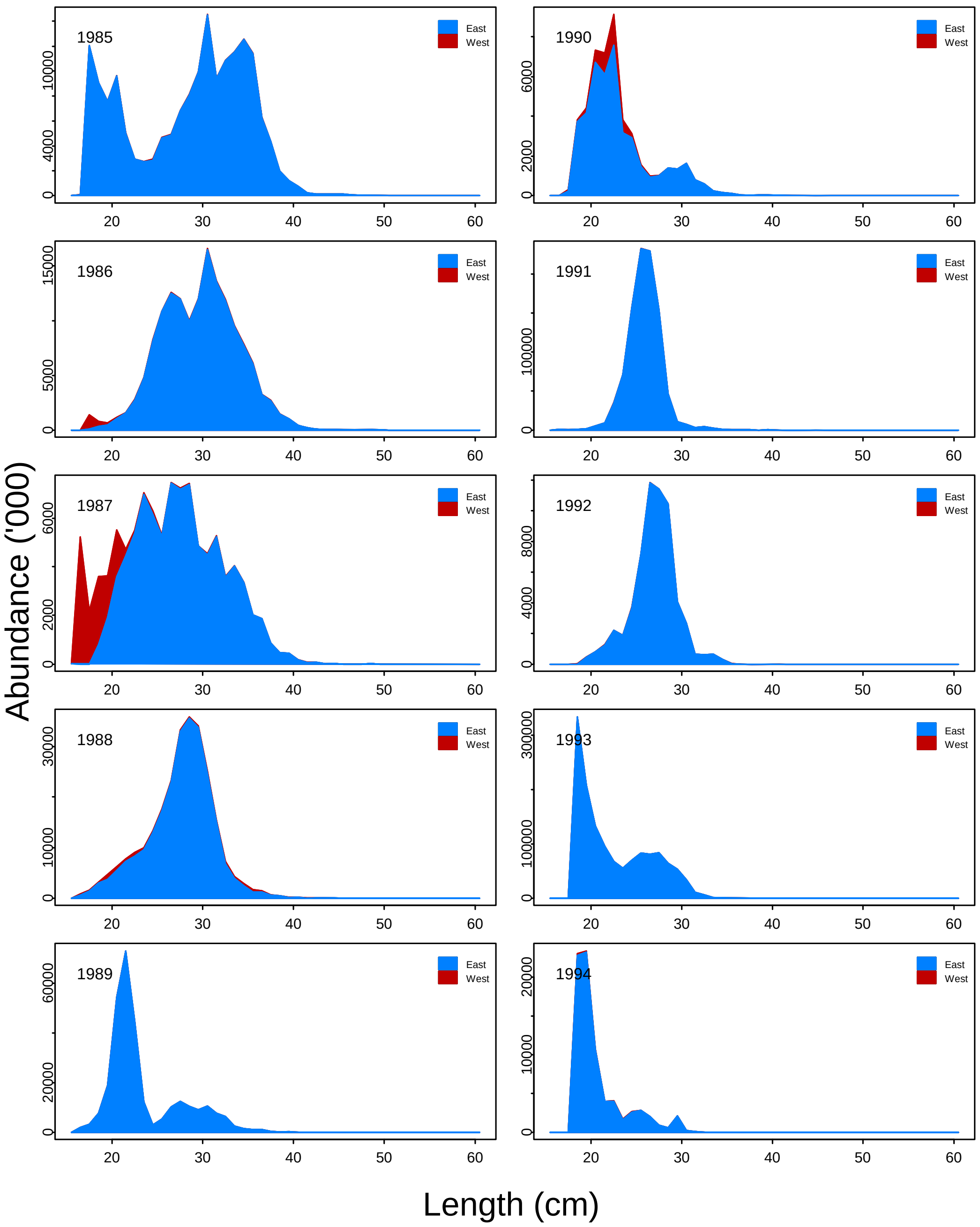


Figure 9.2.1 Demersal *S. mentella* (15-35 cm) on the continental shelves off West- and East-Greenland. Length composition off Greenland is derived from the German and groundfish survey 1985-2004. Note different scale on y-axis.

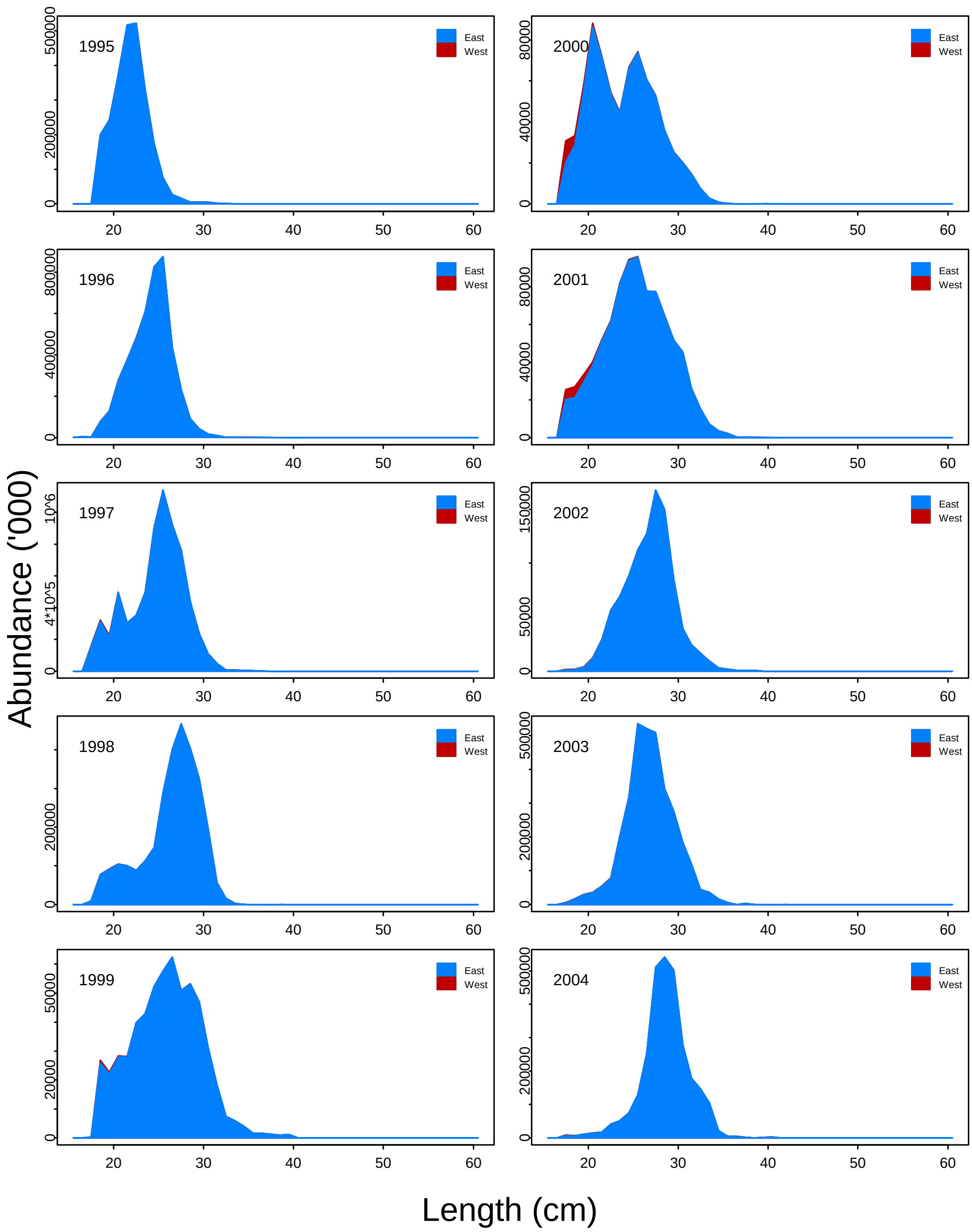


Figure 9.2.1 **Continued.**

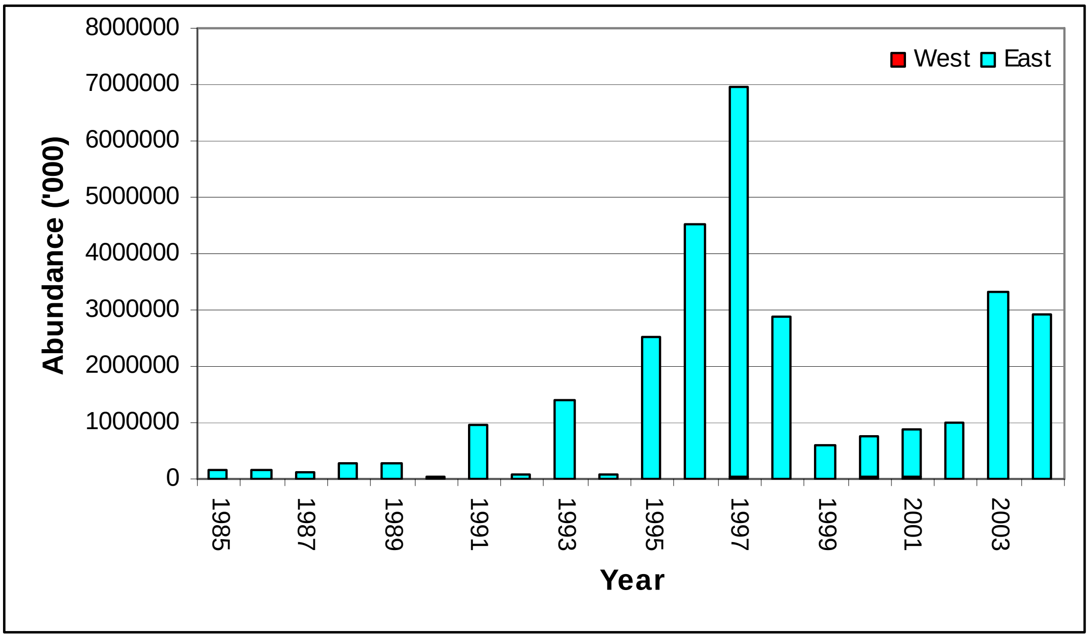


Figure 9.2.2 **Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey abundance indices for East and West Greenland derived from the German groundfish survey 1985–2004.**

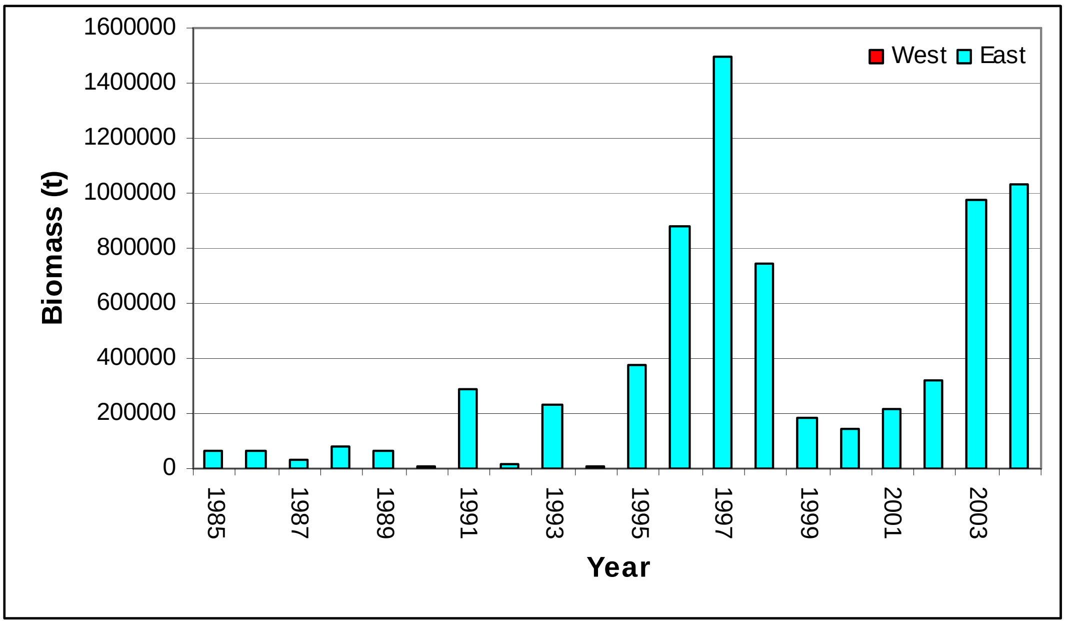
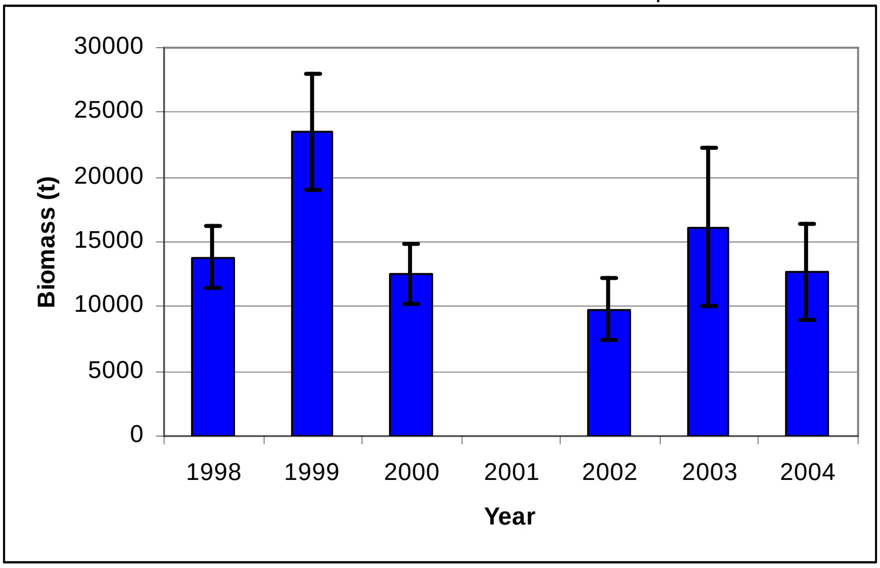
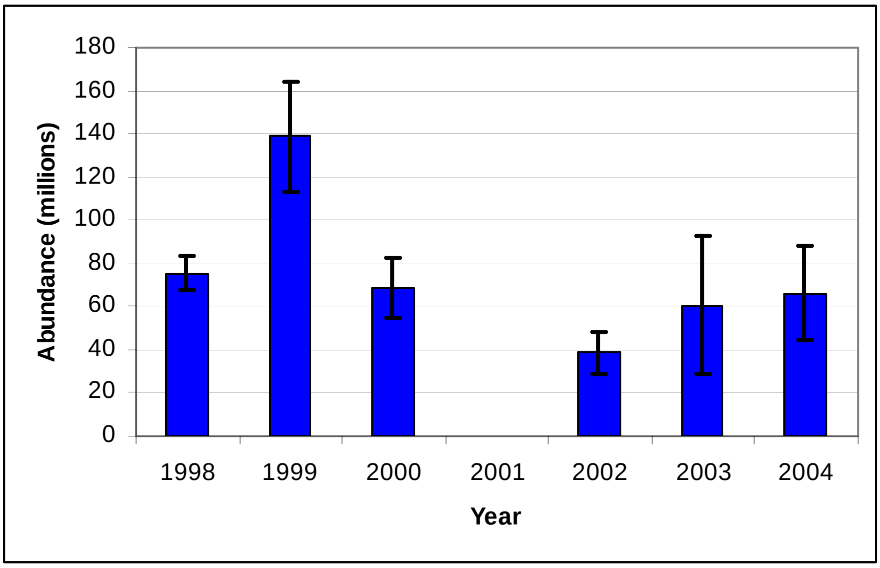


Figure 9.2.3 **Demersal *S. mentella* (>=17 cm) on the continental shelf. Survey biomass indices for East and West Greenland from the German groundfish surveys 1985-2004.**





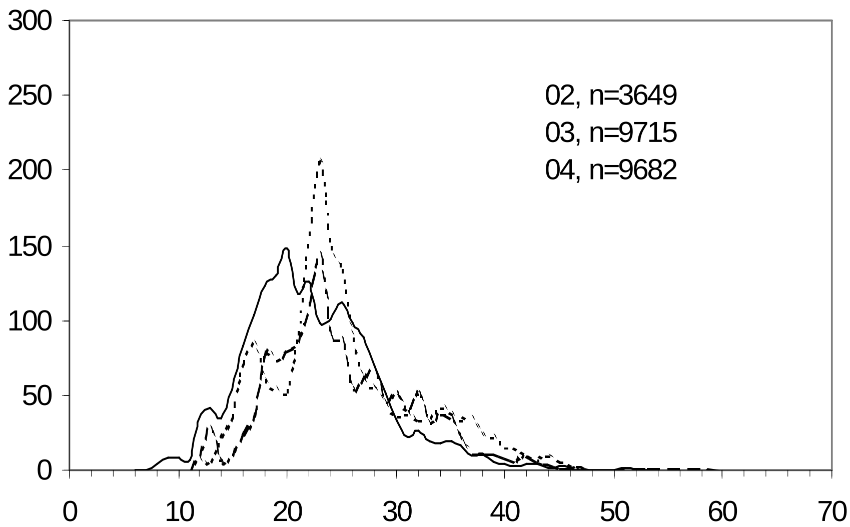


Figure 9.2.4 **Total biomass (top), abundance (middle) estimates and associated standard error of demersal *S. mentella* from the Greenland halibut bottom trawl survey of East Greenland (ICES Division XIV) 1998-2004. No survey was conducted in 2001. Also shown is the overall length distribution (number per km^2) from the same surveys 2002-2004 (bottom). Dashed line 2002, dotted line 2003, and solid line 2004.**

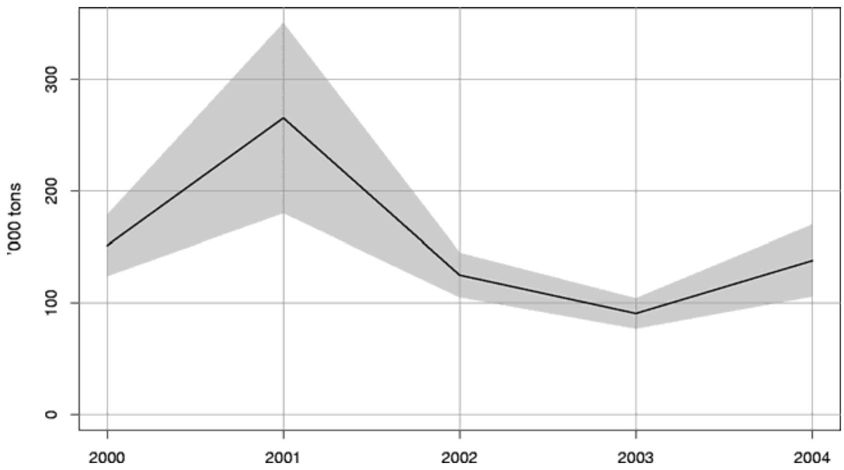


Figure 9.2.5 Total biomass index of the Icelandic shelf demersal ***S. mentella*** in the autumn survey in Division Va 2000-2004.

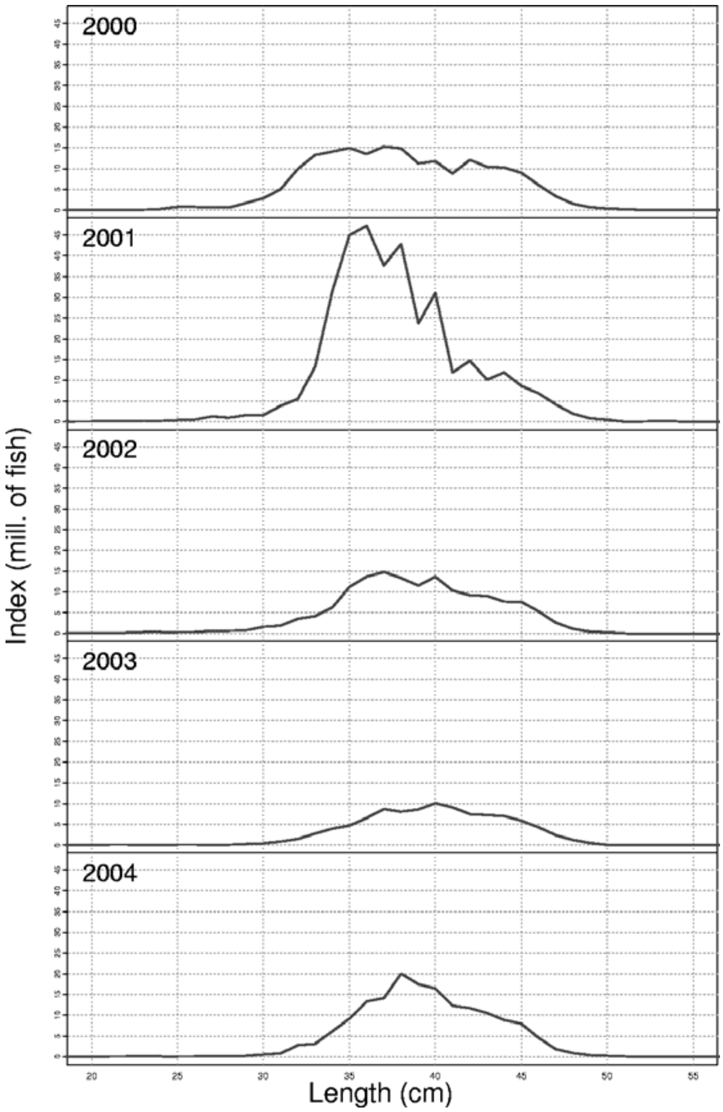


Figure 9.2.6 Length distribution of shelf demersal ***S. mentella*** in the bottom trawl surveys in October 2000-2004 in ICES Division Va.

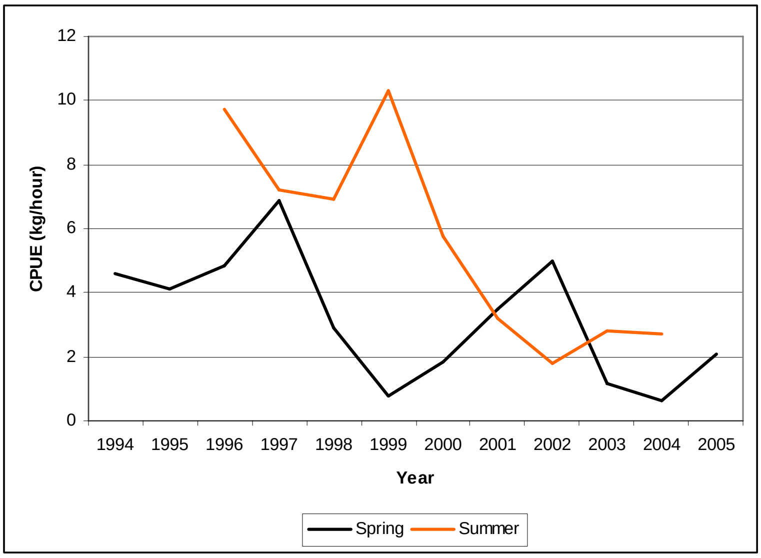


Figure 9.2.7 Demersal *S. mentella*. CPUE (kg/hour) from the Faeroese spring survey 1994-2005 and the summer survey 1996-2004 in ICES Division Vb.

10 Pelagic Sebastes mentella

This section includes information on the pelagic fishery for *S. mentella* both in the Irminger Sea and adjacent areas (Subarea XII, parts of Division Va, Subarea XIV and eastern parts of NAFO Divisions 1F, 2H and 2J).

The Working Group ToR c) and NEAFC special request 1.a) requesting new information on stock identity of *S. mentella* is dealt with in the introductory chapter 7, whereas the requested fishery and survey information on pelagic *S. mentella* (ToR d) and e)) is given in this chapter (10.1 and 10.2).

The pelagic redfish straddles in 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 parties have objected to the decision of NEAFC and set their own national TAC. The NEAFC TAC for pelagic redfish for 2004 was 120,000 t. ACFM has advised for 2005 “that catches should not exceed catches exerted in the period 1989-1992, corresponding to less than 41 000 t.” For 2005, NEAFC has set a TAC of 75,200 t, “of which 4,700 tonnes will be allocated to NAFO, and 200 tonnes will be available to co-operating non contracting parties”.

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, Figure 10.1.1). Since 2000, the WG estimate of the catch has been between 124 000 and 151 000 t, highest in 2003. This is probably an underestimate due to incomplete reporting of catches (see section 10.1.4), especially in Subarea XII, where significant catches were taken by some countries in the past. The recent increase in the total figures since 2000 is mainly due to significant catches in NAFO Divisions 1F and 2J, up to 24 000 t (16% of total catches) in 2004. As in previous years, a small fraction of the catches reported as demersal catches in Division Va (see chapter 9) was caught with pelagic trawls. To minimize the overlap between the pelagic and demersal fisheries, Icelandic authorities have introduced a “redfish line” as division measure (see details in chapter 10.1.2.4).

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 7 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 the area east of 32°W and north of 61°N, and in July (or August), the fleet moves to areas south of 60°N and west of about 32°W where the fishery continues until October (see Figures 10.1.2 and 10.1.3). 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 at a depth range of 200 to 950 m in 1998-2004, 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 WG acknowledges information on trawling depth as provided by some nations, but recommends that all nations should provide depth information in accordance with the NEAFC logbook format.

The following text table summarises the available information from fishing fleets in the Irminger Sea in 2004:

Faroes	4 factory trawlers
Germany	3 factory trawlers
Greenland	1 factory trawler
Iceland	22 factory trawlers
Portugal	5 factory trawlers
Russia	34 factory trawlers
Spain	10 factory trawlers

A summary of the catches 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. During 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. In 1999, the Faroese fishery started in international waters in the NE part of the Irminger Sea in mid/late April (ICES Sub-area XIV). Up to late July, the fishing area was mainly between 61°N-62°N and 27°N-30°W, then they moved to the SW, to south of 60°N and west of 38°W (ICES Sub-area 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. In 2004, this pattern has not changed.

10.1.2.2 Germany

The reported effort in 2004 is by far the lowest observed in the last nine years and amounted to 4 355 hours only (WD10). As observed in previous years, the majority of the 2004 effort was applied during the second and third quarters. During the second quarter in 2004, the hauls were almost exclusively distributed in NEAFC Regulatory Area of ICES Division XIV between the Greenland and Icelandic EEZs. As in 2003, there was significant fishing effort exerted in the NAFO Division 1F in 2004, mainly within the NAFO Regulatory Area. There was also some effort recorded in NAFO Division 2J since 2003. The overall decrease of annual landings continued in 2004 with a figure of 3,700 tons, representing a drastic drop to about one third of the average effort observed in previous years, due to a reallocation of effort to the Greenland halibut fishery off East Greenland. In 2004, 28 % or 1,048 tons of the total landings were taken in the NAFO Divisions. During 1995-1999, the overall unstandardised CPUE decreased from 2.06 t/h by 53 % to 0.97 t/h. In 2000-2004, 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 remains 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

The Icelandic fleet targeting pelagic redfish is usually concentrated in the area between the Greenland 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. 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. In 2001 and 2002, about 33% and 15% of the catch was taken south of Cape Farewell, respectively, due to changes in effort regulation for the fishery. Each vessel was forced to fish given proportion of its catches south of ca. 62°N in order to spread the effort. Only about 11% of the Icelandic catches in 2003 were taken in the “south-western” fishing area shallower than 400 m depth. In 2004, only 36% where caught within the Icelandic EEZ and about 50% of the catches just outside the EEZ (WD 24). 10% of the catches were taken south of Cape Farewell in ICES Sub-area XII and NAFO Division 1F.

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 isobath. This line (see Figure 10.1.4) 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 10.1.4. 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 in Figure 10.1.5. 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.

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 is no information available on length distributions in the catches. In 2003 and 2004, 62% and 79% of the catches were taken in Subarea XIV, respectively.

10.1.2.6 Poland

The Group had a detailed description of the Polish fishery on pelagic redfish available for the first time (WD03). Poland began fishing of pelagic redfish in the Irminger Sea and adjacent waters in 1982. Redfish were fished irregularly in subsequent years. In 1997, the catch amounted to 776 t, followed by a pause in redfish catches until 2002. Since then, catches of this species have been taken regularly. In 2002, 428 t were caught, followed by 917 t in 2003, and 2907 t in 2004. In 2003, the Polish catches were begun in August in NAFO waters. Catches were conducted for two months in Div. 1F at 193-408 m depth (mean 334 m). A total of 776 tons of pelagic redfish were caught. The average CPUE was 1.5 t/h trawling in August and 1.2 t/h trawling in September. In total, 917 tons of pelagic redfish were caught in 2003; of this amount nearly 85% was caught in the NAFO area. In 2004, Polish pelagic redfish catches were begun early in April and continued uninterrupted for five months. Catches were begun in the Subarea XIV. From April to July, a total of 2010 tons of pelagic redfish were caught in this area at depths of 340-900 m (mean 645m). The average CPUE increased in subsequent months from 0.49 t/h trawling in April to 1.92 t/h trawling in July. Starting in the last ten days in July, catches were taken in NAFO waters. By mid August, a total of 897 tons of pelagic redfish had been caught at mean depths of 330-430 m (mean 381 m). The average CPUE was 1.3 t/h trawling in July and 2.6 t/h trawling in August. In contrast to 2002 and 2003, the majority of pelagic redfish catches (over 69 %) in 2004 were taken in fishing grounds located in the NEAFC region.

10.1.2.7 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. Effort and CPUE data for the Portuguese trawl fishery in ICES Div. XII, XIVb and NAFO Div. 1F in 2004 were obtained through the revision of the skipper logbook from one trawler, kindly supplied by it owner (WD05). The CPUE varied between 0.11 to 0.85 t/h (mean 0.46 t/h).

10.1.2.8 Russia

The regular Russian commercial fishery for pelagic redfish in the Irminger Sea started in 1982. The total catch of redfish taken by the USSR/Russia makes up about 0.8 mill. t or 40% of the total world catch for the 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 10.1.6), distributed over a large area in the Irminger Sea (Figure 10.1.7). 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 2004, the Russian fishery for pelagic *S. mentella* in the Irminger Sea and Divisions 1F, 2H and 2J of the NAFO Convention Area lasted from April to October (WD09). 34 trawlers of different types participated in the fishery. Fishing of *S. mentella* spawning concentrations started in April in the traditional area close to the Icelandic EEZ in a depth range of 600 to 900 m. During the second quarter, *S. mentella* were fished in the open waters of ICES Subarea XIV, where the CPUE was about 0.77 t/h. 48% of the catch and 57% of fishing effort were registered in the Southwest to ICES Subarea XII and the Greenlandic EEZ to the depth of 200-650 m. At the same time, in July-September, fishery for *S. mentella* was conducted in Subarea XIV in the 500-900 m depth range, where the CPUE was around 0.90 t/h. At the end of July, Russian vessels started to fish *S. mentella* in the NAFO Convention Area at a depth of 190-320 m. In July-September, the CPUE in the NAFO Convention Area was estimated at 1.29 t/h. The total Russian catch in 2004 is provisionally estimated to be 32,193 tonnes in ICES Subareas XII and XIV and 12,083 tonnes in the NAFO Area.

10.1.2.9 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 Spanish pelagic fishery of redfish in ICES Subareas XII and XIV and in NAFO Divisions 1F and 2J between 2000 and 2004 showed a significant seasonal pattern in terms of its geographical and depth distribution. The effort in the first and fourth quarter is occasional and very low. Effort in 2004 increased by more than 150 fishing days, and most of this increase was carried out inside the Greenland EEZ in the third quarter. The fishing season is occurs mainly during the second and third quarter of the year. In the second quarter, the fleet operates in Subarea XIV, between the Greenlandic and Icelandic EEZs, in depths greater than 500 meters capturing fish of bigger size. The proportion of females in the catches is greater than for the males, the female length distributions in the catches present two clear modes. The yields obtained in this quarter are larger. In the third quarter, the fleet moves towards the Southwest to ICES Subarea XII and NAFO Division 1F and 2J, and the depth of the hauls is less than 500 meters. The length distributions of the catches are smaller than those of the second quarter and show only one mode. The proportion of the males in the catches is larger than for the females. The yields are smaller than those of the second quarter. The fishery in NAFO Div. 1F and 2J is more similar to that one carried out in ICES Subarea XII than fishery in Subarea XIV, particularly in the characteristics of the catches (distributions of sizes, sex ratios, yield, etc.) and season.

10.1.2.10 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. Measurement from 1998 shows that the discard rate had decreased to 2%. Information from observers from 2000-2004 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 %. In recent years, the discards quantities varied annually, from almost no discards in 2000 and 2001 to 6% of total catches in 2003. This variability can also be observed by area, and in 2004, the discarded percentage is larger in the Divisions XII, 1F and 2J. In Division XIV, this variability can be due to that the percentage of discards does not depend directly on fish infested by *Sphyrion lumpi*, but it is related with the haul catch. When the haul catch is very much, the fish is discarded under worse conditions by the lack of time to process the whole catch. When the catches are between the standard values, there is enough time to work up the whole fish, even the one infested, and there is not discards. In Subarea XII, Div. 1F and 2J, the discards rates are more related with parasite fish.

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. In 2003 and 2004, discards amounted to 3.8% and 2.1%, respectively.

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 has been unknown and hence the effort of their vessels is unknown. During the NWWG meeting in 2004, a presentation of ongoing EU project (IMPAST) dealing with this issue was given (WD29 of NWWG2004). 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, and indicated that the unreported effort might be of significant amount and that during the observations in June 2002 and 2003, the effort could be more than 25% higher than reported to NEAFC.

10.1.5 Trends in landings

At the beginning of the fishery in 1982, landings of pelagic redfish were reported from both Subareas XII and XIV (Table 10.1.1). Most of these were taken in Subarea XII (40 000-60 000 t) prior to 1985, and then a greater fraction was reported from Subarea XIV. The landings from Subarea XII were again in the majority in 1994 and in 1995 with 94 000 t and 129 000 t landed, respectively. In 1996-1999, the main part of the total landings was taken from Div. Va and Subarea XIV (Table 10.1.1). Since 2000, considerable amounts of the landings were taken in NAFO Div. 1F, 2J and 2H. In 2004, about 24 000 t were caught in the NAFO Regulatory Area which is a record high. Pelagic *S. mentella* fishery in ICES Div. Va started in 1992. The landings varied from 2 000-14 000 from 1992-1995. From 1995 to 2000, the landings in Div. Va increased to about 45 000 t (Table 10.1.1). Landings in Va in 2004 decreased significantly to 14 000 t.

Total landings estimated for 2003 (about 151 000 t) were the highest since 1996. The landings estimates for most recent years might increase due to the lack of reporting from some countries participating in the fishery, particularly evident in Subarea XII. Furthermore, as described in section 10.1.4, there is information on vessels from nations not reporting catches to any international organisation. As the effort of vessels from these nations is 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. According to the data available to the Group, the total estimated landings in 2004 amounted to 124 000 t.

10.1.6 Biological sampling from the fishery

Length distributions of pelagic *S. mentella* from German, Icelandic, Polish, Portuguese, Russian and Spanish commercial catches were reported for 2004 (WD10, WD24, WD03, WD05, WD09, WD19). The length distributions by ICES and NAFO areas are given in Figures 10.1.9 and 10.1.10 for 2000-2004. The peak length in ICES Subarea XIV was usually 41-42 cm, whereas it was around 35 cm in ICES Subarea XII and NAFO Division 1F and 2J. This mostly reflects the general pattern of a fishery in deeper layers in Subarea XIV and shallower layers in Subarea XII and NAFO 1F and 2J. In 2001, the German catches in Subarea XIV were taken in shallower depths, resulting in markedly smaller fish landed (Figure 10.1.9). In 2004, the landed fish were generally slightly smaller than in previous years.

The biological sampling from catches and landings of pelagic *S. mentella* in each Subarea/Division and by gear type in 2004 is shown in the text table below.

Country	Area	Gear	Landings (t)	No. of samples	No. of fish measured
Germany	XII, XIV and NAFO 1F, 2J	Pelagic	3,377	59	102,064
Iceland	XII, XIV and Va	Pelagic	35,725	60	7,935
Poland	XIV and NAFO 1F	Pelagic	2,907	?	14,582
Portugal	XII, XIV and NAFO 1F	Pelagic	4,419	102	8,160
Russia	XII, XIV and NAFO 1F, 2J	Pelagic	44,275	358	109,671
Spain	XII, XIV and NAFO 1F, 2J	Pelagic	11,675	70	14,110

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 (Stransky, 2000). Age readings within an otolith exchange between Germany, Iceland, Norway, and Spain, based on material collected in July 1999, 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 (Stransky *et al.*, 2005a). 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 (Stransky *et al.*, 2005a), showed the same results. Radiometric ageing (Stransky *et al.*, 2005b), however, indicated that especially larger pelagic *S. mentella* from depths >500 m are generally underestimated by traditional otolith annuli counts.

10.2 Trends in survey and CPUE indices

10.2.1 Acoustic data

Since the last available survey results are from May-June 2003, and the next survey will be carried out in June-July 2005, the trends in survey indices have to be re-evaluated after the availability of the next survey's report in late August 2005.

The most recent trawl-acoustic survey on pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters was carried out by Germany, Iceland and Russia from late May to late June 2003. Approximately 405 000 NM^2 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 deeper than 500 m by using 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 a 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 Tables 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 (<500 m depth) show a drastic decreasing trend. The estimate was only 700 000 and 100 000 t in 2001 and 2003, respectively, compared to 2.2, 1.6, and 0.6 mio. t in 1994, 1996 and 1999, respectively. This represents a reduction of about 2 mio. t in the period. During the same period, the total catch (not divided by depth) has been about 1 mio. t. Therefore, the removed biomass alone cannot explain the changes in the stock estimate. During this period, the fishery has also developed towards greater depths and towards bigger fish, and in recent years, the majority of the catch has been caught at depths > 500 m. Thus, acoustic estimates cannot be considered as 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 >500 m depth and two depth intervals in shallower hauls), evenly distributed over the survey area (Figure 10.2.1 and 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. As 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. Estimates 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 100 000 t, nearly the same value as with the acoustics.

About 700 000 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 series for the largest fleets (representing about 80% of landings) are given Table 10.2.4 and Figures 10.2.3a-c. Figures 10.2.3.a and 10.2.3.b show the CPUE from different fleets in recent years, in depths shallower and deeper than 500 m, respectively. Since 1995, there is no trend in CPUE, both shallower and deeper than 500 m, except for the Icelandic fleet where the CPUE has been increasing slightly. 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. In 2004, the CPUE indices decreased markedly in the deeper layer (Figure 10.2.3b).

Standardised CPUE (Figure 10.2.4), derived from a GLM CPUE model incorporating data from Germany (1995-2003), Iceland (1995-2004), Greenland (1999-2004), Faroe Island (1995-2004), Russia (1997-2004) and Norway (1995-2003) is given. The model takes into account year, month, vessel and area (North - South; see Figure 10.2.5). The model was run on data from a joint database (WD13) and the outcome of three model runs are given in Tables 10.2.4a-c. The model shows that the index is fluctuating both for the south-western and north-eastern 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. In 2004, the combined CPUE decreased again to the 2000 level, mainly due to the decrease of the Icelandic CPUE in the northern area (Figure 10.2.4). It has to be noted, however, that data from Germany and Norway are not included yet for 2004.

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 (ICES CM 2000/ACFM:15).

10.3 State of the stock

At present, the state of the stock is unknown.

The results of the international trawl-acoustic survey series are inconsistent in terms of inter-annual variation of the acoustic estimates and thus do hardly indicate the trend or actual stock status of pelagic redfish.

Although varying, the available commercial CPUE series has remained stable since 1995. It is, however, not known to what extent CPUE series reflect change in stock status of pelagic *S. mentella*. The fishery is focusing on aggregations.

Above average recruitment can be derived from recent survey observations on the East Greenland shelf, which is assumed to contribute to the pelagic stock.

The Group compiled all data except the results from the international survey in June/July 2005, and a review and final advice will be given in October to include the survey data.

10.4 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 unreported catches might be of substantial amount. Furthermore, landings data 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 120 000 t 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 in the southwestern area (almost exclusively shallower than 500 m) remained steady but low, and in the northeastern area (deeper than 500 m) fluctuated but remained steady overall. 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 southwestern fishing ground extended also into the NAFO Convention Area. The parameters analysed so far do suggest, however, that the aggregations in the NAFO Convention Area do not form a separate stock component. NAFO Scientific Council agrees with this conclusion (NAFO, 2005).

ToR d) requested to “update survey and fishery information on the stocks of redfish in Subareas V, VI, XII and XIV. In particular, update information on the on the horizontal and vertical distribution of pelagic redfish and fisheries in the Irminger Sea and adjacent waters as well as seasonal and inter annual changes in distribution. This information should allow NEAFC to further consider the appropriateness of separate management measures of different geographical areas/seasons”.

The Group concludes that at this time there is not enough scientific basis available to propose an appropriate split of catches among the two fisheries/areas.

Some biological features distinguish the fisheries in the two areas: The length distributions of the catches differ between the described two main fishing ground/seasons. The fisheries in the northeastern area (2^{nd} quarter) is mainly targeting at larger and postspawning fish.

The Group expects that under the current TAC regulations, a greater share of the catches in 2005 will be taken in the northeastern area.

The values of the parameters used in the age-based production model in the NWWG Report 1995 (ICES, 1995) that was the basis to suggest a 5% exploitation rate, are not considered the most appropriate regarding the current knowledge of the fishery and the biology of the species. Since 1995, the fishery was conducted predominantly in depths >500 m, targeting at bigger fish with a peak length around 40 cm and maximum lengths of 50 cm. These fish also show a significantly slower growth than previously assumed, as recent radiometric age validation results have shown (Stransky *et al*., 2005b). The basic assumptions of L_{inf}=40 cm and k=0.12 (ICES, 1995) are, therefore, not valid for the estimation of exploitation rates. The sensitivity of changes in the parameters of the model have, however, not been fully evaluated yet.

10.5 Comments on the assessment

The results of the international trawl-acoustic survey are given in chapters 10.2.1 and 10.2.2. Given the high variability in the correlation between trawl and acoustic estimates as well as the assumptions that need to be made about constant catchability with depth and across stocks, the uncertainty of these estimates is very high.

It is not known to what extent CPUE reflect changes in the stock status of pelagic *S. mentella*. The fishery is focusing on aggregations. Therefore, CPUE series might not indicate or reflect actual trends in stock size.

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. These unreported catches have, however, not been quantified as the number of nations not reporting has been unknown and hence the effort of their vessels is unknown.

10.6 Pelagic Surveys on *S. mentella*

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.

Previously, the survey results have not been used for provision of management advice. 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 will be conducted in June/July 2005, the period when both the pelagic redfish shallower and deeper than 500 m can be monitored.

The Study Group on Redfish Stocks [SGRS] met in January 2005 to review the survey design of the international trawl-acoustic surveys in the Irminger Sea and adjacent waters, to advise on the required frequency, number of vessels needed and the timing of the future surveys and to plan the international survey on redfish to be carried out in June/July 2005 (ICES CM 2005/D:02). Recommendations for the upcoming survey in June/July 2005 and for future work were developed by the Group. Especially the signal-to-noise ratios and target strength models applied within the hydroacoustic measurements require further experimental work. The use of a lower transducer frequency (18 kHz) was also considered as a possibility for the estimation of redfish density below the DSL. Three vessels from Germany, Iceland and Russia will participate in the survey and operate within an area of around 400 000 NM^2 in the Irminger and Labrador Sea in June-July 2005 to estimate the abundance and biomass of pelagic redfish. In the depth zone that can be surveyed by hydroacoustic measurements, i.e. shallower than the “deep-scattering layer” (DSL) (down to about 350 m), hydroacoustic measurements and identification trawls will be carried out, whereas within and below the DSL (down to about 1000 m), redfish abundance can currently only be estimated by trawls. Although an annual survey would certainly allow an improved estimation of interannual changes in distribution and abundance, the SGRS felt that the continuation of bi-annual surveys would be more realistic, considering limitations in national budgets for survey time. SGRS recommends that at least four vessels should participate to allow a sufficiently dense coverage of the survey area. The efforts directed at involving other nations in the survey should be continued. Since the most recent survey in May-June 2003 was carried out about 3 weeks earlier than previous surveys and pointed to considerable seasonal effects, SGRS recommends to keep the timing of the survey from (mid-)June to (mid- to late) July.

10.7 Environmental conditions

10.7.1 Water masses shallower than 500 m

Strong positive anomalies of temperature observed in the upper layer of the Irminger Sea with a maximum in 1998, are related to an overall warming of water Irminger Sea and adjacent areas in 1994-2003. These changes were also observed in the Irminger Current above Reykjanes Ridge (Pedchenko, 2001), off Iceland (Malmberg *et al*., 2001; Malmberg and Valdimarsson, 2003) and in the Labrador Sea water (Mortensen and Valdimarsson, 1999). Thus, an increase in temperature and salinity has been found in the Irminger Current since 1997 to higher values than for decades, as well as a withdrawal of the Labrador Sea water due to a slow-down of its formation by winter convection since the extreme year 1988 (ICES, 2002). In May-June 2003, a continuing warming-up of the 0-200 m layer was discovered, mainly northern part of the Irminger Sea around Irminger Current. At the same time decreasing temperature is observed in the southwest and spreading LCW and LSW in up 200-meters layers was recorded due to southern shift border of NACW. At depths between 200 and 500 m, a positive anomalies on the most part of the observation area was observed, but increasing temperature as compared to last survey in June-July 2001 was obtained only north of 60° N in flow Irminger Current above Reykjanes Ridge and northwestern part sea. Within the known spawning areas of redfish near Reykjanes Ridge, decreasing temperature on depth below 400 m was observed. These changes of oceanographic condition might have an effect on the seasonal distribution of redfish, places and periods of spawning, direction and time of feeding migrations and as a result, peculiarities of redfish aggregations.

10.7.2 Water masses deeper than 500 m

Deeper than 500 m, a positive anomaly on the most part of the observation area was observed. Increasing temperature as compared to the last survey in June-July 2001 was obtained only north of 60°N in the Irminger Current above the Reykjanes Ridge and the northwestern part of the Irminger Sea. Within the known spawning areas of redfish near Reykjanes Ridge, decreasing temperature on depth below 400 m was observed.

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 only approximate in latest years.

Year	Va	XII	XIV	NAFO 1F	NAFO 2J	NAFO 2H	Total
1982		39.783	20.798				60.581
1983		60.079	155				60.234
1984		60.643	4.189				64.832
1985		17.300	54.371				71.671
1986		24.131	80.976				105.107
1987		2.948	88.221				91.169
1988		9.772	81.647				91.419
1989		17.233	21.551				38.784
1990		7.039	24.477	385			31.901
1991		10.061	17.089	458			27.608
1992	1.968	23.249	40.745				65.962
1993	2.603	72.529	40.703				115.835
1994	15.472	94.189	39.028				148.689
1995	1.543	132.039	42.260				175.842
1996	4.744	42.603	132.975				180.322
1997	15.301	19.822	87.812				122.935
1998	40.612	22.446	53.910				116.968
1999	36.524	24.085	48.521	534			109.665
2000	44.677	19.862	50.722	10.815			126.076
2001	28.148	32.164	61.457	5.293	1.289	208	128.559
2002	37.279	24.027	66.179	7.942			135.427
2003	46.676	24.091	57.921	17.635	4.128	325	150.776
2004	14.264	6.668	78.890	19.847	4.259		123.927

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	7.703		10.669	3.309	42.472			15.689		5.222		2.514	30.012	10.082			128.559
2002				4.475		13.212	4.099	44.492		1.061	14.656		5.291	429	3.086	36.219	8.407			135.427
2003				4.432		10.608	4.450	48.398		371	14.321		8.399	917	3.989	44.056	10.835			150.776
2004				5.018		3.377	3.169	35.725		613	3.697		9.052	2.907	4.419	44.276	11.675			123.927

Table 10.1.3 Pelagic *S. mentella* catches (in tonnes) in 2004 by countries and depth (A), and in 1996-2004 by depth (B). (Working Group figures and/or as reported to NEAFC).

A.	TOTAL	NOT SPLITTED	SHALLOWER THAN 600 M	DEEPER THAN 600 M
Faroes	5.018		19 %	81 %
Germany	3.377		47 %	53 %
Greenland	3.169			100 %
Iceland	35.725		20 %	80 %
Lithuania	3.697	100 %		
Norway	9.052	100 %		
Poland	2.907		40 %	60 %
Portugal	4.419		11 %	89 %
Russia	44.275		34 %	66 %
Spain	11.675		14 %	86 %
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	128.559	23 %	27 %	50 %
2002	135.427	26 %	19 %	55 %
2003	150.776	10 %	25 %	65 %
2004	123.927	10 %	23 %	67 %

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.

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-June 2003.

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 < 500 m *	540	46.3	626	53.7	1166
1999 > 500 m	74	11.6	564	88.4	638
1999 Sum	614	34.0	1190	66.0	1804
2001 < 500 m	686	63.8	390	36.2	1076
2001 > 500 m	165	15.6	892	84.4	1057
2001 Sum	851	39.9	1282	60.1	2133
2003 < 500 m	18	19	75	81	93
2003 > 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	-	-	1.50	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	1.55	0.75	-[3]
1999	-	0.97	1.52	0.97	-[3]
2000	-	1.05	1.98	1.12	-[3]
2001	-	0.91	1.40	0.88	-[3]
2002	-	1.14	1.73	1.23	0.89
2003	-	1.09	2.67	-	1.10
2004	-	0.93	1.34	-	0.94

1 Preliminary

2 1987-1990 reported as GDR (FVSIV)

3 1997-2001 Russian effort data are only available as fishing days

Table 10.2.5. a. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths shallower than 500 m (south-western area) including single tow data from Germany (1995-2003), Iceland (1995-2004), Greenland (1999-2004), Faroe Island (1995-2004), Russia (1997-2004) 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  0.345103061 0.27737622  1.24416959 1996 1.4121354
factor(yy)1997 -0.152816202 0.10859771 -1.40717701 1997 0.8582875
factor(yy)1998 -0.006889320 0.11223220 -0.06138452 1998 0.9931344
factor(yy)1999 -0.500055530 0.10181886 -4.91122691 1999 0.6064970
factor(yy)2000 -0.205182351 0.11761325 -1.74455140 2000 0.8144988
factor(yy)2001 -0.001802313 0.09969846 -0.01807764 2001 0.9981993
factor(yy)2002 -0.153116970 0.11205132 -1.36648970 2002 0.8580294
factor(yy)2003 -0.106097334 0.11122694 -0.95388164 2003 0.8993371
factor(yy)2004 -0.237537632 0.12720033 -1.86742934 2004 0.7885672

Gaussian model

Response: lafli

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev   Pr(Chi)
          NULL                 545   1127.372
      ltogtimi  1 865.2478       544    262.125 0.0000000
    factor(yy)  9  35.3098       535    226.815 0.0000525
    factor(mm) 10  52.9378       525    173.877 0.0000001
factor(vessel) 72  73.6781       453    100.199 0.4229887
```

Table 10.2.5. b. Results of the GLM model to calculate standardized CPUE for pelagic redfish fishery, by depths deeper than 500 m (north-eastern area) including single tow data from Germany (1995-2003), Iceland (1995-2004), Greenland (1999-2004), Faroe Island (1995-2004), Russia (1997-2004) and Norway (1995-2003). Note that the full output is not shown.

```
[1] "Northern area"

                     Value Std..Error    t.value   ar     index
factor(yy)1996 -0.04241446 0.08632572 -0.4913306 1996 0.9584724
factor(yy)1997 -0.45634809 0.07858980 -5.8067089 1997 0.6335932
factor(yy)1998 -0.18624482 0.07954422 -2.3413998 1998 0.8300703
factor(yy)1999 -0.25639802 0.08269705 -3.1004494 1999 0.7738339
factor(yy)2000  0.04861440 0.08221893  0.5912799 2000 1.0498155
factor(yy)2001 -0.34152473 0.08069420 -4.2323329 2001 0.7106859
factor(yy)2002  0.02315355 0.08264182  0.2801674 2002 1.0234237
factor(yy)2003  0.11651492 0.08381810  1.3900926 2003 1.1235743
factor(yy)2004 -0.42658920 0.08561906 -4.9824096 2004 0.6527316

Response: lafli

Terms added sequentially (first to last)
             Df Deviance Resid. Df Resid. Dev      Pr(Chi)
          NULL                1342   2577.131
      ltogtimi  1 1945.697      1341    631.434 0.000000e+00
    factor(yy)  9   38.425      1332    593.009 1.462028e-05
    factor(mm) 11   43.519      1321    549.490 8.819300e-06
factor(vessel) 86  274.022      1235    275.468 0.000000e+00
```

Table 10.2.5. c. Results of the GLM model to calculate standardized CPUE for all pelagic redfish fishery, including single tow data from Germany (1995-2003), Iceland (1995-2004), Greenland (1999-2004), Faroe Island (1995-2004), Russia (1997-2004) 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)

```
[1] "Combined areas"
                     Value Std..Error    t.value   ar     index
factor(yy)1996 -0.05890060 0.06935745 -0.8492326 1996 0.9428005
factor(yy)1997 -0.41527741 0.05794924 -7.1662269 1997 0.6601571
factor(yy)1998 -0.16511397 0.05928839 -2.7849291 1998 0.8477971
factor(yy)1999 -0.36185725 0.05895377 -6.1379831 1999 0.6963818
factor(yy)2000 -0.02506402 0.06085058 -0.4118946 2000 0.9752475
factor(yy)2001 -0.26798562 0.05882900 -4.5553323 2001 0.7649188
factor(yy)2002 -0.03634354 0.06108397 -0.5949767 2002 0.9643090
factor(yy)2003  0.02879823 0.06167302  0.4669502 2003 1.0292169
factor(yy)2004 -0.40196604 0.06574698 -6.1138332 2004 0.6690035

Gaussian model

Response: lafli

Terms added sequentially (first to last)
               Df Deviance Resid. Df Resid. Dev    Pr(Chi)
          NULL                  1888   3719.004
      ltogtimi  1 2824.098      1887    894.906 0.00000000
  factor(skip) 91  379.364      1796    515.542 0.00000000
    factor(yy)  9   54.723      1787    460.820 0.00000001
    factor(mm) 11   20.240      1776    440.580 0.04215951
factor(reitur)  1    7.642      1775    432.938 0.00570169
```

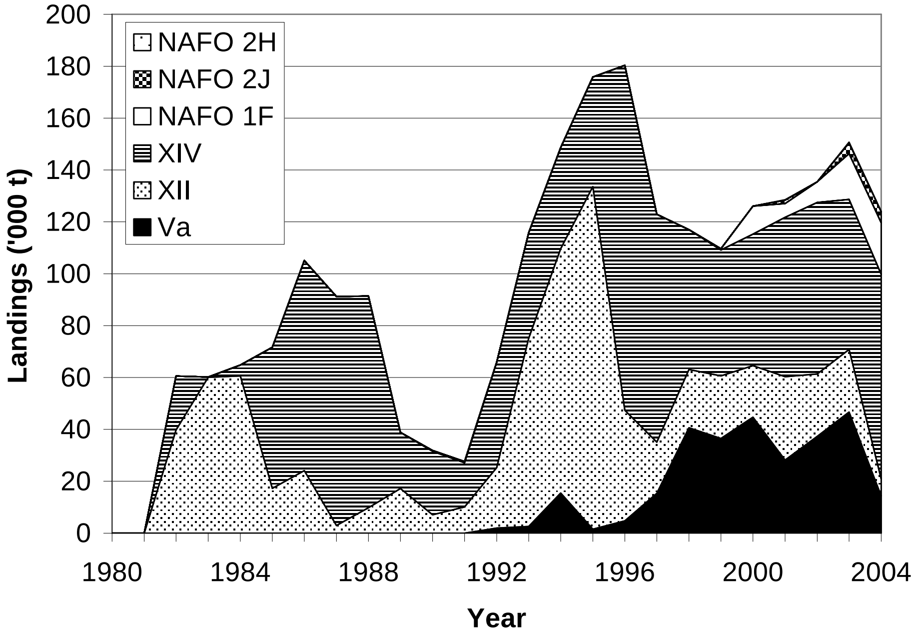


Figure 10.1.1 Landings of pelagic *S. mentella* (Working Group estimates, see Table 10.1.1).

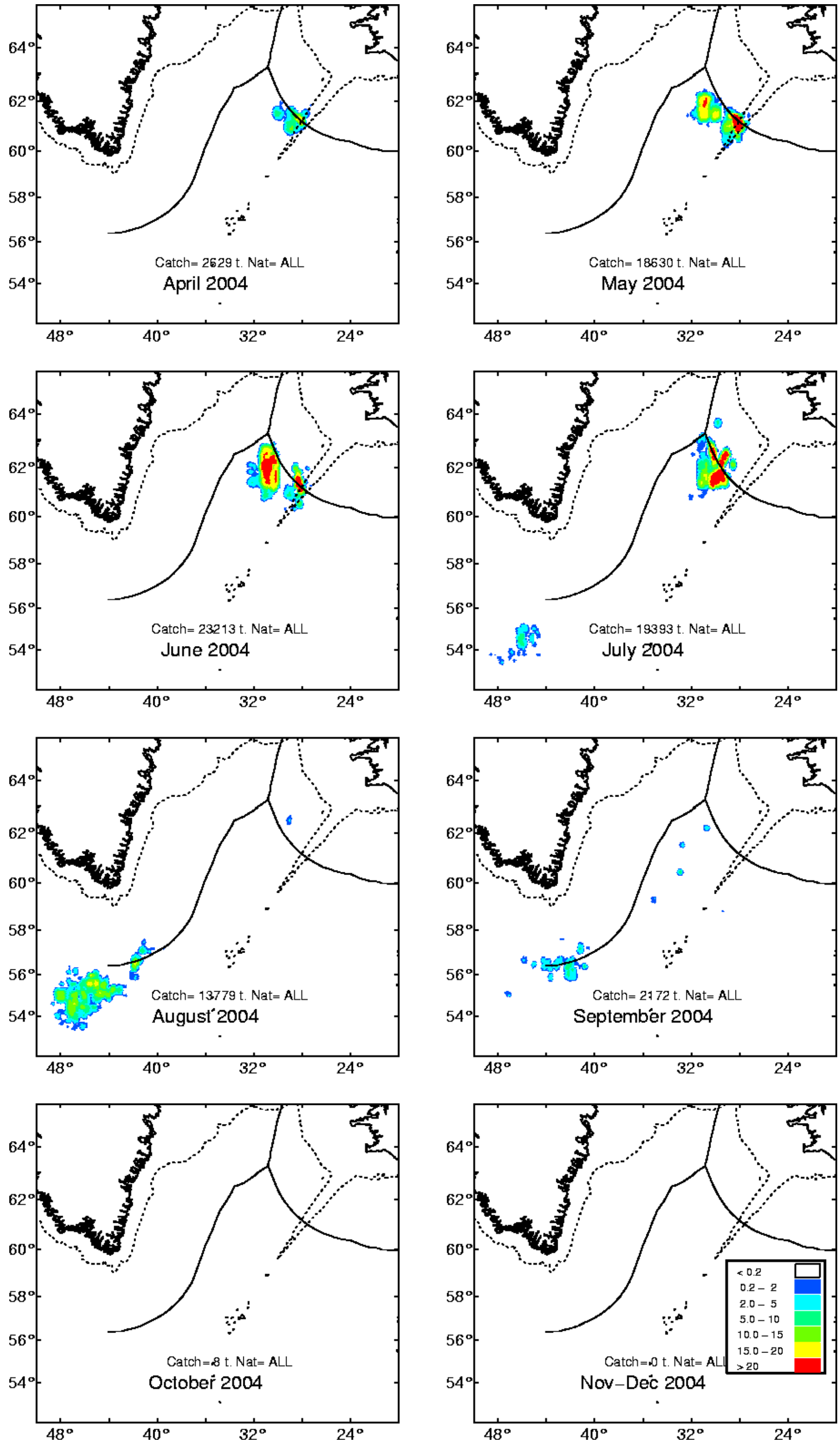


Figure 10.1.2 Fishing areas and total catch of the pelagic redfish (*S. mentella*) by month in 2004, derived from catch statistics provided by Faroes, Greenland, Iceland and Russia. The scale for the catch is in tonnes per squared nautical mile. Total catch for each period is also given.

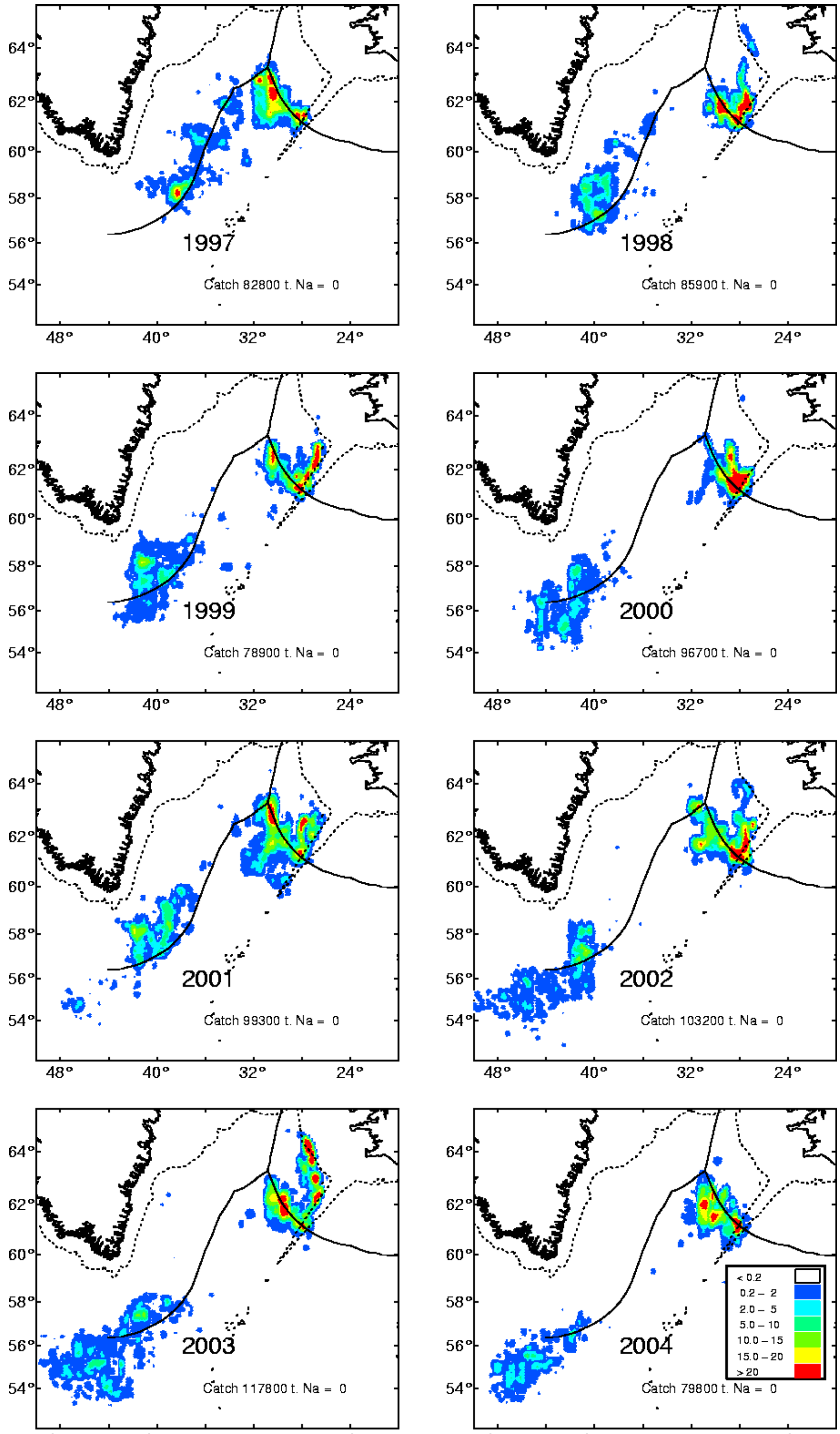


Figure 10.1.3 Fishing areas and total catch of the pelagic redfish (*S. mentella*) in the Irminger Sea and adjacent waters 1997-2004. Data are from the Faroes (1995-2004), Germany (1995-2003), Greenland (1999-2004), Iceland (1995-2004), Norway (1995-2003) and Russia (1997-2004). The scale given is tonnes per square nautical mile.

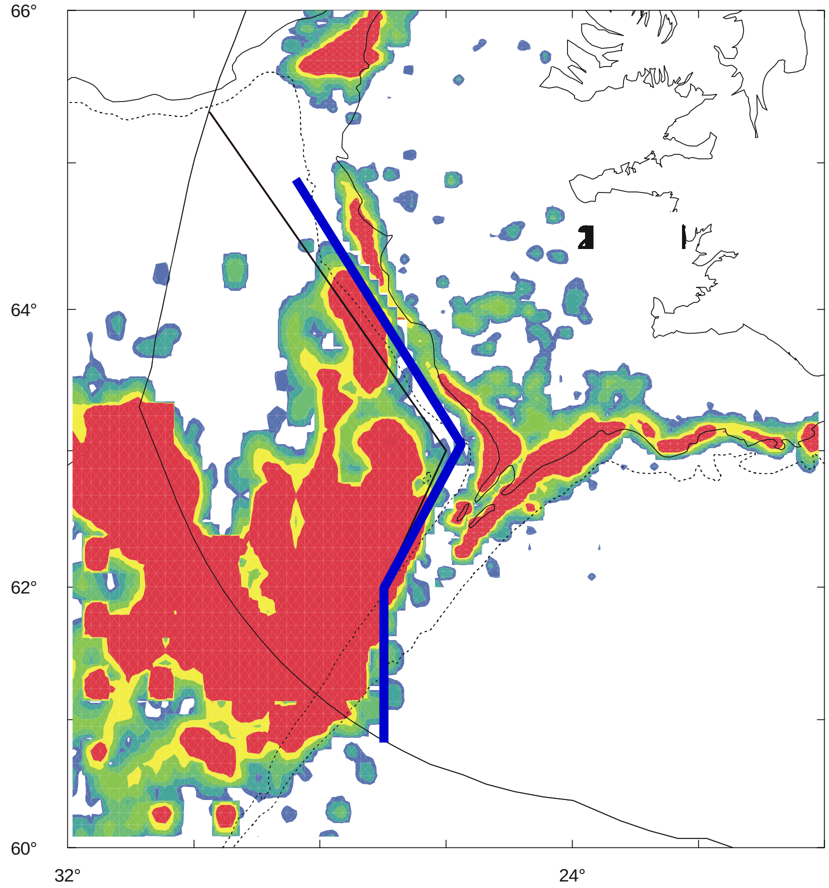


Figure 10.1.4. Icelandic redfish catch southwest of Iceland in 2001-2003. The catch west of the "redfish line" (blue line) is form the pelagic redfish as the catch north and east of the line is of "shelf type"). The thin line is the "old redfish line"; the thick line is the line set in 2003.

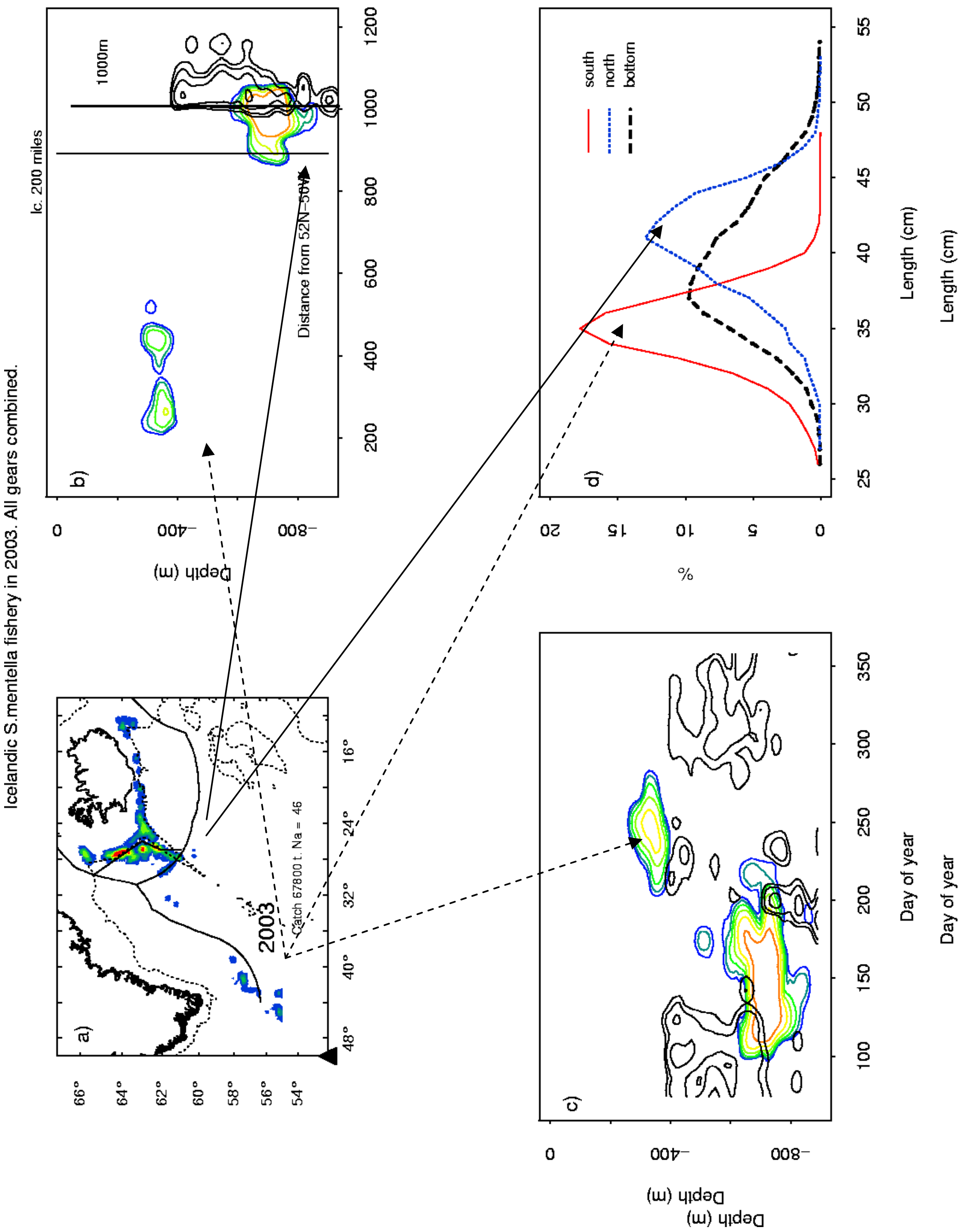


Figure 10.1.5. Graphic presentation on the *S. mentella* fishery in 2003. a) Geographic distribution of the catches where the colour indicates catches at each position. b) Distance-depth plot where distance (in miles) from fixed position is given. The fixed position is 52N-55W, indicated as ▲ on a). The contour lines indicate catches at given area and distance. The coloured contour represents the pelagic fishery, and the black contour indicates demersal fishery. c) Depth-time plot, where the y-axis is depth, x-axis is day of the year and the colour indicates the catches taken at given depth. Black = demersal, colour = pelagic fishery. d) Length distributions from different areas/gears. The lines on the figures explain the concordance between the different presentation of the data.

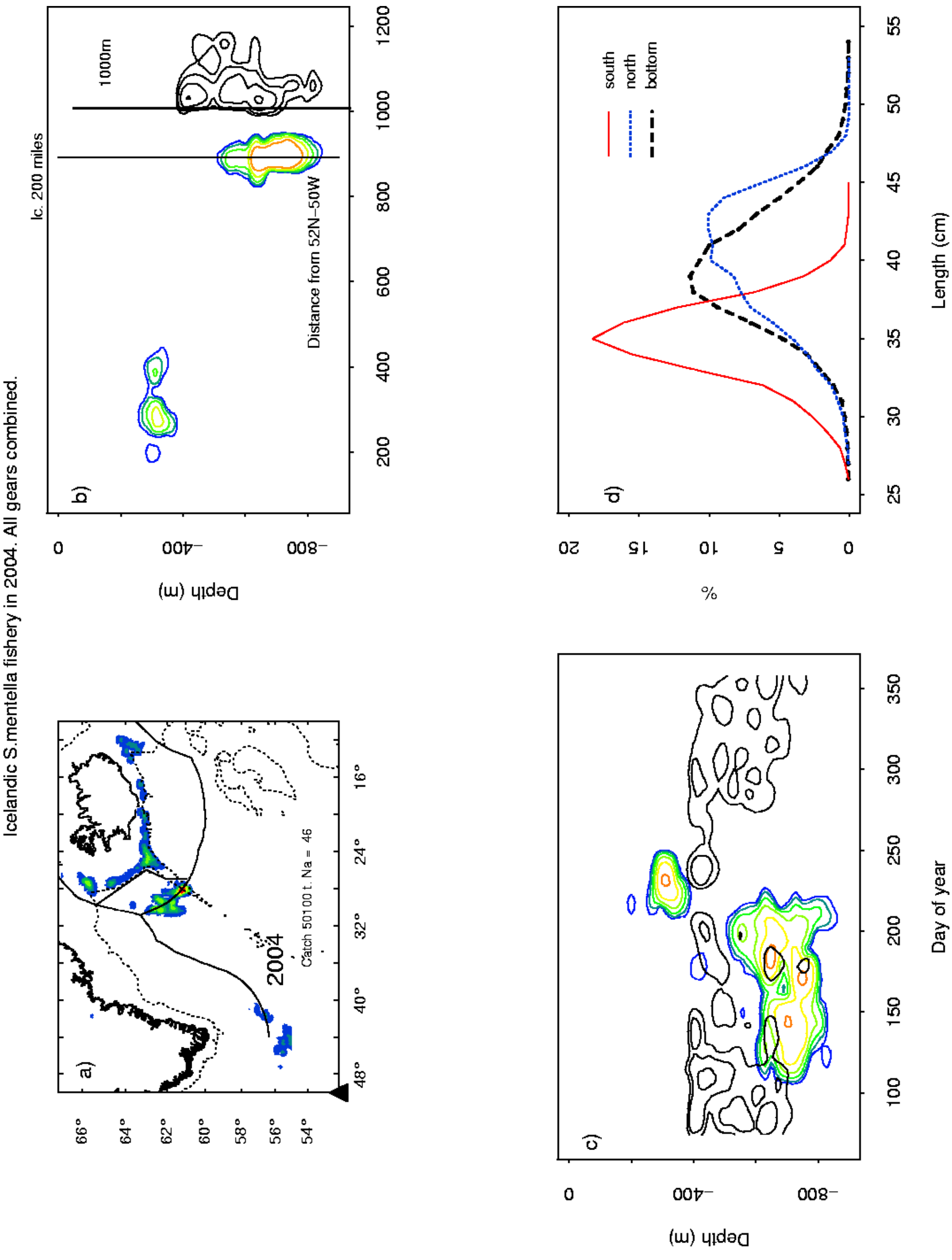


Figure 10.1.6. Graphic presentation on the *S. mentella* fishery in 2004. See Figure 10.1.5 for explanations.

Figure 10.1.7 Percentage of the catch *of S. mentella* by Russian vessels by depth in the Irminger Sea in 1982-2004.

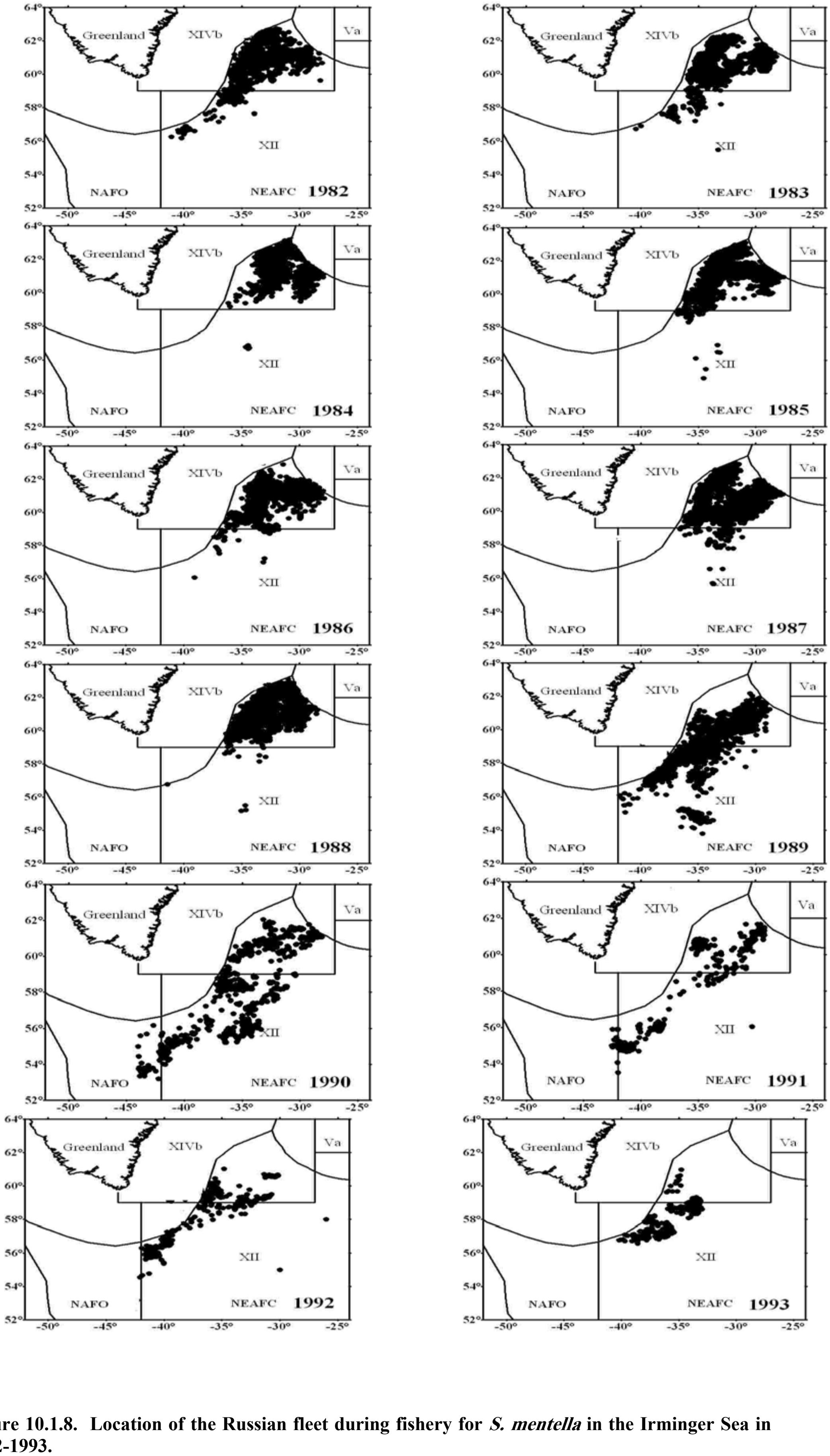


Figure 10.1.8. Location of the Russian fleet during fishery for *S. mentella* in the Irminger Sea in 1982-1993.

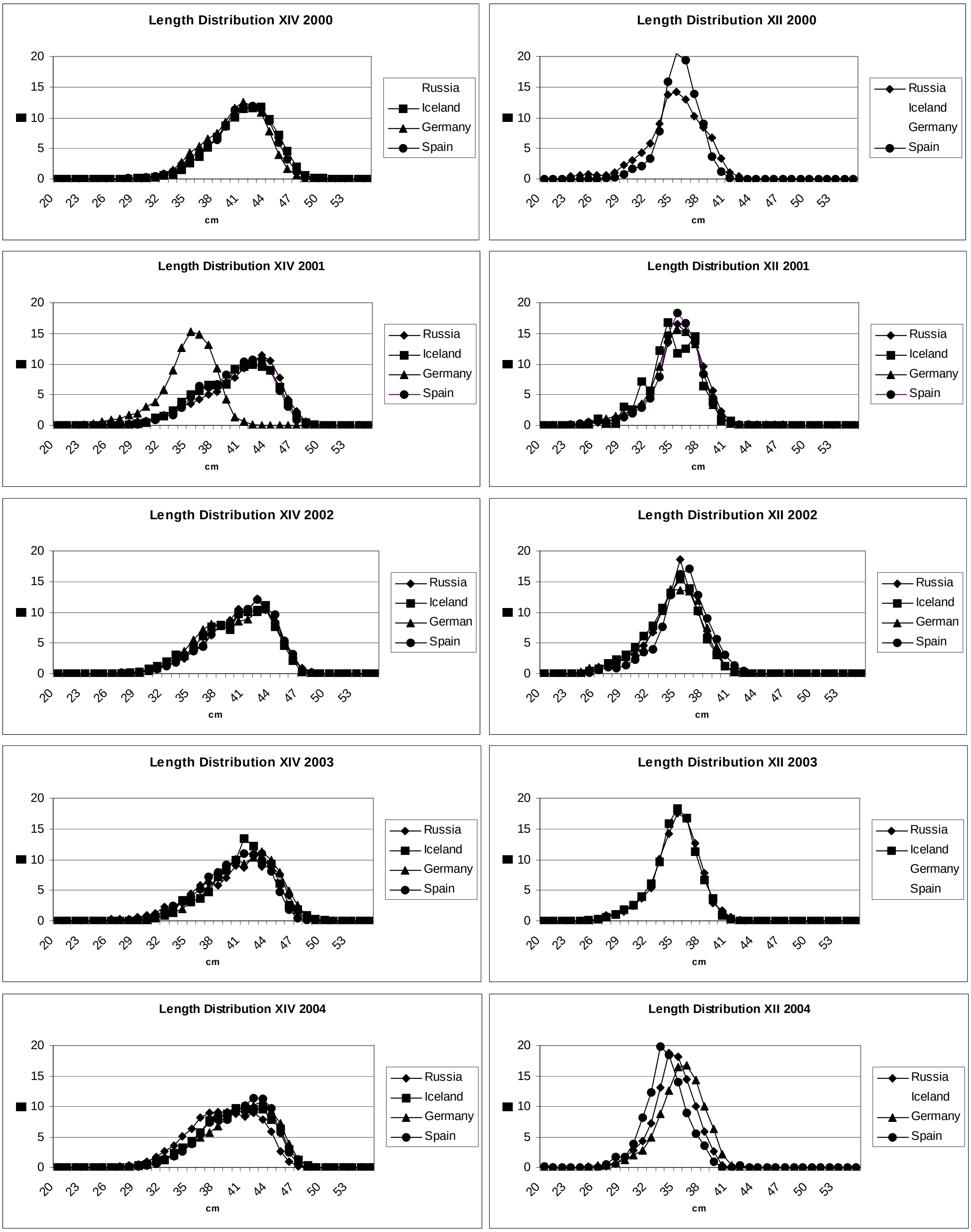


Figure 10.1.9 Length distributions from landings of pelagic *S. mentella* by ICES Sub-areas XII and XIV and country in 2000-2004.

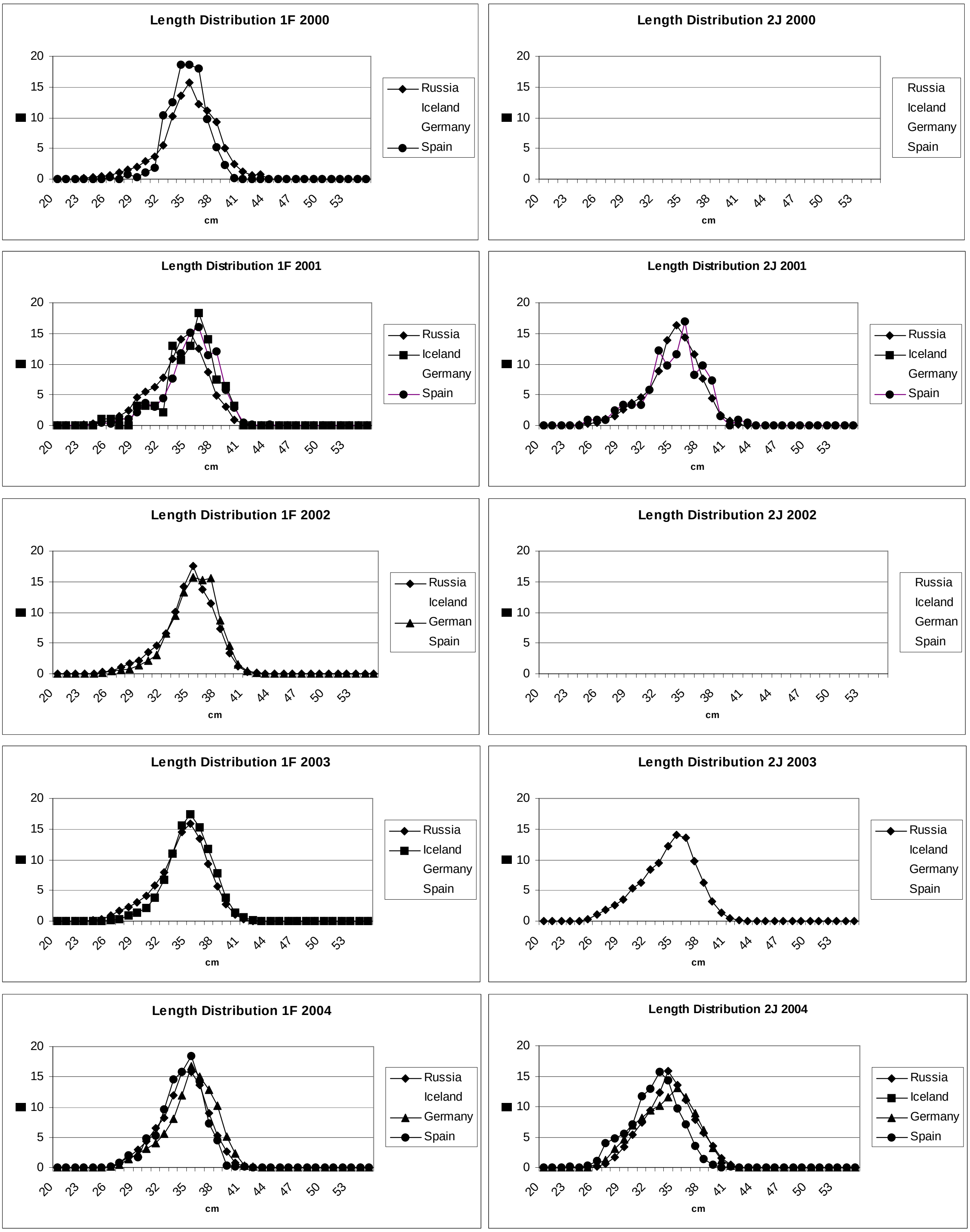


Figure 10.1.10 Length distributions from landings of pelagic *S. mentella* by NAFO Divisions 1F and 2J and country in 2000-2004.

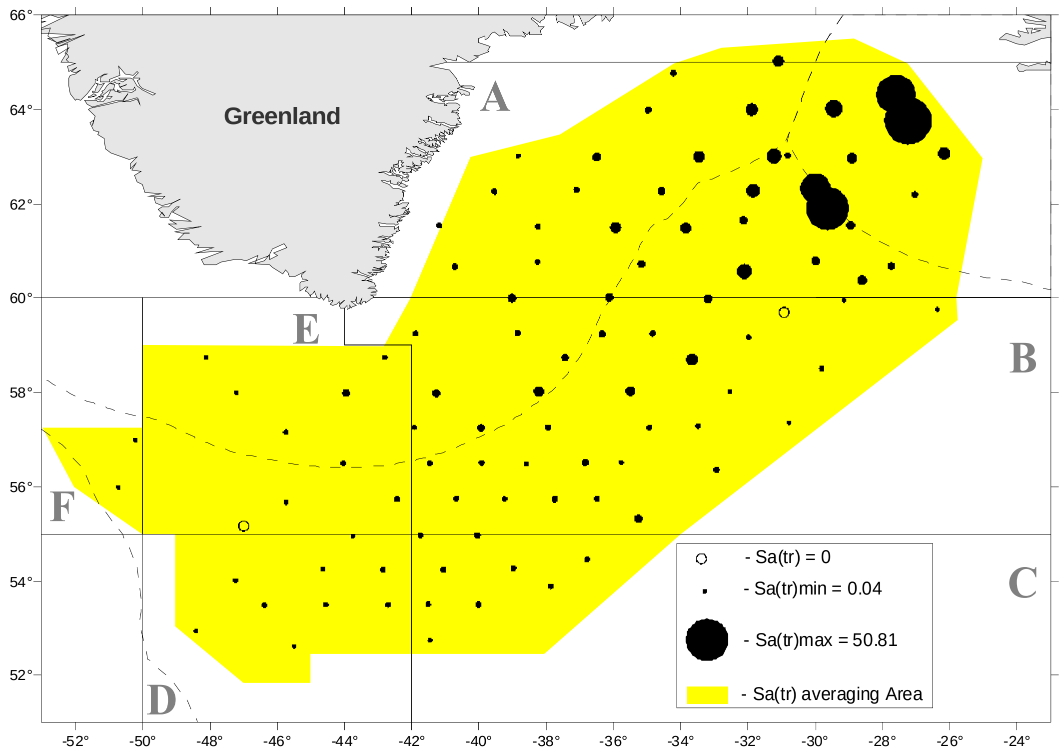


Figure 10.2.1 Geographical distribution patterns of standardised redfish catches deeper than 500 m in the joint trawl-acoustic survey in May-June 2003.

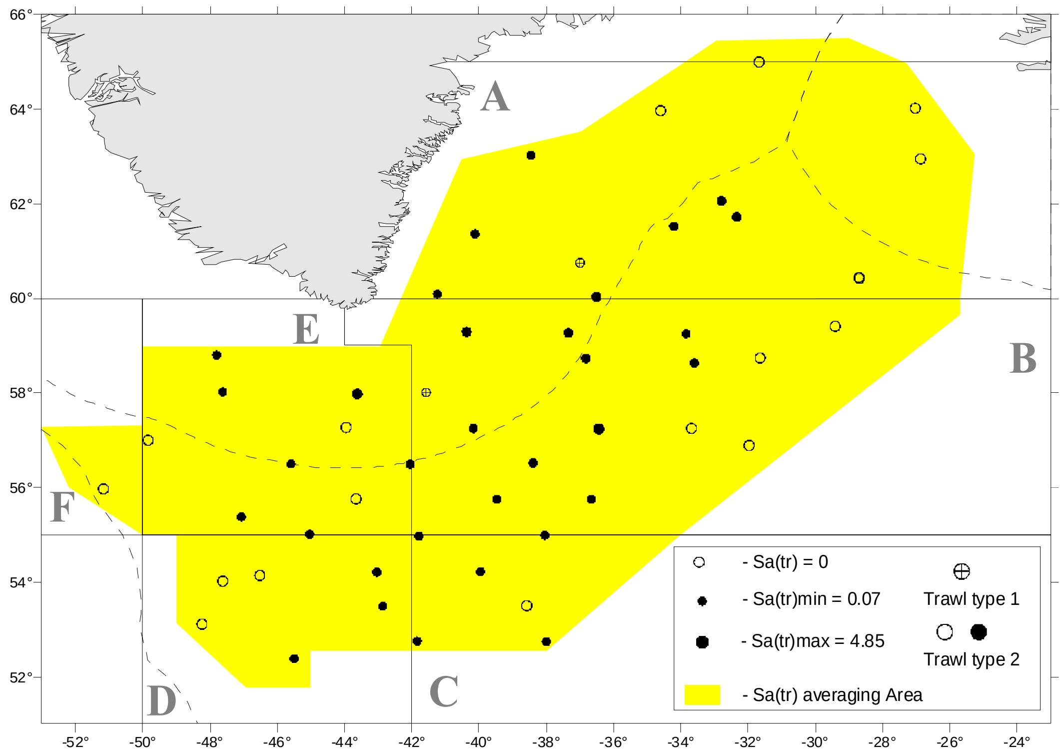


Figure 10.2.2 Geographical distribution patterns of standardised redfish catches shallower than 500 m in the trawl-acoustic survey in May-June 2003.

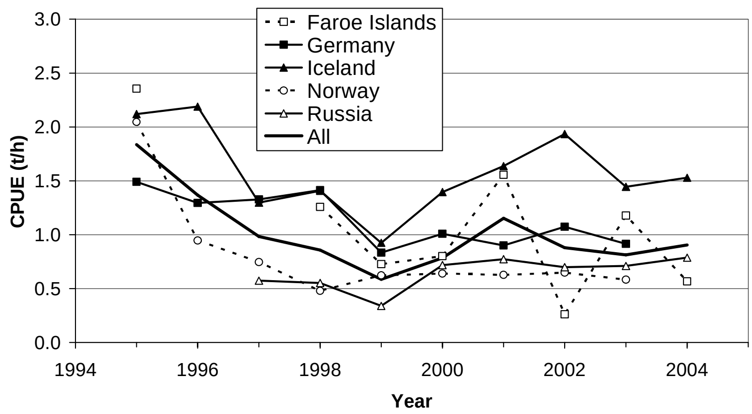


Figure 10.2.3a. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, shallower than 500m (southern area).

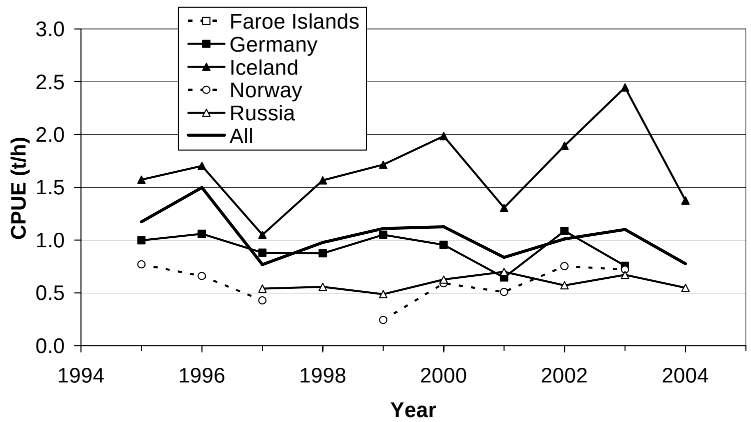


Figure 10.2.3b. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, deeper than 500m (northern area).

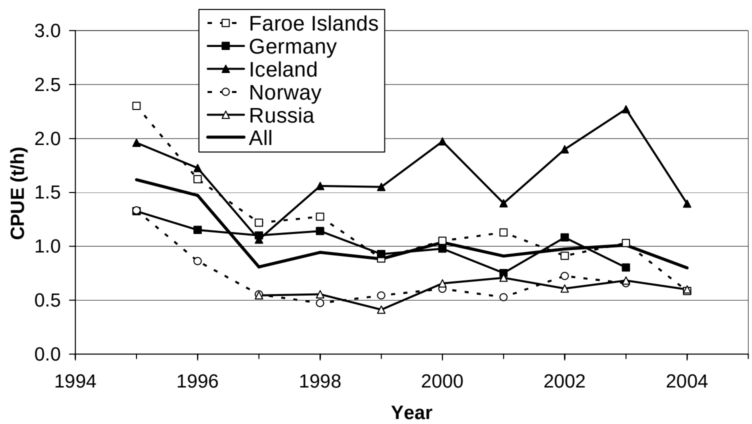


Figure 10.2.3c. Trends in unstandardised CPUE of pelagic *S. mentella* fishery in the Irminger Sea, all data.

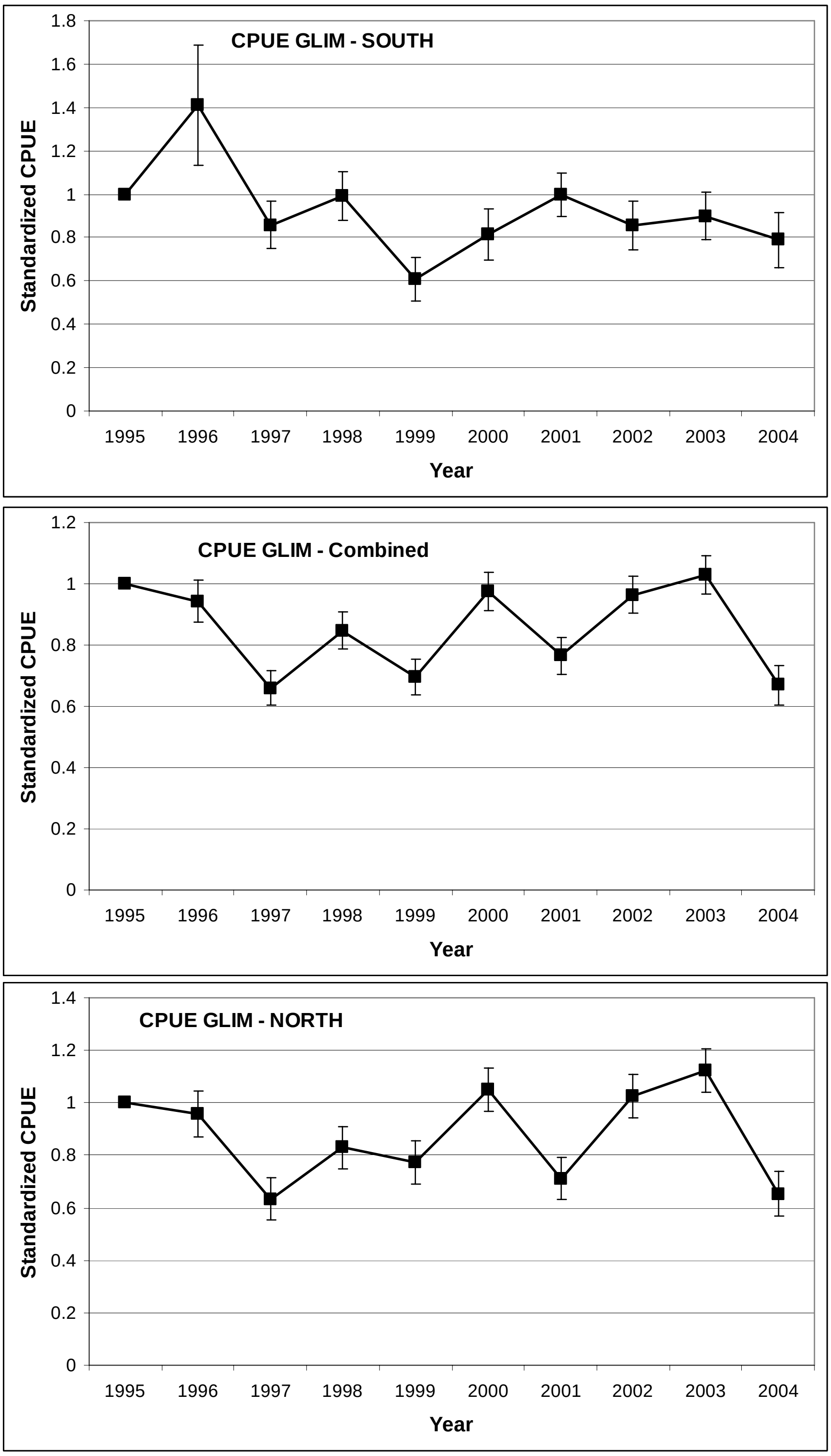


Figure 10.2.4 Standardised CPUE, as calculated by using data from Germany (1995-2004), Iceland (1995-2004), Greenland (1999-2004), Faroes (1995-2004), Russia (1997-2004) and Norway (1995-2003) in the GLM model (see chapter 10.2.3), divided by depths shallower (south-western area) and deeper than 500 m (north-eastern area) and both depth layers (areas) combined. 95% confidence limits are shown. Further details of the GLM models are given in Tables 10.2.5a-c.

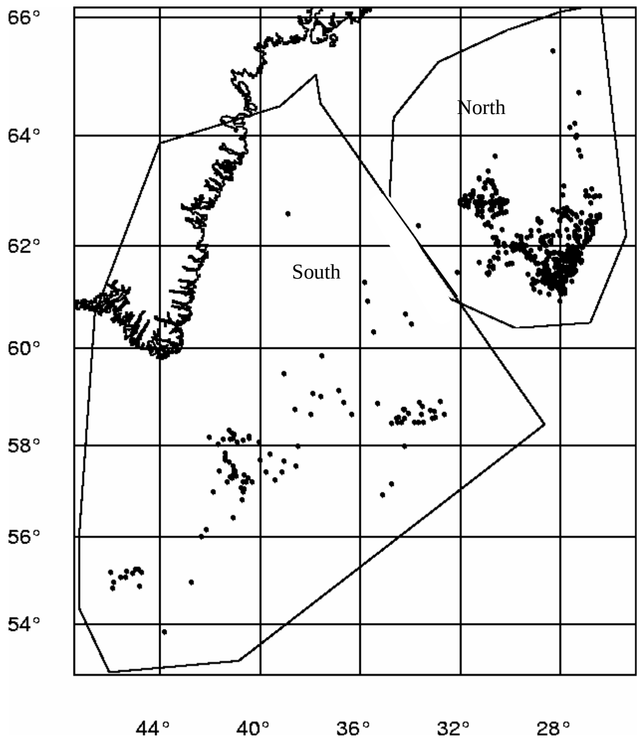


Figure 10.2.5. Division of areas between south an north. The points indicate positions of Icelandic available samples from the catches 1995-2004.

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

11.1 The Fishery

11.1.1 Regulation of the fishery

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

The fishery of the Icelandic capelin has, therefore, been regulated by preliminary catch quotas set prior to each fishing season (July–March). Predictions of TACs have been computed from autumn survey data the year before on the abundance of 1 and 2 year old capelin. The process includes historical relationships between such data and the back-calculated abundance of the same year classes, growth rate and stock in numbers, natural mortality and the provision of a remaining spawning stock biomass of 400 000 t. Final catch quotas for each season have then been set according to the results of acoustic surveys of the maturing, fishable stock, carried out in autumn (October–November) and/or winter (January/February) in that fishing season. For a more detailed description of the method and its past performance see e.g. Gudmundsdottir and Vilhjalmsson 2002; ICES 2004.A summary of the results of this catch regulation procedure is given in Table 11.1.1.

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

11.1.2 The fishery in the 2004/05 season

In November 2003, an attempt to locate juvenile age 1 and 2 capelin (year classes 2002 and 2001 respectively) failed completely, as did a survey carried out in April 2005. Consequently the WGNPBW had no data at its 2004 spring meeting with which to predict fishable/spawning stock abundance in the 2004/05 season. Therefore, the Working Group recommended that the fishery should not be opened until further surveys had shown large enough numbers of maturing capelin to enable a fishery leaving at least 400 000 t to spawn in spring 2005. ACFM concurred with this advice which was accepted by all parties concerned.

Yet another survey was carried out in mid-May, but recorded very small numbers of capelin of ages 2 and 3. In fact it was not until during a survey during late June/early July that enough capelin were located and measured to start a summer fishery in 2004. Details of these and later surveys in 2004 and 2005 are given in Section 11.3 and Tables 11.3.2.1-4 .

The fishery began in late June and in early July capelin schools were being fished in deep waters north of the Vestfirdir peninsula. The fishing grounds then shifted to the north and northwest and in the latter half of July most of the catch was taken in the Greenlandic EEZ. Catch rates were high in the beginning but began to drop off around 20 July and the summer fishery ended in late July. At that time the total international catch amounted to about 85 000 t.

In the last week of November a small fishery started off Vestfirdir and from then until about 20 December a few Icelandic vessels took about 7 000 t at the shelf edge north of the Vestfirdir peninsula. Most of this catch was frozen onboard and sold for human consumption.

The total international catch in the 2004 summer and autumn season was about 92 000 t (Table 11.2.1).

In the first days of January 2005, nine scouting vessels searched the area from west and northwest of Vestfirdir, north of Iceland to 68˚20'N and off the northern east coast to 9˚W. This operation took no more than 3 days and located dense capelin schools near and some way off the shelf edge off the eastern north coast of Iceland. The scouting vessels found no capelin elsewhere. The winter fishery in 2005 started in early January in this area where there were large, dense schools of capelin and high catch rates.

In the first 2-3 weeks of January, the capelin migrated quickly east and southeast along the Icelandic shelf edge and were followed by the fishing fleet. On arriving in the area near the cold-warm boundary area off the southern east coast of Iceland in late January, the southward migration stopped and the schools tended to disperse and reassemble in tune but out of phase with the fishing intensity.

The first spawning migration did not enter the warm Atlantic waters off the southeast coast until mid-February, which is unusually late in view of their relatively early arrival in the area east of Iceland. From there, the capelin migrated slowly westward in near-shore waters. As usual, catch rates were high in the shallow water area throughout February, but from consultations with the fishing skippers it seems obvious that the abundance of capelin migrating west along the coast was nowhere nearly as large as expected from what had been recorded by a research vessel and later observed by the fishing fleet northeast and east of Iceland. Furthermore, maturing was rapid and none of the capelin arriving from the east seemed to round the Reykjanes promontory to spawn off the west coast.

In early March, schools of mature capelin were found migrating south off the Vestfirdir peninsula. Since capelin, that had entered the south coast spawning grounds from the east were already spawning, the fishery shifted to the western area. Good catches were taken in this area for about two weeks. Furthermore, a few loads were taken in Isafjardardjup, the northernmost fjord system on the Vestfirdir peninsula, as well as in the outer reaches of Eyjafjordur on the central north coast. Such occurrences are highly unusual but not previously unknown.

The total international catch during the 2005 winter season was 692 000 t (Table 11.2.1). Due to the abrupt end of the fishery around mid-March, all of the TAC set for the 2003/04 season was not taken.

11.2 Catch Statistics

The total annual catch of capelin in the Iceland-East Greenland-Jan Mayen area since 1964 is given by weight, season, and fleet in Table 11.2.1.

The total catch in numbers during the summer/autumn 1982–2004 and winter 1983–2005 seasons is given by age and years in Tables 11.2.2 and 11.2.3.

The distribution of the catch during the summer-autumn 2004 and winter 2005 seasons is given by length groups at age in Tables 11.2.4 and 11.2.11.

11.3 Surveys of Stock Abundance

11.3.1 0-group surveys

The distribution and abundance of 0-group capelin in the Iceland-East Greenland-Jan Mayen area has been recorded during surveys carried out in August since 1970. The survey methods and computations of abundance indices were described by Vilhjálmsson and Fridgeirsson (1976). These surveys have been discontinued, the last being conducted in 2003. The abundance indices of 0-group capelin until 2003, divided according to areas, are given in Table 11.3.1.1.

It is of interest that since 2000 0-group capelin have been distributed progressively further west and in 2003 there were practically no 0-group capelin in Icelandic waters except far to the north off the Vestfirdir peninsula.

Acoustic estimates of the abundance of 1-group capelin have also been obtained during the August 0-group surveys (e.g. Vilhjálmsson 1994). However, due to the large variability of this time series, the August abundance indices have not been used for stock projections for more than a decade. Directed collection of data on juvenile age 1 and 2 capelin in August has been discontinued. The abundance of 1-group capelin by number, mean length and weight for 1983–2003 is given in Table 11.3.1.2.

11.3.2 Stock abundance in summer/autumn 2004 and winter 2005

11.3.2.1 The adult fishable stock

As described earlier, the autumn 2003 survey located but very small numbers of capelin of the 2001 and 2002 year classes. For that reason, ICES advised that the summer 2004 fishery not be opened until later surveys had located these capelin and assessed them in high enough numbers to justify a fishery with traditional conditions of a remaining spawning stock of 400 000 t.

Attempts were made to establish the whereabouts and assess the abundance of capelin of the above year classes, first during 13-20 April and, second, during 16-22 May 2005. There were severe limitations on area coverage due to drift ice, especially in April, and both of these surveys were dismal failures.

During 25 June – 6 July the area from 31˚W to the east of Iceland was thoroughly searched by 6 scouting vessels. No capelin were found east of 20˚W and the research vessel could therefore concentrate its effort on the region west of that. Capelin were distributed over a wide area between 20˚W and 31˚W and it was believed that the survey had not covered all of the possible distribution area. The details of the June/July survey results are given in Table 11.3.2.1.1.

Despite assistance of 6 scouting vessels, the autumn 2004 acoustic assessment survey recorded very few adult capelin of the 2002 and 2001 year classes (Table 11.3.2.1.2). According to this result the remainder of the preliminary TAC should have been revoked. However, this was not done since there was no ongoing fishery and drift ice precluded surveying parts of the E-Greenland shelf where adult capelin have occasionally been found at this time of year. Due to difficult weather and limited ship time an area east and northeast of Scoresby Sound, often rich in capelin in previous years, was not surveyed.

Due to the unusually large uncertainty associated with the prediction of the fishable stock size in the 2004/05 season, nine fishing vessels were recruited to carry out a coordinated pilot survey off NW- N- and E-Iceland in the beginning of January 2005 Although capelin were only recorded in a fairly restricted areas off the eastern north coast and northeast of Iceland, densities were extremely high in places. On the basis of the findings by the scouting vessels, a research vessel completed an acoustic survey of these areas during 6-10 January. The total adult stock biomass came to 1 270 000 t. Details of this assessment are given in Table 11.3.2.1.3.

Due to the high variability inherent in surveys where there are large variations of density within relatively small areas, it would have been preferable to repeat the assessment. This was not done since the capelin were beginning to migrate east and south at high but variable speed and another estimate would therefore have had to wait for at least 2 weeks, i.e. until all of the capelin had assembled north of the warm water front east of Iceland. However, the January assessment survey was run against the direction of migration and it was not attempted to correct for this possible negative bias.

As mentioned earlier, a capelin migration was found heading southward off the Vestfirdir peninsula in the beginning of March. The abundance of these capelin was assessed in early March at about 165 000 t. These proved to be mature capelin with a somewhat higher proportion of the older year class (2001) than observed among the eastern migration.

Thus, the total biomass of adult capelin, assessed northeast and later west of Iceland in January and March 2005 amounted to a total of 1 435 000 t, assuming that the western migration had not been part of the January assessment.

However, the possibility that part of the westernmost capelin recorded north of Iceland in January at about 16˚-17˚W cannot be excluded. Such a case was observed in winter 1980 when the main migration, having reached longitude 19˚W off central N-Iceland, did an about turn and finally arrived on the spawning grounds off the Icelandic west coast in February/March (Vilhjálmsson 1994). In this connection it may also be noted that during the warm years in the late 1920s and early 1930s it was noted that capelin ceased to spawn south of Iceland, but spawned in stead in the lagoon of Hornafjordur (SE-Iceland as well as off the north coast (Sæmundsson, 1934)

Details of the January and March 2005 acoustic estimates of adult capelin are given in Tables 11.3.2.1.3 - 11.3.2.1.4.

11.3.2.2 Estimates of immature capelin

As stated earlier the acoustic survey, carried out in November 2004, only recorded very few capelin, both adults and juveniles. These capelin were extremely scattered and the total estimate was only 16*109 fish representing a biomass of 192 thousand t. The winter (January-March) 2005 assessment surveys of the mature fishable stock hardly recorded any immature capelin at all. A survey of the Denmark Strait and the Greenland plateau west of there had been planned to take place after the assessment of the adult fishable/spawning stock in January. This plan had to be abandoned because of stormy weather and drift ice.

At present (late April 2005) ice covers the Greenland half of the Denmark Strait. Although the ice cover appears to be diminishing, experience shows that such ice will take several weeks to recede sufficiently for effectively surveying that area for capelin. A survey, aimed at locating and assessing the fishable stock for 2005/06 (year classes 2002 and 2003, is scheduled by the MRI to begin on 20 June. A participation of 4-6 scouting vessels will be arranged.

While the autumn 2004 survey results may correctly reflect an extremely low abundance of the 2003 year class, there may be environmental factors at play, affecting i.a. the geographic distribution of the juvenile stock (see Section 11.7) and therefore its availability to the survey as it was run.

11.4 Historical Stock Abundance

The historical estimates of stock abundance are based on the “best” acoustic estimates of the abundance of maturing capelin in autumn and/or winter surveys, the “best” in each case being defined as that estimate on which the final decision of TAC was based. Taking account of the catch in number and a monthly natural mortality rate of M = 0.035 (ICES 1991/Assess:17; Gudmundsdottir and Vilhjálmsson 2002), abundance estimates of each age group are then projected to the appropriate point in time. Since natural mortality rates of juvenile capelin are not known, their abundance by number has been projected using the same natural mortality rate.

The annual abundance by number and weight at age for mature and immature capelin in the Iceland-East Greenland-Jan Mayen area has been calculated with reference to 1 August and 1 January of the following year for the 1978/79–2004/05 seasons. The results are given in Tables 11.4.1 and 11.4.2 (1 August and 1 January, respectively). Table 11.4.2 also gives the remaining spawning stock by number and biomass in March/April 1979–2005.

The observed annual mean weight at age, obtained from catch and survey data from January, was used to calculate the stock biomass on 1 January. The observed average weight at age of adult capelin in autumn (Table 11.5.1.2) is used to calculate stock biomass of the maturing components in summer. Because there is a small weight increase among mature capelin in February and March, the remaining spawning stock biomass is underestimated.

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

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

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

Acoustic survey estimates of juvenile capelin abundance have been used to predict fishable stock abundance in the following year (fishing season) using the historical comparisons shown in Figure 11.5.2.1. Historical average mean weight at age (in later years the relationship between numerical stock abundance and growth shown in Fig. 11.5.2.2), growth rates and natural mortality have been used for calculations and projections of maturing and fishable stock biomass.

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

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

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

11.6 Precautionary Approach to Fisheries Management

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

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

11.7 Special Comments

The autumn surveys of 2002 and 2003 failed to locate age 1 and 2 immature capelin, i.e. the age groups on which the fishery in the 2003/04 and 2004/05 seasons would be based.

A survey, lasting for one week, was conducted in the area west off Vestfirdir, between 66°N and 68°N and reaching west to 30-31°W during 12-18 April 2003. Considerable and, in places, very dense capelin concentrations were recorded during this survey, mostly on either side of the deep Iceland-Greenland Channel, around 66°N where practically no capelin were seen about two weeks earlier. West of there, the capelin were much more scattered and in places difficult to separate from echoes of other life forms in the area. These recordings consisted exclusively of age groups 2 and 3 and translated into a total of 61.5*109 individuals. This estimate was then projected with an M=0.035/month back in time to November 2002 and then used to predict adult fishable/spawning stock abundance in the 2003/04 season. This gave a preliminary TAC of 835 000 t for the 2003/004 season corresponding to a precautionary TAC of 555 000 t, which subsequently was set.

Like in November 2002, the autumn survey of 2003 also failed to locate immature age 1 and 2 capelin, except in very small numbers. Attempts in April and May 2004 to search for and assess these age groups of the 2004/05 season were unsuccessful, i.a. because of drift ice in the Denmark Strait and westward over the E-Greenland shelf. During 25 June -6 July 2004, these capelin were located and assessed in the area from north of the Vestfirdir peninsula of Iceland (about 20˚W) westward to about 31˚W. Following this abundance estimate, a small precautionary quota of 335 000 t was set for the period June-November 2004. However, the final quota could not be determined until early January 2005 and amounted to just under 900 000 t.

From this, and the unusual westerly distribution of the 2001 and 2002 yeas classes at the 0-group stage, it seems clear that the warming of Icelandic water, observed in the last few years and possibly associated with changes in surface ocean currents, has displaced the drift routes of 0-group capelin westward. From this it has followed naturally that the young capelin have not grown in the waters north of Iceland as they did for the most part in the 1980s and 1990s, but instead on the Greenland plateau much farther west. Naturally, this means that a ‘normal’ autumn survey coverage was inadequate for detecting and assessing juvenile capelin of ages 1 and 2. Fortunately, growth conditions must have been good in these new juvenile areas. This statement is supported, both by the fact that the 2001 and 2002 year classes appear to be of a good average size, and the relatively high mean weight of these fish as adults.

Furthermore, the adult spawning stock has arrived later in autumn/winter than usual, has also tended to keep to deeper waters while migrating towards the spawning grounds in the coastal areas off S- and W-Iceland. Adult capelin have thus also been less available to fish predators such as cod probably explaining, at least in part, the observed reduced mean weight at age in the Icelandic cod in recent years . Whether this situation will prevail for any length of time cannot be predicted, but if it does it will negatively affect bioproduction of Icelandic waters at the higher trophic levels.

Finally, unless the juvenile 1- and 2-group capelin can be located and assessed in late autumn on a regular basis, the established model of predicting the abundance of mature capelin will obviously become obsolete..

An overview of stock developments during 1978–2004 is given in Table 11.7.1.

11.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 2004	15	1500	1575
Survey 2004	23	2300	2270
Fishery 2005	28	2800	2785
Survey 2005	15	1500	1485

Table 11.1.1 Preliminary TACs for the summer/autumn fishery, recommended TACs for the entire season, landings and remaining spawning stock (000 tonnes) in the 1992/93–2004/05 seasons.

SEASON	92/93	93/94	94/95	95/96	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05
Prelim. TAC	500	900	950	800	1100	850	950	866	975	1050	1040	835	335
Rec. TAC	900	1250	850	1390	1600	1265	1200	1000	1090	1325	1000	875	987
Landings	788	1179	842	930	1571	1245	1100	934	1065	1249	988	741	783
Spawn. stock	460	460	420	830	430	492	500	650	450	475	410	535	602

Table 11.2.1 The international capelin catch 1964–2004 (thousand tonnes).

	WINTER SEASON					SUMMER AND AUTUMN SEASON						
Year	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	EU	Season total	Total
1964	8.6	-	-		8.6	-	-	-		-	-	8.6
1965	49.7	-	-		49.7	-	-	-		-	-	49.7
1966	124.5	-	-		124.5	-	-	-		-	-	124.5
1967	97.2	-	-		97.2	-	-	-		-	-	97.2
1968	78.1	-	-		78.1	-	-	-		-	-	78.1
1969	170.6	-	-		170.6	-	-	-		-	-	170.6
1970	190.8	-	-		190.8	-	-	-		-	-	190.8
1971	182.9	-	-		182.9	-	-	-		-	-	182.9
1972	276.5	-	-		276.5		-	-		-	-	276.5
1973	440.9	-	-		440.9	-	-	-		-	-	440.9
1974	461.9	-	-		461.9	-	-	-		-	-	461.9
1975	457.1	-	-		457.1	3.1	-	-		-	3.1	460.2
1976	338.7	-	-		338.7	114.4	-	-		-	114.4	453.1
1977	549.2	-	24.3		573.5	259.7	-	-		-	259.7	833.2
1978	468.4	-	36.2		504.6	497.5	154.1	3.4		-	655.0	1,159.6
1979	521.7	-	18.2		539.9	442.0	124.0	22.0		-	588.0	1,127.9
1980	392.1	-	-		392.1	367.4	118.7	24.2		17.3	527.6	919.7
1981	156.0	-	-		156.0	484.6	91.4	16.2		20.8	613.0	769.0
1982	13.2	-	-		13.2	-	-	-		-	-	13.2
1983	-	-	-		-	133.4	-	-		-	133.4	133.4
1984	439.6	-	-		439.6	425.2	104.6	10.2		8.5	548.5	988.1
1985	348.5	-	-		348.5	644.8	193.0	65.9		16.0	919.7	1,268.2
1986	341.8	50.0	-		391.8	552.5	149.7	65.4		5.3	772.9	1,164.7
1987	500.6	59.9	-		560.5	311.3	82.1	65.2		-	458.6	1,019.1
1988	600.6	56.6	-		657.2	311.4	11.5	48.5		-	371.4	1,028.6
1989	609.1	56.0	-		665.1	53.9	52.7	14.4		-	121.0	786,1
1990	612.0	62.5	12.3		686,8	83.7	21.9	5.6		-	111.2	798.0
1991	202.4	-	-		202.4	56.0	-	-		-	56.0	258.4
1992	573.5	47.6	-		621.1	213.4	65.3	18.9	0.5	-	298.1	919.2
1993	489.1	-	-	0.5	489.6	450.0	127.5	23.9	10.2	-	611.6	1,101.2
1994	550.3	15.0	-	1.8	567.1	210.7	99.0	12.3	2.1	-	324.1	891.2
1995	539.4	-	-	0.4	539.8	175.5	28.0	-	2.2	-	205.7	745.5
1996	707.9	-	10.0	5.7	723.6	474.3	206.0	17.6	15.0	60.9	773.8	1,497.4
1997	774.9	-	16.1	6.1	797.1	536.0	153.6	20.5	6.5	47.1	763.6	1,561.5
1998	457.0	-	14.7	9.6	481.3	290.8	72.9	26.9	8.0	41.9	440.5	921.8
1999	607.8	14.8	13.8	22.5	658.9	83.0	11.4	6.0	2.0	-	102.4	761.3
2000	761.4	14.9	32.0	22.0	830.3	126.5	80.1	30.0	7.5	21.0	265.1	1,095.4
2001	767.2	-	10.0	29.0	806.2	150.0	106.0	12.0	9.0	17.0	294.0	1,061.2
2002	901.0	-	28.0	26.0	955.0	180.0	118.7	-	13.0	28.0	339.7	1,294.7
2003	585.0	-	40.0	23.0	648.0	96.5	78.0	3.5	2.5	18.0	198.5	846.5
2004	478.8	15.8	30.8	17.5	542.9	46.0	34.0	-	12.0		92.0	634.9
2005	594.1	69.0	19.0	10.0	692.1							

Table 11.2.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the autumn season (August-December) 1983–2004.

	Year										
Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
1	0.6	0.5	0.8	+	+	0.3	1.7	0.8	0.3	1.7	0.2
2	7.2	9.8	25.6	10.0	27.7	13.6	6.0	5.9	2.7	14.0	24.9
3	0.8	7.8	15.4	23.3	6.7	5.4	1.5	1.0	0.4	2.1	5.4
4	-	0.1	0.2	0.5	+	+	+	+	+	+	0.2
Total number	8.6	18.2	42.0	33.8	34.4	19.3	9.2	7.7	3.4	17.8	30.7
Total weight	133.4	548.5	919.7	772.9	458.6	371.4	121.0	111.2	56.0	298.1	611.6

	Year										
Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0.6	1.5	0.2	1.8	0.9	0.3	0.2	+	+	0.3	+
2	15.0	9.7	25.2	33.4	25.1	4.7	12.9	17.6	18.3	11.8	5.3
3	2.8	1.1	12.7	10.2	2.9	0.7	3.3	1.2	2.5	1.0	0.5
4	+	+	0.2	0.4	+	+	0.1	+	+	+	-
Total number	18.4	12.3	38.4	45.8	28.9	5.7	16.5	18.8	20.8	14.3	5.8
Total weight	324.1	205.7	773.7	763.6	440.5	102.4	265.1	294.0	339.7	199.5	92

Table 11.2.3 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age group in numbers (billions) and the total catch by numbers and weight (thousand tonnes) in the winter season (January-March) 1984–2005.

	Year										
Age	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
2	2.1	0.4	0.1	+	+	0.1	1.4	0.5	2.7	0.2	0.6
3	18.1	9.1	9.8	6.9	23.4	22.9	24.8	7.4	29.4	20.1	22.7
4	3.4	5.4	6.9	15.5	7.2	7.8	9.6	1.5	2.8	2.5	3.9
5	-	-	0.2	-	0.3	+	0.1	+	+	+	+
Total number	23.6	14.5	17.0	22.4	30.9	30.8	35.9	9.4	34.9	22.8	27.2
Total weight	439.6	348.5	391.8	560.5	657.2	665.1	686.8	202.4	621.1	489.6	567.1

	Year										
Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	1.3	0.6	0.9	0.3	0.5	0.3	0.4	0.1	0.1	0.6	0.1
3	17.6	27.4	29.1	20.4	31.2	36.3	27.9	33.1	32.2	24.6	31.5
4	5.9	7.7	11.0	5.4	7.5	5.4	6.7	4.2	1.9	3.0	3.1
5	+	+	+	+	+	+	+	+	+	+	-
Total number	24.8	35.7	41.0	26.1	39.2	42.0	35.0	37.4	34.4	28.3	34.7
Total weight	539.8	723.6	797.6	481.3	658.9	830.3	787.2	955.0	648.0	542.9	692

Table 11.2.4 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the summer/autumn season of 2004 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 1	Age 2	Age 3	Age 4	Total	Percentage
12	+	49	0	0	49	0.8
12.5	+	396	0	0	396	6.5
13	+	1126	12	0	1138	18.7
13.5	0	1312	25	0	1336	21.9
14	0	1126	111	0	1237	20.3
14.5	0	903	124	0	1027	16.8
15	0	495	74	0	569	9.3
15.5	0	124	99	0	223	3.7
16	0	37	49	0	87	1.4
16.5	0	12	12	+	25	0.4
17		0	12	+	12	0.2
Total number	+	5580	520	+	6100	
Percentage	+	91.5	8.5	+	100.0	100.0
Total weight	0.1	82.0	9.8	0.1	92.0	

Table 11.2.5 The total international catch in numbers (millions) of capelin in the Iceland-East Greenland-Jan Mayen area in the winter season of 2005 by age and length, and the catch in weight (thousand tonnes) by age group.

Total length (cm)	Age 2	Age 3	Age 4	Age 5	Total	Percentage
12	83	0	0	0	83	0.2
12.5	189	0	0	0	189	0.5
13	177	28	0	0	205	0.6
13.5	173	331	0	0	505	1.5
14	39	1536	12	0	1587	4.6
14.5	12	3262	132	0	3406	9.8
15	28	6092	148	0	6268	18.1
15.5	0	6798	436	0	6634	19.1
16	0	5949	474	+	6823	19.7
16.5	0	5384	842	0	5326	15.3
17	0	2035	578	+	2614	7.5
17.5	0	568	312	0	880	2.5
18	0	24	140	0	164	0.5
18.5	0	0	28	0	28	0.1
Total number	701	32006	3102	+	34709	
Percentage	2.0	92.2	8.9	0.0	100.0	100.0
Total weight	7.8	611.3	72.9	0.1	692.1	

Table 11.3.1.1 Abundance indices of 0-group capelin 1970-2003 and their division by areas.

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

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

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

Table 11.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys for 1983–2001.

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

	YEAR							
	1997	1998	1999	2000	2001	2002	2003	2004
						No survey		
Number (10^9)	143	87	55	94	99			
Mean length (cm)	9.3	9.0	9.5	9.5	10.0			
Mean weight (g)	2.8	2.9	3.2	3.1	3.7			

Table 11.3.2.1.1 Assessment of capelin in the Iceland/Grenlnd/Jan Mayen area, 25/6-6/7 2004. (Numbers in billions, biomass in thousand tonnes)

Length (cm)	Age 1	2	3	Number (10^{-9})	Average weight (g)	Biomass (´000 t)
7.5	0.031	0.000	0.000	0.031	1.4	0.1
8	0.249	0.000	0.000	0.249	1.7	0.4
8.5	0.257	0.000	0.000	0.257	2.4	0.6
9	1.042	0.000	0.000	1.042	2.8	2.9
9.5	1.880	0.000	0.000	1.880	3.5	6.6
10	4.307	0.150	0.000	4.457	4.1	18.2
10.5	3.620	0.928	0.000	4.548	4.7	21.3
11	2.053	1.150	0.000	3.203	5.3	17.1
11.5	0.460	1.246	0.000	1.705	5.9	10.1
12	0.000	0.761	0.000	0.761	7.0	5.3
12.5	0.000	1.647	0.000	1.647	7.8	12.9
13	0.000	3.958	0.041	3.999	8.7	34.8
13.5	0.000	5.659	0.044	5.703	10.0	57.3
14	0.000	7.733	0.099	7.832	11.2	87.8
14.5	0.000	8.139	0.370	8.509	12.7	107.9
15	0.000	6.095	0.526	6.621	14.6	96.7
15.5	0.000	5.096	0.444	5.540	16.2	90.0
16	0.000	1.995	0.228	2.223	18.4	40.9
16.5	0.000	0.377	0.062	0.439	20.7	9.1
17	0.000	0.122	0.003	0.126	23.2	2.9
17.5	0.000	0.000	0.022	0.022	25.0	0.6
Total number	13.899	45.056	1.839	60.794	10.3	623.6
Total biomass (´000 t)	58.8	537.1	27.6	623.5		
Average weight (g)	4.2	11.9	15.0	10.3		
Average length (cm)	10.1	14.0	15.1	13.2		
Age ratio by number	0.23.	0.74.	0.03	1		
Ratio of ages 2 and 3		0.96	0.04	1		

Table 11.3.2.1.2 Acoustic abundance estimate of mature and immature capelin, November 2004. Numbers are in millions and biomass in thousand tonnes

			Age		Total	Average	
Length (cm)	1	2	3	4	numbers	weight (g)	Biomass
9.5	22	0	0	0	22	3.2	0.1
10	229	0	0	0	229	3.2	0.7
10.5	243	0	0	0	243	4.2	1.0
11	1111	0	0	0	1111	4.9	5.5
11.5	1737	0	0	0	1737	5.7	9.9
12	394	0	0	0	394	6.6	2.6
12.5	1286	67	0	0	1353	7.2	9.8
13	1165	45	0	0	1210	8.1	9.8
13.5	730	319	0	0	1050	9.7	10.2
14	249	448	0	0	697	11.2	7.8
14.5	282	1255	45	0	1583	12.8	20.2
15	212	1445	192	11	1860	14.5	27.0
15.5	120	1435	169	0	1724	16.6	28.5
16	64	1285	135	0	1485	18.9	28.1
16.5	11	644	80	0	735	20.6	15.1
17	0	373	102	0	475	23.4	11.1
17.5	0	102	11	0	113	26.4	3.0
18	0	22	22	0	45	26.9	1.2
Total number	7858	7440	757	11	16067	11.9	191.6
Total biomass	58.5	119.3	13.7	0.2			
Mean weight (g)	7.4	16.0	18.0	14.5			
Mean length	12.3	15.3	15.8	15.0			
Percent number	48.9	46.3	4.7	0.1			

Table 11.3.2.1.3 Acoustic abundance estimate of capelin by numbers and weight, 6-10 January 2005.

Numbers (N) are billions and (B) is thousand tonnes

		Age			Mean weigth	
Length (cm)	2	3	4	Total N	(g)	Total B
14	0.3	0.4	0.0	0.6	11.0	7.1
14.5	0.0	1.6	0.0	1.6	12.7	19.8
15	0.0	4.2	0.1	4.3	14.4	61.9
15.5	0.0	11.1	0.1	11.2	16.0	179.1
16	0.0	12.0	0.4	12.4	18.1	223.8
16.5	0.0	12.0	1.0	13.0	20.4	266.4
17	0.0	10.1	0.9	11.0	23.0	253.6
17.5	0.0	5.7	0.7	6.4	25.9	166.4
18	0.0	2.1	1.0	3.1	28.2	87.9
18.5	0.0	0.1	0.1	0.2	31.5	5.8
Total	0.3	59.3	4.3	63.9	19.9	1271.6
Mean length (cm)	14.0	16.3	17.1	16.3		
Mean weight (g)	11.0	19.7	23.5	19.9		

Table 11.3.2.1.4 Abundance estimate of capelin by numbers and weight, 6.-9. March 2005. Numbers (N) are billions and (B) is thousand tonnes

	Age				Mean	
Length (cm)	2	3	4	Total N	weigth (g)	Total B
12	0.0	0.0	0.0	0.0	7.3	0.1
12.5	0.1	0.0	0.0	0.1	8.5	0.6
13	0.2	0.1	0.0	0.3	9.1	2.8
13.5	0.2	0.2	0.0	0.3	10.1	3.2
14	0.1	0.3	0.0	0.5	11.6	5.3
14.5	0.0	0.6	0.0	0.6	12.8	8.0
15	0.0	0.6	0.0	0.6	14.3	8.7
15.5	0.0	1.6	0.0	1.6	15.6	25.4
16	0.0	1.2	0.1	1.4	18.6	25.2
16.5	0.0	0.9	0.2	1.1	21.1	22.8
17	0.0	0.8	0.3	1.1	24.9	26.9
17.5	0.0	0.5	0.3	0.9	28.1	24.8
18	0.0	0.2	0.1	0.3	30.5	10.2
18.5	0.0	0.0	0.1	0.1	33.3	2.5
Total	0.7	7.0	1.2	8.8	18.9	166.5
Mean length (cm)	13.50	15.84	17.11	15.8		
Mean weight (g)	10.3	18.5	25.8	18.9		

Table 11.4.1 The estimated number (billions) of capelin on 1 August 1978–2004 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components are also given.

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

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

	Year							
Age/maturity	1998	1999	2000	2001	2002	2003	2004	
1 juvenile	167.9	138.0	145.6	139.7	142.3	131.8*	NA	
2 immature	19.2	24.4	25.0	9.0	23.9	11.4	NA	
2 mature	89.5	85.9	65.7	86.7	68.0	82.1	86.6	NA
3 mature	23.2	12.6	16.0	16.9	5.9	15.7	7.5	NA
4 mature	+	+				+		
Number immat.	187.1	162.4	170.6	148.7	166.2	143.2*	NA	
Number mature	112.7	98.5	81.7	103.6	73.9	97.8	91.4	
Weight immat	621	612	645	615	713	596*	NA	
Weight mature	1576	1703	1519	1817	1280	1544	1392	

*** Preliminary**

NA: Not available

Table 11.4.2 The estimated number (billions) of capelin on 1 January 1979–2005 by age and maturity groups. The total number (billions) and weight (thousand tonnes) of the immature and maturing (fishable) stock components and the remaining spawning stock by number and weight are also given.

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

					Year					
Age/maturity	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2 juvenile	67.8	53.9	98.9	111.6	124.6	121.3	188.1	165.2	160.0	138.8
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	24.1	29.5
3 mature	48.8	31.2	22.3	54.8	46.5	50.5	35.1	75.5	72.4	50.1
4 mature	16.0	12.1	4.5	5.3	3.5	4.6	8.7	20.1	24.8	7.9
5 mature	0.3	+	+	+	+	+	+	+	+	+
Number immat.	87.9	62.5	107.5	119.7	138.5	138.2	217.6	203.1	184.1	168.3
Number mature	64.8	43.3	26.8	60.1	50.0	55.1	43.8	95.6	97.2	58.0
Weight immat.	434	291	501	487	622	573	696	800	672	621
Weight mature	1298	904	544	1106	1017	1063	914	1820	1881	1106
Number sp.st.	22.0	5.5	16.3	25.8	23.6	24.8	19.2	42.8	21.8	27.6
Weight sp. st.	440	115	330	475	499	460	420	830	430	492

					Year		
Age/maturity	1999	2000	2001	2002	2003	2004	2005
2 juvenile	140.9	115.8	122.2	117.3	109.4	110.6*	NA
3 immature	16.1	20.5	21.0	7.6	9.4	11.4	NA
3 mature	53.2	68.2	46.3	59.3	58.4	54.2	86.6
4 mature	16.0	10.0	10.5	10.5	2.9	6.2	7.5
5 mature	+	+	+	+		+	+
Number immat.	157.0	136.3	161.2	126.6	105.1	143.5*	NA
Number mature	69.3	78.2	56.8	69.8	61.3	60.4	72.5
Weight immat.	585	535	655	510	487	511*	NA
Weight mature	1171	1485	1197	1445	1214	1204	1450
Number sp.st.	29.5	34.2	21.3	22.9	20.7	28.2	36.3
Weight sp. st.	500	650	450	475	410	535	765

***Preliminary/Predicted**

NA: Not available

Table 11.5.1.1 Data used in the comparisons between abundance of age groups (numbers) when predicting fishable stock abundance for the calcyulation of preliminary TACS

Year class	AGE 1 Acoustics	AGE 2 Back-calc. Mature	AGE 2 Acoustics Immature	AGE 2 Back-calc. Total	AGE 3 Back-calc. Mature
	N_1	N_{2mat}	N_{2imm}	N_{2tot}	N_{3tot}
1980	23.7	17.1	1.7	32.1	9.8
1981	68.0	53.7	8.2	96.2	27.9
1982	44.1	40.7	4.6	81.6	27.0
1983	73.8	64.6	12.6	164.6	65.8
1984	33.8	35.6	1.4	65.0	20.1
1985	58.0	65.4	5.4	102.6	24.5
1986	70.2	70.3	6.7	94.6	15.8
1987	43.9	42.8	1.8	53.1	6.8
1988	29.2	31.9	1.3	42.0	6.7
1989	*39.2	67.7	5.2	77.2	6.4
1990	60.0	70.7	2.3	87.3	10.9
1991	104.6	86.9	10.8	107.0	13.2
1992	100.4	59.8	6.9	95.0	24.0
1993	119.0	102.2	46.3	147.2	29.6
1994	165.0	100.7	16.4	129.4	19.0
1995	111.9	90.3	30.8	125.5	23.2
1996	128.5	89.5	6.3	108.7	12.6
1997	121.0	85.9	5.0	110.3	16.0
1998	89.8	65.7	11.0	84.1	16.9
1999	103.0	86.7	2.4	95.8	5.9
2000	100.3	68.0	3.7	89.8	15.7
2001	**74.4	82.1	NA	93.5	7.5
2002	NA	86.6	NA		

*** Invalid due to ice conditions.**

**** Projected from assessment in April 2003**

NA: Not available

Table 11.5.1.2 Mean weight (g) of maturing capelin in autumn.

	YEARS							
	1981	1982	1983	1984	1985	1986	1987	1988
Age 2	19.2	16.5	16.1	15.8	15.5	18.1	17.9	15.5
Age 3	24.0	24.1	22.5	25.7	23.8	24.1	25.8	23.4

	Years							
	1989	1990	1991	1992	1993	1994	1995	1996
Age 2	18.0	18.1	16.3	16.5	16.2	16.0	15.3	15.8
Age 3	25.5	25.5	25.4	22.6	23.3	23.6	20.5	20.6

	Years							
	1997	1998	1999	2000	2001	2002	2003	2004
Age 2	14.3	14.1	16.8	17.1	16.3	No data	No data	No dats
Age 3	20.3	18.1	20.6	24.7	23.9	No data	No data	No data

Table 11.5.1.3 Predictions of fishable stock abundance and TACs for the 1987/88–2004/05 seasons.
The last row gives contemporary advice on TACs for comparison.
Age 2 and age 3 = Numbers in billions in age groups at the beginning of season.
Fishable stock = calculated weight of maturing capelin in thousand tonnes (ref. August).
TAC calc = predicted in thousand tonnes.

Season	**87/88**	**88/89**	**89/90**	**90/91**	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**
Year classes	85-84	86-85	87-86	88-87	89-88	90-89	91-90	92-91	93-92
Age 2	55.5	64.8	43.2	31.1	39.4	56.4	93.1	89.6	92.5
Age 3	13.7	29.0	25.5	8.2	3.7	18.3	22.6	27.0	14.9
Fishable stock	1268	1800	1350	724	755	1398	2123	2170	1916
Calculated TAC	642	1105	713	170	197	755	1385	1427	1200
Advised TAC	1115	1036	550	265	740	*900	1250	850	1390

Season	96/97	97/98	98/99	99/00	00/01	01/02	02/03	03/04	04/05
Year classes	94-93	95-94	96-95	97/96	98 /97	99/98	00/99	01/02	02/03
Age 2	90.0	83.8	94.4	89.2	70.9	77.1	77.2	63.0	45.1
Age 3	35.0	30.9	30.8	23.3	19.2	16.9	17.3	15.6	1.9
Fishable stock	2352	2019	2088	1885	1584	1620	1642	1424	710
Calculated TAC	1635	1265	1420	1285	975	1050	1040	835	335
Advised TAC	1600	1265	1200	1000	**1090	1350	1005	875	985

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

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

Table 11.7.1 Capelin in the Iceland-East Greenland-Jan Mayen area 1978-2004. Recruitment of 1 year old fish (unit 10^9) and total stock biomass ('000 t) are given for 1 August Spawning stock biomass ('000 t) is given at the time of spawning (March next year). Landings ('000 t) are the sum of the total landings in the season starting in the summer/autumn of the year indicated and ending in March of the following year.

Year	Recruitment	Total Stock biomass	Landings	Spawning stock biomass
1978	164	2832	1195	600
1979	60	2135	980	300
1980	66	1130	684	170
1981	49	1038	626	140
1982	146	1020	0	260
1983	124	2070	573	440
1984	251	2427	897	460
1985	99	2811	1312	460
1986	156	3106	1333	420
1987	144	2639	1116	400
1988	81	2101	1037	440
1989	64	1482	808	115
1990	118	1293	314	330
1991	133	1975	677	475
1992	163	2058	788	499
1993	144	2287	1179	460
1994	224	2287	864	420
1995	197	3007	929	830
1996	191	2885	1571	430
1997	165	2348	1245	492
1998	168	2197	1100	500
1999	138	2315	933	650
2000	146	2164	1071	450
2001	140	2432	1249	475
2002	142	1993	988	410
2003	*132	*2140	741	535
2004	NA	NA	784	765

***Preliminary**

NA: Not available

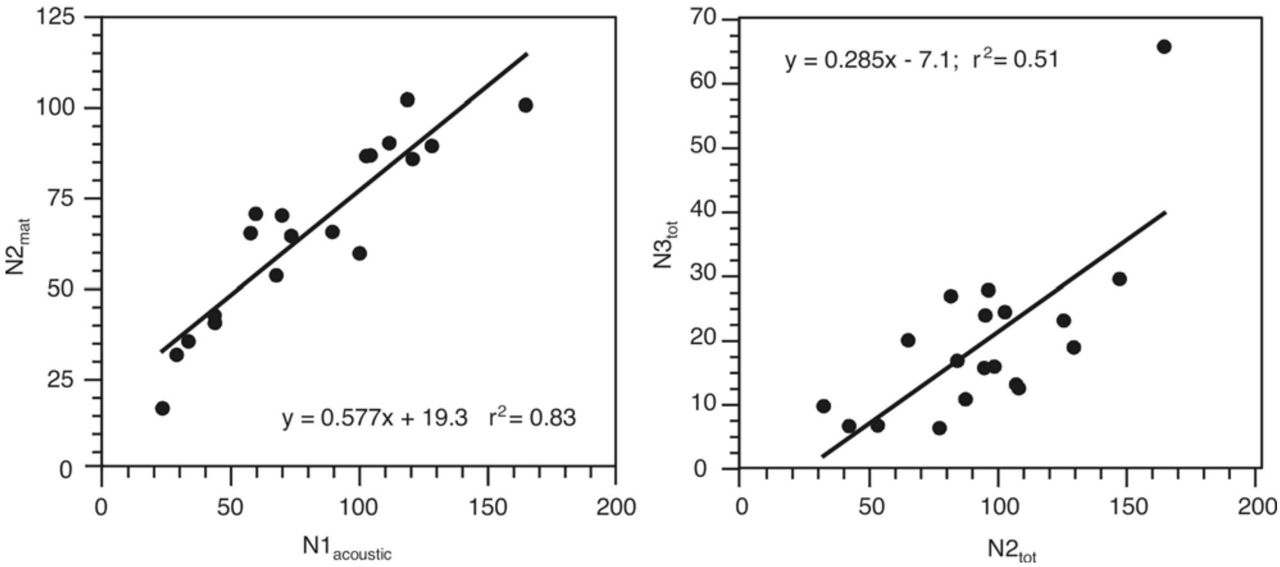


Figure 11.5.2.1. The relationship between the measured numbers of immature 1-group capelin in autumn acoustic surveys and the numbers of maturing capelin in 1 August of the following year (left hand figure) and between measuredtotal numbers of 2-group capelin and the maturing 3-group capelin in the following year (right hand figure).

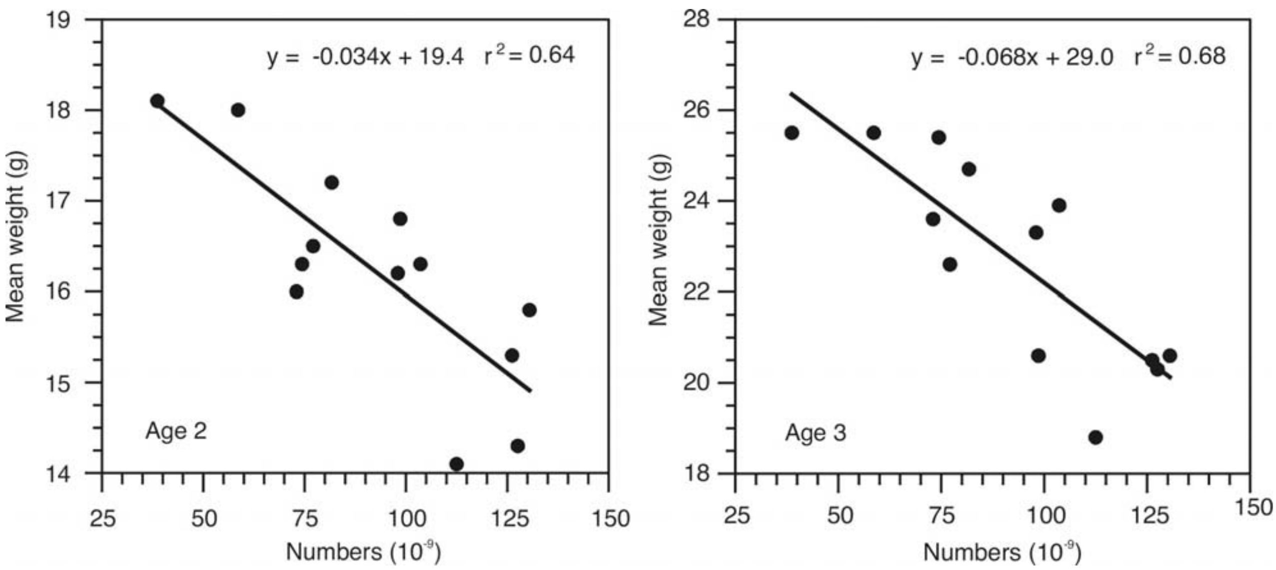


Figure 11.5.2.2. The relationship between the total numbers in the maturing stock and the mean weight of maturing 2-group (left hand figure) and 3-group (right hand figure) in autumn 1989ö2001.

Annex 1: List of participants

NORTH-WESTERN WORKING GROUP

ICES, Headquarters, 26 April - 5 May 2005

LIST OF PARTICIPANTS

NAME	ADDRESS	TELE-PHONE	FAX	E-MAIL
Einar Hjörleifsson (Chair)	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	einarhj@hafro.is
Jesper Boje	Danish Institute of Fisheries Research Dept of Marine Fisheries Charlottenlund Castle 2920 Charlottenlund Denmark	+45 33 96 34 64	+45 33 96 33 33	jbo@dfu.min.dk
Höskuldur Björnsson	Marine Research Institute P.O. Box 1390 Skulagata 4 121 Reykjavik Iceland	+354 552 0240	+354 562 3790	hoski@hafro.is
Fernando Gonzalez	Centro Oceanografico de Vigo Punta de Apio - San Miguel de Oya Apdo 1552 36280 Vigo Spain			fernando.gonzalez@vi.ieo.esSigurdur Jónsson
Asta Gudmundsdóttir	Marine Research Institute P.O. Box 1390 Skúlagata 4 IS-l21 Reykjavík Iceland	+354 575 2114		asta@hafro.is
Agnes C. Gundersen	Møreforsking P.O. Box 5075 6021 Aalesund Norway	+ 47 70 16 13 50	+47 70 13 89 78	agnes@mfaa.no
Sigurdur Thor Jónsson	Marine Research Institute P.O. Box 1390 Skúlagata 4 IS-l21 Reykjavík Iceland			sigurdur@hafro.is

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Kristján Kristinsson	Marine Research Institute P.O. Box 1390 121 Reykjavik Iceland	+354 552 0240	+354 562 3790	krik@hafro.is
Jean-Jacques Maguire	1450 Godefroy Sillery Québec Canada G1T 2E4	+1 418 688 5501	+1 418 688 7924	jjmaguire@ sympatico.ca
Sergei Melnikov	PINRO 6, Knipovitch Street 183763 Murmansk Russia	+47 789 10 518	+47 789 10 58	sergey_m@pinro.ru
Lise Helen Ofstad	Fiskirannsóknarstovan Nóatún 1 P.O. Box 3051 FR-110 Tórshavn Faroe Islands	+298 31 5092	+298 31 8264	liseo@frs.fo
Marie Storr-Paulsen	Greenland Institute of Natural Resources P.O.Box 570 3900 Nuuk Greenland	+299 328 095 244		rie@natur.gl
Hans Joachim Rätz	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+49 40 38905 169	+49 40 38905 263	hans-joachim.raetz@ish.bfa-fisch.de
Jákup Reinert	Fiskirannsóknar-stovan Nóatún 1 P.O. Box 3051 FO-110 Tórshavn Faroe Islands	+298 35 3900	+298 35 3901	jakupr@frs.fo
José Luis del Rio	Inst. Español de Oceanografia Centro Oceanográfico de Vigo Cabo Estay – Canido Apdo 1552 E-36200 Vigo Spain			Joseluis.delrio@ vi.ieo.es
Torsteinn Sigurdsson	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	steini@hafro.is
Bjorn Ævarr Steinarsson	Marine Research Institute Skúlagata 4 121 Reykjavik Iceland	+354 55 20240	+354 56 23790	bjorn@hafro.is

NAME	ADDRESS	TELEPHONE	FAX	E-MAIL
Petur Stein-grund	Fiskirannsóknar-stovan Nóatún P.O. Box 3051 100 Tórshavn Faroe Islands	+298 3 15092	298 3 18264	peturs@frs.fo
Christoph Stransky	Bundesforschungsanstalt f. Fischerei Institut für Seefischerei Palmaille 9 D-22767 Hamburg Germany	+49 4038905228	+49 4038905263	christoph.stransky@ish.bfa-fisch.de
Hjalmar Vilhjalmsson	Marine Research Institute P.O. Box 1390 Skúlagata 4 IS-l21 Reykjavík Iceland			hjalmar@hafro.is

Annex 2: List of working documents

WD01. Rätz, H.-J., Stransky, C. and Lloret, J. 2005. Groundfish survey sesults for cod off Greenland (offshore component) 1982-2004.

WD02. Rätz, H.-J., Stransky, C. and Panten, K. 2005. Data on German landings and effort for Greenland halibut (Reinhardtius hippoglossoides), demersal redfish (Sebastes marinus and demersal S. mentella), and Atlantic cod (Gadus morhua) in ICES Div. Va, Vb, VIa and XIV, 1995-2004.

WD03. Janusz, J. 2005. Description of Polish fishery of pelagic redfish (Sebastes mentella) in the Irminger Sea and adjacent waters in 2002-2004.

WD04. Boje, J. 2005. The fishery for Greenland halibut in ICES Div. XIVb in 2004.

WD05. Alpoim, R., Vargas, J. and Santos, E. 2005. Report of the Portuguese Sebastes mentella fishery in 2004: ICES Div. XII, XIVb and NAFO Div. 1F.

WD06. Storr-Paulsen, M. and Wieland, K. 2005. Survey results and commercial data for Atlantic cod in Greenland inshore and offshore waters in 2004.

WD07. Melnikov, S.P. and Bakay, Y.I. 2005. Proposals on improvement of management measures in demersal and pelagic fisheries of Sebastes mentella in the Reykjanes Ridge area

WD08. Melnikov, S.P., Bakay, Y.I., Makeenko, G.A. and Kalashnikova, M.Y. 2005. Structure of Sebastes mentella concentrations in demersal and pelagic fisheries in the Reykjanes Ridge area.

WD09. Melnikov, S.P. 2005. Preliminary information about Russian fishery for the oceanic S. mentella in ICES Subareas XII, XIV, in NAFO Divisions 1F, 2J in 2004 and biological sampling from commercial catches.

WD10. Stransky, C., Rätz, H.-J. and Panten, K. 2005. On the German fishery and biological characteristics of pelagic redfish (Sebastes mentella Travin) 1991-2004.

WD11. Jørgensen, O.A. 2005. Survey for Greenland halibut in ICES Division 14B, June 2004.

WD12. Ridao Cruz, L. 2005. Some exploratory analysis on the GLM model used to predict maturity for Faroese saithe.

WD13. Sigurdsson, T., Rätz, H.-J., Nedreaas, K., Melnikov, S.P. and Reinert, J. 2005. Fishery on pelagic redfish (S. mentella, Travin): Information based on log-book data from Faroe Island, Germany, Greenland, Iceland, Norway and Russia.

WD14. Stransky, C. and Rätz, H.-J. 2005. Abundance and length composition for Sebastes marinus L., deep sea S. mentella and juvenile redfish (Sebastes spp.) off Greenland based on groundfish surveys 1985-2004.

WD15. Reinert, J. 2005. Some information on the Faroese redfish fishery with emphasize on Faroese Waters.

WD16. Ofstad, L.H. 2005. Preliminary Assessment of Faroe Saithe.

WD17. Durán Muñoz, P., González, F. and Ramilo, L. 2005. By-catch of Greenland halibut in the Spanish bottom trawl commercial fishery at Hatton bank: Some preliminary data (1996-2004).

WD18. Boje, J. and Ridao Cruz, L. 2005. Fishery and survey data on Greenland halibut in Faroese waters (Div. Vb).

WD19. González, F. and del Rio, J.L. 2005. Description of the Spanish pelagic fishery of oceanic redfish (Sebastes mentella Travin) in the North Atlantic (2000-2004).

WD20. Reinert, J. 2005. Preliminary assessment of Faroe haddock.

WD21. Kristinsson, K. and Sigurdsson, T. 2005. Stock assessment of Sebastes marinus from Iceland grounds (ICES Division Va) in 2004. Tables and Figures.

WD22. Kristinsson, K. and Sigurdsson, T. 2005. Stock assessment of shelf deep-sea Sebastes mentella from Iceland grounds (ICES Division Va) in 2004. Tables and figures.

WD23. Thordarson, G. 2005. On the apparent increase of mature aged 4 cod from commercial catches in Iceland in 1991-2004.

WD24. Sigurdsson, T. and Kristinsson, K. 2005. Information on the Icelandic fishery of S. mentella Travin; Information based on log-book data and sampling from the commercial fishery.

WD25. Sigurdsson, T. and Thorsteinsson, V. 2005. In situ tagging of deep-sea redfish: First application of underwater fish tagging equipment.

WD26. Jónsson, S.T. 2005. Simple models of weight at age in stock and landings of saithe in Icelandic waters.

WD27. Steingrund, P. and Mouritsen, R. 2005. Incomplete area coverage of the Faroese summer groundfish survey and the effect upon stock assessment of Faroe Plateau cod.

WD28. Steingrund, P. 2005. Preliminary assessment of Faroe Plateau cod.

WD29. Ofstad, L.H. 2005. Faroese ground fish surveys as tuning series of Faroe saithe.

WD30. Björnsson, H. 2005. Prediction of weights at age for Icelandic cod.

WD31. Gudmundsdottir, A. and Sigurdsson, T. 2005. Icelandic summer spawning herring

Input data and first analysis.

WD32. Stefánsson, M.Ö., Gíslason, D., Þorgilsson, B., Ragnarsdóttrir, A., Pampoulie, C., Chosson, V., Jörundsdóttir, Þ., Daníelsdóttir, A.K., Sigurðsson, Þ. 2005. Depth as a barrier to gene-flow in S. mentella within the Irminger Sea.

WD33. Steingrund, P. 2005. Assessment of Faroe Plateau cod and input to prediction.

WD34. Gudmundsson, G. 2005. Time series analyses of catch-at-age and CPUE observations of Icelandic cod, haddock, saithe and herring.

WD35. Steingrund, P. 2005. Faroe Plateau cod: prediction.

WD36. Gudmundsdottir, A. and Sigurdsson, T. 2005. Some of the assessments runs made during the NWWG 2005.

WD37. Reinert, R. 2005. GLM fitted cpue for Faroe Saithe.

Annex 3: Recommendation

The Group was repeatedly requested to provide information on stock identity of redfish. Since the Group does not have sufficient expertise to thoroughly review the scientific content of new information submitted on stock identification of redfish, the Group recommends to forward this information to the external Expert Groups holding the required expertise.

Annex 4: Technical Minutes

NWWG Review Group 1

May 23-25 2005, ICES Headquarters

Present:

RG Chair: Steve Cadrin
Reviewers: Frans van Beek, Tiit Raid
WG Chair: Einar Hjorleifsson
Others (part time): Mette Bertelsen, Poul Degnbol, Jesper Boje

General Comments

1) The RG compliments the WG and WG chair for their dedication and accomplishments.

2) The RG had several comments on the WG report that applied to multiple sections. Each stock assessment chapter had different format and organization and graphics, diagnostics and tables were not standardized, making technical review less efficient. Most stocks did not have a quality handbook. The RG understands that the WG is overloaded with work, but feels that the work associated with the initial development of a handbook would make the documentation of subsequent WG assessments much easier, and would avoid the many clarifications needed by the RG.

3) One technical theme in many of the assessment is the difficulty estimating maturity and size at age from either fishery or survey data. In some stocks the uncertainty in biological parameters was greater than in the estimation of abundance. This issue may require a coordinated effort of a group of species experts to develop a protocol for estimating maturity and weight at age.

4) The RG noted that information on management, enforcement and how ACFM advice is applied would help the technical review, formulation of advice and drafting of the ACFM report.

NWWG Introduction

1) The RG complimented the WG on a useful description of the ecosystems, particularly the description of the North Atlantic current, the recent rise in temperature and the associated changes in fish distributions. Such changes are important for productivity of fishery resources, effecting the capacity to rebuild to biomass reference points (potentially derived from productivity observed in different conditions) and imposing technical difficulties (changes in fishery and survey catchabilities, biological parameters, etc.).

2) The RG questioned if seal predation was increasing as in other areas of the North Atlantic.

3) On a related note, distribution of the Greenland cod resource, along the east and west coasts of Greenland raises a concern about the western boundary of the NWWG eco-region ‘A: Greenland and Iceland Seas’ (Figure 1). This boundary would exclude the historically productive cod resource west of Greenland (e.g., ~500kt of landings west of Greenland).

4) Some important stocks are missing from the ACFM report to effectively provide fishery-based advice.

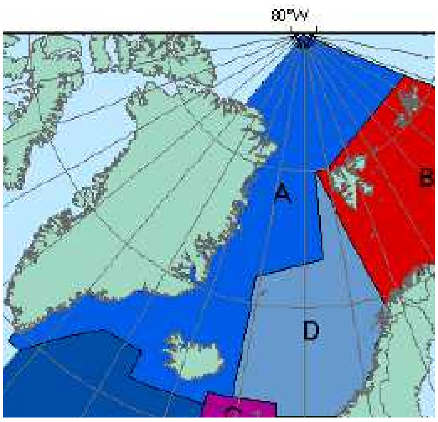


Figure 1. Boundaries of the Greenland and Iceland Seas ecoregion (A).

Icelandic Saithe

The RG accepted the updated CAMERA calibration and the associated estimates of abundance at age. The assumption of fixed exploitation pattern for 1985-2004 was questioned as an unrealistic assumption, but model residuals did not suggest a problem, and CAMERA results were very similar to those from ADAPT which only assumes selectivity of the oldest age. The RG also questioned why the autumn survey was not included in the calibration as an additional tuning series.

The RG did not accept the revised estimates of SSB that used survey-based mean weights and maturity data, and chose to use the same procedure as last year (SPALY). The RG felt that a better justification was needed to revise the methods. Surveys catch few old fish and can only be used to estimate time-averaged mean weights for the older ages. Furthermore, the mean weights of old fish are curiously heavier than those in the catch (Figure 2).

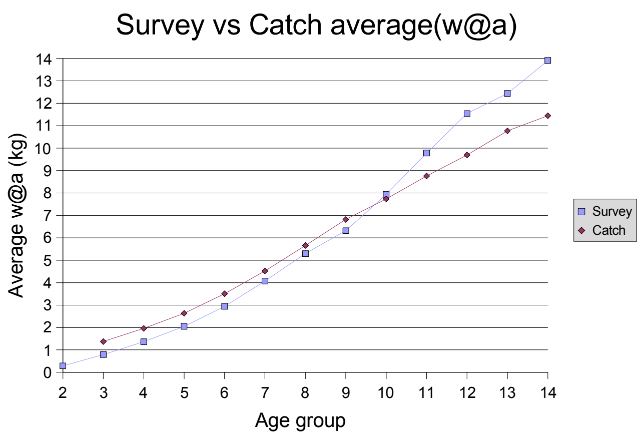


Figure 2. Weight at age of Icelandic saithe from survey and fishery samples.

Maturity predictions also had a severe residual problems, in which model predictions were less than observations for all ages in recent years. Poor estimation of weight and maturity at age added considerable uncertainty to estimates of SSB.

Unfortunately the SPALY calculations were not updated, and the WG chair had to reconstruct the 2004 assessment during the meeting of the reviewgroup, update estimates of SSB and revise projections.

In order to double check the input for the maturity at age that was the basis of the SSB estimates in the last years assessment (Referred to as 2004 assessment) a recalculation was performed, using population numbers at age in the 2004 assessment, catch-weight-at-age in the 2004 assessment, and modelled-maturity-at-age based on observed catch at age in the 2004 assessment (Figure 3). The WG chair verified that the reconstructed maturity at age is the same as used in the 2004 Assessment.

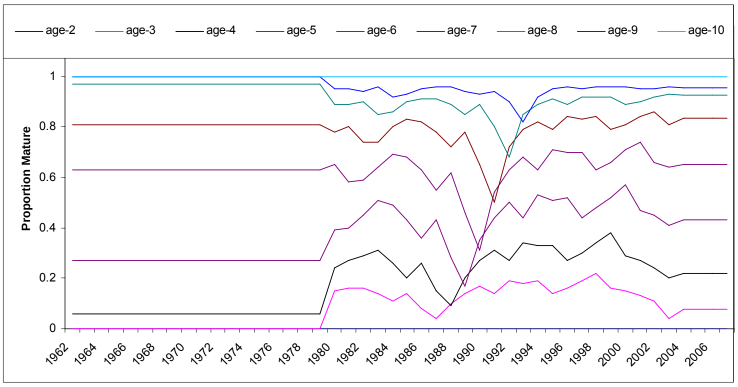


Figure 3. Maturity of Icelandic Saithe based on predictions from fishery samples.

In the absence of an updated modelled maturity at age in the catches the RG decided to use the average modelled maturity at age from the years 2002 and 2003 (Figure 3) as a basis for the input for maturity at age in the year 2004-2007. The reason that the 2004 value is not used is because it a predicted value, without any observation in that year. The calculated SSB indicates some change in the SSB from the 2004 and the 2005 assessment (Figure 4). The SSB in 2005 is greater than B_{pa}, is expected to increase in 2006 and will likely be greater than B_{pa} in 2007 if fished below F_{pa}.

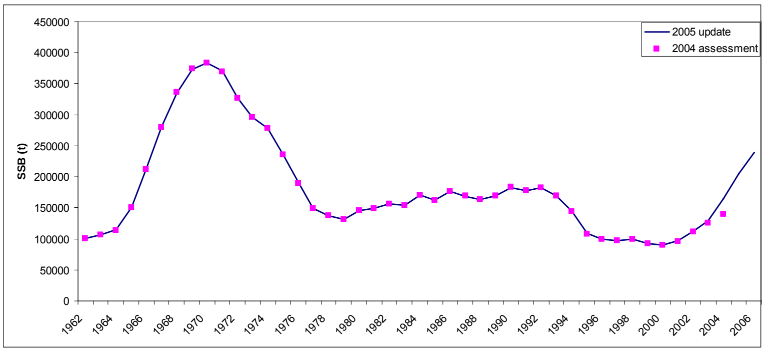


Figure 4. Estimated SSB for Icelandic Saithe.

The RG questioned why Floss was not considered as a candidate for F_{lim}, because B_{lim} is defined as B_{loss}. Quality control plots were provided by the WG chair (Figure 5).

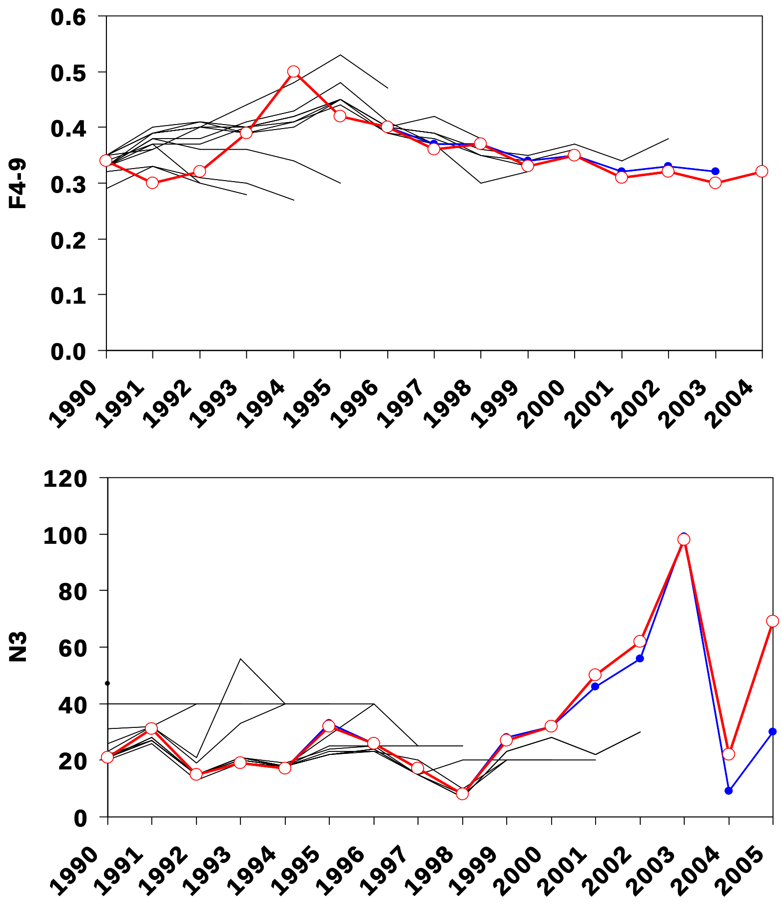


Figure 5. Quality control plots for Icelandic Saithe.

The revised projection (based on SPALY) is in Table 1.This table is not in the summary sheet. I think also it is wrong because Fpa is at 0.30 and here it is 0.15.

Table 1. Revised forecast for Icelandic Saithe, based on SPALY assessement.

Projection of stock and spawning stock biomass (thousand tonnes) in 2005-2007 for different management strategies.

2005				2006				2007				2008			
Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawning stock*	F	Afli *Catch*	Afli *Catch*	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*	F	Afli *Catch*	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*	F	Stofn 4+ *Stock 4+*	Hrygn-stofn *Spawn. stock*	Basis	Fmultiplier
343	205	0.319	75	0	381	228	0.000	0	447	307	0.000	508	384	Zero catch	0
				83	381	228	0.319	83	353	231	0.319	318	219	Fsq	1
				9	381	228	0.030	12	437	299	0.030	484	363	Fpa*0.1	0.094
				22	381	228	0.075	27	422	287	0.075	451	335	Fpa*0.25	0.234
			Fpa	42	381	228	0.150	49	399	268	0.150	403	292	Fpa*0.5	0.469
				61	381	228	0.225	67	378	251	0.225	362	257	Fpa*0.75	0.703
				71	381	228	0.269	75	366	241	0.269	340	238	Fpa*0.9	0.844
				78	381	228	0.299	80	358	235	0.299	326	226	Fpa	0.938
				85	381	228	0.329	85	351	229	0.329	314	215	Fpa*1.1	1.031
				94	381	228	0.374	91	340	220	0.374	296	200	Fpa*1.25	1.172

Icelandic Haddock

The RG considered the two alternative calibrations (using spring and fall surveys) as giving the same general perception of increasing SSB and the state of the stock (high SSB) is robust to calibration differences. The apparently abundant 2003 yearclass present problems for calibrations, because calibrations are extrapolating beyond the previously observed range of survey data. Both calibrations involve large positive residuals in recent years (i.e., both survey indicate greater abundance than the models). Unfortunately the status of the fishery is sensitive to calibration results, with the spring calibration indicating F<Fpa and the fall calibration indicating F>Fpa. Given the greater number of survey stations in haddock habitat, the spring calibration was chosen as the accepted assessment.

The RG feels that the model description was somewhat lacking (e.g., which survey ages were included in the calibrations? Was age-1 catch included in the model?, and requests a more detailed description in next year's report. The RG also suggests including both spring and fall surveys in the calibration to avoid two valid perceptions of stock status.

Although the spring-based calibration was the accepted assessment, the RG felt that some caution was needed in interpretation. Abundance and growth of the 2003 yearclass is not well estimated and different calibrations offer different results. For an alternative perspective on outlook, A forecast table was provided by the WG chair based on the fall-based calibration (Table 2). Based on the contribution of the 2003 yearclass to the forecasted yield associated with Fpa in 2006 (30,000 t) and the forecast based on the fall calibration, the RG proposed advice for 2006 a 110 000t TAC.

Steve, I thought this was not what we had done. You cannot accept the spring callibration and base the prediction on the autumn callibration. We took the unusual arbitrarliy decision to substact 30 000 tonnes from the prediction (these were expected to be relative small fish from the strong yc) which whould otherwise possibly highgraded and because larger fish instead would be landed fishing mortality would increase to above Fpa

Table 2. Forecast for Icelandic haddock based on the fall survey calibration.

	2006			2007			2008		
Tac	SSB	B3+	F4-7	SSB	F4-7	bio307	SSB	bio308	F
90	174	280	0.424	226	0.334	316	255	316	0.292
95	174	280	0.452	222	0.363	311	247	307	0.324
100	174	280	0.481	218	0.393	307	239	298	0.358
105	174	280	0.511	215	0.425	303	231	289	0.396
110	174	280	0.542	211	0.46	298	224	280	0.438
115	174	280	0.573	207	0.496	294	216	271	0.485
120	174	280	0.605	204	0.535	290	208	262	0.538
125	174	280	0.638	200	0.576	285	200	252	0.598
130	174	280	0.671	196	0.62	281	192	243	0.666
135	174	280	0.706	193	0.667	277	184	234	0.743
140	174	280	0.741	189	0.717	272	176	225	0.834

Quality control plots were provided by the WG chair (Figure 6).

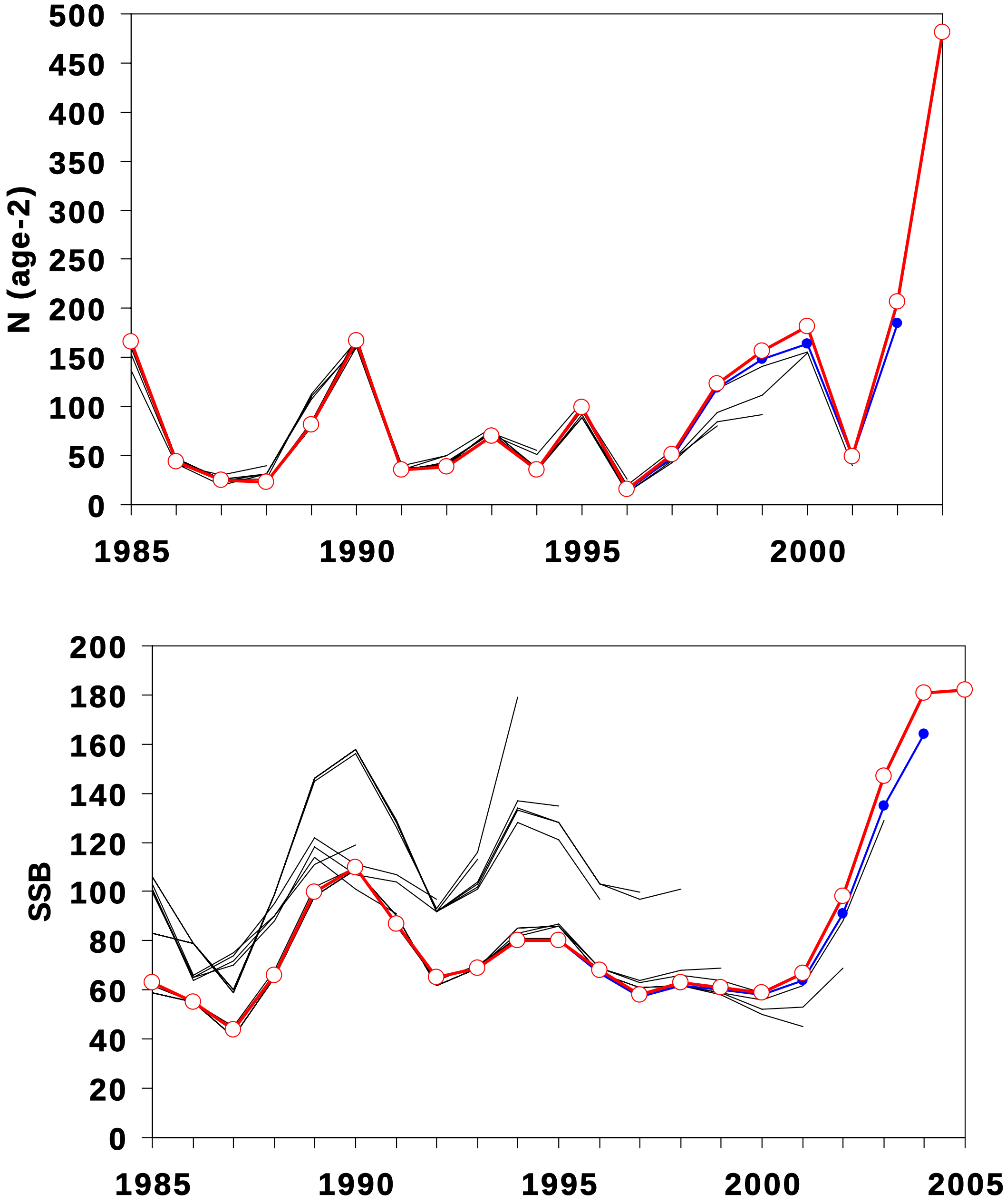


Figure 6. Quality control plots for Icelandic Haddock.

Icelandic Cod

Data:

1) The RG noted the need to evaluate discards.

2) The RG noted that episodic immigrations is included in the model (e.g., 1984 year class at age-6) based on anomalies in the catch at age and weight at age indicating immigration from Greenland.

3) Given the above-average 2003 year class in Greenland, the WG should consider such immigrations in the near future.

4) The relative absence of capelin in the system was considered in discussions of declining weight and maturity at age and the difficulty estimating weight at age in the absence of a capelin biomass estimate.

Model:

1) The RG appreciated the summary of ADCAM model input and settings in the WG report. One detail that was questioned was the starting age-structure assumption (i.e., for 1955).

2) The observed movements between Greenland and Icelandic cod were discussed by the RG. The RG recommended an exploratory joint analysis of the two resources, including movement between areas and dynamics within areas.

Assessment:

1) The RG noted the need for biomass reference points to help evaluate stock status. The RG encouraged the stock-recruit analyses and the application of medium term projections to evaluate the probability of rebuilding to B_{MSY}. Unfortunately, B_{MSY} has little meaning in the management system for Icelandic cod (and in the ICES system in general). Evaluation of B_{MSY} should be further developed and considered by ICES as a rebuilding target.

2) The RG discussed the performance of the harvest control rule and the need for ICES to re-evaluate its effectiveness with respect to conformance to the precautionary approach. The relatively large F's produced by the management system since 1995 (0.51-0.77) as compared to those expected by simulations of the harvest control rule (0.4) probably result from assessment inaccuracies, and implementation problems. ICES's evaluation of the harvest control rule was based on simulations that lacked assessment and implementation error, and was therefore overly optimistic. Given that the control rule produces F's that consistently exceed Fmax and often exceed Fmed, it should be re-evaluated with respect to precautionary limits. Alternative control rules (e.g., the proposal for 22% exploitation rate of current exploitable biomass) should also be considered.

3) Quality control plots were provided by the WG chair (Figure 7).

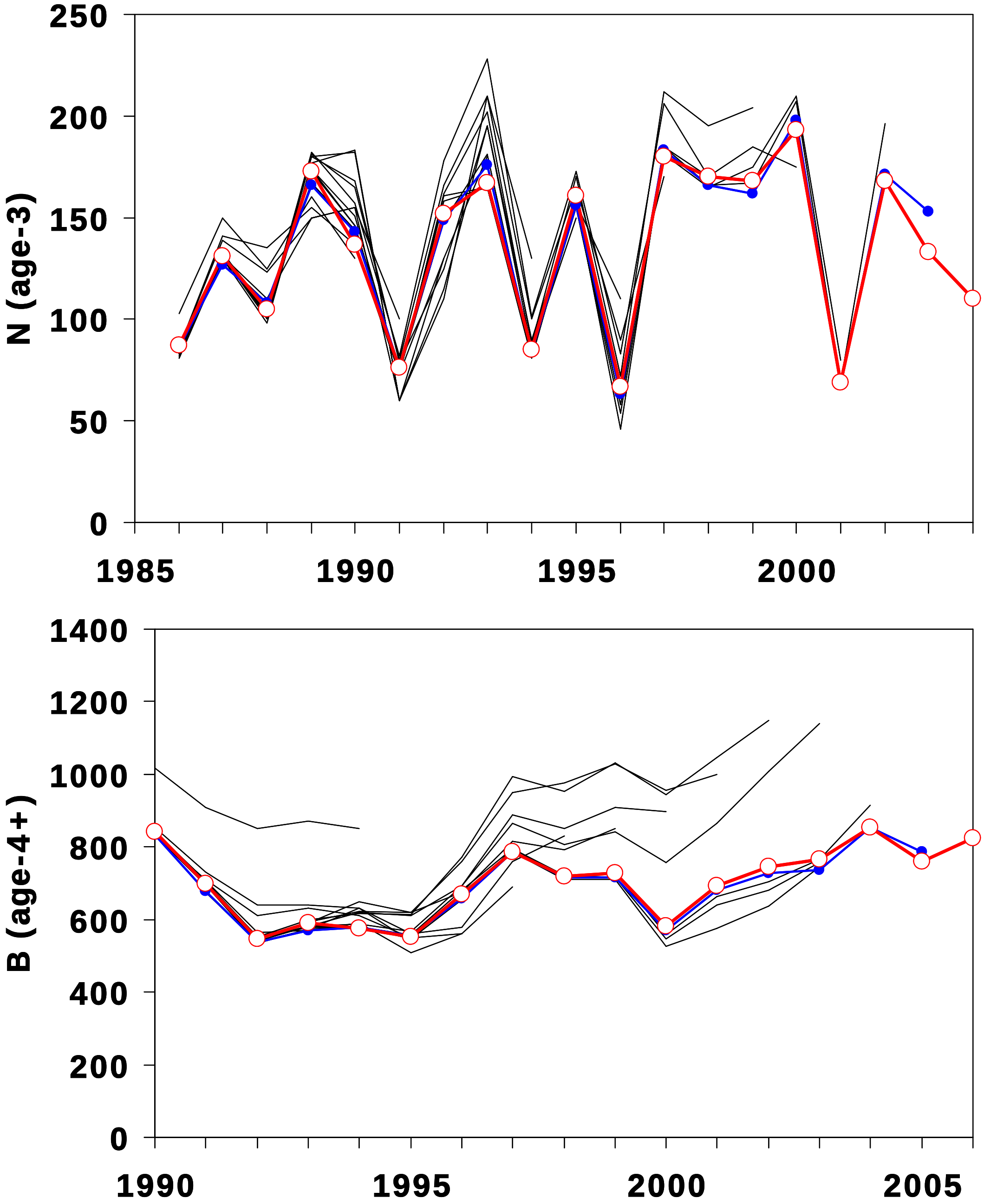


Figure 7. Quality control plots for Icelandic Cod.

Greenland Cod

Data:

1) The RG requested information on seal predation, particularly to determine if seal abundance is increasing as in other areas of the North Atlantic.

2) The RG questioned the perception of strong recruitment of the 2003 yearclass in eastern and western areas. Survey data suggested biomass was greater in the east (NWWG Figures 5.1.2 and 5.1.3), but abundance was greater in the west (NWWG Tables 5.1.5-5.1.6). Feedback from the WG through the WG chair indicated that eastern area had larger fish and confirmed that abundance of the 2003 yearclass was greater in the western area. The RG suggests and investigation of the environmental conditions associated with the production of this yearclass.

Model: The RG complimented the WG on its creative use of the historical assessment to scale the survey, but had some minor questions and recommended caution in interpreting the results too precisely. The RG questioned the simple regression relationship for age-2 abundance, but log-log relationships for older ages.

The observed movements between Greenland and Icelandic cod were discussed by the RG. The RG recommended an exploratory joint analysis of the two resources, including movement between areas and dynamics within areas.

Assessment: The expected increase in SSB from recruitment of the 2003 yearclass demonstrates the critical need for biomass reference points. For example the 2004 ACFM advice was for no fishery until SSB substantially increases. Although SSB is expected to increase tenfold in the medium term (assuming no fishing), the increase will only be temporary and not close to historic levels. If the fishery remains restricted, and the 2003 yearclass can survive to produce subsequent strong yearclasses the stock may truly recover.

Greenland Halibut

Data:

1) The RG noted that information on life history and stock structure is needed. For example results from recent and historical tagging experiments would be a valuable addition to the WG report. The RG noted the continuous distribution of halibut across statistical area boundaries between east Greenland (XIVb) and Icelandic waters (Va). However, the Faeroe resources and fishery are distinctly different than those in Va. Did we conclude this? Why give that advice for boths separately

2) The RG viewed the stable size distribution as unusual, but not 'incredible,' and noted that size distribution may be a misleading indicator of mortality if there is emigration to deeper habitats by larger fish.

3) The RG noted the qualification of the Faroese survey by the WG, and removed it from ACFM report because of its limited coverage of the Greenland halibut resource.

Model: The RG discussed the possibility of reviving an age-structure assessment model. The WG chair reported that the historical XSA was rejected because fishery-independent tuning was not available. Now that a survey is available, archived samples can be aged. However, ageing of Greenland halibut is difficult, and age determination methods should be evaluated.

Assessment:

1) The WG chair reported that there was some concern about the 2004 ACFM advice, which was based solely on CPUE in area Va, because those data do not represent the fishery or the resource in other areas.

2) The RG questioned the approach of basing stock status on CPUE when a survey is available. The CPUE offers a longer, but possibly biased, perspective.

3) The RG noted that the area XIV CPUE is heterogeneous among national fleets and should not be used to determine stock status because of advances in fishing technology. The RG agreed to base stock status on surveys in Va and XIV, confirming trends with CPUE where possible, noting that there may be geographic patterns in abundance that are not indicated by the surveys.

Redfish Overview

1) The combined Icelandic TAC for *Sebastes marinus* and *S. mentella* was discussed as an unnecessary impediment to effective management. The RG felt that it was ironic to spend so much time and resources on determining the status of *S. mentella* oceanic and deep-sea components, when 2 clearly identified species with different fisheries are not being managed separately. Managing redfish species separately is clearly more important than managing fishery components separately.

2) The RG disagreed with the practice on including catches of *S. mentella* by pelagic gear in the demersal *S. mentella* assessment merely because the catch was taken inside the 'redfish line.' The excellent portrayal of spatial patterns of *S. mentella* fishery catches illustrates that the redfish line is ineffective for discriminating pelagic from demersal catches (NWWG Figures 10.1.5 and 10.1.6; simplified by the RG in Figure 8). The portrayal plots locations of 'oceanic,' 'deep-sea' and demersal fisheries in a cross-sectional plane extending from south of Greenland northeast to the Icelandic slope, with the relevant Icelandic EEZ boundary as well as the NAFO-ICES boundary. The 2004 fishery had the more typical pattern of separate deep-sea and demersal fisheries. However, the deep-sea fishery occasionally moves further northeast, as shown for the 2003 fisheries. Some 'demersal' *S. mentella* caught with pelagic trawls, because it is N of the redfish line. Although ACFM decided that stock structure information was inadequate to revise the approach to *S. mentella* management (2 management units: pelagic and demersal), catches (as well as effort and CPUE) from pelagic trawls should be included in the pelagic assessment.

The WG chair felt that the issue is more complex and after the RG meeting provided further elaboration:

Figure 8 illustrates how the fisheries of the two management units have been coming closer in recent years. The overlap was more pronounced in 2003 than ever before, where the pelagic fishery, made up entirely of Icelandic boats completely overlapped the demersal fishery. In response to the 2003 fishery, the Icelandic authorities moved the redfish line eastward in that year, effectively making sure that the pelagic catches would be reported as pelagic, not as demersal. In that year 2000 t of pelagic catch was reported in the demersal management unit. The increase in the demersal catch in 2003 (10 000 thousand tonnes) is thus largely due to demersal gear, and not primarily form including some pelagic catch. If the redfish line would not have been moved eastward that year, the catches attributed to each component would be different.

The Icelandic expert on S.mentella fisheries reports that the pattern observed in 2003 is atypical, and pelagic catches attributed to the demersal management unit are usually distinct from the proper pelagic fisheries. The redfish line is only to the west of Iceland, the demersal fisheries also occur along the south and the southeast continental slope of Iceland. Some of the pelagic catch that is reported in the demersal management unit occurred in south and the southeastern areas, nowhere near the conventional pelagic fisheries in the Irminger sea. The pelagic gear catch that is reported in the demersal management unit occurs more or less above the conventional demersal fisheries. Fishermen predominantly deploy the pelagic gear at night, but during daytime they use demersal gear in similar areas. There is a strong diurnal behaviour in S.marinus, where higher catches are reported at night than in daytime in the bottom trawl deployed in the spring survey. Similar anslyses should be applied toS.mentella. Fishermen claim that they are following diurnal behaviour. Furhtermore, this pelagic fishery that is reported as catch in the demersal management unit occurred predominantly in the fall, i.e. in a different fishing season from the pelagic S.mentella fishery. Therefore, the WG chair concludes that it would be very premature to attribute all pelagic catches in the pelagic management unit.

1) The RG encourages the portrayal of *S. mentella* catches as in (NWWG Figures 10.1.5 and 10.1.6; simplified by the RG in Figure 8) and request that historical catches and survey catches be similarly plotted to investigate changes in spatial patterns of the fishery and possible relationships between oceanic and deep-sea fisheries.
2) The section on IUU catches in the redfish overview is specifically for pelagic redfish – not redfish in general, and should be moved to the pelagic redfish chapter.
3) The RG suggests that the reason redfish species cannot be discriminated for small fish (<17cm) should be explained.
4) The RG requests more information on *S. viviparous*, particularly to explain the huge decrease in landings.
5) The RG felt that multispecies catch tables are not relevant to management of redfish resources and should be removed from the redfish introduction.
6) The WG chair recommended that a NWWG sub chair or co-chair is needed to coordinate redfish tasks in the WG.

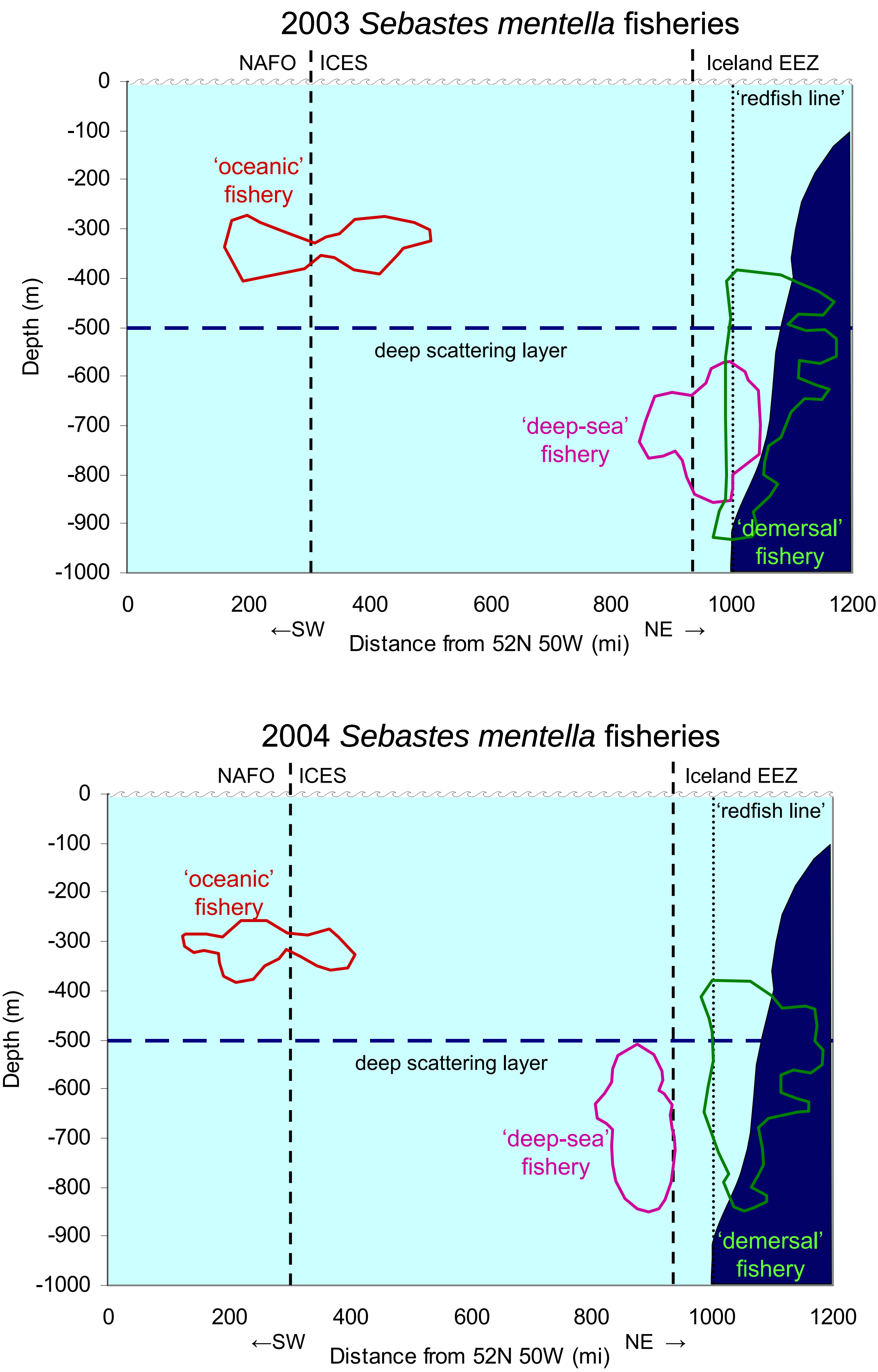


Figure 8. Cross-sectional portrayal of *Sebastes mentella* fisheries in 2003 and 2004 (polygons represent locations of fishery catches; data from NWWG 2005 Report).

Sebastes marinus

1. The catch at age indicates only two strong year classes (1985 and 1990), but the BORMICOM model indicates three strong cohorts (1985, 1990 and 1991). The RG discussed the possibility that this results from the length-based process misinterpreting much catch at length as from the 1991 year class rather than the 1990 year class (possibly resulting from slower growth of that abundant year class). The RG recommends a more conventional age-based assessment of catch at age directly calibrated with both surveys.
2. The RG also had several recommendations to modify the BORMICON model:
   a. allow for multiple surveys.
   b. including all catch (not just Icelandic catch)
   c. calculate SSB
3. The combined Icelandic TAC for *Sebastes marinus* and *S. mentella* was discussed as an unnecessary impediment to effective management. Managing redfish species separately is clearly more important than managing fishery components separately.

Demersal S. mentella

Data:

1) The RG disagrees with the practice on including catches of S. mentella by pelagic gear in the demersal S. mentella assessment merely because the catch was taken inside the 'redfish line.' Although ACFM decided that stock structure information was inadequate to revise the approach to S. mentella management (2 management units: pelagic and demersal), catches (as well as effort and CPUE) from pelagic trawls should be included in the pelagic assessment. A more detailed description of the discussion is in the redfish overview section, above.

2) The RG requested more information on age structure, maturation and growth.

3) The RG noted that the Faroese survey does not sample deep enough to offer a reliable perspective on stock biomass.

Assessment:

1) The RG commented that U_{lim} and U_{pa} should be deleted from CPUE figures, because their basis was rejected by ACFM in 2004.

2) The RG confirmed that commercial CPUE should not be used as an index of abundance, and a survey-based assessment is better than CPUE-based assessment.

3) The combined Icelandic TAC for *Sebastes marinus* and *S. mentella* was discussed as an unnecessary impediment to effective management. Managing redfish species separately is clearly more important than managing fishery components separately.

Pelagic S. mentella

Data:

1) The RG disagrees with the practice on including catches of S. mentella by pelagic gear in the demersal S. mentella assessment merely because the catch was taken inside the 'redfish line.' Although ACFM decided that stock structure information was inadequate to revise the approach to S. mentella management (2 management units: pelagic and demersal), catches (as well as effort and CPUE) from pelagic trawls should be included in the pelagic assessment. A more detailed description of the discussion is in the redfish overview section, above.

2) The RG encourages the portrayal of *S. mentella* catches as in (NWWG Figures 10.1.5 and 10.1.6; simplified by the RG in Figure 8) and request that historical catches and survey catches be similarly plotted to investigate changes in spatial patterns of the fishery and possible relationships between oceanic and deep-sea fisheries.

3) The RG noted that the relationship between acoustic and trawl is poor, and requests that more information on the relationship is needed to help interpret biomass estimates for the deep component.

4) The RG also requests more details on the GLM used to standardize CPUE (e.g., is size of gear standardized?). The RG feels that misallocated catches because of different TACs for oceanic and deep-sea may affect the CPUE.

5) The basis of discard estimates should be described.

6) The size structure shown in the WG report is remarkably stable, but size structure by depth may be more revealing.

7) The section on IUU catches in the redfish overview is specifically for pelagic redfish – not redfish in general, and should be moved to the pelagic redfish chapter.

8) On a related note, the observation that effort could be 25% greater than reported, based on satellite imaging, should be evaluated, particularly in interpretations of CPUE.

Assessment:

1) The RG agreed that the actual decrease in stock biomass may have been greater than indicated from the survey, because of the increasing area covered over the survey time series (NWWG Table 10.2.1)

2) The RG agreed that the assessment will most likely be based on the 2005 acoustic-trawl survey, and agreed to meet by correspondence in August to review results of the survey, conclude on stock status and draft advice for 2006. The SG for the redfish survey will met in late July.

3) The RG requests that NWWG Table 10.2.1 be updated. The RG agreed that unless 2005 survey biomass increases substantially (e.g., 1000kt of biomass in <500m waters), draft advice will be the same as last year: “there should be no directed trawl fishery on this stock and the area closures and low by-catch limits should be retained, until a significant increase in the spawning stock biomass (and a subsequent increase in the number of juveniles) has been detected in surveys.”

Special Request on providing information on stock structure and spatial allocation of catches

1) The RG concluded that information from the three WDs on stock structure referenced in the NWWG report should be reviewed as a part of a comprehensive, multidisciplinary evaluation. The RG noted that the NWWG and associated RGs cannot effectively perform such a comprehensive evaluation.

2) The RG agreed that we do not have the required information to provide advice on spatial allocations to avoid disproportionate exploitation and local depletion. In order to be able to do this, ACFM would need information on seasonal distribution of the resource and movements among areas.

Annex 5: TECHNICAL MINUTES

Review of Report of North Western Working Group

Review Group II - NWWG

Copenhagen, ICES, 19-20 May, 2005

Participants

Review-group Chair: Fátima Cardador (Portugal)
Working Group Chair: Einar Hjörleifsson
Evgeny Shamray (Russia)
Bengt Sjostrand (Sweden)

General Remarks

This Review group was in charge of revising the following stocks:

Faroe stocks:

Faroe Plateau Cod	Observation
Faroe Bank Cod	Experimental
Faroe Haddock	Update
Faroe Saithe	Benchmark

Iceland stocks:

Herring	Benchmark
Capelin	Update

The Review Group spent some time in updating the summary sheets because the Working Group had no time to do it.

The Working Group had used variable approaches when choosing exploitation pattern and the mean weights for the Yield, SSB/recruit calculations.

The WG chair pointed out that he could not give the group any guidelines since the objectives for these calculations have not been clarified by ACFM. If ACFM would specify the objectives of long term yield estimates it would facilitate the choice of proper input values.

The value of natural mortality should be mentioned also in the text and not only in the input data tables for predictions;

The sampling intensity should be provided in quantitative terms, and tabulated by year including the amount sampled per 1000 tonnes landed.

The Overview for Demersal Stocks in Faroe Area, section 2.1.6 (Medium term projections and reference points) is difficult to read because the stocks are grouped, it would be desirable to have subsections by stock.

Faroe Cod Plateau – stock in observation

The WG should present the effects of changing the XSA option from power model to no power model in the present assessment.

The maturity data is obtained from spring surveys since 1983, but the abundance indices start in 1993, why?

When constructing the ALK for the surveys, fish of length 15-34 cm has been regarded as 1 year olds. An evaluation of the overlap in length distribution between 1 and 2 year olds would be beneficial.

Evaluate the likelihood of high grading and the degree of the fishers ability to target different species in connection with the price differences between species.

Mean weight – since the quality handbook is not available yet it would be valuable to have information available of the fit with the model referred to in the report.

The reference fishing mortality is based on a simple average of age group 3 to 7. In some years the fishing mortality of a particular age group may be unduly high and may more reflect sampling error rather than fishing mortality rates. Using a different basis for calculating reference F gives a different indication of the exploitation of this stock. However, this would require a re-evaluation of the F reference points.

The WG is encouraged to continue their analyses of the influence of environmental factors on stock parameters. It may help to explain some of the cyclical variations in recruitment.

Faroe Bank Cod – experimental assessment

The WG provides information about lengths, modes and correlates it with age groups: validation with age readings are required

The WG should clarify what regulative measures that are in force for this stock.

The WG should clarify what is the basis for the assumption that British catches reported as to be taken on the Faroe Bank are assumed to be taken in the Faroe Plateau;

The estimates of the landings should be explained in a more detailed way;

Description of the basis for stock definition of Faroe Bank should be provided in the report (or in the Quality Handbook);

An overview of the sampling intensity through time from commercial and survey data should be presented.

Improvement in the sampling is recommended in order to provide improved assessment.

Faroe Haddock – updated assessment

The WG is asked to critically evaluate what plus group would be most appropriate for this highly variable stock.

In the page 73, section 2.4.7.3.1 is referred a new management system but this refers to 1996 system which is not new.

Figure 2.4.5.B – It is not clear what were the objectives of these results, the WG are invited to explain it;

In Page 104, Figure 2.4.6. are not shown the labels of the corresponding ages;

The Figures 2.4.13 to 2.4.15 with the relationship between survey indices at age and the indices of the same Year Class (YC) one year later, are very helpful and the RG recommends that such figures be include in all the stocks.

The cohort method to predict the mean weight at age should be shown in the report until the annex for this stock is not available;

Recruitment in the predictions: the reason for the choice of the time span for the GM (1980-2005) is not mentioned;

The contributions of the recruitment in the catch in 2006 and SSB in 2007 are important to be shown as it was done for saithe.

The WG should explore the sensitivity to fishing mortality estimates, average, weighted, excluding year classes, etc in the predictions.

The Figure of the residual q plots 2.4.9, page 106, is wrong. In spring survey the age range is 0-6 but the plots indicate ages 2-8.

The value of Fmed shown in Table 2.4.17 (0.3091) is different of the value in Table 2.4.18 (0.299), why?

The RG recommend presenting a map with the fishery distribution.

Faroe Saithe – benchmark assessment

The standardization of the CPUE for the Pair trawlers was carried out using a GLM method, and taking into account the factors season, trawler type, statistical square and year.

Since it is the first time this model is used by the WG, it should be appropriate that the WG provide more explanation about it, model fit and the outcome in the text, specially if the working document was not available to the reviewers; the RG could read the WD during the meeting and it states that the length of the tow is weighted which is not mentioned in the report;

Figure 2.5.3.2 – the weight at age 3 is plotted against the catchability at age 3. There is no explanation of how q was calculated and the intention of presenting this graph. In the discussion by the RG the issue was raised that q may change as a results of changes of weight at age given the high variability in the weight at age for the saithe. The WG should comment qualitatively on the effect of this in the assessment;

Maturity input data: the WG should provide the basis for the fixed maturity at age data during 1961-1982;

Mean weight at age predictions: the values 2006 and 2007 are assumed to be equal to 2005 value. In the Faroe haddock the predicted values for 2006-2007 were based on the prediction of 2005. The WG is invited to investigate this procedure in the saithe.

The method applied to predict weight at age is not transparent and the justification to use year class strength and not the average is not obvious.

The GM 1977-2001 as the input of the Recruitment for predictions is not justified.

F 2004 is misprinted in page 125, instead of 0.34 should be 0.4351 and in page 126 instead of 0.335 should be 0.4351.

The WG has proposed a Bpa of 60000 t but in the text this is not clear. This question is reflected in section 2.5.6.3, first sentence and in section 2.5.7.

Figure 2.5.5.6, page 166, it is not clear which is the ADAPT run.

The report of this stock must be revised carefully, some figures were not correct, some graphs need to be updated. It is not evident how the revised conversion factor from gutted weight to live weight was applied.

The RG consider very useful that the WG show in the report a map with the fisheries distributions, with the location of the fishery by quarter.

The present estimates of fishing mortality in 2003 is 13% higher than estimated last year. SSB for 2004 is 36% lower than estimated in last year's assessment. This decline in SSB estimates is largely attributed to observation of maturity at age and weight at age being lower than predicted last year.

Faroe Stocks

Medium term projections

For Faroe Plateau Cod, Haddock and Saithe, the RG has considered necessary to evaluate the sensitivity of the results to other stock recruitment relationship like Beverton & Holt, hockey stick function or non-random recruitment. These analyses should focus on different target F in relation to Blim.

Biological reference points:

Plateau Cod:

Blim is set as 21 000 t, consistent with the segmented regression analysis done by SGPRP 2003. The corresponding Flim would be 1.44. The WG purpose to set Flim at 1.4.

Haddock:

The WG purpose a new Blim based on the B* or Bloss segmented regression. The value purposed is 23 000 t.

The RG agreed with the Blim value purposed of 23 000 t.

The WG purpose to set an arbitrary value of 1.4 for Flim.

The Blim ICES value was 40 000 t and Bpa is 55 000 t.

Saithe:

The WG purposed the value of Blim of 60000 t as the value of Bpa based on the SGPRP 2003. It argues that SSB and recruitment pairs are of the inverse form where recruitment increases as SSB decreases.

The SGPRP2003 states that:

in the case where the R-SSB relation is inverse, it may therefore be difficult to decide whether $\boldsymbol{B}_{loss}$ *should be* $\boldsymbol{B}_{lim}$ *or* $\boldsymbol{B}_{pa}$*. The rationale adopted in each case should therefore be specified individually.*

The RG did not support the argument that Bloss equal to Bpa.

Icelandic Herring- benchmark assessment

During the review group meeting a correction was given on the catch in the last fishing season 2004/05. The analysis in the WG report was based on catches being 125716 t. The correct catch is however 114 237 t. No reassessment was provided to the review group.

The updated catch at age model was not considered to be reliable because of inconsistencies in the catch and survey data. The RG did not accept the analytical assessment.

In general very little is provided on the methodology used to calculate the input data for the assessment. For example, concerning the acoustic surveys no description or references are given. In section 3.5.5.1 no reference is shown for the Shepherd-Nicholson model.

A description on the port sampling and the methodology used to estimate the catch of Norwegian spring spawning herring should be provided.

Section 3.5.2 – quantify the information on the area closures.

Table 3.5.6.3 – Usually the output VPA is without SOP corrections, why SOP correction was used?

The input data in the prediction table 3.5.7.1 are not corrected per instance the maturity at age, the population at age 3 in 2005 did not taken into account natural mortality and the estimates of selection pattern is not in accordance with the description in the text.

A clarification is needed to which part of the calendar year the stock numbers estimates refer to.

The WG has to provide information on the sampling intensity of the commercial fishery

Icelandic Capelin - updated assessment

A map of the fishery distribution will be valuable.

Some minor corrections must be done in the text concerning the years for particular surveys.

For the TACs predictions there is no description on the methodology used.

It is not clear in the text that the actual acoustic estimates are used as absolute biomass estimates. Therefore the information on target strength and its origin should be quoted.